



SECOND EDITION

# The Physiotherapist's POCKETBOOK

ESSENTIAL FACTS AT YOUR FINGERTIPS



KAREN KENYON • JONATHAN KENYON

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# **The Physiotherapist's Pocket Book**

To Jack and Eva  
For being so wonderful and sleeping when it  
really mattered

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# The Physiotherapist's Pocket Book

## ESSENTIAL FACTS AT YOUR FINGERTIPS

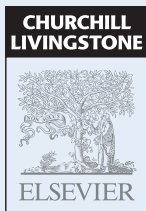
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# Preface

This edition of *The Physiotherapist's Pocket Book* was written with all physiotherapists in mind. We were overwhelmed by the favourable response to the first edition and, thanks to all the invaluable feedback we have had from colleagues, students and academics, have endeavoured to make this edition as comprehensive and as useful as possible to all clinicians.

We have tried to ensure that the contents reflect the dynamic and ever-changing profession we work in. We felt that the book could be expanded without compromising its portability and so have included more definitions of common pathologies, drugs, musculoskeletal special tests and assessment tools, as well as additional anatomical illustrations. The content has also been reorganized and new sections have been created to make it easier to find the relevant information.

We hope that this book continues to fulfil its main purpose – to provide quick and easy access to essential clinical information during everyday practice.

**Karen and Jonathan Kenyon**

*East Sussex, 2009*

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# Acknowledgements

Once again we are indebted to all our colleagues, friends and students for the feedback, advice and encouragement they have offered over the past few years. If we could name them all this would definitely not be a pocket-sized book. Hopefully, they know who they are and appreciate how grateful we are for all their help.

We would like to say a special thanks to the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) for working so hard to meet our deadline, Janet Deane for her contribution to the pathology section and Domenico Spina for reviewing the pharmacology section. We would also like to give our heartfelt thanks to the team at Elsevier – Rita, Veronika, Siobhan and Heidi – for all their support and understanding.

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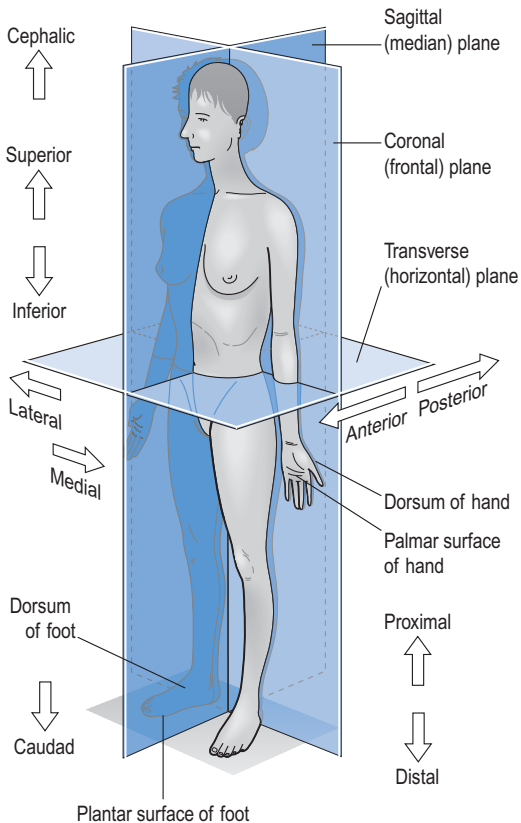
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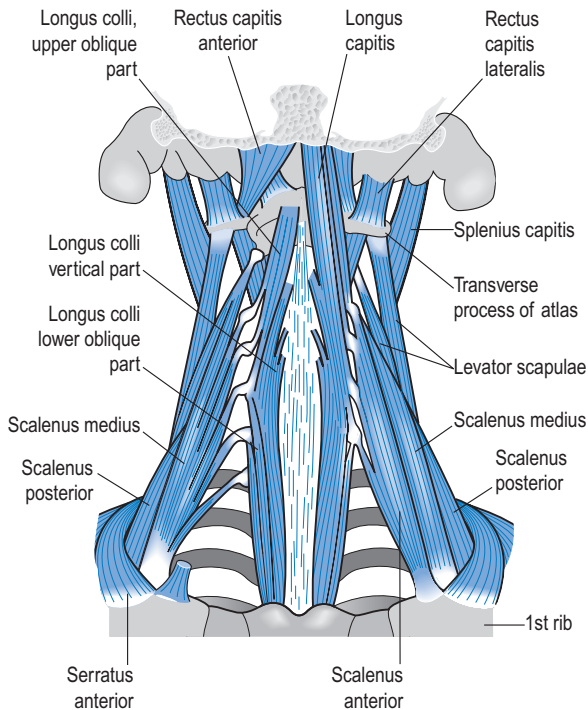
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## Musculoskeletal anatomy illustrations

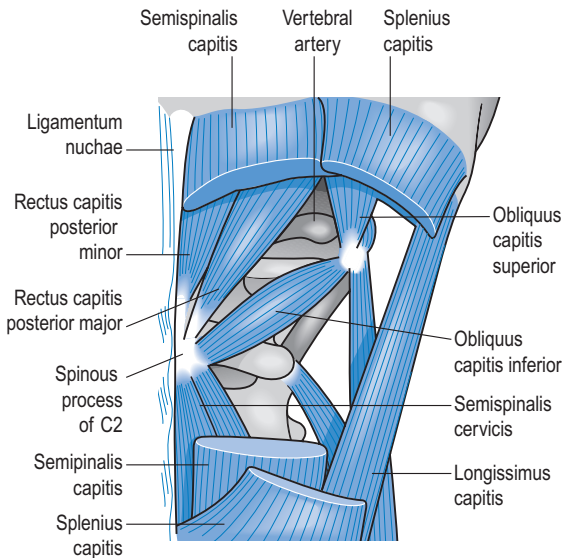


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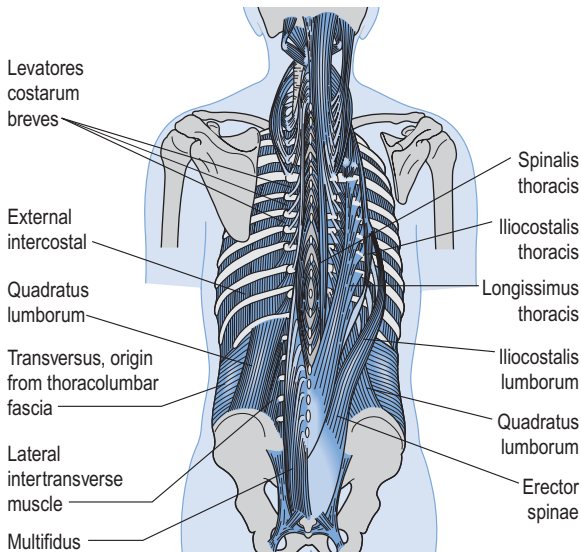


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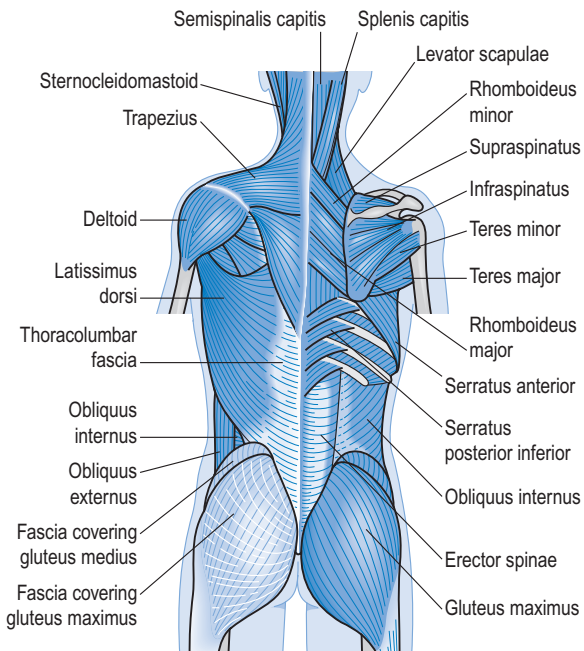




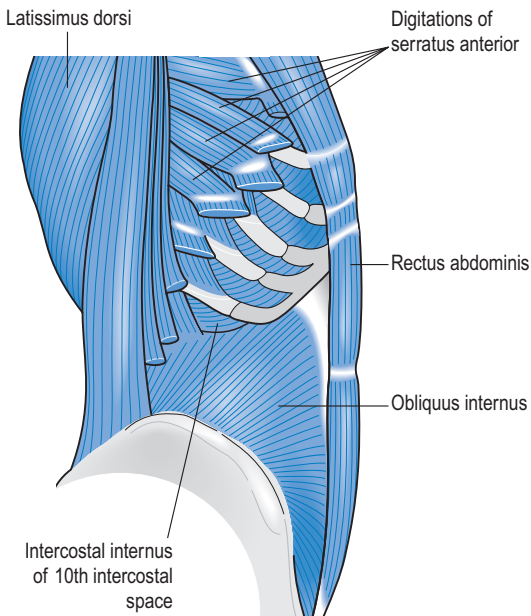
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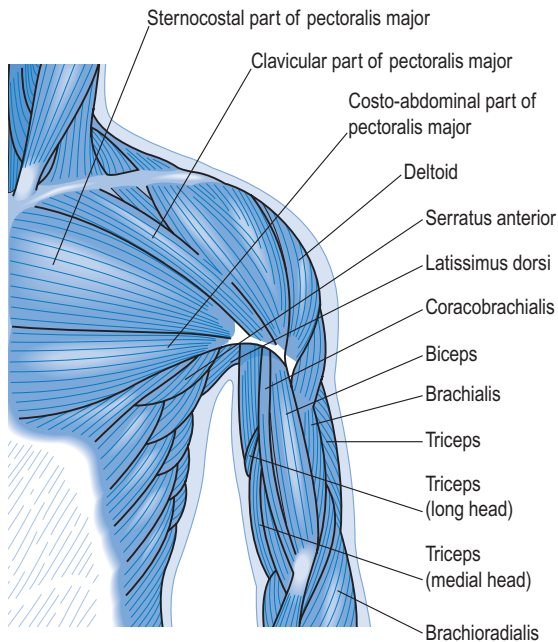
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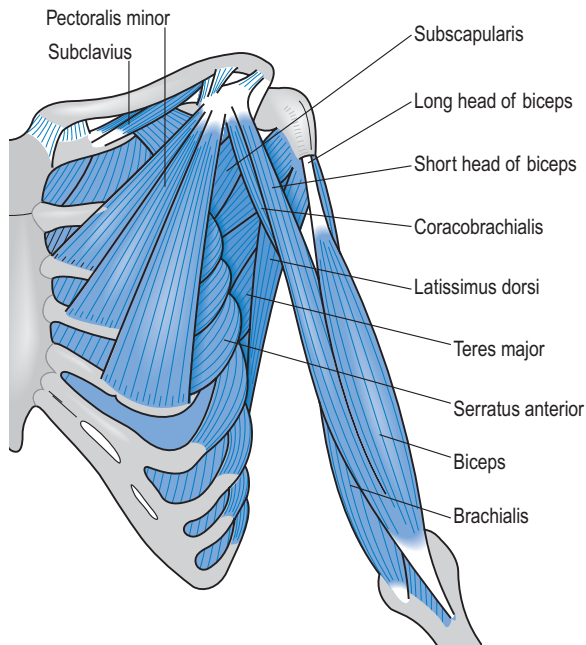
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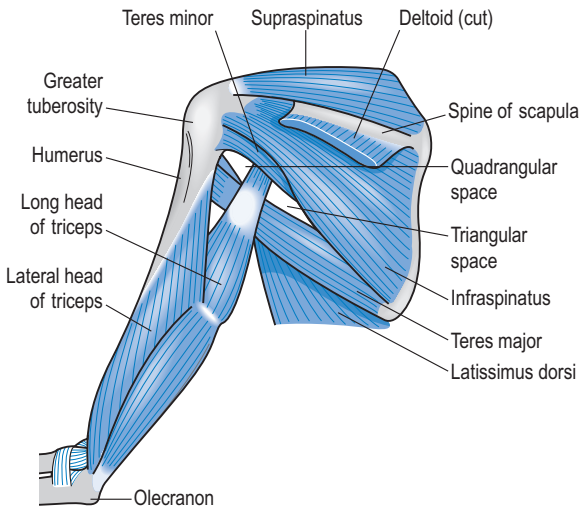
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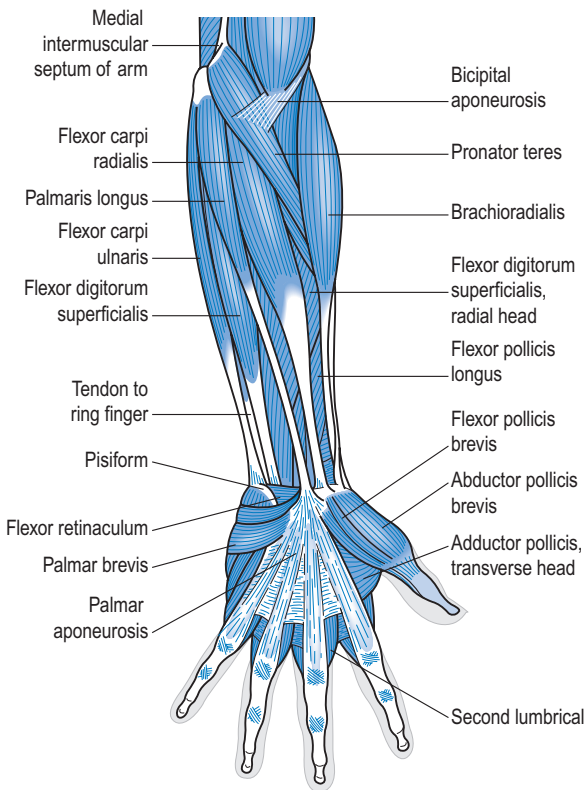
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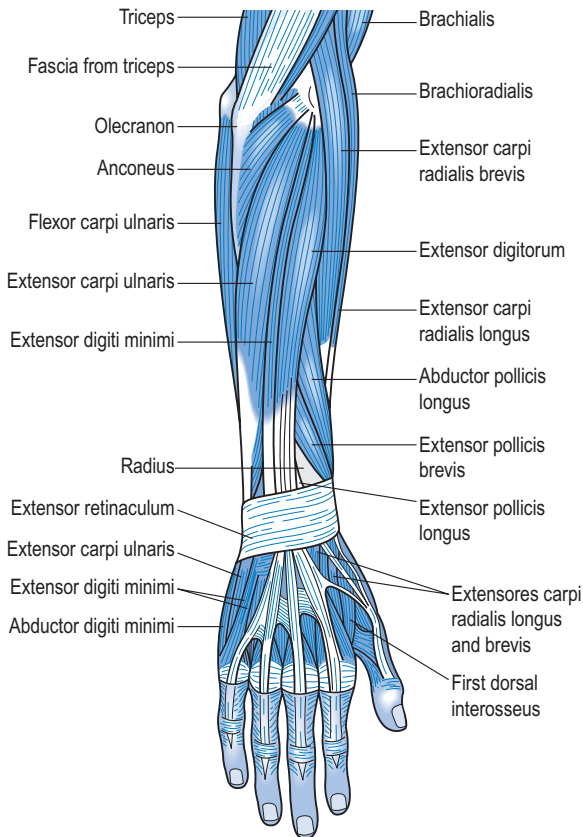


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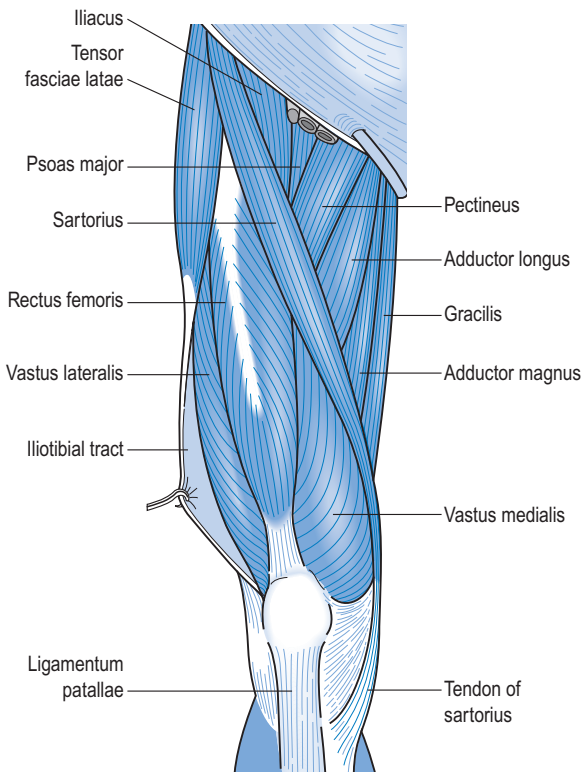


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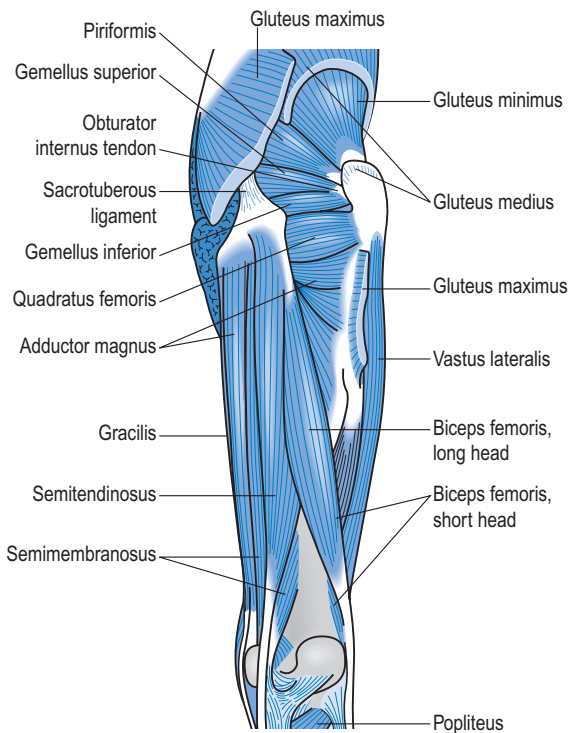




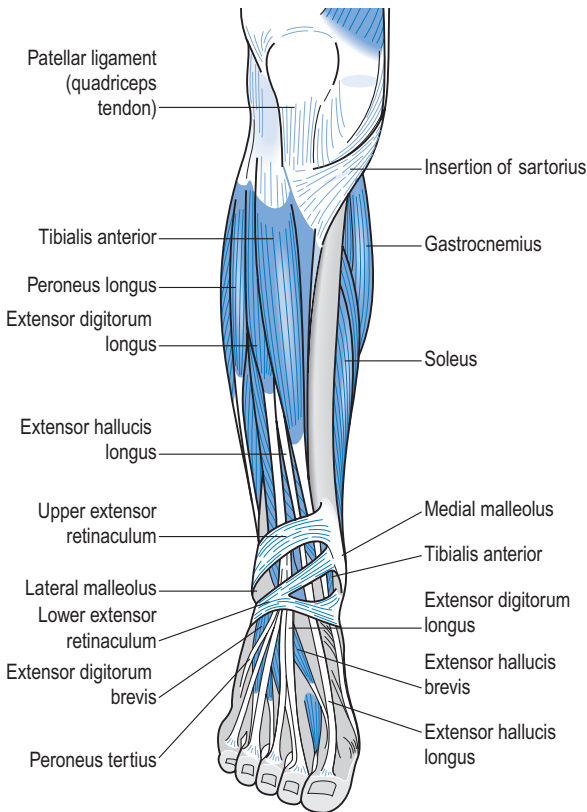
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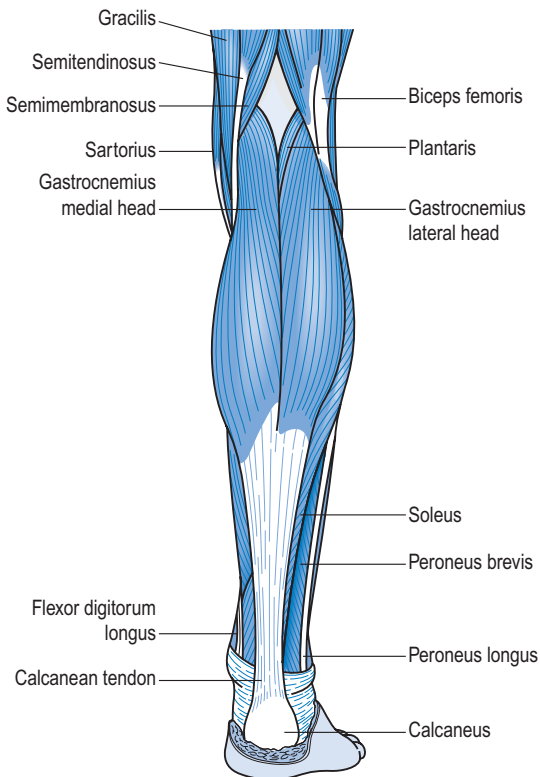
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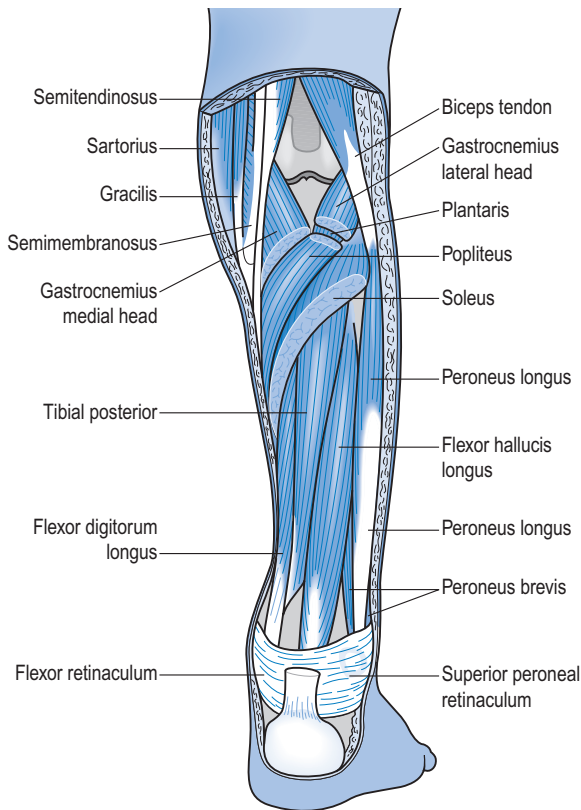
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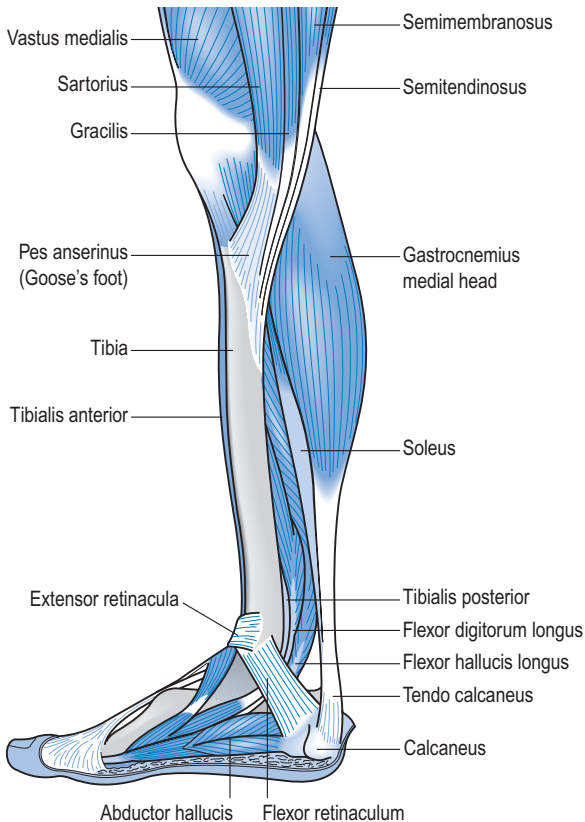
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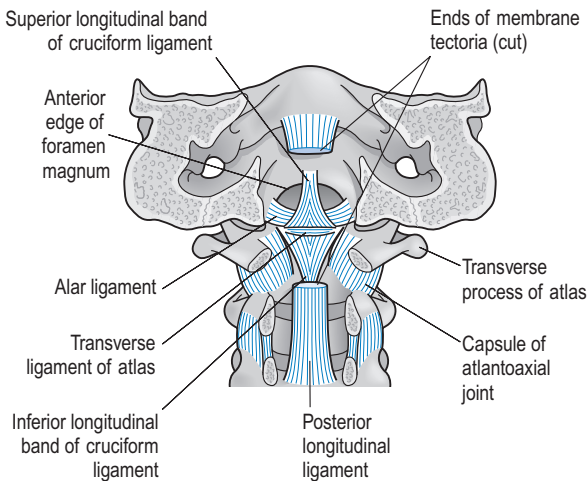
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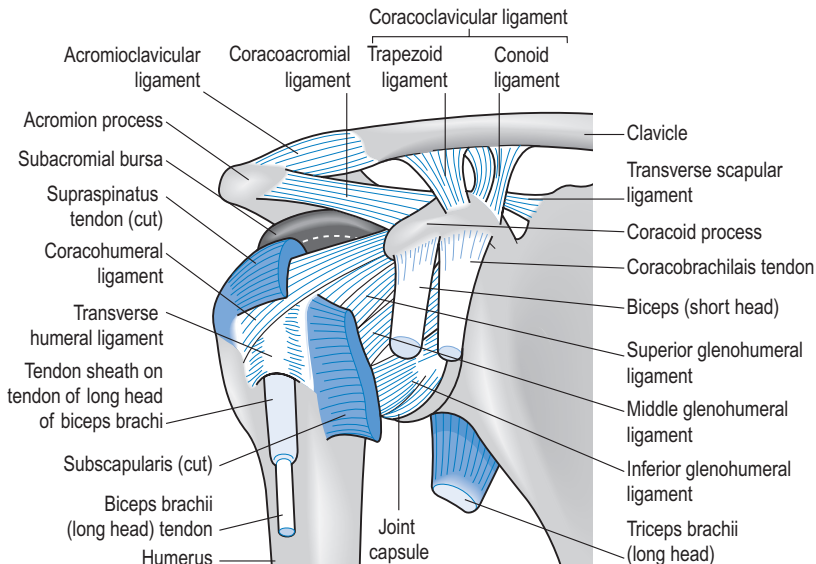


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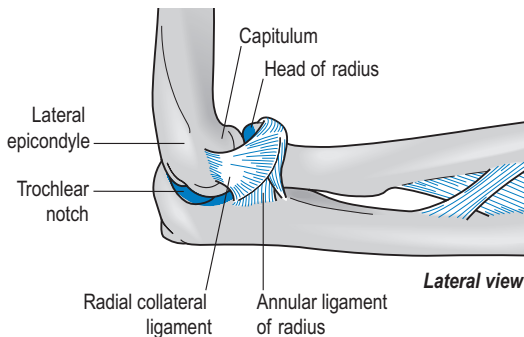
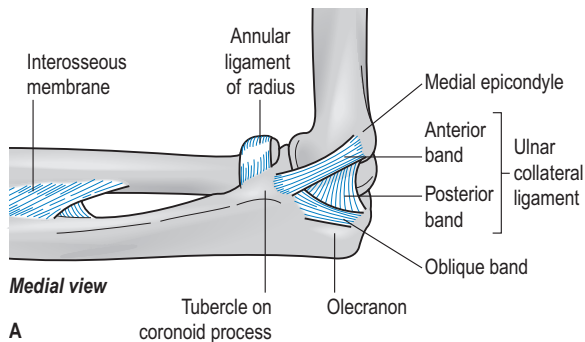


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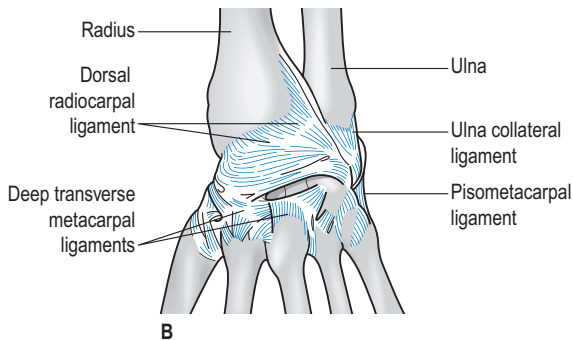
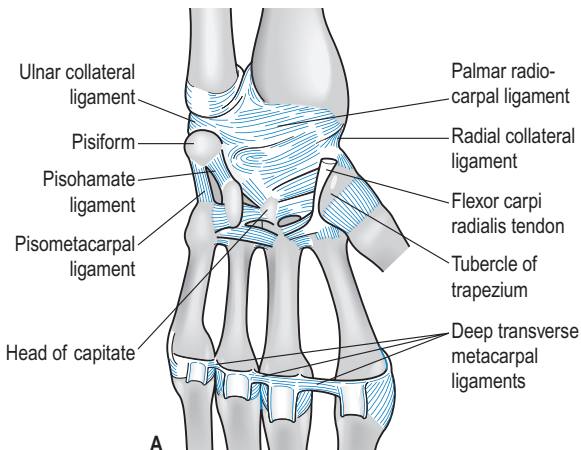




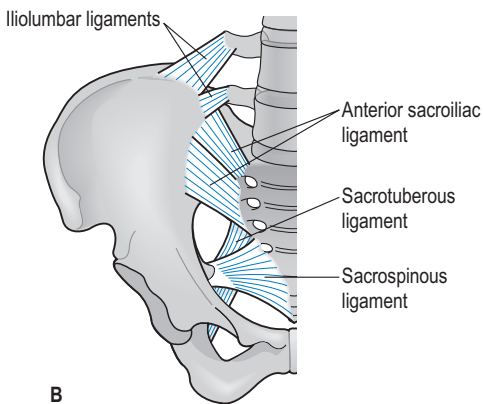
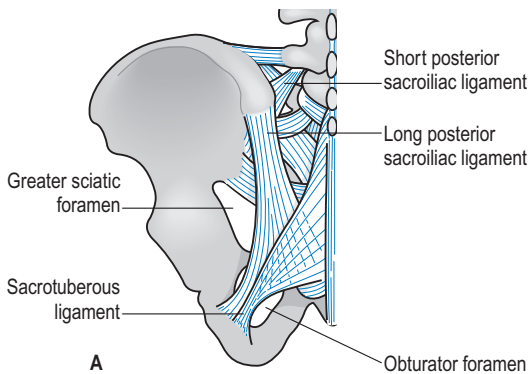
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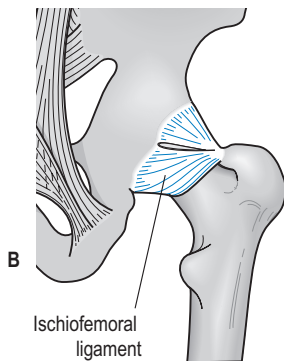
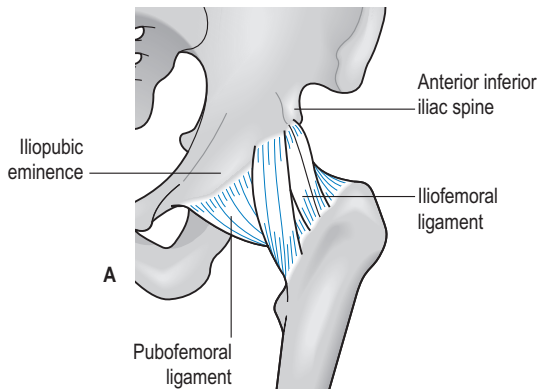
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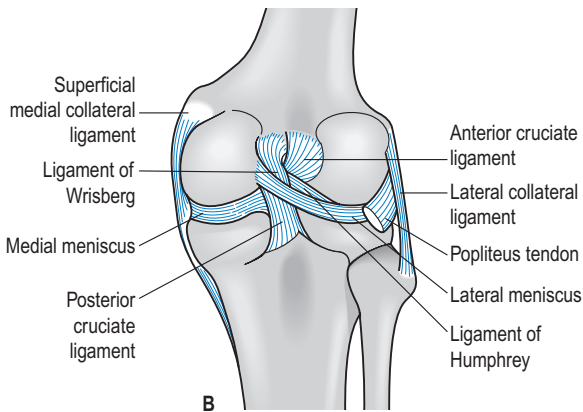
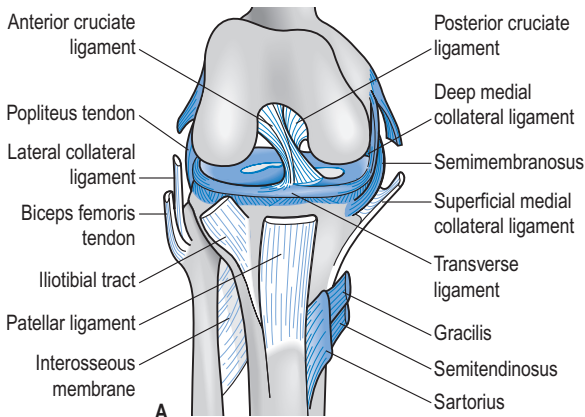
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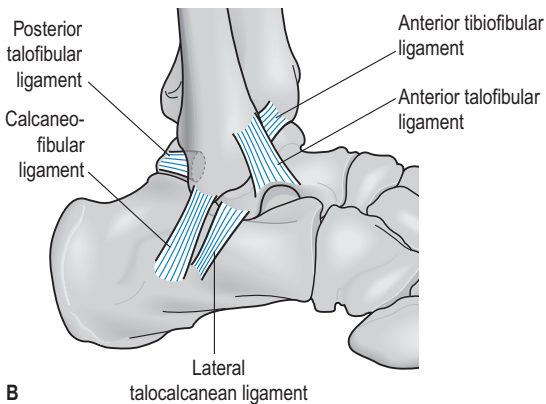
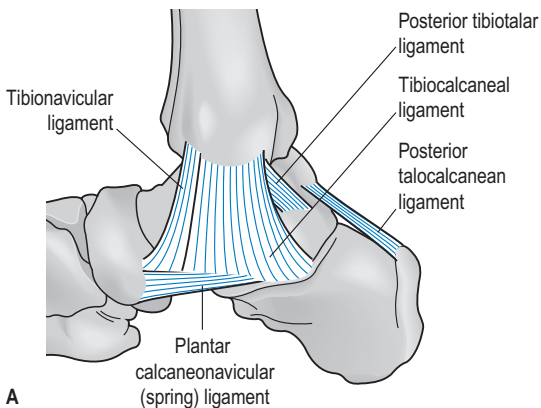
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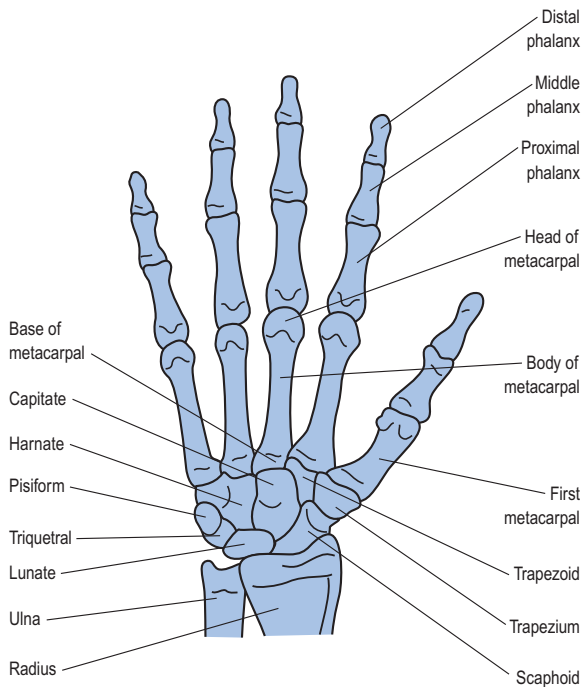
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**Figure 1.24** Ligaments of the knee joint. **A** Anterior. **B** Posterior.

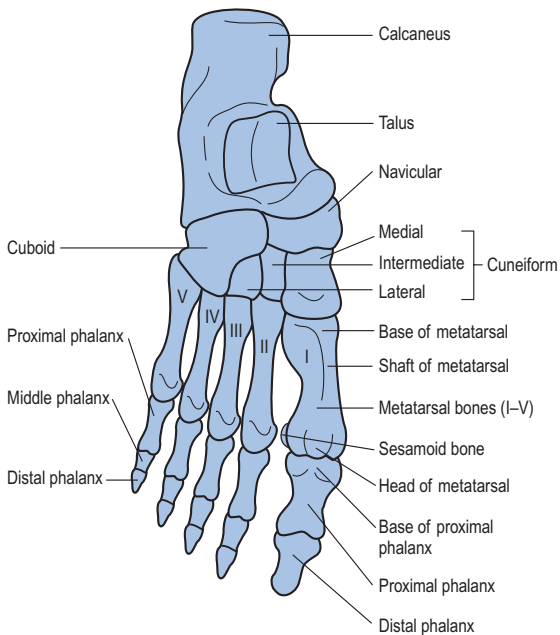


**Figure 1.25** Ligaments of the ankle joint. **A** Medial. **B** Lateral.



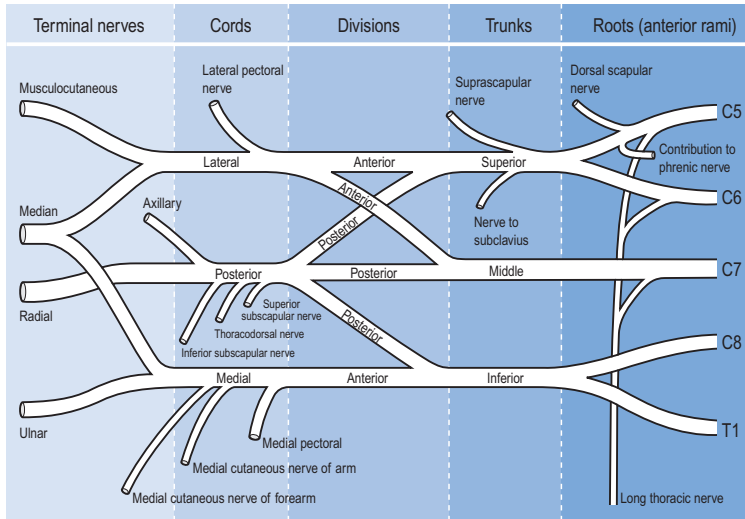
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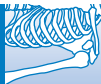


**Figure 1.27** Bones of the right foot.

## Brachial plexus

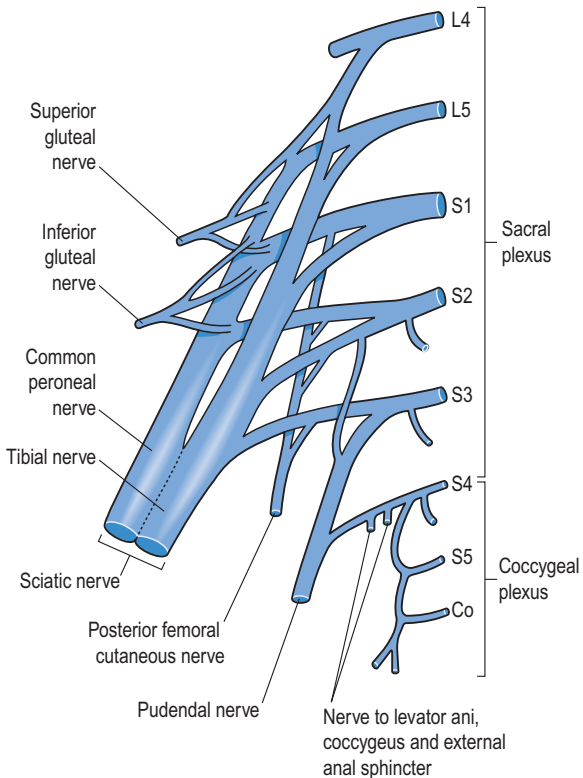


**Figure 1.28** Schematic of brachial plexus.

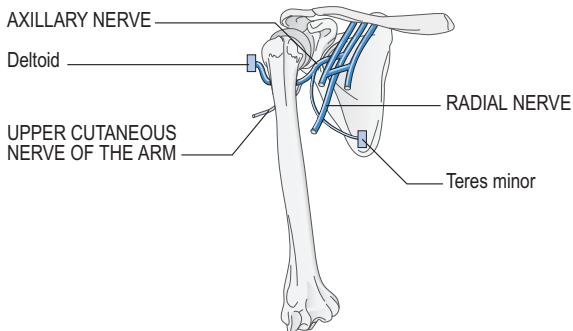
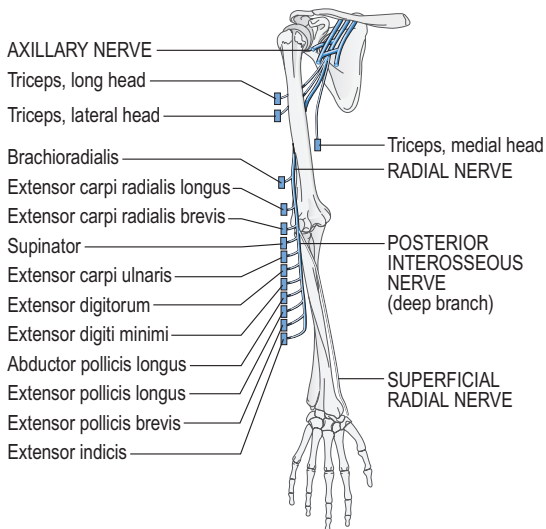


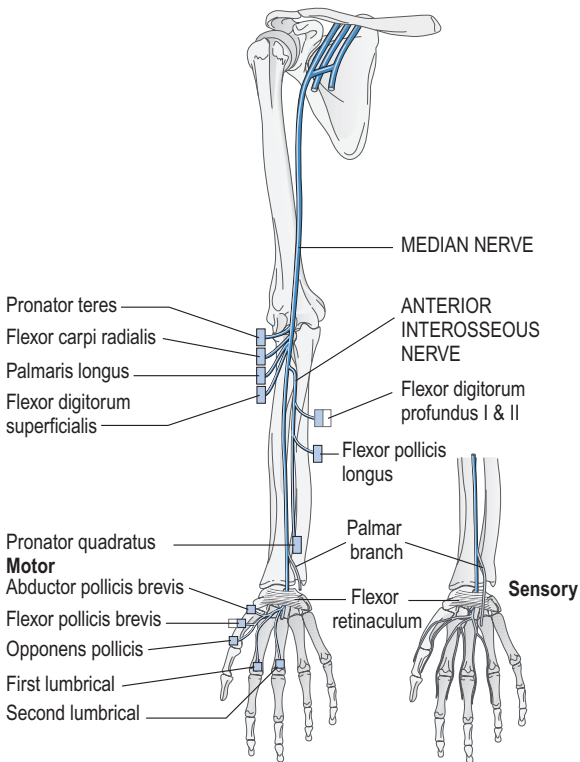


## Lumbosacral plexus

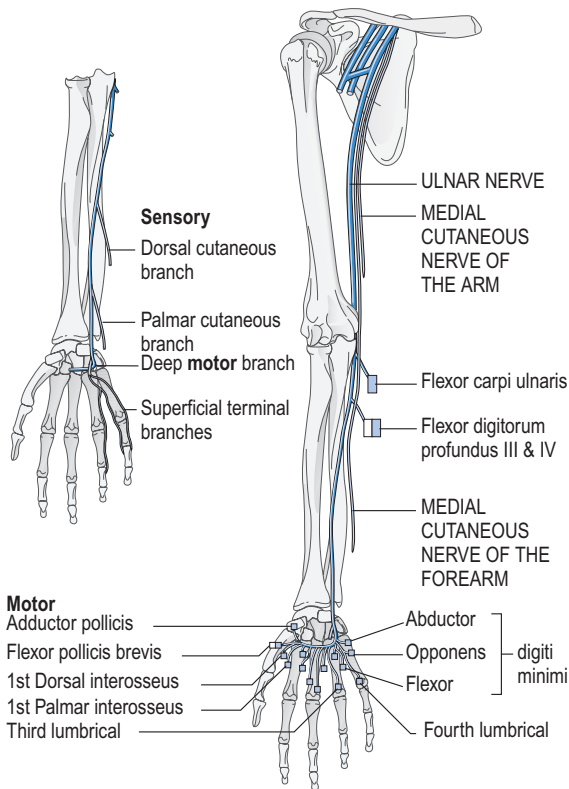


**Figure 1.29** Schematic of lumbosacral plexus.

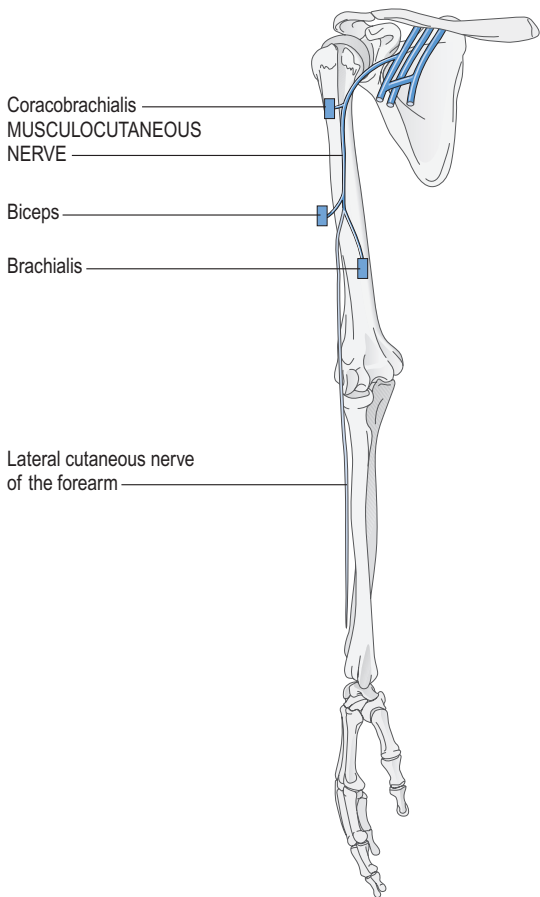
**Peripheral nerve motor innervation** (from O'Brien 2000, with permission)**Figure 1.30** Upper cutaneous nerve of the arm.**Figure 1.31** Axillary and radial nerve.



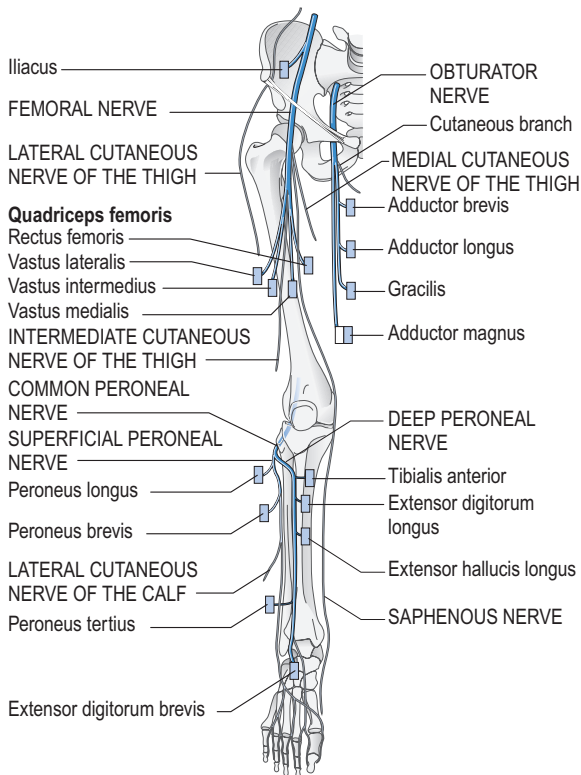
**Figure 1.32** Median nerve.



**Figure 1.33** Ulnar nerve.

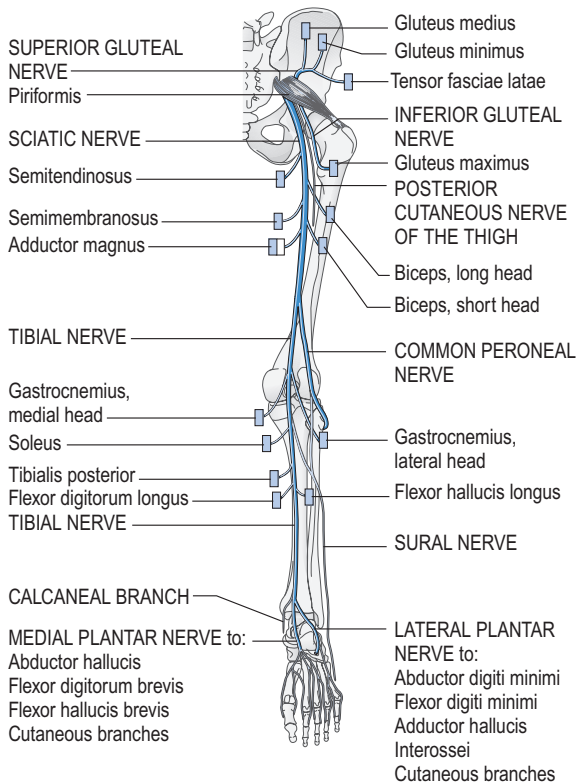


**Figure 1.34** Musculocutaneous nerve.



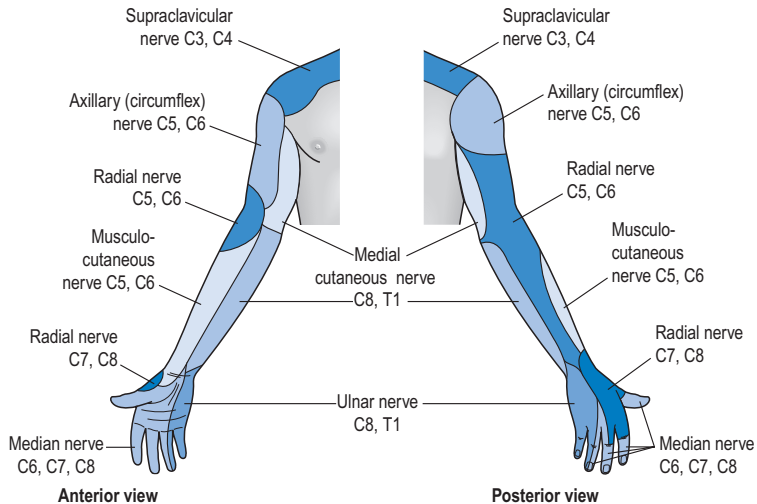
**Figure 1.35** Anterior aspect of lower limb.



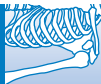


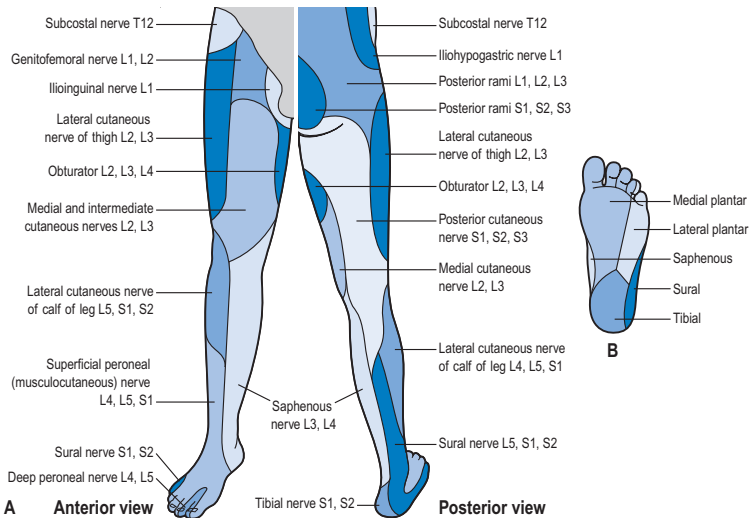
**Figure 1.36** Posterior aspect of lower limb.

## Peripheral nerve sensory innervation

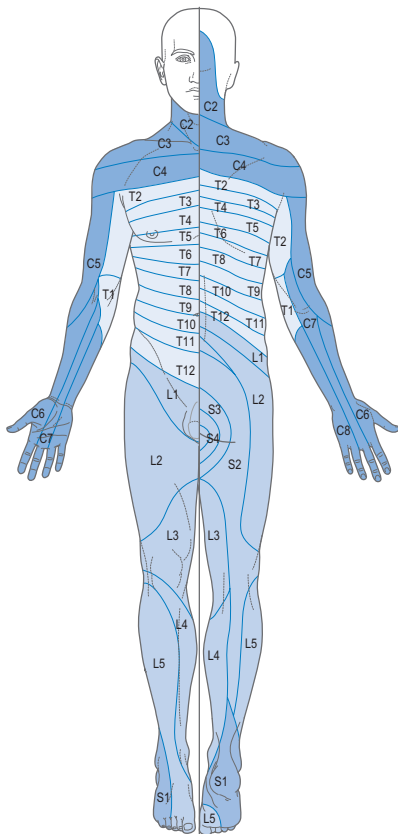


**Figure 1.37** Cutaneous distribution of the upper limb.





**Figure 1.38** Cutaneous distribution of **(A)** the lower limb and **(B)** the foot.



**Figure 1.39** Dermatomes of the whole body.

The above illustration is used extensively in clinical practice to define the body's dermatomal patterns. It represents the dermatomes as lying between clearly defined boundaries with no overlap between areas. However, it is worth noting that studies have shown that there is significant variability in the pattern of segmental innervation and that the above dermatomes do not always describe the patterns found in a large number of patients.



## Myotomes

Root	Joint action	Root	Joint action
C1–C2	Cervical flexion	T1	Finger abduction/ adduction
C3	Cervical lateral flexion	T1–L1	No muscle test
C4	Shoulder girdle elevation	L2	Hip flexion
C5	Shoulder abduction	L3	Knee extension
C6	Elbow flexion	L4	Ankle dorsiflexion
C7	Elbow extension	L5	Great toe extension
C8	Thumb extension	S1	Ankle eversion/hip extension/ankle plantarflexion/ knee flexion
		S2	Knee flexion

## Reflexes

When testing reflexes, the patient must be relaxed and the muscle placed on a slight stretch. Look for symmetry of response between reflexes on both sides and ensure that both limbs are positioned identically. When a reflex is difficult to elicit, a reinforcement manoeuvre can be used to facilitate a stronger response. This is performed while the reflex is being tested. Usually upper limb reinforcement manoeuvres are used for lower limb reflexes and vice versa. Examples



of reinforcement manoeuvres include clenching the teeth or the fists, hooking the hands together by the flexed fingers and pulling one hand against the other (Jendrassik's manoeuvre), crossing the legs at the ankle and pulling one ankle against the other.

Reflexes may be recorded as follows, noting any asymmetry (Petty 2006):

0 or –	absent
1 or –	diminished
2 or +	average/normal
3 or + +	exaggerated
4 or + + +	clonus

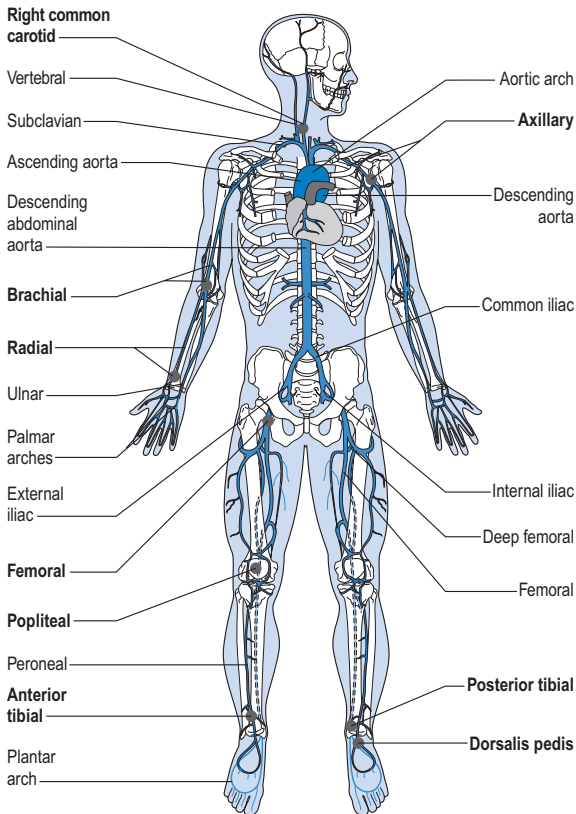
An abnormal reflex response may or may not be indicative of a neurological lesion. Findings need to concur with other neurological observations in order to be considered as significant evidence of an abnormality.

An exaggerated response (excessively brisk or prolonged) may simply be caused by anxiety. However, it may also indicate an upper motor neurone lesion, i.e. central damage. Clonus is associated with exaggerated reflexes and also indicates an upper motor neurone lesion. A diminished or absent response may indicate a lower motor neurone lesion, i.e. loss of ankle jerk with lumbosacral disc prolapse.

Deep tendon reflex	Root	Nerve
Biceps jerk	C5–C6	Musculocutaneous
Brachioradialis jerk	C5–C6	Radial
Triceps jerk	C7–C8	Radial
Knee jerk	L3–L4	Femoral
Ankle jerk	S1–S2	Tibial



Other reflexes	Method	Normal response	Abnormal response (indicating possible upper motor neurone lesion)
Plantar (superficial reflex)	Run a blunt object over lateral border of sole of foot from the heel up towards the little toe and across the foot pad	Flexion of toes	Extension of big toe and fanning of other toes (Babinski response)
Clonus (tone)	Apply sudden and sustained dorsiflexion to the ankle	Oscillatory beats may occur but they are not rhythmic or sustained	More than three rhythmic contractions of the plantarflexors
Hoffman reflex	Flick distal phalanx of third or fourth finger downwards	No movement of thumb	Reflex flexion of distal phalanx of thumb

**Common locations for palpation of pulses****Figure 1.40** Pulse points.





<b>Common carotid</b>	Between the trachea and the sternocleidomastoid muscle
<b>Axillary</b>	Lateral wall of axilla in the groove behind coracobrachialis
<b>Brachial</b>	(a) Between the humerus and biceps on the medial aspect of arm (b) Cubital fossa
<b>Radial</b>	Lateral to flexor carpi radialis tendon
<b>Femoral</b>	In femoral triangle (sartorius, adductor longus and inguinal ligament)
<b>Popliteal</b>	In popliteal fossa. Palpated more easily in prone with the knee flexed about 45°
<b>Anterior tibial</b>	Above level of ankle joint, between tibialis anterior and extensor hallucis longus tendons
<b>Posterior tibial</b>	Posterior aspect of medial malleolus
<b>Dorsalis pedis</b>	Dorsum of foot, between first and second metatarsal bones

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SECTION

1

NEUROMUSCULOSKELETAL ANATOMY

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# SECTION 2

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SECTION

**2**

MUSCULOSKELETAL

## Muscle innervation chart (data from Standring 2004, with permission)

### Upper limb

C1	C2	C3	C4	C5	C6	C7	C8	T1
Inferior and superior oblique								
Rectus capitis posterior major and minor								
Rectus capitis anterior and lateralis								
Longus capitis								
	Longissimus cervicis							
	Longus colli							
		Levator scapulae						
		Trapezius						
		Diaphragm						
		Splenius capitis						
		Scalenus medius						
			Rhomboid major					
			Rhomboid minor					
			Scalenus anterior					
			Longissimus capitis					
				Biceps brachii				
				Brachioradialis				
				Deltoid				
				Infraspinatus				



#### SECTION

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#### MUSCULOSKELETAL



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## MUSCULOSKELETAL

C1	C2	C3	C4	C5	C6	C7	C8	T1
				Subscapularis				
				Supraspinatus				
				Teres minor				
				Brachialis				
				Coracobrachialis				
				Serratus anterior				
				Splenius cervicis				
				Teres major				
				Pectoralis major				
				Pectoralis minor				
					Extensor carpi radialis longus			
					Flexor carpi radialis			
					Pronator teres			
					Supinator			
				Anconeus				
				Latissimus dorsi				
				Scalenus posterior				
				Triceps brachii				
					Abductor pollicis longus			
					Extensor carpi radialis brevis			
					Extensor carpi ulnaris			
					Extensor digiti minimi			
					Extensor digitorum			
					Extensor indicis			

C1	C2	C3	C4	C5	C6	C7	C8	T1
						Extensor pollicis brevis		
						Extensor pollicis longus		
						Flexor pollicis longus		
						Palmaris longus		
						Pronator quadratus		
						Flexor carpi ulnaris		
							Abductor digiti minimi	
							Abductor pollicis brevis	
							Adductor pollicis	
							Dorsal interossei	
							Flexor digiti minimi brevis	
							Flexor digitorum profundus	
							Flexor digitorum superficialis	
							Flexor pollicis brevis	
							Lumbricals	
							Opponens digiti minimi	
							Opponens pollicis	
							Palmar interossei	



## SECTION

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## MUSCULOSKELETAL



## Lower limb



### SECTION

# 2

### MUSCULOSKELETAL

T12	L1	L2	L3	L4	L5	S1	S2	S3
Quadratus lumborum								
	Psoas minor							
	Psoas major							
		Adductor brevis						
		Gracilis						
		Iliacus						
		Pectineus						
		Sartorius						
		Adductor longus						
		Adductor magnus						
		Rectus femoris						
		Vastus intermedius						
		Vastus lateralis						
		Vastus medialis						
		Obturator externus						
		Gluteus medius						
		Gluteus minimus						
		Popliteus						
				Tibialis anterior				
				Tibialis posterior				
				Tensor fascia lata				
					Extensor hallucis longus			
					Extensor digitorum brevis			
					Extensor digitorum longus			


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T12	L1	L2	L3	L4	L5	S1	S2	S3
					Gemellus inferior			
					Gemellus superior			
					Obturator internus			
					Peroneus brevis			
					Peroneus longus			
					Peroneus tertius			
					Quadratus femoris			
					Biceps femoris			
					Flexor digitorum longus			
					Flexor hallucis longus			
					Gluteus maximus			
					Piriformis			
					Semimembranosus			
					Semitendinosus			
					Abductor hallucis			
					Flexor digitorum brevis			
					Flexor hallucis brevis			
					Gastrocnemius			
					Plantaris			
					Soleus			
					Abductor digiti minimi			
					Flexor digitorum accessorius			
					Adductor hallucis			
					Dorsal interossei			
					Flexor digiti minimi brevis			
					Lumbricals			
					Plantar interossei			

## Muscles listed by function

### Head and neck

*Flexors:* longus colli, longus capitis, rectus capitis anterior, sternocleidomastoid, scalenus anterior

*Lateral flexors:* erector spinae, rectus capitis lateralis, scalenes (anterior, medius and posterior), splenius cervicis, splenius capitis, trapezius, levator scapulae, sternocleidomastoid

*Extensors:* levator scapulae, splenius cervicis, trapezius, splenius capitis, semispinalis, superior oblique, sternocleidomastoid, erector spinae, rectus capitis posterior major, rectus capitis posterior minor

*Rotators:* semispinalis, multifidus, scalenus anterior, splenius cervicis, sternocleidomastoid, splenius capitis, rectus capitis posterior major, inferior oblique

### Trunk

*Flexors:* rectus abdominis, external oblique, internal oblique, psoas minor, psoas major, iliacus

*Rotators:* multifidus, rotatores, semispinalis, internal oblique, external oblique

*Lateral flexors:* quadratus lumborum, intertransversarii, external oblique, internal oblique, erector spinae, multifidus

*Extensors:* quadratus lumborum, multifidus, semispinalis, erector spinae, interspinales, rotatores

### Scapula

*Retractors:* rhomboid minor, rhomboid major, trapezius, levator scapulae

*Protractors:* serratus anterior, pectoralis minor

*Elevators:* trapezius, levator scapulae

*Depressors:* trapezius

*Lateral rotators:* trapezius, serratus anterior

*Medial rotators:* rhomboid major, rhomboid minor, pectoralis minor, levator scapulae

### Shoulder

*Flexors:* pectoralis major, deltoid (anterior fibres), biceps brachii (long head), coracobrachialis





*Extensors:* latissimus dorsi, teres major, pectoralis major, deltoid (posterior fibres), triceps (long head)

*Abductors:* supraspinatus, deltoid (middle fibres)

*Adductors:* coracobrachialis, pectoralis major, latissimus dorsi, teres major

*Medial rotators:* subscapularis, teres major, latissimus dorsi, pectoralis major, deltoid (anterior fibres)

*Lateral rotators:* teres minor, infraspinatus, deltoid (posterior fibres)

## Elbow

*Flexors:* biceps brachii, brachialis, brachioradialis, pronator teres

*Extensors:* triceps brachii, anconeus

*Pronators:* pronator teres, pronator quadratus

*Supinators:* supinator, biceps brachii

## Wrist

*Flexors:* flexor carpi ulnaris, flexor carpi radialis, palmaris longus, flexor digitorum superficialis, flexor digitorum profundus, flexor pollicis longus

*Extensors:* extensor carpi radialis longus, extensor carpi radialis brevis, extensor carpi ulnaris, extensor digitorum, extensor indicis, extensor digiti minimi, extensor pollicis longus, extensor pollicis brevis

*Ulnar deviation:* flexor carpi ulnaris, extensor carpi ulnaris

*Radial deviation:* flexor carpi radialis, extensor carpi radialis longus, extensor carpi radialis brevis, abductor pollicis longus, extensor pollicis longus, extensor pollicis brevis

## Fingers

*Flexors:* flexor digitorum superficialis, flexor digitorum profundus, lumbricals, flexor digiti minimi brevis

*Extensors:* extensor digitorum, extensor digiti minimi, extensor indicis, interossei, lumbricals

*Abductors:* dorsal interossei, abductor digiti minimi, opponens digiti minimi

*Adductors:* palmar interossei

## Thumb

*Flexors:* flexor pollicis longus, flexor pollicis brevis

*Extensors:* extensor pollicis longus, extensor pollicis brevis, abductor pollicis longus

*Abductors:* abductor pollicis longus, abductor pollicis brevis

*Adductors:* adductor pollicis

*Opposition:* opponens pollicis

## Hip

*Flexors:* psoas major, iliacus, rectus femoris, sartorius, pectineus

*Extensors:* gluteus maximus, semitendinosus, semimembranosus, biceps femoris

*Abductors:* gluteus maximus, gluteus medius, gluteus minimus, tensor fascia lata, sartorius, piriformis

*Adductors:* adductor magnus, adductor longus, adductor brevis, gracilis, pectineus

*Medial rotators:* gluteus medius, gluteus minimus, tensor fascia lata

*Lateral rotators:* gluteus maximus, piriformis, obturator internus, gemellus superior, gemellus inferior, quadratus femoris, obturator externus, sartorius

## Knee

*Flexors:* semitendinosus, semimembranosus, biceps femoris, gastrocnemius, gracilis, sartorius, plantaris, popliteus

*Extensors:* rectus femoris, vastus lateralis, vastus intermedius, vastus medialis, tensor fascia lata

*Tibial lateral rotators:* biceps femoris

*Tibial medial rotators:* semitendinosus, semimembranosus, gracilis, sartorius, popliteus

## Ankle

*Plantarflexors:* gastrocnemius, soleus, plantaris, peroneus longus, tibialis posterior, flexor digitorum longus, flexor hallucis longus, peroneus brevis

*Dorsiflexors:* tibialis anterior, extensor digitorum longus, extensor hallucis longus, peroneus tertius



*Invertors:* tibialis anterior, tibialis posterior

*Evertors:* peroneus longus, peroneus tertius, peroneus brevis

## Toes

*Flexors:* flexor digitorum longus, flexor digitorum accessorius, flexor digitorum brevis, flexor hallucis longus, flexor hallucis brevis, flexor digiti minimi brevis, interossei, lumbricals, abductor hallucis

*Extensors:* extensor hallucis longus, extensor digitorum longus, extensor digitorum brevis, lumbricals, interossei

*Abductors:* abductor hallucis, abductor digiti minimi, dorsal interossei

*Adductors:* adductor hallucis, plantar interossei



SECTION

2

MUSCULOSKELETAL

## Alphabetical listing of muscles

### Abductor digiti minimi (foot)

*Action:* abducts fifth toe

*Origin:* calcaneal tuberosity, plantar aponeurosis, intermuscular septum

*Insertion:* lateral side of base of proximal phalanx of fifth toe

*Nerve:* lateral plantar nerve (S1–S3)

### Abductor digiti minimi (hand)

*Action:* abducts little finger

*Origin:* pisiform, tendon of flexor carpi ulnaris, pisohamate ligament

*Insertion:* ulnar side of base of proximal phalanx of little finger

*Nerve:* ulnar nerve (C8, T1)

### Abductor hallucis

*Action:* abducts and flexes great toe

*Origin:* flexor retinaculum, calcaneal tuberosity, plantar aponeurosis, intermuscular septum

*Insertion:* medial side of base of proximal phalanx of great toe

*Nerve:* medial plantar nerve (S1, S2)

## **Abductor pollicis brevis**

*Action:* abducts thumb

*Origin:* flexor retinaculum, tubercles of scaphoid and trapezium, tendon of abductor pollicis longus

*Insertion:* radial side of base of proximal phalanx of thumb

*Nerve:* median nerve (C8, T1)

## **Abductor pollicis longus**

*Action:* abducts and extends thumb, abducts wrist

*Origin:* upper part of posterior surface of ulna, middle third of posterior surface of radius, interosseous membrane

*Insertion:* radial side of first metacarpal base, trapezium

*Nerve:* posterior interosseous nerve (C7, C8)

## **Adductor brevis**

*Action:* adducts hip

*Origin:* external aspect of body and inferior ramus of pubis

*Insertion:* upper half of linea aspera

*Nerve:* obturator nerve (L2, L3)

## **Adductor hallucis**

*Action:* adducts great toe

*Origin:* oblique head – bases of second to fourth metatarsal, sheath of peroneus longus tendon; transverse head – plantar metatarsophalangeal ligaments of lateral three toes

*Insertion:* lateral side of base of proximal phalanx of great toe

*Nerve:* lateral plantar nerve (S2, S3)

## **Adductor longus**

*Action:* adducts thigh

*Origin:* front of pubis

*Insertion:* middle third of linea aspera

*Nerve:* anterior division of obturator nerve (L2–L4)

## **Adductor magnus**

*Action:* adducts thigh

*Origin:* inferior ramus of pubis, conjoined ischial ramus, inferolateral aspect of ischial tuberosity

*Insertion:* linea aspera, proximal part of medial supracondylar line

*Nerve:* obturator nerve and tibial division of sciatic nerve (L2–L4)

### **Adductor pollicis**

*Action:* adducts thumb

*Origin:* oblique head – palmar ligaments of carpus, flexor carpi radialis tendon, base of second to fourth metacarpals, capitate; transverse head – palmar surface of third metacarpal

*Insertion:* base of proximal phalanx of thumb

*Nerve:* ulnar nerve (C8, T1)

### **Anconeus**

*Action:* extends elbow

*Origin:* posterior surface of lateral epicondyle of humerus

*Insertion:* lateral surface of olecranon, upper quarter of posterior surface of ulna

*Nerve:* radial nerve (C6–C8)

### **Biceps brachii**

*Action:* flexes shoulder and elbow, supinates forearm

*Origin:* long head – supraglenoid tubercle of scapula and glenoid labrum; short head – apex of coracoid process

*Insertion:* posterior part of radial tuberosity, bicipital aponeurosis into deep fascia over common flexor origin

*Nerve:* musculocutaneous nerve (C5, C6)

### **Biceps femoris**

*Action:* flexes knee and extends hip, laterally rotates tibia on femur

*Origin:* long head – ischial tuberosity, sacrotuberous ligament; short head – lower half of lateral lip of linea aspera, lateral supracondylar line of femur, lateral intermuscular septum

*Insertion:* head of fibula, lateral tibial condyle

*Nerve:* sciatic nerve (L5–S2). Long head – tibial division; short head – common peroneal division





## Brachialis

*Action:* flexes elbow

*Origin:* lower half of anterior surface of humerus, intermuscular septum

*Insertion:* coronoid process and tuberosity of ulna

*Nerve:* musculocutaneous nerve (C5, C6), radial nerve (C7)

## Brachioradialis

*Action:* flexes elbow

*Origin:* upper two-thirds of lateral supracondylar ridge of humerus, lateral intermuscular septum

*Insertion:* lateral side of radius above styloid process

*Nerve:* radial nerve (C5, C6)

## Coracobrachialis

*Action:* adducts shoulder and acts as weak flexor

*Origin:* apex of coracoid process

*Insertion:* midway along medial border of humerus

*Nerve:* musculocutaneous nerve (C5–C7)

## Deltoid

*Action:* anterior fibres – flex and medially rotate shoulder; middle fibres – abduct shoulder; posterior fibres – extend and laterally rotate shoulder

*Origin:* anterior fibres – anterior border of lateral third of clavicle; middle fibres – lateral margin of acromion process; posterior fibres – lower edge of crest of spine of scapula

*Insertion:* deltoid tuberosity of humerus

*Nerve:* axillary nerve (C5, C6)

## Diaphragm

*Action:* draws central tendon inferiorly. Changes volume and pressure of thoracic and abdominal cavities

*Origin:* posterior surface of xiphoid process, lower six costal cartilages and adjoining ribs on each side, medial and lateral arcuate ligaments, anterolateral aspect of bodies of lumbar vertebrae

*Insertion:* central tendon  
*Nerve:* phrenic nerves (C3–5)

### **Dorsal interossei (foot)**

*Action:* abducts toes, flexes metatarsophalangeal joints  
*Origin:* proximal half of sides of adjacent metatarsals  
*Insertion:* bases of proximal phalanges and dorsal digital expansion (first attaches medially to second toe; second, third and fourth attach laterally to second, third and fourth toes, respectively)  
*Nerve:* lateral plantar nerve (S2, S3)

### **Dorsal interossei (hand)**

*Action:* abducts index, middle and ring fingers, flexes metacarpophalangeal joints and extends interphalangeal joints  
*Origin:* adjacent sides of two metacarpal bones (four bipennate muscles)  
*Insertion:* bases of proximal phalanges and dorsal digital expansions (first attaches laterally to index finger; second and third attach to both sides of middle finger; fourth attaches medially to ring finger)  
*Nerve:* ulnar nerve (C8, T1)

### **Erector spinae**

See iliocostalis, longissimus and spinalis

### **Extensor carpi radialis brevis**

*Action:* extends and abducts wrist  
*Origin:* lateral epicondyle via common extensor tendon  
*Insertion:* posterior surface of base of third metacarpal  
*Nerve:* posterior interosseous branch of radial nerve (C7, C8)

### **Extensor carpi radialis longus**

*Action:* extends and abducts wrist  
*Origin:* lower third of lateral supracondylar ridge of humerus, intermuscular septa  
*Insertion:* posterior surface of base of second metacarpal  
*Nerve:* radial nerve (C6, C7)



## Extensor carpi ulnaris

*Action:* extends and adducts wrist

*Origin:* lateral epicondyle via common extensor tendon

*Insertion:* medial side of fifth metacarpal base

*Nerve:* posterior interosseous nerve (C7, C8)

## Extensor digiti minimi

*Action:* extends fifth digit and wrist

*Origin:* lateral epicondyle via common extensor tendon, intermuscular septa

*Insertion:* dorsal digital expansion of fifth digit

*Nerve:* posterior interosseous nerve (C7, C8)

## Extensor digitorum

*Action:* extends fingers and wrist

*Origin:* lateral epicondyle via common extensor tendon, intermuscular septa

*Insertion:* lateral and dorsal surfaces of second to fifth digits

*Nerve:* posterior interosseous branch of radial nerve (C7, C8)

## Extensor digitorum brevis

*Action:* extends great toe and adjacent three toes

*Origin:* superolateral surface of calcaneus, inferior extensor retinaculum, interosseous talocalcaneal ligament

*Insertion:* base of proximal phalanx of great toe, lateral side of dorsal hood of adjacent three toes

*Nerve:* deep peroneal nerve (L5, S1)

## Extensor digitorum longus

*Action:* extends lateral four toes, ankle dorsiflexor

*Origin:* upper three-quarters of medial surface of fibula, interosseous membrane, lateral tibial condyle

*Insertion:* middle and distal phalanges of four lateral toes

*Nerve:* deep peroneal nerve (L5, S1)

## Extensor hallucis longus

*Action:* extends great toe, ankle dorsiflexor

*Origin:* middle half of medial surface of fibula, interosseous membrane

*Insertion:* base of distal phalanx of great toe

*Nerve:* deep peroneal nerve (L5)

### **Extensor indicis**

*Action:* extends index finger and wrist

*Origin:* lower part of posterior surface of ulna, interosseous membrane

*Insertion:* dorsal digital expansion on back of proximal phalanx of index finger

*Nerve:* posterior interosseous nerve (C7, C8)

### **Extensor pollicis brevis**

*Action:* extends thumb and wrist, abducts wrist

*Origin:* posterior surface of radius, interosseous membrane

*Insertion:* dorsolateral base of proximal phalanx of thumb

*Nerve:* posterior interosseous nerve (C7, C8)

### **Extensor pollicis longus**

*Action:* extends thumb and wrist, abducts wrist

*Origin:* middle third of posterior surface of ulna, interosseous membrane

*Insertion:* dorsal surface of distal phalanx of thumb

*Nerve:* posterior interosseous nerve (C7, C8)

### **External oblique**

*Action:* flexes, laterally flexes and rotates trunk

*Origin:* outer borders of lower eight ribs and their costal cartilages

*Insertion:* outer lip of anterior two-thirds of iliac crest, abdominal aponeurosis to linea alba stretching from xiphoid process to symphysis pubis

*Nerve:* ventral rami of lower six thoracic nerves (T7–T12)

### **Flexor carpi radialis**

*Action:* flexes and abducts wrist

*Origin:* medial epicondyle via common flexor tendon

*Insertion:* front of base of second and third metacarpals

*Nerve:* median (C6, C7)



## Flexor carpi ulnaris

*Action:* flexes and adducts wrist

*Origin:* humeral head – medial epicondyle via common flexor tendon; ulnar head – medial border of olecranon and upper two-thirds of border of ulna

*Insertion:* pisiform, hook of hamate and base of fifth metacarpal

*Nerve:* ulnar nerve (C7–T1)

## Flexor digiti minimi brevis (foot)

*Action:* flexes fifth metatarsophalangeal joint, supports lateral longitudinal arch

*Origin:* plantar aspect of base of fifth metatarsal, sheath of peroneus longus tendon

*Insertion:* lateral side of base of proximal phalanx of fifth toe

*Nerve:* lateral plantar nerve (S2, S3)

## Flexor digiti minimi brevis (hand)

*Action:* flexes little finger

*Origin:* hook of hamate, flexor retinaculum

*Insertion:* ulnar side of base of proximal phalanx of little finger

*Nerve:* ulnar nerve (C8, T1)

## Flexor digitorum accessorius

*Action:* flexes distal phalanges of lateral four toes

*Origin:* medial head – medial tubercle of calcaneus; lateral head – lateral tubercle of calcaneus and long plantar ligament

*Insertion:* flexor digitorum longus tendon

*Nerve:* lateral plantar nerve (S1–S3)

## Flexor digitorum brevis

*Action:* flexes proximal interphalangeal joints and metatarsophalangeal joints of lateral four toes

*Origin:* calcaneal tuberosity, plantar aponeurosis, intermuscular septa

*Insertion:* tendons divide and attach to both sides of base of middle phalanges of second to fifth toes

*Nerve:* medial plantar nerve (S1, S2)





## Flexor digitorum longus

*Action:* flexes lateral four toes, plantarflexes ankle

*Origin:* medial part of posterior surface of tibia, deep transverse fascia

*Insertion:* plantar aspect of base of distal phalanges of second to fifth toes

*Nerve:* tibial nerve (L5–S2)

## Flexor digitorum profundus

*Action:* flexes fingers and wrist

*Origin:* medial side of coronoid process of ulna, upper three-quarters of anterior and medial surfaces of ulna, interosseous membrane

*Insertion:* base of palmar surface of distal phalanx of second to fifth digits

*Nerve:* medial part – ulnar nerve (C8, T1); lateral part – anterior interosseous branch of median nerve (C8, T1)

## Flexor digitorum superficialis

*Action:* flexes fingers and wrist

*Origin:* humeroulnar head – medial epicondyle via common flexor tendon, medial part of coronoid process of ulna, ulnar collateral ligament, intermuscular septa; radial head – upper two-thirds of anterior border of radius

*Insertion:* tendons divide and insert into sides of shaft of middle phalanx of second to fifth digits

*Nerve:* median (C8, T1)

## Flexor hallucis brevis

*Action:* flexes metatarsophalangeal joint of great toe

*Origin:* medial side of plantar surface of cuboid, lateral cuneiform

*Insertion:* medial and lateral side of base of proximal phalanx of great toe

*Nerve:* medial plantar nerve (S1, S2)

## Flexor hallucis longus

*Action:* flexes great toe, plantarflexes ankle

*Origin:* lower two-thirds of posterior surface of fibula, interosseous membrane, intermuscular septum

*Insertion:* plantar surface of base of distal phalanx of great toe

*Nerve:* tibial nerve (L5–S2)

### **Flexor pollicis brevis**

*Action:* flexes metacarpophalangeal joint of thumb

*Origin:* flexor retinaculum, tubercle of trapezium, capitate, trapezoid

*Insertion:* base of proximal phalanx of thumb

*Nerve:* median nerve (C8–T1). Sometimes also supplied by ulnar nerve (C8–T1)

### **Flexor pollicis longus**

*Action:* flexes thumb and wrist

*Origin:* anterior surface of radius, interosseous membrane

*Insertion:* palmar surface of distal phalanx of thumb

*Nerve:* anterior interosseous branch of median nerve (C7, C8)

### **Gastrocnemius**

*Action:* plantarflexes ankle, flexes knee

*Origin:* medial head – posterior part of medial femoral condyle;  
lateral head – lateral surface of lateral femoral condyle

*Insertion:* posterior surface of calcaneus

*Nerve:* tibial nerve (S1, S2)

### **Gemellus inferior**

*Action:* laterally rotates hip

*Origin:* upper part of ischial tuberosity

*Insertion:* with obturator internus tendon into medial surface of greater trochanter

*Nerve:* nerve to quadratus femoris (L5, S1)

### **Gemellus superior**

*Action:* laterally rotates hip

*Origin:* gluteal surface of ischial spine

*Insertion:* with obturator internus tendon into medial surface of greater trochanter

*Nerve:* nerve to obturator internus (L5, S1)





## Gluteus maximus

*Action:* extends, laterally rotates and abducts hip

*Origin:* posterior gluteal line of ilium, posterior border of ilium and adjacent part of iliac crest, aponeurosis of erector spinae, posterior aspect of sacrum, side of coccyx, sacrotuberous ligament, gluteal aponeurosis

*Insertion:* iliotibial tract of fascia lata, gluteal tuberosity of femur

*Nerve:* inferior gluteal nerve (L5–S2)

## Gluteus medius

*Action:* abducts and medially rotates hip

*Origin:* gluteal surface of ilium between posterior and anterior gluteal lines

*Insertion:* superolateral side of greater trochanter

*Nerve:* superior gluteal nerve (L4–S1)

## Gluteus minimus

*Action:* abducts and medially rotates hip

*Origin:* gluteal surface of ilium between anterior and inferior gluteal lines

*Insertion:* anterolateral ridge on greater trochanter

*Nerve:* superior gluteal nerve (L4–S1)

## Gracilis

*Action:* flexes knee, adducts hip, medially rotates tibia on femur

*Origin:* lower half of body and inferior ramus of pubis, adjacent ischial ramus

*Insertion:* upper part of medial surface of tibia

*Nerve:* obturator nerve (L2, L3)

## Iliacus

*Action:* flexes hip and trunk

*Origin:* superior two-thirds of iliac fossa, inner lip of iliac crest, ala of sacrum, anterior sacroiliac and iliolumbar ligaments



*Insertion:* blends with insertion of psoas major into lesser trochanter

*Nerve:* femoral nerve (L2, L3)

### **Iliocostalis cervicis**

*Action:* extends and laterally flexes vertebral column

*Origin:* angles of third to sixth ribs

*Insertion:* posterior tubercles of transverse processes of C4 to C6

*Nerve:* dorsal rami

### **Iliocostalis lumborum**

*Action:* extends and laterally flexes vertebral column

*Origin:* medial and lateral sacral crests, spines of T11, T12 and lumbar vertebrae and their supraspinous ligaments, medial part of iliac crest

*Insertion:* angles of lower six or seven ribs

*Nerve:* dorsal rami

### **Iliocostalis thoracis**

*Action:* extends and laterally flexes vertebral column

*Origin:* angles of lower six ribs

*Insertion:* angles of upper six ribs, transverse process of C7

*Nerve:* dorsal rami

### **Inferior oblique**

*Action:* rotates atlas and head

*Origin:* lamina of axis

*Insertion:* transverse process of atlas

*Nerve:* dorsal ramus (C1)

### **Infraspinatus**

*Action:* laterally rotates shoulder

*Origin:* medial two-thirds of infraspinous fossa and infraspinous fascia

*Insertion:* middle facet on greater tubercle of humerus, posterior aspect of capsule of shoulder joint

*Nerve:* suprascapular nerve (C5, C6)





### Intercostales externi

*Action:* elevate rib below towards rib above to increase thoracic cavity volume for inspiration

*Origin:* lower border of rib above

*Insertion:* upper border of rib below

*Nerve:* intercostal nerves

### Intercostales interni

*Action:* draw ribs downwards to decrease thoracic cavity volume for expiration

*Origin:* lower border of costal cartilage and costal groove of rib above

*Insertion:* upper border of rib below

*Nerve:* intercostal nerves

### Internal oblique

*Action:* flexes, laterally flexes and rotates trunk

*Origin:* lateral two-thirds of inguinal ligament, anterior two-thirds of intermediate line of iliac crest, thoracolumbar fascia

*Insertion:* lower four ribs and their cartilages, crest of pubis, abdominal aponeurosis to linea alba

*Nerve:* ventral rami of lower six thoracic nerves, first lumbar nerve

### Interspinales

*Action:* extend and stabilize vertebral column

*Origin and insertion:* extend between adjacent spinous processes (best developed in cervical and lumbar regions – sometimes absent in thoracic)

*Nerve:* dorsal rami of spinal nerves

### Intertransversarii

*Action:* laterally flex lumbar and cervical spine, stabilize vertebral column

*Origin:* transverse processes of cervical and lumbar vertebrae

*Insertion:* transverse process of vertebra superior to origin

*Nerve:* ventral and dorsal rami of spinal nerves

## Latissimus dorsi

*Action:* extends, adducts and medially rotates shoulder

*Origin:* spinous processes of lower six thoracic and all lumbar and sacral vertebrae, intervening supra- and interspinous ligaments, outer lip of iliac crest, outer surfaces of lower three or four ribs, inferior angle of scapula

*Insertion:* intertubercular sulcus of humerus

*Nerve:* thoracodorsal nerve (C6–C8)

## Levator scapulae

*Action:* elevates, medially rotates and retracts scapula, extends and laterally flexes neck

*Origin:* transverse processes of C1–C3/4

*Insertion:* medial border of scapula between superior angle and base of spine

*Nerve:* ventral rami (C3, C4), dorsal scapular nerve (C5)

## Longissimus capitis

*Action:* extends, laterally flexes and rotates head

*Origin:* transverse processes of T1–T4/5, articular processes of C4/5–C7

*Insertion:* posterior aspect of mastoid process

*Nerve:* dorsal rami

## Longissimus cervicis

*Action:* extends and laterally flexes vertebral column

*Origin:* transverse processes of T1–T4/5

*Insertion:* transverse processes of C2–C6

*Nerve:* dorsal rami

## Longissimus thoracis

*Action:* extends and laterally flexes vertebral column

*Origin:* transverse and accessory processes of lumbar vertebrae and thoracolumbar fascia

*Insertion:* transverse processes of T1–T12 and lower nine or ten ribs

*Nerve:* dorsal rami



## Longus capitis

*Action:* flexes neck

*Origin:* occipital bone

*Insertion:* anterior tubercles of transverse processes of C3–C6

*Nerve:* anterior primary rami (C1–C3)

## Longus colli

*Action:* flexes neck

*Origin:* inferior oblique part – front of bodies of T1–T2/3; vertical intermediate part – front of bodies of T1–T3 and C5–C7; superior oblique part – anterior tubercles of transverse processes of C3–C5

*Insertion:* inferior oblique part – anterior tubercles of transverse processes of C5 and C6; vertical intermediate part – front of bodies of C2–C4; superior oblique part – anterior tubercle of atlas

*Nerve:* anterior primary rami (C2–C6)

## Lumbricals (foot)

*Action:* flexes metatarsophalangeal joints and extends interphalangeal joints of lateral four toes

*Origin:* tendons of flexor digitorum longus

*Insertion:* medial side of extensor hood and base of proximal phalanx of lateral four toes

*Nerve:* first lumbrical – medial plantar nerve (S2, S3); lateral three lumbricals – lateral plantar nerve (S2, S3)

## Lumbricals (hand)

*Action:* flexes metacarpophalangeal joints and extends interphalangeal joints of fingers

*Origin:* tendons of flexor digitorum profundus

*Insertion:* lateral margin of dorsal digital expansion of extensor digitorum

*Nerve:* first and second – median nerve (C8, T1); third and fourth – ulnar nerve (C8, T1)

## Multifidus

*Action:* extends, rotates and laterally flexes vertebral column

*Origin:* back of sacrum, aponeurosis of erector spinae, posterior superior iliac spine, dorsal sacroiliac ligaments,



mamillary processes in lumbar region, all thoracic transverse processes, articular processes of lower four cervical vertebrae

*Insertion:* spines of all vertebrae from L5 to axis (deep layer attaches to vertebrae above; middle layer attaches to second or third vertebrae above; outer layer attaches to third or fourth vertebrae above)

*Nerve:* dorsal rami of spinal nerves

### **Obturator externus**

*Action:* laterally rotates hip

*Origin:* outer surface of obturator membrane and adjacent bone of pubic and ischial rami

*Insertion:* trochanteric fossa of femur

*Nerve:* posterior branch of obturator nerve (L3, L4)

### **Obturator internus**

*Action:* laterally rotates hip

*Origin:* internal surface of obturator membrane and surrounding bony margin

*Insertion:* medial surface of greater trochanter

*Nerve:* nerve to obturator internus (L5, S1)

### **Opponens digiti minimi**

*Action:* abducts fifth digit, pulls it forwards and rotates it laterally

*Origin:* hook of hamate, flexor retinaculum

*Insertion:* medial border of fifth metacarpal

*Nerve:* ulnar nerve (C8, T1)

### **Opponens pollicis**

*Action:* rotates thumb into opposition with fingers

*Origin:* flexor retinaculum, tubercles of scaphoid and trapezium, abductor pollicis longus tendon

*Insertion:* radial side of base of proximal phalanx of thumb

*Nerve:* median nerve (C8, T1)



## Palmar interossei

*Action:* adducts thumb, index, ring and little finger

*Origin:* shaft of metacarpal of digit on which it acts

*Insertion:* dorsal digital expansion and base of proximal phalanx of same digit

*Nerve:* ulnar nerve (C8, T1)

## Palmaris longus

*Action:* flexes wrist

*Origin:* medial epicondyle via common flexor tendon

*Insertion:* flexor retinaculum, palmar aponeurosis

*Nerve:* median (C7, C8)

## Pectineus

*Action:* flexes and adducts hip

*Origin:* pecten pubis, iliopectineal eminence, pubic tubercle

*Insertion:* along a line from lesser trochanter to linea aspera

*Nerve:* femoral nerve (L2, L3), occasionally accessory obturator (L3)

## Pectoralis major

*Action:* adducts, medially rotates, flexes and extends shoulder

*Origin:* clavicular attachment – sternal half of anterior surface of clavicle; sternocostal attachment – anterior surface of manubrium, body of sternum, upper six costal cartilages, sixth rib, aponeurosis of external oblique muscle

*Insertion:* lateral lip of intertubercular sulcus of humerus

*Nerve:* medial and lateral pectoral nerves (C5–T1)

## Pectoralis minor

*Action:* protracts and medially rotates scapula

*Origin:* outer surface of third to fifth ribs and adjoining intercostal fascia

*Insertion:* upper surface and medial border of coracoid process

*Nerve:* medial and lateral pectoral nerves (C5–T1)

## Peroneus brevis

*Action:* everts and plantarflexes ankle

*Origin:* lower two-thirds of lateral surface of fibula, intermuscular septa



*Insertion:* lateral side of base of fifth metatarsal

*Nerve:* superficial peroneal nerve (L5, S1)

### **Peroneus longus**

*Action:* everts and plantarflexes ankle

*Origin:* lateral tibial condyle, upper two-thirds of lateral surface of fibula, intermuscular septa

*Insertion:* lateral side of base of first metatarsal, medial cuneiform

*Nerve:* superficial peroneal nerve (L5, S1)

### **Peroneus tertius**

*Action:* everts and dorsiflexes ankle

*Origin:* distal third of medial surface of fibula, interosseous membrane, intermuscular septum

*Insertion:* medial aspect of base of fifth metatarsal

*Nerve:* deep peroneal nerve (L5, S1)

### **Piriformis**

*Action:* laterally rotates and abducts hip

*Origin:* front of second to fourth sacral segments, gluteal surface of ilium, pelvic surface of sacrotuberous ligament

*Insertion:* medial side of greater trochanter

*Nerve:* anterior rami of sacral plexus (L5–S2)

### **Plantar interossei**

*Action:* adduct third to fifth toes, flex metatarsophalangeal joints of lateral three toes

*Origin:* base and medial side of lateral three toes

*Insertion:* medial side of base of proximal phalanx of same toes and dorsal digital expansions

*Nerve:* lateral plantar nerve (S2, S3)

### **Plantaris**

*Action:* plantarflexes ankle, flexes knee

*Origin:* lateral supracondylar ridge, oblique popliteal ligament



*Insertion:* tendo calcaneus  
*Nerve:* tibial nerve (S1, S2)

## **Popliteus**

*Action:* medially rotates tibia, flexes knee  
*Origin:* outer surface of lateral femoral condyle  
*Insertion:* posterior surface of tibia above soleal line  
*Nerve:* tibial nerve (L4–S1)

## **Pronator quadratus**

*Action:* pronates forearm  
*Origin:* lower quarter of anterior surface of ulna  
*Insertion:* lower quarter of anterior surface of radius  
*Nerve:* anterior interosseous branch of median nerve (C7, C8)

## **Pronator teres**

*Action:* pronates forearm, flexes elbow  
*Origin:* humeral head – medial epicondyle via common flexor tendon, intermuscular septum, antebrachial fascia; ulnar head – medial part of coronoid process  
*Insertion:* middle of lateral surface of radius  
*Nerve:* median nerve (C6, C7)

## **Psoas major**

*Action:* flexes hip and lumbar spine  
*Origin:* bodies of T12 and all lumbar vertebrae, bases of transverse processes of all lumbar vertebrae, lumbar intervertebral discs  
*Insertion:* lesser trochanter  
*Nerve:* anterior rami of lumbar plexus (L1–L3)

## **Psoas minor (not always present)**

*Action:* flexes trunk (weak)  
*Origin:* bodies of T12 and L1 vertebrae and intervertebral discs  
*Insertion:* pecten pubis, iliopubic eminence, iliac fascia  
*Nerve:* anterior primary ramus (L1)





## Quadratus femoris

*Action:* laterally rotates hip

*Origin:* ischial tuberosity

*Insertion:* quadratus tubercle midway down intertrochanteric crest

*Nerve:* nerve to quadratus femoris (L5, S1)

## Quadratus lumborum

*Action:* laterally flexes trunk, extends lumbar vertebrae, steadies twelfth rib during deep inspiration

*Origin:* iliolumbar ligament, posterior part of iliac crest

*Insertion:* lower border of twelfth rib, transverse processes of L1–L4

*Nerve:* ventral rami of T12 and L1–L3/4

## Rectus abdominis

*Action:* flexes trunk

*Origin:* symphysis pubis, pubic crest

*Insertion:* fifth to seventh costal cartilages, xiphoid process

*Nerve:* ventral rami of T6/7–T12

## Rectus capitis anterior

*Action:* flexes neck

*Origin:* anterior surface of lateral mass of atlas and root of its transverse process

*Insertion:* occipital bone

*Nerve:* anterior primary rami (C1, C2)

## Rectus capitis lateralis

*Action:* laterally flexes neck

*Origin:* transverse process of atlas

*Insertion:* jugular process of occipital bone

*Nerve:* ventral rami (C1, C2)

## Rectus capitis posterior major

*Action:* extends and rotates neck

*Origin:* spinous process of axis

*Insertion:* lateral part of inferior nuchal line of occipital bone

*Nerve:* dorsal ramus (C1)

## Rectus capitis posterior minor

*Action:* extends neck

*Origin:* posterior tubercle of atlas

*Insertion:* medial part of inferior nuchal line of occipital bone

*Nerve:* dorsal ramus (C1)

## Rectus femoris

*Action:* extends knee, flexes hip

*Origin:* straight head – anterior inferior iliac spine; reflected head – area above acetabulum, capsule of hip joint

*Insertion:* base of patella, then forms part of patellar ligament

*Nerve:* femoral nerve (L2–L4)

## Rhomboid major

*Action:* retracts and medially rotates scapula

*Origin:* spines and supraspinous ligaments of T2–T5

*Insertion:* medial border of scapula between root of spine and inferior angle

*Nerve:* dorsal scapular nerve (C4, C5)

## Rhomboid minor

*Action:* retracts and medially rotates scapula

*Origin:* spines and supraspinous ligaments of C7–T1, lower part of ligamentum nuchae

*Insertion:* medial end of spine of scapula

*Nerve:* dorsal scapular nerve (C4, C5)

## Rotatores

*Action:* extends vertebral column and rotates thoracic region

*Origin:* transverse process of each vertebra

*Insertion:* lamina of vertebra above

*Nerve:* dorsal rami of spinal nerves

## Sartorius

*Action:* flexes hip and knee, laterally rotates and abducts hip, medially rotates tibia on femur

*Origin:* anterior superior iliac spine and area just below

*Insertion:* upper part of medial side of tibia

*Nerve:* femoral nerve (L2, L3)



## Scalenus anterior

*Action:* flexes, laterally flexes and rotates neck, raises first rib during respiration

*Origin:* anterior tubercles of transverse processes of C3–C6

*Insertion:* scalene tubercle on inner border of first rib

*Nerve:* ventral rami (C4–C6)

## Scalenus medius

*Action:* laterally flexes neck, raises first rib during respiration

*Origin:* transverse processes of atlas and axis, posterior tubercles of transverse processes of C3–C7

*Insertion:* upper surface of first rib

*Nerve:* ventral rami (C3–C8)

## Scalenus posterior

*Action:* laterally flexes neck, raises second rib during respiration

*Origin:* posterior tubercles of transverse processes of C4–C6

*Insertion:* outer surface of second rib

*Nerve:* ventral rami (C6–C8)

## Semimembranosus

*Action:* flexes knee, extends hip and medially rotates tibia on femur

*Origin:* ischial tuberosity

*Insertion:* posterior aspect of medial tibial condyle

*Nerve:* tibial division of sciatic nerve (L5–S2)

## Semispinalis capitis

*Action:* extends and rotates head

*Origin:* transverse processes of C7–T6/7, articular processes of C4–C6

*Insertion:* between superior and inferior nuchal lines of occipital bone

*Nerve:* dorsal rami of spinal nerves

## Semispinalis cervicis

*Action:* extends and rotates vertebral column

*Origin:* transverse processes of T1–T5/6



*Insertion:* spinous processes of C2–C5

*Nerve:* dorsal rami of spinal nerves

### **Semispinalis thoracis**

*Action:* extends and rotates vertebral column

*Origin:* transverse processes of T6–T10

*Insertion:* spinous processes of C6–T4

*Nerve:* dorsal rami of spinal nerves

### **Semitendinosus**

*Action:* flexes knee, extends hip and medially rotates tibia on femur

*Origin:* ischial tuberosity

*Insertion:* upper part of medial surface of tibia

*Nerve:* tibial division of sciatic nerve (L5–S2)

### **Serratus anterior**

*Action:* protracts and laterally rotates scapula

*Origin:* outer surfaces and superior borders of upper eight, nine or ten ribs and intervening intercostal fascia

*Insertion:* costal surface of medial border of scapula

*Nerve:* long thoracic nerve (C5–C7)

### **Soleus**

*Action:* plantarflexes ankle

*Origin:* soleal line and middle third of medial border of tibia, posterior surface of head and upper quarter of fibula, fibrous arch between tibia and fibula

*Insertion:* posterior surface of calcaneus

*Nerve:* tibial nerve (S1, S2)

### **Spinalis (capitis\*, cervicis\*, thoracis)**

*Action:* extends vertebral column

*Origin:* spinalis thoracis – spinous processes of T11–L2

*Insertion:* spinalis thoracis – spinous processes of upper four to eight thoracic vertebrae

\*Spinalis capitis and spinalis cervicis are poorly developed and blend with adjacent muscles

*Nerve:* dorsal rami



## Splenius capitis

*Action:* extends, laterally flexes and rotates neck

*Origin:* lower half of ligamentum nuchae, spinous processes of C7–T3/4 and their supraspinous ligaments

*Insertion:* mastoid process of temporal bone, lateral third of superior nuchal line of occipital bone

*Nerve:* dorsal rami (C3–C5)

## Splenius cervicis

*Action:* laterally flexes, rotates and extends neck

*Origin:* spinous processes of T3–T6

*Insertion:* posterior tubercles of transverse processes of C1–C3/4

*Nerve:* dorsal rami (C5–C7)

## Sternocleidomastoid

*Action:* laterally flexes and rotates neck; anterior fibres flex neck, posterior fibres extend neck

*Origin:* sternal head – anterior surface of manubrium sterni; clavicular head – upper surface of medial third of clavicle

*Insertion:* mastoid process of temporal bone, lateral half of superior nuchal line of occipital bone

*Nerve:* accessory nerve (XI)

## Subscapularis

*Action:* medially rotates shoulder

*Origin:* medial two-thirds of subscapular fossa and tendinous intramuscular septa

*Insertion:* lesser tubercle of humerus, anterior capsule of shoulder joint

*Nerve:* upper and lower subscapular nerves (C5, C6)

## Superior oblique

*Action:* extends neck

*Origin:* upper surface of transverse process of atlas

*Insertion:* superior and inferior nuchal lines of occipital bone

*Nerve:* dorsal ramus (C1)





## Supinator

*Action:* supinates forearm

*Origin:* inferior aspect of lateral epicondyle, radial collateral ligament, annular ligament, supinator crest and fossa of ulna

*Insertion:* posterior, lateral and anterior aspects of upper third of radius

*Nerve:* posterior interosseous nerve (C6, C7)

## Supraspinatus

*Action:* abducts shoulder

*Origin:* medial two-thirds of supraspinous fossa and supraspinous fascia

*Insertion:* capsule of shoulder joint, greater tubercle of humerus

*Nerve:* suprascapular nerve (C5, C6)

## Tensor fascia lata

*Action:* extends knee, abducts and medially rotates hip

*Origin:* outer lip of iliac crest between iliac tubercle and anterior superior iliac spine

*Insertion:* iliotibial tract

*Nerve:* superior gluteal nerve (L4–S1)

## Teres major

*Action:* extends, adducts and medially rotates shoulder

*Origin:* dorsal surface of inferior scapular angle

*Insertion:* medial lip of intertubercular sulcus of humerus

*Nerve:* lower subscapular nerve (C5–C7)

## Teres minor

*Action:* laterally rotates shoulder

*Origin:* upper two-thirds of dorsal surface of scapula

*Insertion:* lower facet on greater tuberosity of humerus, lower posterior surface of capsule of shoulder joint

*Nerve:* axillary nerve (C5, C6)

## Tibialis anterior

*Action:* dorsiflexes and inverts ankle

*Origin:* lateral tibial condyle and upper two-thirds of lateral surface of tibia, interosseous membrane

*Insertion:* medial and inferior surface of medial cuneiform, base of first metatarsal

*Nerve:* deep peroneal nerve (L4, L5)

### **Tibialis posterior**

*Action:* plantarflexes and inverts ankle

*Origin:* lateral aspect of posterior surface of tibia below soleal line, interosseous membrane, upper half of posterior surface of fibula, deep transverse fascia

*Insertion:* tuberosity of navicular, medial cuneiform, sustentaculum tali, intermediate cuneiform, base of second to fourth metatarsals

*Nerve:* tibial nerve (L4, L5)

### **Transversus abdominis**

*Action:* compresses abdominal contents, raises intra-abdominal pressure

*Origin:* lateral third of inguinal ligament, anterior two-thirds of inner lip of iliac crest, thoracolumbar fascia between iliac crest and twelfth rib, lower six costal cartilages where it interdigitates with diaphragm

*Insertion:* abdominal aponeurosis to linea alba

*Nerve:* ventral rami of lower six thoracic and first lumbar spinal nerve

### **Trapezius**

*Action:* upper fibres elevate scapula, middle fibres retract scapula, lower fibres depress scapula, upper and lower fibres together laterally rotate scapula. Also extends and laterally flexes head and neck

*Origin:* medial third of superior nuchal line, external occipital protuberance, ligamentum nuchae, spinous processes and supraspinous ligaments of C7–T12

*Insertion:* upper fibres – posterior border of lateral third of clavicle; middle fibres – medial border of acromion,

superior lip of crest of spine of scapula; lower fibres – tubercle at medial end of spine of scapula

*Nerve:* accessory nerve (XI), ventral rami (C3, C4)

## Triceps brachii

*Action:* extends elbow and shoulder

*Origin:* long head – infraglenoid tubercle of scapula, shoulder capsule; lateral head – above and lateral to spiral groove on posterior surface of humerus; medial head – below and medial to spiral groove on posterior surface of humerus

*Insertion:* upper surface of olecranon, deep fascia of forearm

*Nerve:* radial nerve (C6–C8)

## Vastus intermedius

*Action:* extends knee

*Origin:* upper two-thirds of anterior and lateral surfaces of femur, lower part of lateral intermuscular septum

*Insertion:* deep surface of quadriceps tendon, lateral border of patella, lateral tibial condyle

*Nerve:* femoral nerve (L2–L4)

## Vastus lateralis

*Action:* extends knee

*Origin:* intertrochanteric line, greater trochanter, gluteal tuberosity, lateral lip of linea aspera

*Insertion:* tendon of rectus femoris, lateral border of patella

*Nerve:* femoral nerve (L2–L4)

## Vastus medialis

*Action:* extends knee

*Origin:* intertrochanteric line, spiral line, medial lip of linea aspera, medial supracondylar line, medial intermuscular septum, tendons of adductor longus and adductor magnus

*Insertion:* tendon of rectus femoris, medial border of patella, medial tibial condyle

*Nerve:* femoral nerve (L2–L4)





## The Medical Research Council scale for muscle power



### SECTION

# 2

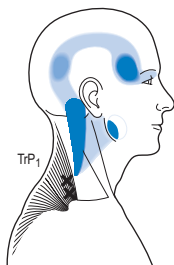
### MUSCULOSKELETAL

Grade	Response
0	No movement
1	Flicker of contraction
2	Active movement with gravity eliminated
3	Active movement against gravity
4	Active movement against resistance but not to full strength
5	Normal power

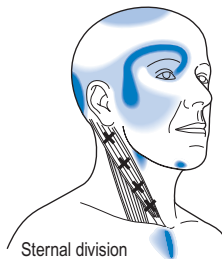
In addition, grade 4 movements may be subdivided into:

- 4– movement against slight resistance
- 4 movement against moderate resistance
- 4+ movement against strong resistance.

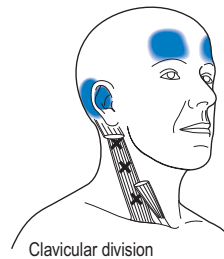
## Trigger points



**Trapezius**

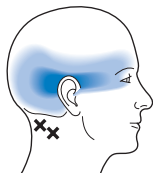


Sternal division

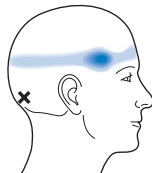


Clavicular division

**Sternocleidomastoid**



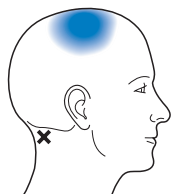
**Suboccipital**



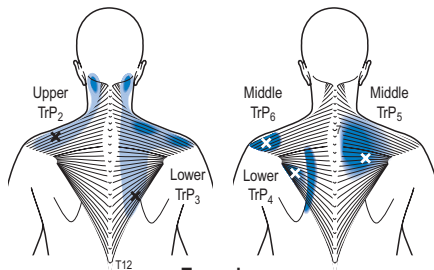
**Semispinalis capitis**



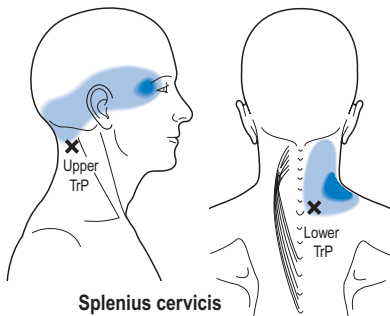
**Semispinalis cervicis**



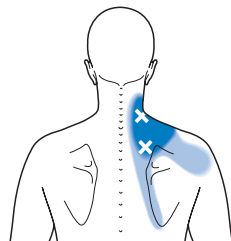
Splenius capitis



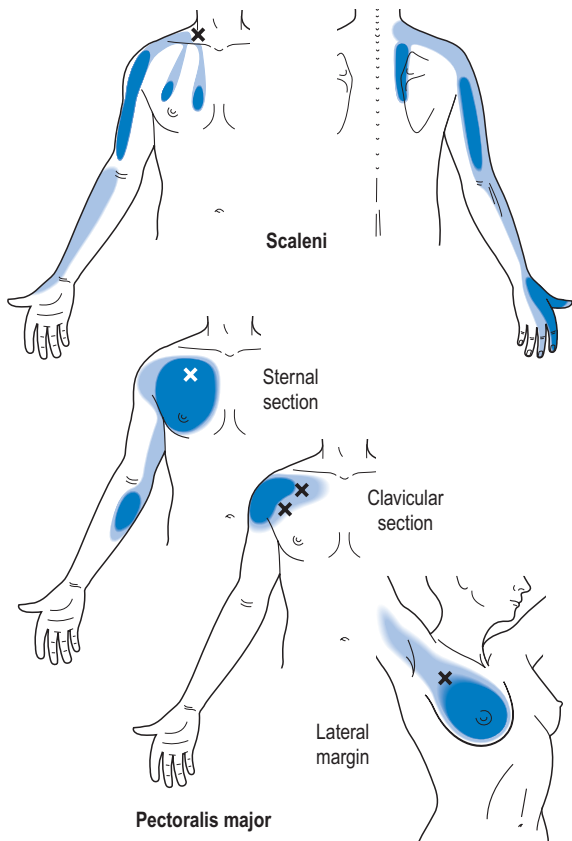
Trapezius

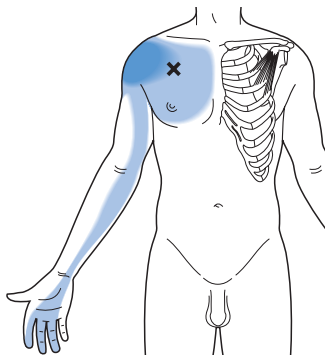


Splenius cervicis

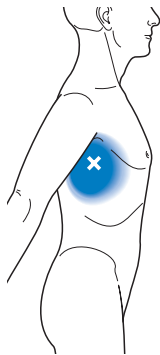


Levator scapulae

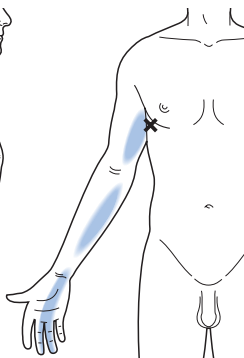
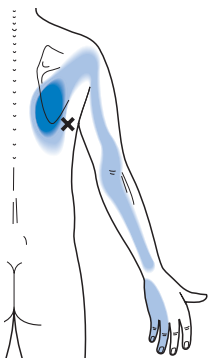




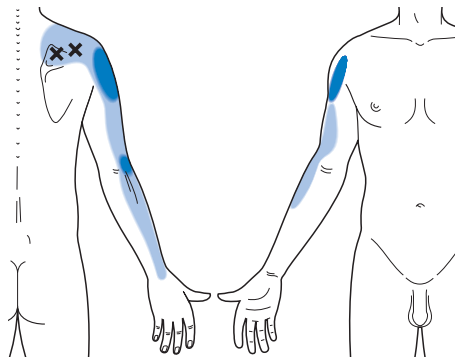
**Pectoralis minor**



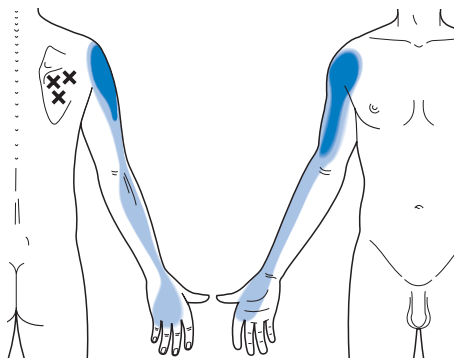
**Serratus anterior**



**Latissimus dorsi**



**Supraspinatus**



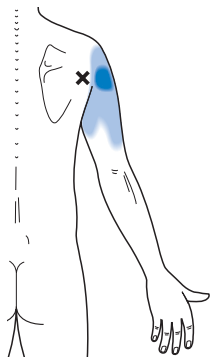
**Infraspinatus**



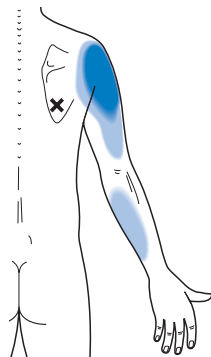
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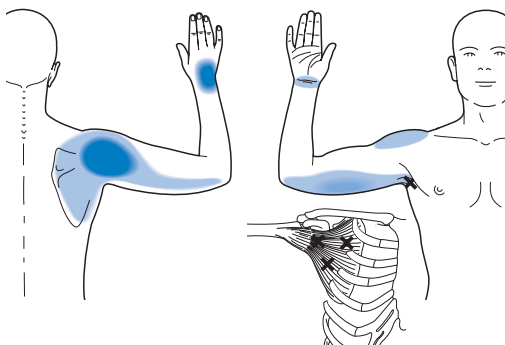
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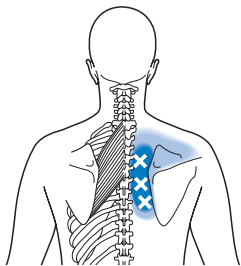
**Teres minor**



**Teres major**



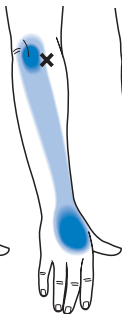
**Subscapularis**



**Rhomboideus**



**Extensor  
carpi ulnaris**



**Extensor  
carpi radialis  
longus**



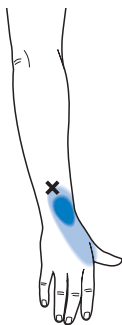
**Extensor  
carpi radialis  
brevis**



**Middle finger**



**Ring finger**



**Extensor indicis**

**Finger extensors**

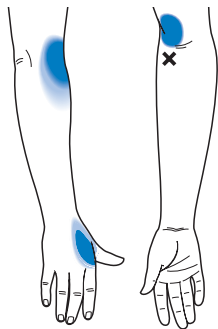




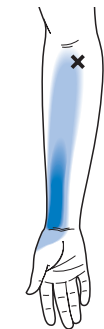


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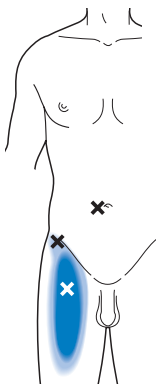
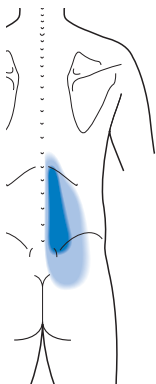
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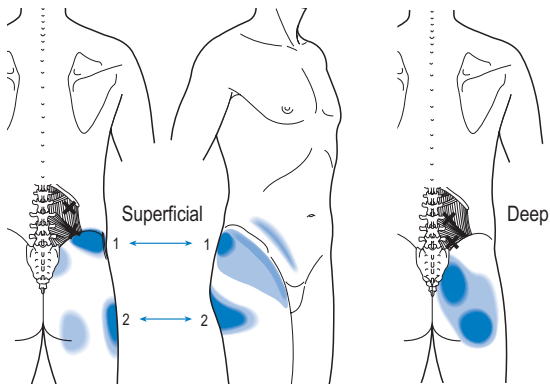
Supinator



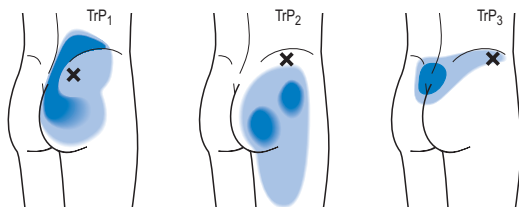
Pronator teres



Iliopsoas



**Quadratus lumborum**



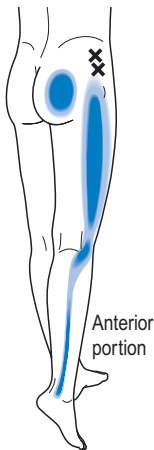
**Gluteus medius**



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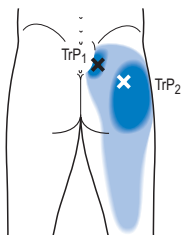
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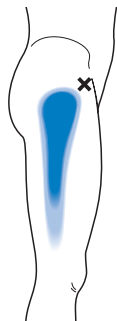


Gluteus medius

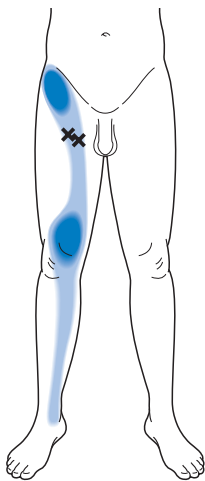
Anterior portion



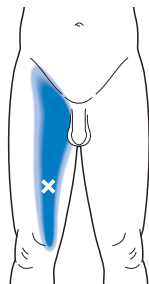
Piriformis



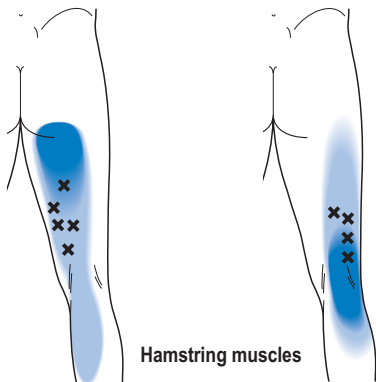
Tensor fasciae latae



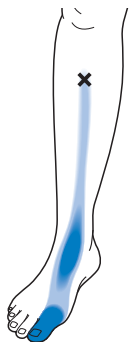
Adductor brevis



Adductor magnus



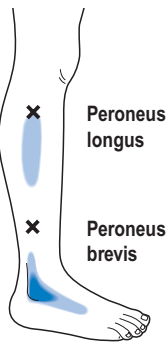
Hamstring muscles



Tibialis anterior



Extensor digitorum longus



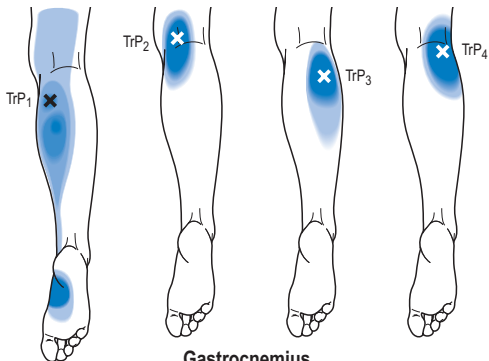
Peroneus longus

Peroneus brevis

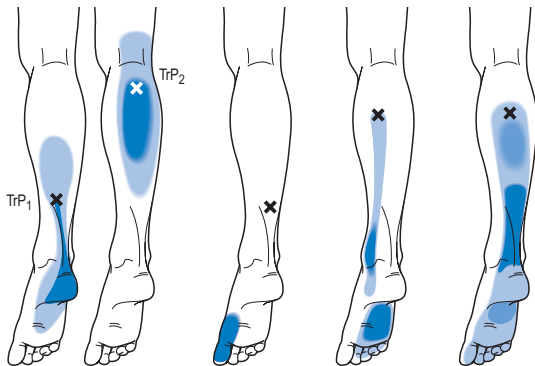


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**Gastrocnemius**



**Soleus**

**Flexor  
hallucis  
longus**

**Flexor  
digitorum  
longus**

**Tibialis  
posterior**

## Normal joint range of movement

### Shoulder

Flexion	160–180°
Extension	50–60°
Abduction	170–180°
Medial rotation	70–90°
Lateral rotation	80–100°

### Elbow

Flexion	140–150°
Extension	0°
Pronation	80–90°
Supination	80–90°

### Wrist

Flexion	70–80°
Extension	60–80°
Radial deviation	15–25°
Ulnar deviation	30–40°

### Hip

Flexion	120–125°
Extension	15–30°
Abduction	30–50°
Adduction	20–30°
Medial rotation	25–40°
External rotation	40–50°



## Knee

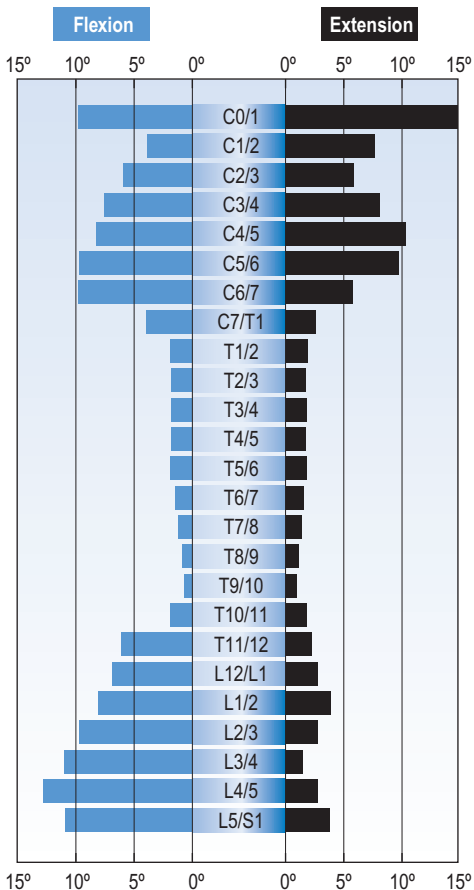
Flexion	130–140°
Extension	0°

## Ankle

Dorsiflexion	15–20°
Plantarflexion	50–60°
Inversion	30–40°
Eversion	15–20°

Normal ranges of movement vary greatly between individuals. The above figures represent average ranges of movement.

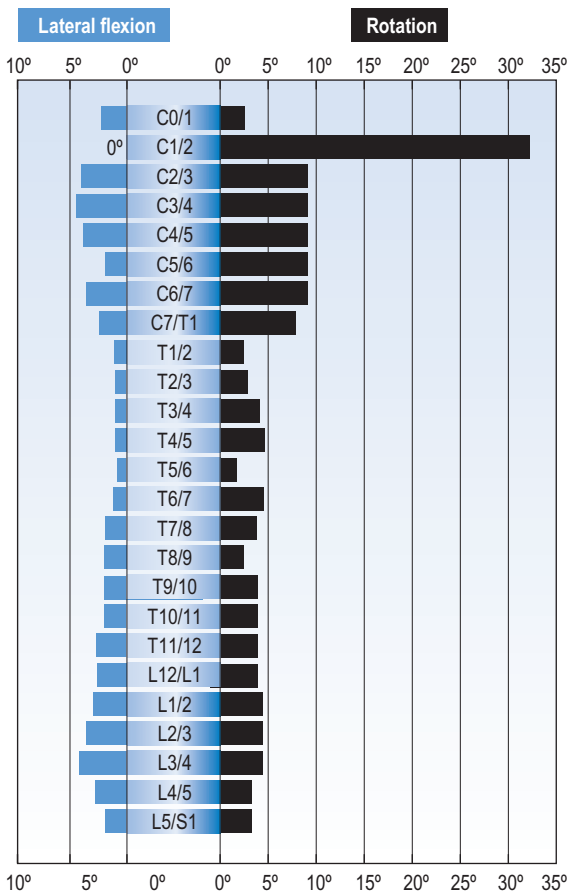
**Average range of segmental movement (Middleditch & Oliver 2005, with permission)**



**Figure 2.1** Spinal flexion and extension.







**Figure 2.2** Spinal lateral flexion and rotation.

## Close packed positions and capsular patterns for selected joints

Joint	Close packed position	Capsular pattern*
Temporomandibular	Clenched teeth	Opening mouth
Cervical spine	Extension (also applies to thoracic and lumbar spine)	Side flexion and rotation equally limited; flexion is full but painful, extension is limited
Glenohumeral	Abduction and lateral rotation	Lateral rotation then abduction then medial rotation
Humeroulnar	Extension	Flexion then extension
Radiocarpal	Extension with radial deviation	Flexion and extension equally limited
Trapeziometacarpal	None	Abduction and extension, full flexion
Metacarpophalangeal interphalangeal	<i>Metacarpophalangeal</i> Flexion (fingers) Opposition (thumb) <i>Interphalangeal</i> Extension	Flexion then extension
Hip	Extension and medial rotation	Flexion, abduction and medial rotation (order may vary) Extension is slightly limited
Knee	Extension and lateral rotation of tibia	Flexion then extension

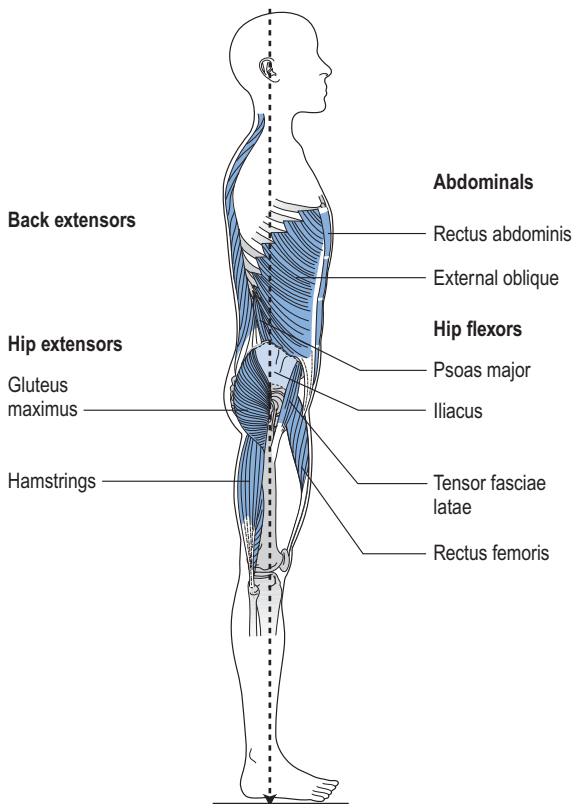




Joint	Close packed position	Capsular pattern*
Talocrural	Dorsiflexion	Plantarflexion then dorsiflexion
Subtalar	Inversion	Inversion
Mid-tarsal	Inversion (also applies to tarsometatarsal)	Dorsiflexion, plantarflexion, adduction and medial rotation
First metatarsophalangeal	<i>Metatarsophalangeal</i> Extension <i>Interphalangeal</i> Extension	Extension then flexion

\*Movements are listed in order of restriction, from the most limited to the least limited.  
Data from Cyriax (1982) and Magee (2008).

**Ideal alignment: side view (Fig. 2.3)**

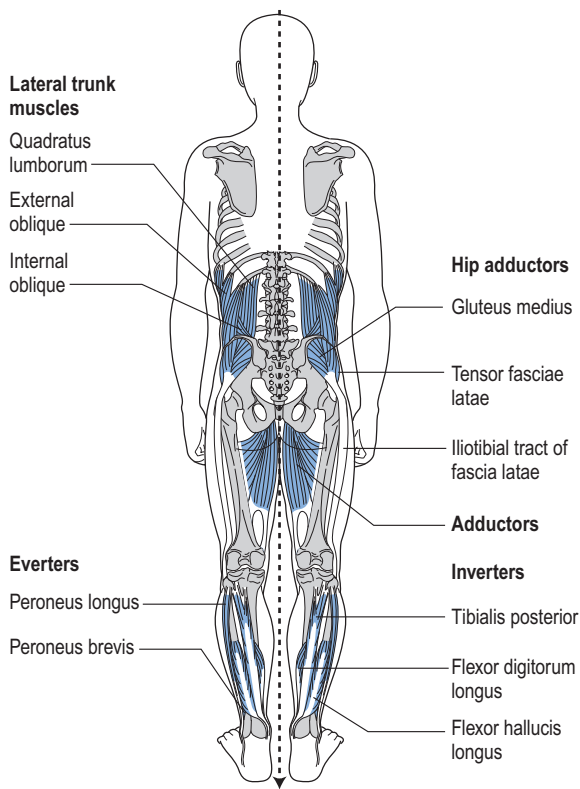


**Figure 2.3** Ideal alignment (side view).



Anteriorly, the abdominal muscles pull upward and the hip flexors pull downward. Posteriorly, the back muscles pull upward and the hip extensors pull downward. Thus, the abdominal and hip extensor muscles work together to tilt the pelvis posteriorly; the back and hip flexor muscles work together to tilt the pelvis anteriorly.

### Ideal alignment: posterior view (Fig. 2.4)



**Figure 2.4** Ideal alignment (posterior view).

Laterally, the following groups of muscles work together in stabilizing the trunk, pelvis and lower extremities:

- Right lateral trunk flexors
- Right hip adductors
- Left hip abductors
- Right tibialis posterior
- Right flexor hallucis longus
- Right flexor digitorum longus
- Left peroneus longus and brevis
- Left lateral trunk flexors
- Left hip adductors
- Right hip abductors
- Left tibialis posterior
- Left flexor hallucis longus
- Left flexor digitorum longus
- Right peroneus longus and brevis

### **Kyphosis–lordosis posture (Fig. 2.5)**

*Short and strong:* neck extensors and hip flexors. The low back is strong and may or may not develop shortness.

*Elongated and weak:* neck flexors, upper back erector spinae and external oblique. Hamstrings are slightly elongated but may or may not be weak.

### **Sway-back posture (Fig. 2.6)**

*Short and strong:* hamstrings and upper fibres of internal oblique. Strong but not short: lumbar erector spinae.

*Elongated and weak:* one-joint hip flexors, external oblique, upper back extensors and neck flexors.

### **Flat-back posture (Fig. 2.7)**

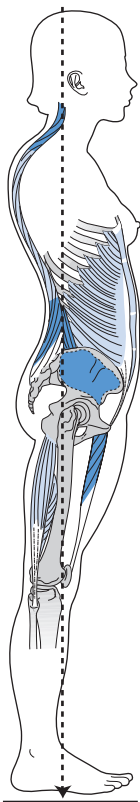
*Short and strong:* hamstrings and often the abdominals.

*Elongated and weak:* one-joint hip flexors.

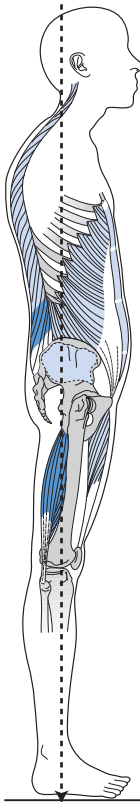
### **Faulty alignment: posterior view (Fig. 2.8)**

*Short and strong:* right lateral trunk muscles, left hip abductors, right hip adductors, left peroneus longus and brevis, right tibialis posterior, right flexor hallucis longus, right





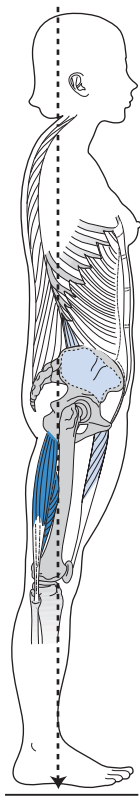
**Figure 2.5** Kyphosis–lordosis posture.



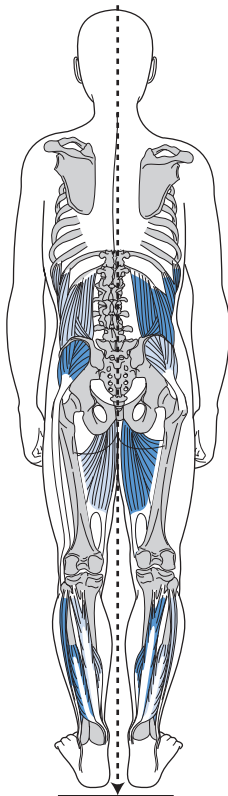
**Figure 2.6** Sway-back posture.

flexor digitorum longus. The left tensor fascia lata is usually strong and there may be tightness in the iliotibial band.

*Elongated and weak:* left lateral trunk muscles, right hip abductors (especially posterior gluteus medius), left hip



**Figure 2.7** Flat-back posture.



**Figure 2.8** Faulty alignment (posterior view). Typical of right-handed individuals.

adductors, right peroneus longus and brevis, left tibialis posterior, left flexor hallucis longus, left flexor digitorum longus. The right tensor fascia lata may or may not be weak.



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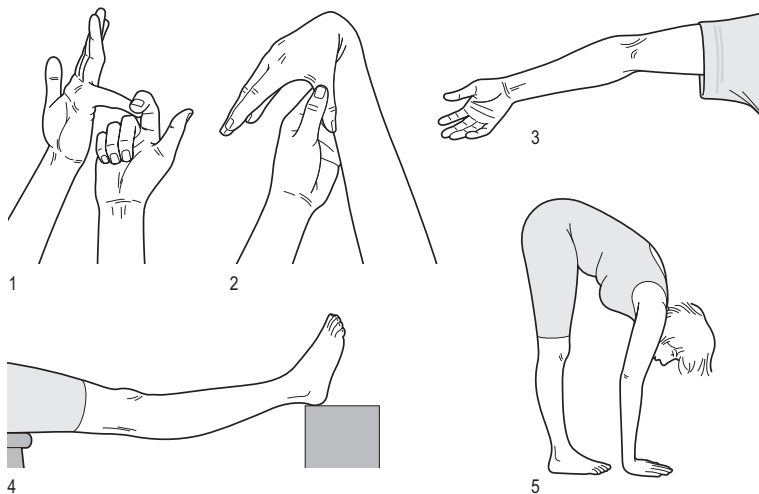
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## Beighton hypermobility score



**Figure 2.9** Beighton score for joint hypermobility.

## Nine-point Beighton hypermobility score

The ability to:		Right	Left
1	Passively extend the fifth metacarpophalangeal joint to $\geq 90^\circ$	1	1
2	Passively appose the thumb to the anterior aspect of the forearm	1	1
3	Passively hyperextend the elbow to $\geq 10^\circ$	1	1
4	Passively hyperextend the knee to $\geq 10^\circ$	1	1
5	Actively place hands flat on the floor without bending the knees	1	
TOTAL		9	

One point is given for each side for manoeuvres 1–4 so that the hypermobility score will have a maximum of 9 points if all are positive.

It is generally considered that hypermobility is present if 4 out of 9 points are scored.

**Beighton criteria: diagnostic criteria for benign joint hypermobility syndrome** (from Grahame et al 2000, with permission)

### Major criteria

1. A Beighton score of 4/9 or greater (either currently or historically)
2. Arthralgia for longer than 3 months in four or more joints

### Minor criteria

1. A Beighton score of 1, 2 or 3/9 (0, 1, 2 or 3 if aged 50+)
2. Arthralgia ( $\geq 3$  months) in 1–3 joints, or back pain ( $\geq 3$  months), spondylosis, spondylolysis/spondylolisthesis
3. Dislocation/subluxation in more than one joint, or in one joint on more than one occasion
4. Soft tissue rheumatism  $\geq 3$  lesions (e.g. epicondylitis, tenosynovitis, bursitis)





5. Marfanoid habitus: tall, slim, span : height ratio  $>1.03$ , upper : lower segment ratio  $<0.89$ , arachnodactyly (positive Steinberg/wrist signs)
6. Abnormal skin: striae, hyperextensibility, thin skin, papyraceous scarring
7. Eye signs: drooping eyelids or myopia or anti-mongoloid slant
8. Varicose veins or hernia or uterine/rectal prolapse

Benign joint hypermobility syndrome (BJHS) is diagnosed in the presence of **two** major criteria, or **one** major and **two** minor criteria, or **four** minor criteria. **Two** minor criteria will suffice where there is an unequivocally affected first-degree relative. BJHS is excluded by the presence of Marfan or Ehlers–Danlos syndrome (EDS) (other than the EDS hypermobility type – formerly EDS III). Criteria Major 1 and Minor 1 are mutually exclusive, as are Major 2 and Minor 2.

## Common classifications of fractures

### Proximal humeral fractures: Neer's classification

#### Group I

All proximal humeral fractures where there is minimal displacement or angulation.

#### Group II

Displaced fractures of the anatomical neck ( $>1$  cm).

#### Group III

Severely displaced or angled fractures of the surgical neck. These may be impacted or comminuted.

#### Group IV

Displaced fractures of the greater tuberosity.

#### Group V

Displaced fractures of the lesser tuberosity.

#### Group VI

Fracture-dislocations.

## Radial head fractures: Hotchkiss modification of Mason's classification

### Type 1

Small vertical split with minimal displacement (<2 mm). Stability and rotation largely uncompromised.

### Type 2

Displaced single fragment fracture (<2 mm), usually distally. Any fracture that restricts rotation. Any comminuted fracture that can be internally fixated.

### Type 3

Highly comminuted fractures that cannot be internally fixated.

## Fractures of the radius and ulna

### Monteggia fracture-dislocation

Fracture of the ulna associated with dislocation of the radial head.

### Galeazzi fracture-dislocation

Fracture of the distal third of the radius associated with dislocation of the inferior radioulnar joint.

### Colles' fracture

Transverse fracture of the distal radius with dorsal (posterior) displacement of the distal fragment.

### Smith's fracture

Transverse fracture of the distal radius with volar (anterior) displacement of the distal fragment (often called a 'reversed Colles').

### Barton's fracture

The true Barton's fracture is a form of Smith's fracture associated with volar subluxation of the carpus. However, dorsal subluxation of the carpus can also occur, which is sometimes called a 'dorsal Barton's fracture'.



## Fractures of the thumb metacarpal

### Bennett's fracture

Oblique fracture of the first metacarpal extending into the trapeziometacarpal joint associated with dislocation of the carpometacarpal joint.

### Rolando's fracture

Intra-articular comminuted fracture of the base of the first metacarpal.

## Scaphoid fractures: Herbert classification

- A1 Fracture of the tubercle (stable)
- A2 Hairline fracture of the waist (stable)
- B1 Oblique fracture of distal third (unstable)
- B2 Displaced fracture of the waist (unstable)
- B3 Proximal pole fracture (unstable)
- B4 Fracture associated with carpal dislocation (unstable)
- B5 Comminuted fracture (unstable)

## Pelvic fractures: Tile classification

### Type A (stable)

- A1: fractures of the pelvis not involving the pelvic ring
- A2: stable, minimally displaced fractures of the pelvic ring

### Type B (rotationally unstable but vertically stable)

- B1: anteroposterior compression fractures (open book fractures)
- B2: lateral compression fractures, ipsilateral
- B3: lateral compression fractures, contralateral

### Type C (rotationally and vertically unstable)

- C1: unilateral
- C2: bilateral
- C3: associated with acetabular fracture

## Intracapsular fractures of the neck of femur: Garden classification

### Type I

Incomplete fracture of the neck of femur with angulation of the trabecular lines.



### Type II

Complete fracture without displacement of the neck of femur. The trabecular lines are interrupted but not angulated.

### Type III

Complete fracture with partial displacement of the neck of femur.

### Type IV

Complete fracture with total displacement of the neck of femur.

## Tibial plateau fractures: Schatzker classification

### Type I

Split or wedge fracture of the lateral tibial condyle.

### Type II

Split or wedge fracture of the lateral tibial condyle combined with depression of the adjacent remaining load-bearing portion of the lateral plateau.

### Type III

Pure depression fracture of the lateral tibial plateau without an associated split or wedge fracture.

### Type IV

Fracture of the medial tibial plateau. May be a split or a split depression fracture.

### Type V

Split fracture of both the medial and lateral tibial condyles.

### Type VI

Combined condylar and subcondylar fractures that separate the tibial shaft from the tibial condyles.

## Ankle fractures: Weber's classification

Fibular fractures are classified into three types:

### Type A

Fracture below the tibiofibular syndesmosis.



### Type B

Fracture at the level of the tibial plafond, which often spirals upwards. The syndesmosis is usually involved; however, it remains intact.

### Type C

Fracture above the tibiofibular syndesmosis. The syndesmosis is ruptured.

## Classification of ligament and muscle sprains

### Ligament sprains

#### Grade I/mild sprain

Few ligament fibres torn, stability maintained.

#### Grade II/moderate sprain

Partial rupture, increased laxity but no gross instability.

#### Grade III/severe sprain

Complete rupture, gross instability.

### Muscle strains

#### Grade I/mild strain

Few muscle fibres torn, minimum loss of strength and pain on muscle contraction.

#### Grade II/moderate strain

Approximately half of muscle fibres torn, significant muscle weakness and loss of function. Moderate to severe pain on isometric contraction.

#### Grade III/severe strain

Complete tear of the muscle, significant muscle weakness and severe loss of function. Minimum to no pain on isometric contraction.

## Common musculoskeletal tests

A brief description of each test is given below. For a fuller description of how each test is performed, please refer to



a musculoskeletal assessment textbook (e.g. Magee 2008, Malanga & Nadler 2006, Petty 2006).

## Cervical spine

### Spurling's test

*Tests:* nerve root compression.

*Procedure:* patient sitting. Extend neck and rotate head. Apply downward pressure to head.

*Positive sign:* radiating pain into shoulder or arm on side to which the head is rotated.

### Distraction test

*Tests:* nerve root compression.

*Procedure:* patient in sitting. Place one hand under chin and other hand under occiput. Gently lift patient's head.

*Positive sign:* relief or decrease in pain.

## Shoulder

### Active compression test (O'Brien)

*Tests:* labral pathology, acromioclavicular joint pathology.

*Procedure:* patient upright with elbow in extension and shoulder in 90° flexion, 10–15° adduction and medial rotation. Stand behind patient and apply downward force to arm. Repeat with arm in lateral rotation.

*Positive sign:* pain/increased pain with medial rotation and decreased pain with lateral rotation. Pain inside the glenohumeral joint indicates labral abnormality. Pain over the acromioclavicular joint indicates acromioclavicular joint abnormality.

### Anterior drawer test

*Tests:* anterior shoulder stability.

*Procedure:* patient supine. Place shoulder in 80–120° abduction, 0–20° forward flexion and 0–30° lateral rotation. Stabilize scapula. Draw humerus anteriorly.

*Positive sign:* click and/or apprehension.

### Anterior slide test

*Tests:* labral pathology.

*Procedure:* patient upright with hands on hips, thumbs facing posteriorly. Stand behind patient and stabilize scapula and





clavicle with one hand. With the other, apply an antero-superior force to elbow while instructing the patient to gently push back against the force.

*Positive sign:* pain/reproduction of symptoms/click.

### Apprehension test

*Tests:* glenohumeral joint stability.

*Procedure:* patient in standing or supine. Abduct shoulder to 90°. Move it into maximum lateral rotation. If movement well tolerated, apply a posteroanterior force to humeral head.

*Positive sign:* apprehension and pain.

### Biceps load test I

*Tests:* superior labral pathology.

*Procedure:* patient supine with shoulder in 90° abduction, elbow in 90° flexion and forearm supinated. Laterally rotate shoulder until patient becomes apprehensive. Maintain this position. Resist elbow flexion.

*Positive sign:* pain/apprehension remains unchanged or increases during resisted elbow flexion.

### Biceps load test II

*Tests:* superior labral pathology.

*Procedure:* patient supine with shoulder in 120° abduction and maximum lateral rotation, elbow in 90° flexion and forearm supinated. Resist elbow flexion.

*Positive sign:* increased pain during resisted elbow flexion.

### Clunk test

*Tests:* tear of glenoid labrum.

*Procedure:* patient supine. Abduct shoulder over patient's head. Apply anterior force to posterior aspect of humeral head while rotating humerus laterally.

*Positive sign:* a clunk or grinding sound and/or apprehension if anterior instability present.

### Crank test

*Tests:* labral pathology.

*Procedure:* patient sitting or supine with shoulder in 160° flexion in scapular plane. Hold elbow and apply a longitudinal compressive force to humerus while rotating it medially and laterally.



*Positive sign:* pain/reproduction of symptoms, with or without click, usually during lateral rotation.

### Crossed-arm adduction test (Apley scarf test)

*Tests:* acromioclavicular joint pathology.

*Procedure:* patient upright. Horizontally adduct the arm as far as possible.

*Positive sign:* pain around acromioclavicular joint.

### Drop test (external rotation lag sign)

*Tests:* infraspinatus and supraspinatus integrity.

*Procedure:* patient upright with shoulder in 20° abduction (in the scapular plane) with elbow in 90° flexion. Place shoulder in full lateral rotation. Support elbow and ask patient to hold position.

*Positive sign:* arm drops into medial rotation.

### Hawkins–Kennedy impingement test

*Tests:* impingement of supraspinatus tendon.

*Procedure:* patient sitting or standing. Forward flex shoulder to 90° and flex elbow to 90°. Apply passive medial rotation.

*Positive sign:* reproduction of symptoms.

### Hornblower's sign

*Tests:* teres minor integrity.

*Procedure:* patient sitting or standing with arms by side. Patient lifts hands up to mouth.

*Positive sign:* inability to lift the hand to the mouth without abducting arm first (this compensatory manoeuvre on the affected side is the hornblower's sign).

### Jerk test

*Tests:* posterior shoulder stability.

*Procedure:* patient sitting. Place shoulder in 90° forward flexion and medial rotation. Apply longitudinal cephalad force to humerus and move arm into horizontal adduction.

*Positive sign:* sudden jerk or clunk.

### Lift-off test

*Tests:* subscapularis integrity.



*Procedure:* patient upright with arm medially rotated behind back. Patient lifts hand away from back.

*Positive sign:* inability to lift arm indicates tendon rupture.

### Load and shift test

*Tests:* anterior and posterior shoulder stability.

*Procedure:* patient sitting. Stabilize scapula by fixing coracoid process and spine of scapula. Grasp humeral head and apply a medial, compressive force to seat it in the glenoid fossa (load). Glide the humeral head anteriorly and posteriorly (shift).

*Positive sign:* increased anterior or posterior glide indicates anterior or posterior instability.

### Neer impingement test

*Tests:* impingement of supraspinatus tendon and/or biceps tendon.

*Procedure:* patient sitting or standing. Passively elevate arm through forward flexion and medial rotation.

*Positive sign:* reproduction of symptoms.

### Patte's test

*Tests:* infraspinatus and teres minor integrity.

*Procedure:* patient sitting. Place shoulder in 90° flexion in the scapular plane and elbow in 90° flexion. Patient rotates arm laterally against resistance.

*Positive sign:* resistance with pain indicates tendinopathy. Inability to resist with gradual lowering of the arm or forearm indicates tendon rupture.

### Posterior drawer test

*Tests:* posterior shoulder stability.

*Procedure:* patient supine. Place shoulder in 100–120° abduction and 20–30° forward flexion with elbow flexed to 120°. Stabilize scapula. Medially rotate and forward flex shoulder between 60° and 80° while pushing head of humerus posteriorly.

*Positive sign:* significant posterior displacement and/or patient apprehension.





### Relocation test (Fowler's sign)

*Tests:* differentiates between anterior shoulder stability and primary impingement.

*Procedure:* perform the apprehension test in supine. At the point where the patient feels pain or apprehension apply an anteroposterior force to humeral head.

*Positive sign:* persistence of pain or apprehension indicates primary impingement. Decrease in pain or apprehension and increased lateral rotation indicates instability and secondary impingement.

### Speed's test

*Tests:* biceps tendon pathology.

*Procedure:* patient sitting or standing. Forward flex shoulder, supinate forearm and extend elbow. Resist patient's attempt to flex shoulder.

*Positive sign:* increased pain in bicipital groove.

### Sulcus sign

*Tests:* inferior shoulder stability.

*Procedure:* patient standing or sitting, arm by side. Grip arm below elbow and pull distally.

*Positive sign:* reproduction of symptoms and/or appearance of sulcus under acromion.

### Supraspinatus (empty can) test

*Tests:* supraspinatus tendon pathology; suprascapular nerve neuropathy.

*Procedure:* patient sitting or standing. Abduct shoulder to 90°. Horizontally flex to 30° and medially rotate so thumbs point downwards. Resist patient's attempt to abduct.

*Positive sign:* reproduction of symptoms or weakness.

### Yergason's test

*Tests:* biceps tendon pathology; subacromial impingement.

*Procedure:* patient sitting or standing with elbow in 90° flexion and forearm pronated. Resist patient's attempts to supinate.

*Positive sign:* increased pain in bicipital groove.

## Elbow

### Elbow flexion test

*Tests:* cubital tunnel (ulnar nerve) syndrome.

*Procedure:* patient standing or sitting. Fully flex elbows with wrist extended. Hold for 5 minutes.

*Positive sign:* tingling or paraesthesia in ulnar nerve distribution.

### Lateral epicondylitis (tennis elbow) test: method 1

*Tests:* lateral epicondylitis.

*Procedure:* passively extend elbow, pronate forearm and flex wrist and fingers while palpating lateral epicondyle.

*Positive sign:* reproduction of symptoms.

### Lateral epicondylitis (tennis elbow) test: method 2

*Tests:* lateral epicondylitis.

*Procedure:* resist extension of middle finger distal to PIP (proximal interphalangeal) joint.

*Positive sign:* reproduction of symptoms.

### Medial epicondylitis (golfer's elbow) test

*Tests:* medial epicondylitis.

*Procedure:* passively extend elbow, supinate forearm and extend wrist and fingers while palpating medial epicondyle.

*Positive sign:* reproduction of symptoms.

### Pinch grip test

*Tests:* anterior interosseous (median) nerve entrapment.

*Procedure:* patient pinches tips of index finger and thumb together.

*Positive sign:* inability to pinch tip to tip.

### Tinel's sign (at elbow)

*Tests:* point of regeneration of sensory fibres of ulnar nerve.

*Procedure:* tap ulnar nerve in groove between olecranon and medial epicondyle.

*Positive sign:* tingling sensation in ulnar distribution of forearm and hand. Furthest point at which abnormal sensation felt indicates point to which the nerve has regenerated.





### Valgus stress test

*Tests:* stability of medial collateral ligament.

*Procedure:* patient in sitting. Stabilize upper arm with elbow in 20–30° flexion and humerus in full lateral rotation.

Apply abduction/valgus force to forearm.

*Positive sign:* increased laxity or reproduction of symptoms.

### Varus stress test

*Tests:* stability of lateral collateral ligament.

*Procedure:* patient in sitting. Stabilize upper arm with elbow in 20–30° flexion and humerus in full medial rotation.

Apply adduction/varus force to forearm.

*Positive sign:* excessive laxity or reproduction of symptoms.

## Wrist and hand

### Finkelstein test

*Tests:* tenosynovitis of abductor pollicis longus and extensor pollicis brevis tendons (de Quervain's tenosynovitis).

*Procedure:* patient makes a fist with thumb inside. Passively move wrist into ulnar deviation.

*Positive sign:* reproduction of symptoms.

### Froment's sign

*Tests:* ulnar nerve paralysis.

*Procedure:* grip piece of paper between index finger and thumb. Pull paper away.

*Positive sign:* flexion of IP (interphalangeal) thumb joint as paper pulled away.

### Ligamentous instability test for the fingers

*Tests:* stability of collateral ligaments.

*Procedure:* apply valgus and varus force to PIP (proximal interphalangeal) or DIP (distal interphalangeal) joint.

*Positive sign:* increased laxity.

### Linburg's sign

*Tests:* tendon pathology at interconnection between flexor pollicis longus and flexor indicis.

*Procedure:* thumb flexion onto hypothenar eminence and index finger extension.

*Positive sign:* limited extension and reproduction of symptoms.

### Lunotriquetral ballotement (Reagan's) test

*Tests:* stability of lunotriquetral ligament.

*Procedure:* stabilize lunate and apply posterior and anterior glide to triquetrum and pisiform.

*Positive sign:* reproduction of symptoms, crepitus or laxity.

### Phalen's (wrist flexion) test

*Tests:* median nerve pathology; carpal tunnel syndrome.

*Procedure:* place dorsal aspect of hands together with wrists flexed. Hold for 1 minute.

*Positive sign:* tingling in distribution of median nerve.

### Reverse Phalen's test

*Tests:* median nerve pathology.

*Procedure:* place palms of hands together with wrists extended. Hold for 1 minute.

*Positive sign:* tingling in distribution of median nerve.

### Sweater finger sign

*Tests:* rupture of flexor digitorum profundus tendon.

*Procedure:* patient makes a fist.

*Positive sign:* loss of DIP joint flexion of one of the fingers.

### Tinel's sign (at the wrist)

*Tests:* median nerve pathology; carpal tunnel syndrome.

*Procedure:* tap over carpal tunnel.

*Positive sign:* tingling or paraesthesia in median distribution in hand. Furthest point at which abnormal sensation felt indicates point to which the nerve has regenerated.

### Triangular fibrocartilage complex (TFCC) load test

*Tests:* triangular fibrocartilage complex integrity.

*Procedure:* hold forearm. With other hand hold wrist in ulnar deviation then move it through supination and pronation while applying a compressive force.

*Positive sign:* pain, clicking, crepitus.

### Watson (scaphoid shift) test

*Tests:* stability of scaphoid.



*Procedure:* hold wrist in full ulnar deviation and slight extension. With other hand apply pressure to scaphoid tubercle (palmar aspect) and move wrist into radial deviation and slight flexion.

*Positive sign:* pain and/or subluxation of scaphoid.

## Pelvis

### Compression test

*Tests:* sprain of posterior sacroiliac joint or ligaments.

*Procedure:* patient supine or side lying. Push right and left ASIS (anterior superior iliac spine) towards each other.

*Positive sign:* reproduction of symptoms.

### Gapping test (distraction)

*Tests:* sprain of anterior sacroiliac joint or ligaments.

*Procedure:* patient supine. Push right and left ASIS apart.

*Positive sign:* reproduction of symptoms.

### Femoral shear test

*Tests:* sacroiliac joint pathology.

*Procedure:* patient supine with knee flexed and hip in slight flexion, abduction and 45° lateral rotation. Apply a graded longitudinal cephalad force along the femoral axis.

*Positive sign:* pain.

### Gillet's test

*Tests:* sacroiliac joint dysfunction.

*Procedure:* patient standing. Palpate PSIS (posterior superior iliac spine) and sacrum at same level. Patient flexes hip and knee on side being palpated while standing on opposite leg. Repeat test on other side and compare.

*Positive sign:* if the PSIS on the side tested does not move downwards in relation to the sacrum it indicates hypomobility on that side.

### Piedallu's sign (sitting flexion)

*Tests:* movement of sacrum on ilia.

*Procedure:* patient sitting. Left and right PSIS are palpated while patient forward flexes.

*Positive sign:* one side moves higher than the other, indicating hypomobility on that side.







### Standing flexion

*Tests:* movement of ilia on sacrum.

*Procedure:* patient standing. Left and right PSIS are palpated while patient forward flexes.

*Positive sign:* one side moves higher than the other, indicating hypomobility on that side.

### Supine to sit (long sitting) test

*Tests:* sacroiliac joint dysfunction caused by pelvic torsion or rotation.

*Procedure:* patient supine. Note level of inferior borders of medial malleoli. Patient sits up and relative position of malleoli noted.

*Positive sign:* one leg moves up more than the other.

## Hip

### Faber's test (Patrick's test)

*Tests:* hip joint or sacroiliac joint dysfunction; spasm of iliopsoas muscle.

*Procedure:* patient supine. Place foot of test leg on opposite knee. Gently lower knee of test leg.

*Positive sign:* knee remains above the opposite leg; pain or spasm.

### Leg length test

*Tests:* leg-length discrepancy.

*Procedure:* patient supine. Measure between the anterior superior iliac spine and the medial or lateral malleolus.

*Positive sign:* a difference of more than 1.3 cm is considered significant.

### Ober's sign

*Tests:* tensor fascia lata and iliotibial band contractures.

*Procedure:* patient in side lying with hip and knee of lower leg flexed. Stabilize pelvis. Passively abduct and extend upper leg with knee extended or flexed to 90°, then allow it to drop towards plinth.

*Positive sign:* upper leg remains abducted and does not lower to plinth.



### Piriformis test

*Tests:* piriformis involvement in sciatic pain.

*Procedure:* patient side lying on edge of bed with test leg uppermost. Flex hip to 60° with knee flexed. Stabilize hip and apply downward pressure to knee.

*Positive sign:* localized pain indicates tight piriformis. Pain with radiation indicates sciatic nerve involvement.

### Quadrant test

*Tests:* intra-articular hip joint pathology.

*Procedure:* patient supine. Place hip in full flexion and adduction. Abduct hip in a circular arc, maintaining full flexion, while applying a longitudinal compressive force.

*Positive sign:* pain, locking, crepitus, clicking, apprehension.

### Rectus femoris contracture test

*Tests:* rectus femoris contracture.

*Procedure:* patient supine with test knee flexed to 90° over edge of plinth. Patient hugs other knee to chest.

*Positive sign:* knee over edge of plinth extends.

### Thomas test

*Tests:* hip flexion contracture.

*Procedure:* patient supine. Patient hugs one knee to chest.

*Positive sign:* opposite leg lifts off plinth.

### Trendelenburg's sign

*Tests:* stability of the hip, strength of hip abductors (gluteus medius).

*Procedure:* patient stands on one leg.

*Positive sign:* pelvis on opposite side drops.

### Weber–Barstow manoeuvre

*Tests:* leg length asymmetry.

*Procedure:* patient supine with hips and knees flexed. Hold patient's feet, palpating medial malleoli with thumbs. Patient lifts pelvis off bed and returns to starting position. Passively extend legs and compare relative position of medial malleoli.

*Positive sign:* leg length asymmetry.

## Knee

### Abduction (valgus) stress test

*Tests:* full knee extension: anterior cruciate ligament, medial quadriceps expansion, semimembranosus muscle, medial collateral ligaments, posterior oblique ligament, posterior cruciate ligament, posteromedial capsule.

20–30° flexion: medial collateral ligament, posterior oblique ligament, posterior cruciate ligament, posteromedial capsule.

*Procedure:* patient supine. Stabilize ankle and apply medial pressure (valgus stress) to knee joint at 0° and then at 20–30° extension.

*Positive sign:* excessive movement compared with opposite knee.

### Adduction (varus) stress test

*Tests:* full knee extension: cruciate ligaments, lateral gastrocnemius muscle, lateral collateral ligament, arcuate–popliteus complex, posterolateral capsule, iliotibial band, biceps femoris tendon.

20–30° flexion: lateral collateral ligament, arcuate–popliteus complex, posterolateral capsule, iliotibial band, biceps femoris tendon.

*Procedure:* patient supine. Stabilize ankle. Apply lateral pressure (varus stress) to knee joint at 0° and then at 20–30° extension.

*Positive sign:* excessive movement compared to opposite knee.

### Anterior drawer test

*Tests:* anterior cruciate ligament, posterior oblique ligament, arcuate–popliteus complex, posteromedial and posterolateral capsules, medial collateral ligament, iliotibial band.

*Procedure:* patient supine with hips flexed to 45° and knee flexed to 90°. Stabilize foot. Apply posteroanterior force to tibia.

*Positive sign:* tibia moves more than 6 mm on the femur.

### Apley's test

*Tests:* distraction for ligamentous injury; compression for meniscus injury.





*Procedure:* patient prone with knee flexed to 90°. Medially and laterally rotate tibia – first with distraction and then compression.

*Positive sign:* pain.

### Brush test

*Tests:* mild effusion.

*Procedure:* stroke medial side of patella from just below joint line up to suprapatellar pouch two or three times. Use opposite hand to stroke down lateral side of patella.

*Positive sign:* fluid travels to medial side and appears as bulge below distal border of patella.

### External rotation recurvatum test

*Tests:* posterolateral rotary stability in knee extension.

*Procedure:* patient supine. Hold heel and place knee in 30° flexion. Slowly extend knee while palpating posterolateral aspect of knee.

*Positive sign:* excessive hyperextension and lateral rotation palpated.

### Fairbanks' apprehension test

*Tests:* patellar subluxation or dislocation.

*Procedure:* patient supine with knee in 30° flexion and quads relaxed. Passively glide patella laterally.

*Positive sign:* patient apprehension or excessive movement.

### Hughston plica test

*Tests:* inflammation of suprapatellar plica.

*Procedure:* patient supine. Flex and medially rotate knee while applying medial glide to patella and palpating medial femoral condyle. Passively extend and flex knee.

*Positive sign:* popping of plica band over femoral condyle, tenderness.

### Lachman's test

*Tests:* anterior cruciate ligament, posterior oblique ligament, arcuate–popliteus complex.

*Procedure:* patient supine with knee flexed 0–30°. Stabilize femur. Apply posteroanterior force to tibia.

*Positive sign:* soft end feel or excessive movement.

## McConnell test for chondromalacia patellae

*Tests:* chondromalacia patellae.

*Procedure:* patient in high sitting with femur laterally rotated.

Isometric quad contractions are performed at 0°, 30°, 60°, 90° and 120° of knee flexion for 10 seconds. If pain is produced with any of these movements, repeat test with patella pushed medially.

*Positive sign:* decrease in symptoms with medial glide.

## McMurray test

*Tests:* medial meniscus and lateral meniscus injury.

*Procedure:* patient supine with test knee completely flexed. To test the medial meniscus, laterally rotate knee and passively extend to 90° while palpating joint line. To test the lateral meniscus, repeat test with the knee in medial rotation.

*Positive sign:* a snap or click.

## Posterior drawer test

*Tests:* posterior cruciate ligament, arcuate–popliteus complex, posterior oblique ligament, anterior cruciate ligament.

*Procedure:* patient supine with hips flexed to 45° and knee flexed to 90°. Stabilize foot. Apply anteroposterior force to tibia.

*Positive sign:* excessive movement.

## Posterior sag sign

*Tests:* posterior cruciate ligament, arcuate–popliteus complex, posterior oblique ligament, anterior cruciate ligament.

*Procedure:* patient supine with hips flexed to 45° and knee flexed to 90° with feet on plinth.

*Positive sign:* tibia drops posteriorly.

## Slocum test for anterolateral rotary instability

*Tests:* anterior and posterior cruciate ligaments, posterolateral capsule, arcuate–popliteus complex, lateral collateral ligaments, iliotibial band.

*Procedure:* patient supine with hips flexed to 45° and knee flexed to 90°. Place foot in 30° medial rotation and stabilize. Apply posteroanterior force to tibia.

*Positive sign:* excessive movement on lateral side when compared with other knee.





### Slocum test for anteromedial rotary instability

*Tests:* medial collateral ligament, posterior oblique ligament, posteromedial capsule, anterior cruciate ligament.

*Procedure:* patient supine with hips flexed to 45° and knee flexed to 90°. Place foot in 15° lateral rotation and stabilize. Apply posteroanterior force to tibia.

*Positive sign:* excessive movement on medial side when compared with other knee.

## Ankle and foot

### Anterior drawer sign

*Tests:* medial and lateral ligament integrity.

*Procedure:* patient prone with knee flexed. Apply posteroanterior force to talus with ankle in dorsiflexion and then plantarflexion.

*Positive sign:* excessive anterior movement (both ligaments affected) or movement on one side only (ligament on that side affected).

### Talar tilt

*Tests:* adduction: mainly integrity of calcaneofibular ligament but also anterior talofibular ligament. Abduction: integrity of deltoid ligament.

*Procedure:* patient prone, supine or side lying with knee flexed. Tilt talus into abduction and adduction with patient's foot in neutral.

*Positive sign:* excessive movement.

### Thompson's test

*Tests:* Achilles tendon rupture.

*Procedure:* patient prone with feet over edge of plinth. Squeeze calf muscles.

*Positive sign:* absence of plantarflexion.

## Common vascular tests

### Adson's manoeuvre

*Tests:* thoracic outlet syndrome.

*Procedure:* patient sitting. Patient turns head towards test arm and extends head. Laterally rotate and extend shoulder

and arm while palpating radial pulse. Patient takes a deep breath and holds it.

*Positive sign:* disappearance of radial pulse.

### Homan's test

*Tests:* deep vein thrombophlebitis.

*Procedure:* patient supine. Passive dorsiflexion of ankle with knee extended.

*Positive sign:* pain in the calf.

### Provocation elevation test

*Tests:* thoracic outlet syndrome.

*Procedure:* patient standing with arms above head. Opens and closes hands 15 times.

*Positive sign:* fatigue, cramp, tingling.

## Neurodynamic tests (from Petty & Moore 2001, with permission)

### Upper limb neurodynamic tests

When conducting the upper limb neurodynamic tests (ULNT) the sequence of the test movements is relatively unimportant and may be adapted to suit the patient's condition. However, if the tests are to be of value as an assessment tool, the order used for a particular patient must be the same each time the patient is tested.

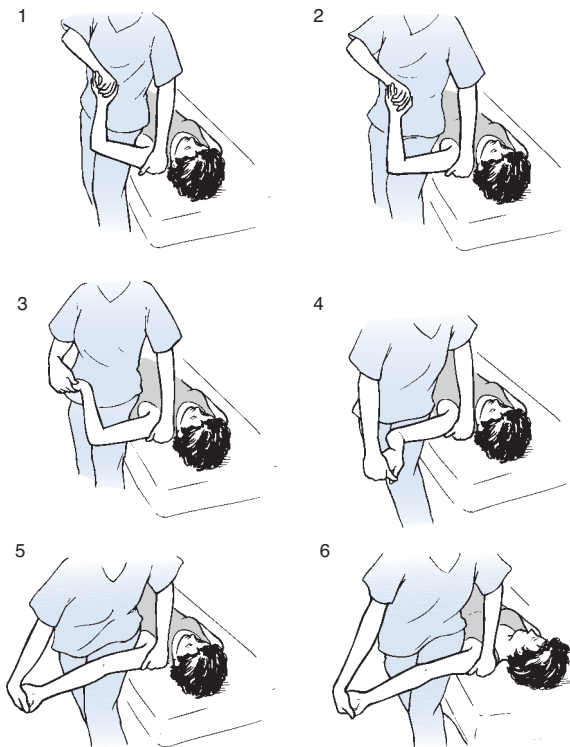
#### ULNT 1

ULNT 1 (Fig. 2.10) consists of:

- Fixing shoulder to prevent shoulder elevation during abduction [1]
- Shoulder joint abduction [2]
- Wrist and finger extension [3]
- Forearm supination [3]
- Shoulder lateral rotation [4]
- Elbow extension [5]

*Sensitizing test:* cervical lateral flexion away from the symptomatic side [6].





**Figure 2.10** (1–6) Upper limb neurodynamic test 1.

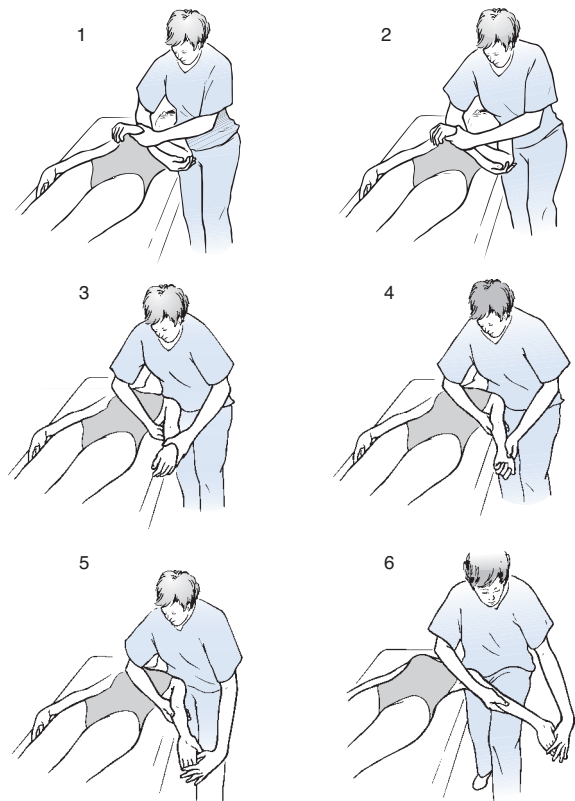
*Desensitizing test:* cervical lateral flexion towards the symptomatic side.

### ULNT 2a

ULNT 2a (Fig. 2.11) consists of:

- Shoulder girdle depression [1, 2]
- Elbow extension [3]
- Lateral rotation of whole arm [4]





**Figure 2.11** (1–6) Upper limb neurodynamic test 2a. Median nerve bias.

- Wrist, finger and thumb extension [5]
- Abduction of shoulder [6]

*Sensitizing test:* cervical lateral flexion away from the symptomatic side.

*Desensitizing tests:* cervical lateral flexion towards the symptomatic side or release of the shoulder girdle depression.

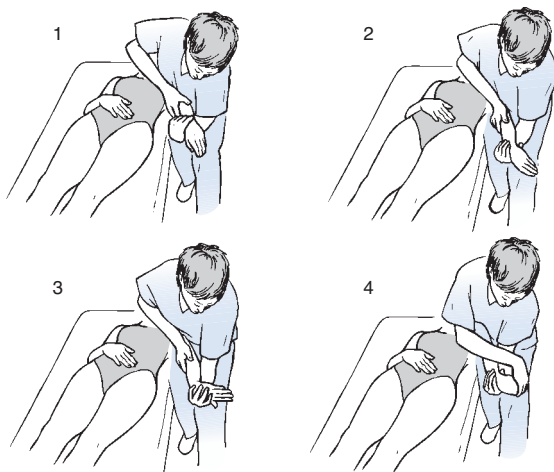
### ULNT 2b

ULNT 2b (Fig. 2.12) consists of:

- Shoulder girdle depression [1]
- Elbow extension [2]
- Medial rotation of whole arm [3]
- Wrist and finger flexion [4]
- Shoulder abduction

*Sensitizing test:* cervical lateral flexion away from the symptomatic side.

*Desensitizing tests:* cervical lateral flexion towards the symptomatic side or release of the shoulder girdle depression.



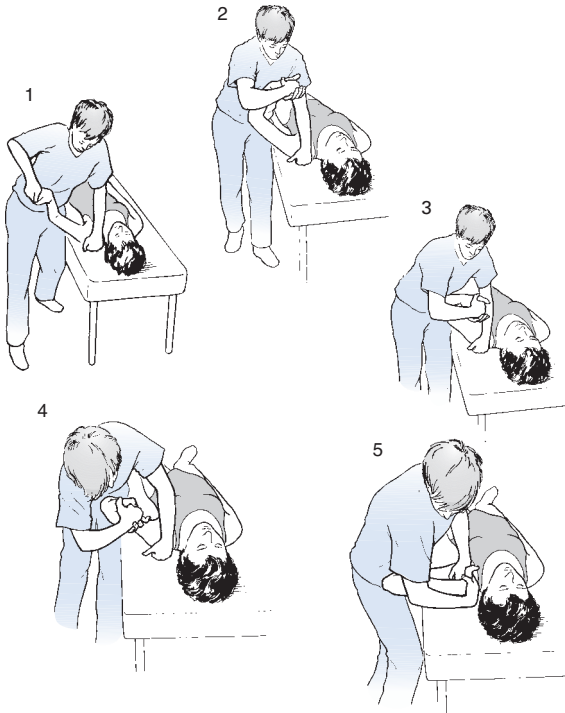
**Figure 2.12** (1–4) Upper limb neurodynamic test 2b. Radial nerve bias.



## ULNT 3

ULNT 3 (Fig. 2.13) consists of:

- Shoulder girdle depression [1]
- Wrist and finger extension [1]
- Forearm pronation [2]
- Elbow flexion [3]
- Shoulder lateral rotation [4]
- Shoulder abduction [5]



**Figure 2.13** (1–5) Upper limb neurodynamic test 3. Ulnar nerve bias.



*Sensitizing test:* cervical lateral flexion away from the symptomatic side.

*Desensitizing tests:* cervical lateral flexion towards the symptomatic side or release of the shoulder girdle depression.

For all the upper limb neurodynamic tests you may wish to place the patient's head in contralateral cervical flexion before you do the test and then instruct them to bring their head back to midline at the end of the sequence.

### Slump test (Fig. 2.14)

*Starting position:* patient sits upright with knee crease at the edge of plinth and hands behind back [1].

The slump test consists of:

- Spinal slump [2]
- Neck flexion [3]

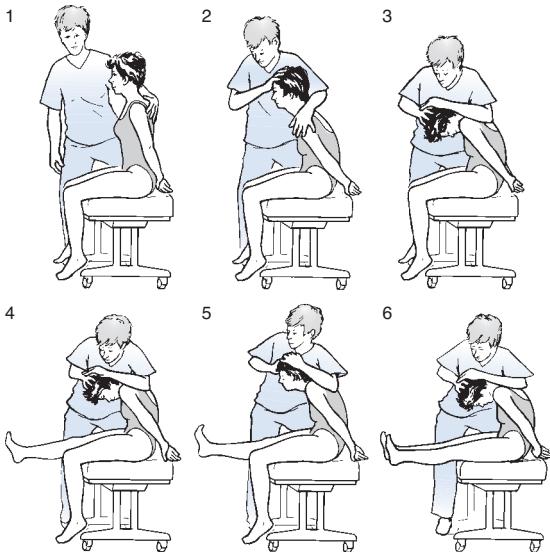


Figure 2.14 (1–6) Slump test.

- Knee extension [4]
- Release neck flexion [5]

The steps can be performed in any order.

*Additional movements:* add dorsiflexion or plantarflexion with knee extension; bilateral knee extension [6], hip abduction (obturator nerve bias).

## Straight leg raise



**Figure 2.15** Straight leg raise.

The test consists of passive hip flexion with the knee extended.

*Sensitizing tests:* dorsiflexion, hip adduction, hip medial rotation, neck flexion and spinal lateral flexion.

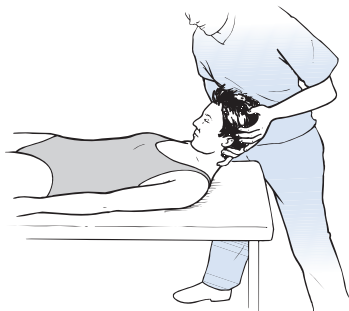
*Additional sensitizing tests:* Add ankle dorsiflexion and eversion (tibial nerve bias), plantarflexion and inversion (superficial peroneal nerve bias), dorsiflexion and inversion (sural nerve bias).

## Passive neck flexion

The test consists of passive neck flexion.

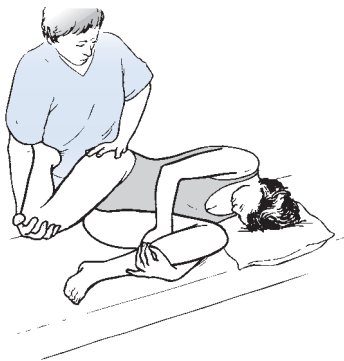
*Sensitizing tests:* straight leg raise, upper limb neurodynamic tests.





**Figure 2.16** Passive neck flexion.

### Slump knee bend




**Figure 2.17** Slump knee bend.

*Starting position:* patient in side lying. Holds bottom knee to chest and flexes neck.

The slump knee bend consists of:

1. Flex uppermost knee
2. Hip extension

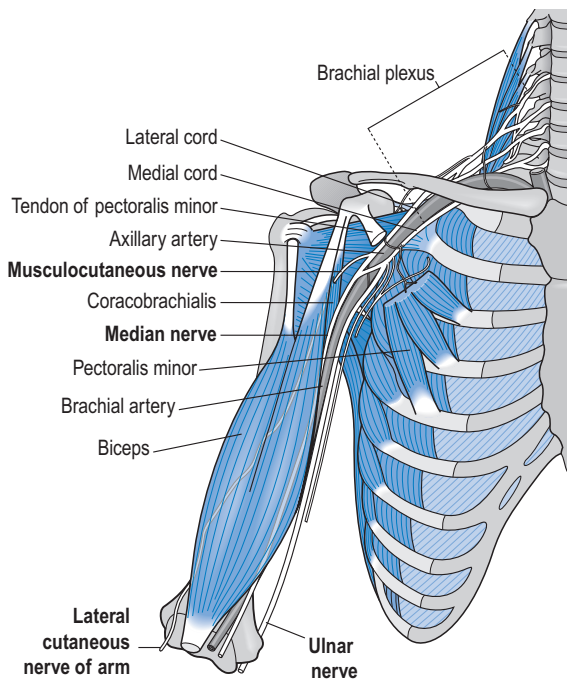
*Desensitizing test:* cervical extension.



**Precautions with physical neural examination and management** (from Butler 2000 *The Sensitive Nervous System*, Noigroup Press, with permission of Noigroup Publications)

- Patients with suspected ‘red flags’ need to be identified and managed accordingly.
- Take care with elongation and pinching manoeuvres with acute nerve root disorders.
- Watch that repeated movements do not aggravate a central sensitivity state.
- Be careful in acute states, when clinical pictures such as disc trauma or compartment syndrome suggest that nerve irritation/compression could occur.
- Take care with recent apparent peripheral severe nerve injury that may, initially, be clinically silent. Wait for a few days to see what the clinical expression will be.
- There are some states where peripheral nerves appear tethered and will not move with various physical therapies. Repeated attempts will just worsen the problem. A surgical opinion is necessary.
- Take care with disorders such as diabetes, rheumatoid arthritis and Guillain–Barré. However, programmes including graded mobilization and fitness may be useful for symptomatic relief and to minimize complications.
- Where there are hard upper motor neurone signs, as could occur after trauma or with tethered cord syndrome, seek specialist medical opinion.

### Brachial plexus



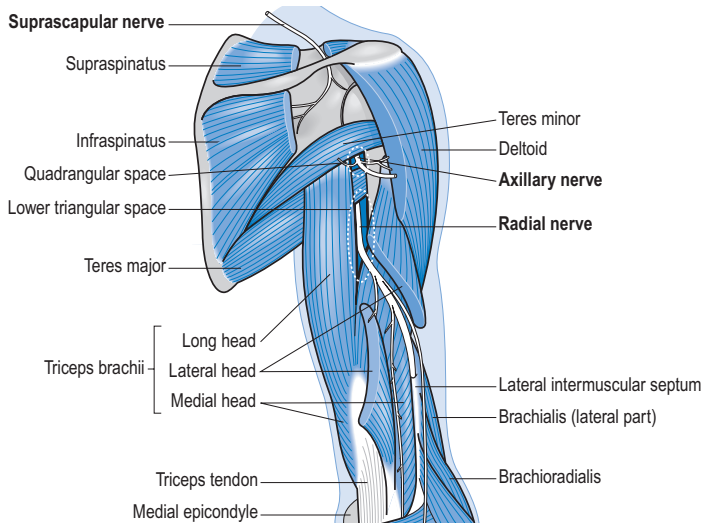
**Figure 2.18** Brachial plexus.



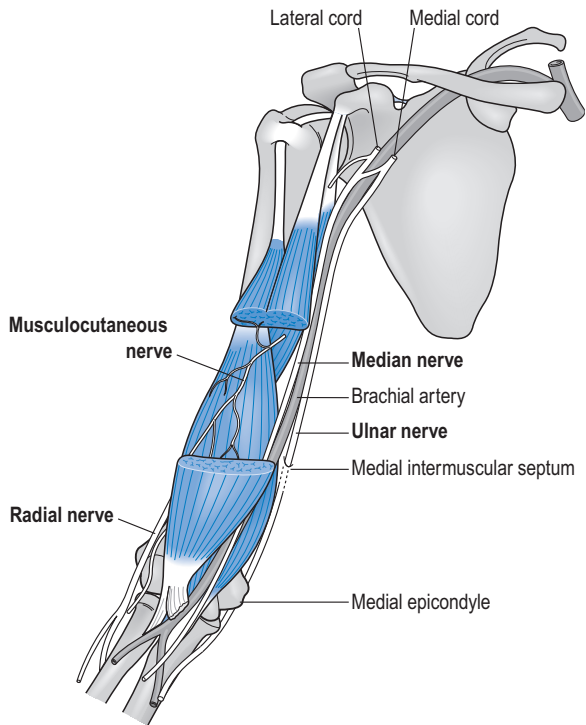




## Upper limb

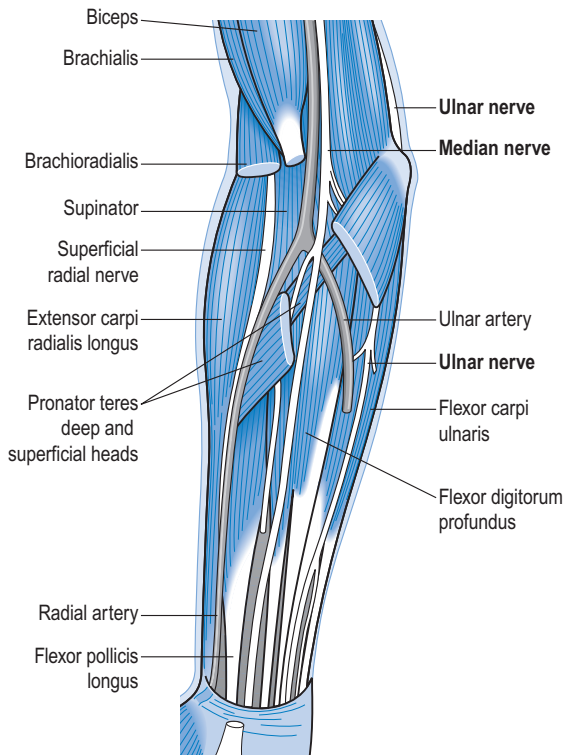


**Figure 2.19** Axillary and radial nerves.

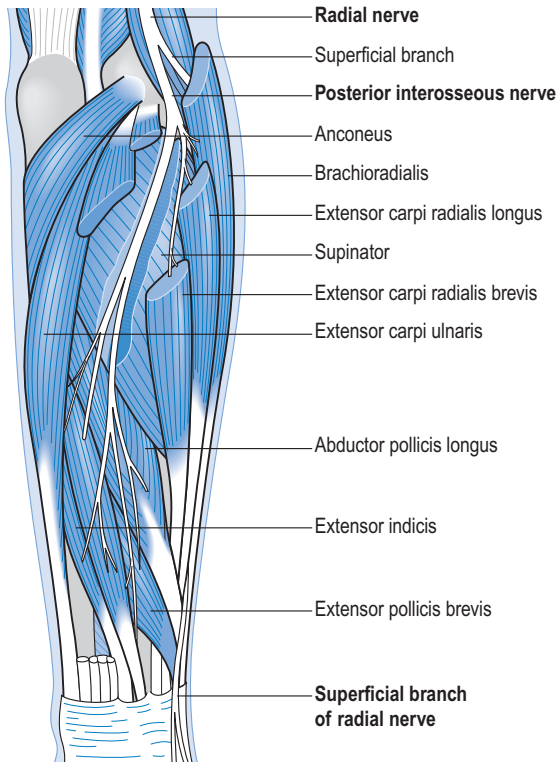


**Figure 2.20** Musculocutaneous, median and ulnar nerves.





**Figure 2.21** Ulnar and median nerves.



**Figure 2.22** Radial nerve.



## Axillary

*Origin:* Posterior cord (C5–C6)

*Course:*

- Descends laterally posterior to axillary artery and anterior to subscapularis
- Passes posteriorly at lower border of subscapularis together with posterior circumflex humeral vessels via quadrangular space
- Divides: anterior and posterior branches. Anterior branch winds around surgical neck of humerus and supplies anterior deltoid. Posterior branch supplies teres minor and posterior deltoid. Continues as upper lateral cutaneous nerve of the arm after passing around deltoid

## Musculocutaneous nerve

*Origin:* Large terminal branch of lateral cord (C5–C7)

*Course:*

- Descends from lower border of pectoralis minor, lateral to axillary artery
- Pierces coracobrachialis and descends diagonally between biceps and brachialis to lateral side of arm
- Pierces deep fascia of antecubital fossa and continues as lateral cutaneous nerve of the forearm
- Divides: anterior and posterior branches

## Ulnar nerve

*Origin:* Large terminal branch of the medial cord (C7, C8, T1)

*Course:*

- Descends medial to brachial artery and anterior to triceps as far as the insertion of coracobrachialis
- Penetrates medial intermuscular septum and enters posterior compartment to continue descent anterior to medial head of triceps
- Passes posterior to medial epicondyle
- Enters anterior compartment between humeral and ulnar heads of flexor carpi ulnaris





- Descends medially, anterior to flexor digitorum profundus and posterior to flexor carpi ulnaris
- Pierces deep fascia lateral to flexor carpi ulnaris and proximal to flexor retinaculum
- Passes anterior to flexor retinaculum and lateral to pisiform
- Crosses hook of hamate
- Divides: superficial and deep branches

### Median nerve

*Origin:* Lateral cord (C5–C7) and medial cord (C8, T1)

*Course:*

- The two cords unite anterior to the third part of the axillary artery at the inferior margin of teres major
- Descends lateral to brachial artery and posterior to biceps, passing medial and anterior to brachial artery at the insertion of coracobrachialis
- Crosses front of elbow lying on brachialis and deep to bicipital aponeurosis
- Dives between the two heads of pronator teres and descends through flexor digitorum superficialis and profundus
- Becomes superficial near the wrist, passing between the tendons of flexor carpi radialis (lateral) and flexor digitorum superficialis (medial), deep to palmaris longus
- Passes through the carpal tunnel
- Divides: medial and lateral branches

### Radial nerve

*Origin:* Posterior cord (C5–C8 (T1))

*Course:*

- Descends posterior to axillary and brachial arteries and anterior to tendons of subscapularis, latissimus dorsi and teres major
- Enters posterior compartment via lower triangular space together with profunda brachii artery
- Descends obliquely towards lateral humerus along spiral groove lying between lateral and medial head of triceps



- Enters anterior compartment via lateral intermuscular septum to lie between brachialis and brachioradialis
- Divides: superficial radial nerve (sensory) and posterior interosseous nerve (motor) anterior to lateral epicondyle

### Posterior interosseous nerve

*Course:*

- Enters posterior compartment between two heads of supinator
- Descends between deep and superficial groups of extensors
- Ends in flattened expansion on interosseous membrane

### Lumbosacral plexus

(See Figure 2.23)

### Lower limb

(See Figure 2.24 to 2.28)

### Sciatic nerve

*Origin:* Ventral rami L4–S3

*Course:*

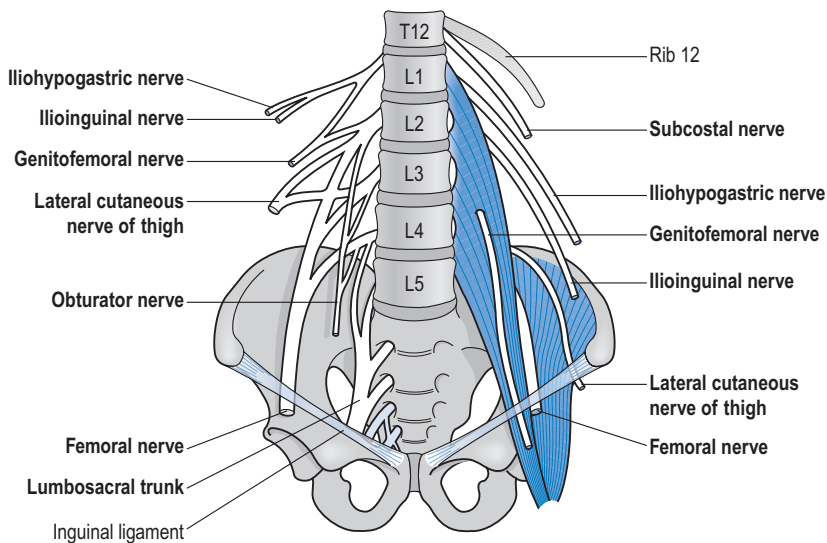
- Forms anterior to piriformis. Leaves pelvis via greater sciatic foramen below piriformis
- Enters gluteal region approximately midway between ischial tuberosity and greater trochanter
- Descends on top of superior gemellus, obturator internus, inferior gemellus, quadratus femoris and adductor magnus and under gluteus maximus and long head of biceps femoris
- Divides: tibial and common peroneal nerves at approximately distal third of thigh

### Tibial nerve

*Origin:* Medial terminal branch of sciatic nerve (L4–S3)

*Course:*

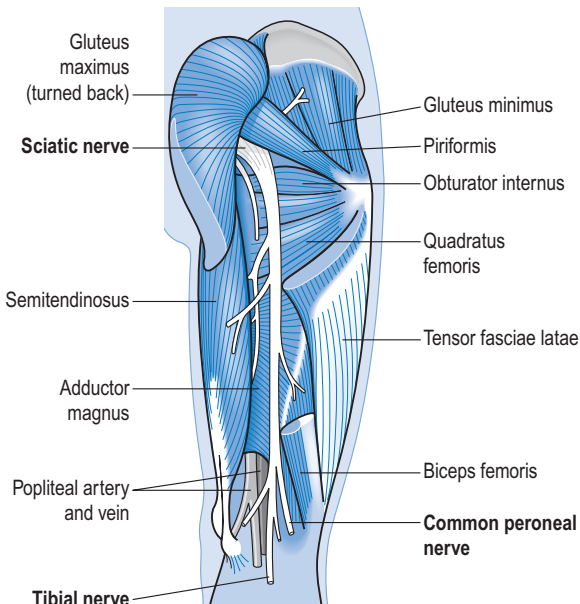
- Descends through popliteal fossa, passing laterally to medially across the popliteal vessels
- Passes under tendinous arch of soleus



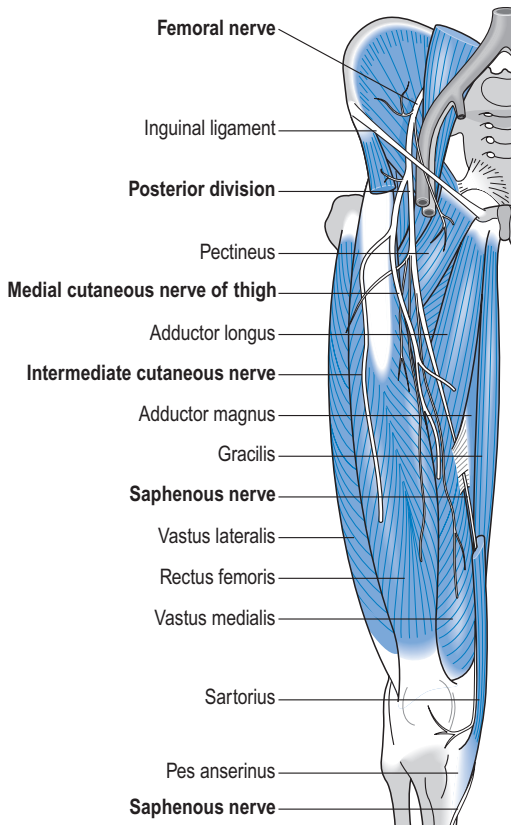
**Figure 2.23** Lumbosacral plexus.





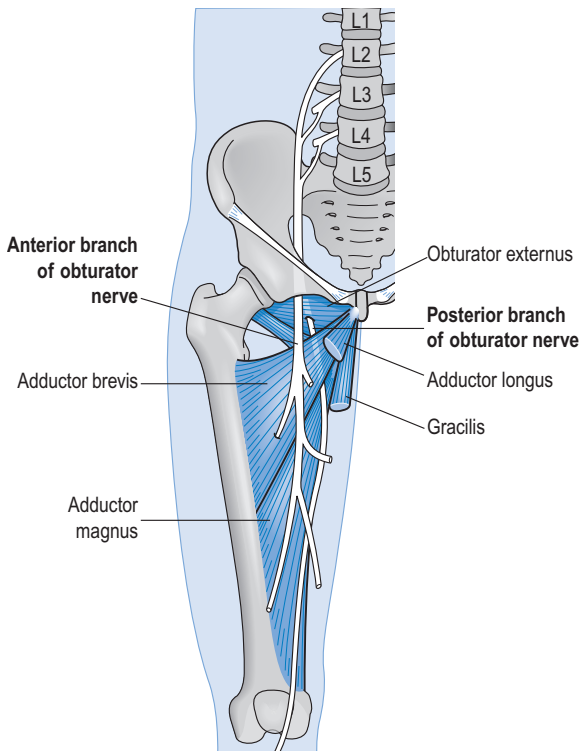


**Figure 2.24** Sciatic nerve.

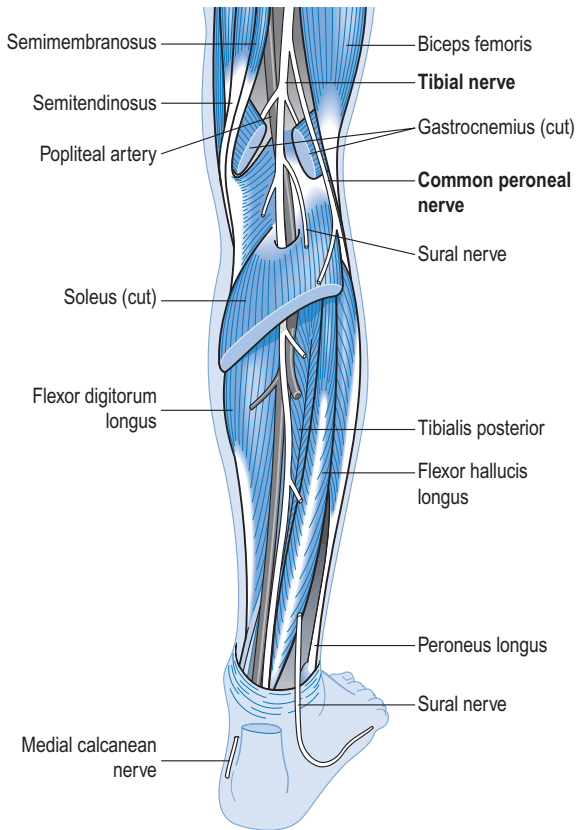


**Figure 2.25** Femoral nerve.



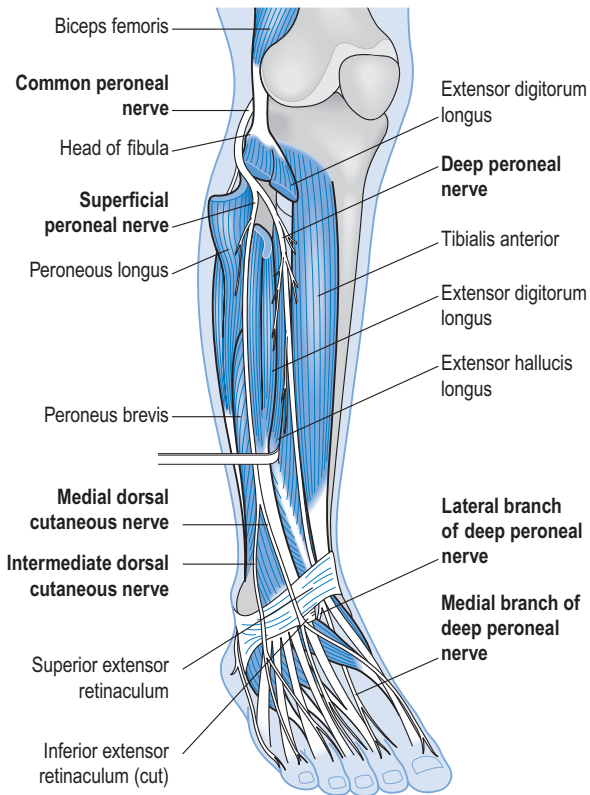


**Figure 2.26** Obturator nerve.



**Figure 2.27** Tibial and common peroneal nerves.





**Figure 2.28** Superficial and deep peroneal nerves.

- Descends inferomedially under soleus and gastrocnemius, lying on tibialis posterior and between flexor digitorum longus and flexor hallucis longus
- Passes through tarsal tunnel (formed by the flexor retinaculum, which extends from the medial malleolus to the medial calcaneus)

- Enters plantar aspect of foot
- Divides: medial and lateral plantar nerves

## Common peroneal nerve

*Origin:* Lateral terminal branch of sciatic nerve (L4–S3)

*Course:*

- Descends along lateral side of popliteal fossa between biceps femoris and lateral head of gastrocnemius
- Passes anteriorly by winding around the neck of the fibula, deep to peroneus longus
- Divides: superficial and deep peroneal nerves

## Superficial peroneal nerve

*Course:*

- Descends between extensor digitorum longus and peroneus longus, anterior to the fibula
- Pierces deep fascia halfway down the leg to become superficial
- Divides: medial and intermediate dorsal cutaneous nerves which enter foot via anterolateral aspect of ankle

## Deep peroneal nerve

*Course:*

- Passes inferomedially into anterior compartment deep to extensor digitorum longus
- Descends on interosseous membrane deep to extensor hallucis longus and superior extensor retinaculum
- Crosses ankle deep to inferior extensor retinaculum and tendon of extensor hallucis longus and medial to tibialis anterior
- Enters dorsum of foot between tendons of extensor hallucis and digitorum longus
- Divides: medial and lateral branches

## Obturator nerve

*Origin:* Anterior divisions of L2–L4

*Course:*

- Anterior divisions unite in psoas major
- Emerges from psoas major on lateral aspect of sacrum





- Crosses sacroiliac joint and obturator internus
- Enters obturator canal below superior pubic rami
- Exits obturator canal above obturator externus in medial compartment of thigh
- Divides: anterior and posterior branches (separated by obturator externus and adductor brevis)

## Femoral nerve

*Origin:* Posterior divisions of L2–L4

*Course:*

- Posterior divisions unite in psoas major
- Emerges from lower lateral border of psoas major
- Descends in groove between psoas major and iliacus, deep to iliac fossa
- Passes posterior to inguinal ligament and lateral to femoral artery
- Enters femoral triangle
- Divides: number of anterior and posterior branches

**Diagnostic triage for back pain (including red flags)** (from Clinical Standards Advisory Group 1994, with permission)

The main diagnostic indicators for simple backache, nerve root pain and possible serious spinal pathology ('red flags') are outlined below:

### Simple backache

- Onset generally age 20–55 years
- Lumbosacral region, buttocks and thighs
- Pain mechanical in nature
  - varies with physical activity
  - varies with time
- Patient well
- Prognosis good (90% recover from acute attack in 6 weeks)



## Nerve root pain

- Unilateral leg pain > back pain
- Pain generally radiates to foot or toes
- Numbness and paraesthesia in the same distribution
- Nerve irritation signs
  - reduced straight leg raising which reproduces leg pain
- Motor, sensory or reflex change
  - limited to one nerve root
- Prognosis reasonable (50% recover from acute attack within 6 weeks)

## Possible serious spinal pathology

### Red flags

- Age of onset <20 or >55 years
- Violent trauma: e.g. fall from a height, road traffic accident
- Constant, progressive, non-mechanical pain
- Thoracic pain
- Previous medical history – carcinoma
- Systemic steroids
- Drug abuse, HIV
- Systemically unwell
- Weight loss
- Persisting severe restriction of lumbar flexion
- Widespread neurology
- Structural deformity

If there are suspicious clinical features, or if pain has not settled in 6 weeks, an ESR and plain X-ray should be considered.

### Cauda equina syndrome/widespread neurological disorder

- Difficulty with micturition
- Loss of anal sphincter tone or faecal incontinence
- Saddle anaesthesia about the anus, perineum or genitals
- Widespread (more than one nerve root) or progressive motor weakness in the legs or gait disturbance



## Inflammatory disorders (ankylosing spondylitis and related disorders)

- Gradual onset
- Marked morning stiffness
- Persisting limitation of spinal movements in all directions
- Peripheral joint involvement
- Iritis, skin rashes (psoriasis), colitis, urethral discharge
- Family history

## **Psychosocial yellow flags** (Accident Compensation Corporation 2004, with permission)

### **Attitudes and beliefs about back pain**

- Belief that pain is harmful or disabling, resulting in fear-avoidance behaviour, e.g. the development of guarding and fear of movement
- Belief that a pain must be abolished before attempting to return to work or normal activity
- Expectation of increased pain with activity or work, lack of ability to predict capability
- Catastrophizing, thinking the worst, misinterpreting bodily symptoms
- Belief that pain is uncontrollable
- Passive attitude to rehabilitation behaviours
- Use of extended rest, disproportionate 'downtime'
- Reduced activity level with significant withdrawal from activities of daily living
- Irregular participation or poor compliance with physical exercise, tendency for activities to be in a 'boom-bust' cycle
- Avoidance of normal activity and progressive substitution of lifestyle away from productive activity
- Report of extremely high intensity of pain, e.g. above 10, on a 0–10 visual analogue scale
- Excessive reliance on use of aids or appliances
- Sleep quality reduced since onset of back pain

- High intake of alcohol or other substances (possibly as self-medication), with an increase since onset of back pain
- Smoking

## Compensation issues

- Lack of financial incentive to return to work
- Delay in accessing income support and treatment cost, disputes over eligibility
- History of claim/s due to other injuries or pain problems
- History of extended time off work due to injury or other pain problem (e.g. more than 12 weeks)
- History of previous back pain, with a previous claim/s and time off work
- Previous experience of ineffective case management (e.g. absence of interest, perception of being treated punitively)

## Diagnosis and treatment

- Health professional sanctioning disability, not providing interventions that will improve function
- Experience of conflicting diagnoses or explanations for back pain, resulting in confusion
- Diagnostic language leading to catastrophizing and fear (e.g. fear of ending up in a wheelchair)
- Dramatization of back pain by health professional producing dependency on treatments, and continuation of passive treatment
- Number of visits to health professional in previous year (excluding the present episode of back pain)
- Expectation of a 'techno-fix', e.g. requests to treat as if body were a machine
- Lack of satisfaction with previous treatment for back pain
- Advice to withdraw from job

## Emotions

- Fear of increased pain with activity or work
- Depression (especially long-term low mood), loss of sense of enjoyment
- More irritable than usual





- Anxiety about and heightened awareness of body sensations (includes sympathetic nervous system arousal)
- Feeling under stress and unable to maintain sense of control
- Presence of social anxiety or lack of interest in social activity
- Feeling useless and not needed

## Family

- Over-protective partner/spouse, emphasizing fear of harm or encouraging catastrophizing (usually well intentioned)
- Solicitous behaviour from spouse (e.g. taking over tasks)
- Socially punitive responses from spouse (e.g. ignoring, expressing frustration)
- Extent to which family members support any attempt to return to work
- Lack of support person to talk to about problems

## Work

- History of manual work, notably from the following occupational groups:
  - Fishing, forestry and farming workers
  - Construction, including carpenters and builders
  - Nurses
  - Truck drivers
  - Labourers
- Work history, including patterns of frequent job changes, experiencing stress at work, job dissatisfaction, poor relationships with peers or supervisors, lack of vocational direction
- Belief that work is harmful; that it will do damage or be dangerous
- Unsupportive or unhappy current work environment
- Low educational background, low socioeconomic status
- Job involves significant bio-mechanical demands, such as lifting, manual handling of heavy items, extended sitting, extended standing, driving, vibration, maintenance of constrained or sustained postures, inflexible work schedule preventing appropriate breaks



- Job involves shift work or working unsociable hours
- Minimal availability of selected duties and graduated return to work pathways, with unsatisfactory implementation of these
- Negative experience of workplace management of back pain (e.g. absence of a reporting system, discouragement to report, punitive response from supervisors and managers)
- Absence of interest from employer

Remember the key question to bear in mind while conducting these clinical assessments is: **‘What can be done to help this person experience less distress and disability?’**

### How to judge if a person is at risk for long-term work loss and disability

A person may be at risk if:

- There is a cluster of a few very salient factors
- There is a group of several less important factors that combine cumulatively

There is good agreement that the following factors are important and consistently predict poor outcomes:

- Presence of a belief that back pain is harmful or potentially severely disabling
- Fear-avoidance behaviour (avoiding a movement or activity due to misplaced anticipation of pain) and reduced activity levels
- Tendency to low mood and withdrawal from social interaction
- An expectation that passive treatments rather than active participation will help

Suggested questions (to be phrased in treatment provider’s own words):

- Have you had time off work in the past with back pain?
- What do you understand is the cause of your back pain?
- What are you expecting will help you?
- How is your employer responding to your back pain? Your co-workers? Your family?

- What are you doing to cope with back pain?
- Do you think that you will return to work? When?

## Musculoskeletal assessment

Patients present with a variety of conditions, and assessments need to be adapted to suit their needs. This section provides a basic framework for the subjective and physical musculoskeletal assessment of a patient.

### Subjective examination

#### Body chart

Location of current symptoms

Type of pain

Depth, quality, intensity of symptoms

Intermittent or constant

Abnormal sensation (e.g. pins and needles, numbness)

Relationship of symptoms

Check other relevant regions

#### Behaviour of symptoms

Aggravating factors

Easing factors

Severity

Irritability

Daily activities/functional limitations

24-hour behaviour (night pain)

Stage of the condition

#### Special questions

Red flags

Spinal cord or cauda equina symptoms

Bilateral extremity numbness/pins and needles

Dizziness or other symptoms of vertebrobasilar insufficiency  
(diplopia, drop attacks, dysarthria, dysphagia, nausea)

#### History of present condition

Mechanism of injury

History of each symptomatic area

Relationship of onset of each symptomatic area  
Change of each symptom since onset  
Recent X-rays or investigations

### Past medical history

Relevant medical history  
Previous episodes of present complaint  
Previous treatment and outcome  
General health

**THREAD** (**T**hyroid disorders, **H**eart problems, **R**heumatoid arthritis, **E**pilepsy, **A**sthma or other respiratory problems, **D**abetes)

### Drug history

Current medication  
Steroids  
Anticoagulants  
Allergies

### Social and family history

Age and gender  
Home and work situation  
Dependants  
Hobbies and activities  
Exercise  
Yellow flags

## Physical examination

### Observation

Posture  
Function  
Gait  
Structural abnormalities  
Muscle bulk and tone  
Soft tissues

### Active and passive joint movements

Active and passive physiological movements  
Joint effusion measurement





### Muscle tests

- Muscle strength
- Muscle control and stability
- Muscle length
- Isometric muscle testing

### Neurological tests

- Integrity of the nervous system
  - dermatomes
  - reflexes
  - myotomes
- Mobility of the nervous system
  - straight leg raise
  - slump test
  - slump knee bend
  - passive neck flexion
  - upper limb neurodynamic tests
- Special tests (e.g. coordination)

### Palpation

- Skin and superficial soft tissue
- Muscle and tendon
- Nerve
- Ligament
- Joint
- Bone

### Joint integrity tests

### Passive accessory movements

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## SECTION

## 2

## MUSCULOSKELETAL

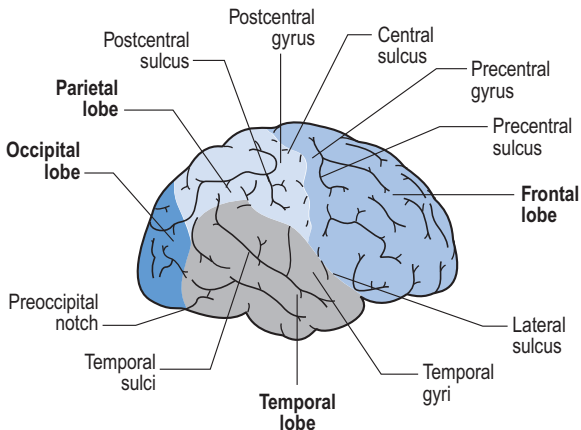
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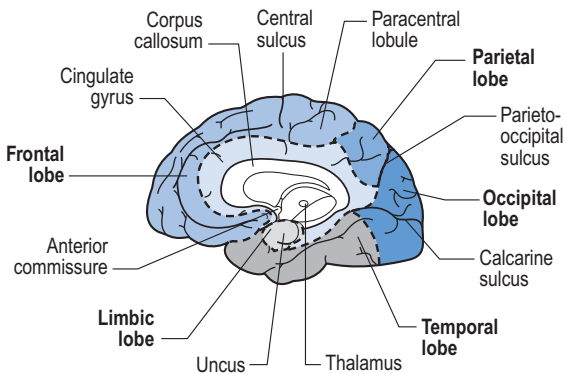
# SECTION 3

# Neurology

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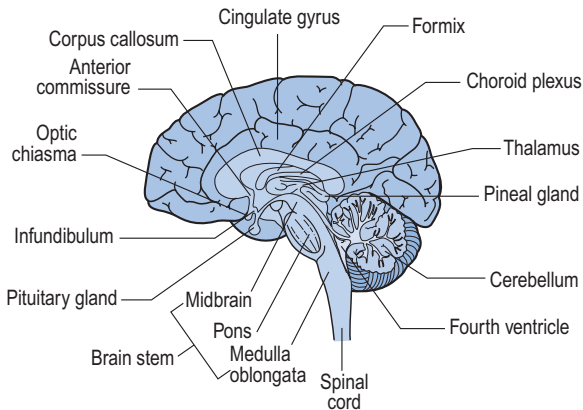


**Figure 3.1** Lateral view of right cerebral hemisphere.

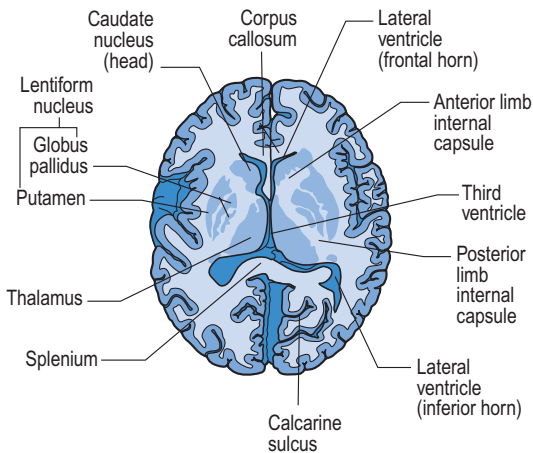


**Figure 3.2** Medial view of right cerebral hemisphere.



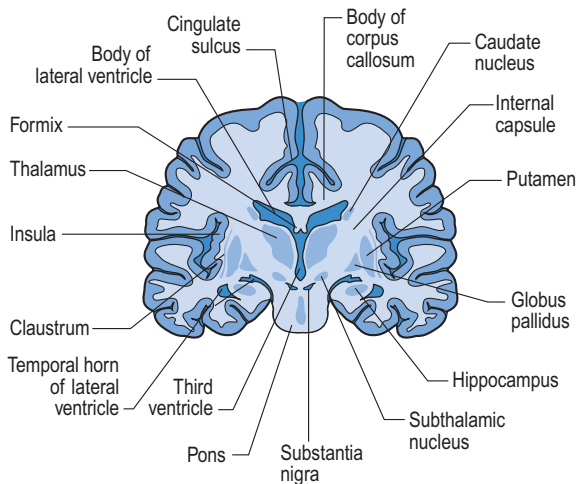


**Figure 3.3** Mid-sagittal section of the brain.

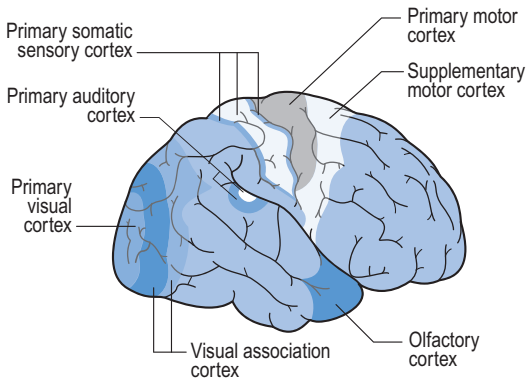


**Figure 3.4** Horizontal section through the brain.

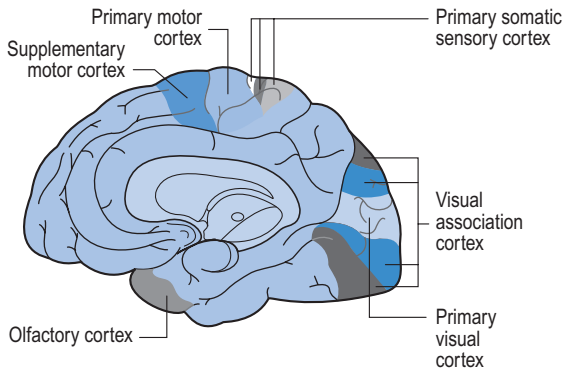




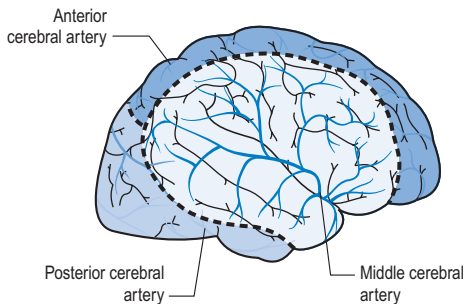
**Figure 3.5** Coronal section of the brain.



**Figure 3.6** Lateral view of sensory and motor cortical areas.

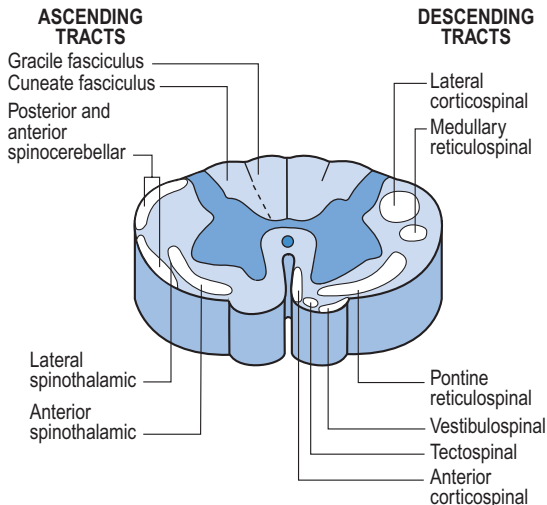


**Figure 3.7** Medial view of sensory and motor cortical areas.



**Figure 3.8** Lateral view of right hemisphere showing territories supplied by the cerebral arteries.

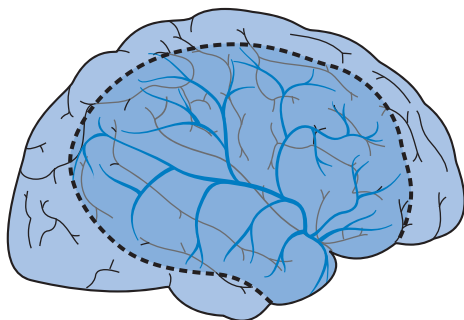




**Figure 3.9** Ascending and descending spinal cord tracts.

Ascending tracts	Descending tracts
Gracile fasciculus – proprioception and discriminative touch in legs and lower trunk	Lateral corticospinal – voluntary movements
Cuneate fasciculus – proprioception and discriminative touch in arms and upper trunk	Medullary retrospinal – locomotion and posture
Posterior and anterior spinocerebellar – reflex and proprioception	Pontine reticulospinal – locomotion and posture
Lateral spinothalamic – pain and temperature	Vestibulospinal – balance and antigravity muscles
Anterior spinothalamic – light touch	Tectospinal – orientates head to visual stimulation
	Anterior corticospinal – voluntary movements

### Middle cerebral artery (MCA)



**Figure 3.10** Middle cerebral artery.

The middle cerebral artery arises from the internal carotid artery. The proximal part supplies a large portion of the frontal, parietal and temporal lobes. The deep branches supply the basal ganglia (corpus striatum and globus pallidus), internal capsule and thalamus.

Signs and symptoms	Structures involved
Contralateral weakness/paralysis of face, arm, trunk and leg	Motor cortex (precentral gyrus)
Contralateral sensory impairment/loss of face, arm, trunk and leg	Somatosensory cortex (postcentral gyrus)
Broca's dysphasia	Motor speech area of Broca (dominant frontal lobe)
Wernicke's dysphasia	Sensory speech area of Wernicke (dominant parietal/temporal lobe)

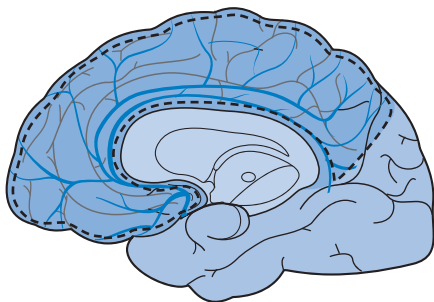






Signs and symptoms	Structures involved
Neglect of contralateral side, dressing and constructional apraxia, geographical agnosia, anosognosia	Parietal lobe (non-dominant lobe)
Homonymous hemianopia (often upper homonymous quadrantanopia)	Optic radiation – temporal fibres
Ocular deviation	Frontal lobe
Gait disturbance	Frontal lobe (usually bilateral)
Pure motor hemiplegia	Posterior limb of internal capsule and adjacent corona radiata
Pure sensory syndrome	Ventral posterior nucleus of thalamus

### Anterior cerebral artery (ACA)



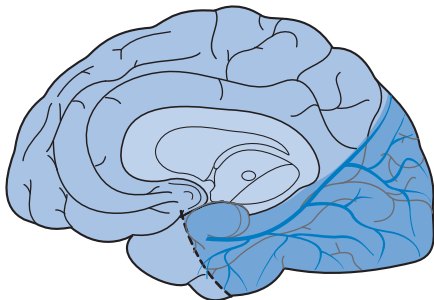
**Figure 3.11** Anterior cerebral artery.

The anterior cerebral artery arises from the internal carotid artery and is connected by the anterior communicating artery. It follows the curve of the corpus callosum and supplies the medial aspect of the frontal and parietal lobes, corpus callosum, internal capsule and basal ganglia (caudate nucleus and globus pallidus).

Signs and symptoms	Structures involved
Contralateral hemiplegia/ hemiparesis (lower limb > upper limb)	Motor cortex
Contralateral sensory loss/ impairment (lower limb > upper limb)	Somatosensory cortex
Urinary incontinence	Superior frontal gyrus (bilateral)
Contralateral grasp reflex	Frontal lobe
Akinetic mutism, whispering, apathy	Frontal lobe (bilateral)
Apraxia of left limbs	Corpus callosum
Tactile agnosia	Corpus callosum
Spastic paresis of lower limb	Bilateral motor leg area



## Posterior cerebral artery (PCA)



**Figure 3.12** Posterior cerebral artery.

The posterior cerebral artery arises from the basilar artery. It supplies the occipital and temporal lobes, midbrain, choroid plexus, thalamus, subthalamic nucleus, optic radiation, corpus callosum and cranial nerves III and IV. The posterior communicating arteries connect the posterior cerebral arteries to the middle cerebral arteries anteriorly.



Signs and symptoms	Structures involved
Thalamic syndrome: hemisensory loss, chorea or hemiballism, spontaneous pain and dysaesthesias	Posterior nucleus of thalamus
Weber's syndrome: oculomotor paralysis and contralateral hemiplegia	Cranial nerve III and cerebral peduncle
Contralateral hemiballism	Subthalamic nucleus
Contralateral homonymous hemianopia	Primary visual cortex or optic radiation
Bilateral homonymous hemianopia, visual hallucinations	Bilateral occipital lobe
Alexia, colour anomia, impaired memory	Dominant corpus callosum (occipital lobe)
Memory defect, amnesia	Bilateral inferomedial portions of temporal lobe
Prosopagnosia	Calcarine sulcus and lingual gyrus (non-dominant occipital lobe)

## Vertebral and basilar arteries

The vertebral arteries arise from the subclavian arteries at the root of the neck and enter the skull through the foramen magnum. Within the skull they fuse to form the basilar artery. They supply the medulla, pons, midbrain and cerebellum.

Signs and symptoms	Structures involved
Lateral medullary syndrome: <ul style="list-style-type: none"><li>– vertigo, vomiting, nystagmus</li><li>– ipsilateral limb ataxia</li><li>– ipsilateral loss of facial pain and thermal sensation</li><li>– ipsilateral Horner's syndrome</li></ul>	Vestibular nuclei Spinocerebellar tract Cranial nerve V  Descending sympathetic tract



Signs and symptoms	Structures involved
<ul style="list-style-type: none"><li>– ipsilateral dysphagia, hoarseness, vocal cord paralysis and reduced gag reflex</li><li>– contralateral loss of pain and thermal sensation in trunk and limbs</li></ul>	Cranial nerves IX and X  Lateral spinothalamic tract
Ipsilateral tongue paralysis and hemiatrophy	Cranial nerve XII
Contralateral impaired tactile sensation and proprioception	Medial lemniscus
Diplopia, lateral and vertical gaze palsies, pupillary abnormalities	Cranial nerve VI, medial longitudinal fasciculus
Bulbar palsy, tetraplegia, changes in consciousness	Bilateral corticospinal tracts
Pseudobulbar palsy, emotional instability	Bilateral supranuclear fibres, cranial nerves IX–XII
Locked-in syndrome	Bilateral medulla or pons
Coma, death	Brainstem

### Signs and symptoms of injury to the lobes of the brain (adapted from Lindsay & Bone 2004, with permission)

#### Frontal lobe

Function	Signs of impairment
<b>Precentral gyrus (motor cortex)</b> Contralateral movement: face, arm, leg, trunk	Contralateral hemiparesis/hemiplegia
<b>Broca's area (dominant hemisphere)</b> Expressive centre for speech	Broca's dysphasia (dominant)



Function	Signs of impairment
<b>Supplementary motor area</b> Contralateral head and eye turning	Paralysis of contralateral head and eye movement
<b>Prefrontal areas</b> 'Personality', initiative	Disinhibition, poor judgement, akinesia, indifference, emotional lability, gait disturbance, incontinence, primitive reflexes, e.g. grasp
<b>Paracentral lobule</b> Cortical inhibition of bladder and bowel voiding	Incontinence of urine and faeces

## Parietal lobe

Function	Signs of impairment
<b>Postcentral gyrus (sensory cortex)</b> Posture, touch and passive movement	Hemisensory loss/disturbance: postural, passive movement, localization of light touch, two-point discrimination, astereognosis, sensory inattention
<b>Supramarginal and angular gyri</b> <i>Dominant hemisphere (part of Wernicke's language area):</i> integration of auditory and visual aspects of comprehension <i>Non-dominant hemisphere:</i> body image, awareness of external environment, ability to construct shapes, etc.	Wernicke's dysphasia  Left-sided inattention, denies hemiparesis Anosognosia, dressing apraxia, geographical agnosia, constructional apraxia
<b>Dominant parietal lobe</b> Calculation, using numbers	Finger agnosia, acalculia, agraphia, confusion between right and left
<b>Optic radiation</b> Visual pathways	Homonymous quadrantanopia

## Temporal lobe

Function	Signs of impairment
<b>Superior temporal gyrus (auditory cortex)</b> Hearing of language (dominant hemisphere), hearing of sounds, rhythm and music (non-dominant)	Cortical deafness, difficulty hearing speech – associated with Wernicke's dysphasia (dominant), amusia (non-dominant), auditory hallucinations
<b>Middle and inferior temporal gyri</b> Learning and memory	Disturbance of memory and learning
<b>Limbic lobe</b> Smell, emotional/affective behaviour	Olfactory hallucination, aggressive or antisocial behaviour, inability to establish new memories
<b>Optic radiation</b> Visual pathways	Upper homonymous quadrantanopia



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## Occipital lobe

Function	Signs of impairment
<b>Calcarine sulcus</b> <i>Primary visual/striate cortex:</i> Relay of visual information to parastriate cortex  <i>Association visual/parastriate cortex:</i> Relay of visual information to parietal, temporal and frontal lobes	Cortical blindness (bilateral involvement), homonymous hemianopia with or without macular involvement  Cortical blindness without awareness (striate and parastriate involvement), inability to direct gaze associated with agnosia (bilateral parieto-occipital lesions), prosopagnosia (bilateral occipito-temporal lesions)

## Signs and symptoms of haemorrhage to other areas of the brain

### Putamen

Function	Signs of impairment
<b>Part of basal ganglia</b> Involved in selective movement	Contralateral hemiplegia/hemiparesis, contralateral hemisensory loss, hemianopia (posterior segment), contralateral gaze palsy (posterior segment), Wernicke-type dysphasia (posterior segment, left side), anosognosia (posterior segment, right side), apathy, motor imperistence, temporary unilateral neglect (anterior segment), coma/death (large lesion)

### Thalamus

Function	Signs of impairment
<b>Thalamus</b> Receives motor and sensory inputs and transmits them to the cerebral cortex	Contralateral hemiparesis/hemiplegia, contralateral hemisensory loss, impaired consciousness, ocular disturbances (varied), dysphasia (dominant), contralateral neglect (non-dominant)

### Pons

Function	Signs of impairment
<b>Part of brainstem</b> Contains descending motor pathways, ascending sensory pathways and cranial nerve nuclei V–VIII	Coma/death (large bilateral lesions), locked-in syndrome (bilateral), tetraplegia (bilateral), lateral gaze palsy towards affected side, contralateral hemiplegia, contralateral hemisensory loss, ipsilateral facial weakness/sensory loss



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## Cerebellum

Function	Signs of impairment
<b>Anterior lobe (spinocerebellum)</b> Muscle tone, posture and gait control	Hypotonia, postural reflex abnormalities
<b>Posterior lobe (neocerebellum)</b> Coordination of skilled movements	Ipsilateral ataxia: dysmetria, dysdiadochokinesia, intention tremor, rebound phenomenon, dyssynergia, dysarthria
<b>Flocculonodular lobe (vestibulocerebellum)</b> Eye movements and balance	Disturbance of balance, unsteadiness of gait and stance, truncal ataxia, nystagmus, ocular disturbances

### Cranial nerves

The cranial nerves form part of the peripheral nervous system and originate from the brain. Each nerve is named according to its function or appearance and is numbered using Roman numerals from I to XII. The numbers roughly correspond to their position as they descend from just above the brainstem (I and II), through the midbrain (III and IV), pons (V to VII) and medulla (VIII to XII).



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Name	Function	Test	Abnormal signs
Olfactory (I)	Smell	Identify a familiar odour, e.g. coffee, orange, tobacco, with one nostril at a time	Partial or total loss of smell Altered or increased sense of smell
Optic (II)	Sight	Visual acuity: read with one eye covered  Peripheral vision: detect objects or movement from the corner of the eye with the other eye covered	Visual fields defects, loss of visual acuity, colour-blind
Oculomotor (III)	Movement of eyelid and eyeball, constriction of pupil, lens accommodation	Follow the examiner's finger, which moves up and down and side to side, keeping the head in mid-position	Squint, ptosis, diplopia, pupil dilation
Trochlear (IV)	Movement of eyeball upwards	As for oculomotor	Diplopia, squint
Trigeminal (V)	Mastication, sensation for eye, face, sinuses and teeth	Test facial sensation  Clench teeth (the examiner palpates the masseter and temporalis muscles)	Trigeminal neuralgia, loss of mastication and sensation in eye, face, sinuses and teeth

Abducens (VI)	Movement of eyeball into abduction, controls gaze	As for oculomotor	Gaze palsy
Facial (VII)	Facial movements, sensation and taste for anterior two-thirds of tongue, secretion of saliva and tears	Test ability to move the face, e.g. close eyes tightly, wrinkle brow, whistle, smile, show teeth	Bell's palsy, loss of taste and ability to close eyes
Vestibulocochlear (VIII)	Hearing, balance	Examiner rubs index finger and thumb together noisily beside one ear and silently beside the other. Patient identifies the noisy side	Tinnitus, deafness, vertigo, ataxia, nystagmus
Glossopharyngeal (IX)	Sensation and taste for posterior third of tongue, swallow, salivation, regulation of blood pressure	Swallow Evoke the gag reflex by touching the back of the throat with a tongue depressor	Loss of tongue sensation and taste, reduced salivation, dysphagia
Vagus (X)	Motor and sensation for heart, lungs, digestive tract and diaphragm, secretion of digestive fluids, taste, swallow, hiccups	As for glossopharyngeal	Vocal cord paralysis, dysphagia, loss of sensation from internal organs





Name	Function	Test	Abnormal signs
Accessory (XI)	Motor to soft palate, larynx, pharynx, trapezius and sternocleidomastoid	Rotate neck to one side and resist flexion, i.e. contract sternocleidomastoid. Shrug shoulders against resistance	Paralysis of innervated muscles
Hypoglossal (XII)	Tongue control and strap muscles of neck	Stick out the tongue. Push tongue into the left and right side of the cheek	Dysphagia, dysarthria, difficulty masticating

## Key features of upper and lower motor neurone lesions

	Upper motor neurone	Lower motor neurone
Muscle tone	Increased	Decreased
Clonus	Present	Absent
Muscle fasciculation	Absent	Present
Tendon reflexes	Increased	Depressed or absent
Plantar response	Extensor (Babinski's sign)	Flexor (normal)
Distribution	Extensor weakness in upper limb and flexor weakness in lower limb Whole limb(s) involved	Weakness of muscle groups innervated by affected spinal segment/root, plexus or peripheral nerve

### Upper motor neurone

*Origin:* cerebral cortex

*Terminates:* cranial nerve nuclei or spinal cord anterior horn

### Lower motor neurone

*Origin:* cranial nerve motor nuclei or spinal cord anterior horn

*Terminates:* skeletal muscle motor unit



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## Functional implications of spinal cord injury

Level	Motor control	Personal independence	Equipment	Mobility
C1–C2	Swallow, talk, chew, blow (cough absent)	Type, turn pages, use telephone and computer	Hoist, respirator, mouthstick, reclining powered wheelchair using breath/chin control	Wheelchair
C3	Neck control, weak shoulder elevation	As above	Hoist, respirator, mouth/head stick, wheelchair as above	Wheelchair
C4	Respiration, neck control, shoulder shrug	Feed possible	Mouth/head stick, hoist, mobile arm supports, wheelchair as above	Wheelchair
C5	Shoulder external rotation, protraction, elbow flexion, supination	Feed, groom, roll in bed, weight shift, push wheelchair on flat, use brake	Adapted feeding/grooming equipment and hand splints, mobile arm supports, powered wheelchair with hand controls or lightweight manual with grips	Wheelchair
C6	Shoulder, elbow flexion, wrist extension, pronation. Weak elbow extension, wrist flexion and thumb control	Tenodesis grip, drink, write, personal ADL, transfers, dress upper body, light domestic chores, push wheelchair on slope	Adapted equipment and splints, transfer board, hand-controlled car, lightweight manual wheelchair, powered for short distances	Bed mobility, bed to chair transfers, wheelchair, car

C7	Elbow extension, finger flexion and extension, limited wrist flexion	Dress lower body, personal and skin care, showering, all transfers, pick up from floor, wheelchair sports	Bath board, shower chair, hand-controlled car, wheelchair as above	All transfers, wheelchair, car
C8	Wrist flexion, hand control	Bladder and bowel care	Grab rails, standing frame, non-adapted wheelchair	Stand in frame
T1–T5	Top half of intercostals and long back muscles	Trunk support, improved balance, assisted cough, negotiate kerbs with wheelchair, routine domestic chores	Bilateral knee–ankle orthoses with spinal attachment, standing frame/table	Full wheelchair independence, transfer floor to chair, mobilize with assistance for short distances
T6–T12	Abdominals	Good balance, weak to normal cough, improved stamina	Bilateral knee–ankle orthoses, crutches or frame	Mobilize independently indoors, transfer chair to crutches
L1–L2	Hip flexion		Calipers	Stairs, transfer floor to crutches





<b>Level</b>	<b>Motor control</b>	<b>Personal independence</b>	<b>Equipment</b>	<b>Mobility</b>
L3–L5	Knee extension, weak knee flexion, dorsiflexion and eversion		Ankle–foot orthoses, crutches/sticks	
S1–S2	Hip extension	Improved standing balance		Normal gait without aids
S2–S4	Bladder, bowel and sexual function			

## Glossary of neurological terms

<b>Acalculia</b>	inability to calculate
<b>Agnosia</b>	inability to interpret sensations such as sounds (auditory agnosia), three-dimensional objects by touch (tactile agnosia) or symbols and letters (visual agnosia)
<b>Agraphia</b>	inability to write
<b>Akinesia</b>	loss of movement
<b>Alexia</b>	inability to read
<b>Amnesia</b>	total or partial loss of memory
<b>Amusia</b>	impaired recognition of music
<b>Anomia</b>	inability to name objects
<b>Anosmia</b>	loss of ability to smell
<b>Anosognosia</b>	denial of ownership or the existence of a hemiplegic limb
<b>Aphasia</b>	inability to generate and understand language whether verbal or written
<b>Astereognosis</b>	inability to recognize objects by touch alone, despite intact sensation
<b>Ataxia</b>	shaky and uncoordinated voluntary movements that may be associated with cerebellar or posterior column disease
<b>Athetosis</b>	involuntary writhing movements affecting face, tongue and hands
<b>Bradykinesia</b>	slowness of movement
<b>Chorea</b>	irregular, jerky, involuntary movement
<b>Clonus</b>	more than three rhythmic contractions of the plantarflexors in response to sudden passive dorsiflexion
<b>Diplopia</b>	double vision
<b>Dysaesthesia</b>	perverted response to sensory stimuli producing abnormal and sometimes unpleasant sensation



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**Dysarthria**  
**Dysdiadochokinesia**

difficulty articulating speech  
clumsiness in performing rapidly alternating movements

**Dysmetria**

under- or overshooting while reaching towards a target

**Dysphagia**  
**Dysphasia**

difficulty or inability to swallow  
difficulty understanding language (receptive dysphasia) or generating language (expressive dysphasia)

**Dysphonia**  
**Dyspraxia**

difficulty in producing the voice  
inability to make skilled movements despite intact power, sensation and coordination

**Dyssynergia**  
**Dystonia**

clumsy, uncoordinated movements  
abnormal postural movements caused by co-contraction of agonists and antagonists, usually at an extreme of flexion or extension

**Graphaesthesia**

inability to recognize numbers or letters traced onto the skin with a blunt object

**Hemianopia**  
**Hemiballismus**

loss of half the normal visual field  
sudden, involuntary violent flinging movements of an entire limb, usually unilateral

**Hemiparesis**

weakness affecting one side of the body

**Hemiplegia**

paralysis affecting one side of the body

**Homonymous**

affecting the same side, i.e. homonymous diplopia

**Hyperacusis**  
**Hyperreflexia**

increased sensitivity to sound  
increased reflexes

**Hypertonia**  
**Hypertrophy**  
**Kinaesthesia**

increase in normal muscle tone  
abnormal increase in tissue size  
perception of body position and movement

**Miosis**  
**Nystagmus**

pupil constriction  
involuntary movements of the eye



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<b>Paraesthesia</b>	tingling sensation often described as ‘pins and needles’
<b>Paraphasia</b>	insertion of inappropriate or incorrect words in person’s speech
<b>Paraplegia</b>	paralysis of both legs
<b>Paresis</b>	muscle weakness
<b>Photophobia</b>	intolerance to light
<b>Prosopagnosia</b>	inability to recognize faces
<b>Ptosis</b>	drooping of the upper eyelid
<b>Quadrantanopia</b>	loss of quarter the normal visual field
<b>Quadriplegia</b>	paralysis of all four limbs
<b>Stereognosis</b>	ability to identify common objects by touch alone
<b>Tetraplegia</b>	another term for quadriplegia



## Neurological tests

### Finger–nose test

Hold your finger about an arm’s length from the patient. Ask the patient to touch your finger with their index finger and then touch their nose, repeating the movement back and forth. Patients may demonstrate past pointing (missing your finger) or intention tremor.

*Indicates:* possible cerebellar dysfunction.

### Heel–shin test

With the patient lying down, ask them to place one heel on the opposite knee and then run the heel down the tibial shaft towards the ankle and back again. Patients may demonstrate intention tremor, an inability to keep the heel on the shin or uncoordinated movements.

*Indicates:* possible cerebellar dysfunction.

### Hoffman reflex

Flick the distal phalanx of the patient’s third or fourth finger. Look for any reflex flexion of the patient’s thumb.

*Indicates:* possible upper motor neurone lesion.

## Joint position sense

Test the most distal joint of the limb, i.e. distal phalanx of the index finger or interphalangeal joint of the hallux. With the patient's eyes open, demonstrate the movement. To test, get the patient to close their eyes. Hold the joint to be tested at the sides between two fingers and move it up and down. Ask the patient to identify the direction of movement, ensuring that you are not moving more proximal joints or brushing against the neighbouring toes or fingers. If there is impairment, test more proximal joints.

*Indicates:* loss of proprioception.

## Light touch

Use a wisp of cotton wool. With the patient's eyes open, demonstrate what you are going to do. To test, get the patient to close their eyes. Stroke the patient's skin with the cotton wool at random points, asking them to indicate every time they feel the touch.

*Indicates:* altered touch sensation.

## Pin prick

Use a disposable neurological pin which has a sharp end and a blunt end. With the patient's eyes open, demonstrate what you are going to do. To test, get the patient to close their eyes. Test various areas of the limb randomly using sharp and blunt stimuli and get the patient to tell you which sensation they feel.

*Indicates:* altered pain sensation.

## Plantar reflex (Babinski)

Apply a firm pressure along the lateral aspect of the sole of the foot and across the base of the toes, observing the big toe. If the big toe flexes, the response is normal. If the big toe extends and the other toes spread it indicates a positive Babinski's sign.

*Indicates:* A positive Babinski's sign signifies a possible upper motor neurone lesion.





## Rapidly alternating movement

Ask the patient to hold out one hand palm up and then alternately slap it with the palmar and then dorsal aspect of the fingers of the other hand. Where there is a loss of rhythm and fluency it is referred to as dysdiadochokinesia. For the lower limbs get the patient to tap first one foot on the floor and then the other.

*Indicates:* possible cerebellar dysfunction.

## Romberg's test

Patient stands with feet together and eyes open. Ask the patient to close their eyes (ensuring that you can support them if they fall). Note any excessive postural sway or loss of balance.

*Indicates:* proprioceptive or vestibular deficit if they fall only when they close their eyes.

## Temperature

A quick test involves using a cold object such as a tuning fork and asking the patient to describe the sensation when applied to various parts of the body. For more formal testing, two test tubes are filled with cold and warm water and patients are asked to distinguish between the two sensations.

*Indicates:* altered temperature sensation.

## Two-point discrimination

Requires a two-point discriminator, a device similar to a pair of blunted compasses. With the patient's eyes open, demonstrate what you are going to do. Get the patient to close their eyes. Alternately touch the patient with either one prong or two. Reduce the distance between the prongs until the patient can no longer discriminate between being touched by one prong or two prongs. Varies according to skin thickness but normal young patients can distinguish a separation of approximately 5 mm in the index finger and approximately 4 cm in the legs. Compare left to right.

*Indicates:* impaired sensory function.

## Vibration sense

Use a 128 Hz tuning fork. Ask the patient to close their eyes. Place the tuning fork on a bony prominence or on the fingertips or toes. The patient should report feeling the vibration and not simply the contact of the tuning fork. If in doubt, apply the tuning fork and then stop it vibrating suddenly by pinching it between your fingers and see if the patient can correctly identify when it stops vibrating.

*Indicates:* altered vibration sense.



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### Modified Ashworth scale

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion (ROM) when the affected part(s) is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone passive, passive movement difficult
4	Affected part(s) rigid in flexion or extension

### Neurological assessment

Patients present with a variety of conditions, and assessments need to be adapted to suit their needs. This section provides a basic framework for the subjective and objective neurological assessment of a patient.

## Database

History of present condition

Past medical history

Drug history

Results of specific investigations (X-rays, CT scans, blood tests, etc.)

## Subjective examination

Social situation

- family support
- accommodation
- employment
- leisure activities
- social service support

Normal daily routine

Indoor and outdoor mobility

Continence

Vision

Hearing

Swallowing

Fatigue

Pain

Other ongoing treatment

Past physiotherapy and response to treatment

Perceptions of own problems/main concern

Expectations of treatment

## Objective examination

### Posture and balance

Alignment

Neglect

Sitting balance

Standing balance

- Romberg's test

### Voluntary movement

Range of movement

Strength



- Coordination
  - finger–nose test
  - heel–shin test
  - rapidly alternating movement
- Endurance

### Involuntary movement

- Tremor
- Clonus
- Chorea
- Associated reactions

### Tone

- Decreased/flaccid
- Increased
  - spasticity (clasp-knife)
  - rigidity (cogwheel or lead-pipe)

### Reflexes

- Deep tendon reflexes
  - biceps (C5/6)
  - triceps (C7/8)
  - knee (L3/4)
  - ankle (S1/2)
- Plantar reflex
- Hoffman's reflex

### Muscle and joint range

- Passive range of movement

### Sensory

- Light touch
- Pin prick
- Two-point discrimination
- Vibration sense
- Joint position sense
- Temperature
- Vision and hearing

### Functional activities

- Bed mobility
- Sitting balance
- Transfers



Upper limb function

Mobility

Stairs

### Gait

Pattern

Distance

Velocity

Use of walking aids

Orthoses

Assistance from others

### Exercise tolerance/fatigue

### Cognitive status

Attention

Orientation

Memory

### Emotional state

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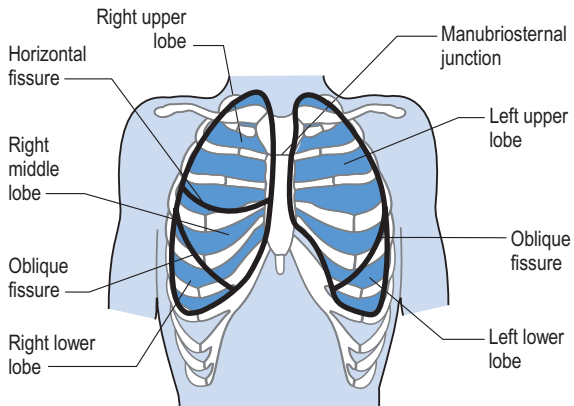
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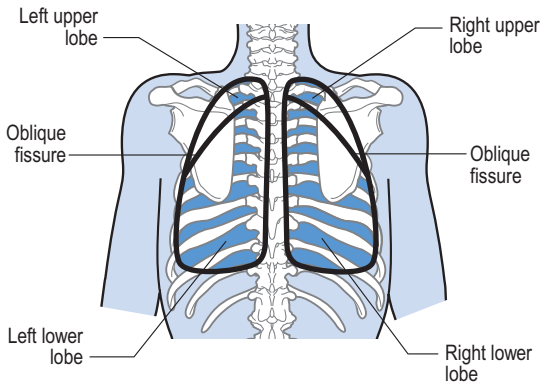
# Respiratory

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## Respiratory anatomy illustrations



**Figure 4.1** Lung markings – anterior view.



**Figure 4.2** Lung markings – posterior view.



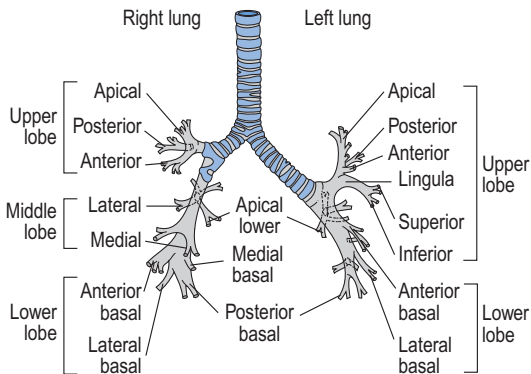
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Useful lung markings*	
Apex	Anterior – 2.5 cm above clavicles Posterior – T1
Lower borders	Anterior – sixth rib Posterior – T10/11 Mid-axilla – eighth rib
Tracheal bifurcation	Anterior – manubriosternal junction Posterior – T4
Right horizontal fissure	Anterior – fourth rib (above the nipple)
Oblique fissures	Anterior – sixth rib (below the nipple) Posterior – T2/3
Left diaphragm	Anterior – sixth rib Posterior – T10 Mid-axilla – eighth rib
Right diaphragm	Anterior – fifth rib Posterior – T9 Mid-axilla – eighth rib

\*These lung markings are approximate and can vary between individuals.



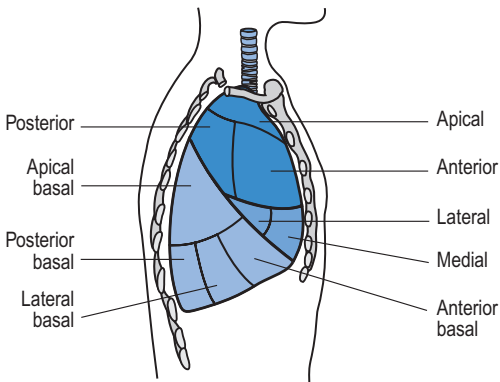
**Figure 4.3** Anterior view of bronchial tree.



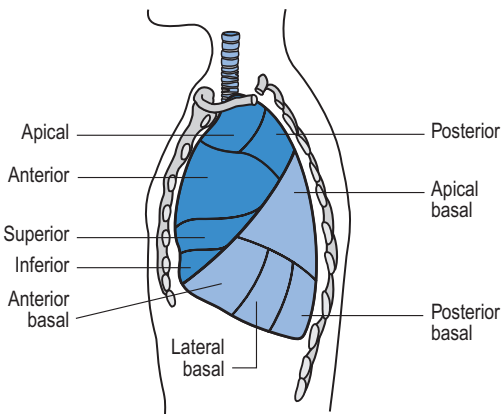
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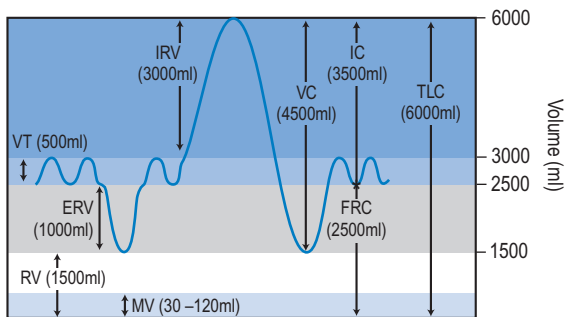
**Figure 4.4** Bronchopulmonary segments – right lateral view.



**Figure 4.5** Bronchopulmonary segments – left lateral view.



## Respiratory volumes and capacities



**Figure 4.6** Respiratory volumes and capacities. Average volumes in healthy adult male.

### Lung volumes

#### $V_T$ (tidal volume)

Volume of air inhaled or exhaled during a single normal breath

Value: 500 mL

#### IRV (inspiratory reserve volume)

Maximum amount of air that can be inspired on top of a normal tidal inspiration

Value: 3000 mL

#### ERV (expiratory reserve volume)

Maximum amount of air that can be exhaled following a normal tidal expiration

Value: 1000 mL

#### RV (residual volume)

Volume of air remaining in the lungs after a maximal expiration

Value: 1500 mL



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### MV (minimal volume)

The amount of air that would remain if the lungs collapsed

*Value:* 30–120 mL

### Lung capacities

A capacity is the combination of two or more lung volumes

#### TLC (total lung capacity)

Total volume of your lungs at the end of maximal inspiration

$$TLC = V_T + IRV + ERV + RV$$

*Value:* 6000 mL

#### VC (vital capacity)

Maximum amount of air that can be inspired and expired in a single breath

$$VC = V_T + IRV + ERV$$

*Value:* 4500 mL

#### IC (inspiratory capacity)

The maximum volume of air that can be inspired after a normal tidal expiration

$$IC = V_T + IRV$$

*Value:* 3500 mL

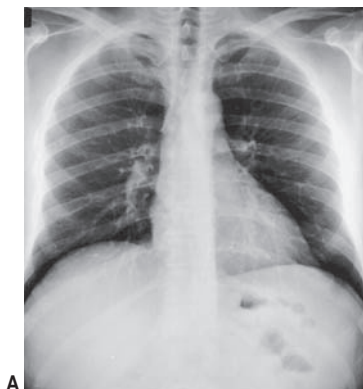
#### FRC (functional residual capacity)

Volume of air remaining in the lungs at the end of a normal tidal expiration

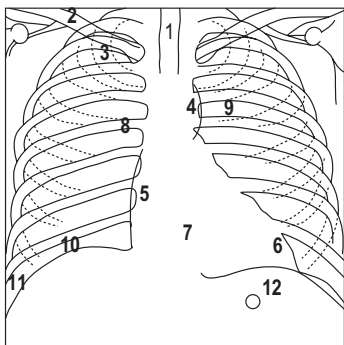
$$FRC = ERV + RV$$

*Value:* 2500 mL





A



B

- |                      |                        |
|----------------------|------------------------|
| 1 Air in the trachea | 7 Right ventricle      |
| 2 Clavicle           | 8 Right hilum          |
| 3 1st rib            | 9 Left hilum           |
| 4 Aortic arch        | 10 Right hemidiaphragm |
| 5 Right atrium       | 11 Costophrenic angle  |
| 6 Left ventricle     | 12 Gastric bubble      |

**Figure 4.7** **A** Normal PA chest X-ray (from Pryor & Prasad 2008); **B** structures normally visible on X-ray.



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## Analysing chest X-rays

Adopt a systematic approach when analysing X-rays. You should check the following:

### Patient's details

- Name, date and time of X-ray

### Is it anteroposterior (AP) or posteroanterior (PA)?

#### Supine or erect?

- AP X-rays are taken using a mobile machine with the patient in supine. The heart appears larger and the scapulae are visible.
- PA X-rays are taken in the radiology department with the patient standing erect. The quality is generally better and the scapulae are out of the way.

### Is the patient positioned symmetrically?

- The medial ends of the clavicle should be equidistant from the adjacent vertebral body. If the patient is rotated the position of the heart, spine and rib cage may appear distorted.

### Degree of inspiration

- On full inspiration the sixth or seventh rib should intersect the midpoint of the right hemidiaphragm anteriorly or the ninth rib posteriorly.

### Exposure

- If the film appears too dark it is overpenetrated (overexposed).
- If the film appears too light it is underpenetrated (underexposed).

*Think of toast: dark is overdone and white is underdone.*

- The spinous processes of the cervical and upper thoracic vertebra should be visible, as should the outline of the mid-thoracic vertebral bodies.

### Extrathoracic soft tissues

- Surgical emphysema is often seen in the supraclavicular areas, around the armpit and the lateral chest wall.



- The lateral wall of the chest may be obscured by breast shadows.

### Invasive medical equipment

- Note the position and presence of any tubes, cannulas, electrodes, etc.
- The tip of the endotracheal tube should lie about 2 cm above the carina.

### Bony structures

- Check for fractures, deformities and osteoporosis.

### Intercostal spaces

- Small intercostal spaces and steeply sloping ribs indicate reduced lung volume.
- Large intercostal spaces and horizontal ribs indicate hyperinflation.

### Trachea

- Lies centrally with the lower third inclining slightly to the right.
- Deviation of the trachea indicates mediastinal shift. It shifts towards collapse and away from tumours, pleural effusions and pneumothoraces.
- Bifurcation into the left and right bronchi is normally seen. The right bronchus follows the line of the trachea whereas the left bronchus branches off at a more acute angle.

### Hila

- Made up of the pulmonary vessels and lymph nodes.
- The left and right hilum should be roughly equal in size, though the left hilum appears slightly higher than the right. Their silhouette should be sharp.

### Heart

- On a PA film the diameter of the heart is usually less than half the total diameter of the thorax. In the majority of cases, one-third of the cardiac shadow lies on the right and two-thirds on the left, which should be sharply defined. The density of both sides should be equal. The heart may appear bigger on an AP film or if the patient is rotated.



## Diaphragm

- The right side of the diaphragm is about 2 cm higher than the left because the right lobe of the liver is situated directly underneath it. Both hemidiaphragms should be dome shaped and sharply defined.
- The costophrenic angle is where the diaphragm meets the ribs.
- The cardiophrenic angle is where the diaphragm meets the heart.

## Auscultation

Auscultation should be conducted in a systematic manner, comparing the same area on the left and right side while visualizing the underlying lung structures. Ideally patients should be sitting upright and be asked to breathe through the mouth to reduce nose turbulence.

## Breath sounds

### Normal

More prominent at the top of the lungs and centrally, with the volume decreasing towards the bases and periphery. Expiration is shorter and quieter than inspiration and follows inspiration without a pause.

### Abnormal (bronchial breathing)

Similar to the breath sounds heard when listening over the trachea. They are typically loud and harsh and can be heard throughout inspiration and expiration. Expiration is longer than inspiration and there is a pause between the two. They occur if air is replaced by solid tissue, which transmits sound more clearly. Caused by consolidation, areas of collapse with adjacent open bronchus, pleural effusion, tumour.

### Diminished

Breath sounds will be reduced if air entry is compromised by either an obstruction or a decrease in airflow. Caused by pneumothorax, pleural effusion, emphysema, collapse with occluded bronchus, atelectasis, inability to breathe deeply, obesity.



## Added sounds

### Crackles

Heard when airways that have been narrowed or closed, usually by secretions, are suddenly forced open on inspiration. Usually classified as fine (originating from small, distal airways), coarse (from large, proximal airways), localized or widespread. They can be further defined as being early or late, depending on when they are heard on inspiration or expiration.

*Early inspiratory* – reopening of large airways (e.g. bronchiectasis and bronchitis)

*Late inspiratory* – reopening of alveoli and peripheral airways (e.g. pulmonary oedema, pulmonary fibrosis, pneumonia, atelectasis)

*Early expiratory* – secretions in large airways

*Late expiratory* – secretions in peripheral airways

### Wheeze

Caused by air being forced through narrowed or compressed airways. Described as either high or low pitched and monophonic (single note) or polyphonic (where several airways may be obstructed). Airway narrowing can be caused by bronchospasm, mucosal oedema or sputum retention. An expiratory wheeze with prolonged expiration is usually indicative of bronchospasm, while a low-pitched wheeze throughout inspiration and expiration is normally caused by secretions.

### Pleural rub

If the pleural surfaces are inflamed or infected they become rough and rub together, creating a creaking or grating sound. Heard equally during inspiration and expiration.

### Voice sounds

In normal lung tissue, voice sounds are indistinct and unintelligible. When there is consolidation, sound is transmitted more clearly and loudly and speech can be distinguished. Voice sounds can be diminished in the presence of emphysema, pneumothorax and pleural effusion. They can be heard through a stethoscope (vocal resonance) or felt by



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hand (vocal fremitus). To test voice sounds patients can be asked to say or whisper '99' repeatedly.

### Percussion note

Elicited by placing the middle finger of one hand firmly in the space between the ribs and tapping the distal phalanx sharply with the middle finger of the other hand.

The pitch of the note is determined by whether the lungs contain air, solid or fluid and will either sound normal, resonant, dull or stony dull.

*Resonant* = normal

*Hyper-resonant* = emphysema (bullae) or pneumothorax

*Dull* = consolidation, areas of collapse, pleural effusion

### Interpreting blood gas values

Arterial blood analysis	Reference ranges in adults
pH	7.35–7.45 pH
PaO <sub>2</sub>	10.7–13.3 kPa (80–100 mmHg)
PaCO <sub>2</sub>	4.7–6.0 kPa (35–45 mmHg)
HCO <sub>3</sub> <sup>-</sup>	22–26 mmol/L
Base excess	-2 to +2

### Assessing acid–base disorders

Assessing acid–base disorders involves examining the pH, PaCO<sub>2</sub> and HCO<sub>3</sub><sup>-</sup>:

- pH – a low pH (<7.4) indicates a tendency towards acidosis, a high pH (>7.4) indicates a tendency towards alkalosis.
- PaCO<sub>2</sub> – an increase in PaCO<sub>2</sub> leads to acidosis, a decrease to alkalosis.
- HCO<sub>3</sub><sup>-</sup> – an increase in HCO<sub>3</sub><sup>-</sup> leads to alkalosis, a decrease to acidosis.



## Assessment

1. Establish whether the patient's pH is acidotic, alkalotic or normal.
2. If the pH is acidotic establish whether this is due to:
  - increased  $\text{PaCO}_2$  – indicating respiratory acidosis
  - decreased  $\text{HCO}_3^-$  – indicating metabolic acidosis.
3. If the pH is alkalotic establish whether this is due to:
  - decreased  $\text{PaCO}_2$  – indicating respiratory alkalosis
  - increased  $\text{HCO}_3^-$  – indicating metabolic alkalosis.
4. If the pH is within normal range the original abnormality can be identified by comparing the pH to the  $\text{PaCO}_2$  and the  $\text{HCO}_3^-$ . If the pH is below 7.4 (tending towards acid) then the component that correlates with acidosis (increased  $\text{PaCO}_2$  or decreased  $\text{HCO}_3^-$ ) is the cause and the other is the compensation. Likewise, if the pH is above 7.4 (tending towards alkaline) the component that correlates with alkalosis (decreased  $\text{PaCO}_2$  or increased  $\text{HCO}_3^-$ ) is the cause and the other is the compensation.



## Simple acid–base disorders

	pH	$\text{PaCO}_2$	$\text{HCO}_3^-$
<b>Respiratory acidosis</b>			
Uncompensated	↓	↑	N
Compensated	N	↑	↑
<b>Respiratory alkalosis</b>			
Uncompensated	↑	↓	N
Compensated	N	↓	↓
<b>Metabolic acidosis</b>			
Uncompensated	↓	N	↓
Compensated	N	↓	↓
<b>Metabolic alkalosis</b>			
Uncompensated	↑	N	↑
Compensated	N	↑	↑

↓ = decreased; ↑ = increased; N = normal.

## Base excess

Allows assessment of the metabolic component of acid–base disturbances and therefore the degree of renal compensation that has occurred. A base deficit (less than  $-2$ ) indicates a metabolic acidosis and a base excess (greater than  $+2$ ) correlates with metabolic alkalosis.

## Respiratory failure

Broadly defined as an inability of the respiratory system to maintain blood gas values within normal ranges. There are two types:

### Type I (hypoxaemic respiratory failure)

A decreased  $\text{PaO}_2$  (hypoxaemia) with a normal or slightly reduced  $\text{PaCO}_2$  due to inadequate gas exchange. Causes include pneumonia, emphysema, fibrosing alveolitis, severe asthma and adult respiratory distress syndrome.

**Defined as  $\text{PaO}_2 < 8 \text{ kPa (60 mmHg)}$ .**

### Type II (ventilatory failure)

A decreased  $\text{PaO}_2$  with an increased  $\text{PaCO}_2$  (hypercapnia) caused by hypoventilation. Causes include neuromuscular disorders (e.g. muscular dystrophy, Guillain–Barré), lung diseases (e.g. asthma, COPD), drug-related respiratory drive depression and injuries to the chest wall.

**Defined as  $\text{PaO}_2 < 8 \text{ kPa (60 mmHg)}$ ,  $\text{PaCO}_2 > 6.7 \text{ kPa (50 mmHg)}$ .**

## Arterial blood gas classification of respiratory failure

	pH	$\text{PaCO}_2$	$\text{HCO}_3^-$
Acute	↓	↑	N
Chronic	N	↑	↑
Acute on chronic	↓	↑	↑

↓ = decreased; ↑ = increased; N = normal.



## Nasal cannula

The following values are approximate as the patient's flow rates, ability to breathe through the nose, type of cannula and build-up of nasal mucus may all affect the amount of oxygen received. As a general rule the  $\text{FiO}_2$  is raised by 3–4% for each litre of oxygen.

To convert litres of $\text{O}_2$ to $\text{FiO}_2$
RA $\approx$ 21% $\text{FiO}_2$
1 L/min $\approx$ 24% $\text{FiO}_2$
2 L/min $\approx$ 28% $\text{FiO}_2$
3 L/min $\approx$ 32% $\text{FiO}_2$
4 L/min $\approx$ 36% $\text{FiO}_2$
5 L/min $\approx$ 40% $\text{FiO}_2$
6 L/min $\approx$ 44% $\text{FiO}_2$

RA = room air.

> 6L/min has little effect on  $\text{FiO}_2$  and may lead to irritation and drying of the nasal mucosa.

## Sputum analysis (Middleton & Middleton 2008, with permission)

	Description	Causes
Saliva	Clear watery fluid	
Mucoid	Opalescent or white	Chronic bronchitis without infection, asthma
Muco-purulent	Slightly discoloured, but not frank pus	Bronchiectasis, cystic fibrosis, pneumonia



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Purulent	Thick, viscous: <ul style="list-style-type: none"><li>– yellow</li><li>– dark green/brown</li><li>– rusty</li><li>– redcurrant jelly</li></ul>	<i>Haemophilus</i> <i>Pseudomonas</i> <i>Pneumococcus</i> , <i>Mycoplasma</i> <i>Klebsiella</i>
Frothy	Pink or white	Pulmonary oedema
Haemoptysis	Ranging from blood specks to frank blood, old blood (dark brown)	Infection (tuberculosis, bronchiectasis), infarction, carcinoma, vasculitis, trauma, also coagulation disorders, cardiac disease
Black	Black specks in mucoid secretions	Smoke inhalation (fires, tobacco, heroin), coal dust

## Modes of mechanical ventilation

### Controlled mechanical ventilation (CMV)

Delivers a preset number of breaths to the patient at a preset tidal volume, pressure and flow rate. The ventilator performs all the work of breathing – the patient cannot trigger the machine or breathe spontaneously. Patients on CMV are sedated and paralysed.

### Assist/control ventilation (ACV)

Spontaneously breathing patients trigger a breath and the ventilator delivers gas at a preset tidal volume or preset pressure. The ventilator will initiate a breath automatically should the patient fail to trigger within a preset time.

### Intermittent mandatory ventilation (IMV)

Delivers a preset number of breaths at a preset tidal volume and flow rate but allows the patient to take spontaneous breaths between machine-delivered breaths.

## Synchronized intermittent mandatory ventilation (SIMV)

Synchronizes breaths from the ventilator with the patient's spontaneous breaths. If the patient fails to take a spontaneous breath within a set time the ventilator delivers a mandatory breath at either a preset tidal volume (SIMV/volume cycled) or preset inspiratory pressure (SIMV/pressure cycled).

## Pressure support (PS)

Patients breathe spontaneously, triggering the ventilator to deliver a set level of positive pressure to assist air entry and reduce the work of breathing. The patient controls the tidal volume, respiratory rate and flow rate. Pressure support can be added to SIMV to compensate for the resistance from the endotracheal tube, making it easier for the patient to breathe.

## High-frequency ventilation

This mode of ventilation does not try to imitate normal physiological breathing. Instead it delivers low tidal volumes at high respiratory rates. This results in lower airway pressures, thereby reducing the risk of complications associated with barotrauma. There are three types:

- *High-frequency positive pressure ventilation*: delivers small tidal volumes at high respiratory rates (60–100 breaths/min).
- *High-frequency oscillation ventilation*: oscillates small bursts of gas to and fro at high rates (up to 3000 cycles/min).
- *High-frequency jet ventilation*: delivers a short, rapid, high-pressure jet to the airways through a small-bore cannula (100–600 cycles/min).

## Continuous positive airway pressure (CPAP)

A high flow of gas delivered continuously throughout inspiration and expiration during spontaneous breathing. The alveoli and smaller airways are splinted open, increasing lung volume at the end of expiration (i.e. the functional residual capacity), thereby reversing atelectasis and improving



gas exchange. It also increases lung compliance and decreases the work of breathing.

### **Bilevel positive airway pressure (BiPAP)**

Similar to CPAP, positive airway pressure is delivered throughout inspiration and expiration during spontaneous breathing but the level of positive airway pressure alters between inspiration and expiration. A higher level is delivered during inspiration and a lower level during expiration. The alteration between pressure levels is synchronized with the patient's breathing. This is usually by means of a trigger that is sensitive to changes in flow (triggered or spontaneous mode) but the ventilator can also deliver breaths should the patient fail to inhale spontaneously (timed/spontaneous mode or assist-control mode).

### **Non-invasive ventilation (NIV)**

NIV is the provision of ventilatory support without intubation, usually via a mask or similar device, to the upper airway. Positive pressure ventilation is the most common form, though negative pressure ventilation is used in some situations. Positive pressure devices may be pressure, volume or time controlled and the following modes may be used: controlled mechanical ventilation, assist/control ventilation, pressure support ventilation (assisted spontaneous breathing), CPAP, BiPAP and proportional assist ventilation.

**Contraindications to NIV** (British Thoracic Society 2002, with permission)

- Facial trauma/burns
- Recent facial, upper airway or upper gastrointestinal tract surgery\*
- Fixed obstruction of the upper airway
- Inability to protect airway\*
- Life-threatening hypoxaemia\*
- Haemodynamic instability\*
- Severe co-morbidity\*
- Impaired consciousness\*
- Confusion/agitation\*



- Vomiting
- Bowel obstruction\*
- Copious respiratory secretions\*
- Focal consolidation on chest radiograph\*
- Undrained pneumothorax\*

\*NIV may be used, despite the presence of these contraindications, if it is to be the 'ceiling' of treatment.

## Cardiorespiratory monitoring

### Arterial blood pressure (ABP)

Measured via an intra-arterial cannula which allows continuous monitoring of the patient's blood pressure and also provides an access for arterial blood sampling and blood gas analysis.

*Normal value:* 95/60–140/90 mmHg in adults (increases gradually with age)

*Hypertension:* >145/95 mmHg

*Hypotension:* <90/60 mmHg

### Cardiac output (CO)

Amount of blood pumped into the aorta each minute.

$$CO = HR \times SV$$

*Normal value:* 4–8 L/min

### Cardiac index (CI)

Cardiac output related to body size. Body surface area is calculated by using the patient's weight and height and a nomogram. Allows reliable comparison between patients of different sizes.

$$CI = CO \div \text{body surface area}$$

*Normal value:* 2.5–4 L/min/m<sup>2</sup>



## Central venous pressure (CVP)

Measured via a central venous cannula inserted into the internal or external jugular vein or subclavian vein with the tip resting close to the right atrium within the superior vena cava. Provides information on circulating blood volume, the effectiveness of the heart to pump that volume, vascular tone and venous return.

*Normal value:* 3–15 cmH<sub>2</sub>O

## Cerebral perfusion pressure (CPP)

Pressure required to ensure adequate blood supply to the brain.

$$\text{CPP} = \text{MAP} - \text{ICP}$$

*Normal value:* >70 mmHg

## Ejection fraction (EF)

The stroke volume (SV) as a percentage of the total volume of the ventricle prior to systolic contraction, i.e. end-diastolic volume (EDV).

$$\text{EF} = \text{SV} \div \text{EDV}$$

*Normal value:* 65–75%

## Heart rate (HR)

The number of times the heart contracts in a minute.

*Normal value:* 50–100 beats/min

*Tachycardia:* >100 beats/min at rest

*Bradycardia:* <50 beats/min at rest

## Intracranial pressure (ICP)

Pressure exerted by the brain tissue, cerebrospinal fluid and blood volume within the rigid skull and meninges. Neurological insults such as space-occupying lesions, cerebral oedema, hydrocephalus, cerebral haemorrhage, hypoxia and infection cause this pressure to rise, resulting in a decreased blood supply to the brain. When treating patients



with raised ICP, minimize handling and ensure that the head is maintained in midline and raised 15–30° from supine. A marked degree of hip flexion should be avoided to ensure optimal circulation and prevent potential increase in ICP.

*Normal value:* 0–10 mmHg

### Mean arterial pressure (MAP)

Measures the average pressure of blood being pushed through the circulatory system. It relates to cardiac output and systemic vascular resistance and reflects tissue perfusion pressure.

$$\text{MAP} = (\text{diastolic BP} \times 2) + (\text{systolic BP}) \div 3$$

*Normal value:* 80–100 mmHg

< 60 mmHg indicates inadequate circulation to the vital organs

### Oxygen saturation (SpO<sub>2</sub>)

Arterial oxygen saturation is measured using non-invasive pulse oximetry.

*Normal value:* 95–98%

### Pulmonary artery pressure (PAP)

A pulmonary artery balloon catheter (Swan–Ganz) is inserted via the CVP catheter route and floated into the pulmonary artery via the right ventricle. The PAP measures pressures of the blood in the vena cava, right atrium and right ventricle and provides a measure of the ability of the right side of the heart to push blood through the lungs and to the left side of the heart.

*Normal value:* 15–25/8–15 mmHg

*Mean value:* 10–20 mmHg

### Pulmonary artery wedge pressure (PAWP)

Similar to PAP but the Swan–Ganz catheter is moved further along until it wedges in a small pulmonary artery. The balloon tip is inflated to occlude the artery in order to allow measurement of the pressure in the pulmonary capillaries in



front of it and the left atrium. PAWP is also known as pulmonary capillary wedge pressure (PCWP).

*Normal value:* 6–12 mmHg

### **Respiratory rate (RR)**

Number of breaths taken in a minute.

*Normal value:* 12–16 breaths/min

*Tachypnoea:* >20 breaths/min

*Bradypnoea:* <10 breaths/min

### **Stroke volume (SV)**

The amount of blood ejected from the ventricles during each systolic contraction. Affected by preload (amount of tension on the ventricular wall before it contracts), afterload (resistance that the ventricle must work against when it contracts) and contractility (force of contraction generated by the myocardium).

$$SV = (CO \times 1000) \div HR$$

*Normal value:* 60–130 mL/beat

### **Systemic vascular resistance (SVR)**

Evaluates the vascular component of afterload in the left ventricle. Vasoconstriction will increase systemic vascular resistance while vasodilation will decrease it.

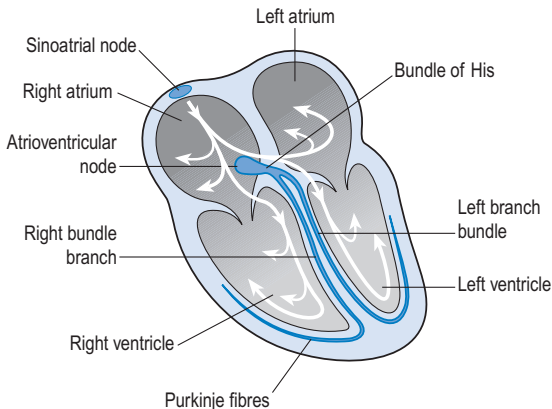
$$SVR = (MAP - CVP \div CO) \times 79.9$$

*Normal value:* 800–1400 dyn · s · cm<sup>-5</sup>

## **ECGs**

ECGs detect the sequence of electrical events that occur during the contraction (depolarization) and relaxation (repolarization) cycle of the heart. Depolarization is initiated by the sinoatrial (SA) node, the heart's natural pacemaker, which transmits the electrical stimulus to the atrioventricular (AV) node. From here the impulse is conducted through the bundle





**Figure 4.8** Conduction system of the heart.

of His and along the bundle branches to the Purkinje fibres, causing the heart to contract.

The atrioventricular (AV) node can also function as a pacemaker when there is a dysfunction of the SA node, e.g. failure to generate an impulse (sinus arrest), when the impulse generated is too slow (sinus bradycardia) or when the impulse is not conducted to the AV node (SA block, AV block).

ECGs are recorded on graphed paper that travels at 25 mm/s. It is divided into large squares of 5 mm width, which represents 0.2 s horizontally. Each square is then divided into five squares of 1 mm width (i.e. 0.04 s horizontally). Electrical activity is measured in millivolts (mV). A 1 mV signal moves the recording stylus vertically 1 cm (i.e. two large squares).

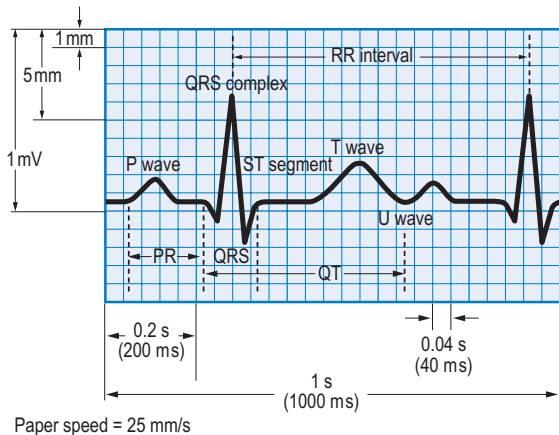
An ECG complex consists of five waveforms labelled with the letters P, Q, R, S and T, which represent the electrical events that occur in one cardiac cycle.

**The P wave** represents the activation of the atria (atrial depolarization).

- P amplitude: <math>< 2.5\text{ mm}</math>
- P duration: 0.06–0.12 s







**Figure 4.9** Normal ECG.

**The PR interval** represents the time between the onset of atrial depolarization and the onset of ventricular depolarization, i.e. the time taken for the impulse to travel from the SA node through the AV node and the His–Purkinje system.

- PR duration: 0.12–0.20 s

**The QRS complex** represents the activation of the ventricles (ventricular depolarization).

- QRS amplitude: 5–30 mm
- QRS duration: 0.06–0.10 s

**The ST segment** represents the end of ventricular depolarization and the beginning of ventricular repolarization.

**The T wave** represents ventricular repolarization.

- T amplitude: <10 mm (approximately more than one-eighth but less than two-thirds of corresponding R wave)

**The QT interval** represents the total time for ventricular depolarization and repolarization.

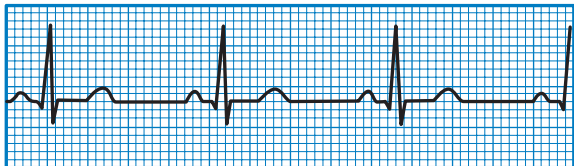
- QT duration: 0.35–0.45 s

The **U wave** represents repolarization of the His–Purkinje system and is not always present on an ECG.

## Examples of ECGs

### Normal sinus rhythm

- Regular rhythms and rates (60–100 beats/min)
- Has a P wave, QRS complex and T wave; all similar in size and shape

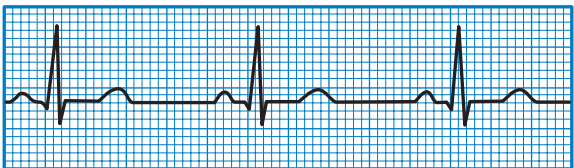


**Figure 4.10** Sinus rhythm.

### Sinus bradycardia

Defined as a sinus rhythm with a resting heart rate of less than 60 beats/min.

- Heart rate < 60 beats/min
- Regular sinus rhythm



**Figure 4.11** Sinus bradycardia.

Causes include cardiomyopathy, acute myocardial infarction, drugs (e.g.  $\beta$ -blockers, digoxin, amiodarone), obstructive jaundice, raised intracranial pressure, sick sinus syndrome, hypothermia, hypothyroidism, electrolyte abnormalities.

Can be a normal finding in extremely fit individuals and during sleep.



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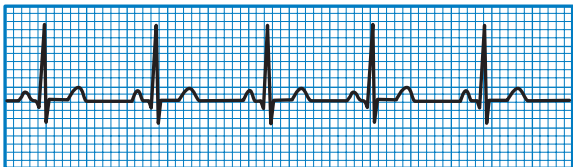
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### Sinus tachycardia

Defined as a sinus rhythm with a resting heart rate of more than 100 beats/min.

- Heart rate > 100 beats/min
- Regular sinus rhythm



**Figure 4.12** Sinus tachycardia.

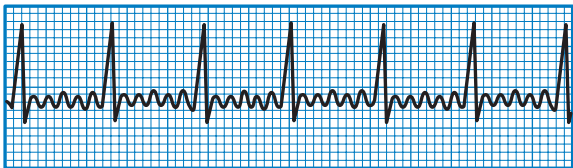
Causes include sepsis, fever, anaemia, pulmonary embolism, hypovolaemia, hypoxia, hyperthyroidism, phaeochromocytoma, drugs (e.g. salbutamol, alcohol, caffeine).

Can occur as a response to increased demand for blood flow, e.g. exercise or in high emotional states, e.g. fear, anxiety, pain.

### Atrial fibrillation

Where rapid, unsynchronized electrical activity is generated in the atrial tissue, causing the atria to quiver. Transmission of the impulses to the ventricles via the AV node is variable and unpredictable, leading to an irregular heartbeat.

- Absent P wave replaced by fine baseline oscillations (atrial impulses fire at a frequency of 350–600 beats/min)
- Irregular ventricular complexes; RR interval irregular
- Ventricular rate varies between 100 and 180 beats/min but can be slower



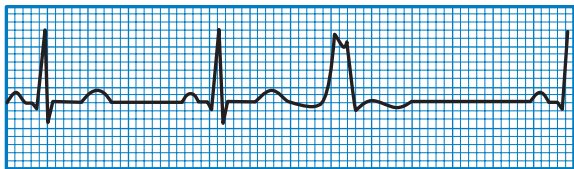
**Figure 4.13** Atrial fibrillation.



Causes include hypertension, coronary artery disease, mitral valve disease, post-cardiac surgery, sick sinus syndrome, pneumonia, pulmonary embolism, hyperthyroidism, alcohol misuse, chronic pulmonary disease.

### Ventricular ectopics or premature ventricular contractions (PVCs)

Early beats (ectopics) usually caused by electrical irritability in the ventricular conduction system or myocardium. Can occur in normal individuals and be asymptomatic. However, can indicate impending fatal arrhythmias in patients with heart disease. Can occur singly, in clusters of two or more or in repeating patterns such as bigeminy (every other beat) or trigeminy (every third beat).



**Figure 4.14** Ventricular ectopics and PVCs.

- Irregular rhythm during PVC; however, underlying rhythm and rate is usually regular, i.e. sinus
- P wave absent, QRS complex wide and early, T wave in opposite direction from QRS complex during PVC

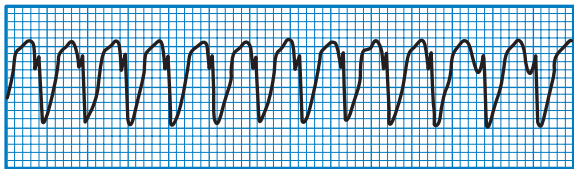
Causes include acute myocardial infarction, valvular heart disease, electrolyte disturbances, metabolic acidosis, medications including digoxin and tricyclic antidepressants, drugs such as cocaine, amphetamines and alcohol, anaesthetics and stress.

### Ventricular tachycardia

Defined as three or more heartbeats of ventricular origin at a rate exceeding 100 beats/minute. May occur in short bursts of less than 30 seconds and may terminate spontaneously with few or no symptoms (non-sustained). Episodes lasting



more than 30 seconds (sustained) lead to rapid deterioration and ventricular fibrillation that requires immediate treatment to prevent death.



**Figure 4.15** Ventricular tachycardia.

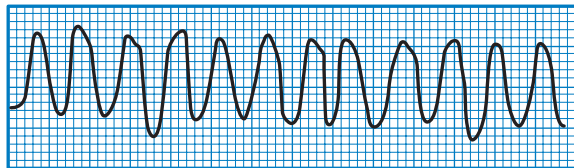
- Ventricular rate 100–200 beats/min
- Ventricular rhythm is usually regular
- QRS complex is wide, P wave is absent

Causes include acute myocardial infarction, myocardial ischaemia, cardiomyopathy, mitral valve prolapse, electrolyte imbalance, drugs (digoxin, anti-arrhythmics), myocarditis.

#### Ventricular fibrillation

Rapid, ineffective contractions of the ventricles caused by chaotic electrical impulses resulting in no cardiac output. Unless treated immediately, it is fatal.

Ventricular fibrillation is the most commonly identified arrhythmia in cardiac arrest patients and the primary cause of sudden cardiac death (SCD).



**Figure 4.16** Ventricular fibrillation.

No recognizable pattern: irregular, chaotic, immeasurable.



## Biochemical and haematological studies

### Blood serum studies

Test	Function	Interpretation
<b>Albumin</b> 36–47 g/L	Most abundant plasma protein. Maintains osmotic pressure of the blood. Transports blood constituents such as fatty acids, hormones, enzymes, drugs and other substances	<i>Increased:</i> relative increase with haemoconcentration, where there is severe loss of body water <i>Decreased:</i> malnutrition, malabsorption, severe liver disease, renal disease, gastrointestinal conditions causing excessive loss, thyrotoxicosis, chemotherapy, Cushing's disease
<b>Bilirubin</b> 2–17 mmol/L	Pigment produced by the breakdown of haem	<i>Increased:</i> hepatitis, biliary tract obstruction, haemolysis, haematoma <i>Decreased:</i> iron deficiency, anaemia
<b>C-reactive protein</b> <7 mg/L	Protein produced in the acute inflammatory phase of injury. Index for monitoring disease activity	<i>Increased:</i> pyrexia, all inflammatory conditions (e.g. rheumatoid arthritis, pneumococcal pneumonia), trauma, during late pregnancy





Test	Function	Interpretation
<b>Calcium</b> 2.1–2.6 mmol/L	Nerve impulse transmission, bone and teeth formation, skeletal and myocardial muscle contraction, activation of enzymes, blood coagulation, cell division and repair, membrane structure and absorption of vitamin B <sub>12</sub>	<i>Increased (hypercalcaemia):</i> hyperparathyroidism, malignancy, Paget's disease, osteoporosis, immobilization, renal failure  <i>Decreased (hypocalcaemia):</i> hypoparathyroidism, vitamin D deficiency, acute pancreatitis, low blood albumin, low blood magnesium, large transfusion of citrated blood, increased urine excretion, respiratory acidosis
<b>Creatine kinase</b> <i>Men:</i> 30–200 U/L <i>Women:</i> 30–150 U/L	Enzyme found in heart, brain and skeletal muscle. Increased when one of these areas is stressed or damaged. Testing for a specific creatine kinase isoenzyme indicates area of damage (e.g. raised CK-MB indicates damage to heart)	<i>Increased:</i> heart (myocardial infarction, myocarditis, open heart surgery), brain (brain cancer, trauma, seizure) and skeletal muscle damage (intramuscular injections, trauma, surgery, strenuous exercise, muscular dystrophy)
<b>Creatinine</b> 55–150 mmol/L	End-product of normal muscle metabolism	<i>Increased:</i> renal failure, urinary obstruction, muscle disease  <i>Decreased:</i> pregnancy, muscle wasting
<b>Glucose</b> 3.6–5.8 mmol/L	Metabolized in the cells to produce energy	<i>Increased:</i> diabetes mellitus, Cushing's disease, patients on steroid therapy  <i>Decreased:</i> severe liver disease, adrenocortical insufficiency, drug toxicity, digestive diseases

<p><b>Lactate dehydrogenase</b> 230–460 U/L</p>	<p>Enzyme that converts pyruvic acid into lactate. High levels found in myocardial and skeletal muscle, the liver, lungs, kidneys and red blood cells</p>	<p><i>Increased:</i> tissue damage due to myocardial infarction, liver disease, renal disease, cellular damage in trauma, hypothyroidism, muscular diseases</p>
<p><b>Magnesium</b> 0.7–1.0 mmol/L</p>	<p>Neuromuscular transmission, cofactor in activation of many enzyme systems for cellular metabolism (e.g. phosphorylation of glucose, production and functioning of ATP), regulation of protein synthesis</p>	<p><i>Increased (hypermagnesaemia):</i> renal failure, adrenal insufficiency, excessive oral or parenteral intake of magnesium, severe hydration</p> <p><i>Decreased (hypomagnesaemia):</i> excessive loss from GIT (diarrhoea, nasogastric suction, pancreatitis), decreased gut absorption, renal disease, long-term use of certain drugs (e.g. diuretics, digoxin), chronic alcoholism, increased aldosterone secretion, polyuria</p>
<p><b>Phosphate</b> 0.8–1.4 mmol/L</p>	<p>Bone formation, formation of high energy compounds (e.g. ATP), nucleic acid synthesis, enzyme activation</p>	<p><i>Increased (hyperphosphataemia):</i> renal failure, hypoparathyroidism, chemotherapy, excessive phosphorus intake</p> <p><i>Decreased (hypophosphataemia):</i> hyperparathyroidism, chronic alcoholism, diabetes, respiratory alkalosis, excessive glucose ingestion, hypoalbuminaemia, chronic use of antacids</p>







Test	Function	Interpretation
<b>Potassium</b> 3.6–5.0 mmol/L	Nerve impulse transmission, contractility of myocardial, skeletal and smooth muscle	<p><i>Increased (hyperkalaemia):</i> renal failure, increased intake of potassium, metabolic acidosis, tissue trauma (e.g. burns and infection), potassium-sparing diuretics, adrenal insufficiency</p> <p><i>Decreased (hypokalaemia):</i> potassium-wasting diuretics, vomiting, diarrhoea, metabolic alkalosis, excess aldosterone secretion, polyuria, profuse sweating</p>
<b>Sodium</b> 136–145 mmol/L	Regulates body's water balance, maintains acid–base balance and electrical nerve potentials	<p><i>Increased (hypernatraemia):</i> excessive fluid loss or salt intake, water deprivation, diabetes insipidus, excess aldosterone secretion, diarrhoea</p> <p><i>Decreased (hyponatraemia):</i> kidney disease, excessive water intake, adrenal insufficiency, diarrhoea, profuse sweating, diuretics, congestive heart failure, inappropriate secretion of ADH</p>
<b>Urea</b> 2.5–6.5 mmol/L	Waste product of metabolism	<p><i>Increased:</i> renal failure, decreased renal perfusion because of heart disease, shock</p> <p><i>Decreased:</i> high carbohydrate/low protein diets, late pregnancy, malabsorption, severe liver damage</p>

## Haematological studies (data from Matassarini-Jacobs 1997, with permission of W B Saunders)

Test	Assesses	Interpretation
<b>Red blood cell count (RBC)</b> Men: $4.5\text{--}6.5 \times 10^{12}/\text{L}$ Women: $3.8\text{--}5.3 \times 10^{12}/\text{L}$	Blood loss, anaemia, polycythaemia (increase in Hb concentration of the blood)	<i>Increased:</i> polycythaemia vera, dehydration, cardiac and pulmonary disorders characterized by cyanosis, acute poisoning <i>Decreased:</i> leukaemia, anaemia, fluid overload, haemorrhage
<b>White blood cell count (WBC)</b> $4.0\text{--}11.0 \times 10^9/\text{L}$	Detects infection or inflammation. Monitors response to radiation and chemotherapy	<i>Increased:</i> leukaemia, tissue necrosis, infection <i>Decreased:</i> bone marrow suppression
<b>White blood cell differential</b> <i>Neutrophils:</i> $1.5\text{--}7.0 \times 10^9/\text{L}$ <i>Eosinophils:</i> $0.0\text{--}0.4 \times 10^9/\text{L}$ <i>Lymphocytes:</i> $1.2\text{--}3.5 \times 10^9/\text{L}$ <i>Monocytes:</i> $0.2\text{--}1.0 \times 10^9/\text{L}$ <i>Basophils:</i> $0.0\text{--}0.2 \times 10^9/\text{L}$	Evaluates body's ability to resist infection. Detects and classifies leukaemia	<i>Increased:</i> Neutrophil – bacterial infection, non-infective acute inflammation, tissue damage Eosinophil – allergic reaction, parasitic worm infections Lymphocyte – viral infection, chronic bacterial infection Monocyte – chronic bacterial infections, malignancies Basophil – myeloproliferative disorders





Test	Assesses	Interpretation
<b>Packed cell volume (PCV)/haematocrit (Hct)</b> Men: 0.40–0.54 L/L Women: 0.35–0.47 L/L	Blood loss and fluid balance	<i>Increased:</i> polycythaemia, dehydration <i>Decreased:</i> anaemia, acute blood loss, haemodilution
<b>Haemoglobin (Hb)</b> Men: 130–180 g/L Women: 115–165 g/L	Anaemia and polycythaemia	<i>Increased:</i> polycythaemia, dehydration <i>Decreased:</i> anaemia, recent haemorrhage, fluid overload
<b>Platelets (Plt)</b> 150–400 × 10 <sup>9</sup> /L	Severity of thrombocytopenia	<i>Increased:</i> polycythaemia vera, splenectomy, malignancy <i>Decreased:</i> anaemias, infiltrative bone marrow disease, haemolytic disorders, disseminated intravascular coagulopathy, idiopathic thrombocytopenic purpura, viral infections, AIDS, splenomegaly, with radiation or chemotherapy
<b>Prothrombin time (PT)</b> 12–16 s	Measures extrinsic clotting time of blood plasma and clotting factor deficiencies	<i>Increased:</i> bile duct obstruction, liver disease, disseminated intravascular coagulation, malabsorption of nutrients from GIT, vitamin K deficiency, warfarin therapy, factor I (fibrinogen), II (prothrombin), V, VII, X deficiency

<p><b>Activated partial thromboplastin time (APTT)</b> 30–40 s</p>	<p>Measures intrinsic clotting time of blood plasma and clotting factor deficiencies</p>	<p><i>Increased:</i> liver disease, disseminated intravascular coagulation, factor XI, VIII (haemophilia A) and IX (haemophilia B) deficiency, hypofibrinogenaemia, malabsorption from GIT, heparin or warfarin therapy</p>
<p><b>International normalized ratio (INR)</b> 0.89–1.10</p>	<p>Standardized measure of clotting time derived from the PT. An INR of 1 is assigned to the time it takes for normal blood to clot</p>	<p><i>Increased:</i> indicates excessive bleeding tendencies <i>Decreased:</i> indicates increased risk of thrombosis</p>
<p><b>Erythrocyte sedimentation rate (ESR)</b> <i>Men:</i> 3–15 mm/h <i>Women:</i> 1–10 mm/h</p>	<p>The rate at which red blood cells settle in a tube of blood over 1 hour. A non-specific test that screens for significant inflammatory, infectious or malignant disease</p>	<p><i>Increased:</i> autoimmune disease, malignancy, acute post-trauma, severe infection (mainly bacterial), myocardial infarction <i>Decreased:</i> heart failure, sickle cell anaemia, steroid treatment</p>

Values vary from laboratory to laboratory, depending on testing methods used. These reference ranges should be used as a guide only. All reference ranges apply to adults only; they may differ in children.



### Positioning

Positioning the patient optimizes cardiovascular and cardio-pulmonary function and thus oxygen transport. Correct positioning of the patient can maximize lung volume, lung compliance and the ventilation/perfusion ratio. It can also reduce the work of breathing and aid secretion removal and cough. This may involve positioning adult patients in side lying with the 'good' lung (dependent) facing down and the 'bad' lung (non-dependent) facing uppermost. Always monitor the patient after positioning.



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#### Precautions when placing 'bad' lung up

Recent pneumonectomy

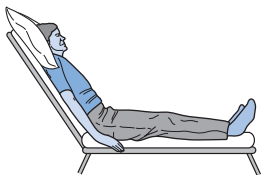
- Large pleural effusion
- Bronchopleural fistula
- Presence of a large tumour in a main stem bronchus

Reproduced with the permission of Nelson Thornes Ltd from *Physiotherapy In Respiratory Care: An Evidence-based Approach to Respiratory and Cardiac Management*, Alexandra Hough, 9787-0-7487-4037-6, first published in 1991.

**Note:** Positioning small children and infants to maximize ventilation/perfusion – rather than for postural drainage and removal of secretions – requires a different approach from that used with adults. In children with unilateral lung disease the good lung should be positioned uppermost to improve oxygenation.

### Postural drainage

Positioning the patient according to the anatomy of the bronchial tree in order to use gravity to assist drainage of secretions.



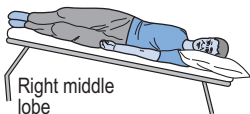
Apical segments  
upper lobes



Posterior segment  
right upper lobe



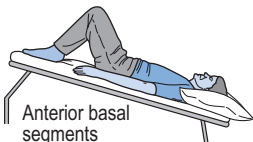
Posterior segment  
left upper lobe



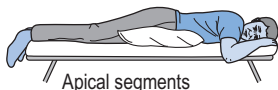
Right middle  
lobe



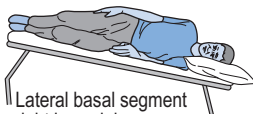
Anterior segments  
upper lobes



Anterior basal  
segments



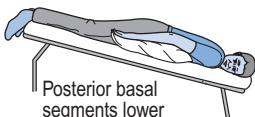
Apical segments  
lower lobes



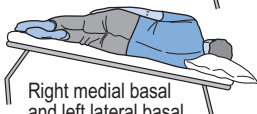
Lateral basal segment  
right lower lobe



Lingula



Posterior basal  
segments lower  
lobes



Right medial basal  
and left lateral basal  
segments lower lobes



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**Figure 4.17** Postural drainage positions.

### Contraindications and precautions for head-down position (Harden 2004, with permission)

#### Contraindications

- Hypertension
- Severe dyspnoea

- Recent surgery
- Severe haemoptysis
- Nose bleeds
- Advanced pregnancy
- Hiatus hernia
- Cardiac failure
- Cerebral oedema
- Aortic aneurysm
- Head or neck trauma/surgery

### Precautions

- Diaphragmatic paralysis/weakness
- Mechanical ventilation

### Manual chest clearance techniques

These can be used while the patient is in a postural drainage position to aid the clearance of secretions. Manual techniques include percussion, vibrations and shaking.

	Contraindications	Precautions
<b>Percussion</b>	Directly over rib fracture Directly over surgical incision or graft	Profound hypoxaemia Bronchospasm Pain
	Frank haemoptysis Severe osteoporosis	Osteoporosis Bony metastases Near chest drains
<b>Vibrations</b>	Directly over rib fracture Directly over surgical incision Severe bronchospasm	Long-term oral steroids Osteoporosis Near chest drains
<b>Shaking</b>	Directly over rib fracture Directly over surgical incision	Long-term oral steroids Osteoporosis Bony metastases Near chest drains Severe bronchospasm



## Active cycle of breathing technique (ACBT)

This consists of three different breathing techniques, namely breathing control (normal tidal breaths), thoracic expansion exercises (deep inspiratory breaths, usually combined with a 3 s end-inspiratory hold) and forced expiration technique (forced expirations following a breath in that can be performed at different lung volumes), that are repeated in cycles in order to mobilize and clear bronchial secretions. These can be used in different combinations according to the patient's needs and in conjunction with other treatment techniques.

### Contraindications

- None if technique(s) adapted to suit the patient's condition

### Precautions

- Bronchospasm

## Airway suction

The removal of bronchial secretions through a suction catheter inserted via the nose (nasopharyngeal/NP) or mouth (oropharyngeal), or via a tracheostomy or endotracheal tube using vacuum pressure (usually in the range 8.0–20 kPa/60–150 mmHg).

### Contraindications

- CSF leak/basal skull fracture (applies to nasopharyngeal approach only)
- Stridor
- Severe bronchospasm
- Pulmonary oedema

### Precautions

- Clotting disorders
- Recent oesophagectomy, lung transplant or pneumonectomy

### Adverse effects

- Tracheobronchial trauma
- Bronchospasm
- Atelectasis





- Pneumothorax
- Hypoxia
- Cardiac arrhythmias
- Raised ICP

## Manual hyperinflation

The use of a rebreathing bag to manually inflate the lungs in order to increase lung volume, aid the removal of secretions and assess or improve lung compliance. The peak airway pressure being delivered should not exceed 40 cmH<sub>2</sub>O.

### Contraindications

- Undrained pneumothorax
- Bullae
- Surgical emphysema
- Cardiovascular instability
- Patients at risk of barotrauma, e.g. emphysema, fibrosis
- Recent pneumonectomy/lobectomy (first 10 days)
- Severe bronchospasm (if peak airway pressure >40 cmH<sub>2</sub>O)
- Unexplained haemoptysis
- Acute head injury

### Adverse effects

- Barotrauma
- Haemodynamic compromise – reduced or increased blood pressure
- Cardiac arrhythmia
- Reduced oxygen saturation
- Raised intracranial pressure
- Reduced respiratory drive
- Bronchospasm

#### Considerations when treating patients with raised ICP

Minimize suction

Minimize manual techniques

Minimize manual hyperinflation (maintain hypocapnia)

Consider sedation/inotropic support if ICP increased or unstable

Monitor CPP: should be >70 mmHg



## Intermittent positive pressure breathing (IPPB)

Assisted breathing using positive airway pressure to deliver gas throughout inspiration until a preset pressure is reached. Inspiration is triggered when the patient inhales and expiration is passive.

### Effects

- Increases tidal volume
- Reduces work of breathing
- Assists clearance of bronchial secretions
- Improves alveolar ventilation

### Contraindications

IPPB should not normally be used when any of the following conditions are present. If in doubt, medical advice should be sought.

- Undrained pneumothorax
- Facial fractures
- Acute head injury
- Large bullae
- Lung abscess
- Severe haemoptysis
- Vomiting
- Tumour or obstruction in proximal airways
- Surgical emphysema
- Recent lung and oesophageal surgery

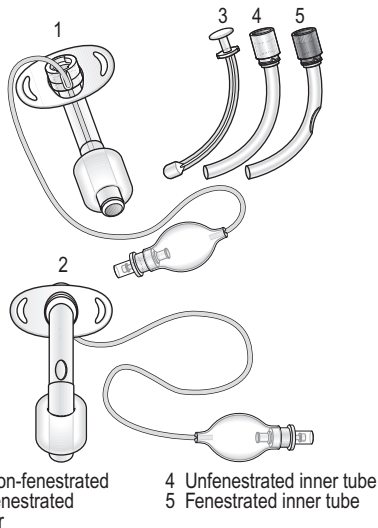
## Tracheostomies

A tracheostomy is an opening in the anterior wall of the trachea to facilitate ventilation. It is sited below the level of the vocal cords.

### Indications

- Provide and maintain a patent airway when the upper airways are obstructed.
- Provide access for the removal of tracheobronchial secretions.





- 1 Cuffed non-fenestrated
- 2 Cuffed fenestrated
- 3 Obturator

- 4 Unfenestrated inner tube
- 5 Fenestrated inner tube

**Figure 4.18** Different types of tracheostomy tubes.

- Prevent aspiration of oral and gastric secretions in patients unable to protect their own airway.
- Used in patients who need longer-term ventilation.

## Types of tube

### Metal or plastic

- Metal tubes are used by long-term tracheostomy patients as they are more durable. They are made of either stainless steel or sterling silver and do not have connections for respiratory equipment, e.g. a resuscitation bag. On some tubes an adaptor can be attached.
- Plastic tubes are cheaper and therefore more disposable.

### Cuffed or uncuffed

- Cuffed tubes have an air-filled sac at their distal end. When inflated a cuffed tube provides a seal between the trachea

and the tube. It protects the airway against aspiration and allows positive pressure ventilation. Patients cannot speak when the cuff is inflated, unless the tube is fenestrated.

- Uncuffed tubes are used for paediatric patients as the air space around the tube can be sealed without the need for a cuff. Also used when the cuff is no longer required for ventilation, when there is no risk of aspiration, or in patients on long-term ventilation.

### Fenestrated

- Fenestrated tubes enable air to pass through the tube and over the vocal cords, allowing speech. They can also be used as part of the weaning process by allowing patients to breathe through the tube and use their upper airway.

### Single or double lumen

- Single lumen tubes consist of a single cannula. Used for invasive ventilation. They are for short-term use only as they carry the risk of becoming blocked by secretions and obstructing the airway.
- Double lumen tubes consist of an inner and outer cannula. The inner cannula is removable and can be cleaned to prevent the accumulation of secretions. To allow speech the inner tube and outer tube need to be fenestrated. However, during suctioning the inner tube must be replaced with an unfenestrated tube to prevent the catheter passing through the fenestration. It must also be in place if the patient is put on positive pressure ventilation in order to maintain pressure.

### Mini tracheostomy

- A small tracheostomy that is primarily indicated for sputum retention as it allows regular suctioning. Talking and swallowing are unaffected.

### Complications

- Haemorrhage
- Pneumothorax
- Tracheal tube misplacement



- End of tube blocked if pressed against carina or tracheal wall
- Surgical emphysema
- Secretions occluding tube
- Herniation of cuff causing tube blockage
- Stenosis of trachea due to granulation
- Tracheo-oesophageal fistula
- Infection of tracheostomy site
- Tracheal irritation, ulceration and necrosis caused by overinflated cuff or excessive tube movement

## Respiratory assessment

Patients present with a variety of conditions, and assessments need to be adapted to suit their needs. This section provides a basic framework for the subjective and objective respiratory assessment of a patient.

### Database

- History of present condition
- Past medical history
- Drug history
- Family history
- Social history
  - support at home
  - home environment
  - occupation and hobbies
  - smoking

### Subjective examination

- Patient's main concern
- Symptoms
  - shortness of breath
  - cough (productive or non-productive)
  - pain
  - wheeze
- Functional ability/exercise tolerance



## Objective examination

X-rays and other diagnostic imaging (e.g. MRI, CT)

### Charts

- Blood pressure
- Heart rate
- Temperature
- Oxygen requirement
- Oxygen saturation
- Respiratory rate
- Weight
- Peak flow
- Spirometry
- Fluid balance
- Urine output
- Medications

### + ITU/HDU charts

- Mode of ventilation
- FiO<sub>2</sub>
- Heart rhythm
- Pressure support/volume control
- Airway pressure
- Tidal volume
- I : E ratio
- PEEP
- MAP
- CVP
- GCS
- ABGs
- Blood chemistry

### Observation

- General appearance
- Position
- Oxygen therapy
- Humidification
- Lines and drains
- Presence of wheeze or cough



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- Sputum
  - colour
  - volume
  - viscosity
- Quality of voice
- Ability to talk in full sentences
- Skin colour
- Jugular venous pressure
- Oedema
- Clubbing
- Flapping tremor
- Chest
  - shape
  - breathing pattern
  - work of breathing
  - chest wall movement
  - respiratory rate



## SECTION

# 4

## RESPIRATORY

### Palpation

- Chest excursion
- Skin hydration
- Trachea
- Percussion note

### Auscultation

- Breath sounds
- Added sounds
- Voice sounds

### Functional ability

### Exercise tolerance

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# Pathology

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## SECTION 5

## Alphabetical listing of pathologies

### Acute respiratory distress syndrome (ARDS)

ARDS can be caused by a wide variety of factors including pneumonia, sepsis, smoke inhalation, aspiration, major trauma and burns. As a result, the body launches an inflammatory response that affects the alveolar epithelium and pulmonary capillaries. In ARDS the alveolar walls break down and the pulmonary capillaries become more permeable allowing plasma and blood to leak into the interstitial and alveolar spaces, while at the same time the capillaries become blocked with cellular debris and fibrin. The lungs become heavy, stiff and waterlogged and the alveoli collapse. This leads to ventilation/perfusion mismatch and hypoxaemia and patients normally require mechanical ventilatory support to achieve adequate gas exchange. Symptoms usually develop within 24–48 hours after the original injury or illness but can develop 5–10 days later.

### Adhesive capsulitis

A condition that affects the glenohumeral joint synovial capsule and is characterized by a significant restriction of active and passive shoulder movement.

The aetiology is unknown but it has been linked to diabetes, heart disease, shoulder trauma or surgery, inflammatory disease, cervical disease and hyperthyroidism. The condition usually affects the middle-aged, particularly women. It normally follows three distinct phases, each lasting approximately 6–9 months (although this can be extremely variable):

Phase 1: increasing pain accompanied by increasing stiffness

Phase 2: decreasing pain with the stiffness remaining

Phase 3: decreasing stiffness and gradual return to normal function

Also known as frozen shoulder.

### AIDS (acquired immunodeficiency syndrome)

Caused by infection with the human immunodeficiency virus (HIV), which destroys a subgroup of lymphocytes and



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monocytes, resulting in suppression of the immune system. The virus enters the host cell and causes a mutation of its DNA so that the host cell becomes an infective agent (known as the provirus). Signs and symptoms include fever, malaise, painful throat, swollen lymph nodes and aching muscles in the initial period following infection. After a variable period of latency (1–15 years) weight loss, night sweats, long-lasting fever and diarrhoea occur as AIDS itself develops, which eventually progresses to the acquisition of major opportunistic infections and cancers such as pneumonia or Kaposi's sarcoma (a malignant skin tumour appearing as purple to dark brown plaques). Antiretroviral drugs are used to prolong the lives of infected individuals although there is no cure or vaccine for the disease.

### **Alzheimer's disease**

A form of dementia that is characterized by slow, progressive mental deterioration. Symptoms may start with mild forgetfulness, difficulty remembering names and faces or recent events and progress to memory failure, disorientation, speech disturbances, motor impairment and aggressive behaviour. It is the most common form of dementia and is distinguished by the presence of neuritic plaques (primarily in the hippocampus and parietal lobes), and neurofibrillary tangles (mainly affecting the pyramidal cells of the cortex). Definitive diagnosis is post-mortem.

### **Ankylosing spondylitis**

A chronic inflammatory disease of synovial joints, involving the capsule and its attached ligaments and tendons. The spinal and sacroiliac joints are primarily affected, resulting in pain, stiffness, fatigue, loss of movement and function. Bone gradually forms in the outer layers of the annulus fibrosus and the anterior longitudinal ligament and, as the disease progresses, the vertebrae fuse together. 'Bamboo spine' is the term commonly used to describe its appearance on X-ray. The disease is more common in young males.



## Asthma

A chronic inflammatory disease of the airways that makes them hyper-responsive to a wide range of stimuli including allergens, pollution, infection, exercise and stress. As a result the airways narrow, leading to coughing, wheezing, chest tightness and difficulty breathing. These symptoms can range from mild to severe; and may even result in death.

## Baker's cyst

Distension of the popliteal bursa, which may be accompanied by herniation of the synovial membrane of the knee-joint capsule forming a fluid-filled sac at the back of the knee. Associated with rheumatoid arthritis and osteoarthritis.

## Bell's palsy

An acute, lower motor neurone paralysis of the face, usually unilateral, related to inflammation and swelling of the facial nerve (VII) within the facial canal or at the stylomastoid foramen. Symptoms include inability to close the eye on the affected side, hyperacusis and impairment of taste. Good recovery is common.

## Boutonnière deformity

A flexion deformity of the proximal interphalangeal joint combined with a hyperextension deformity of the distal interphalangeal joint. Caused by a rupture of the central slip of the extensor tendon at its insertion into the base of the middle phalanx. This causes the proximal phalanx to push upwards through the lateral slips. The most common causes are rheumatoid arthritis and direct trauma.

## Broca's dysphasia

A lesion of Broca's area, on the inferior frontal cortex, causing non-fluent, hesitant speech that is characterized by poor grammar and reduced word output while meaning is preserved. Persistent repetition of a word or phrase (perseveration) can occur and writing may be impaired but comprehension remains relatively intact. Broca's area is near the



motor cortex for the face and arm and so may be associated with weakness in these areas.

## Bronchiectasis

Dilatation and destruction of the bronchi as a result of recurrent inflammation or infection. It may be present from birth (congenital bronchiectasis) or acquired as a result of another disorder (acquired bronchiectasis). Causes of infection include impaired mucociliary clearance due to congenital disorders such as primary ciliary dyskinesia or cystic fibrosis as well as bronchial obstruction and impaired inflammatory response, either acquired after a severe episode of inflammation or secondary to immunodeficiency. The inability of the airways to clear secretions in the bronchi leads to a vicious circle of infection, damage and obstruction of the bronchi. Clinical features include: productive cough, episodic fever, pleuritic pain and night sweats. Patients may develop pneumothorax, respiratory and heart failure, emphysema and haemoptysis.

## Bronchiolitis

A common respiratory problem affecting young infants. Caused by inflammation of the bronchioles due to infection by the human respiratory syncytial virus (RSV). Commonly occurs in winter. Signs and symptoms are similar to those of the common cold and include runny or blocked nose, temperature, difficulty feeding, a dry cough, dyspnoea and wheeze. In severe cases, hypoxia, cyanosis, tachypnoea and a refusal to eat may develop and hospitalization is necessary.

## Bronchitis

An inflammation of the bronchi. Acute bronchitis is commonly associated with viral respiratory infections, i.e. the common cold or influenza, causing a productive cough, fever and wheezing. Chronic bronchitis is defined as a cough productive of sputum for 3 months a year for more than 2 consecutive years. It is characterized by inflammation of the airways leading to permanent fibrotic changes, excessive mucus production and thickening of the bronchial wall. This results in sputum retention and narrowing and obstruction of the airways.



In severe cases irreversible narrowing of the airways leads to dyspnoea, cyanosis, hypoxia, hypercapnia and heart failure. These patients are often described as 'blue bloaters'.

### **Brown-Séquard syndrome**

A neurological condition that occurs when there is damage to one half of the spinal cord. Below the lesion there is motor loss on the same side and loss of pain and temperature on the opposite side.

### **Bulbar palsy**

A bilateral or unilateral lower motor neurone lesion that affects the nerves supplying the bulbar muscles of the head and neck. Causes paralysis or weakness of the muscles of the jaw, face, palate, pharynx and larynx leading to impaired swallow, cough, gag reflex and speech.

### **Bursitis**

Inflammation of the bursa caused by mechanical irritation or infection. Bursas that are commonly affected include the prepatellar, olecranon (can be associated with gout), subacromial, trochanteric, semimembranosus and the 'bunion' associated with hallux valgus. May or may not be painful.

### **Carpal tunnel syndrome**

Compression of the median nerve as it passes beneath the flexor retinaculum, caused by inflammation due to joint disease, trauma, repetitive injury or during menopause. Characterized by pain, numbness, tingling or burning sensation in the distribution of the median nerve, i.e. the radial three and a half fingers and nail beds and the associated area of the palm. Symptoms are often worse at night. Patients also complain of clumsiness performing fine movements of the hand, particularly in the early morning.

### **Cerebral palsy**

An umbrella term for a variety of posture and movement disorders arising from permanent brain damage incurred before, during, or immediately after birth. The disorder is most



frequently associated with premature births and is often complicated by other neurological problems including epilepsy, visual, hearing and sensory impairments, communication and feeding difficulties, cognitive and behavioural problems. Common causes include intrauterine infection, intrauterine cerebrovascular insult, birth asphyxia, postnatal meningitis and postnatal cerebrovascular insult. The most common disability is a spastic paralysis, which can be associated with choreoathetosis (irregular, repetitive, writhing and jerky movements).

### **Charcot–Marie–Tooth disease**

A progressive hereditary disorder of the peripheral nerves that is characterized by gradual progressive distal weakness and wasting, mainly affecting the peroneal muscle in the leg. Early symptoms include difficulty running and foot deformities. The disease is slowly progressive and in the late stages the arm muscles can also be involved. Also known as hereditary motor sensory neuropathy (HMSN).

### **Chondromalacia patellae**

Refers to degeneration of the patellar cartilage causing pain around or under the patella. Common among teenagers and young adults, especially girls, it is linked to structural changes and muscle imbalance associated with periods of rapid growth. This leads to excessive and uneven pressure on patellar cartilage. May also result from an acute injury to the patella.

### **Chronic fatigue syndrome**

A condition where patients complain of long-term, persistent fatigue along with other symptoms such as muscle pain, joint pains, disturbed sleep, poor concentration, headaches, sore throat and tender lymph nodes in the armpit and neck, though patients will not necessarily have all of them. Diagnosis is based on symptoms and tests that rule out other causes. No single cause of the disease has been established.

### **Chronic obstructive pulmonary disease (COPD)**

An umbrella term for respiratory disorders that lead to obstruction of the airways. COPD is associated mainly with





emphysema and chronic bronchitis but also includes chronic asthma. Risk factors include smoking, recurrent infection, pollution and genetics. Symptoms include cough, dyspnoea, excessive mucus production and chest tightness. Patients may also develop oedema and heart failure.

### **Claw toe**

A flexion deformity of both the proximal interphalangeal and the distal interphalangeal joints combined with an extension deformity of the metatarsophalangeal joint.

### **Coccydynia**

Pain around the coccyx. Often due to trauma, such as a fall onto the buttocks, or childbirth; however, the cause is often unknown.

### **Compartment syndrome**

Soft tissue ischaemia caused by increased pressure in a fascial compartment of a limb. This increased pressure can have a number of causes but the main ones are swelling following major trauma, a cast being applied too tightly over an injured limb, or repetitive strain injury. Signs and symptoms are pain, pale/plum colour, absent pulse, paraesthesia and loss of active movement. If left untreated, it leads to necrosis of nerve and muscle in the affected compartment, which is known as Volkmann's ischaemic contracture.

### **Complex regional pain syndrome (CRPS)**

An umbrella term for a number of conditions, usually affecting the distal extremities, whose common features include unremitting severe pain (often described as burning) and autonomic changes in the affected region such as swelling, tenderness, restriction of movement, increased skin temperature, sweating, discoloration of the skin (usually blue or dusky red) and osteoporosis. CRPS is subdivided into two groups:

*Group II* – conditions where there has been an injury to a major peripheral nerve (e.g. sciatic nerve). Also referred to as causalgia ('hot pain').



*Group I* – conditions where minor or major trauma has occurred but there is no identifiable nerve injury, e.g. after Colles' fractures. Also referred to as reflex sympathetic dystrophy and Sudeck's atrophy.

## Conversion disorder

A psychological disorder in which conflict or stress is 'converted' into physical symptoms such as blindness, deafness, loss of sensation, gait abnormalities, paralysis and seizures, for which no underlying cause can be found.

## Coxa vara

Any condition that affects the angle between the femoral neck and shaft so that it is less than the normal 120–135°. It can be either congenital (present at birth), developmental (manifests clinically during early childhood and progresses with growth) or acquired (mal-united and non-united fractures, a slipped upper femoral epiphysis, Perthes' disease and bone 'softening', e.g. osteomalacia, Paget's disease).

## Cubital tunnel syndrome

Compression of the ulnar nerve as it passes through the cubital tunnel (between the medial epicondyle and the olecranon). Symptoms include pain, weakness and dysaesthesia along the medial aspect of the elbow, forearm and hand.

## Cystic fibrosis

A progressive genetic disorder of the mucus-secreting glands of the lungs, pancreas, mouth, gastrointestinal tract and sweat glands. Chloride ion secretion is reduced and sodium ion absorption is accelerated across the cell membrane, resulting in the production of abnormally viscous mucus. This thickened mucus lines the intestine and lung leading to malabsorption, malnutrition and poor growth as well as recurrent respiratory infections that eventually lead to chronic lung disease. The increased concentration of sodium in sweat upsets the mineral balance in the blood and causes abnormal heart rhythms. Other complications include male



infertility, diabetes mellitus, liver disease and vasculitis. The disease is eventually fatal.

## De Quervain's syndrome

See 'Tenovaginitis'.

## Developmental dysplasia of the hip

Used to describe a spectrum of disorders causing hip dislocation either at birth or soon afterwards. The acetabulum is abnormally shallow so that the femoral head is easily displaced. Females and the left hip are more commonly affected.

## Diabetes insipidus

A condition that leads to frequent excretion of large amounts of diluted urine. The symptoms of excessive thirst and urination are similar to diabetes mellitus but the two conditions are unrelated. Urine excretion is governed by antidiuretic hormone (ADH), which is made in the hypothalamus and stored in the pituitary gland. Diabetes insipidus is caused by damage to the pituitary gland or by insensitivity of the kidneys to ADH. This leads to the body losing its ability to maintain fluid balance.

## Diabetes mellitus

A chronic condition caused by the body's inability to produce or effectively use the hormone insulin to regulate the transfer of glucose from the blood into the cells. This leads to higher than normal levels of blood sugar. If not corrected this can lead to coma, kidney failure and ultimately, death. In the long term, high levels of glucose can damage blood vessels, nerves and organs leading to cardiovascular disease, chronic renal failure, retinal damage and poor wound healing.

There are two types of diabetes:

*Type I* – little or no insulin is produced. Requires lifelong treatment with insulin injections, diet control and lifestyle adaptations.

*Type II* – the body produces inadequate amounts of insulin or is unable to utilize insulin effectively. Mainly occurs in people over the age of 40 and is linked to obesity.



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## Diffuse idiopathic skeletal hyperostosis (DISH)

A condition that is characterized by widespread calcification and ossification of ligaments, tendons and joint capsule insertions. Mainly affects the spine with calcification of the anterior longitudinal ligament, which radiologically gives the appearance of candle wax dripping down the spine. Other joints may be affected with ossification of ligament and tendon insertions. Radiographically distinguishable from spondyloarthropathies and degenerative disc disease in that underlying bone and disc height are preserved and the facet joints are unaffected. It mainly affects men over 50 and in most cases it is asymptomatic, though some patients complain of stiffness and mild pain. The cause is unknown. Also known as Forestier's disease.

## Dupuytren's contracture

Thickening and shortening of the palmar aponeurosis together with flexion contracture of one or more fingers. The cause is unknown.

## Ehlers–Danlos syndrome (EDS)

A hereditary disorder of connective tissue that represents a collection of disorders (types I–X) characterized by a combination of joint hypermobility and hyperextensible (stretchy) skin. EDS types I and II are associated with mutations of collagen and feature high degrees of hypermobility, which may materialize in deformity or excessive dislocation. Type III, however, is associated with greater skin extensibility resulting in more obvious scarring or striae in the skin (in the thigh or lumbar region). The poorest prognosis is associated with EDS type IV, which results from a mutation in procollagen. Although rare, it commonly causes death through arterial rupture.

## Emphysema

The walls of the terminal bronchioles and alveoli are destroyed by inflammation and lose their elasticity. This



causes excessive airway collapse on expiration which traps air in the enlarged alveolar sacs. This irreversible airways obstruction leads to symptoms of dyspnoea, productive cough, wheeze, recurrent respiratory infection, hyperinflated chest and weight loss. These patients are often described as 'pink puffers' who may hyperventilate, typically overusing their accessory respiratory muscles, and breathe with pursed lips in order to maintain airway pressure to decrease the amount of airway collapse.

### **Empyema**

A collection of pus in the pleural cavity following nearby lung infection. Can cause a build-up of pressure in the lung which causes pain and shortness of breath.

### **Enteropathic arthritis**

This form of chronic inflammatory arthritis is associated with ulcerative colitis or Crohn's disease, which are types of inflammatory bowel disease (IBD). It affects around a fifth of IBD sufferers and it mainly affects the peripheral joints such as the knees, ankles and elbows.

### **Fibromyalgia/fibrositis**

A non-articular rheumatological disorder associated with widespread myofascial and joint pain and pain and tenderness in at least 11 of 18 trigger points. Other problems associated with fibromyalgia include fatigue, disturbed sleep, depression, anxiety and morning stiffness. The cause and pathogenesis of fibromyalgia is unknown, but it can either develop on its own or together with other conditions such as rheumatoid arthritis or systemic lupus erythematosus.

### **Forestier's disease**

See 'Diffuse idiopathic skeletal hyperostosis'.

### **Freiberg's disease**

Degenerative aseptic necrosis of the metatarsal head, usually the second metatarsal head, which mainly affects athletic females aged 10–15 years.



## Ganglion

An abnormal but harmless cystic swelling that often develops over a tendon sheath or joint capsule, especially on the back of the wrist.

## Golfer's elbow (medial epicondylitis)

Tendinopathy of the common origin of the forearm flexors causing pain and tenderness at the medial aspect of the elbow and down the forearm.

## Gout

Characterized by attacks of acute joint inflammation secondary to hyperuricaemia (raised serum uric acid) where monosodium urate or uric acid crystals are deposited into the joint cavity. The disease usually affects middle-aged men and mainly affects the big toe. If the disease progresses, urates may be deposited in the kidney (stones) or the soft tissues (tophi), especially the ears. Further joint destruction can occur.

## Guillain-Barré syndrome (GBS)

An acute inflammatory polyneuropathy that usually occurs 1–4 weeks after fever associated with viral infection or following immunization. Thought to be an autoimmune disorder, it leads to segmental demyelination of spinal roots and axons, denervation atrophy of muscle and inflammatory infiltration of the brain, liver, kidneys and lungs. Clinical features include loss of sensation in hands and feet, symmetrical progressive ascending motor weakness, paralysis, muscle wasting, diminished reflexes, pain and autonomic disturbances. In severe cases, the respiratory and bulbar systems are affected and ventilation/tracheostomy may be required. Recovery is common.

## Haemothorax

Blood in the pleural cavity. Commonly due to chest trauma but also found in patients with lung and pleural cancer and in those who have undergone thoracic or heart surgery.



## Hallux valgus

A lateral deviation of the great toe at the metatarsophalangeal joint. The metatarsal head becomes prominent (bunion) and, along with the overlying bursa, may become inflamed.

## Hammer toe

An extension deformity of the metatarsophalangeal joint, combined with a flexion deformity of the proximal interphalangeal joint. The second toe is the most commonly affected.

## Hereditary disorders of connective tissue

See 'Joint hypermobility syndrome', 'Marfan syndrome', 'Ehlers–Danlos syndrome', 'Osteogenesis imperfecta'.

## Herpes zoster

See 'Shingles'.

## Horner's syndrome

A group of symptoms caused by a lesion of the sympathetic pathways in the hypothalamus, brainstem, spinal cord, C8–T2 ventral spinal roots, superior cervical ganglion or internal carotid sheath. It causes ipsilateral pupil constriction, drooping of the upper eyelid and loss of facial sweating on the affected side of the face.

## Huntingdon's disease

A hereditary disease caused by a defect in chromosome 4 that can be inherited from either parent. Onset is insidious and occurs between 35 and 50 years of age. Symptoms include sudden, involuntary movements (chorea) accompanied by behavioural changes and progressive dementia.

## Hyperparathyroidism

Overactivity of the parathyroid glands leads to excessive secretion of parathyroid hormone (PTH), which regulates levels of calcium and phosphorus. Overproduction of PTH causes excessive extraction of calcium from the bones and leads to hypercalcaemia. Symptoms include fatigue, memory loss, renal stones and osteoporosis.



## Hyperthyroidism

Occurs when the thyroid gland produces too much thyroxine, a hormone that regulates metabolism. This increase in metabolism causes most body functions to accelerate and symptoms may include tachycardia, palpitations, hand tremors, nervousness, shortness of breath, irritability, anxiety, insomnia, fatigue, increased bowel movements, muscle weakness, heat intolerance, weight loss despite an increase in appetite, thinning of skin and fine brittle hair. Also known as overactive thyroid or thyrotoxicosis.

## Hyperventilation syndrome

Breathing in excess of metabolic requirements, which causes low arterial carbon dioxide levels, leading to alkalosis and changes in potassium and calcium ion distribution. As a result, neuromuscular excitability and vasoconstriction occur. Clinical features include light-headedness, dizziness, chest pain, palpitations, breathlessness, tachycardia, anxiety, paraesthesia and tetanic cramps.

## Hypothyroidism

Occurs when the thyroid gland does not produce enough thyroxine, a hormone that regulates metabolism. This decrease in metabolism causes most body functions to slow down and symptoms may include tiredness, weight gain, dry skin and hair, cold intolerance, hoarse voice, memory loss, muscle cramps, constipation and depression. Also known as underactive thyroid.

## Interstitial lung disease

An umbrella term for a wide range of respiratory disorders characterized by inflammation and, eventually, fibrosis of the lung connective tissue. The bronchioles, alveoli and vasculature may all be affected, causing the lungs to stiffen and decrease in size. Examples of interstitial lung disease include fibrosing alveolitis, asbestosis, pneumoconiosis, bird fancier's or farmer's lung, systemic lupus erythematosus, scleroderma, rheumatoid disease, cryptogenic pulmonary fibrosis and sarcoidosis.





## Joint hypermobility syndrome (JHS)

Hypermobility describes a condition in which joint movement is in excess of normal range. In some cases this poses no problem to the individual but in others it makes joints more susceptible to soft tissue injury and internal derangement, arthritis, arthralgias and myalgias. Joint hypermobility with associated symptoms is termed joint hypermobility syndrome (JHS). The clinical features and number of joints affected are highly variable and features may include a history of dislocation/subluxation/sprains, tendinitis, proprioceptive deficit, skin hyperextensibility, striae atrophicae, autonomic dysfunction and prolapse (mitral, rectal, uterine). JHS is said to overlap with the hereditary disorders of connective tissue, which include Marfan syndrome, Ehlers-Danlos syndrome and osteogenesis imperfecta.

## Jones fracture

A stress fracture of the proximal fifth metatarsal. The fracture occurs within 1.5 cm distal to the tuberosity of the metatarsal.

## Köhler's disease

A condition where the navicular bone undergoes avascular necrosis. The cause is unclear but it mainly affects boys around the age of 5 years.

## Locked-in syndrome

A rare neurological disorder characterized by total paralysis of all voluntary muscles except those controlling eye movement and some facial movements. May be caused by traumatic brain injury, vascular disease, demyelinating diseases or overdose. Patients are unable to speak or move but sight, hearing and cognition are normal. Prognosis for recovery is poor with most patients not regaining function.

## Lung abscess

A pus-filled necrotic cavity within the lung parenchyma caused by infection.



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## Mallet toe/finger

A flexion deformity of the distal interphalangeal joint due to damage to the extensor tendon at its insertion into the distal phalanx. The result is an inability to extend the distal phalanx.

## March fracture

A stress fracture of the metatarsal. Usually affects the second or third metatarsal but it can affect the fourth and fifth. Initially the fracture may not be visible on X-ray but abundant callus is seen on later X-rays.

## Marfan syndrome (MFS)

A hereditary disorder of connective tissue that is thought to result from a mutation in the fibrillin gene. Patients present with a distinct collection of features known as the marfanoid habitus which include a tall, slender body, an elongated head and long extremities (fingers, toes, hands, arms and legs), pectus excavatum, pectus carinatum, scoliosis, myopia and dislocation of the ocular lens. MFS also carries an increased risk of aortic aneurysm.

## Meningitis

An acute inflammation of the meninges due to infection by bacteria or viruses. Age groups most at risk are the under-5s, especially infants under 1 year, and adolescents between 15 and 19 years of age. The most common causes of bacterial meningitis in young children are *Neisseria meningitidis* (meningococcal meningitis) and *Haemophilus influenzae*. The classic triad of clinical features is fever, headache and neck stiffness. Skin rash and septic shock may occur where septicaemia has developed as a result of widespread meningococcal infection. Other signs in adults include confusion and photophobia. Onset of symptoms may be gradual or sudden; however, deterioration is rapid, often requiring intensive supportive therapy.

## Morton's metatarsalgia

A fibrous thickening of the digital nerve as it travels between the metatarsals. Can be caused by irritation, trauma or



compression. Usually occurs between the third and fourth toes. Symptoms include burning, numbness, paraesthesia and pain in the ball of the foot. Also known as plantar neuroma and plantar digital neuritis.

## Motor neurone disease

A group of progressive degenerative diseases of the motor system occurring in middle to late adult life, causing weakness, wasting and eventual paralysis of muscles. It primarily affects the anterior horn cells of the spinal cord, the motor nuclei of the brainstem and the corticospinal tracts. There are three distinct types:

### Progressive muscle atrophy

Starts early in life, typically before 50 years of age. Affects the cervical region leading to atrophy of the muscles of the hand. Involvement spreads to the arms and shoulder girdle and may extend to the legs.

### Amyotrophic lateral sclerosis

There are upper motor neurone changes as well as lower motor neurone changes. Characterized by weakness and atrophy in the hands, forearms and legs but may also spread to the body and face.

### Progressive bulbar palsy

Caused by damage to the motor nuclei in the bulbar region in the brainstem which results in wasting and paralysis of muscles of the mouth, jaw, larynx and pharynx. General features include pain and spasms, dyspnoea, dysphagia, dysarthria and sore eyes.

## Multiple sclerosis

A chronic, progressive disease characterized by multiple demyelinating lesions (plaques) throughout the central nervous system. It predominantly affects young adults in temperate latitudes and is more prevalent in women. The disease is usually characterized by recurrent relapses (attacks) followed by remissions, although some patients follow a chronic, progressive course. The plaques interfere with normal nerve



impulses along the nerve fibre, and the site of the lesions and the degree of inflammation at each site leads to a variety of neurological signs and symptoms. Common symptoms include visual disturbances, ataxia, sensory and motor disturbance, bulbar dysfunction, fatigue, bladder and bowel symptoms, cognitive and emotional disturbances, pain and spasm.

### **Muscular dystrophy**

A group of genetically determined progressive muscle wasting diseases in which the affected muscle fibres degenerate and are replaced by fat and connective tissue. Duchenne muscular dystrophy is the most common form, affecting boys before the age of 4 years. Clinical features include difficulty walking, pseudohypertrophy of proximal muscles, postural problems, diminished reflexes and difficulty standing from squatting (Gower's sign).

### **Myalgic encephalomyelitis**

See 'Chronic fatigue syndrome'.

### **Myasthenia gravis**

A disorder of the neuromuscular junction caused by an impaired ability of the neurotransmitter acetylcholine to induce muscular contraction, most likely due to an autoimmune destruction of the postsynaptic receptors for acetylcholine. It predominantly affects adolescents and young adults (mainly women) and is characterized by abnormal weakness and fatiguing of some or all muscle groups to the point of temporary paralysis. Onset of symptoms is usually gradual and includes drooping of the upper eyelid, double vision, dysarthria and weakness of other facial muscles.

### **Myositis ossificans**

Growth of bone in the soft tissues near a joint that occurs after fracture or severe soft tissue trauma, particularly around the elbow. Also occurs in a congenital progressive form, usually leading to early death during adolescence.



## Osgood–Schlatter disease

Seen mainly in teenage boys, it affects the tibial tubercle. Vigorous physical activity can cause the patellar tendon to pull at its attachment to the tibial tuberosity, resulting in detachment of small cartilage fragments.

## Osteoarthritis

A chronic disease of articular cartilage, associated with secondary changes in the underlying bone, causing joint inflammation and degeneration. Primarily affects the large, weight-bearing joints such as the knee and hip, resulting in pain, loss of movement and loss of normal function.

## Osteochondritis

An umbrella term for a variety of conditions where there is compression, fragmentation or separation of a piece of bone, e.g. Osgood–Schlatter, osteochondritis dissecans, Perthes', Scheuermann's, Sever's, Sinding–Larsen–Johansson disease.

## Osteochondritis dissecans

Seen mainly in adolescent boys, it is a gradual localized separation of a fragment of bone and cartilage into a joint. The medial femoral condyle and the capitulum of the humerus are the most common sites. The loose body can enter the joint space, resulting in pain, swelling and reduced movement.

## Osteogenesis imperfecta

A hereditary disorder of connective tissue caused by an abnormal synthesis of type I collagen. As a result, bone is susceptible to fracture and deformity and connective tissue may also be affected. There are several different forms, which vary in appearance and severity. In its mildest form, features may include a history of fractures (which mainly occur before puberty), lax joints, low muscle tone, tinted sclera ranging from nearly white to dark blue or grey and adult-onset deafness. Those with a more severe form of the disease suffer short stature, progressive bone deformity and frequent fractures. Some types of the disease can be fatal in the perinatal period. Also known as brittle bone disease.



## Osteomalacia

Softening of the bone caused by a deficiency in vitamin D from poor nutrition, lack of sunshine or problems absorbing or metabolizing vitamin D. A lack of vitamin D leads to incomplete calcification of the bones so that they become weak and easily fractured. This is particularly noticeable in the long bones, which become bowed. In children, the condition is called rickets.

## Osteomyelitis

An inflammation of the bone and bone marrow due to infection. The most common causes are infection of an open fracture or postoperatively after bone or joint surgery. The infection is often spread from another part of the body to the bone via the blood.

## Osteoporosis

A reduction in bone density which results from the body being unable to form enough new bone or when too much calcium and phosphate is reabsorbed back into the body from existing bones. This leads to thin, weak, brittle bones that are susceptible to fracture. Osteoporosis is common in postmenopausal women where a loss of ovarian function results in a reduction in oestrogen production. It can also be caused by prolonged disuse and non-weight-bearing, endocrine disorders such as Cushing's disease, and steroid therapy.

## Paget's disease

Characterized by an excessive amount of bone breakdown associated with abnormal bone formation causing the bones to become enlarged, deformed and weak. Normal architecture of the trabeculae is affected, making the bones brittle. Paget's disease is usually confined to individual bones although more than one bone can be affected. Also known as osteitis deformans. The cause remains unknown.

## Parkinson's disease

A degenerative disease of the substantia nigra that reduces the amount of dopamine in the basal ganglia. Depletion of



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dopamine levels affects the ability of the basal ganglia to control movement, posture and coordination and leads to the characteristic symptoms of rigidity, slowness of voluntary movement, poor postural reflexes and resting tremor. Parkinson's has a gradual, insidious onset and affects mainly those aged between 50 and 65 years. Early symptoms of Parkinson's include aches and stiffness, difficulty with fine manipulative movements, slowness of walking, resting tremor of head, hands (pill rolling) and feet, while later symptoms may include shuffling gait, difficulties with speech, a mask-like appearance and depression.

### **Pellegrini–Stieda syndrome**

Local calcification of the femoral attachment of the medial collateral ligament (MCL), usually following direct trauma or a sprain/tear of the MCL. Signs and symptoms include chronic pain and tenderness, difficulty extending and twisting the knee, marked restriction of knee range of movement and a tender lump over the proximal portion of the knee.

### **Perthes' disease**

Seen mainly in young boys, it affects the upper femoral epiphysis, which becomes ischaemic and necrotic. The tissues of the femoral head become soft and fragmented but eventually reform over a period of several years. However, the reformed head is flatter and larger than the original, which can lead to deformity, shortening and secondary osteoarthritis. The cause is unknown.

### **Piriformis syndrome**

Irritation of the sciatic nerve by the piriformis muscle. Swelling of the muscle through injury or overuse causes it to compress on the sciatic nerve, resulting in deep buttock pain and pain along the posterior thigh and calf.

### **Plantar fasciitis**

An inflammatory or degenerative condition affecting the plantar fascia. Pain is usually felt along the medial aspect



of the calcaneal tuberosity where the plantar aponeurosis inserts and may extend down the proximal plantar fascia.

## Pleural effusion

A collection of excess fluid in the pleural cavity which can be caused by a number of mechanisms:

- increased hydrostatic pressure, e.g. congestive heart failure
- decreased plasma-oncotic pressure, e.g. cirrhosis of the liver, malnutrition
- increased capillary permeability, e.g. inflammation of the pleura
- impaired lymphatic absorption, e.g. malignancy
- communication with peritoneal space and fluid, e.g. ascites.

The fluid can either be clear/straw-coloured and have a low protein content (known as a transudate), indicating a disturbance of the normal pressure in the lung, or it can be cloudy and have a high protein content (known as an exudate), indicating infection, inflammation or malignancy.

## Pleurisy

Inflammation of the pleura causing severe pain as a result of friction between their adjoining surfaces. Pain is focused at the site of the inflammation and is increased with deep inspiration and coughing. Most commonly associated with pneumonia but also tuberculosis, rheumatic diseases and chest trauma.

## Pneumonia

An inflammation of the lung tissue, mostly caused by bacterial or viral infection but also by fungi or aspiration of gastric contents. Pneumonia can be divided into two types:

- Community-acquired pneumonia: most commonly caused by the bacterium *Streptococcus pneumoniae*
- Hospital-acquired pneumonia: tends to be more serious as patients are often immunocompromised and they may be infected by bacteria resistant to antibiotics.





The most common infective agents are bacteria such as *Pseudomonas*, *Klebsiella* and *Escherichia coli*. Clinical features include cough, pleuritic pain, fever, fatigue and, after a few days, purulent and/or blood-stained sputum.

## Pneumothorax

A collection of air in the pleural cavity following a lesion in the lung or trauma to the chest, which causes the lung to collapse. Clinical features include acute pain, dyspnoea and decreased movement of the chest wall on the affected side. They are classified by how they are caused and divided into three types:

### Spontaneous pneumothorax

Caused by rupture of an emphysematous bulla, in association with diseases such as asthma, cystic fibrosis, pneumonia or COPD. It can also develop in people with no underlying lung disease and frequently affects tall, thin young men, especially smokers.

### Traumatic pneumothorax

Caused by traumatic injury to the chest, e.g. perforation of lung tissue by fractured ribs or stab wound, or during medical procedures such as insertion of central venous lines, lung biopsies or mechanical ventilation.

### Tension pneumothorax

Produced when pressure within the pleural cavity increases as a result of a tear in the visceral pleura acting as a one-way valve, allowing air to enter on inspiration but preventing it from escaping on expiration. In severe cases it can cause a mediastinal shift, impairing venous return, leading to respiratory and cardiac arrest. Clinical features include increased respiratory distress, cyanosis, hypotension, tachycardia and tracheal deviation.

## Poliomyelitis

Poliomyelitis is a highly contagious infectious disease caused by one of three types of poliovirus. The extent of the disease varies, with some people experiencing no or mild symptoms,



while others develop the paralytic form of the disease. It can strike at any age, but affects mainly children under the age of 3 years. The poliovirus destroys motor neurones in the anterior horn. The muscles of the legs are affected more often than those of the arm but the paralysis can spread to the muscles of the thorax and abdomen. In the most severe form (bulbar polio), the motor neurones of the brainstem are attacked, reducing breathing capacity and causing difficulty in swallowing and speaking. Without respiratory support, bulbar polio can result in death.

### **Polyarteritis nodosa**

A vasculitic syndrome where small and medium-sized arteries are attacked by rogue immune cells causing inflammation and necrosis. Tissue supplied by the affected arteries, most commonly the skin, heart, kidneys and nervous system, is damaged by the impaired blood supply. Common manifestations are fever, renal failure, hypertension, neuritis, skin lesions, weight loss and muscle and joint pain.

### **Polymyalgia rheumatica**

A vasculitic syndrome associated with fever and generalized pain and stiffness, especially in the shoulder and pelvic girdle areas. Symptoms usually begin abruptly and it mainly affects women over 50. Severe cases can suffer loss of vision, stroke and migraines due to involvement of the cranial arteries.

### **Polymyositis**

An autoimmune, inflammatory muscle disease of unknown aetiology causing progressive weakness of skeletal muscle. The muscles of the shoulder girdle, hip and pelvis are most commonly affected, although, less commonly, the distal musculature or swallowing can be affected. The muscles can ache and be tender to touch. The disease sometimes occurs with a skin rash over the upper body and is known as dermatomyositis.

### **Post polio syndrome**

A recurrence or progression of neuromuscular symptoms that appears in people who have recovered from acute



paralytic poliomyelitis, usually 15–40 years after the original illness. Symptoms include progressive muscle weakness, severe fatigue and pain in muscles and joints.

### **Primary ciliary dyskinesia**

A genetic condition affecting the cilia causing abnormal ciliary activity and consequently, poor mucociliary clearance. Can be associated with situs inversus (the location of internal organs on the opposite side of the body), and where the two conditions exist together this is known as Kartagener's syndrome. Sperm can also be affected as they share a similar structure to cilia, leading to infertility in males. Clinical features include recurrent ear, sinus and chest infections, which can eventually lead to bronchiectasis.

### **Pseudobulbar palsy**

An upper motor neurone lesion that affects the corticomotoneuronal pathways and results in weakness and spasticity of the oral and pharyngeal musculature. Leads to slurring of speech and dysphagia. Patients also exhibit emotional incontinence. They are unable to control their emotional expression and may laugh or cry without apparent reason.

### **Psoriatic arthritis**

A chronic autoimmune and heritable disorder associated with psoriasis. Only a minority of psoriasis sufferers are affected and it can either precede or follow the onset of the skin disease. Males and females are affected equally and it can sometimes be indistinguishable from rheumatoid arthritis. It can affect any joint, though the most common pattern is for one large joint to be infected along with a number of small joints in the fingers or toes.

### **Pulmonary embolus**

A blockage in the pulmonary arterial circulation most commonly caused by blood clots from the veins in the pelvis or the legs. This causes a ventilation/perfusion imbalance and leads to arterial hypoxaemia. Risk factors include prolonged bed rest or prolonged sitting (e.g. long flights), oral



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contraception, surgery, pregnancy, malignancy and fractures of the femur.

### **Pulmonary oedema**

Accumulation of fluid in the lungs. Usually caused by left ventricular failure whereby a back pressure builds up in the pulmonary veins eventually causing fluid to be pushed from the veins into the alveoli. Pulmonary oedema can also be caused by myocardial infarction, damage to mitral or aortic valves, direct lung injury, severe infection, poisoning or fluid overload. Symptoms include shortness of breath, wheezing, sweating, tachycardia and coughing up white or pink-tinged frothy secretions.

### **Raynaud's phenomenon**

A vasospastic disorder affecting the arterioles of the hands and feet, usually triggered by cold weather or emotional stress. The affected digits first turn pale and cold (ischaemia), then blue (cyanosis) and then bright red (reperfusion). The condition can either be primary, with no known cause, or secondary to an underlying disease such as systemic lupus erythematosus, polymyositis, rheumatoid arthritis and scleroderma.

### **Reactive arthritis**

A chronic inflammatory disease that is caused by gastrointestinal or genitourinary infections. The syndrome is classically composed of arthritis (usually involving the lower limb), urethritis and conjunctivitis; although not all three symptoms occur in all affected individuals. It mainly affects males aged 20–40.

### **Reiter's syndrome**

See 'Reactive arthritis'.

### **Rheumatoid arthritis**

Thought to be an autoimmune disease involving the synovium, often affecting several joints at the same time. The joints are affected symmetrically and eventually there is destruction of articular cartilage, capsule, ligaments and tendons, leading



to deformity. Clinical features include stiffness, pain, swelling, heat, loss of movement and function. Other manifestations of the disease include subcutaneous nodules, osteoporosis, vasculitis, muscle weakness, fatigue and anaemia. The disease is more common in young to middle-aged women.

## Sarcoidosis

An autoimmune disease that is characterized by the formation of nodules or lumps (granulomas) in one or more organs of the body. It mainly affects the lungs, eyes, skin, and lymph glands and may change how the organ functions. Patients commonly present with dyspnoea, persistent dry cough, skin rashes, or eye inflammation. They may also complain of being unwell or fatigued, and suffer fever and weight loss. In some cases the patients are asymptomatic. The cause is unknown.

## Scheuermann's disease

Seen mainly in adolescent boys, it is a growth disturbance of the thoracic vertebral bodies, resulting in degeneration of the intervertebral disc into the vertebral endplate. Can lead to a thoracic kyphosis of varying severity.

## Septic arthritis

An infection in the joint caused by bacteria (e.g. *Staphylococcus aureus*) or, rarely, by a virus or fungus. Patients present with pain, swelling, erythema, restricted movement and fever. In most cases it only affects one joint. Risk factors include recent joint trauma, surgery or replacement, intravenous drug abuse, immunosuppressants, bacterial infection and existing joint conditions, e.g. rheumatoid arthritis. Early diagnosis is essential as delay can result in joint destruction. Also known as pyogenic arthritis and infective arthritis.

## Seronegative spondyloarthropathies

A group of inflammatory joint disorders that include ankylosing spondylitis, psoriatic arthritis and Reiter's syndrome. They all share notable characteristics: the spine is usually affected, though other large joints are occasionally implicated; there is a strong link to human leukocyte antigen HLA-B27;



there is an absence of rheumatoid factor in the blood; males are predominantly affected; enthesopathy (inflammation of the ligaments and tendon where they attach to bone) commonly occurs, and onset is usually before the age of 40.

### Sever's disease

A painful inflammation of the calcaneal apophysis that mainly affects growing, active children between the ages of 9 and 14. The pull of the Achilles tendon at its insertion causes traction of the apophysis, resulting in localized pain and tenderness of the heel. It is exacerbated by sport and activities like running and jumping.

### Shingles

An infection of a sensory nerve and the area of skin that it supplies by the varicella/zoster virus (chickenpox). Following chickenpox infection the virus remains dormant in a sensory nerve ganglion but can be reactivated later in life. Characterized by pain, paraesthesia and the appearance of a rash along the dermatomal distribution of the affected nerve. Mainly occurs in the trunk although the face and other parts of the body can be affected. Occurs predominantly in the middle-aged and older population as well as the immunocompromised. Also known as herpes zoster.

### Sinding–Larsen–Johansson disease

Seen mainly in adolescent boys, it affects the inferior pole of the patella. Most commonly occurs in running and jumping sports, which cause the patellar tendon to pull at its attachment at the inferior patellar pole. Results in fragmentation of the inferior patella and/or calcification in the proximal patellar tendon.

### Sjögren's syndrome

An autoimmune disorder in which the body's immune system attacks the moisture-producing glands, such as the salivary and tear glands. This produces the primary features of dry eyes and dry mouth. It can be primary or secondary to other autoimmune diseases such as rheumatoid arthritis,



systemic sclerosis, systemic lupus erythematosus and polymyositis. Ninety per cent of those affected are women.

## Sleep apnoea

A cessation of breathing for more than 10 seconds caused by recurrent collapse of the upper airway leading to disturbed sleep. This may occur as a result of loss of muscle tone in the pharynx as the patient relaxes during sleep (obstructive sleep apnoea) and is usually associated with obesity or enlarged tonsils or adenoids. It may also be caused by abnormal central nervous system control of breathing (central sleep apnoea) or occur as a result of a restrictive disorder of the chest wall, e.g. scoliosis or ankylosing spondylitis, where normal use of accessory respiratory muscles is inhibited during sleep. Pulmonary hypertension, respiratory and/or heart failure may develop in severe cases.

## Spina bifida

A developmental defect that occurs in early pregnancy in which there is incomplete closure of the neural tube. The posterior part of the affected vertebrae does not fuse, leaving a gap or split. There are three main types:

### Spina bifida occulta

A mild form in which there is no damage to the meninges or spinal cord. The defect is covered with skin that may be dimpled, pigmented or hairy. In the vast majority of cases it presents with no symptoms. However, in some cases the spinal cord may become tethered against the vertebrae, with possible impairment of mobility or bladder control.

### Spina bifida cystica

When a blister-like sac or cyst balloons out through the opening in the vertebrae.

There are two forms:

*Meningocele*: the spinal cord and nerves remain in the spinal canal but the meninges and cerebrospinal fluid balloon out through the opening in the vertebrae, forming a sac. This is the least common form of spina bifida.



**Myelomeningocele:** the spinal cord and nerves are pushed out through the opening, along with the meninges and cerebrospinal fluid. The spinal cord at this level is damaged, leading to paralysis and loss of sensation below the affected segment. This is the most serious and more common form and is often associated with hydrocephalus.

### Spinal muscular atrophies (SMA)

A group of inherited degenerative disorders of the anterior horn cell causing muscle atrophy. There are three main types, which are classified by age of onset: *SMA I (Werdnig–Hoffman disease)* is the most severe form with onset from pre-term to 6 months. It causes weakness and hypotonia ('floppy' babies) leading to death within 3 years. *SMA II (intermediate type)* usually develops between 6 and 15 months of age. It has the same pathological features as SMA I but progresses more slowly. *SMA III (Wohlfart–Kugelberg–Welander disease)* has a late onset, between 1 year and adolescence, leading to progressive, proximal limb weakness.

### Spinal stenosis

Narrowing of the spinal canal, nerve root canals or intervertebral foramina. May be caused by a number of factors, including loss of disc height, osteophytes, facet hypertrophy, disc prolapse and hypertrophic ligamentum flavum.

Compression of the nerve root may lead to radiating leg or arm pain, numbness and paraesthesia in the affected dermatome, muscle weakness, neurogenic claudication and low back pain. In severe cases the spinal cord may be compromised.

### Spondylolisthesis

A spontaneous forward displacement of one vertebral body upon the segment below it (usually L5/S1). Displacement may be severe, causing compression of the cauda equina, requiring urgent surgical intervention. Spondylolisthesis is classified according to its cause:

- I Dysplastic – congenital
- II Isthmic – fatigue fracture of the pars interarticularis due to overuse





- III Degenerative – osteoarthritis
- IV Traumatic – acute fracture
- V Pathological – weakening of the pars interarticularis by a tumour, osteoporosis, tuberculosis or Paget's disease

In rare cases the displacement may be backwards, known as a retrolisthesis.

## Spondylolysis

A defect in the pars interarticularis of the lumbar vertebrae (usually L5), often the result of a fatigue fracture. It can be unilateral or bilateral and may or may not progress to spondylolisthesis.

## Spondylosis

Degeneration and narrowing of the intervertebral discs leading to the formation of osteophytes at the joint margin and arthritic changes of the facet joints. The lowest three cervical joints are most commonly affected, causing neck pain and stiffness, sometimes with radiation to the upper limbs, although the condition may remain symptomless. In some cases osteophytes may encroach sufficiently upon an intervertebral foramen to cause nerve root pressure signs, or, more rarely, the spinal canal to cause dysfunction in all four limbs and possibly the bladder. The vertebral artery can also be involved.

## Stroke/cerebrovascular accident (CVA)

An illness in which part of the brain is suddenly severely damaged or destroyed as a consequence of an interruption to the flow of blood in the brain. This interruption may be caused by a blood clot (ischaemic stroke) or by a ruptured blood vessel (haemorrhagic stroke), either within the brain (intracerebral) or around the brain (subarachnoid). The most common symptoms of stroke are numbness, weakness or paralysis on one side of the body, contralateral to the side of the brain in which the cerebrovascular accident occurred. Other symptoms include dysphasia, dysphagia, dysarthria, dyspraxia, disturbance of vision and perception, inattention



or unilateral neglect, and memory or attention problems. Where symptoms resolve within 24 hours, this is known as a transient ischaemic attack (TIA).

### **Swan neck deformity**

A hyperextension deformity of the proximal interphalangeal joint combined with a flexion deformity of the distal interphalangeal joints and, sometimes, a flexion deformity of the metacarpophalangeal joints due to failure of the proximal interphalangeal joint's volar/palmar plate. Usually seen in rheumatoid arthritis.

### **Systemic lupus erythematosus (SLE)**

A chronic, inflammatory autoimmune connective tissue disorder involving the skin, joints and internal organs. Clinical features and severity can vary widely depending on the area affected but may include butterfly rash on face, polyarthritis, vasculitis, Raynaud's phenomenon, anaemia, hypertension, neurological disorders, renal disease, pleurisy and alopecia. Of those affected by the disease, around 90% are women.

### **Systemic sclerosis (scleroderma)**

An autoimmune connective tissue disorder that causes an increase in collagen metabolism. Excessive collagen deposits cause damage to microscopic blood vessels in the skin (scleroderma) and other organs (systemic sclerosis), leading to fibrosis and degeneration. Any organ can be affected and its effects can be localized or diffuse, as well as progressive. Middle-aged women are most commonly affected. Clinical features include oedema of hands and feet, contractures and finger deformities, alteration of facial features and dry, shiny, tight skin.

### **Talipes calcaneovalgus**

A common deformity of the foot and ankle, usually postural, where the foot is dorsiflexed and everted, and is resistant to plantarflexion. Common in breech births and often associated with developmental dysplasia of the hip.



## Talipes equinovarus

A common deformity of the foot and ankle, often congenital, where the foot is plantarflexed, adducted and supinated. This deformity can either be fixed (structural talipes) or passively corrected (positional talipes). Males are more commonly affected. Also known as club foot.

## Tarsal tunnel syndrome

Compression of the posterior tibial nerve or its branches as it passes through the tarsal tunnel (behind the medial malleolus). Symptoms include pain, dysaesthesia and weakness in the medial and plantar aspects of the foot and ankle. Can be confused with plantar fasciitis.

## Tennis elbow (lateral epicondylitis)

Tendinopathy of the common origin of the forearm extensors causing pain and tenderness at the lateral aspect of the elbow and down the forearm.

## Tenosynovitis

Inflammation of the synovial lining of a tendon sheath caused by mechanical irritation or infection, often associated with overuse and repetitive movements. A similar inflammatory process can affect the paratenon of those tendons without synovial sheaths (peritendinitis).

## Tenovaginitis

Inflammatory thickening of the fibrous tendon sheath, sometimes leading to the formation of nodules, usually caused by repeated minor injury. Characterized by restricted movement of the tendon and pain. Common sites to be affected are the flexor sheaths in the fingers or thumb ('trigger' finger) and the sheaths of the extensor pollicis brevis and abductor pollicis longus tendons (de Quervain's syndrome).

## Thoracic outlet syndrome

An umbrella term for a group of conditions that result from compression of the neurovascular bundle in the



cervicoaxillary canal. Common sites of compression are the costoclavicular space (between the first rib and the clavicle) and the triangle between the anterior scalene, middle scalene and first rib. Causes include muscle shortening and spasm, poor posture, stretching of the lower trunk of the brachial plexus, traumatic structural changes, or, more rarely, congenital anatomical abnormalities such as an enlarged C7 transverse process, cervical rib or clavicular bony abnormality. Clinical features include paraesthesia, pain, subjective weakness, oedema, pallor, discoloration or venous engorgement involving the neck and affected shoulder and upper limb.

## Torticollis

Refers to the position of the neck in a number of conditions (rotated and tilted to one side). From the Latin *torti* meaning twisted and *collis* meaning neck.

### Congenital torticollis

Caused by injury, and possible contracture, of the sternocleidomastoid by birth trauma or malpositioning in the womb. Seen in babies and young children.

### Acquired torticollis

*Acute torticollis* (wry neck) is caused by spasm of the neck muscles (usually trapezius and sternocleidomastoid) that often results from a poor sleeping position. Usually resolves within a few days. *Spasmodic torticollis* is a focal dystonia caused by disease of the central nervous system which leads to prolonged and involuntary muscle contraction.

## Transverse myelitis

A demyelinating disorder of the spinal cord where inflammation spreads more or less completely across the tissue of the spinal cord, resulting in a loss of its normal function to transmit nerve impulses up and down. Paralysis and numbness affect the legs and trunk below the level of diseased tissue. Causes include spinal cord injury, immune reaction, atherosclerotic vascular disease and viral infection, e.g. smallpox,



measles or chickenpox. Some patients progress to multiple sclerosis. Recovery varies.

### Trigeminal neuralgia

A condition that is characterized by brief attacks of severe, sharp, stabbing facial pain in the territory of one or more divisions of the trigeminal nerve (cranial nerve V). It can be caused by degeneration of the nerve or compression on it (e.g. by a tumour), though often the cause is unknown. Attacks can last for several days or weeks after which the patient may be pain-free for months.

### Trigger finger

See 'Tenovaginitis'.

### Tuberculosis

A chronic infectious disease caused by *Mycobacterium tuberculosis* that is spread via the circulatory system or the lymph nodes. Any tissue can be infected but the lungs are the most common site as the route of infection is most often by inhalation, although it can also be by ingestion. Other sites of infection include lymph nodes, bones, gastrointestinal tract, kidneys, skin and meninges. The disease is characterized by the development of granulomas in the infected tissues. The initial lesion that develops on first exposure to the disease is referred to as the primary complex. The primary lesion can be asymptomatic and heal itself with no further complications. However, the disease can be reactivated, especially following infection, inadequate immunity and malnutrition, and is known as post-primary tuberculosis. Clinical features include cough, haemoptysis, weight loss, fatigue, fever and night sweats.

### Wernicke's dysphasia

A lesion of Wernicke's area (posterolateral left temporal and inferior parietal language region of the left cortex) causing fluent but nonsensical speech. Writing and comprehension are greatly impaired. The patient is unaware of the language problem.



## Diagnostic imaging

### Plain radiography (X-rays)

An image formed by exposure to short wavelengths of electromagnetic radiation (X-rays) that pass through the body and hit a photographic receptor (radiographic plate or film) placed behind the patient's body. The X-rays pass through soft tissue such as muscle, skin and organs and turn the plate black while hard tissue such as bone blocks the X-rays leaving the film white. Useful for detecting fractures, dislocations and many bony abnormalities including degenerative joint disease, spondylolisthesis, infections, tumours, avascular necrosis and metabolic bone diseases. Two views in planes at right angles to each other, usually anteroposterior and lateral, are usually required in order to adequately examine a region.

Can be used in conjunction with the instillation of iodinated contrast material into various structures of the body. These block the X-rays and help visualize the structure:

*Angiography* (blood vessels): cerebral aneurysms, vascular malformations and occluded or stenosed arteries and veins

*Arthrography* (joints): internal derangements of joints

*Discography* (intervertebral disc space): disc pathology

*Myelography* (thecal sac): compressive lesions of the spinal cord and cauda equina.

*Tenography* (tendon sheath): tendon pathology and ligament ruptures

### Computed tomography (CT)

Involves scanning part of the body from several angles by rotating a thin X-ray beam and detector around it. The data from the X-rays is then compared and reconstructed by computer to produce a cross-sectional image, which can be manipulated to emphasize bony or soft tissue structures. Provides good detail of bony structures, especially cortical bone, and is particularly useful for complex fractures and dislocations as well as for osteochondral lesions, stress fractures, loose bodies and certain spinal pathologies such as stenosis and disc herniation. It can also be used for diagnosing aneurysms,



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brain tumours and brain damage and detecting tumours and abscesses throughout the body. As with plain film radiography, it can also be used in conjunction with the administration of iodinated contrast material into various body structures to image the brain, neck, chest, abdomen and pelvis.

## Magnetic resonance imaging (MRI)

A cross-sectional image is formed by placing the body in a powerful magnetic field and using radiofrequency pulses to excite hydrogen nuclei within tissue cells. The signals emitted by the nuclei are measured and reconstructed by computer to create an image of soft tissue and bone. Different pulse sequences are used to accentuate different characteristics of tissue. T1-weighted images show good anatomical detail with fluid being dark and fat being bright. T2-weighted images are better at identifying soft tissue pathology but anatomical detail is less clear. Fluid appears bright.

MRI provides superior soft tissue contrast in multiple imaging planes and is used to examine the central nervous, musculoskeletal and cardiovascular systems. MRI has no known adverse physiological effects. It is often used with gadolinium, an intravenous contrast agent, to improve diagnostic accuracy (T1-weighted). Patients with a cardiac pacemaker, brain aneurysm clip or other metallic implants with the exception of those attached to bone, i.e. prosthetic joints, cannot undergo MRI.

## Radionuclide scanning

Involves the administration of a radioactive label (radioisotope) along with a biologically active substance that is readily taken up by the tissue being examined, e.g. iodine for the thyroid gland. The radioisotope emits a particular type of radiation that can be picked up by gamma ray cameras or detectors as it travels through the body. Highly active cells in the target organ will take up more of the radionuclide and emit more gamma rays resulting in 'hot spots'. Is used to identify areas of abnormal pathology. Bone scans detect areas of increased activity and can pick up metastatic disease, infection (osteomyelitis) and fractures. It can also be used to investigate



kidney, liver and spleen function, coronary blood flow, thyroid activity and to detect pulmonary emboli in the lungs.

## Dual-energy X-ray absorptiometry (DEXA) scanning

The most commonly used technique to measure bone mineral density. Two low-dose photon (X-ray) beams of different energies are transmitted through the bone being examined and are measured by a detector on the other side of the patient. The denser the bone, the fewer the X-rays that reach the detector. Used to diagnose and grade osteoporosis and assess the risk of a particular bone becoming fractured. The World Health Organization has defined bone mass according to the DEXA scan's T-scores, which are standard deviation (SD) measurements referenced to the young adult mean.

*Normal:* not more than 1 standard deviation below the average value

*Osteopenia:* more than 1 but less than 2.5 standard deviations below the average value

*Osteoporosis:* more than 2.5 standard deviations below the average value

## Ultrasound

Involves high-frequency sound waves being directed into the body via a transducer, which are then reflected back from different tissue interfaces and converted into a real-time image. Can be used to examine a broad range of soft tissue structures (abdomen, peripheral musculoskeletal system, fetus in pregnancy, thyroid, eyes, neck, prostate and blood flow (Doppler)). However, it cannot penetrate bone or deep structures.

## Electrodiagnostic tests

### Electroencephalography (EEG)

A technique that records the electrical activity of the brain via electrodes attached to the scalp. Used in the diagnosis of epilepsy, coma and certain forms of encephalitis.



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## Evoked potentials (EP)

A technique that studies nerve conduction of specific sensory pathways within the brain by measuring the time taken for the brain to respond to a stimulus. The stimulus may either be visual (e.g. flashed light, which measures conduction in the occipital pathways), auditory (e.g. click, which measures conduction in the auditory pathways) or somatosensory (e.g. electrical stimulation of a peripheral nerve, which measures conduction in the parietal cortex). Used for detecting multiple sclerosis, brainstem and cerebellopontine angle lesions (e.g. acoustic neuroma), various cerebral metabolic disorders in infants and children as well as lesions in the sensory pathways (e.g. brachial plexus injury and spinal cord tumour).

## Nerve conduction studies

Measures conduction along a sensory or motor peripheral nerve following stimulation of that nerve from two different sites. The conduction velocity is calculated by dividing the distance between the two sites by the difference in conduction times between the two sites. Useful in the diagnosis of nerve entrapments (e.g. carpal tunnel syndrome), peripheral neuropathies, motor and sensory nerve damage and multifocal motor neuropathy.

## Electromyography (EMG)

Involves the insertion of a needle electrode into muscle to record spontaneous and induced electrical activity within that particular muscle. Used in the diagnosis of a broad range of myopathies and neuropathies.



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# Pharmacology

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## SECTION 6

## Drug classes

### ACE inhibitors

Angiotensin-converting enzyme (ACE) inhibitors allow blood vessels to dilate by preventing the formation of angiotensin II, a powerful artery constrictor. Used in the treatment of heart failure, hypertension, diabetic nephropathy and post-myocardial infarction.

### Analgesics

Used to relieve pain and can be divided into opioids and non-opioids.

Opioids block transmission of pain signals within the brain and spinal cord. They include morphine and pethidine and are used to treat moderate to severe pain arising from surgery, serious injury and terminal illness.

Non-opioids are less powerful and work by blocking the production of prostaglandins, thereby preventing stimulation of nerve endings at the site of pain. They include paracetamol and non-steroidal anti-inflammatory drugs such as aspirin.

### Antibiotics

Used to treat bacterial disorders ranging from minor infections to deadly diseases. Antibiotics work by destroying the bacteria or preventing them from multiplying while the body's immune system works to clear the invading organism. There are different classes of antibiotic, which include penicillins (amoxicillin, ampicillin, benzylpenicillin), cephalosporins (cefaclor, cefotaxime, cefuroxime), macrolides (erythromycin), tetracyclines (oxytetracycline, tetracycline), aminoglycosides (gentamicin) and glycopeptides (vancomycin).

### Antiemetics

Act by blocking signals to the vomiting centre in the brain which triggers the vomiting reflex. Used to prevent or treat vomiting and nausea caused by motion sickness, vertigo, digestive tract infection and to counteract the side-effects of some drugs.



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## Antiepileptics

Used to prevent or terminate epileptic seizures. There are several types of epilepsy, each treated by a specific antiepileptic medication. It is therefore essential to classify the type of seizure in order to treat it effectively and minimize side-effects.

## Antiretrovirals

Specific antiviral drugs for the treatment of infection caused by the human immunodeficiency virus (HIV). There are two groups:

*Reverse transcriptase inhibitors* reduce the activity of the reverse transcriptase enzyme, which is vital for virus replication. They are divided according to their chemical structure into nucleoside and non-nucleoside inhibitors.

*Protease inhibitors* interfere with the protease enzyme.

To reduce the development of drug resistance the drugs are used in combination. Treatment is usually initiated with a combination of two nucleoside reverse transcriptase inhibitors (NRTI) plus a non-nucleoside reverse transcriptase inhibitor (NNRTI) or a protease inhibitor (often referred to as 'triple therapy'). Antiretrovirals are not a cure for HIV but they increase life expectancy considerably. However, they are toxic and treatment regimens have to be carefully balanced.

## $\beta$ -blockers

Prevent stimulation of the  $\beta$ -adrenoreceptors in the heart muscle (mainly  $\beta_1$ -receptors) and peripheral vasculature, bronchi, pancreas and liver (mainly  $\beta_2$ -receptors). Used to treat hypertension, angina, myocardial infarction, arrhythmias and thyrotoxicosis. Can also be used to alleviate some symptoms of anxiety. Since blocking  $\beta$ -adrenoreceptors in the lungs can lead to constriction of air passages, care needs to be taken when treating patients with asthma or COPD.

## Benzodiazepines

Increase the inhibitory effect of gamma-aminobutyric acid (GABA), which depresses brain cell activity in the higher centres of the brain controlling consciousness. Used for anxiety,



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insomnia, convulsions, sedation for medical procedures and alcohol withdrawal.

## Bronchodilators

Dilate the airways to assist breathing when constricted or congested with mucus. There are two main types:

*Sympathomimetics* (e.g. salbutamol) stimulate  $\beta_2$ -adreno-receptors on the surface of bronchial smooth muscle cells causing the muscle to relax.

*Anticholinergics* (e.g. ipratropium bromide) act by blocking the neurotransmitters that trigger muscle contraction.

Both are used to treat asthma and other conditions associated with reversible airways obstruction such as COPD.

## Calcium channel blockers

Interfere with the transport of calcium ions through the cell walls of cardiac and vascular smooth muscle. Reduce the contractility of the heart, depress the formation and conduction of impulses in the heart and cause peripheral vasodilation. Used to treat angina, hypertension and arrhythmias.

## Corticosteroids

Reduce inflammation by inhibiting the formation of inflammatory mediators, e.g. prostaglandins. Used to control many inflammatory disorders thought to be caused by excessive or inappropriate activity of the immune system, e.g. asthma, rheumatoid arthritis, lupus, eczema, as well as inflammation caused by strain and damage to muscles and tendons. Also known as glucocorticoids.

## Diuretics

Work on the kidneys to increase the amount of sodium and water excreted. There are different types of diuretic that work on the nephron:

*Thiazides* (bendroflumethiazide/bendrofluazide)

*Loop* (furosemide/frusemide, bumetanide)

*Potassium-sparing* (amiloride, spironolactone)

*Osmotic* (mannitol)

*Carbonic anhydrase inhibitors* (acetazolamide, dorzolamide)



Used to treat hypertension (thiazides), chronic heart failure and oedema (loop diuretics, thiazides or a combination of both), glaucoma (carbonic anhydrase inhibitors or osmotic), raised intracranial pressure (osmotic).

## Inotropes

Work by increasing the contractility of the heart muscle. They can be divided into three groups:

*Cardiac glycosides* (e.g. digoxin) assist activity of heart muscle by increasing intracellular calcium storage in myocardial cells.

Used for heart failure and supraventricular arrhythmias.

*Sympathomimetics* (e.g. dobutamine, dopamine) stimulate  $\beta_1$ -receptors on the heart which increase the rate and force of myocardial contraction. Provide inotropic support in infarction, cardiac surgery, cardiomyopathies, septic shock and cardiogenic shock.

*Phosphodiesterase inhibitors* (e.g. milrinone) inactivate cyclic AMP, which increases the force of myocardial contraction and relaxes vascular smooth muscle. Used to treat congestive heart failure.

## Mucolytics

Reduce the viscosity of bronchopulmonary secretions by breaking down their molecular complexes. Used to treat excessive or thickened mucus secretions.

## Non-steroidal anti-inflammatory drugs (NSAIDs)

Inhibit the production of prostaglandins, which are responsible for inflammation and pain following tissue damage. They are called non-steroidals to distinguish them from corticosteroids, which have a similar function. Used for inflammatory diseases, pain and pyrexia.

### A–Z of drugs

#### Acetylcysteine (mucolytic)

Reduces the viscosity of secretions associated with impaired or abnormal mucus production. Administered with a



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bronchodilator as it can cause bronchospasm and inhibit ciliary function. Also used as an antidote for paracetamol overdose.

*Side-effects:* bronchoconstriction, nausea and vomiting.

### Aciclovir (antiviral)

Used against infections caused by herpes virus (herpes simplex and varicella zoster).

*Side-effects* are rare.

### Adenosine (anti-arrhythmic)

Reverses supraventricular tachycardias to sinus rhythm.

*Side-effects:* chest pain, dyspnoea, nausea, bronchospasm, facial flush.

### Adrenaline/epinephrine (sympathomimetic agent)

Used during cardiopulmonary resuscitation to stimulate heart activity and raise low blood pressure. Adrenaline (epinephrine) acts as a vasoconstrictor and is used to reduce bleeding and prolong the effects of local anaesthetic. It is also used to treat anaphylactic shock as it raises blood pressure and causes bronchodilation. Since it lowers pressure in the eye by decreasing production of aqueous humour it is used for glaucoma and eye surgery.

*Side-effects:* dry mouth, anxiety, restlessness, palpitations, tremor, headache, blurred vision, hypertension, tachycardias.

### Alendronate (bisphosphonate)

Inhibits the release of calcium from bone by interfering with the activity of osteoclasts, thereby reducing the rate of bone turnover. Used in the prophylaxis and treatment of postmenopausal osteoporosis and corticosteroid-induced osteoporosis. Often used in conjunction with calcium tablets. Also used in the treatment of Paget's disease, hypercalcaemia of malignancy and in bone metastases in breast cancer.

*Side-effects:* oesophageal irritation and ulceration, gastrointestinal upset, increased bone pain in Paget's disease.

### Alfentanil (opioid analgesic)

Fast-acting, it is used as a respiratory depressant in patients needing prolonged assisted ventilation. Also used as an analgesic during surgery and to enhance anaesthesia.



*Side-effects:* drowsiness, nausea, vomiting, constipation, dizziness, dry mouth.

### Allopurinol (anti-gout)

A prophylactic for gout and uric acid kidney stones.

*Side-effects:* rash, itching, nausea.

### Aminophylline (xanthine)

Acts as a bronchodilator and is used for reversible airways obstruction and intravenously for acute severe asthma.

*Side-effects:* tachycardias, palpitations, nausea, headache, insomnia, arrhythmias, convulsions.

### Amiodarone (anti-arrhythmic)

Slows nerve impulses in the heart muscle. Used to treat ventricular and supraventricular tachycardias and prevent recurrent atrial and ventricular fibrillation.

*Side-effects:* photosensitivity, reversible corneal depositions, liver damage and thyroid disorders.

### Amitriptyline (tricyclic antidepressant)

Used as a long-term treatment for depression, particularly when accompanied by anxiety or insomnia, owing to its sedative properties. In low doses it is also useful for the treatment of neuropathic pain. It is also sometimes used to treat nocturnal enuresis (bedwetting) in children.

*Side-effects:* drowsiness, sweating, dry mouth, blurred vision, dizziness, fainting, palpitations, gastrointestinal upset.

### Amlodipine (calcium channel blocker)

Used to treat hypertension and angina. Can be used safely by asthmatics and non-insulin-dependent diabetics.

*Side-effects:* oedema, headache, dizziness, fatigue, sleep disturbances, palpitations, flushing, gastrointestinal upset.

### Amoxicillin (penicillin antibiotic)

See antibiotics in 'Drug classes'.

### Ampicillin (penicillin antibiotic)

See antibiotics in 'Drug classes'.



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### Aspirin (NSAID)

Used as an anti-inflammatory, as an analgesic and to reduce fever. It also inhibits thrombus formation and is used to reduce the risk of heart attacks and stroke.

*Side-effects:* gastric irritation leading to dyspepsia and bleeding, and wheezing in aspirin-sensitive asthmatics.

### Atenolol ( $\beta$ -blocker)

Used to treat hypertension, angina and arrhythmias.

*Side-effects:* muscle ache, fatigue, dry eyes, bradycardia and atrioventricular (AV) block, hypotension, cold peripheries.

### Atorvastatin (statin)

Lowers low-density lipoprotein (LDL) cholesterol and is prescribed for those who have not responded to diet and lifestyle modification to protect them from cardiovascular disease.

*Side-effects:* mild: gastrointestinal upset, headache, fatigue, rarely myositis.

### Atracurium (non-depolarizing muscle relaxant)

Used as a muscle relaxant during surgery and to facilitate intermittent positive pressure breathing in intensive care unit.

*Side-effects:* skin rash, flushing, hypotension.

### Atropine (antimuscarinic)

Relaxes smooth muscle by blocking the action of acetylcholine and is used to treat irritable bowel syndrome. Can be used to paralyse ciliary action and enlarge the pupils during eye examinations. Also used to reverse excessive bradycardia, in cardiopulmonary resuscitation and for patients who have been poisoned with organophosphorous anticholinesterase drugs.

*Side-effects:* blurred vision, dry mouth, thirst, constipation, flushing, dry skin.

### Azathioprine (immunosuppressant)

Prevents rejection of transplanted organs by the immune system and in a number of autoimmune and collagen diseases (including rheumatoid arthritis, polymyositis, systemic lupus erythematosus).

*Side-effects:* nausea, vomiting, hair loss, loss of appetite, bone marrow suppression.



### Baclofen (skeletal muscle relaxant)

Acts on the central nervous system to reduce chronic severe spasticity resulting from a number of disorders, including multiple sclerosis, spinal cord injury, brain injury, cerebral palsy or stroke.

*Side-effects:* drowsiness, nausea, urinary disturbances.

### Beclometasone (corticosteroid)

Given by inhaler and used to control asthma in those who do not respond to bronchodilators alone. Also used in creams to treat inflammatory skin disorders and to relieve and prevent symptoms of vasomotor and allergic rhinitis.

*Side-effects:* cough, nasal discomfort/irritation, hoarse voice, sore throat, nosebleed (with inhalers/nasal spray).

### Bendroflumethiazide/bendrofluazide (thiazide diuretic)

Used to treat hypertension, cardiac failure and resistant oedema. Also reduces urinary calcium excretion and so decreases rate of recurrence in patients with recurrent renal stones.

*Side-effects:* hypokalaemia, dehydration, postural hypotension, gout and hyperglycaemia.

### Benzylpenicillin (penicillin antibiotic)

See antibiotics in 'Drug classes'.

### Budesonide (corticosteroid)

Used as an inhaler in the prophylactic treatment of asthma and COPD. Also given systemically in a controlled-release form for Crohn's disease.

*Side-effects:* nasal irritation, cough, sore throat.

### Calcitonin (salmon)/salcatonin (hormone)

Regulates bone turnover and is used to treat hypercalcaemia in Paget's disease of bone and metastatic cancer. Also given for prophylaxis and treatment of osteoporosis and for short-term pain relief following vertebral fracture or in metastatic disease.

*Side-effects:* gastrointestinal upset, flushing.

### Captopril (ACE inhibitor)

Reduces peripheral vasoconstriction and is used to treat hypertension, congestive heart failure, post-myocardial infarction and diabetic nephropathy.



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*Side-effects:* postural hypotension, persistent dry cough, rash, loss of taste, reduced kidney function.

### Carbamazepine (anticonvulsant)

Used to reduce likelihood of generalized tonic-clonic seizures and partial seizures. Also used to relieve severe pain in trigeminal neuralgia and for prophylaxis of bipolar disorder.

*Side-effects:* drowsiness, ataxia, blurred vision, confusion, nausea, loss of appetite.

### Cefaclor (cephalosporin antibiotic)

See antibiotics in 'Drug classes'.

### Cefotaxime (cephalosporin antibiotic)

See antibiotics in 'Drug classes'.

### Cefuroxime (cephalosporin antibiotic)

See antibiotics in 'Drug classes'.

### Celecoxib (NSAID)

Used to relieve the symptoms of osteoarthritis and rheumatoid arthritis. Has a relatively selective action on the inflammatory response compared to other NSAIDs, causing fewer gastrointestinal disturbances. However, it is also associated with a greater risk of adverse cardiovascular effects.

*Side-effects:* dizziness, fluid retention, hypertension, headache, itching, insomnia.

### Chlorpromazine (antipsychotic)

Has a sedative effect and is used to control the symptoms of schizophrenia and to treat agitation without causing confusion and stupor. Also used to treat nausea and vomiting in terminally ill patients.

*Side-effects:* extrapyramidal symptoms (e.g. parkinsonian symptoms, dystonia, akathisia, tardive dyskinesia), hypotension, dry mouth, blurred vision, urinary retention, constipation, jaundice.

### Ciclosporin (immunosuppressant)

Used to prevent rejection of organ and tissue transplantation. Also used to treat rheumatoid arthritis, and severe resistant psoriasis and dermatitis when other treatments have failed.



*Side-effects:* nephrotoxicity, hypertension, increased body hair, nausea, tremor, swelling of gums.

### Cimetidine (anti-ulcer – H<sub>2</sub>-receptor antagonist)

Decreases gastric acid production and is used to treat gastric and duodenal ulcers, and for gastro-oesophageal reflux disease.

*Side-effects:* none.

### Ciprofloxacin (antibacterial)

Treats mainly Gram-negative infection and some Gram-positive infections. Used for chest, intestine and urinary tract infections and to treat gonorrhoea.

*Side-effects:* nausea, vomiting, abdominal pain, diarrhoea.

### Clomipramine (tricyclic antidepressant)

Used for long-term treatment of depression, especially when associated with phobic and obsessional states.

*Side-effects:* drowsiness, sweating, dry mouth, blurred vision, dizziness, fainting, palpitations, gastrointestinal upset.

### Clonidine (α<sub>2</sub>-adrenoceptor agonist)

Acts centrally to reduce sympathetic activity and thereby reduces peripheral vascular reactivity. Used in the prophylaxis of migraine and in the treatment of menopausal flushing. Sometimes used to treat hypertension.

*Side-effects:* gastrointestinal upset, dry mouth, headache, dizziness, rash, sedation, nocturnal unrest, depression, bradycardia, fluid retention.

### Codeine phosphate (opioid analgesic)

A mild opioid analgesic that is similar to, but weaker than, morphine. Used to treat mild to moderate pain and is often combined with a non-opioid analgesic such as paracetamol (to form co-codamol). Also used as a cough suppressant and for the short-term control of diarrhoea.

*Side-effects:* constipation.

### Dexamethasone (corticosteroid)

Suppresses inflammatory and allergic disorders. Used to diagnose Cushing's disease. Used to treat cerebral oedema, congenital adrenal hyperplasia, nausea and vomiting associated with chemotherapy and various types of shock.



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*Side-effects:* indigestion, acne, increased body hair, moon-face, hypertension, weight gain/oedema, impaired glucose tolerance, cataract, glaucoma, osteoporosis, peptic ulcer, candida.

### Diazepam (benzodiazepine)

Has a wide range of uses. Most commonly used to reduce anxiety, relax muscles, promote sleep and in the treatment of alcohol withdrawal. Also used for febrile convulsions and status epilepticus.

*Side-effects:* daytime drowsiness, dizziness, unsteadiness, confusion in the elderly. Dependence develops with prolonged use.

### Didanosine (ddI) (antiretroviral – NRTI)

Prevents the replication of HIV and therefore the progression of AIDS by blocking the action of the reverse transcriptase enzyme. Usually used in combination with other antiretroviral drugs.

*Side-effects:* pancreatitis, peripheral neuropathy, headache, insomnia, gastrointestinal upset, fatigue, breathlessness, cough, blood disorders, rash, liver damage.

### Diclofenac (NSAID)

Used to relieve mild to moderate pain associated with inflammation such as rheumatoid arthritis, osteoarthritis and musculoskeletal disorders. Also used to treat acute gout and postoperative pain.

*Side-effects:* gastrointestinal disorders.

### Digoxin (cardiac glycoside)

Used in heart failure to control breathlessness, tiredness and fluid retention. Also used to treat supraventricular arrhythmias, particularly atrial fibrillation.

*Side-effects:* anorexia, nausea, vomiting, diarrhoea, visual disturbances, headache, tiredness, palpitations.

### Dihydrocodeine/DF118 (opioid analgesic)

Similar to, but weaker than, morphine and more potent than codeine. Used to relieve moderate acute and chronic pain and is often combined with a non-opioid analgesic such as paracetamol (to form co-dydramol).



*Side-effects:* drowsiness, nausea, vomiting, constipation, dizziness, dry mouth.

### **Diltiazem (calcium channel blocker)**

Used to prevent and treat angina and to lower high blood pressure.

*Side-effects:* bradycardia, headache, nausea, dizziness, dry mouth, hypotension, ankle and leg swelling.

### **Dobutamine (inotropic sympathomimetic)**

Provides inotropic support in acute severe heart failure, cardiac surgery, cardiomyopathies, septic shock and cardiogenic shock.

*Common side-effect:* tachycardias.

### **Donepezil (anticholinesterase)**

Inhibits the breakdown of acetylcholine. Used to improve cognitive function in mild to moderate dementia due to Alzheimer's disease, although the underlying disease process is not altered.

*Side-effects:* gastrointestinal upset, fatigue, insomnia, muscle cramps.

### **Dopamine (inotropic sympathomimetic)**

Used to treat cardiogenic shock after myocardial infarction, hypotension after cardiac surgery, acute severe heart failure and to start diuresis in chronic heart failure.

*Side-effects:* nausea, vomiting, peripheral vasoconstriction, hypotension, hypertension, tachycardia.

### **Dornase alfa (mucolytic)**

A synthetic version of a naturally occurring human enzyme that breaks down the DNA content of sputum. Used by inhalation in cystic fibrosis to facilitate expectoration.

*Side-effects:* pharyngitis, laryngitis, chest pain.

### **Dosulepin/Dothiepin (tricyclic antidepressant)**

Used for long-term treatment of depression, especially when associated with agitation, anxiety and insomnia.

*Side-effects:* drowsiness, sweating, dry mouth, blurred vision, dizziness, fainting, palpitations, gastrointestinal upset.



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### Doxapram (respiratory stimulant)

Used in hospital to treat acute exacerbations of COPD with type II respiratory failure when ventilation is unavailable or contraindicated.

*Side-effects:* tachycardia, hypertension, cerebral oedema, hyperthyroidism, dizziness, sweating, confusion, seizures, nausea, vomiting, perineal warmth.

### Efavirenz (antiretroviral – NNRTI)

Used to treat HIV infection, specifically HIV type 1 (HIV-1) in combination with other antiretroviral drugs. Not effective for HIV-2.

*Side-effects:* gastrointestinal upset, rash, itching, anxiety, depression, sleep disturbances, dizziness, headache, impaired concentration.

### Enalapril (ACE inhibitor)

Used in the treatment of hypertension, chronic heart failure and in the prevention of recurrent myocardial infarction following a heart attack.

*Side-effects:* postural hypotension, persistent dry cough, rash, loss of taste, reduced kidney function, dizziness, headache.

### Epinephrine/adrenaline (sympathomimetic agent)

See 'Adrenaline'.

### Erythromycin (macrolide antibiotic)

See antibiotics in 'Drug classes'.

### Estradiol (oestrogen for hormone replacement therapy)

A naturally occurring female sex hormone used to treat menopausal and postmenopausal symptoms such as hot flushes, night sweats and vaginal atrophy. Can also be used for the prevention of osteoporosis in high-risk women with early menopause.

*Side-effects:* withdrawal bleeding, sodium and fluid retention, gastrointestinal upset, weight changes, breast enlargement, venous thromboembolism.

### Etidronate (bisphosphonate)

Inhibits the release of calcium from bone by interfering with the activity of osteoclasts, thereby reducing the rate of bone



turnover. Used in the prophylaxis and treatment of postmenopausal osteoporosis and corticosteroid-induced osteoporosis. Often used in conjunction with calcium tablets. Also used in the treatment of Paget's disease, hypercalcaemia of malignancy and in bone metastases in breast cancer.

*Side-effects:* oesophageal irritation and ulceration, gastrointestinal upset, increased bone pain in Paget's disease.

### **Fentanyl (opioid analgesic)**

Used to depress respiration in patients needing prolonged assisted ventilation. Also used as an analgesic during surgery and to enhance anaesthesia.

*Side-effects:* drowsiness, nausea, vomiting, constipation, dizziness, dry mouth.

### **Ferrous sulphate (iron salt)**

Used to treat iron-deficiency anaemia.

*Side-effects:* nausea, epigastric pain, constipation or diarrhoea, darkening of faeces.

### **Flucloxacillin (penicillin antibiotic)**

See antibiotics in 'Drug classes'.

### **Fluoxetine (selective serotonin re-uptake inhibitor)**

More commonly known by its brand name, Prozac, it increases serotonin levels and is used to treat depressive illness, obsessive-compulsive disorder and bulimia nervosa.

*Side-effects:* headache, nervousness, insomnia, anxiety, nausea, diarrhoea, weight loss, sexual dysfunction.

### **Furosemide/frusemide (loop diuretic)**

A powerful, fast-acting diuretic that is used in emergencies to reduce acute pulmonary oedema secondary to left ventricular failure. It also reduces oedema and dyspnoea associated with chronic heart failure and is used to treat oliguria secondary to acute renal failure.

*Side-effects:* postural hypotension, hypokalaemia, hyponatraemia, hyperuricaemia, gout, dizziness, nausea.

### **Gabapentin (anticonvulsant)**

Used as an adjunct in the management of partial and general epileptic seizures, as well as for the treatment of neuropathic pain. Can also be used in trigeminal neuralgia.



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*Side-effects:* drowsiness, dizziness, ataxia, nystagmus, tremor, diplopia, gastrointestinal upset, peripheral oedema, amnesia, paraesthesia.

### **Gentamicin (aminoglycoside antibiotic)**

See antibiotics in 'Drug classes'.

### **Gliclazide (sulphonylurea)**

Oral antidiabetic drug that lowers blood sugar and is used to treat type II diabetes mellitus.

*Side-effects:* hypoglycaemia, weight gain.

### **GTN/glyceryl trinitrate (organic nitrate)**

A potent coronary and peripheral vasodilator that relieves angina and is used to treat heart failure.

*Side-effects:* headaches, dizziness, flushing, postural hypotension, tachycardias.

### **Haloperidol (antipsychotic)**

Used to control violent and dangerously impulsive behaviour associated with psychotic disorders such as schizophrenia, mania and dementia. Also used to treat motor tics.

*Side-effects:* parkinsonism, acute dystonia, akathisia, drowsiness, postural hypotension.

### **Heparin (anticoagulant)**

Prevents blood clots forming and is used to prevent and treat deep vein thrombosis and pulmonary embolism. Also used in the management of unstable angina, myocardial infarction and acute occlusion of peripheral arteries.

*Side-effects:* haemorrhage, thrombocytopenia.

### **Hydrocortisone (corticosteroid)**

Given as replacement therapy for adrenocortical insufficiency. Suppresses a variety of inflammatory and allergic disorders, e.g. psoriasis, eczema, rheumatic disease, inflammatory bowel disease. Also used as an immunosuppressant following organ transplant and for treating shock.

*Side-effects:* indigestion, acne, increased body hair, moon-face, hypertension, weight gain/oedema, impaired glucose tolerance, cataract, glaucoma, osteoporosis, peptic ulcer, candida.



### Hyoscine (muscarinic antagonist)

Used to manage motion sickness, giddiness and nausea caused by disturbances of the inner ear and reduce intestinal spasm in irritable bowel syndrome. Used as a pre-medication to dry bronchial secretions before surgery.

*Side-effects:* sedation, dry mouth, blurred vision.

### Ibuprofen (NSAID)

Used to reduce pain, stiffness and inflammation associated with conditions such as rheumatoid arthritis, osteoarthritis, sprains and other soft tissue injuries. Also used to treat post-operative pain, headache, migraine, menstrual and dental pain, and fever and pain in children.

*Side-effects:* heartburn, indigestion.

### Imipramine (tricyclic antidepressant)

Less sedating than some other antidepressants, it is used for long-term treatment of depression and also for nocturnal enuresis (bedwetting) in children.

*Side-effects:* drowsiness, sweating, dry mouth, blurred vision, dizziness, fainting, palpitations, gastrointestinal upset.

### Indinavir (antiretroviral – protease inhibitor)

Used to treat HIV infection in combination with other antiretroviral drugs.

*Side-effects:* gastrointestinal upset, anorexia, hepatic dysfunction, pancreatitis, blood disorders, sleep disturbances, fatigue, headache, dizziness, paraesthesia, myalgia, myositis, taste disturbance, rash, itching, anaphylaxis.

### Insulin (peptide hormone)

Lowers blood sugar and is given by injection to control type I and sometimes type II diabetes mellitus.

*Side-effects:* injection site irritation, weakness, sweating, hypoglycaemia, weight gain.

### Interferon (antiviral and anticancer)

Group of proteins produced by the body in response to viral infection that stimulate the immune response:

*Interferon alfa* – used for certain lymphomas and tumours (e.g. leukaemia) and chronic active hepatitis B and C.



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*Side-effects:* anorexia, nausea, influenza-like symptoms, lethargy.

*Interferon beta* – used for relapses of multiple sclerosis.

*Side-effects:* irritation at injection site, influenza-like symptoms.

*Interferon gamma* – used in conjunction with antibiotics to treat chronic granulomatous disease.

*Side-effects:* fever, headache, chills, myalgia, fatigue, nausea, vomiting, arthralgia, rashes and injection-site reactions.

### Ipratropium (antimuscarinic)

Bronchodilator that is used to treat reversible airways obstruction, particularly in chronic obstructive pulmonary disease.

*Side-effects:* dry mouth and throat.

### Isoprenaline (inotropic sympathomimetic)

Increases heart rate and cardiac contractility. Used to treat heart block and severe bradycardia.

*Side-effects:* tachycardia, arrhythmias, hypotension, sweating, tremor, headache.

### Isosorbide mononitrate (organic nitrate)

A coronary and peripheral vasodilator. Used as prophylaxis in angina and as an adjunct in congestive heart failure.

*Side-effects:* headaches, dizziness, flushing, postural hypotension, tachycardias.

### Ketamine (intravenous anaesthetic)

Used to induce and maintain anaesthesia during surgery.

*Side-effects:* hallucinations and other transient psychotic sequelae, increased blood pressure, tachycardia, increased muscle tone, apnoea, hypotension.

### Lactulose (osmotic laxative)

Used to relieve constipation. Also used to treat hepatic encephalopathy.

*Side-effects:* flatulence, belching, stomach cramps, diarrhoea.

### Lansoprazole (proton-pump inhibitor)

Reduces the amount of acid produced by the stomach and is used to treat stomach and duodenal ulcers as well as gastro-oesophageal reflux and oesophagitis.



*Side-effects:* headache, gastrointestinal upset, dizziness.

### **Levodopa/L-dopa (dopamine precursor)**

Used to treat idiopathic Parkinson's disease by replacing the depleted dopamine in the brain. It is combined with an inhibitor such as carbidopa (to form co-caraldopa) or benserazide (to form co-beneldopa) which prolongs and enhances its action. It becomes less effective with continued use.

*Side-effects:* nausea, vomiting, abdominal pain, anorexia, postural hypotension, dysrhythmias, dizziness, discoloration of urine and other bodily fluids, abnormal involuntary movements, nervousness, agitation.

### **Levothyroxine (thyroid hormone)**

Used in the treatment of hypothyroidism.

*Side-effects:* usually at excessive dosage. Include cardiac arrhythmias, tachycardia, anxiety, weight loss, muscular weakness and cramps, sweating, diarrhoea.

### **Lidocaine/lignocaine (local anaesthetic, class I anti-arrhythmic agent)**

Used as a local anaesthetic and for ventricular dysrhythmias, especially following myocardial infarction.

*Side-effects:* nausea, vomiting, drowsiness, dizziness.

### **Lisinopril (ACE inhibitor)**

Vasodilator that is used to treat hypertension, congestive heart failure and following myocardial infarction.

*Side-effects:* nausea, vomiting, dry cough, altered sense of taste, hypotension.

### **Lithium (antimanic)**

Used to prevent and treat mania, bipolar disorders and recurrent depression. Its effects (including toxicity) are increased if it is combined with a thiazide diuretic.

*Side-effects:* weight gain, nausea, vomiting, diarrhoea, fine tremor.

### **Loperamide (antimotility)**

Inhibits peristalsis and prevents the loss of water and electrolytes. Used to treat diarrhoea.

*Side-effects:* none.



### Losartan (angiotensin-II receptor antagonist)

Shares similar properties to ACE inhibitors and is used to treat hypertension, heart failure and diabetic neuropathy. Does not cause a persistent dry cough, which commonly complicates ACE inhibitor therapy.

*Side-effects:* dizziness.

### Mannitol (osmotic diuretic)

Reduces cerebral oedema and therefore intracranial pressure. Used preoperatively to reduce intraocular pressure in glaucoma.

*Side-effects:* chills, fever, fluid/electrolyte imbalance.

### Meloxicam (NSAID)

Used to relieve the symptoms of rheumatoid arthritis, ankylosing spondylitis and acute episodes of osteoarthritis. Has a relatively selective action on the inflammatory response compared to other NSAIDs, causing less gastrointestinal disturbances. However, it is also associated with a greater risk of cardiovascular adverse effects.

*Side-effects:* gastrointestinal upset, headache, dizziness, vertigo, rash.

### Metformin (biguanide)

Used to treat type II diabetes mellitus by decreasing glucose production, increasing peripheral glucose utilization and reducing glucose absorption in the digestive tract.

*Side-effects:* anorexia, nausea, vomiting, diarrhoea.

### Methotrexate (cytotoxic and immunosuppressive)

Inhibits DNA, RNA and protein synthesis leading to cell death. Used to treat leukaemia, lymphoma and a number of solid tumours. Also used for rheumatoid arthritis and psoriatic arthritis.

*Side-effects:* bone marrow suppression, anorexia, diarrhoea, nausea, vomiting, hepatotoxicity, dry cough, mouth and gum ulcers and inflammation.

### Methyldopa (antihypertensive)

Used to treat high blood pressure, especially in pregnancy.

*Side-effects:* drowsiness, headache, postural hypotension, depression, impotence.



### Metoclopramide (dopamine antagonist)

Used to treat nausea and vomiting caused by radiotherapy, anti-cancer drug and opioid treatment, migraines, and following surgery. Also used to reduce symptoms of gastro-oesophageal reflux.

*Side-effects:* acute dystonic reactions, especially in children and young adults.

### Midazolam (benzodiazepine)

Water-soluble and short-acting, it is given by injection or infusion to relieve anxiety and to provide sedation with amnesia. Used during small procedures under local anaesthetic and in ITU units for those on ventilatory support.

*Side-effects:* apnoea, hypotension, drowsiness, light-headedness, confusion, ataxia, amnesia, dependence, muscle weakness.

### Milrinone (phosphodiesterase inhibitor)

A positive inotrope with vasodilating properties, it increases cardiac contractility and reduces vascular resistance. Used to treat severe congestive heart failure and myocardial dysfunction.

*Side-effects:* hypotension, cardiac arrhythmias, tachycardia, headache, insomnia, nausea, vomiting, diarrhoea.

### Morphine (opioid analgesic)

Used to relieve severe pain and suppress cough in palliative care. Also effective in the relief of acute left ventricular failure.

*Side-effects:* drowsiness, nausea, vomiting, constipation, dizziness, dry mouth and respiratory depression.

### Naloxone (antagonist for central and respiratory depression)

Used to reverse respiratory depression caused by opioid analgesics, mainly in overdose.

*Side-effects:* nausea, vomiting, tachycardia, fibrillation.

### Naproxen (NSAID)

Used to relieve the symptoms of adult and juvenile rheumatoid arthritis, acute musculoskeletal disorders, acute gout and menstrual cramps.



*Side-effects:* gastrointestinal disturbances.

### **Nelfinavir (antiretroviral – protease inhibitor)**

Used to treat HIV infection in combination with other antiretroviral drugs.

*Side-effects:* gastrointestinal upset, anorexia, hepatic dysfunction, pancreatitis, blood disorders, sleep disturbances, fatigue, headache, dizziness, paraesthesia, myalgia, myositis, taste disturbance, rash, itching, anaphylaxis.

### **Nevirapine (antiretroviral – NNRTI)**

Used to treat HIV infection, specifically HIV type 1 (HIV-1) in combination with other antiretroviral drugs. Not effective for HIV-2.

*Side-effects:* gastrointestinal upset, rash, itching, anxiety, depression, sleep disturbances, dizziness, headache, impaired concentration, toxic epidermal necrolysis, hepatitis.

### **Nicorandil (potassium-channel activator)**

Used for the prevention and treatment of angina. Acts on both the coronary arteries and veins to cause dilation, thus improving blood flow.

*Side-effects:* headache, flushing, nausea.

### **Nifedipine (calcium channel blocker)**

Used to treat hypertension, angina and Raynaud's disease.

*Side-effects:* headache, flushing, ankle swelling, dizziness, fatigue, hypotension.

### **Nimodipine (calcium channel blocker)**

Relaxes vascular smooth muscle, acting preferentially on the cerebral arteries. Used to treat cerebral vasospasm associated with subarachnoid haemorrhage.

*Side-effects:* hypotension, ECG abnormalities, headache, gastrointestinal disorders, nausea, sweating.

### **Nitrous oxide (inhalational agent)**

Used for maintenance of anaesthesia and, in smaller doses, for analgesia without loss of consciousness, especially in labour.

*Side-effects* are rare.



### Noradrenaline/norepinephrine (sympathomimetic agent)

Administered intravenously to constrict peripheral vessels to raise blood pressure in patients with acute hypotension.

*Side-effects:* hypertension, headache, bradycardia, arrhythmias, peripheral ischaemia.

### Omeprazole (proton-pump inhibitor)

Reduces the amount of acid produced by the stomach and is used to treat stomach and duodenal ulcers as well as gastro-oesophageal reflux and oesophagitis.

*Side-effects:* headache, gastrointestinal upset, dizziness.

### Ondansetron (serotonin antagonist)

Used to treat nausea and vomiting associated with anti-cancer drug therapy, radiotherapy and following surgery.

*Side-effects:* headache, constipation.

### Orphenadrine (antimuscarinic)

Blocks the action of the neurotransmitter acetylcholine and is used to reduce rigidity and tremor in younger patients with parkinsonism. Not useful for bradykinesia.

*Side-effects:* dry mouth/skin, constipation, blurred vision, retention of urine.

### Oxybutinin (antimuscarinic)

Reduces unstable contractions of the bladder, thereby increasing its capacity. Used to treat urinary frequency, urgency and incontinence, nocturnal enuresis and neurogenic bladder instability.

*Side-effects:* dry mouth and eyes, gastrointestinal upset, difficulty in micturition, skin reactions, blurred vision.

### Oxytetracycline (tetracycline antibiotic)

See antibiotics in 'Drug classes'.

### Pancuronium (muscle relaxant)

Long-acting, it is used as a muscle relaxant during surgical procedures and to facilitate tracheal intubation. Also used on patients receiving long-term mechanical ventilation.

*Side-effects:* tachycardia, hypertension, skin flushing, hypotension, bronchospasm.



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### Paracetamol (non-opioid analgesic)

Used to treat mild pain and reduce fever. Does not irritate the gastric mucosa and so can be used by those who have peptic ulcers or can be used in place of aspirin for those who are aspirin-intolerant.

*Side-effects* are rare but overdose is dangerous, causing liver failure.

### Paroxetine (selective serotonin re-uptake inhibitor)

Increases serotonin levels and is used in depression, obsessive-compulsive disorder, panic disorder, social phobia, post-traumatic stress disorder and generalized anxiety disorder.

*Side-effects*: as for amitriptyline and, in addition, yawning. Extrapyramidal reactions (e.g. parkinsonian symptoms) and withdrawal syndrome appear to be more common than with other selective serotonin re-uptake inhibitors (SSRIs).

### Pethidine (opioid analgesic)

Used to treat moderate to severe pain, especially during labour.

*Side-effects*: dizziness, nausea, vomiting, drowsiness, confusion, constipation.

### Phenytoin (anticonvulsant)

Used to treat all forms of epilepsy (except absence seizures) as well as trigeminal neuralgia.

*Side-effects*: dizziness, headache, confusion, nausea, vomiting, insomnia, acne, increased body hair.

### Piroxicam (NSAID)

Has a long duration of action and is used to relieve the symptoms of adult and juvenile rheumatoid arthritis, acute gout, osteoarthritis and acute musculoskeletal disorders.

*Side-effects*: gastrointestinal upset.

### Pizotifen (antimigraine)

Inhibits the action of histamine and serotonin on blood vessels in the brain and is used in the prevention of vascular headache including classical and common migraines and cluster headache.

*Side-effects*: increased appetite, weight gain, drowsiness.



### Pravastatin (statin)

Lowers LDL cholesterol and is prescribed for those who have not responded to diet and lifestyle modification to protect them from cardiovascular disease.

*Side-effects:* mild: gastrointestinal upset, headache, fatigue, rarely myositis.

### Prednisolone (corticosteroid)

In high doses it is used to suppress inflammatory and allergic disorders, e.g. asthma, eczema, inflammatory bowel disease, rheumatoid arthritis. Also used as an immunosuppressant following organ transplant and to treat leukaemia. It is used in lower doses for replacement therapy in adrenal deficiency, though cortisol (hydrocortisone) is preferred.

*Side-effects:* indigestion, acne, increased body hair, moon-face, hypertension, weight gain/oedema, impaired glucose tolerance, cataract, glaucoma, osteoporosis, peptic ulcer, candida, adrenal suppression.

### Propofol (IV anaesthetic)

Used to induce and maintain anaesthesia. Also used as a sedative on ITU and during investigative procedures.

*Side-effects:* hypotension, tremor.

### Propranolol ( $\beta$ -blocker)

Used to treat hypertension, angina, arrhythmias, hyperthyroidism, migraine, anxiety and for prophylaxis after myocardial infarction.

*Side-effects:* fatigue, cold peripheries, bronchoconstriction, bradycardia, heart failure, hypotension, gastrointestinal upset, sleep disturbances.

### Quinine (antimalarial)

Used for the treatment of malaria. Also used to prevent nocturnal leg cramps.

*Side-effects:* tinnitus, headache, blurred vision, confusion, gastrointestinal upset, rash, blood disorders.

### Raloxifene (selective oestrogen receptor modulator (SERM))

Used to prevent vertebral fractures in postmenopausal women at increased risk of osteoporosis.



*Side-effects:* hot flushes, leg cramps, peripheral oedema, venous thromboembolism, thrombophlebitis.

### Ramipril (ACE inhibitor)

As a vasodilator it is used to treat hypertension and congestive heart failure. Also used following myocardial infarction.

*Side-effects:* nausea, dizziness, headache, cough, dry mouth, taste disturbance.

### Repaglinide (meglitinide)

Oral, short-acting, antidiabetic drug that lowers blood glucose levels after eating. Used to treat type II diabetes mellitus.

*Side-effects:* gastrointestinal upset.

### Rifampicin (antituberculous agent)

Antibacterial used to treat tuberculosis, leprosy and other serious infections such as Legionnaires' disease and osteomyelitis. Used as a prophylactic against meningococcal meningitis and *Haemophilus influenzae* (type b) infection.

*Side-effects:* red-orange-coloured tears and urine.

### Riluzole (no classification)

Used to extend life or delay mechanical ventilation in patients with motor neurone disease.

*Side-effects:* gastrointestinal upset, headache, dizziness, weakness.

### Risperidone (antipsychotic)

Used for acute psychiatric disorders and long-term psychotic illness such as schizophrenia.

*Side-effects:* insomnia, agitation, anxiety, headache, weight gain, postural hypotension, mild extrapyramidal symptoms (e.g. parkinsonian symptoms).

### Rivastigmine (anticholinesterase)

Inhibits the breakdown of acetylcholine. Used to improve cognitive function in mild to moderate dementia due to Alzheimer's disease, although the underlying disease process is not altered.

*Side-effects:* weakness, weight loss, dizziness, gastrointestinal upset, drowsiness, tremor, confusion, depression.



### Salbutamol ( $\beta_2$ agonist)

A bronchodilator, it is used to relieve asthma, chronic bronchitis and emphysema. It is also used in premature labour to relax uterine muscle.

*Side-effects:* tremor, tachycardia, anxiety, nervous tension, restlessness.

### Salmeterol ( $\beta_2$ agonist)

A bronchodilator that is used to treat asthma and bronchospasms. It is longer-acting than salbutamol and so is useful in preventing nocturnal asthma. It should not be used to relieve acute asthma attacks as it has a slow onset of effect.

*Side-effects:* fine tremors, especially in the hands.

### Saquinavir (antiretroviral – protease inhibitor)

Used to treat HIV infection in combination with other antiretroviral drugs.

*Side-effects:* gastrointestinal upset, anorexia, hepatic dysfunction, pancreatitis, blood disorders, sleep disturbances, fatigue, headache, dizziness, paraesthesia, myalgia, myositis, taste disturbance, rash, itching, anaphylaxis, peripheral neuropathy and mouth ulcers.

### Senna (stimulant laxative)

Used to treat constipation by increasing the response of the colon to normal stimuli.

*Side-effects:* abdominal cramps, diarrhoea.

### Simvastatin (statin)

Lowers LDL cholesterol and is prescribed for those who have not responded to diet and lifestyle modification to protect them from cardiovascular disease.

*Side-effects:* mild: gastrointestinal upset, headache, fatigue, rarely myositis.

### Sodium aurothiomalate (gold salt)

Used in the treatment of active progressive rheumatoid arthritis and juvenile arthritis with the aim of suppressing the disease process.

*Side-effects:* mouth ulcers, proteinuria, skin reactions, blood disorders.



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### Sodium cromoglicate (mast cell inhibitor)

Used to prevent the onset of asthma and other allergic conditions. It has a slow onset of action and so is not useful in treating acute asthma. It is also used to prevent allergic conjunctivitis, allergic rhinitis and for food allergies.

*Side-effects:* cough, hoarseness, throat irritation, bronchospasm.

### Sodium valproate (antiepileptic)

Used to treat all types of epilepsy.

*Side-effects:* nausea, vomiting, weight gain.

### Streptokinase (fibrinolytic agent)

An enzyme that dissolves blood clots by acting on the fibrin contained within it. Due to its fast-acting nature it is useful in treating acute myocardial infarction. Also used to treat a number of thromboembolic events such as pulmonary embolism and thrombosed arteriovenous shunts.

*Side-effects:* excessive bleeding, hypotension, nausea, vomiting, allergic reactions.

### Sulfasalazine (aminosalicylate)

Used as an anti-inflammatory to treat ulcerative colitis and active Crohn's disease. Also found to help in the treatment of rheumatoid arthritis.

*Side-effects:* nausea, vomiting, loss of appetite, headache, joint pain, abdominal discomfort, anorexia.

### Sumatriptan (5HT<sub>1</sub> (serotonin) agonist)

Used to treat severe acute migraine and cluster headaches (subcutaneous injection only).

*Side-effects:* feeling of tingling/heat, flushing, feeling of heaviness/weakness, lethargy.

### Tamoxifen (anti-oestrogen)

Used in the treatment of breast cancer (when the tumour is oestrogen-receptor positive) to slow the growth of a tumour and to prevent the recurrence of the cancer following surgical removal. Also used in the treatment of infertility due to failure of ovulation.

*Side-effects:* gastrointestinal upset, hot flushes, vaginal bleeding.



### Tamsulosin ( $\alpha$ -blocker)

Used to treat urinary retention due to benign prostatic hypertrophy by causing the urethral smooth muscle to relax.

*Side-effects:* dizziness, postural hypotension, headache, abnormal ejaculation, drowsiness, palpitations.

### Temazepam (benzodiazepine)

Used as a short-term treatment for insomnia and as a pre-medication before surgery.

*Side-effects:* daytime drowsiness, dependence.

### Terbutaline ( $\beta_2$ agonist)

Acts as a bronchodilator and is used to treat and prevent bronchospasm associated with asthma, chronic bronchitis and emphysema.

*Side-effects:* nausea, vomiting, fine tremor, restlessness, anxiety.

### Tetracycline (tetracycline antibiotic)

See antibiotics in 'Drug classes'.

### Theophylline (methylxanthine)

Acts as a bronchodilator and is used to treat asthma, bronchitis and emphysema.

*Side-effects:* headache, nausea, vomiting, palpitations.

### Thiopental (barbiturate)

Used to induce general anaesthesia, as well as reducing intracranial pressure in patients whose ventilation is controlled.

*Side-effects:* cardiovascular and respiratory depression.

### Tibolone (hormone replacement therapy)

A synthetic steroid used as a short-term treatment for symptoms of menopause, especially hot flushes. Has both oestrogenic and progestogenic activity. Also used as a second-line preventative treatment for postmenopausal osteoporosis.

*Side-effects:* weight changes, dizziness, headache, dermatitis, gastrointestinal upset, increased facial hair, vaginal bleeding.

### Timolol ( $\beta$ -blocker)

Used to treat hypertension, angina and for prophylaxis following myocardial infarction. Also commonly administered



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as eye drops for glaucoma and occasionally given for the prevention of migraine.

*Side-effects:* see propranolol.

### **Tizandine ( $\alpha_2$ -adrenoceptor agonist)**

Acts centrally to reduce muscle spasticity associated with multiple sclerosis or spinal cord injury or disease.

*Side-effects:* drowsiness, fatigue, dizziness, dry mouth, gastrointestinal upset, hypotension.

### **Tolterodine (antimuscarinic)**

Reduces unstable contractions of the bladder, thereby increasing its capacity. Used to treat urinary frequency, urgency and incontinence.

*Side-effects:* dry mouth and eyes, gastrointestinal upset, headache, drowsiness.

### **Tramadol (opioid analgesic)**

Used to treat moderate to severe pain.

*Side-effects:* nausea, vomiting, dry mouth, tiredness, drowsiness, dependence.

### **Trazodone (antidepressant)**

Used to treat depression and anxiety, particularly where sedation is required. Has fewer cardiovascular effects than tricyclic antidepressants and therefore commonly prescribed to the elderly.

*Side-effects:* drowsiness.

### **Trihexyphenidyl/benzhexol (antimuscarinic)**

Blocks the action of the neurotransmitter acetylcholine and is used to reduce rigidity and tremor in younger patients with parkinsonism. Not useful for bradykinesia.

*Side-effects:* dry mouth/skin, constipation, blurred vision, retention of urine.

### **Vancomycin (glycopeptide antibiotic)**

Administered intravenously for the treatment of serious infections caused by Gram-positive bacteria or in situations where patients are allergic to, or have failed to respond to other less toxic antibiotics such as penicillins or cephalosporins. Commonly used for MRSA infections and



endocarditis. Given orally exclusively for the treatment of gastrointestinal infections, notably pseudomembranous colitis caused by the *Clostridium difficile* organism.

*Side-effects:* nephrotoxicity, ototoxicity (damage to the auditory nerve), blood disorders.

#### Vecuronium (muscle relaxant)

Used as a muscle relaxant during surgical procedures and to facilitate tracheal intubation, it has an intermediate duration of action.

*Side-effects:* skin flushing, hypotension, bronchospasm are rare.

#### Verapamil (calcium channel blocker)

Used in the treatment of hypertension, angina of effort and supraventricular dysrhythmias.

*Side-effects:* constipation, headache, ankle swelling, nausea, vomiting.

#### Warfarin (oral anticoagulant)

Prevention and treatment of pulmonary embolism and deep vein thrombosis. Decreases the risk of transient ischaemic attacks as well as thromboembolism in people with atrial fibrillation and following artificial heart valve surgery.

*Side-effects:* haemorrhage, bruising.

#### Zalcitabine (antiretroviral – NRTI)

Prevents the replication of HIV and therefore the progression of AIDS by blocking the action of the reverse transcriptase enzyme. Usually used in combination with other antiretroviral drugs.

*Side-effects:* pancreatitis, peripheral neuropathy, headache, insomnia, gastrointestinal upset, fatigue, breathlessness, cough, blood disorders, rash, liver damage, oral and oesophageal ulcers.

#### Zidovudine (antiretroviral – NRTI)

Action, uses and side-effects similar to zalcitabine. Also used to prevent maternal–fetal HIV transmission.

*Other side-effects:* anaemia, myopathy, paraesthesia, taste disturbance, chest pain, impaired concentration, urinary frequency, itching, influenza-like symptoms.



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## Prescription abbreviations

Abbreviation	Latin	English
a.c.	ante cibum	before food
b.d.	bis die	twice a day
o.d.	omni die	daily
o.m.	omni mane	in the mornings
o.n.	omni nocte	at night
p.c.	post cibum	after food
p.r.n.	pro re nata	when required
q.d.s.	quater die sumendum	four times a day
q.q.h.	quaque quarta hora	every 4 hours
stat.	statim	immediately
t.d.s.	ter die sumendum	three times a day
t.i.d.	ter in die	three times a day

## Further reading

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## Maitland symbols (Hengeveld & Banks 2005, with permission)

Peripheral joints		Spine	
F	Flexion		Central posteroanterior (PAs)
E	Extension		with a (L) inclination
Ab	Abduction		Central anteroposterior pressures (Aps)
Ad	Adduction		Unilateral PAs on (L)
	Medial rotation		with a medial inclination
	Lateral rotation		Unilateral APs on the (L)
HF	Horizontal flexion		Transverse pressure towards (L)
HE	Horizontal extension		Rotation of head, thorax or pelvis towards (L)
HBB	Hand behind back		Lateral flexion towards (L)
Inv	Inversion		Longitudinal movement (state cephalad or caudad)
Ev	Eversion		Unilateral PAs at angle of (R) 2nd rib
DF	Dorsiflexion		Further laterally on (R) on 2nd rib
PF	Plantarflexion		Unilateral APs on (R)
Sup	Supination		Cervical traction in flexion
P	Pronation		Cervical traction in neutral
EI	Elevation		Sitting
De	Depression		Lying
Protr	Protraction	CT	IVCT 10 3/0 15
Retr	Retraction	CT	Intermittent variable cervical traction in some degree of neck flexion, the strength of pull being 10 kg with a 3-second hold period, no rest period, for a treatment time lasting 15 minutes
Med	Medial	IVCT	
Lat	Lateral	IVCT	
OP	Overpressure		
PPIVM	Passive physiological intervertebral movements		
PAIVM	Passive accessory intervertebral movements		
ULNT	Upper limb neural tests		
LLNT	Lower limb neural tests	LT	
Q	Quadrant	LT 30/15	Lumbar traction, the strength of pull being 30 kg for a treatment time of 15 minutes
Lock	Locking position		
F/Ab	Flexion abduction		
F/Ad	Flexion adduction	LT crk 15/5	Lumbar traction with hips and knees flexed: 15 kg for 5 minutes
E/Ab	Extension abduction		
E/Ad	Extension adduction	IVLT 50 0/0 10	Intermittent variable lumbar traction, the strength of pull being 50 kg, with no hold period and no rest period, for a treatment time of 10 minutes
Distr	Distraction		
	Posteror anterior movement		
	Anteroposterior movement		
	Transverse movement in the direction indicated		
	Gliding adjacent joint surfaces		
	Compression		
	Longitudinal movement:		
Ceph	Cephalad		
Caud	Caudad		

Figure A.1 Maitland symbols.



## Grades of mobilization/manipulation (Hengeveld & Banks 2005, with permission)

Grade I – a small amplitude movement performed at the beginning of the available range. Usually performed as a slow smooth oscillatory movement.

Grade II – a large amplitude movement performed within a *resistance-free* part of the available range. If performed near the beginning of the available range, it will be classified as a grade II–, and if taken deep into the range, yet still not reaching resistance, it will be classified as a grade II+

Grade III – a large amplitude movement performed into resistance or up to the limit of the available range. If the movement is carried firmly to the limit of the available range it is expressed as a grade III+ but if it nudges gently into the resistance yet short of the limit of the available range, it is expressed as a grade III–.

Grade IV – a small amplitude movement performed into resistance or up to the limit of the available range. Can be expressed as 4+ or 4– in the same way as grade III.

Grade V – a small amplitude, high velocity general movement performed usually, but not always, at the end of the available range.

Grade loc V – a small amplitude high velocity thrust localized to a single joint movement usually, but not always, at the end of the available range.

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## Abbreviations

<b>AAA</b>	abdominal aortic aneurysm
<b>Ab</b>	antibody
<b>ABGs</b>	arterial blood gases
<b>ABPA</b>	allergic bronchopulmonary aspergillosis
<b>ACBT</b>	active cycle of breathing technique
<b>ACE</b>	angiotensin-converting enzyme



<b>ACT</b>	activated clotting time
<b>ACTH</b>	adrenocorticotrophic hormone
<b>AD</b>	autogenic drainage
<b>ADH</b>	anti-diuretic hormone
<b>ADL</b>	activities of daily living
<b>ADR</b>	adverse drug reaction
<b>AE</b>	air entry
<b>AEA</b>	above elbow amputation
<b>AF</b>	atrial fibrillation
<b>AFB</b>	acid-fast bacillus
<b>AFO</b>	ankle-foot orthosis
<b>Ag</b>	antigen
<b>AGN</b>	acute glomerulonephritis
<b>AHRF</b>	acute hypoxaemic respiratory failure
<b>AI</b>	aortic insufficiency
<b>AIDS</b>	acquired immune deficiency syndrome
<b>AKA</b>	above knee amputation
<b>AL</b>	acute leukaemia
<b>ALD</b>	alcoholic liver disease
<b>ALI</b>	acute lung injury
<b>AML</b>	acute myeloid leukaemia
<b>AP</b>	anteroposterior
<b>APACHE</b>	acute physiology and chronic health evaluation
<b>ARDS</b>	acute respiratory distress syndrome
<b>ARF</b>	acute renal failure
<b>AROM</b>	active range of movement
<b>AS</b>	ankylosing spondylitis
<b>ASD</b>	atrial septal defect
<b>ATN</b>	acute tubular necrosis
<b>AVAS</b>	absolute visual analogue scale
<b>AVF</b>	arteriovenous fistula
<b>AVR</b>	aortic valve replacement
<b>AVSD</b>	atrioventricular septal defect
<b>AXR</b>	abdominal X-ray
<b>BE</b>	bacterial endocarditis/barium enema/base excess
<b>BEA</b>	below elbow amputation
<b>BiPAP</b>	bilevel positive airway pressure
<b>BIVAD</b>	biventricular device
<b>BKA</b>	below knee amputation



<b>BM</b>	blood glucose monitoring
<b>BMI</b>	body mass index
<b>BO</b>	bowels open
<b>BP</b>	blood pressure
<b>BPD</b>	bronchopulmonary dysplasia
<b>BPF</b>	bronchopleural fistula
<b>bpm</b>	beats per minute
<b>BS</b>	bowel sounds/breath sounds
<b>BSA</b>	body surface area
<b>BSO</b>	bilateral salpingo-oophorectomy
<b>BVHF</b>	bi-ventricular heart failure
<b>Ca</b>	carcinoma
<b>CABG</b>	coronary artery bypass graft
<b>CAD</b>	coronary artery disease
<b>CAH</b>	chronic active hepatitis
<b>CAL</b>	chronic airflow limitation
<b>CAO</b>	chronic airways obstruction
<b>CAPD</b>	continuous ambulatory peritoneal dialysis
<b>CAVG</b>	coronary artery vein graft
<b>CAVHF</b>	continuous arterial venous haemofiltration
<b>CBD</b>	common bile duct
<b>CBF</b>	cerebral blood flow
<b>CCF</b>	congestive cardiac failure
<b>CCU</b>	coronary care unit
<b>CDH</b>	congenital dislocation of the hip
<b>CF</b>	cystic fibrosis
<b>CFA</b>	cryptogenic fibrosing alveolitis
<b>CHD</b>	coronary heart disease
<b>CHF</b>	chronic heart failure
<b>CI</b>	chest infection
<b>CK</b>	creatine kinase
<b>CLD</b>	chronic lung disease
<b>CML</b>	chronic myeloid leukaemia
<b>CMV</b>	controlled mandatory ventilation/cytomegalovirus
<b>CNS</b>	central nervous system
<b>CO</b>	cardiac output
<b>C/O</b>	complains of
<b>COAD</b>	chronic obstructive airways disease
<b>COPD</b>	chronic obstructive pulmonary disease



<b>CP</b>	cerebral palsy
<b>CPAP</b>	continuous positive airway pressure
<b>CPM</b>	continuous passive movements
<b>CPN</b>	community psychiatric nurse
<b>CPP</b>	cerebral perfusion pressure
<b>CPR</b>	cardiopulmonary resuscitation
<b>CRF</b>	chronic renal failure
<b>CRP</b>	C-reactive protein
<b>CSF</b>	cerebrospinal fluid
<b>CT</b>	computed tomography
<b>CTEV</b>	congenital talipes equinovarus
<b>CV</b>	closing volume
<b>CVA</b>	cerebrovascular accident
<b>CVP</b>	central venous pressure
<b>CVS</b>	cardiovascular system
<b>CVVHF</b>	continuous veno-venous haemofiltration
<b>CXR</b>	chest X-ray
<b>D&amp;C</b>	dilation and curettage
<b>D/C</b>	discharge
<b>D/W</b>	discussed with
<b>DBE</b>	deep breathing exercises
<b>DDH</b>	developmental dysplasia of the hips
<b>DH</b>	drug history
<b>DHS</b>	dynamic hip screw
<b>DIB</b>	difficulty in breathing
<b>DIC</b>	disseminated intravascular coagulopathy
<b>DIOS</b>	distal intestinal obstruction syndrome
<b>DLCO</b>	diffusing capacity for carbon monoxide
<b>DM</b>	diabetes mellitus
<b>DMD</b>	Duchenne muscular dystrophy
<b>DN</b>	district nurse
<b>DNA</b>	deoxyribonucleic acid/did not attend
<b>DSA</b>	digital subtraction angiography
<b>DU</b>	duodenal ulcer
<b>DVT</b>	deep vein thrombosis
<b>DXT</b>	deep X-ray therapy
<b>EBV</b>	Epstein–Barr virus
<b>ECG</b>	electrocardiogram
<b>EEG</b>	electroencephalogram



<b>EIA</b>	exercise-induced asthma
<b>EMG</b>	electromyography
<b>ENT</b>	ear, nose and throat
<b>EOR</b>	end of range
<b>Ep</b>	epilepsy
<b>EPAP</b>	expiratory positive airway pressure
<b>EPP</b>	equal pressure points
<b>ERCP</b>	endoscopic retrograde cholangiopancreatography
<b>ERV</b>	expiratory reserve volume
<b>ESR</b>	erythrocyte sedimentation rate
<b>ESRF</b>	end-stage renal failure
<b>ETCO<sub>2</sub></b>	end-tidal carbon dioxide
<b>ETT</b>	endotracheal tube
<b>EUA</b>	examination under anaesthetic
<b>FB</b>	foreign body
<b>FBC</b>	full blood count
<b>FDP</b>	fibrin degradation product
<b>FET</b>	forced expiration technique
<b>FEV<sub>1</sub></b>	forced expiratory volume in 1 second
<b>FFD</b>	fixed flexion deformity
<b>FG</b>	French gauge
<b>FGF</b>	fibroblast growth factor
<b>FH</b>	family history
<b>FHF</b>	fulminant hepatic failure
<b>FiO<sub>2</sub></b>	fractional inspired oxygen concentration
<b>FRC</b>	functional residual capacity
<b>FROM</b>	full range of movement
<b>FVC</b>	forced vital capacity
<b>FWB</b>	full weight-bearing
<b>GA</b>	general anaesthetic
<b>GBS</b>	Guillain–Barré syndrome
<b>GCS</b>	Glasgow Coma Scale
<b>GH</b>	general health
<b>GIT</b>	gastrointestinal tract
<b>GOR</b>	gastro-oesophageal reflux
<b>GPB</b>	glossopharyngeal breathing
<b>GTN</b>	glyceryl trinitrate
<b>GU</b>	gastric ulcer/genitourinary
<b>H<sup>+</sup></b>	hydrogen ion





<b>[H<sup>+</sup>]</b>	hydrogen ion concentration
<b>HASO</b>	hip abduction spinal orthosis
<b>Hb</b>	haemoglobin
<b>HC</b>	head circumference
<b>Hct</b>	haematocrit
<b>HD</b>	haemodialysis
<b>HDU</b>	high dependency unit
<b>HF</b>	heart failure
<b>HFCWO</b>	high-frequency chest wall oscillation
<b>HFJV</b>	high-frequency jet ventilation
<b>HFO</b>	high-frequency oscillation
<b>HFOV</b>	high-frequency oscillatory ventilation
<b>HFPPV</b>	high-frequency positive pressure ventilation
<b>HH</b>	hiatus hernia/home help
<b>HI</b>	head injury
<b>HIV</b>	human immunodeficiency virus
<b>HLA</b>	human leukocyte antigen
<b>HLT</b>	heart–lung transplantation
<b>HME</b>	heat and moisture exchanger
<b>HPC</b>	history of presenting condition
<b>HPOA</b>	hypertrophic pulmonary osteoarthropathy
<b>HR</b>	heart rate
<b>HRR</b>	heart rate reserve
<b>HT</b>	hypertension
<b>IABP</b>	intra-aortic balloon pump
<b>ICC</b>	intercostal catheter
<b>ICD</b>	intercostal drain
<b>ICP</b>	intracranial pressure
<b>ICU</b>	intensive care unit
<b>IDC</b>	indwelling catheter
<b>IDDM</b>	insulin-dependent diabetes mellitus
<b>Ig</b>	immunoglobulin
<b>IHD</b>	ischaemic heart disease
<b>ILD</b>	interstitial lung disease
<b>IM</b>	intramedullary
<b>IM/i.m.</b>	intramuscular
<b>IMA</b>	internal mammary artery
<b>IMV</b>	intermittent mandatory ventilation
<b>INR</b>	international normalized ratio



<b>IPAP</b>	inspiratory positive airway pressure
<b>IPPB</b>	intermittent positive pressure breathing
<b>IPPV</b>	intermittent positive pressure ventilation
<b>IPS</b>	inspiratory pressure support
<b>IRV</b>	inspiratory reserve volume
<b>IS</b>	incentive spirometry
<b>ITU</b>	intensive therapy unit
<b>IV/i.v.</b>	intravenous
<b>IVB</b>	intervertebral block
<b>IVC</b>	inferior vena cava
<b>IVH</b>	intraventricular haemorrhage
<b>IVI</b>	intravenous infusion
<b>IVOX</b>	intravenacaval oxygenation
<b>IVUS</b>	intravascular ultrasound
<b>JVP</b>	jugular venous pressure
<b>KAFO</b>	knee–ankle–foot orthosis
<b>KO</b>	knee orthosis
<b>LA</b>	local anaesthetic
<b>LAP</b>	left atrial pressure
<b>LBBB</b>	left bundle branch block
<b>LBP</b>	low back pain
<b>LED</b>	light-emitting diode
<b>LFT</b>	liver function test/lung function test
<b>LL</b>	lower limb/lower lobe
<b>LOC</b>	level of consciousness
<b>LP</b>	lumbar puncture
<b>LRTD</b>	lower respiratory tract disease
<b>LSCS</b>	lower segment caesarean section
<b>LTOT</b>	long-term oxygen therapy
<b>LVAD</b>	left ventricular assist device
<b>LVEF</b>	left ventricular ejection fraction
<b>LVF</b>	left ventricular failure
<b>LVRS</b>	lung volume reduction surgery
<b>MAP</b>	mean airway pressure/mean arterial pressure
<b>MAS</b>	minimal access surgery
<b>MCH</b>	mean corpuscular haemoglobin
<b>MC&amp;S</b>	microbiology, culture and sensitivity
<b>MCV</b>	mean corpuscular volume
<b>MDI</b>	metered dose inhaler



<b>ME</b>	metabolic equivalents/myalgic encephalomyelitis
<b>MI</b>	myocardial infarction
<b>ML</b>	middle lobe
<b>MM</b>	muscle
<b>MMAD</b>	mass median aerodynamic diameter
<b>MND</b>	motor neurone disease
<b>MOW</b>	meals on wheels
<b>MRI</b>	magnetic resonance imaging
<b>MRSA</b>	meticillin-resistant <i>Staphylococcus aureus</i>
<b>MS</b>	mitral stenosis/multiple sclerosis
<b>MSU</b>	midstream urine
<b>MUA</b>	manipulation under anaesthetic
<b>MVO<sub>2</sub></b>	myocardial oxygen consumption
<b>MVR</b>	mitral valve replacement
<b>MVV</b>	maximum voluntary ventilation
<b>NAD</b>	nothing abnormal detected
<b>NAI</b>	non-accidental injury
<b>NBI</b>	no bony injury
<b>NBL</b>	non-directed bronchial lavage
<b>NBM</b>	nil by mouth
<b>NCPAP</b>	nasal continuous positive airway pressure
<b>NEPV</b>	negative extrathoracic pressure ventilation
<b>NFR</b>	not for resuscitation
<b>NG</b>	nasogastric
<b>NH</b>	nursing home
<b>NIDDM</b>	non-insulin-dependent diabetes mellitus
<b>NIPPV</b>	non-invasive intermittent positive pressure ventilation
<b>NITU</b>	neonatal intensive care unit
<b>NIV</b>	non-invasive ventilation
<b>NOF</b>	neck of femur
<b>NOH</b>	neck of humerus
<b>NP</b>	nasopharyngeal
<b>NPA</b>	nasopharyngeal airway
<b>NPV</b>	negative pressure ventilation
<b>NR</b>	nodal rhythm
<b>NREM</b>	non-rapid eye movement
<b>N/S</b>	nursing staff
<b>NSAID</b>	non-steroidal anti-inflammatory drug



<b>NSR</b>	normal sinus rhythm
<b>NWB</b>	non-weight-bearing
<b>OA</b>	oral airway/osteoarthritis
<b>OB</b>	obliterative bronchiolitis
<b>OD</b>	overdose
<b>O/E</b>	on examination
<b>OGD</b>	oesophagogastroduodenoscopy
<b>OHFO</b>	oral high-frequency oscillation
<b>OI</b>	oxygen index
<b>OLT</b>	orthotopic liver transplantation
<b>OPD</b>	outpatient department
<b>ORIF</b>	open reduction and internal fixation
<b>OT</b>	occupational therapist
<b>PA</b>	pernicious anaemia/posteroanterior/pulmonary artery
<b>P<sub>A</sub>CO<sub>2</sub></b>	partial pressure of carbon dioxide in alveolar gas
<b>PaCO<sub>2</sub></b>	partial pressure of carbon dioxide in arterial blood
<b>PADL</b>	personal activities of daily living
<b>P<sub>A</sub>O<sub>2</sub></b>	partial pressure of oxygen in alveolar gas
<b>PaO<sub>2</sub></b>	partial pressure of oxygen in arterial blood
<b>PAP</b>	pulmonary artery pressure
<b>PAWP</b>	pulmonary artery wedge pressure
<b>PBC</b>	primary biliary cirrhosis
<b>PC</b>	presenting condition/pressure control
<b>PCA</b>	patient-controlled analgesia
<b>PCD</b>	primary ciliary dyskinesia
<b>PCIRV</b>	pressure-controlled inverse ratio ventilation
<b>PCP</b>	<i>Pneumocystis carinii</i> pneumonia
<b>PCPAP</b>	periodic continuous positive airway pressure
<b>PCV</b>	packed cell volume
<b>PCWP</b>	pulmonary capillary wedge pressure
<b>PD</b>	Parkinson's disease/peritoneal dialysis/postural drainage
<b>PDA</b>	patent ductus arteriosus
<b>PE</b>	pulmonary embolus
<b>PEEP</b>	positive end-expiratory pressure
<b>PEF</b>	peak expiratory flow
<b>PEFR</b>	peak expiratory flow rate
<b>PEG</b>	percutaneous endoscopic gastrostomy



<b>PeMax</b>	peak expiratory mouth pressure
<b>PEP</b>	positive expiratory pressure
<b>PFC</b>	persistent fetal circulation
<b>PFO</b>	persistent foramen ovale
<b>PHC</b>	pulmonary hypertension crisis
<b>PID</b>	pelvic inflammatory disease
<b>PIE</b>	pulmonary interstitial emphysema
<b>PIF</b>	peak inspiratory flow
<b>PIFR</b>	peak inspiratory flow rate
<b>PiMax</b>	peak inspiratory mouth pressure
<b>PIP</b>	peak inspiratory pressure
<b>PMH</b>	previous medical history
<b>PMR</b>	percutaneous myocardial revascularization
<b>PN</b>	percussion note
<b>PND</b>	paroxysmal nocturnal dyspnoea
<b>POMR</b>	problem-oriented medical record
<b>POP</b>	plaster of paris
<b>PROM</b>	passive range of movement
<b>PS</b>	pressure support/pulmonary stenosis
<b>PTB</b>	pulmonary tuberculosis
<b>PTCA</b>	percutaneous transluminal coronary angioplasty
<b>PTFE</b>	polytetrafluoroethylene
<b>PTT</b>	partial thromboplastin time
<b>PVC</b>	polyvinyl chloride
<b>PVD</b>	peripheral vascular disease
<b>PVH</b>	periventricular haemorrhage
<b>PVL</b>	periventricular leucomalacia
<b>PVR</b>	pulmonary vascular resistance
<b>PWB</b>	partial weight-bearing
<b>QOL</b>	quality of life
<b>RA</b>	rheumatoid arthritis/room air
<b>RAP</b>	right atrial pressure
<b>RBBB</b>	right bundle branch block
<b>RBC</b>	red blood cell
<b>RDS</b>	respiratory distress syndrome
<b>REM</b>	rapid eye movement
<b>RFT</b>	respiratory function test
<b>RH</b>	residential home
<b>RhF</b>	rheumatic fever



SECTION

7

<b>RIP</b>	rest in peace
<b>RMT</b>	respiratory muscle training
<b>R/O</b>	removal of
<b>ROM</b>	range of movement
<b>ROP</b>	retinopathy of prematurity
<b>RPE</b>	rating of perceived exertion
<b>RPP</b>	rate pressure product
<b>RR</b>	respiratory rate
<b>RS</b>	respiratory system
<b>RSV</b>	respiratory syncytial virus
<b>RTA</b>	road traffic accident
<b>RV</b>	residual volume
<b>RVF</b>	right ventricular failure
<b>SA</b>	sinoatrial
<b>SAH</b>	subarachnoid haemorrhage
<b>SALT</b>	speech and language therapist
<b>SaO<sub>2</sub></b>	arterial oxygen saturation
<b>SB</b>	sinus bradycardia
<b>SBE</b>	subacute bacterial endocarditis
<b>SCI</b>	spinal cord injury
<b>SDH</b>	subdural haematoma
<b>SG<sub>AW</sub></b>	specific airway conductance
<b>SH</b>	social history
<b>SHO</b>	senior house officer
<b>SIMV</b>	synchronized intermittent mandatory ventilation
<b>SLAP</b>	superior labrum, anterior and posterior
<b>SLE</b>	systemic lupus erythematosus
<b>SMA</b>	spinal muscle atrophy
<b>SN</b>	Swedish nose
<b>SOA</b>	swelling of ankles
<b>SOB</b>	shortness of breath
<b>SOBAR</b>	short of breath at rest
<b>SOBOE</b>	short of breath on exertion
<b>SOOB</b>	sit out of bed
<b>SpO<sub>2</sub></b>	pulse oximetry arterial oxygen saturation
<b>SpR</b>	special registrar
<b>SPS</b>	single point stick
<b>SR</b>	sinus rhythm
<b>SS</b>	social services



<b>ST</b>	sinus tachycardia
<b>SV</b>	self-ventilating
<b>SVC</b>	superior vena cava
<b>SVD</b>	spontaneous vaginal delivery
<b>SVG</b>	saphenous vein graft
<b>SVO<sub>2</sub></b>	mixed venous oxygen saturation
<b>SVR</b>	systemic vascular resistance
<b>SVT</b>	supraventricular tachycardia
<b>SW</b>	social worker
<b>T21</b>	trisomy 21 (Down's syndrome)
<b>TAA</b>	thoracic aortic aneurysm
<b>TAH</b>	total abdominal hysterectomy
<b>TAVR</b>	tissue atrial valve repair
<b>TB</b>	tuberculosis
<b>TBI</b>	traumatic brain injury
<b>TcCO<sub>2</sub></b>	transcutaneous carbon dioxide
<b>TcO<sub>2</sub></b>	transcutaneous oxygen
<b>TED</b>	thromboembolic deterrent
<b>TEE</b>	thoracic expansion exercises
<b>TENS</b>	transcutaneous electrical nerve stimulation
<b>TFA</b>	transfemoral arteriogram
<b>TGA</b>	transposition of the great arteries
<b>THR</b>	total hip replacement
<b>TIA</b>	transient ischaemic attack
<b>TKA</b>	through knee amputation
<b>TKR</b>	total knee replacement
<b>TLC</b>	total lung capacity
<b>TLCO</b>	transfer factor in lung of carbon monoxide
<b>TLSO</b>	thoracolumbar spinal orthosis
<b>TM</b>	tracheostomy mask
<b>TMR</b>	transmyocardial revascularization
<b>TMVR</b>	tissue mitral valve repair
<b>TOP</b>	termination of pregnancy
<b>TPN</b>	total parenteral nutrition
<b>TPR</b>	temperature, pulse and respiration
<b>TURBT</b>	transurethral resection of bladder tumour
<b>TURP</b>	transurethral resection of prostate
<b>TV</b>	tidal volume
<b>TWB</b>	touch weight-bearing



<b>Tx</b>	transplant
<b>U&amp;E</b>	urea and electrolytes
<b>UAO</b>	upper airway obstruction
<b>UAS</b>	upper abdominal surgery
<b>UL</b>	upper limb/upper lobe
<b>URTI</b>	upper respiratory tract infection
<b>USS</b>	ultrasound scan
<b>UTI</b>	urinary tract infection
<b>V</b>	ventilation
<b>V<sub>A</sub></b>	alveolar ventilation/alveolar volume
<b>VAD</b>	ventricular assist device
<b>VAS</b>	visual analogue scale
<b>VATS</b>	video-assisted thoracoscopy surgery
<b>VBG</b>	venous blood gas
<b>VC</b>	vital capacity/volume control
<b>V<sub>E</sub></b>	minute ventilation
<b>VE</b>	ventricular ectopics
<b>VEGF</b>	vascular endothelial growth factor
<b>VER</b>	visual evoked response
<b>VF</b>	ventricular fibrillation/vocal fremitus
<b>V/P shunt</b>	ventricular peritoneal shunt
<b>V/Q</b>	ventilation/perfusion ratio
<b>VR</b>	vocal resonance
<b>VRE</b>	vancomycin-resistant enterococcus
<b>VSD</b>	ventricular septal defect
<b>V<sub>T</sub></b>	tidal volume
<b>VT</b>	ventricular tachycardia
<b>WBC</b>	white blood count
<b>WCC</b>	white cell count
<b>WOB</b>	work of breathing
<b>W/R</b>	ward round

### Prefixes and suffixes

Prefix/suffix	Definition	Example
adeno-	gland	adenoma
-aemia	blood	hyperglycaemia







Prefix/suffix	Definition	Example
-algia	pain	neuralgia
angio-	vessel	angiogram
ante-	before	antenatal
arteri-	artery	arteriosclerosis
arthro-	joint	arthroscopy
-asis	condition	homeostasis
atel-	imperfect	atelectasis
athero-	fatty	atherosclerosis
auto-	self	autoimmunity
baro-	pressure	barotrauma
bi-	two, twice or double	bilateral, biconcave
bili-	bile	bilirubin
-blast	cell	osteoblast
brachi-	arm	brachial artery
brady-	slow	bradycardia
carcin-	cancer	carcinogen
cardio-	heart	cardiology
carpo-	wrist	carpal tunnel
-centesis	to puncture	amniocentesis
cephal-	head	cephalad
cerebro-	brain	cerebrospinal fluid
cervic-	neck	cervical fracture
chol-	bile	cholestasis
chondro-	cartilage	chondromalacia
contra-	against	contraindicated
costo-	rib	costochondral junction
cranio-	skull	craniotomy
cryo-	cold	cryotherapy
cut-	skin	cutaneous
cyano-	blue	cyanosis
cysto-	bladder	cystoscopy

Prefix/suffix	Definition	Example
cyto-	cell	cytoplasm
dactyl-	finger	dactylomegaly
derm-	skin	dermatome
diplo-	double	diplopia
dors-	back	dorsum
dys-	difficult	dyspnoea
-ectasis	dilatation	bronchiectasis
ecto-	outside	ectoplasm
-ectomy	excision	appendectomy
encephalo-	brain	encephalitis
endo-	within	endochondral
entero-	intestine	enterotomy
erythro-	red	erythrocyte
extra-	outside	extrapyramidal
ferro-	iron	ferrous sulphate
gastro-	stomach	gastroenteritis
-genic	producing	iatrogenic
haem-	blood	haematoma
hepato-	liver	hepatectomy
hetero-	dissimilar	heterosexual
homo-	same	homosexual
hydro-	water	hydrotherapy
hyper-	excessive	hyperactive
hypo-	deficiency	hypoxaemia
iatro-	medicine, doctors	iatrogenic
idio-	one's own	idiopathic
infra-	beneath	infrapatellar
inter-	among	interrater
intra-	inside	intrarater
iso-	equal	isotonic
-itis	inflammation	tendinitis
laparo-	loins, abdomen	laparotomy



## SECTION

## 7



Prefix/suffix	Definition	Example
lipo-	fat	liposuction
-lysis	breakdown	autolysis
macro-	large	macroductyly
mal-	bad, abnormal	malignant
-malacia	softening	osteomalacia
mammo-	breast	mammogram
mast-	breast	mastectomy
-megalo	enlarged	cardiomegaly
mening-	membranes	meninges
-morph	form or shape	ectomorph
myel-	spinal cord, marrow	myelitis
myo-	muscle	myotonic
naso-	nose	nasopharyngeal
necro-	death	necrosis
nephro-	kidney	nephritis
oculo-	eyes	monocular
-oid	resembling	marfanoid
oligo-	deficiency	oliguria
-oma	tumour	lymphoma
oophoro-	ovaries	oophorectomy
-opsy	examine	biopsy
-osis	state, condition	nephrosis
osseo-	bone	osseous
osteo-	bone	osteolysis
-ostomy	to form an opening	colostomy
oto-	ear	otalgia
-otomy	to make a cut	osteotomy
para-	beside	paraspinal
-penia	deficiency	thrombocytopenia
peri-	around	periosteum
phago-	eat, destroy	phagocytosis

Prefix/suffix	Definition	Example
pharyngo-	throat	pharyngoscope
-philia	love of	hydrophilia
phleb-	vein	phlebitis
-phobia	fear of	hydrophobia
-plasia	formation	hyperplasia
-plasty	moulding	rhinoplasty
-plegia	paralysis	hemiplegia
pneum-	breath, air	pneumothorax
-pnoea	breathing	dyspnoea
poly-	many	polymyositis
pseud-	false	pseudoplegia
pyelo-	kidney	pyeloplasty
reno-	kidneys	renography
retro-	behind	retrograde
rhino-	nose	rhinitis
-rrhagia	abnormal flow	haemorrhage
salping-	fallopian tube	salpingostomy
sarco-	flesh	sarcoma
sclero-	hardening	scleroderma
-scopy	examination	endoscopy
somat-	body	somatic
spondyl-	vertebrae	spondylosis
-stasis	stagnation	haemostasis
steno-	narrow	stenosis
-stomy	surgical opening	colostomy
supra-	above	suprapubic
syn-	united with	syndesmosis
tachy-	swift	tachycardia
thoraco-	chest	thoracotomy
thrombo-	clot	thrombolytic
-tomy	incision	gastrostomy
trans-	across	transection
-trophy	growth	hypertrophy

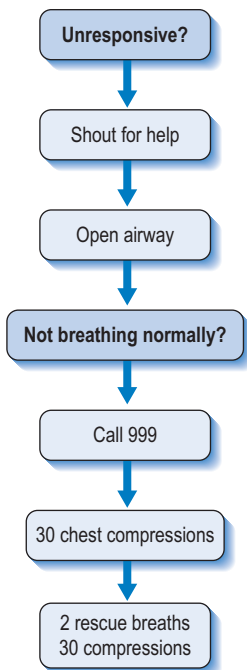


## SECTION

## 7

Prefix/suffix	Definition	Example
uro-	urine	urology
vaso-	vessel	vasospasm
veno-	vein	venography

## Adult basic life support

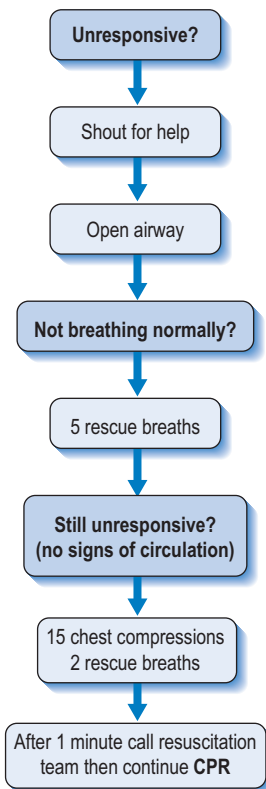


**Figure A.2** Adult basic life support. (From the 2005 Resuscitation Guidelines, with permission of the Resuscitation Council UK; [www.resus.org.uk](http://www.resus.org.uk).)



## Paediatric basic life support

(Healthcare professionals with a duty to respond.)



**Figure A.3** Paediatric basic life support. (From the 2005 Resuscitation Guidelines, with permission of the Resuscitation Council UK.)



SECTION

7

APPENDICES

## Conversions and units

### Pounds/kg

lb	kg
1	0.45
2	0.91
3	1.36
4	1.81
5	2.27
6	2.72
7	3.18
8	3.63
9	4.08
10	4.54
11	4.99
12	5.44
13	5.90
14	6.35

### Stones/kg

Stones	kg
1	6.35
2	12.70
3	19.05
4	25.40
5	31.75
6	38.10
7	44.45
8	50.80
9	57.15
10	63.50
11	69.85
12	76.20



Stones	kg
13	82.55
14	88.90
15	95.25
16	101.60
17	107.95
18	114.30

## Mass

1 kilogram (kg)	= 2.205 pounds (lb)
1 pound (lb)	= 454 milligrams (mg)
	= 16 ounces (oz)
1 oz	= 28.35 grams (g)

## Length

1 inch (in)	= 2.54 centimetres (cm)
1 metre (m)	= 3.281 feet (ft)
	= 39.37 in
1 foot (ft)	= 30.48 cm
	= 12 in

## Volume

1 litre (L)	= 1000 millilitres (mL)
1 pint	≈ 568 mL

## Pressure

1 millimetre of mercury (mmHg)	= 0.133 kilopascal (kPa)
1 kilopascal (kPa)	= 7.5 mmHg

## Laboratory values

### Biochemistry

Alanine aminotransferase (ALT)	10–40 U/L
Albumin	36–47 g/L
Alkaline phosphatase	40–125 U/L
Amylase	90–300 U/L





Aspartate aminotransferase (AST)	10–35 U/L
Bicarbonate (arterial)	22–28 mmol/L
Bilirubin (total)	2–17 mmol/L
Caeruloplasmin	150–600 mg/L
Calcium	2.1–2.6 mmol/L
Chloride	95–105 mmol/L
Cholesterol (total)	Desirable level <5.2 mmol/L
Cholesterol (HDL)	
<i>Men</i>	0.5–1.6 mmol/L
<i>Women</i>	0.6–1.9 mmol/L
Copper	13–24 mmol/L
Creatine kinase (total)	
<i>Men</i>	30–200 U/L
<i>Women</i>	30–150 U/L
Creatinine	55–150 mmol/L
Globulins	24–37 g/L
Glucose	3.6–5.8 mmol/L
Iron	
<i>Men</i>	14–32 mmol/L
<i>Women</i>	10–28 mmol/L
Lactate (arterial)	0.3–1.4 mmol/L
Lactate dehydrogenase (total)	230–460 U/L
Magnesium	0.7–1.0 mmol/L
Osmolality	275–290 mmol/kg
Phosphate (fasting)	0.8–1.4 mmol/L
Potassium (serum)	3.6–5.0 mmol/L
Protein (total)	60–80 g/L
Sodium	136–145 mmol/L
Transferrin	2–4 g/L
Urea	2.5–6.5 mmol/L
Vitamin A	0.7–3.5 mmol/L
Vitamin C	23–57 mmol/L
Zinc	11–22 mmol/L

### Haematology

Activated partial thromboplastin time (APTT)	30–40 s
Bleeding time (Ivy)	2–8 min



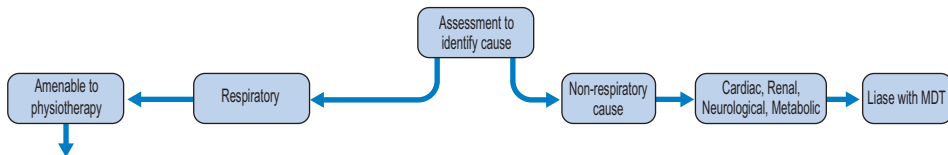
Erythrocyte sedimentation rate (ESR)	
<i>Adult men</i>	1–10 mm/h
<i>Adult women</i>	3–15 mm/h
Fibrinogen	1.5–4.0 g/L
Folate (serum)	4–18 mg/L
Haemoglobin	
<i>Men</i>	130–180 g/L (13–18 g/dL)
<i>Women</i>	115–165 g/L (11.5–16.5 g/dL)
International normalized ratio (INR)	0.89–1.10
Mean cell haemoglobin (MCH)	27–32 pg
Mean cell haemoglobin concentration (MCHC)	30–35 g/dL
Mean cell volume (MCV)	78–95 fL
Packed cell volume (PCV or haematocrit)	
<i>Men</i>	0.40–0.54 (40–54%)
<i>Women</i>	0.35–0.47 (35–47%)
Platelets (thrombocytes)	150–400 × 10 <sup>9</sup> /L
Prothrombin time (PT)	12–16 s
Red cells	
<i>Men</i>	4.5–6.5 × 10 <sup>12</sup> /L
<i>Women</i>	3.85–5.30 × 10 <sup>12</sup> /L
White cell count (leukocytes)	4.0–11.0 × 10 <sup>9</sup> /L

Values vary from laboratory to laboratory, depending on testing methods used. These reference ranges should be used as a guide only. All reference ranges apply to adults only; they may differ in children.

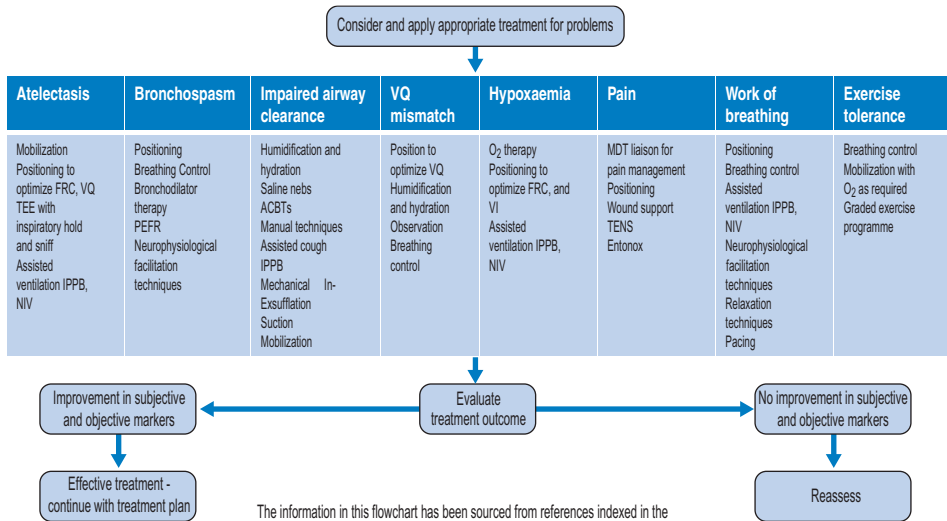




## Physiotherapy management of the spontaneously breathing, acutely breathless patient



Atelectasis	Bronchospasm	Impaired airway clearance	VQ mismatch	Hypoxaemia	Pain	Work of breathing	Exercise tolerance
↓ SaO <sub>2</sub> Auscultation: - ↓ breath sounds - late insp crackles Percussion note dull CXR signs of volume loss ↓ Thoracic expansion	↓ SaO <sub>2</sub> Auscultation: - exp wheeze ↓ PEFR CXR hyperinflation Altered breathing pattern	↓ SaO <sub>2</sub> Auscultation: - added sounds Sputum production and colour changes Cough	↓ SaO <sub>2</sub> Percussion note Auscultation CXR volume loss or consolidation ABGs	↓ SaO <sub>2</sub> ABGs Colour Level of consciousness AVPU, GCS (Consider PaCO <sub>2</sub> )	↓ SaO <sub>2</sub> ABGs Impaired cough Pain score	Breathing pattern Consider other problems as a cause of increased WOB	↓ SaO <sub>2</sub> Exercise tests Borg scale VAS Peripheral muscle strength



The information in this flowchart has been sourced from references indexed in the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Respiratory Review <http://www.acprc.org.uk>

**Figure A.4** Physiotherapy management of the spontaneously breathing, acutely breathless patient. (Used with kind permission of the Association of Chartered Physiotherapists in Respiratory Care.)



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## Normal values

Arterial blood analysis	Reference ranges	Venous blood analysis	Reference ranges
pH	7.35–7.45	pH	7.31–7.41
PaO <sub>2</sub>	10.7–13.3 kPa/80–100 mmHg	PO <sub>2</sub>	5.0–5.6 kPa/37–42 mmHg
PaCO <sub>2</sub>	4.7–6.0 kPa/35–45 mmHg	PCO <sub>2</sub>	5.6–6.7 kPa/42–50 mmHg
Bicarbonate	22–26 mmol/L		
Base excess	–2 to +2		

### P/F ratio (PaO<sub>2</sub> ÷ FiO<sub>2</sub>)

	In kPa	In mmHg
Normal	>40	>300
Acute lung injury	<40	<300
Acute respiratory distress syndrome	<26	<200

## Urine

Urine output 1 mL/kg/hour

Age group	Heart rate – mean (range)	Respiratory rate	Blood pressure
Preterm	150 (100–200)	40–60	39–59/16–36
Newborn	140 (80–200)	30–50	50–70/25–45
<2 years	130 (100–190)	20–40	87–105/53–66
>2 years	80 (60–140)	20–40	95–105/53–66
>6 years	75 (60–90)	15–30	97–112/57–71
Adults	70 (50–100)	12–16	95–140/60–90

## Cardiorespiratory values

Cardiac index	CI	2.5–4 L/min/m <sup>2</sup>
Cardiac output	CO	4–8 L/min
Central venous pressure	CVP	3–15 cmH <sub>2</sub> O
Cerebral perfusion pressure	CPP	>70 mmHg
Intracranial pressure	ICP	0–10 mmHg
Mean arterial pressure	MAP	80–100 mmHg
Pulmonary artery pressure	PAP	15–25/8–15 mmHg
Pulmonary artery wedge pressure	PAWP	6–12 mmHg
Stroke volume	SV	60–130 mL/beat
Systemic vascular resistance	SVR	800–1400 dyn • s • cm <sup>-5</sup>

## The Glasgow Coma Scale

Eye opening	Best motor response	Best verbal response
Spontaneous 4	Obeys commands 6	Orientated and converses 5
To sound 3	Localizes to pain 5	Disorientated and converses 4
To pain 2	Flexion withdrawal to pain 4	Inappropriate words 3
No response 1	Abnormal flexion 3	Incomprehensible sounds 2
	Extension 2	No response 1
	No response 1	

Total score: 3–15