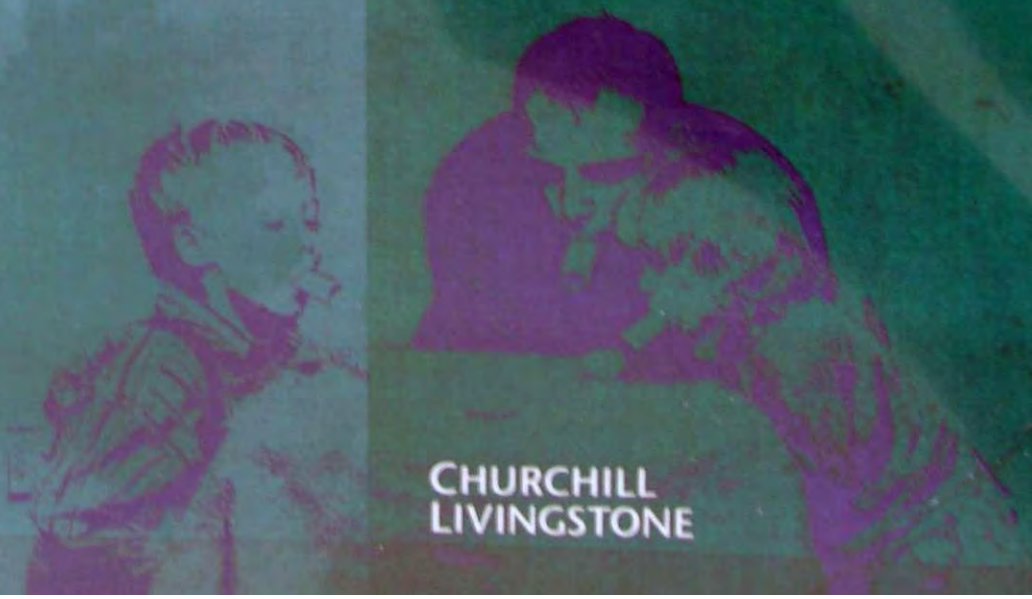
SECOND EDITION

Physiotherapy for Respiratory and Cardiac Problems

Edited by
Jennifer A. Pryor
Barbara A. Webber



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To John R Plant OBE
whose enthusiasm and interest have always encouraged development of the Physiotherapy Department at Royal Brompton Hospital.

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Contents

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Preface to second edition

During the last five years the term 'evidence based medicine' has had an increasing profile in medicine and 'purchasers' of physiotherapy services are asking for outcomes and evidence that physiotherapy is of benefit in specific patients with specific problems.

We cannot answer all these questions but the database of clinical trials is growing. In assessing the evidence it is important to remember the definition of Sackett et al (1996): 'Evidence based medicine involves integrating individual clinical expertise and the best external evidence available from systematic research'.

In this book we have referenced statements where possible, but there are still many areas of practice which are anecdotal. We must not lose the skills and techniques in these areas if there are indications of patient benefit

The second edition includes separate and new chapters on surgery and intensive care, and new chapters on non-invasive ventilation and pulmonary rehabilitation. Other chapters have been expanded with sections written by physiotherapy specialists in the field — manual therapy and acupuncture. All the chapters have been updated and new references included.

No text can meet every reader's need but we hope that the material here will lead the reader on to other sources and contacts, and by open exchange of information and ideas we should be able to take the profession forward to benefit our patients.

London 1997

J.A.P

B.A.W

Preface to first edition

This book is intended for physiotherapy students/new graduates and postgraduate physiotherapists with an interest in patients with respiratory and cardiac problems.

Assessment of the patient should reveal the patient's problems. If some or all of these problems can be influenced by physical means, physiotherapy is indicated. Physiotherapy is also indicated when potential problems have been identified and preventative measures should be taken. The role of the physiotherapist as an educator in both the prevention and treatment of problems is another important aspect.

Diagnoses will continue to provide useful medical categories, but treatment can become prescriptive and inappropriate or ineffective if given in response to a diagnosis alone. The pathology behind the problem provides the key as to whether it is a physiotherapy problem or a medical problem.

It is by accurate assessment of the patient that short- and long-term patient goals can be identified and agreed, and an effective treatment plan outlined. Continuous reassessment of the patient and the treatment outcomes will identify the need for continuation or modification of treatment

This book begins with assessment of the patient and the interpretation of medical investigations. This is followed by a section on mechanical support and cardiopulmonary resuscitation.

An important part of our role is communication, counselling and health education. The skills available to the cardiorespiratory physiotherapist are many and varied. Practical skills have been outlined and referenced where possible. All skills are not yet supported by rigorous clinical studies, but it is important that we continue to use them if outcome measures support their place in clinical practice. In the future measurement tools could validate their use. Research should be an integral part of the practice of physiotherapy.

Patients' problems and their management are outlined in the context of differing pathologies. One pathological process may present as several patient problems. Pneumothorax, for example, appears under the problems of both pain and breathlessness. The characteristic problems of some patient groups and diagnostic categories are then discussed detailing the pathology, medical management physiotherapy and evaluation of treatment.

This book should be read in conjunction with specialized texts on anatomy, physiology and pathology. Further reading is indicated within each chapter. Throughout the text, for simplicity, the patient is referred to as he/him and the physiotherapist as she/her, but it is not intended to imply that all patients are male or that all physiotherapists are female.

It is hoped that the problem orientated approach to physiotherapy practice will facilitate the learning process for the physiotherapist and improve the quality of the care we provide.

London 1993

B.A.W.

J.A.P.

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SECTION 1

Investigations, patients' problems and management

SECTION CONTENTS

CHAPTER CONTENTS

1

Assessment

Sally Middleton *Peter G. Middleton*

INTRODUCTION

The aim of assessment is to define the patient's problems accurately. It is based on both a subjective and an objective assessment of the patient. Without an accurate assessment it is impossible to develop an appropriate plan of treatment. Equally, a sound theoretical knowledge is required to develop an appropriate treatment plan for those problems which may be improved by physiotherapy. Once treatment has commenced it is important to assess its effectiveness regularly in relation to both the problems and goals.

The system of patient management used in this book is based on the problem oriented medical system (POMS) first described by Weed in 1968. This system has three components:

- Problem oriented medical records (POMR)
- Audit
- Educational programme.

The POMR is now widely used as the method of recording the assessment, management and progress of a patient. It is divided into five sections, as shown in Figure 1.1 and summarized below.

- *Database.* Here personal details, medical history, relevant social history, results of investigations and tests, together with the physiotherapist's assessment of the patient are recorded.
- ***Problem list.*** This is a concise list of the patient's problems, compiled after the assessment is complete. Problems are not always written in order of priority. The list includes

problems both related and unrelated to physiotherapy. The resolution of problems and the appearance of new ones are noted appropriately.

* *Initial plan and goals, A* treatment plan *is* formulated to address the physiotherapy-related problems, keeping in mind the patient's other problems. Long- and short-term goals are then formulated. Long-term goals are what the patient and the physiotherapist want to finally achieve and should relate to the problems. Short-term goals are the stages by which the long-term goals should be achieved.

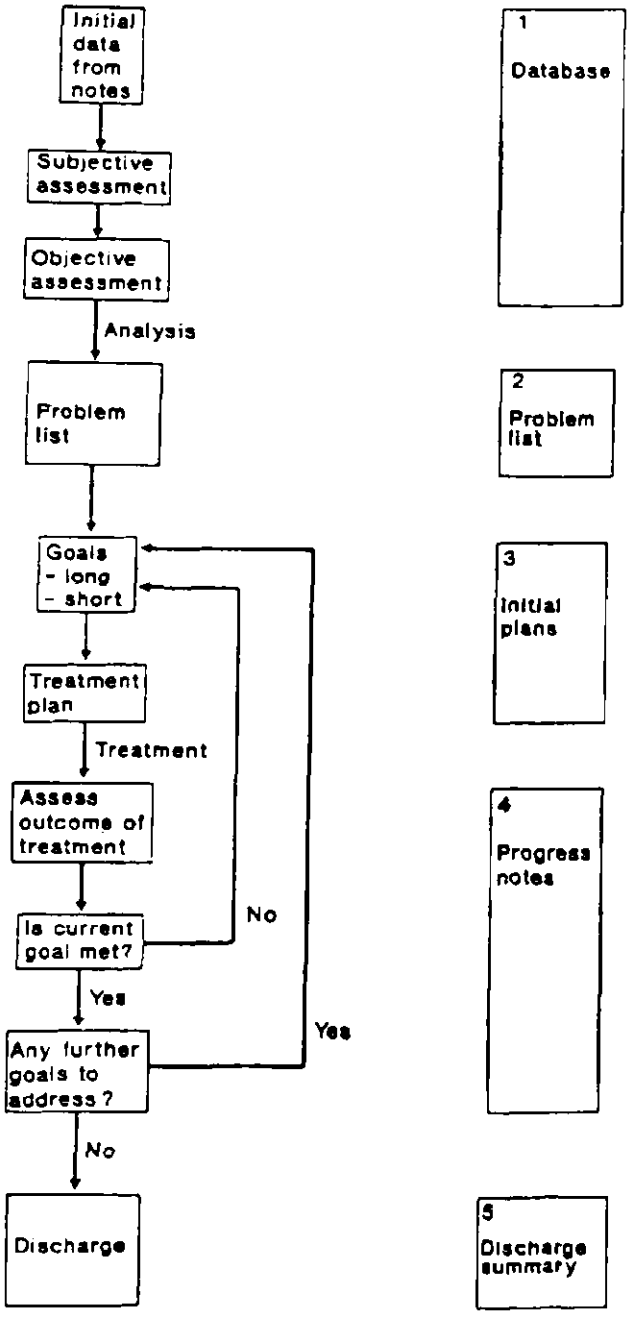


Fig. 1.1 The process *of* problem oriented medical records.

- *Progress notes.* These are written to document the patient's progress, especially highlighting any changes. The notes are written in the 'subjective, objective, analysis, plan' (SOAP) format for each problem, and provide an up-to-date summary of the patient's progress.
- *Discharge summary.* This is written when the patient is discharged from treatment or transferred to another institution. It includes presenting problems, treatment given, outcomes of treatment together with any home programme or follow-up instructions.

DATABASE

The database contains a concise summary of the relevant information about the patient taken from the medical notes, together with the subjective and objective assessment made by the physiotherapist. The format may differ from hospital to hospital, but will contain the same information.

The first part contains the patient's personal details including name, date of birth, address, hospital number, and referring doctor. It may also contain the diagnosis and reason for referral. The second part summarizes the history from the medical notes and the physiotherapy assessment. This is often divided into several sections:

History of presenting condition (HPC) summarizes the patient's current problems, including relevant information from the medical notes.

Previous medical history ***(PMH)*** summarizes the entire list of medical and surgical problems that the patient has had in the past. It may be written in disease-specific groupings or as a chronological account.

Drug history (OH) is a list of the patient's current medications (including *dosage) taken* from the medication charts. Drug allergies should also be noted.

Family history (FH) includes a list of any major

diseases suffered by members of the immediate family.

Social history (SH) provides a picture of the patient's social situation. It is important to specifically question the patient about the level of support available at home, and to gain an idea of the patient's expected contribution to household duties. The layout of the patient's home should also be ascertained with particular emphasis on stairs. Occupation and hobbies, both past and present, give further information about the patient's lifestyle. Finally, history of smoking and alcohol use should be noted.

Patient examination includes all information collected in the physiotherapist's subjective and objective assessment of the patient.

Test results contain any significant findings as they become available. These may include arterial blood gases, spirometry, blood tests, sputum analysis, chest radiographs, computerized tomography (CT) and any other relevant tests (e.g. hepatitis B positive).

Subjective assessment

Subjective assessment is based on an interview with the patient. It should generally start with open-ended questions - What is the main problem? What troubles you most? - allowing the patient to discuss the problems that are most important to him at that time. Indeed, by asking such questions, previously unmentioned problems may surface. As the interview progresses, questioning may become more focused on those important features that need clarification. There are five main symptoms of respiratory disease:

- Breathlessness (dyspnoea)
- Cough
- Sputum and haemoptysis
- Wheeze
- Chest pain.

With each of these symptoms, enquiries should be made concerning:

- *Duration* - both the absolute time since first recognition of the symptom (months, years) and the duration of the present symptoms (days, weeks)
- *Severity* - in absolute terms and relative to the recent and distant past
- ***Pattern*** - seasonal or daily variations
- *Associated factors* - including précipitants, relieving factors, and associated symptoms, if any.

Breathlessness

Breathlessness is the subjective awareness of an increased work of breathing. It is, the predominant symptom of both cardiac and respiratory disease. It also occurs in anaemia where the oxygen-carrying capacity of the blood is reduced, in neuromuscular disorders where the respiratory muscles are affected, and in metabolic disorders where there is a change in the acid-base equilibrium (see Ch. 3) or metabolic rate (e.g. hyperthyroid disorders). Breathlessness is also found in hyperventilation syndrome where it is due to psychological factors (e.g. anxiety).

The pathophysiological mechanisms causing breathlessness are still the subject of intensive investigation. Many factors are involved, including respiratory muscle. length-tension relationships, respiratory muscle fatigue, stimulation of pulmonary stretch receptors, and alterations in central respiratory drive.

The duration and severity of breathlessness is most easily assessed through enquiries about the level of functioning in the recent and distant past. For example, a patient may say that 3 years ago he could walk up five flights of stairs without stopping, but now cannot even manage one flight. Some patients may deny breathlessness as they have (unconsciously) decreased their activity levels so mat they do not get breathless* They may only acknowledge breathlessness when it interferes with important activities, e.g. bathing. The physiotherapist should always relate breathlessness to the level of function that the patient can achieve.

Comparison of the severity of breathlessness between patients is difficult because of differences in perception and expectations. To overcome these difficulties, numerous tradings have

Table 1.1 The New York Heart Association classification of breathlessness

Class I	**No symptoms with ordinary activity, breathlessness only occurring with severe exertion, e.g. running up hills, fast bicycling, cross-country skiing**
Class II	**Symptoms with ordinary activity, e.g. walking up stairs, making beds, carrying large amounts of shopping**
Class III	**Symptoms with mild exertion, e.g. bathing, showering, dressing**
Class IV	**Symptoms at rest**

been proposed, The New York Heart Association grading (1964) shown in Table 1.1, was developed for patients with cardiac disease, but is also applicable to respiratory patients. No scale is universal and it is important that ail staff within one institution use the same scale.

Breathlessness is usually worse during exercise and better with rest The one exception is hyperventilation syndrome where breathlessness may improve with exercise. Two patterns of breathlessness have been given specific names:

- *Orthopnoea* is breathlessness when lying flat.
- *Paroxysmal nocturnal dyspnoea (PND)* is breathlessness that wakes the patient at night In the cardiac patient, lying flat increases venous return from the legs so that blood pools in the lungs, causing breathlessness. A *similar* pattern may be described in patients with severe asthma, but here the breathlessness is caused by nocturnal bronchoconstriction.

Further insight into a patient's breathlessness may be gained by enquiring about precipitating and relieving factors. Breathlessness associated with exposure to allergens and relieved by brunchodilators is typically found in asthma-

Cough

Coughing is a protective reflex which rids the airways of secretions or foreign bodies. Any stimulation of receptors located in the pharynx, larynx, trachea, or bronchi may induce cough. Cough is a difficult symptom to clarify as most people cough normally every day, yet a repetitive persistent cough is both troublesome and distressing. Smokers may discount their early morning cough as being 'normal' when in fact it signifies chronic bronchitis.

Important .features concerning cough are its effectiveness, and whether it is productive or dry. The severity of cough may range from an occasional disturbance to a continual.trouble. A loud, barking cough, which is often termed 'bovine', may signify laryngeal or tracheal disease. Recurrent coughing after eating or drinking is an important symptom of aspiration. A chronic productive cough every day is a fundamental feature of chronic bronchitis and bronchiectasis. Interstitial l**ung** disease is characterized by a persistent dry cough. Nocturnal cough is an important symptom of asthma, in children, and young adults, but in older patients—it is more commonly due to. cardiac failure. Drugs, especially beta-blockers and some other antihypertensive agents, can cause a chronic cough. Chronic cough may cause fractured ribs (cough fractures) and hernias. Stress incontinence is a common complication of chronic cough, especially in women. As this subject is often embarrassing to the patient, specific questioning may be required (see page 8).

Postoperatively, the strength and effectiveness of cough is important for the physiotherapist to assess.

Sputum

In a normal adult, approximately 100 ml of tracheobronchial secretions are produced daily and cleared subconsciously. Sputum is the excess tracheobronchial secretions that is cleared from the airways by coughing or huffing. It may contain mucus, cellular debris, microorganisms, blood and foreign particles. Questioning should determine the colour, consistency and quantity of sputum produced each day. This may clarify the diagnosis and the severity of disease (Table 1.2).

A number of grading systems for mucoid—mucopurulent-puru lent sputum have been proposed. For example. Miller (1963) suggested:

Ml	mucoid with no suspicion of pus
M2	predominantly mucoid, suspicion of pus

Table **1.2** Sputum analysis

	Description	Causes
Saliva	Clear watery fluid	
Mucoid	Opalescent or white	Chronic bronchitis without infection, asthma
Mucopurulent	Slightly discoloured, but not frank pus	Bronchiectasis, cystic fibrosis, pneumonia
Purulent	Thick, viscous: Yellow Dark green/brown *Rusty* Red currant jelly	Haemophilus Pseudomonas Pneurnococcus. mycoplasma Klebsiella
Frothy	Pink or white	Pulmonary oedema
Haemoptysis	Ranging from Wood *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

PI 1/3 *purulent,* 2/3 mucoid
P2 2/3 purulent 1/3 mucoid
P3 >2/3 purulent

However, in clinical practice sputum is often classified as mucoid, mucopurulent or purulent, together with an estimation of the volume (1 teaspoon, 1 egg cup, V4 cup, 1 cup).

Sputum 'plugs' are hard rubbery casts in the shape of the bronchial tree which may be produced in asthma, allergic bronchopulmonary aspergillosis (ABPA) and occasionally in bronchiectasis.

Haemoptysis is the presence of blood in the sputum It may range from slight streaking of the sputum to frank blood. Frank haemoptysis can be life threatening, requiring bronchial artery embolization or surgery. Isolated haemoptysis may be the first sign of bronchogenic carcinoma, even when the chest radiograph is normal. Patients with chronic infective lung disease often suffer from recurrent haemoptyses.

Odour emanating from sputum signifies infection. In general, particularly offensive odours suggest infection with anaerobic organisms (e.g. aspiration pneumonia, lung abscess).

WheezB

Wheeze is a whjstiing or musical sound produced by turbulent airflow through narrowed airways. These sounds are generally noted by patients when audible at the mouth. Stridor, the sound oLan upper airway obstruction. $ often mistakenly called 'wheeze.' t£y__P_atjejtfs. Heart failure may also cause wheezing in those patients with significant mucosal oedema. For a full discussion of wheeze see page 18.

Chest pain

Chest pain in respiratory patients usually originates from musculoskeletal, pleural or tracheal inflammation, as the lung parenchyma and small airways contain no pain fibres.

Pleuritic chest pain is caused by inflammation of the parietal pleura, and is usually described as.a severe, shajcp, stabbing pain which is worse oninspirajtion. It is not reproduced by palpation.

Tracheitis generally causes a constant burning pain in the centre of the chest aggravated by breathing.

Musculoskeletal (chest wall) pain may originate from the muscles, bones, joints or nerves of ***ihe*** thoracic cage. It is usually well localized and exacerbated by chest and/or arm movement. Palpation will usually reproduce the pain.

Angina pectoris is a major symptom of cardiac disease. Myocardial ischaemia characteristically causes a dull central retrosternal gripping or band-like sensation which may radiate to either arm, neck or jaw.

Pericarditis may cause pain similar to angina or pleurisy.

A differential diagnosis of chest pain is given in Table 1.3.

Incontinence

Incontinence is a problem which is often aggravated by chronic cough. Coughing and huffing increase intra-abdominal pressure which may precipitate urine leakage. Fear of this may influence compliance with physiotherapy. Thus identification and treatment of incontinence is important. Questions may need to be specific to elicit this symptom: *'When you cough,* do *you find that you leak some urine?' 'Does this interfere with your physiotherapy?*.*

Other symptoms

Of the other symptoms a patient may report, a number have particular importance.

Table 1.3 Syndromes of chest pain

Condition	Description	Causes
Pulmonary		
Pleurisy	Sharp, stabbing, rapid onset, limits inspiration, well localized, often 'catches' at a certain lung volume, not tender on palpation	Pfeuraf infection or inflammation of the pleura, trauma (haemothorax), malignancy
Pulmonary embolus	Usually has pleuritic pain, with or without severe central pain	Pulmonary infarction
Pneumothorax	Severe central chest discomfort, with or without pleuritic component, severity depends on extent of mediastinal shift	Trauma, spontaneous, lung diseases (e.g., cystic fibrosis, **AIDS)**
Tumours	May mimic any form of chest pain, depending on site and structures involved	Primary or secondary carcinoma, mesothelioma
Rib fracture	Localized point tenderness, often sudden onset, increases with inspiration	Trauma, tumour, cough fractures (e.g. in chronic lung diseases, osteoporosis)
Muscular	Superficial, increases on inspiration and some body movements, with or without palpable muscle spasm	Trauma, unaccustomed exercise (excessive coughing during exacerbations of lung disease), accessory muscles may be affected
Costochondritis (Tietze's syndrome)	Localized to one or more costochondral joints, with or without generalized, non-specific chest pain	Viral infection
Neuralgia	Pain or paraesthesia in a dermatomal distribution	Thoracic spine dysfunction, tumour, trauma, herpes zoster (shingles)
Cardiac		
Ischaemic heart disease (angina or infarct)	Dull, central, retrosternal discomfort like a weight or band with or without radiation to the jaw and/or either arm, may be associated with palpitations, nausea, or vomiting	Myocardial ischaemia, onset at rest is more suggestive of infarction
Pericarditis	Often retrosternal, exacerbated by respiration, may mimic cardiac ischaemia or pleurisy, often relieved by sitting	Infection, inflammation, trauma, tumour
Mediastinum		
Dissecting aortic aneurysm	Sudden onset, severe, poorly localized central chest pain	Trauma, atherosclerosis, Marian's syndrome
Oesophageal	Retrosternal burning discomfort, but can mimic all other pains, worse lying flat or bending forward	Oesophageal reflux, trauma, tumour
Mediastinal shift	Severe, poorly localized central discomfort	Pneumothorax, rapid drainage of a large pleural effusion

Fever (pyrexia) is one of the common features of infection, but low-grade fevers can also occur with malignancy and connective tissue disorders. Equally, infection may occur without fever, especially in immunosuppressed (e.g. chemotherapy) patients or those on corticosteroids. High fevers occurring at night, with associated sweating (night sweats), may be the first indicator of pulmonary tuberculosis.

Headache is an uncommon feature of respiratory disease. Morning headaches in patients with severe respiratory failure may signify nocturnal carbon dioxide retention. Early morning arterial blood gases or nocturnal transcutaneous carbon dioxide monitoring are required for confirmation.

Peripheral oedema in the respiratory patient suggests right heart failure which may be due to cor pulmonale (right ventricular failure secondary to hypoxic pulmonary vasoconstriction). Peripheral oedema may also occur in patients taking high-dose corticosteroids, as a result of salt and water retention.

Functional ability

It is important to assess the patient as a whole, enquiring about his daily activities. If the patient is employed, what does his job *actually* entail? For example, a surveyor may sit behind a desk all day, or he may be climbing 25-storey buildings. The home situation should also be documented, in particular the number of stairs to the front door and within the house. With whom does the patient live? What roles does the patient perform in the home (shopping, housework, cooking)? Finally, questions concerning activities and recreation often reveal areas where significant improvements in quality of life can be made.

Disease awareness

During the interview it is important to ascertain the patient's knowledge of his disease and treatment. The level of compliance with treatment, often difficult to assess initially, may become evident as rapport develops. These issues will influence the goals of treatment.

Objective assessment

Objective assessment is based on examination of the patient, together with the use of tests such as spirometry, arterial blood gases and chest radiographs. Although a full examination of the patient should be available from the medical notes, it is worthwhile to make a thorough examination at all times as the patient's condition may have changed since the last examination, and the physiotherapist may need greater detail of certain aspects than is available from the notes. A good examination will provide an objective baseline for the future measurement of the patient's progress. By developing a standard method of examination, the findings are quickly assimilated, and the physiotherapist remains confident that nothing has been omitted.

General observation

Examination starts by observing the patient from the end of the bed. Is the patient short of breath, sitting on the edge of the bed, distressed? Is he obviously cyanosed? Is he on supplemental oxygen? If so, how much? What is his speech pattern - long fluent paragraphs without discernible pauses for breath, quick sentences, just a few words, or is he too breathless to speak? When he moves around or undresses, does he become distressed? With a little practice, these observations should become second nature and can be noted whilst introducing yourself to the patient.

In the intensive care patient there are a number of further features to be observed. The level of ventilatory support must be ascertained. This includes both the mode of ventilation (e.g. supplemental oxygen, continuous positive airway pressure, intermittent positive pressure ventilation) and the route of ventilation (mask, endotracheal tube, tracheostomy). The level of cardiovascular support should also be noted, including drugs to control blood pressure and cardiac output, pacemakers and other mechanical devices. The patient's level of consciousness should also be noted. Any patient with a decreased level of consciousness is at risk of aspiration and reten-

Table 1.4 Coma Scale

Eye opening	Spontaneous	4
	To speech	3
	To pain	*2*
	None	1
Best verbal **ronponse**	Oriented	5
	Confused speech	4
	Inappropriate words	3
	Incomprehensible sounds	2
	None	1
Best motor **response**	Obeys commands	6
	Localizes to pain	5
	Withdraws (generalized)	4
	Flexion	3
	Extension	2
	No response	1

Maximum total **score** is 15; minimum total score is 3.

Hon of pulmonary secretions. In those patients who are not pharmacologically sedated, the level of consciousness is often measured using the Glasgow Coma Scale (Table 1.4). This gives the patient a score (from 3 to 15) based on his best motor, verbal and eye responses.

The patient's chart should then be examined for recordings of temperature, pulse, blood pressure and respiratory rate. These measurements are ***usually performed*** by the nursing staff immediately on admission of the patient and regularly thereafter.

For details of the assessment of the infant and child see page 332.

Body temperature. Body temperature can be measured in a number of ways. Oral temperatures are the most convenient method in adults but should not be performed for at least 15 minutes after smoking or consuming hot or cold food or drink. Aural, axillary and rectal temperature may also be measured.

Body temperature is maintained within the range 36.5-37.5°C. It is lowest in the early morning and highest in the afternoon.

Fever (pyrexia) is the elevation of the body temperature above 37.5°C, and is associated with an increased metabolic rate. For every 0.6°C (1°F) rise in body temperature, there is an approximately 10% increase in oxygen consumption and carbon dioxide production. This places extra demand on the cardiorespiratory system which causes a compensatory increase in heart rate and respiratory rate.

Heart rate. Heart rate is most accurately measured by auscultation at the cardiac apex. The pulse rate is measured by palpating a peripheral artery (radial, femoral or carotid). In most situations, the heart rate and pulse rate are identical; a difference between the two is called the 'pulse deficit'. This indicates that some heart beats have not caused sufficient blood flow to reach the periphery and is commonly found in atrial fibrillation and some other arrhythmias.

The normal adult heart rate is 60-100 beats per minute.

Tachycardia is defined as a heart rate greater than 100 beats/min at rest. It is found with anxiety, exercise, fever, anaemia and hypoxia. It is also common in patients with cardiac disorders. Medications such as bronchodilators and some cardiac drugs may also increase heart rate.

Bradycardia is defined as a heart rate less than 60 beats/min. It may be a normal finding in athletes and may also be caused by some cardiac drugs (especially beta-blockers).

Blood pressure (BP). With every contraction of the heart (systole) the arterial pressure increases, with the peak called the 'systolic' pressure. During the relaxation phase of the heart (diastole), the arterial pressure drops, with the minimum called the 'diastolic' pressure. Blood pressure is usually measured non-invasively by placing a sphygmomanometer cuff around the upper arm, and listening over the brachial artery with a stethoscope. The cuff width should be approximately one-half to two-thirds of the length of the upper arm, otherwise readings may be inaccurate. Cuff inflation to above systolic pressure collapses the artery, blocking flow. With release of the air, the cuff pressure gradually falls to a point just below systolic. At this point, the peak pressure within the artery is greater than the pressure outside the artery, so flow recommences. This turbulent flow is audible through the stethoscope. As the cuff is further deflated the noise continues. When the cuff pressure drops to just below diastolic, the pressure within the artery is greater than that of the

cuff throughout the cardiac cycle, so turbulence abates and the noise ceases.

Blood pressure is recorded as systolic/diastolic pressure. Normal adult blood pressure is between 95/60 and 140/90 mmHg.

Hypertension is defined as a blood pressure of greater than 145/95 mmHg, usually due to changes in vascular tone and/or aortic valve disease.

Hypotension is defined as a blood pressure of less than 90/60 mmHg. It is often a normal finding during sleep. Daytime hypotension may be due to heart failure, blood loss or decreased vascular tone.

Postural hypotension is a drop in blood pressure of more than 5 mmHg between lying and sitting or standing, and may be due to decreased circulating blood volume, or loss of vascular tone.

Pulsus paradoxus is die exaggeration of the drop in blood pressure that occurs with inspiration. Normally, during inspiration the negative intrathoracic pressure reduces venous return and drops cardiac output slightly. Exaggeration of mis normal response where blood pressure drops by more man 10 mmHg is seen in situations where the intrathoracic pressure swings are greater, as occurs in severe airway obstruction.

Respiratory rate. Respiratory rate should be measured with the patient seated comfortably. The normal adult respiratory rate is approximately 12-16 breaths/min.

Tachypnoea is defined as a respiratory rate greater than 20 breaths /min, and can be seen in any form of lung disease. It may also occur with metabolic acidosis and anxiety.

Bradypnoea is defined as a respiratory rate of less than 10 breaths/min. It is an uncommon finding, and is usually due to central nervous system depression by narcotics or trauma.

Body weight Weight is often recorded on the observation chart. Respiratory function can be compromised by both obesity and severe malnourishment. As ideal body weight has a large normal range, the body mass index (BMI) has been proposed as an alternative. This is calculated by dividing the weight in kilograms by the square of the height in metres (kg/m^2); the normal range is 20-25 kg/m^2. Patients with values below 20 are underweight, those with values of 25-30 are overweight, and those with values over 30 are classified as obese.

Malnourished patients often exhibit depression of their immune system with increased risk of infection. They also have weaker respiratory muscles which are more likely to fatigue. Obesity causes an increase in residual volume (RV) and a decrease in functional residual capacity (FRC) (Rubinstein et al 1990). Thus tidal breathing ***occurs close to*** closing volumes. This is particularly important postoperatively, where the obese are more prone to subsegmental lung collapse.

An accurate daily weight gives a good estimate of fluid volume changes, as any change in weight of more than 250 g/day is usually due to fluid accumulation or loss. Daily weights are commonly used in intensive care, renal and cardiac patients to assess fluid balance.

Other measures. In the intensive care patient there is a plethora of monitoring that can be performed. As well as the parameters listed above, measures of central venous pressure (CVP), pulmonary artery pressure (PAP), and intracranial pressure (ICP) will need to be reviewed as part of the physiotherapy assessment. Some intensive care units now record this information on bedside computer terminals. Further details of intensive care monitoring can be found in Chapters 4 and 5.

Apparatus. At this point the lines and tubes going into and coming out of the patient should be noted. Venous lines provide constant direct access to the bloodstream, and vary widely in site, complexity and function. The simplest cannula in a small peripheral vein, usually in the forearm, is called a 'drip'. It is used for the administration of intravenous (IV) fluids and most IV drugs. At the other end of the spectrum are the multi-lumen lines placed in the subclavian, internal jugular or femoral veins, ending in the venae cavae close to the heart. These central lines allow simultaneous administration of multiple drugs and can be used for central venous pressure monitoring. Central lines can be potentially dangerous, as disconnection of the line can quickly suck air into the central

veins, causing an air embolus which may be fatal.

Some patients, especially those in intensive care, may have an arterial line for continuous recording of blood pressure and for repeated sampling of arterial blood. These lines are usually inserted in the radial or brachial artery. If accidentally disconnected, rapid blood loss will occur.

After cardiac surgery, most patients have cardiac pacing wires which exit through the skin overlying the heart. In most cases these wires are not required and are removed routinely before discharge. In the event of clinically significant cardiac arrhythmias, these wires are connected to a pacing box that electrically stimulates the heart. In medical patients, pacemaker wires are Introduced through one of the central veins and rest in the apex of the right ventricle. Care must be taken with all pacing wires as dislodgement may be life threatening.

Intercostal drains are placed between two ribs into the pleural space to remove air, fluid or pus which has accumulated. They are also used routinely after cardiothoracic surgery. In general, the tube is attached to a bottle partially filled with sterile water, called an 'underwater seal drain'. The bottle should be positioned at least 0.5 *metres* below the patient's chest (usually on the floor). Bubbling indicates that air is entering the tube from the pleural space at that time. Frequent observations must be made of the fluid level within the tube which should oscillate or 'swing' with every breath. If the fluid does not swing, the tube is not patent and requires medical attention. In certain situations the bottle may be connected to continuous suction which will dampen the fluid 'swing'. Those patients who are producing large volumes of fluid or pus may be connected to a double bottle system, where the first bottle acts as a reservoir to collect the fluid and the second provides the underwater seal. More recently, fully enclosed disposable plastic systems have been devised. Any patient with a chest drain should have a pair of large forceps available at all times to clamp the tube if any connection becomes *loosened.*

Postoperatively, drains may be placed at any operation site (e.g. abdomen) to prevent the collection of fluid or blood. These are generally connected to sterile bags. Nasogastric tubes are placed for two reasons: soft fine-bore tubes are used to facilitate feeding, whilst firm, wider-bore tubes allow aspiration of gastric contents.

The hands. The hands provide a wealth of information. A fine tremor will often be seen in association with high-dose bronchodilators. Warm and sweaty hands with an irregular flapping tremor may be due to acute carbon dioxide retention. Weakness and wasting of the small muscles in the hands may be an early sign of an upper lobe tumour involving the brachial plexus (Pancoast's tumour). Examination of the fingers may show nicotine staining from smoking.

Clubbing is the term used to describe the changes in the fingers and toes as shown in Figure 1.2. The first sign of clubbing is the loss of the angle between the nail bed and the nail itself. Later, the finger pad becomes enlarged. The nail bed may also become 'spongy', but this is a difficult sign to elicit. A summary of the diseases associated with clubbing is given in Table 1.5. The exact cause of clubbing is unknown. It is interesting to note that clubbing in cystic fibrosis patients disappears after heart and lung or lung transplant.

The eyes. The eyes should be examined for pallor (anaemia), plethora (high haemoglobin) or Jaundice (yellow colour due to liver or blood disturbances). Drooping of one eyelid with enlargement of that pupil suggests Horner's syndrome where there is a disturbance in the sympathetic nerve supply to that side of the head (sometimes seen in cancer of the lung).

Cyanosio. This is a bluish discolouration of the skin and mucous membranes. Central cyanosis, seen on examination of the tongue and mouth, is caused by hypoxaemia where there is an increase in the amount of haemoglobin not bound to oxygen. The degree of blueness is related to the quantity of unbound haemoglobin. Thus a greater degree of hypoxia is necessary to produce cyanosis in an anaemic patient (low haemoglobin), whilst a patient with poly* cythaemia (increased haemoglobin) may appear

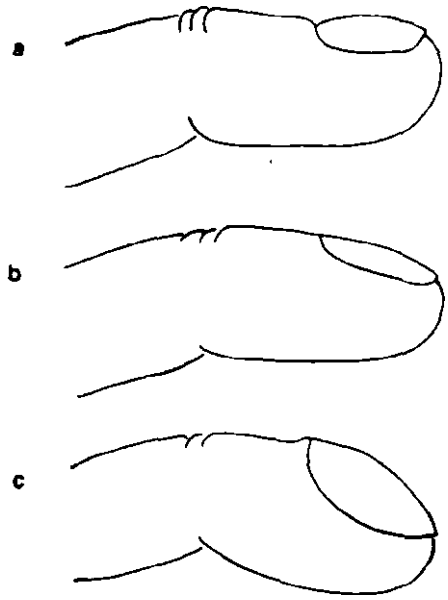


Fig. 1.2 Clubbing: a normal; b early clubbing; e advanced clubbing.

Table 1.5 Causes of clubbing

Lung disease	Infective (bronchiectasis, lung abscess, empyema) Fibre tic Malignant (bronchogenic cancer, mesothelioma)
Cardiac disease	Congenital cyanotic heart disease Bacterial endocarditis
Other	Familial Cirrhosis Gastrointestinal disease (Crohn's disease, ulcerative colitis, coeliac disease)

cyanosed with only a small drop in oxygen levels. Peripheral cyanosis, affecting the toes, fingers and earlobes may also be due to poor peripheral circulation, especially in cold weather.

Jugular venous pressure. On the side of the neck the jugular venous pressure (JVP) is seen as a flickering impulse in the jugular vein. It is normally seen at the base of the neck when the patient is lying back at 45°. The JVP is usually measured in relation to the sternal angle as this point is relatively fixed in relation to the right atrium. A normal JVP at the base of the neck corresponds to a vertical height approximately 3-4 cm above the sternal angle. The JVP is generally expressed as the vertical height (in centimetres) above norms]. The JVP provides a quick assessment of the volume of blood in the great vessels entering the heart. Most commonly it is elevated in right heart failure. This may occur in patients with chronic lung disease complicated by cor pulmonale. In contrast dehydrated patients may only have a visible JVP when lying flat.

Peripheral oedema. This is an important sign of cardiac failure, but may also be found in patients with a low albumin level, impaired venous or lymphatic function, or those on high-dose steroids. When mild it may only affect the ankles, with increasing severity it may progress up the body. In bedbound patients, it is important to check the sacrum.

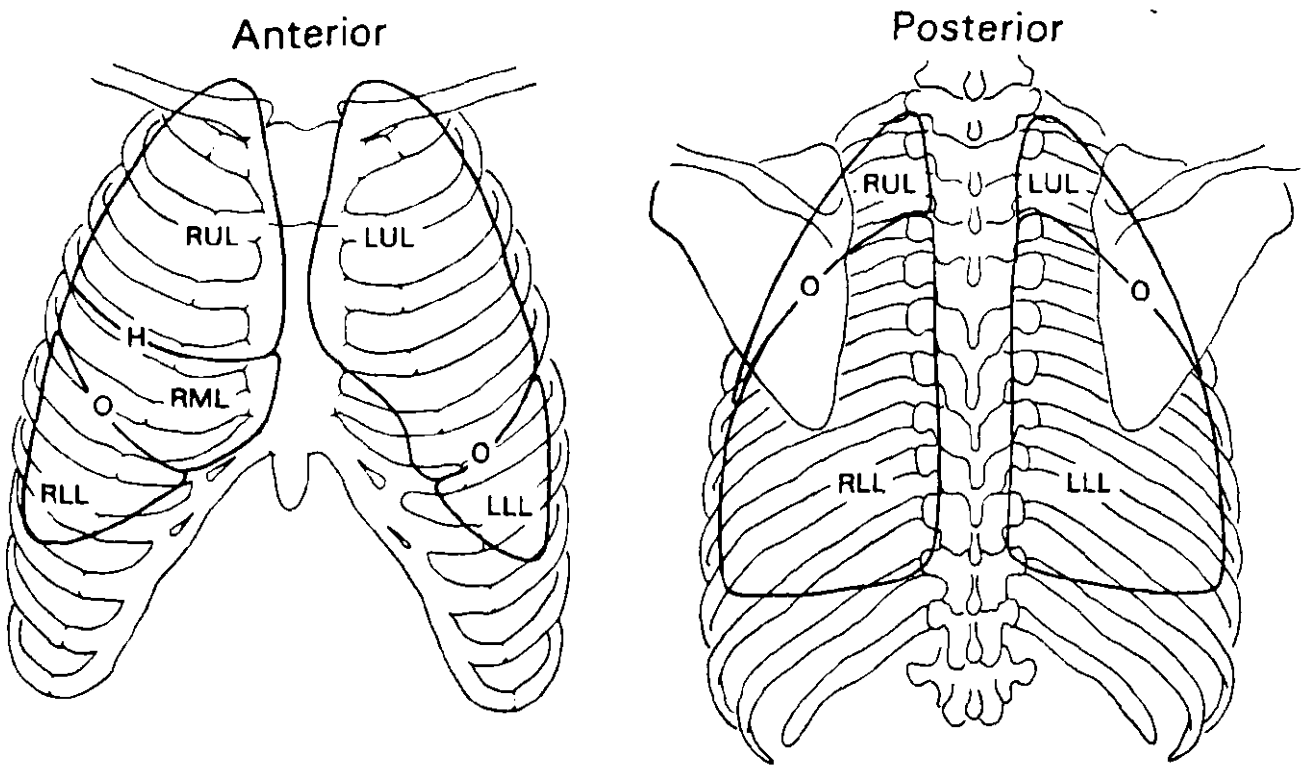
Observation of the chest

When examining the chest fit is important to remember the surface landmarks of the thoracic contents (Fig. 1.3).

Some important points are:

- The oblique fissure, dividing the upper and middle lobes from the lower lobes, runs underneath a line drawn from the spinous process of T2 around the chest to the 6th costochondral junction anteriorly.
- The horizontal fissure on the right dividing the upper lobe from the middle lobe, runs from the 4th intercostal space at the right sternal edge horizontally to the midaxillary line, where it joins the oblique fissure.
- The diaphragm sits at approximately the 6th rib anteriorly, the 8th rib in the midaxillary line, and the 10th rib posteriorly.
- The trachea bifurcates just below the level of die manubriosternal junction.
- The apical segment of both upper lobes extends 2.5 cm above the clavicles.

Chest shape. The chest should be symmetrical with, the ribs, in adults, descending at approximately 45° from the spine. The transverse diameter should be greater than the anteroposterior (AP) diameter. The thoracic spine should have



Pig. 1.3 Surface markings of (he lungs: H, horizontal fissure; O. oblique Fissures; **RUL,** right upper lobe; LUL, left upper lobe; **RML,** right middle **lobe;** 111,, left **lower lobe; RLL, right lower lobe.**

a slight kyphosis. Important common abnormalities include:

Kyphosis, where the normal flexion of the thoracic spine is increased.

Kyphoscoliosis, which comprises both lateral curvature of the spine with vertebral rotation (scoliosis) and an element of kyphosis. This causes a restrictive lung defect which, when severe, may cause respiratory failure**«L****t

Pectus excavatum,or 'funnel' chest, is where part of the sternum is depressed inwards. This rarely causes significant changes in lung function but may be corrected surgically for cosmetic reasons.

Pectus carinatum, or 'pigeon chest, is where the sternum protrudes anteriorly This may be present in children with severe asthma and rarely causes significant lung function abnormalities.

Hyperinflation, where the ribs lose their normal 45° angle with the thoracic spine and become almost horizontal. The anteroposterior diameter of the chest increases to almost equal the transverse diameter. This is commonly seen in severe emphysema.

Breathing pattern. Observation of the breathing pattern gives further information concerning ***the*** type and severity of respiratory disease.

Normal.breathing should be regular with a rate of 12-16 breaths /min, as mentioned previously. Inspiration is active and expiration passive. The approximate ratio of inspiratory to expiratory time (I: E ratio) is 1:1.5 to 1:2.

Prolonged expiration may be seen in patients with obstructive lung disease, where expiratory airflow is severely limited by dynamic closure of the smaller airways. In severe obstruction the I: £ ratio may increase to 1:3 or 1:4.

Pursed-lip breathing is often seen in patients with severe airways disease. By opposing the lips during expiration the airway pressure inside the chest is maintained, preventing the floppy airways from collapsing. Thus overall airflow is increased.

Apnoea is the absence of breathing for more than 15 seconds.

Hypopnoea is diminished breathing with inadequate ventilation. It may be seen during sleep in patients with lung disease*

Kussmaul's respiration is rapid, deep breathing with a high minute ventilation. It is usually seen in patients with metabolic acidosis.

Cheyne Stokes respiration refers to irregular breathing with cycles consisting of a few relatively deep breaths, progressively shallower breaths (sometimes to the point of apnoea), and then slowly increasing depth of breaths. This is usually associated with heart failure, severe neurological disturbances, or drugs (e.g. narcotics).

Ataxic breathing consists of haphazard, uncoordinated deep and shallow breams. This may be found in patients with cerebellar disease.

Apneustic breathing is characterized by prolonged inspiration, and is usually the result of brain damage.

Chest movement During normal inspiration, there are symmetrical increases in the anteroposterior, transverse and vertical diameters of the chest. The increase in vertical diameter is achieved by contraction of the diaphragm, causing the abdominal contents to descend. Sternal and rib movements are responsible for the increases in anteroposterior and transverse diameters of the chest. These movements can be divided into two components (Fig. 1.4). When elevated, the anterior ends of the ribs move forward and upwards with anterior movement of the sternum. This increase in anteroposterior diameter is likened to the movement of an old fashioned 'pump handle'. At the same time, rotation of the ribs causes an increase in the transverse diameter, likened to the movement of a 'bucket handle'.

During normal quiet breathing, the diaphragm is the main inspiratory muscle increasing the vertical diameter. There is also an increase in the lower thoracic transverse diameter due to external intercostal muscle contraction. Expiration is passive, caused by the elastic recoil of the lung and chest wall. When breathing is increased, all the accessory inspiratory muscles (sternomastoid, scalenes, trapezii) contract to

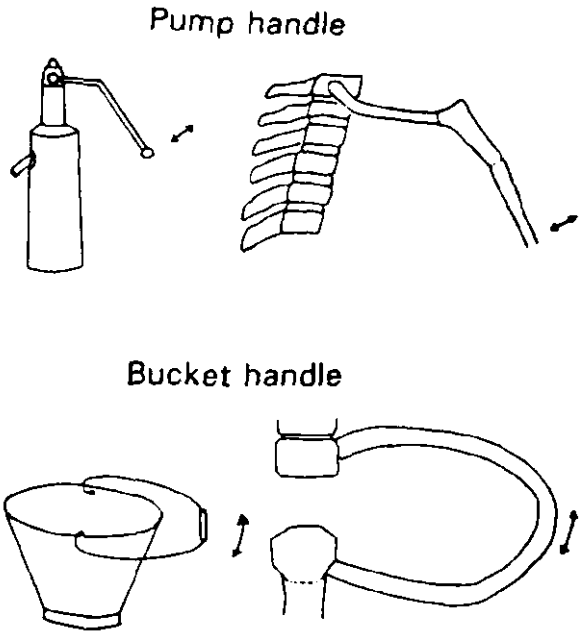


Fig. 1.4 Chest wall movement.

increase the anteroposterior and transverse diameters, and the diaphragm activity increases, thus further increasing the vertical dimensions. Expiration may become active with contraction of the abdominal and internal intercostal muscles.

Intercostal indrawing occurs where the skin between the ribs is drawn inwards during inspiration. It may be seen in patients with severe inspiratory airflow resistance. Larger negative pressures during inspiration suck the soft tissues inwards. This is an important sign of respiratory distress in children, but is less often seen in adults.

Palpation of the chest

Trachea. Firstly, the trachea is palpated to assess its position in relation to the sternal notch. Tracheal deviation indicates underlying mediastinal shift The trachea may be pulled towards a collapsed or fibrosed upper lobe, or pushed away from a pneumothorax or large pleural effusion.

Chest expansion. This can be assessed by observation, but palpation is more accurate. The patient is instructed to expire slowly to residual volume. At residual volume the examiner's

hands are placed spanning the posterolateral segments of both bases, with the thumbs touching in the midline posteriorly, as shown in Figure 1.5. In obese patients, it helps if the skin of the anterior chest wall is slightly retracted by the fingertips. The patient is then instructed to inspire slowly and the movement of both thumbs is observed. Both sides should move equally, with 3-5 cm being the normal displacement.

A similar technique may be used anteriorly, again to measure basal movements. Measurement of apical movement is more difficult. By placing the hand over the upper chest anteriorly, a qualitative comparison of the two sides can be made. In all cases, diminished movement is abnormal.

Paradoxical breathing is where some or all of the chest wall moves inwards on inspiration and outwards on expiration. It can involve anything from a localized area to the entire chest wall. Localized paradox occurs when the integrity of the chest wall is disrupted. Fractures of multiple ribs with two or more breaks in each rib will result in the central section losing the support usually provided by the rest of the thoracic cage. Thus, during inspiration, this loose segment (often called a 'flail segment') is drawn inwards as the rest of the chest wall moves out. In expiration the reverse occurs.

Paradoxical movement of one hemithorax may be remarkably difficult to observe. It may be caused by unilateral diaphragm paralysis. Paradox of the entire chest wall occurs in bilateral diaphragm weakness or paralysis. It is most apparent when the patient is supine.

Paradoxical movement of the lower chest can occur in patients with severe chronic airflow limitation who are extremely hyperinflated. As the dome of the diaphragm cannot descend any further, diaphragm contraction during inspiration pulls the lower ribs inwards. This is called 'Hoover's sign'.

Surgical emphysema. Air in the subcutaneous tissues of the chest, neck or face should also be noted. On palpation there is a characteristic crackling in the skin. This occurs when a pneumomediastinum (air in the mediastinum) has tracked outwards. A chest radiograph must

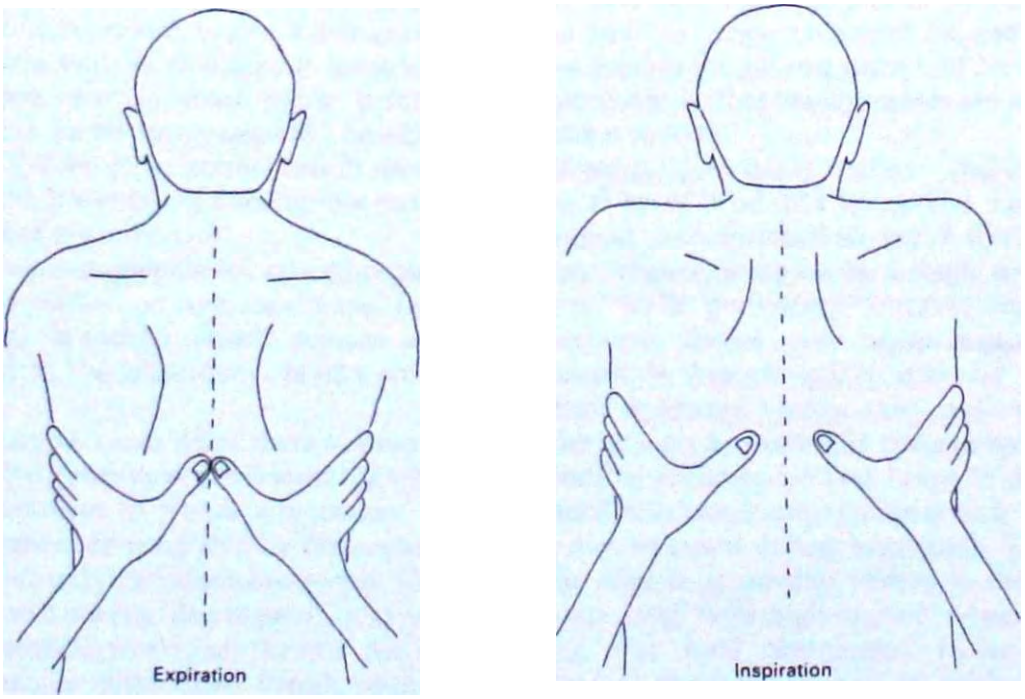


Fig. 1.5 Palpation of thoracic expansion.