The National Level 4 Community Pulmonary Rehabilitation Course
Student Manual
<table>
<thead>
<tr>
<th>SECTION 1</th>
<th>SECTION 2</th>
<th>SECTION 3</th>
<th>SECTION 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION TO PULMONARY REHABILITATION</td>
<td>ANATOMY AND PHYSIOLOGY</td>
<td>LUNG VOLUMES AND CAPACITIES</td>
<td>THE PATHOPHYSIOLOGY OF PULMONARY DISEASE</td>
</tr>
<tr>
<td>1.1 Lung disease prevalence</td>
<td>2.1 Structure of the respiratory tract</td>
<td>3.1 Lung capacities and volumes</td>
<td>4.1 Chronic Obstructive Pulmonary Disease (COPD)</td>
</tr>
<tr>
<td>1.2 A brief history of pulmonary rehabilitation</td>
<td>2.2 Breathing mechanisms</td>
<td>3.2 Control of respiration</td>
<td>4.1.1 Emphysema</td>
</tr>
<tr>
<td>1.3 The role of pulmonary rehabilitation</td>
<td>2.3 Lung volumes and ventilation</td>
<td>3.2.1 The respiratory rhythmicity centre</td>
<td>4.1.2 Chronic Bronchitis</td>
</tr>
<tr>
<td>1.4 The structure of pulmonary rehabilitation</td>
<td>2.4 Pulmonary diffusion</td>
<td>3.2.2 Chemoreceptors</td>
<td>4.2 Asthma</td>
</tr>
<tr>
<td>1.5 Contra-indications to exercise</td>
<td>2.5. Lung compliance</td>
<td>3.3 Exercise and respiration</td>
<td>4.3 Bronchiectasis</td>
</tr>
<tr>
<td></td>
<td>2.6. Summary- Physiological variables which affect breathing</td>
<td>3.4 Ageing and respiratory system</td>
<td>4.4 Cystic fibrosis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECTION 5</th>
<th>SECTION 6</th>
<th>SECTION 7</th>
<th>SECTION 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIAGNOSIS AND CLASSIFICATIONS OF SEVERITY</td>
<td>MEDICATIONS AND THEIR EFFECTS ON EXERCISE</td>
<td>PR STRUCTURE, DATA GATHERING AND REFERRAL PROTOCOLS</td>
<td>GATHERING INFORMATION: CONSULTATION PRACTICAL</td>
</tr>
<tr>
<td>5.1 COPD</td>
<td>6.1 Bronchodilators</td>
<td>7.1 The exercise referral process</td>
<td>5.1. The referral form</td>
</tr>
<tr>
<td>5.2 Dyspnoea</td>
<td>6.2 Anticholinergics</td>
<td>7.2 Exercise referral: an update on processes</td>
<td>7.1 Other information to gather</td>
</tr>
<tr>
<td>5.2.1 Assessing dyspnoea</td>
<td>6.3 Corticosteroids</td>
<td>7.3 Who’s involved</td>
<td>7.6 Physical data collection</td>
</tr>
<tr>
<td>5.2.2 Managing dyspnoea during exercise</td>
<td>6.4 Antibiotics</td>
<td>7.4 Pulmonary rehabilitation structure</td>
<td>7.7 Interacting appropriately with PR specialists</td>
</tr>
<tr>
<td>5.2.3 Pacing exercise and controlling intensity for dyspnoea</td>
<td>6.5 Mast cell stabilizers</td>
<td>7.5 The referral form</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.6 Oxygen therapy</td>
<td>7.5.1 Other information to gather</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.7 Exercise implications with respiratory medications</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.8 Managing exacerbations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.9 Exercise and exacerbations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTENTS</th>
</tr>
</thead>
</table>
SECTION 9
TESTING AND ASSESSING

9.1 The 6 minute walk test (6MW)
9.2 The incremental Shuttle Walk Test
9.3 The BODE Index
9.4 Strength testing
9.4.1 One repetition max (1RM)
9.4.2 Co-efficient 1RM
9.4.3 Hand grip strength test
9.5 Other measures for client safety
9.6 Questionnaires used in Pulmonary Rehabilitation
9.6.1 St Georges Respiratory Questionnaire and the Chronic Respiratory Disease Questionnaire
9.6.2 Hospital, Anxiety, Depression scale (HADs)
9.6.3 Short Form 36 (SF-36)

SECTION 10
CO-MORBIDITIES

10.1 Advancing age
10.1.1 The cardiovascular system
10.1.2 The skeletal system
10.1.3 Muscular system
10.1.4 Neural
10.2 Heart failure
10.3 Coronary heart disease
10.4 Overlap syndrome
10.5 Hypertension
10.6 Diabetes
10.7 Osteoarthritis
10.10 Obesity
10.11 Depression and anxiety

SECTION 11
THE IMPACT OF COPD ON FUNCTIONAL PERFORMANCE AND EMOTIONAL WELL-BEING

11.1 Muscle morphology
11.2 Pain
11.3 Psychological and emotional

SECTION 12
ACUTE AND CHRONIC RESPONSE TO EXERCISE

12.1 Recap on disease effects
12.2 Aims of PR
12.3 Acute responses
12.4 Chronic effects
12.5 Benefits of PR

SECTION 13
EXERCISE PROGRAMMING AND MANAGEMENT

13.1 Exercise training principles
13.2 Exercise testing
13.3 Endurance training
13.4 Strength training
13.5 Other recommendations
13.6 Managing a safe environment
13.7 Responding to emergency situations

SECTION 14 - MOTIVATION AND BEHAVIOUR CHANGE

14.1 Typical patterns of motivation
14.2 Behaviour change models
14.3 Endurance training
14.2.1 The Transtheoretical Mode
14.2.2 The health belief model

SECTION 15 - MEDICO-LEGAL ISSUES

SECTION 16 - REFERENCES
The British Thoracic Society in conjunction with St George’s University of London, Nottingham University and Imperial College London presented 2012 statistics of lung disease prevalence across the United Kingdom (UK). 12.7 million people in the UK suffered from long term lung disease in 2012, with 8 million people being diagnosed with asthma, 1.2 million with Chronic Obstructive Pulmonary Disease (COPD), and over 150,000 with interstitial lung diseases. A recent epidemiological study, published in the British Medical Journal (Snell et al., 2016), also reported 1.2 million people (2%) in the UK to have diagnosed COPD. This makes COPD the 2nd most prevalent lung disease after Asthma and the disease has increased in prevalence by 27% over the past 10 years. The disease and mortality from the disease is greater in men and prevalence is greater in Scotland and the North of England, with poverty and deprivation being cited as a major factor. COPD is responsible for 140,000 hospital admissions per year and over 1 million bed days (1.7% of total) with the clear majority (97%) being for emergency treatment, meaning COPD creates a significant burden on health care services in the UK.

Globally, putting a figure on the prevalence of COPD is more difficult with an estimated 7.5 billion people populating the world in 2015 (Lopez-Campos et al., 2015) but estimates vary by author and publication, and figures of up to 600 million have been widely used since 2011.

In 2017 The Lancet reported that COPD ranked 8th in the global burden of disease. In 2016 COPD was the third biggest cause of mortality in the world (WHO, 2016).
TOP GLOBAL CAUSES OF DEATHS, 2016

<table>
<thead>
<tr>
<th>Cause Group</th>
<th>Communicable, maternal neonatal and nutritional conditions</th>
<th>Noncommunicable diseases</th>
<th>Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischaemic heart disease</td>
<td>Stroke</td>
<td>Chronic obstructive pulmonary disease</td>
<td>Lower respiratory infection respiratory infection</td>
</tr>
<tr>
<td>Alzheimer disease and other dementias</td>
<td>Trachea, bronchus, lung cancers</td>
<td>Diabetes mellitus</td>
<td>Road injury</td>
</tr>
<tr>
<td>Diarrhoeal disease</td>
<td>Tuberculosis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Global Health Estimates 2016: Death by Cause, Age, Sex, by country and by Region, 200-2016. Geneva, World Health Organization, 2018

WHO KEY FACTS OF COPD

- Globally, it is estimated that 3.17 million deaths were caused by the disease in 2016 (that is, 5% of all deaths globally in that year).
- More than 90% of COPD deaths occur in low and middle income countries.
- The primary cause of COPD is exposure to tobacco smoke (either active smoking or secondhand smoke).
- Other risk factors include exposure to indoor and outdoor air pollution and occupational dusts and fumes.
- Exposure to indoor air pollution can affect the unborn child and represent a risk factor for developing COPD later in life.
- Some cases of COPD are due to long-term asthma.
- COPD is likely to increase in coming years due to higher smoking prevalence globally and aging populations in many countries.
- Many cases of COPD are preventable by avoidance or early cessation of smoking.
- COPD is not curable, but treatment can relieve symptoms, improve quality of life and reduce the risk of death.

WELSH NATIONAL COPD AUDIT (2015-2017): PLANNING FOR EVERY BREATH

Recently an audit of COPD outputs was commissioned to gain recent knowledge into the prevalence of and nature of COPD in Wales, and to draw up guidance of care. In total 408 practices (94% of all GP practices in Wales) opted in, providing data on 82,696 patient records for analysis. The average patient age was 70.7 years with a male to female split of 50.5% and 49.5% respectively.

Co-morbidities included Anxiety (30.5%), Depression (30.1%), severe mental illness (7.8%), Hypertension (52.7%), CHD (40%) and 41.9% had a co-diagnosis of Asthma. Smokers were seen to be 10% less likely to have been referred to pulmonary rehabilitation and 47% less likely to have received the flu vaccination. Of smokers, only 12.5% had a record of having been referred to a behavioural change intervention and prescribed smoking cessation pharmacotherapy in the past 2 years. There was a socio-economic effect observed with the poorest 10% being 7% less likely to have an MRC score (Medical Research Council Dyspnoea Scale). The full report can be found at the link below:

www.rcplondon.ac.uk/projects/outputs/primary-care-audit-wales-2015-17-planning-every-breath
1.2 A BRIEF HISTORY OF PULMONARY REHABILITATION

The seeds of what we now know as Pulmonary Rehabilitation were sown in the late 19th century when it was written that exercise in the form of physical activity and breathing techniques could improve function in pulmonary patients. By the mid-20th century COPD was recognized as a significant health issue and although prevalence and understanding was nowhere near as it is today it was accepted that, like angina, avoiding the onset of the primary symptom (dyspnoea) would be appropriate disease management. In 1952 Alvan Barach identified, in oxygen dependent emphysema patients, a marked increase in exercise capacity following an exercise programme, although it would be another 40 years before the physiological effects would be fully accepted. In the late 1960’s Thomas Petty formed a team of pulmonary specialists to develop the first outpatient center for pulmonary rehabilitation and later published a trail-blazing paper “A Comprehensive Care Program for Chronic Airway Obstruction,” which demonstrated the effects of physical activity, education and breathing training on reducing hospitalization, increasing exercise capacity and returning to work (Casaburi, 2008).

Following a brief loss of faith in Pulmonary Rehabilitation in the 1980’s, where it was thought that exercise tolerance couldn’t possibly be increased due to the limitations placed by the lungs, the 1990’s brought a new approach which examined training intensities and the effects the disease had on the muscles of the lower limbs. It was seen that patients with COPD exercised at intensities of higher percentages of maximum than healthy people. Training people with respiratory disease using “healthy” training parameters and guidelines did not work as the dose was too low. Earlier suggestions in the 1980’s that muscle function could not be improved in COPD patients were refuted in 1996 when Maltais and colleagues showed high intensity exercise increased aerobic enzymes in the lower limb muscles, therefore showing that exercise could increase oxygen uptake at the muscle, thus providing a direct improvement in exercise capacity (Maltais et al., 1996).

In 1999 the American Thoracic Society and European Respiratory Society were formed, their aims to present the evidence on muscle training and improved function and to steer the world of Pulmonary Rehabilitation into a new era of understanding that exercise training, particularly of the skeletal muscles, play a key role in the management and rehabilitation of people diagnosed with COPD and other respiratory diseases. Although exercise for respiratory disease management was once seen as a secondary intervention, the growing body of evidence since the mid 1990’s has propelled the status of Pulmonary Rehabilitation to play a key role in managing symptoms and improving prognosis. In 1997 The Global Initiative for Chronic Obstructive Lung Disease (GOLD) was launched in collaboration with the National Heart, Lung, and Blood Institute, National Institutes of Health USA, and the World Health Organization (WHO). Its main role is to shape guidelines of care for COPD sufferers across the world by forming collaborations of world leading experts in COPD medicine and management:

GOLD objectives
- Recommend effective COPD management and prevention strategies for use in all countries.
- Increase awareness of the medical community, public health officials and the general public that COPD is a public health problem.
- Decrease morbidity and mortality from COPD through implementation and evaluation of effective programmes for diagnosis and management.
- Promote study into reasons for the increasing prevalence of COPD, including its relationship with the environment.
- Implement effective programs to prevent COPD.

In 2018 GOLD released its “Global Strategy for the Diagnosis, Management and Prevention of COPD” details of which can be found at http://goldcopd.org

Today, in the UK, the British Thoracic Society (BTS) and the British Lung Foundation (BLF), along with The National Institute for Health and Care Excellence (NICE) work to commission research and set guidelines for best practice in respiratory disease management including Pulmonary Rehabilitation. Revisiting guidelines for Pulmonary Rehabilitation in 2013 the BTS summarised the following key points:

1.3 THE ROLE OF PULMONARY REHABILITATION

- Pulmonary rehabilitation should be offered to patients with chronic obstructive pulmonary disease (COPD) with a view to improving exercise capacity by a clinically important amount.
- Pulmonary rehabilitation should be offered to patients with COPD with a view to improving dyspnoea and health status by a clinically important amount.
Different components within a pulmonary rehabilitation programme, such as resistance training, can influence quadriceps strength.

Pulmonary rehabilitation should be offered to patients with COPD with a view to improving psychological wellbeing.

As a minimum, efficacy of pulmonary rehabilitation programmes needs to be regularly assessed by demonstrating clinically important improvements in exercise capacity, dyspnoea and health status.

As part of regular assessment, patient satisfaction and feedback should be sought.

Referral and assessment of patients for pulmonary rehabilitation

The point of referral to pulmonary rehabilitation should be used as an opportunity to explore the patient’s understanding of pulmonary rehabilitation, address concerns and to educate patients about the benefits of a pulmonary rehabilitation programme.

Healthcare professionals making referrals to pulmonary rehabilitation should have basic knowledge about what a programme entails and effectiveness. A pulmonary rehabilitation programme should be presented by the referrer as a fundamental treatment for COPD rather than an optional extra.

Initial assessment for pulmonary rehabilitation provides an opportunity to assess and refer for treatment of comorbidities prior to commencing.

The setting of pulmonary rehabilitation, skill mix of the team and other comorbidities should always be considered in the risk assessment of patients entering a rehabilitation programme.

You can find the 2013 publication of BTS guidelines at: Bolton et al., 2013 (http://thorax.bmj.com/content/68/Suppl_2/ii1).

1.4 THE STRUCTURE OF PULMONARY REHABILITATION

Pulmonary Rehabilitation aims to reduce the burden of symptoms and disability in patients and its effectiveness is generally well received and accepted (NICE, 2016). It is fair to say that the provision in the UK has, in previous years, somewhat lagged behind other countries who have for some time accepted it as a pivotal, primary intervention which runs alongside clinical management. There is now strong scientific evidence however, to recommend the application of pulmonary rehabilitation programmes that comprise physical training, education, dietetics, occupational therapy, psychology, and social support, and efficacy in the UK is improving (Bolton et al., 2013). The benefits include improvements in exercise performance, health status, dyspnoea, and reduction in usage of health services (BTS). Research has been largely centered around training principles and this has borne fruit as our knowledge in best practice has grown and shall be presented in detail later in the course. In terms of the structure and quality of Pulmonary Rehabilitation, NICE presented a quality statement (2016) setting out the aims and standards for the UK, a summary of which is below:

- People with stable chronic obstructive pulmonary disease (COPD) and exercise limitation due to breathlessness are referred to a pulmonary rehabilitation programme through their health care professional (G.P., Physiotherapist, Respiratory nurse, Exercise and Clinical Physiologists, Occupational therapist). It is important that the clinician discusses, with the patient, the process and the expectations of the patient. Knowledge and understanding of pulmonary rehabilitation and allaying the patients concerns has been shown to increase take up of schemes (BTS, 2013).

Service providers must have appropriate systems in place including suitably qualified exercise professionals (REPs Level 4) and a system of evaluation should be in place to follow impact and effectiveness. Clinical commissioners must ensure that services are commissioned so that suitably impaired patients can be referred through a standardised pathway of Pulmonary Rehabilitation. The programmes must be set up so as to be convenient for the service user including consideration of location, access, time, transportation and the programme should begin within a reasonable time frame from the referral being given. The intervention should comprise of an individualised exercise programme which is supported with a structured education component. The intervention should last at least 6 weeks and include at least 2 supervised training sessions (with at least 1 independent extra session per week) of bespoke, progressive exercise, which includes both cardio-vascular and resistance training.

1.5 CONTRA-INDICATIONS TO REFERRAL INCLUDE:

- People with unstable cardiac disease
- Locomotor or neurological impairment which makes exercise impossible
- People with terminal illness
- People with significant cognitive or psychiatric impairment (BTS, 2013)
Absolute contraindications

• Acute myocardial infarction (MI), within 2 days
• Ongoing unstable angina
• Uncontrolled cardiac arrhythmia with hemodynamic compromise
• Active endocarditis
• Symptomatic severe aortic stenosis
• Decompensated heart failure
• Acute pulmonary embolism, pulmonary infarction, or deep vein thrombosis
• Acute pericarditis
• Acute aortic dissection
• Physical disability that precludes safe and adequate exercise

Relative contraindications

• Known obstructive left main coronary artery stenosis
• Moderate to severe aortic stenosis with uncertain relation to symptoms
• Tachyarrhythmias with uncontrolled ventricular rates
• Acquired advanced or complete heart block
• Hypertrophic obstructive cardiomyopathy with severe resting gradient
• Recent stroke or transient ischemic attack
• Mental impairment with limited ability to safely cooperate
• Resting hypertension with systolic or diastolic blood pressures > 200/110 mmHg
• Uncorrected medical conditions, such as significant anemia, important electrolyte imbalance, and hyperthyroidism

Note to the Pulmonary Rehabilitation exercise candidate
The above contra-indications should be screened out at the clinical level so occurrence at the exercise facility should be rare. It is important that you are aware of them however, particularly blood pressure which is common as a co-morbidity and in the elderly.

It wasn’t until I took part actively in Pulmonary rehabilitation that I realised how tremendously effective this service is.

Patrick Flood-Page
Royal Gwent Hospital,
Aneurin Bevan University Health Board
Consultant Respiratory Physician
If you're fitter outside your lungs, your heart and your body will compensate for your lung disease to a certain extent.

Patrick Flood-Page
Royal Gwent Hospital,
Aneurin Bevan University Health Board
Consultant Respiratory Physician
By the end of this session the student will be able to demonstrate an understanding of:

1. The anatomy of the respiratory system including respiratory muscles
2. The mechanics of breathing
3. The process of gaseous exchange
4. Lung volumes and description

The respiratory system is responsible for the process of gaseous exchange through breathing and respiration, the purpose of which is to provide essential oxygen (O2) to the cells of the body. The air we breathe consists of 78.09% nitrogen, 20.95% oxygen, 0.93% argon, 0.04% carbon dioxide, and small amounts of other gases. Air also contains a variable amount of water vapor, on average around 1% at sea level, and 0.4% over the entire atmosphere. It is the job of the respiratory system to take in air and distribute its components as needed, essentially passing oxygen to the cardiovascular system to be transported to the cells and taking harmful carbon dioxide (CO2) from the blood to be exhaled out of the body.

The respiratory tract is split into an upper and lower part. The organs involved in the upper part are the nose, nasal cavity, pharynx, and larynx. The lower part is made up of the trachea, the bronchi and bronchioles and parenchyma (lung tissue and alveoli). Additionally, the respiratory system also involves several supplementary structures, like the oral cavity, rib cage, and respiratory muscles, including the diaphragm (Patton and Thibodeau 2007). The lungs can expand and contract without friction due to the pleura, a thin membranous structure. The visceral pleura surrounds the lungs while the parietal pleura lines the wall of the thoracic cavity. The pleura is separated by a small fluidic space called the pleural cavity.
**Nasal cavity**
Air enters through the nose and into the nasal cavity which is lined with tiny hairs, mucus cells and lysozymes—enzymes which kill off bacteria. As the air travels up the nose, dirt and dust particles are trapped by the mucus coated hairs. Air then enters the Paranasal sinuses where it is warmed and moistened.

**Pharynx (throat)**
The pharynx is used for both respiration and digestion and leads down to the oesophagus and larynx. Two types of muscles make up the pharynx, circular and long, which aid in swallowing food and, in the case of circular, also stop air from being swallowed.

**Larynx (voice box)**
The Larynx sits in front of the cervical vertebrae and is responsible for mainly creating sound, housing “vocal folds”. The Larynx creates pitch and volume and although predominantly carries out the role of voice production is also involved in the breathing process.

**Epiglottis**
This cartilaginous “flap” sits at the top of the Larynx and acts as a stop flap between the Larynx and oesophagus. It prevents food entering the Trachea when eating and thus permits air to enter the lungs and food to enter the digestive tract.

**Trachea (wind pipe)**
The trachea (or windpipe) is about 6 inches long and 2 to 3cm in diameter. The trachea serves as a passage for air, moistens and warms it while it passes into the lungs, and protects the respiratory surface from an accumulation of foreign particles. The trachea is lined with a moist mucous-membrane layer composed of cells containing small hair like projections called cilia. The cilia project into the channel (lumen) of the trachea to trap particles. There are also goblet cells and ducts in the mucous membrane that secrete mucus droplets and water molecules. At the base of the mucous membrane there is a complex network of tissue composed of elastic and collagen fibres that aid in the expansion, contraction, and stability of the tracheal walls. Around the tracheal wall there is a series of 16 to 20 cartilage rings.

**Bronchi and Bronchioles**
The Trachea splits at the Carina into the left and right branches of the Bronchi which enter the lungs. The right lung has three lobes, upper, middle and lower while the left has two. The right Bronchus is slightly shorter than the left and descends at a straighter angle leaving it susceptible to aspiration of food or fluid. The Bronchi, like the Trachea are cartilaginous, lined with Cilia, mucous producing cells and epithelium. As the Bronchi get further into the lungs they become smaller, less cartilaginous and composed more of smooth muscle until reaching the Bronchioles which contain no cartilage. The Bronchioles are formed from smooth muscle and lined with ciliated epithelial and mucus producing cells.

**Alveoli**
The final destination of inhaled air is the Alveoli. There are approximately 500,000,000 Alveoli in the lungs depending on gender, size and lung condition. The walls of Alveoli are not ciliated or smooth muscle but made up of Type 1 and Type 2 pneumocytes. Type 2 Pneumocytes produce a gel like liquid called surfactant. Surfactant is important as it decreases surface tension and keeps the Alveoli open, maintaining the Alveoli structure, particularly under pressure and stopping it from collapsing in on itself.
2.2 BREATHING MECHANICS

Air is moved in and out of the lungs by expanding and contracting the muscles of the rib cage and thus allowing the rib cage to expand/contract and the lungs to inflate and deflate accordingly. During the process of inhalation, the lung volume expands as a result of the diaphragm contracting and flattening and the intercostal muscle contracting and pulling the rib cage up and outward. This increase in volume creates negative pressure within the lungs and as a result environmental pressure becomes greater. Based on simple theory of pressure gradients, the higher atmospheric air pressure rushes into the lower, filling the lungs with air. The resulting increase in volume is largely attributed to an increase in alveolar space because the bronchioles and bronchi are stiff structures that do not change in size.

Breathing is involuntary but can obviously be overridden as it is performed by skeletal muscles, largely the intercostal muscles of the thoracic cage.

In cases of increased respiratory demand, such as during symptoms of asthma and exercise, accessory muscles of respiration may be used, i.e., muscles of the abdomen to help the diaphragm, and the shoulder girdle muscles to assist with inspiration.

2.3 LUNG VOLUMES AND VENTILATION

Lung volume varies between 4 and 6 litres and if the surface area of diffusion provided by the alveoli (air sacs) is measured, it varies between 60-80m2, which is roughly 35 times greater than the surface area of the individual and would cover almost an entire tennis court. It is the alveoli that provide the vital surface area for gaseous exchange. They are intermeshed with elastic, thin-walled blood capillaries.

The close proximity of these thin membranous walls facilitates gaseous diffusion. Further gaseous mixing is achieved via small pores between adjacent alveoli, providing for indirect ventilation of some alveoli, which is especially important in diseased lungs.

At rest, approximately 250ml of O2 enters the bloodstream through alveolar diffusion, whilst 200ml of CO2 diffuses in the opposite direction and is expired. During heavy aerobic exercise, these amounts can be increased 25-fold.

2.4. PULMONARY DIFFUSION

Once air has entered the lungs it is the job of the respiratory system to transfer the O2 into the blood to be carried to the body’s cells. This is done passively via another pressure gradient where high Oxygen partial pressures (PO2) diffuse into lower ones. Environmental PO2 is about 160mmHg whereas alveoli PO2 is only 100mmHg so oxygen naturally passes into the alveoli from the environment.

The O2 still needs to get into the pulmonary capillaries however, to be bound onto Hemoglobin but the PO2 in the pulmonary capillaries is only 40mmHg so, again, the O2 easily diffuses across the capillary membrane.

inhalation and exhalation: The lungs, chest wall, respiratory muscles and diaphragm are all involved in respiration, both inhalation and expiration.

During this process, the chest wall expands out and away from the lungs. The lungs are elastic; therefore, when air fills the lungs, the elastic recoil within the tissues of the lung exerts pressure back toward the interior of the lungs and the air is forced from the lungs (high pressure) out into the environment (lower pressure) and exhalation occurs. Ventilation is performed against resistance in the airways due to turbulence (80%) and against tissue resistance (20%). The tissue resistance, or elasticity, of the chest is termed compliance (the ability to stretch).
The same must occur for CO2 to be dispelled from the alveoli and back out into the environment. Blood within the returning capillaries has a PCO2 of 46mmHg so, therefore, diffuses into the lower pressure gradient of the alveoli (40mmHg) and from there out into the even lower PCO2 pressure gradient of the atmosphere (0.03mmHg).

2.5. LUNG COMPLIANCE

Pulmonary compliance describes the ability of the lungs to stretch under pressure. There are two components, static and dynamic compliance. Static compliance describes stretch at periods where there is no active flow of air, such as an inspiratory pause, whereas dynamic is when there is active air flow, for example during the active phase of a breath. A decrease in lung compliance is often due to fibrosis or stiffening of the lung tissue, reducing the lungs ability to stretch, whereas high compliance is associated with COPD due to lost alveoli, hyperinflation of the lungs and reduced elasticity.

Low compliance represents a stiff lung and therefore greater effort is required to breathe in and inhale a usual volume of air. For high compliance imagine a brown paper bag. When you fill it with air it quickly expands but has little elasticity, so, deflates slowly, often leaving air behind (this is representative of the air trapping seen in COPD which we will discuss later). A balloon, however, is more elastic so requires more energy to inflate but when released the air bursts out very forcefully. In emphysema, high compliance is caused by a reduced ability of the lung tissue to recoil and exhale (leaving air behind).

So, in COPD extra effort is used when exhaling. Surfactant is also important in lung compliance by providing stability. Surfactant prevents the alveoli from sticking to one another and reduces the surface tension, thus aiding compliance and preventing the alveoli from collapsing.

2.6. SUMMARY- PHYSIOLOGICAL VARIABLES WHICH AFFECT BREATHING

**Elasticity** - this is the ability of the lungs to recoil back to their resting position and shape after each breath. Loss of elasticity of the connective tissue as in emphysema, requires forced expiration and increased effort on inspiration.

**Compliance** - this is the lungs ability to stretch and the effort required to inflate the alveoli. In a healthy individual the lungs are very compliant and inflation occurs with ease, when compliance is low as in fibrosis, insufficient surfactant availability or stiffening of the lungs due to ageing, greater effort is needed to inflate the lungs. Compliance and elasticity act as opposing forces.

**Airway resistance** - if there is constriction in the airways, such as the Bronchioles, then resistance is increased and greater effort is needed to inflate the lungs. Asthma causes inflammation of the airways, increasing airway resistance and making it difficult to get air into the lungs.

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*COPD patients have good medication, but that medication ultimately cannot change their lung problem. Pulmonary rehabilitation is designed to make the patient’s symptoms better*

Tom Lines
Cardiff and Vale University Health Board, Respiratory Physiotherapist

*COPD patients have good medication, but that medication ultimately cannot change their lung problem. Pulmonary rehabilitation is designed to make the patient’s symptoms better*

Tom Lines
Cardiff and Vale University Health Board, Respiratory Physiotherapist

Pulmonary rehab is a really good news story. If we can get patients into pulmonary rehab, the vast majority get a huge benefit

Mike Roberts
COPD Audit Lead, Royal college of Physicians
Lung volumes and capacities describe the amount of air being held or moved through each phase of the respiratory cycle. Under normal conditions, the average adult takes 12 to 16 breaths a minute. A breath is one complete respiratory cycle that consists of one inspiration and one expiration. Volumes differ from person to person due to several factors. Total lung volume of normal adults is about 6L. A number of physiological factors like age, gender, height and ethnicity affect lung volumes:

<table>
<thead>
<tr>
<th>Larger volumes</th>
<th>Smaller volumes</th>
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<tr>
<td>Tall people</td>
<td>Short people</td>
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<tr>
<td>Living at high altitude</td>
<td>Living at sea level</td>
</tr>
<tr>
<td>Physically fit</td>
<td>Obese</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>Long-term smoker</td>
</tr>
</tbody>
</table>

### LUNG VOLUMES

<table>
<thead>
<tr>
<th>Total Lung Capacity (TLC)</th>
<th>The total volume the lung can accommodate. 4-8 litres (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal Volume (TV)</td>
<td>Volume of air moved during a normal breath. 0.4-1 L</td>
</tr>
<tr>
<td>Residual Volume (RV)</td>
<td>Volume of air remaining in the lungs despite maximal expiration. 1-1.5 L</td>
</tr>
<tr>
<td>Functional Residual Capacity (FRC)</td>
<td>Volume of air in the lungs after a passive expiration 2-2.5 L</td>
</tr>
<tr>
<td>Inspiratory Reserve Volume (IRV)</td>
<td>The extra volume of air which can be maximally inspired over and above typical resting tidal volume. 2.5-3.5 L</td>
</tr>
<tr>
<td>Expiratory Reserve Volume (ERV)</td>
<td>Volume of air which can be actively expired over and above passive expiration. 1 L</td>
</tr>
<tr>
<td>Forced Vital Capacity (FVC)</td>
<td>The max volume of air which can be moved in and out during a single breath following a maximal inspiration. 3.5L</td>
</tr>
<tr>
<td>Inspiratory Capacity (IC)</td>
<td>The max volume of air, which can be inspired at the end of a passive expiration. 5-6 L</td>
</tr>
</tbody>
</table>
3.2. CONTROL OF RESPIRATION

In order to maintain homeostasis, it is important that our respiratory function is controlled. If this is not achieved harmful levels of gases will accumulate and an insufficient O2 supply will cause hypoxia, both incidences will cause illness and eventually a shutdown of our bodily systems. The respiratory system must adapt to internal and environmental changes to maintain gas levels and O2 supply and it does this by using several, autonomic, pathways.

3.2.1. THE RESPIRATORY RHYTHMICITY CENTRE

This is a group of nerve cells located in the medulla and pons of the brainstem which control rate and depth of breathing. Messages pass from the brain to create motor impulses leaving the respiratory center down to the motor nerve ends of the intercostals and diaphragm to stimulate respiration. The respiratory center regulates the breathing muscles and therefore ventilation.

3.2.2. CHEMORECEPTORS

Chemoreceptors sense and respond to changes in partial pressures of O2 and CO2 in the blood and cerebrospinal fluid. They are located centrally and peripherally.

Central chemoreceptors- located at the medulla oblongata they are covered in cerebrospinal fluid. When hypercapnia occurs (increase in PCO2) they cause a respiratory response, by stimulating the respiratory centre, thus increasing ventilation and clearing CO2 to return PCO2 to normal levels.

Peripheral chemoreceptors- located at the arch of the aorta and carotid bodies. The aortic body detects changes in blood oxygen and carbon dioxide, but not pH (acidity), while carotid body receptors detects all three, they are much more sensitive to CO2 changes than O2. On a rise in CO2 they send an impulse to the respiratory centre to increase ventilation and clear CO2 and increase blood pH.

3.3. EXERCISE AND RESPIRATION

Exercise causes an “oxygen debt”, that is to say that as the muscles work harder they demand more O2 and produce more lactic acid, other waste products and CO2. The respiratory system not only has to increase ventilation to take in more O2 but to also clear the high levels of CO2. It does this by way of chemoreceptors, through the respiratory centre.

Oxygen debt is such that increased respiration continues for many hours after exercise. Excess Post Oxygen Consumption (EPOC) is a significant increase in oxygen uptake after strenuous exercise. EPOC’s role is not to just rebalance the oxygen but to resynthesize ATP, recover hormones and anabolics and repair cells and neurons.
3.4. AGEING AND THE RESPIRATORY SYSTEM

Ageing starts to occur from the mid to late 20’s and rate of ageing is largely determined by genetics, fitness, activity maintenance and disease. The effect of muscle atrophy through ageing (sarcopenia) has a significant effect on the respiratory muscles. Weakened intercostal muscles and the diaphragm, as well as respiratory supplemental muscles reduce the ability to expand the rib cage and inflate the lungs.

There is also cartilage wear and tear, making the rib cage more compressed and stiff. General loss of elastic tissue and increased stiffening of the connective tissue decrease lung compliance and can cause the small airways and alveoli to collapse, thus reducing lung volume. Varying degrees of Emphysema can be seen in older adults in the absence of symptoms. The risk of lung infection increases due to a weaker immune system and reduced mucus production and, due to neural ageing, the respiratory reflexes which stimulate ventilation through chemoreceptors slows, meaning clearing CO₂ becomes impaired in older adults.

These responses with ageing are significantly increased with smoking and living a sedentary life, whilst the effects of ageing generally seem to be slower and less impacting when the individual remains active and healthy throughout the decades.

“Only about one third of the patients who are eligible for pulmonary rehabilitation, who would benefit from pulmonary rehabilitation, are being referred.”

Professor Mike Roberts
COPD Audit Lead, Royal college of Physicians
Only about one third of the patients who are eligible for pulmonary rehabilitation, who would benefit from pulmonary rehabilitation, are being referred.

Professor Mike Roberts
COPD Audit Lead, Royal college of Physicians
COPD is a complex inflammatory disease characterised by either trauma and damage to the parenchyma (emphysema) or disease of the small airways (chronic bronchitis), however due to cigarette smoking patients often present with a combination of the two. The result is impairment of breathing mechanics which leads to harmful alterations in gas homeostasis, air trapping, mucus hypersecretion, chest infections, pulmonary “dead space”, increased “Work of Breath” and functional limitations which reduce quality of life and can lead to premature mortality. COPD is an irreversible disease and although treatment cannot cure the condition it can be managed and progression slowed by medication, education and a well-formed intervention of exercise and physical activity. It is also now accepted that COPD affects systems beyond the respiratory tract and is commonly associated with muscle atrophy, cardiovascular disease, heart failure and cancer, the latter 2 being the most common cause of death. COPD patients make up around 90% of all participants of Pulmonary Rehabilitation (BTS, 2013)

COPD has been defined by GOLD as a progressive, obstructive, disease which causes an inflammatory response and ultimately leads to death from respiratory failure or associated co-morbidities. It worsens over decades and is most prevalent in men and those of advanced age. There is a strong socio-economic relationship with smoking cigarettes accounting for over 90% of causation.

Difficulties in breathing and airway obstruction in COPD patients can be due to three pathological effects:
1. Thickening and fibrosis of the small airways caused by long term inflammation (chronic obstructive bronchiolitis)
2. Small airway collapse during exhalation due to Emphysema and reduced elasticity of the lung
3. Obstruction of the airways through hypersecretion of mucus.

These effects can lead to air trapping within the lung and hyperinflation, the result of which is dyspnoea and functional impairment. Hypoxia and Hypercapnia add to limitations and further trauma to the parenchyma as well as a reduction in FEV1 as the ability to sufficiently deflate the lungs during exhalation, due to high compliance, is impaired.

By far the greatest risk factor and cause of COPD is smoking cigarettes but environmental factors are present all be it to a lesser extent. Coal dust, asbestos and other chemicals and pollutants are responsible, as is a deficiency in α1 anti- trypsin, characterised by diagnosis at earlier ages.

4.1.1. EMPHYSEMA

Emphysema usually occurs as a result of long term cigarette exposure and the inflammatory responses which occur as a result. In some patients a deficiency in a protective protein, α1 anti-trypsin, can cause the disease and these patients are often diagnosed at younger ages. It is well known that smoking leads to airway inflammation, pro-destructive pathways and down regulation of anti-inflammatory, anti-oxidant and repair pathways (Goldklang and Stockley, 2016).

Enzymes released due to smoking or coal dust exposure (Trypsin) cause trauma and damage to the elastic tissue of the lungs, leaving recoil ability to be impaired and the chest to progressively expand outward (barrel chested). In addition, distension (dilation) to the bronchioles and alveolar sacs cause lost elasticity and a reduction in surface area for gas exchange, it also means clearing bacteria and waste becomes more difficult. Over time, destruction of the alveolar walls occurs, leaving large cavities of dead space and those alveoli remaining have less elastic recoil to empty during exhalation.

The lungs themselves become dilated and their capacity is increased. As the alveoli are enlarged and dilated their capacity increases, however intake of air remains unchanged so the PO2 within the alveoli is reduced, thus reducing the concentration.
COPD is a complex inflammatory disease characterised by either trauma and damage to the parenchyma (emphysema) or disease of the small airways (chronic bronchitis), however due to cigarette smoking patients often present with a combination of the two
Chronic Bronchitis is characterized by progressive inflammation of the large and intermediate airways due to continuous trauma to the airway epithelium. Its main cause is cigarette smoking and can worsen in cold, damp environments, exposure to pollutants or chest infections. The trauma causes both hypertrophy (bigger) and hyperplasia (more of) of mucus and goblet cells meaning mucus hypersecretion is often the most debilitating symptom of the disease. Over time the lumen of the bronchioles can become increasingly damaged and collagenized, cells can be lost and replaced by un-ciliated cells and the lumen can collapse increasing obstruction on exhalation. In some patients the change in epithelial cell type can progress to malignant disease (Waugh and Grant, 2014).

It has numerous clinical consequences, including an accelerated decline in lung function, greater risk of the development of airflow obstruction in smokers, a predisposition to lower respiratory tract infection, higher exacerbation frequency, and worse overall mortality (Kim and Criner, 2013). Ventilation becomes extremely difficult, particularly on exertion and can lead to hypoxia, pulmonary hypertension and right sided heart failure. Hypoxemia (low PO2) is present in conjunction with hypercapnia (high PCO2). In the latter stages of the disease the smaller bronchioles are affected as are the alveoli and emphysema often develops (Kim and Criner, 2013).

Asthma is a very common inflammatory disorder which affects the airways and is characterised by reversible bouts of airflow obstruction. The muscles of the bronchioles become thickened and enlarged as do the mucus membrane and cells. Invasion of inflammatory cells and “exudate” increase the swelling and airflow obstruction further. During an asthma attack bronchospasm occurs (repeated contractions of the bronchial muscles), narrowing the airways and making breathing extremely difficult and traumatic if severe. Dyspnoea results and hyperinflation of the lungs as breathing is only partial and the patient will wheeze and gasp for breath. Attacks may last for minutes or hours and can be fairly mild or severe, in some, relatively rare cases fatal (Kudo et al., 2013).

In some people who have asthma, airflow limitation may be only partially reversible. Permanent structural changes can occur in the airways, these are associated with a progressive loss of lung function that is not prevented by or fully reversible by current therapy. Airway remodeling involves an activation of many of the structural cells, with consequent permanent changes in the airway that increase airflow obstruction and airway responsiveness which render the patient less responsive to therapy (Holgate and Polosa, 2006).

Asthma is normally “triggered” by an agent or activity which catalyzes an attack. Cold air, pollutants, pet hair, dust, pollen, pesticides, upper respiratory tract infections and exercise can all be triggers and patients will tend to be more sensitive to one or a few rather than all. Asthma attacks are often treated successfully with medication; however, an attack may leave the patient breathless and fatigued on exertion for some time after.

Bronchiectasis is a permanent dilation of the bronchi and bronchioles associated with bacterial infections and occasionally a history of childhood lung disease particularly cystic fibrosis. The bronchi are blocked by mucus and inflammatory exudate, making breathing difficult and the bronchial tree susceptible to collapse. Due to extra mucus production, infection is common and this causes more damage to the airways. Elastic tissue is damaged and replaced by fibrous adhesions which stick to the pleura causing further dilation of the airways and coughing to clear excessive mucus increases pressure, exacerbating dilation further. The lower lobe is often affected most and progressive fibrosis of the tissue leads to hypoxia, pulmonary hypertension and right sided heart failure (bronchiectasis.com/pathophysiology).
4.4. CYSTIC FIBROSIS (CF)

This is a genetic disorder affecting people from birth. Mucus is the biggest problem in the early stages and infection, possibly leading to pneumonia. Coughing is a common side effect as the patient works to clear phlegm. CF is treated with medications to clear the airways and to fight off infections and with physiotherapy to attempt to clear the lungs. Exercise is becoming more accepted as part of management but can be difficult in some patients due to coughing and dyspnoea. CF also affects other parts of the body including the pancreas and digestive system and in some cases digestion of proteins and fats in children can cause malnourishment and cirrhosis due to blocks in the bile ducts.

Long term lung and heart complications are common and typical life expectancy is around 50 years, although a baby born today can expect to live longer (Waugh and Grant, 2014; cysticfibrosis.org).

4.5. INTERSTITIAL LUNG DISEASE

Interstitial lung disease (ILD) includes a group of diseases that have thickening of the supporting tissues between the air sacs of the lungs as the common factor. The Interstitium is a thin layer of tissue that normally appears as a fine lace on X-rays. Interstitial lung disease results from a variety of causes that lead to thickening of the supporting tissue around the air sacs rather than the air sacs themselves. Interstitial lung disease usually involves all of the lungs rather than affecting only one area. In ILD the Interstitial becomes scarred and stiff, so the alveoli cannot inflate as well, therefore it is difficult to get air into the lungs.

Causes can vary but include lung infections, inhalation of pollutants, chemotherapy and radiotherapy and certain autoimmune diseases. Over time the heart can enlarge as a result and the patient can suffer from pulmonary hypertension, right sided heart failure and respiratory failure.
In the 2018 GOLD Guide to COPD Diagnosis, Management and Prevention it was stated that COPD should be considered if dyspnoea, chronic cough, sputum production and a history of risk factors were present. A full medical history is required and reports of symptoms and smoking or toxin inhalation history should be followed up by post-bronchodilator spirometry. A FEV1/FVC of <0.70 is an indicator for diagnosis of COPD if symptoms and history are present. If FEV1 is ≥ 80% predicted normal, a diagnosis of COPD should only be made in the presence of respiratory symptoms, for example breathlessness and persistent cough (NICE, 2016).

**SECTION 5 DIAGNOSIS AND CLASSIFICATIONS OF SEVERITY**

### 5.1. COPD

In the 2018 GOLD Guide to COPD Diagnosis, Management and Prevention it was stated that COPD should be considered if dyspnoea, chronic cough, sputum production and a history of risk factors were present. A full medical history is required and reports of symptoms and smoking or toxin inhalation history should be followed up by post-bronchodilator spirometry. A FEV1/FVC of <0.70 is an indicator for diagnosis of COPD if symptoms and history are present. If FEV1 is ≥ 80% predicted normal, a diagnosis of COPD should only be made in the presence of respiratory symptoms, for example breathlessness and persistent cough (NICE, 2016).

<table>
<thead>
<tr>
<th>GOLD guidance for the diagnosis of COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>History</strong></td>
</tr>
<tr>
<td>Productive cough</td>
</tr>
<tr>
<td>Dyspnoea</td>
</tr>
<tr>
<td>Cigarette smoking</td>
</tr>
<tr>
<td><strong>Spirometry</strong></td>
</tr>
<tr>
<td>Reduced FEV1</td>
</tr>
<tr>
<td>FEV1/FVC &lt;0.70</td>
</tr>
<tr>
<td>Fixed and Progressive</td>
</tr>
<tr>
<td><strong>Inflammatory response</strong></td>
</tr>
<tr>
<td>Macrophages and Neutrophils</td>
</tr>
<tr>
<td>Fibrosis</td>
</tr>
<tr>
<td>Destruction to parenchyma</td>
</tr>
<tr>
<td><strong>Noxious particles and gases</strong></td>
</tr>
<tr>
<td>Cigarettes</td>
</tr>
<tr>
<td>Coal dust</td>
</tr>
<tr>
<td>Pollution</td>
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<tr>
<td>Bio mass Fuel</td>
</tr>
</tbody>
</table>

**Fig. 5. GOLD guidance for the diagnosis of COPD**

**CLASSIFICATION OF SEVERITY OF AIRFLOW LIMITATION IN COPD**

*In patients with FEV₁/FVC < 0.70:*

- **GOLD 1:** Mild FEV₁, ≥80% predicted
- **GOLD 2:** Moderate FEV₁, 50% - 80% predicted
- **GOLD 3:** Severe FEV₁, 30% -50% predicted
- **GOLD 4:** Very Severe FEV₁, <30% predicted

*Based on Post-Bronchodilator FEV₁* © 2017 Global Initiative for Chronic Obstructive Lung Disease
In the 2018 GOLD Guide to COPD Diagnosis, Management and Prevention it was stated that COPD should be considered if dyspnoea, chronic cough, sputum production and a history of risk factors were present.
### Note to Level 4 Pulmonary Rehabilitation instructor - Diagnosis and spirometry will be carried out at a clinical level so it is unlikely you will be asked to carry out the test. In some cases, however, you may assist the clinician and it is important to understand the stages of airflow severity as this will impact on your exercise programming.

### NICE (2018) statement of the diagnosis of COPD

“COPD is characterised by airflow obstruction that is not fully reversible. The airflow obstruction does not change markedly over several months and is usually progressive in the long term. COPD is predominantly caused by smoking. Other factors, particularly occupational exposures, may also contribute to the development of COPD. Exacerbations often occur, where there is a rapid and sustained worsening of symptoms beyond normal day-to-day variations”.

The following should be used as a definition of COPD:

Airflow obstruction is defined as a reduced FEV1/FVC ratio (where FEV1 is forced expired volume in 1 second and FVC is forced vital capacity), such that FEV1/FVC is less than 0.7. If FEV1 is ≥ 80% predicted normal a diagnosis of COPD should only be made in the presence of respiratory symptoms, for example breathlessness or persistent cough. The airflow obstruction is present because of a combination of airway and parenchymal damage.

The damage is the result of chronic inflammation that differs from that seen in asthma and which is usually the result of tobacco smoke. Significant airflow obstruction may be present before the person is aware of it. COPD produces symptoms, disability and impaired quality of life which may respond to pharmacological and other therapies that have limited or no impact on the airflow obstruction.

COPD is now the preferred term for the conditions in patients with airflow obstruction who were previously diagnosed as having chronic bronchitis or emphysema. There is no single diagnostic test for COPD. Making a diagnosis relies on clinical judgement based on a combination of history, physical examination and confirmation of the presence of airflow obstruction using spirometry.


### 5.2. Dyspnoea and its effects on exercise ability

Dyspnoea, or shortness of breath, is a common and subjective symptom of many respiratory and cardiac morbidities (Burki and Lee, 2010). Patients describe it by using terms such as: ‘It’s like suffocating’; ‘Tightening feeling of fear in your chest and mind’; ‘Going to take your last breath’; ‘Feels like I am not going to breathe again’; ‘Could not get enough air in’. It is often the functional impairment which results from dyspnoea which causes sufferers of lung and cardiac disease to visit their G.P. Dyspnoea is characterised in patients as an increased need to breath along with a feeling of increased effort to breath (O’Donnell et al., 2009). It is not singular in its cause but comprises of neurological, chemical and physical responses which can lead to increased emotional distress with the potential to panic. Other factors are thought to contribute to a patient’s perception such as their awareness of dyspnoea, previous exercise experiences, psychological state and bodily preoccupation (Murray and Nadel, 2016).

As we breath resistance is created through the mechanical process of inspiration and exhalation. The amount of effort used to expand the lungs as determined by lung compliance, airway resistance and the use of accessory muscles is termed “work of breathing”. The energy expended in a healthy person for normal, restful breathing is 2-5%. In patients with advanced chronic respiratory disease energy expended through breathing, at rest, can be significantly greater. During strenuous exercise pulmonary ventilation may increase by 20 times, causing energy expenditure to increase. People with COPD can experience air trapping as their ability to fully exhale is impaired. This creates a mis-match between respiratory drive and load as they are unable to increase respiratory muscle power to match the increased airflow placed upon it by exercise. The perception of workload is increased and worsened as both the respiratory and peripheral muscles weaken. Changes in arterial blood pH, Pco2, and Po2 can be sensed by the central and peripheral chemoreceptors and the stimulation of these cause an increase in respiratory motor activity, as discussed earlier. The dyspnoea produced by hypercapnia results largely from chemically induced respiratory motor activity through the respiratory rhythmicity center. The breathing discomfort associated with acute hypercapnia is not a reflection of respiratory muscle activity but rather a reflection of increased respiratory muscle workload as CO2 builds up in the lungs generating afferent information from vagal receptors in the lungs (and possibly mechanoreceptors in the respiratory muscles) to the sensorimotor cortex.
resulting in the sensation of dyspnoea (Burki and Lee, 2010). In hypercapnic COPD patients an increase in PaCO2 seems to be the most important stimulus overriding all other inputs for dyspnoea (Grazzini et al., 2005). It is accepted that dyspnoea perception is worsened or managed by the patient’s response to breathlessness. The feeling of acute breathlessness commonly causes a sense of anxiety and the sufferer may consciously attempt to change their breathing habits. A natural response is to attempt to take “big breaths” but of course this increases the flow of air into lungs and exacerbates the problems discussed. Anxiety can be particularly damaging, as breathlessness increases individuals may fear they will be unable to take the next breath. This creates a cycle of muscle tension and increased work of breathing by recruiting accessory muscles, leading to fatigue and further anxiety.

5.2.1. ASSESSING DYSPNOEA & BREATHLESSNESS

The main goal of rehabilitation is to improve dyspnoea; hence, quantifying dyspnoea through specific scales is essential in order to describe the level of chronic disability and to assess eventual changes as a result of any intervention (Crisafulli and Clini, 2010). There are 2 main methods used for monitoring your client’s breathlessness, however your independent place of work may use other methods. NICE (2018) state that dyspnoea is the main symptom of COPD and that The Medical Research Council (MRC) dyspnoea scale should be used to grade the breathlessness according to the level of effort which triggers it. Fletcher, whilst observing coal miner’s respiratory limitations in the 1940’s, first gave thought to the idea of quantifying dyspnoea. He devised a short questionnaire that allowed a numeric value to be placed on each subject’s exercise limitations. The questions were first published in 1952 (Fletcher, 1952) and from this the MRC breathlessness scale was devised and has been in widespread use since:

<table>
<thead>
<tr>
<th>MRC Dyspnoea scale (for COPD patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
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<td>3</td>
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<td>4</td>
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<td>5</td>
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</tbody>
</table>

The MRC dyspnoea scale gives a grade of how limiting breathlessness is on a day to day basis, however during the exercise session the BORG breathlessness scale can be used to determine the severity of breathing and therefore monitor intensity and safety of the client. The BORG breathlessness scale is not to be confused with the BORG rating of perceived exertion (RPE) however. The RPE scale is a scale of general physical exertion and typically come in 2 scale forms, 6-20 or 1-10. It quantifies general discomfort during exercise and, although a valid form of exercise intensity analysis, is not as suitable for pulmonary patients as the BORG breathlessness scale which specifically measures breathing difficulty.

The patient should be exercised to a point of breathlessness so that they can not only improve their physical fitness but also become familiar with the feeling of dyspnoea in a supervised and controlled environment. One of the main barriers to exercise efficacy in COPD patients is fear. The fear of severe breathlessness makes patients nervous as they worry they will not be able to recover. When a patient, who had completed their 8-week Pulmonary Rehabilitation course, was asked what the most beneficial aspect of the course was, he responded:

“I used to sit in my lounge bursting for the toilet but too afraid to go up the stairs in case I lost my breath and panicked. Now I know that not only do I not get as breathless as I used to, I can control my breathlessness better, so it doesn’t bother me anymore”.

This is a perfect example of how Pulmonary Rehabilitation, by improving dyspnoea and dyspnoea perception, can improve quality of life in its simplest form.

If you’re talking to a COPD patient about taking control of your life, being the person who dictates how ill or how well you are, exercising is really really important.

Professor Mike Roberts
COPD Audit Lead, Royal college of Physicians
PATIENT INSTRUCTION FOR BORG DYSPNOEA SCALE

“this is a scale that asks you to rate the difficulty of your breathing. It starts at number 0 where your breathing is causing you no difficulty at all and progresses through to number 10 where your breathing difficulty is your breathing causing you right now?”

<table>
<thead>
<tr>
<th>Modified Borg Dyspnoea Scale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Nothing at all</td>
</tr>
<tr>
<td>0.5</td>
<td>Very, very slight (just noticeable)</td>
</tr>
<tr>
<td>1</td>
<td>Very slight</td>
</tr>
<tr>
<td>2</td>
<td>Slight</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td>4</td>
<td>Somewhat severe</td>
</tr>
<tr>
<td>5</td>
<td>Severe</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Very severe</td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Very, very severe</td>
</tr>
<tr>
<td>10</td>
<td>Maximal</td>
</tr>
</tbody>
</table>
5.2.2. MANAGING DYSPNOEA DURING EXERCISE

In COPD patients the exercise should be at an intensity to elicit a 3 to 4 (somewhat severe) on the dyspnoea scale. The patient should be encouraged to recognise when they have achieved level 4 and when they are exceeding it, at which point they should have a strategy of recovery. This may be to stop exercising until they return to comfortable breathing, or to reduce the intensity until they return to 3 on the scale. Sometimes, the patient may slowly walk around, controlling their breathing, until they feel ready to return to the activity, other patients may lean on the wall or sit down and focus their minds on controlling their breathing until they are ready to return to the activity. It is largely the preference of the patient which should determine what action is taken but the important thing is that they can recognise when they should slow or stop to recover their breathing. Below are some “positions of ease” take from “The Lung Institute” which can be shown to the patient but ultimately, they will choose their preferred position or strategy to recover and avoid panic. Once the patient reports above 4 they should rest and recover their breathing through controlling their breathing and using the “pursed lips” technique. Because COPD is an obstructive condition exhaling is difficult, so when breathing is increased through exercise or stress it is difficult to clear the lungs. By using pursed lips, the volume of air entering the lungs is reduced while the volume exhaled is not. This technique not only helps balance the flow in and out but can also focus the mind on controlled breathing patterns and prevent the patient from becoming stressed.

Positions of ease (https://lunginstitute.com/blog/best-positions-to-reduce-shortness-of-breath/)

5.2.3. PACING EXERCISE AND CONTROLLING INTENSITY FOR DYSPNOEA

Duration is too long. Dyspnoea is a common cause of lost exercise efficacy in COPD patients so it is wise that the exercise professional teaches the patient how to avoid it. Firstly, intensity is important and can be controlled in the supervised environment. This can be done by using the BORG breathlessness scale, starting at light, easy to manage intensities and slowly progressing intensity as the patient grows in confidence and efficacy. It is common that after the first exercise session the clients confidence, motivation and efficacy will significantly increase if the session has been comfortable and enjoyable.
is likely they will look forward to their next session. If the session is too hard and the patient becomes very breathless and stressed, it is unlikely they will return.

The classification of airflow limitation will be important in determining the patients exercise capacity. Someone with mild COPD may be able to sustain continuous cycling for 5-10 minutes at a low to moderate intensity before they feel their breathlessness score increasing, whereas someone with more severe COPD may only manage 1 minute. Pacing is when breaks are taken before fatigue or breathlessness rises to uncomfortable levels. You may start with a circuit style programme where the exercise is set at 45 seconds, then a rest is taken for 30 seconds while the patient changes exercise station. The rest period will allow time for recovery at a lower level of physical stress. The patient is likely to work for longer this way than when exercising to a point of breathlessness, resting, then starting again. The latter strategy also requires longer recovery periods which may have implications on heart rate lowering and blood pooling.

The method can be adopted for longer duration exercise such as walking or cycling too. Set a walking/cycling cadence which is comfortable for the patient. In time the patient will get breathless so reduce the speed at set times throughout the exercise.

At a steady, continuous, pace the patient may become breathless after 5 minutes or so but by slowing the speed at 3 minutes for a minute, allowing for some recovery, they will be able to exercise for longer and increase their cardio-pulmonary endurance much better. A good example of this is a 65 year old patient who was referred with COPD.

In the gym he was able to sustain 5-6 minutes of walking before becoming breathless and exceeding level 4. He reported that when he was litter picking (he volunteered in the community) he was out for half an hour to an hour without becoming so breathless as he did after 6 minutes in the gym.

When litter picking he would walk for a minute or 2 before stopping to pick up some litter and put it in the bag. He was also stopping regularly to chat to people who passed by. The exercise was intermittent in nature so allowed him to continue for longer. Pacing the exercise will allow the muscles to exercise for longer and take up more oxygen from the blood, in time they will adapt and you can increase the duration of exercise before putting in the rest period.
Tai Chi is very helpful in teaching relaxation and control of breathing. For people with COPD who have a high level of anxiety, because the sensation of breathlessness is pretty unpleasant, being able to control breathing and reducing anxiety levels is really important.

Professor Mike Roberts  
COPD Audit Lead, Royal college of Physicians
6.1. BRONCHODILATORS

Patients with respiratory disease may be prescribed many forms of medication for many reasons. We have discussed the complex mix of comorbidities which a person on pulmonary rehabilitation may present with and it is likely a typical client will take medication for conditions outside of respiratory disease. These should not be ignored and you should refer to your exercise referral course material for information on exercise considerations for these. The focus of this section will concentrate on the typical medications for Pulmonary disease, when a person is prescribed them and how they may impact on the exercise session.

Note to the instructor- It is important that you have an awareness of the typical medications your client may take, however, it is not your responsibility to be involved in the prescription or administration of medications. Under no circumstances should you independently advise or clear your clients to take or not take their medication. If you feel that for whatever reason your client should change, or reduce their medication you should refer them back to their G.P. or clinician.

Many respiratory drugs are given by inhalation with some given in tablet form. Giving medications by the inhaled route has several advantages over systemic administration: a smaller dose can be used, adverse effects are often reduced, the drug is delivered quickly to lung tissue or the bloodstream, administration is painless, and delivery is usually safe and convenient. NICE state that a combination of drugs should be prescribed with the main bronchodilators forming the back bone of therapy then further pharmceutacle management offered when the patient needs, such as when chest infections are present, symptoms worsen or during and following exacerbations.

6.1. BRONCHODILATORS

These are the most frequently used inhaled medications. Bronchodilators can be subdivided into sympathomimetic (adrenergic) drugs and parasympatholytic (anticholinergic) drugs, as well as being classified as short acting or long acting. The adrenergic drugs stimulate the sympathetic nervous system, while anticholinergic drugs block the parasympathetic system. Adrenergic agents work to cause bronchodilation, anticholinergic drugs block bronchoconstriction.

Short-acting bronchodilators or short actin beta 2 adrenergic agonists (SABA) are effective for 4 to 6 hours and long-acting bronchodilators or long acting beta 2 adrenergic agonists (LABA) generally last about 12 hours. There are many bronchodilators which can be prescribed by clinicians depending on NICE guidance and requirement. Salbutamol is a short acting bronchodilator which acts almost immediately (within a few minutes) and give relief for between 4-6 hours and is delivered by a reliever in either aerosol or a powder.

The most common brand name is Ventolin. It is prescribed for COPD and Asthma.

Salmeterol is a long acting bronchodilator, lasting up to 12 hours but taking slightly longer to take effect (about 20 minutes). They too are used to relieve the airway constriction caused by COPD and Asthma. Salmeterol is also taken as a relieving dry powder inhaler or aerosol.

NICE described the use of salmeterol to be for sufferers of COPD and Asthma who are 5 years and over and include; nocturnal asthma in patients requiring long-term regular bronchodilator therapy, prevention of exercise-induced bronchospasm in patients requiring long-term regular bronchodilator therapy, chronic asthma only in patients who regularly use an inhaled corticosteroid. Salmeterol is typically taken twice a day.

Folmeterol is another LABA licenced by NICE for patients with reversible airway obstruction from COPD and Asthma, nocturnal Asthma and to relieve bronchospasm in exercise induced Asthma. It is delivered by inhalation of a powder.

Salbutamol
Salmeterol
It is important that you have an awareness of the typical medications your client may take, however, it is not your responsibility to be involved in the prescription or administration of medications.
**6.2. ANTICHOLINERGICS**

Anticholinergic medications are bronchodilators which provide relief from bronchospasm and shortness of breath. They are used in treating symptoms of asthma, colds, allergies, and COPD. They block the effect of acetylcholine on airways (bronchi) and nasal passages. Acetylcholine is a chemical that nerves use to communicate with muscle cells. In Asthma and COPD, cholinergic nerves going to the lungs cause narrowing of the airways by stimulating muscles surrounding the airways to contract. The drugs “anti-cholinergic” properties block the effect of cholinergic nerves, causing the muscles to relax and airways to dilate. Mucus glands in the nose are also controlled by nerves that use acetylcholine to communicate and so Anticholinergics are able to prevent the production of mucus by the mucus glands. They can be used alone or in combination with SABA and LABA.

Of the anticholinergic drugs, the most familiar is Ipratropium Bromide (Atrovent). Atrovent is a short acting drug and should be taken every 6 hours in an aerosol. The combination of Salmeterol and Atrovent has a significantly better effect than one or the other alone. A newer formulation of this type of bronchodilator is Tiotropium, which targets more specific muscarinic receptors. Tiotropium promotes bronchodilation for 24 hours. Spriva is perhaps the most prescribed long acting anti-cholinergic. Spriva is taken as a dry powder once a day and lasts for up to 24 hours in most patients. Spriva works in the same way as Atrovent.

Nonetheless, some adverse effects are associated with inhaled steroids. These include oral candidiasis (thrush), hoarseness and changes in the voice, and cough. These problems can be minimized through the use of a spacer with a metered-dose inhaler, along with brushing the teeth and gargling to help reduce residual medication in the oropharynx after using the inhaled medication. Recently developed inhaled steroids provide long-lasting drug coverage that does not require the patient to take multiple puffs from an inhaler, helping to increase compliance.

Fluticasone, Budesonide, and Mometasone have become popular as effective steroids that reduce the number of puffs needed. Budesonide has an advantage over other steroids in that it can be nebulized.

**6.3. CORTICOSTEROIDS**

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**6.4. ANTIBIOTICS**

Pulmonary patients are open to chest infections and as such antibiotics may be a feature of your clients pharmacetical management from time to time. They should usually be prescribed a short course to deal with the infection however if chest infections persist a longer term dose may be given.
6.5. MAST CELL STABILIZERS

Used for Asthma these stabilize Mast cells. Mast cells are formed in the bone marrow and locate themselves in the bodies tissues, particularly at mucosal surfaces of the gut and lungs, in the skin and around blood vessels. They are important in our defensive systems as each mast cell contains secretory granules (storage sacs), each containing powerful biologically active molecules called mediators. These can be secreted when mast cells are triggered, leading to allergic and inflammatory diseases. Mast cell stabilizers act by preventing the secretion of these granules and therefore preventing the release of Histamine and other inflammatory agents which exacerbate or trigger Asthma.

6.6. OXYGEN THERAPY

Your client may use oxygen therapy during exercise if their oxygen saturation levels drop to below 88% or in those with a resting partial pressure of oxygen in arterial blood (PaO₂) <55 mmHg. This will usually have been assessed and prescribed at hospital rehabilitation or by clinical assessment. Ambulant oxygen therapy is delivered with a tank held on the client's back by a cannister holster. The oxygen is delivered through a nose canulae or small mask. NICE and British Thoracic Society guidelines have extensive guidance on the assessment for and the administration of oxygen therapy while at rest and for exercise. Severely affected patients with advanced disease may require Oxygen while at rest, however it is likely that your client will only use oxygen for the exercise session and on personal exertion. It is unlike that in your community rehabilitation programme a client will require acute oxygen therapy, however this is worth discussing with your clinical referral team and may be a reason for exclusion from your scheme if trained staff are not available to administer the oxygen if required.

6.7. EXERCISE IMPLICATIONS WITH RESPIRATORY MEDICATIONS

It is essential that your client has their reliever with them when they arrive at the training facility. If they do not have their SABA they should not exercise. In some Asthma clients, who have very mild Asthma, the same is true however it is quite common that due to their minimal or infrequent symptoms they will argue for the opposite. Regardless of how they feel about bringing their inhalor, the instructor must insist they bring it with them at all times. Short-acting β-adrenergic agonists are generally well tolerated, but commonly increasing blood pressure and heart rate is observed following its administration and can have side effects of tachycardia, palpitations, and anxiety. The incidence and severity of its side effects depend on the dosage, route of administration and the presence of comorbidities such as hypertension, cardiac tachyarrhythmias and coronary heart disease. It is wise to monitor your clients heart rate and blood pressure before they begin exercising to check that they are safe to exercise. Patients who are poorly educated in taking their medication can administer too frequently or too much and as a result can become tachycardic or experience palpitations which require a physicians investigation before participating in an exercise programme. Other side effects of respiratory medication include: Shakiness, headache, dizziness, dry mouth and feeling anxious. It is important that you screen for these side effects and design your programme of exercise in response to any experienced by the client. Ensure your client is cool and hydrated throughout the session as they can become quickly over heated if the intensity is quite high. Obviously, dizziness can leave the client confused and disoriented and quick transitions of movement should be avoided. Take care or avoid lying the client down if they are experiencing dizziness and avoid standing up quickly, instead encouraging them to take their time. If floor work is used they should be taught how to get down and rise slowly and safely, using a tool of support such as a chair. Turning the body around in circles, as may be encouraged in a group aerobics type class, should be avoided as this may cause dizziness and if the client is elderly will be a falls risk anyhow. Take the co-morbidities into consideration and the medications for the other conditions your client takes. Hypertension is common as is musculo-skeletal morbidity and the drugs use to manage these can affect exercise consideration quite a lot. Beta blockers restrict maximal heart rate significantly and RPE should be chosen to monitor work intensity over heart rate. Other anti-Hypertensives can cause hypotension, dehydration (in the case of diuretics) and muscle cramps. Again standing up too quickly, especially from a lying position, can cause syncope (fainting), particularly in those with low blood pressure and who are elderly. If the client uses corticosteroids frequently there are implications to muscle and connective tissue weakness, muscle soreness and cramps and osteoporosis. Ensure your range of motion is not to large and does not pass level to the joint, the weight is not too heavy and avoid ballistic and high impact movements which cause “jerking” to the joints or create high forces through the bones. Warm ups typically should be prolonged to 15 minutes, be very gradual and progressive to allow the respiratory and cardiovascular systems to adapt sufficiently, as should cool downs. Upper body work such as arm ergometry and shoulder press cause an increase in respiratory and cardiovascular workload and increase cardiac output rapidly so use sparingly (details will be discussed later).
6.8. MANAGING EXACERBATIONS

GOLD defines an exacerbation of COPD as ‘an acute event characterised by a worsening of the patient’s respiratory symptoms that is beyond normal day-to-day variations and leads to a change in medication’. People with COPD experience between one and four exacerbations per year.

A recent paper published a review into exacerbations of COPD (Viniol and Vogelmeier, 2018) and stated that recurrent exacerbations had a significant influence on poorer survival outcomes. The paper highlights the triggers of exacerbations to be smoking, severe airflow limitation, bronchiectasis, bacterial and viral infections. Exacerbations of COPD and Asthma can be serious and often require hospitalisation and it is suggested that patients should be educated on the risks and signs of them.

It is sometimes difficult to see the signs of a chest infection or worsening symptoms, particularly in COPD as the person is more often than not breathless most of the time.

The environment plays a large role in symptoms, cold weather, unclean air and stress can all bring on or worsen breathlessness and patients may ignore significant signs, due to the inconsistent nature of the disease. In 2017 GOLD refined the ABCD assessment tool to bring frequent exacerbators (> 2 or 1 hospitalisation in the last year) to category C and D, meaning that treatment warrants bronchodilation and anti-inflammatory inhaled corticosteroid intervention, category A and B should not be given corticosteroids and will now be categorised as having < 1 exacerbation in the last year.

NICE have produced some guidance on managing exacerbations and how to help keep them to a minimum, some of the information is highlighted below:

• The frequency of exacerbations should be reduced by appropriate use of inhaled corticosteroids and bronchodilators, and vaccinations.

• The impact of exacerbations should be minimised by: giving self-management advice on responding promptly to the symptoms of an exacerbation; starting appropriate treatment with oral steroids and/or antibiotics; use of non-invasive ventilation when indicated; use of hospital-at-home or assisted-discharge schemes.

6.9. EXERCISE AND EXACERBATIONS

It is unlikely that your client could or should exercise whilst suffering an exacerbation. A Cochrane review involving 1477 patients found that pulmonary rehabilitation following an exacerbation had substantial favourable outcomes on exercise capacity and quality of life. On mortality and further hospitalisation results were found to be mixed with some showing a sound benefit and others not, leading the authors to down grade the evidence in these 2 categories as only moderate.

There is no doubt that your client should return to rehabilitation once their exacerbation has ceased, so long as their physician deems them safe to. Studies show that very low level strength and mobility exercise as early as during hospitalisation have benefits and are safe with no see adverse effects, however during this early period moderate or high intensity should be avoided. On leaving hospital however the patient should and can return to typical rehabilitation (Holland, 2014). On return it is important to pace the exercise, as discussed later in this manual, and monitor your clients breathlessness and discomfort. If they have been away for a long time it may be wise to re-assess their capacity and strength, co-morbidities, general health and fitness status and review their medications.

“A COPD patient at the end of a formal Pulmonary Rehab programme might be able to walk 30% further than they were able to do before without feeling that level of breathlessness, their fitness and muscle strength has build up through an exercise programme”

Professor Mike Roberts
COPD Audit Lead, Royal college of Physicians
Pulmonary rehabilitation adds values by helping people specifically with efficient breathing. I come across a lot of people who are very breathless because they have got hyperinflation. How do you try and help somebody get over that? The first thing to do is reduce the respiratory rate, going at a slower pace. What you need to do is spend more time breathing out, and less time breathing in. It’s the breathing out that’s difficult.

Professor Mike Roberts  
COPD Audit Lead, Royal college of Physicians
Both the British Thoracic Society and NICE have stated that all patients who meet the inclusion criteria for pulmonary rehabilitation should be offered a place at their local scheme. They state that success is largely dependent on the clinicians involved at the point of diagnosis or referral. Information and education about the scheme, the benefits of taking part in it and their concerns discussed. They suggest that a lack of understanding may play a role in poor take-up of schemes.

Clinicians should discuss what the patient hopes to achieve from the scheme and should encourage uptake and aid motivation. The patient, after being clinically assessed, will be referred to a local pulmonary rehabilitation scheme where Physiotherapists, Nurses or Exercise Physiologists carry out assessments of quality of life, exercise capacity and take a detailed history of exercise and lifestyle. It may be so that at some schemes Level 4 exercise practitioners will be involved in this screening and testing process as schemes across the UK are responsible for their own management. Schemes typically run for between 6 – 12 weeks, although, again, this varies. Throughout the intervention the clients will be monitored for safety and progression. Pulmonary rehabilitation requires a larger staff to client ratio than a normal exercise class so usually there is a team of clinicians and exercise professionals involved. Courses in medication, nutrition, behaviour change and understanding the condition are delivered as part of the intervention and smoking cessation will form an important service for some. Details of responsibilities and roles are discussed later. Once the client has completed the intervention they will be moved on to a maintenance class, if one is available, however due to budget strains these are becoming more difficult to keep going and practitioners are looking for other pathways to signpost their successful patients to. One option is exercise referral.

7.2. EXERCISE REFERRAL: AN UPDATE OF PROCESSES

Recent Professional Standards for Exercise Referral assembled by a Joint Consultative Forum have stipulated that a major goal for exercise referral is to be long term behaviour change, something previously that has not been a major objective.

To that end in the hope to motivate more GPs to refer to schemes, a low risk category has been introduced.

Low risk populations may be referred to a referral scheme but can carry out an array of activities such as walking groups and group exercise classes which are monitored and structured, but do not necessarily require supervising by a REPs level 3 referral practitioner.

This has now seen the inclusion of a Moderate risk.

Moderate risk participants can be referred with stable and controlled chronic conditions and will be supervised during exercise by a qualified level 3 referral instructor.

Finally, high risk populations have unstable conditions or are part of a rehabilitation programme, such as Cardiac, Pulmonary and Stroke rehabilitation.

Participants classed as high risk should be supervised by an appropriately qualified level 4 practitioner, whose qualification must correspond to the condition in question.

Very few clients are referred with one condition and the combination of co-morbidities in respect of risk stratification should be considered in relation to whether the skill set of the staff meet the relevant criteria to deal with the participants (regarding the referral, this is down to the discretion of the referrer).
7.3. WHO’S INVOLVED?

It is also highlighted in the new guidance that a referrer does not need to be a GP necessarily. Any medical or allied health care professional is welcome to refer to a scheme should they deem it beneficial to the patient, this would include physiotherapists, nurses, dieticians, occupational therapists, specialist care units (e.g. cancer, stroke, pulmonary). The British Heart Foundation stipulate that ultimately it is the responsibility of the scheme or service to set inclusion/exclusion criteria based on their facilities and skill set within the staffing and referrers should be made aware of this when being approached.

7.4. PULMONARY REHABILITATION STRUCTURE

It is very important that as an exercise professional specialising in the rehabilitation of any medical condition, you are aware of the processes and systems in place. This includes medico-legal aspects, the referral structure, who can refer into your scheme and who to ask if you seek help and support. As mentioned earlier, many clinicians can refer into an exercise referral scheme but in the case of specific conditions, including pulmonary disease, patients/clients will often be assessed at the clinical level, by doctors, exercise physiologists or physiotherapists and will likely have completed a course of low level exercise prescription before being referred to your scheme.

You should make a point of knowing and forming a relationship with the clinical team and your local pulmonary rehabilitation structure will have a person or team who co-ordinate the process and who you should contact if you need support or need to refer patients back to if you feel their condition is worsening, not improving or if they develop new symptoms or co-morbidities.

Pulmonary rehabilitation should consist of a multi-disciplinary team and offer a collection of services which aid management of the disease and reduce symptoms. Gloeckl et al. (2018) suggest the following:

COMPONENTS OF A PULMONARY REHABILITATION SCHEME

**TREATMENT OPTIMIZATION**
(medication, incl.long-term oxygen therapy)

**EXERCISE TRAINING**
+ Breathing retraining/physiotherapy

**EDUCATION AND INSTRUCTION**
(Inhalation technique, nutritional advice, etc)

**NON-INVASIVE VENTILATION**
+ training (optional)

**SMOKING CESSATION**

**EXACERBATION MANAGEMENT**

**COPD REHABILITATION**

**Fig. 10**
Clinicians should discuss what the patient hopes to achieve from the scheme and should encourage uptake and aid motivation.
7.5. THE REFERRAL FORM SHOULD CONTAIN THE FOLLOWING INFORMATION:

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To that end in the hope to motivate more GPs to refer to schemes, a low risk category has been introduced. Low risk populations may be referred to a referral scheme but can carry out an array of activities such as walking groups and group exercise classes which are monitored and structured, but do not necessarily require supervising by a REPs level 3 referral practitioner.

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- Main diagnosis and significant co-morbidities
- Oxygen requirements
- Smoking history
- Medication
- Lung function (FEV1 % predicted and FEV1.FVC (%)
- Exercise tolerance (distance achieved, heart rate at rest and post-test/s breathlessness score pre and post-test/s, reasons for termination of test and oxygen saturation)
- Pre and post exercise test e.g incremental shuttle walk test (ISWT), 6-minute walk test or endurance shuttle walking test) (indication as to whether undertaken with or without oxygen)
- Exercise completed during pulmonary rehabilitation (frequency, intensity, type and duration)

7.6. PHYSICAL DATA COLLECTION

It is important to gather the correct and complete information before starting the training intervention. Incorrect or incomplete information may lead to inaccurate planning and programming and in the case of exercise referral could have serious implications. To help from a process of data gathering the acronym SOAPP is often used:

**Subjective data:** referral form, screening, interview, history, disease, symptoms, identify what is wrong, limitations, medication;

**Objective data:** use subjective data to determine which physical tests are required

**Assess:** carry out the assessment and identify strengths/weaknesses, training parameters

**Plan:** using the prioritised problems, draw-up an action plan, but again prioritise the requirements of the individual case.

**Programming:** design the exercise priorities from all of the information gathered.

In terms of Pulmonary Rehabilitation, the 6-minute walk test and Incremental shuttle walk test (ISWT) are commonly used as directed by guidelines but a strength test may also be considered. Of course, co-morbidities are very prevalent and can often be more debilitating and limiting than the primary reason for referral (dyspnoea), so balance, pain, anxiety and depression and body composition are all measures you might consider. It must be noted however, that time and facilities often limit what you are able to do. For example, in an ideal world the 6-minute walk test would be carried out on a 30 meter course, however it is rare a facility has this much space so 10 meters is often used.

Most pulmonary rehabilitation schemes are focused on specific measures of COPD limitation.

Some tests may not be suitable for your patient. For example, when using skin-fold calipers to analyse somebody’s body-fat, care must be taken not to embarrass the patient, as they may already have low self-esteem or dislike the way they look and not want to reveal their body in front of you.

Regularity of testing depends largely on what is being tested. For example, mobility of the shoulder will progress on a weekly basis however strength or cardiovascular fitness requires several weeks.
to show a significant improvement. Typically, a 6-minute walk test will be carried out every 4-6 weeks, strength a little longer (6-8 weeks), whereas monitoring blood pressure and heart rate may be done every week.

7.7. INTERACTING APPROPRIATELY WITH PULMONARY REHABILITATION SPECIALISTS

It is highly conceivable that in your role as a specialist exercise professional you will, and should, regularly interact with clinicians and people of field expertise. This could be at the start when you are building your referral base or throughout when receiving referrals or asking about patients and practices. It is important that from the start you agree a named link with a clinical individual or team from Pulmonary Rehabilitation that you can contact with questions and for details about patients/clients. It is important that you are aware of local protocols used when transferring patients from clinical rehabilitation to a long-term maintenance scheme and the support that is available to you. You must therefore present yourself in a respectable, professional manner and although you should not be intimidated, you should address the clinician with the respect they deserve and in turn you can expect the same.

It is accepted that you are not a doctor or specialist, but the medical professional will expect you to have some, appropriate, level of knowledge in the subject area and to be able to discuss in an appropriate level of dialect. The clinician maintains the clinical responsibility in your relationship but is not an expert in exercise testing, programming or delivery and will therefore expect you to lead conversation in these matters. In the past clinicians and referrers have become frustrated with exercise referral schemes who have referred patients back to them unnecessarily. Therefore, you must know appropriate times and circumstances to refer a patient back. Should the patient’s condition worsen, should they form new symptoms or persistent medical complaint, should they psychologically deteriorate, or should you suspect their medication is not doing what you would expect it to do (e.g. lower B.P.), then you are probably warranted to make a referral back to their G.P.

Consultations and barriers to communication

Once you have received a referral you must then arrange an initial consultation to meet your new client and to discuss their needs and plan the journey ahead. This is your opportunity to put the client at ease and make them feel welcome. They may be very intimidated and, in some cases, anxious of meeting you as they will not know that exercise referral is very different from the typical gym experience. You are essentially selling exercise to them but not in the traditional salesman approach. Going from a very clinical exercise environment where physio’s, nurses and physiologists are present to look after them, to a gym-based environment can be daunting and barriers will have formed within the client about you and your intervention. In exercise referral personality is key to breaking down these barriers. A big smile and open, welcoming approach will go a long way but once in the consultation it is good to demonstrate a little of your knowledge to the client to show that you do actually understand their unique situation.

“I see your 6-minute walk test was very good and you managed 300 meters, well done. Do you get more breathless when you go up a slight incline or perhaps when the weather is colder?”

This is a very simple statement to make and requires little complex knowledge but to the client, who is concerned about your understanding of their condition, it is relatable and demonstrates that you have insight into how their condition affects them from day to day. You can discuss their medications...

“So, I see you have 2 inhalers, a blue and brown. Do you take your brown one in the morning and then the blue one as you need throughout the day?”

Again, this is not complex clinical terminology but demonstrates to the client that you have a level of knowledge and understanding, and this will help them to build their efficacy in you. The key thing is that they leave the first session having had a nice and fun time and are calmer than when they arrived.

Although useful to demonstrate an understanding you must also take the persons feelings into consideration. Remember they may have never entered a gym before so it is important to be empathic and caring without patronising them.

Try to pick up the persons personality quickly and address them accordingly. Are they very anxious? Are they impatient and frustrated that they have to be there? Are they confident and professional? Are they having a laugh and a joke from the moment they enter the room? All these personality traits warrant a different approach and by picking up on them you will help lower the barriers and form a meaningful and successful relationship. There are more helpful tips of how to form relationships and address barriers in the “motivation and behaviour change” section.
“I see your 6-minute walk test was very good and you managed 300 meters, well done. Do you get more breathless when you go up a slight incline or perhaps when the weather is colder?”
8.1. THE 6-MINUTE WALK TEST (6MWT)

The 6-minute walk test is used to demonstrate the distance walked by the patient/client in the 6-minute time limit. Guidelines state that a 30m straight course should be set up for the participant to walk between but alternative protocols are common in Pulmonary Rehabilitation due to space and time restrictions. A 2015 study however found that the 10m course provokes significantly shorter distances than the recommended 30m track (Singh et al., 2015).

Suggested Equipment:

- 6MWT recording form
- Cones
- Stop watch or timer
- Chairs (put out at even stages over the course)
- Sphygmomanometer and stethoscope, or similar method of accurately assessing BP
- Trundle wheel or 30m tape measure for measuring the 6MWT track and the distance walked
- Pulse oximeter for measuring heart rate and SpO2
- RPE scale

The client:

- Comfortable clothing
- Appropriate shoes
- Walking aid (should be used)
- Take medication as usual
- No vigorous exercise prior to test

Repeat measures

Two 6MWTs are often recommended for initial assessments due to a learning effect when performing the test. Recent studies have demonstrated however that a single measure is often acceptable.

Should you choose to do repeat measures in succession, this should be done each time so that measures are consistent and a duration of at least 15 minutes provided between tests to allow adequate recovery. Often however musculo-skeletal pain is the main cause or a contributor to stopping the test, in which case it is unwise to repeat the test.

Administering the test

1. Prior to walking say to patient:

   “The object of this test is to walk as FAR AS POSSIBLE for 6 minutes. You will walk back and forth along this course (demonstrate one lap) for six minutes. You may slow down if necessary. If you stop, I want you to continue to walk again as soon as possible. You will be informed of the time and encouraged each minute. Please do not talk during the test unless you have a problem or I ask you a question. You must let know if you have any chest pain or dizziness. When six minutes is up I will ask you to STOP where you are. Do you have any questions?”

2. To begin say to patient:

   “Start now, or whenever you are ready (start stopwatch when walking starts).”

3. During the test:

   Provide the following standard encouragements in even tones. Do not use other words of encouragement or body language to speed up.

   At 1 minute: You are doing well. You have 5 minutes to go.
   At 2nd minute: Keep up the good work. You have 4 minutes to go.
   At 3rd minute: You are doing well. You are halfway done.
   At 4th minute: Keep up the good work. You have only 2 minutes left.
   At 5th minute: You are doing well. You have only 1 minute to go.
   At 6th minute: Please stop where you are.
If the patient stops during the test:

Allow the patient to rest or sit in a chair if they wish, and check SpO2 and heart rate. Ask the patient why they stopped.

Keep the stopwatch running and advise: Please resume walking whenever you feel able.

4. At the end of the test:
Record the total distance walked in meters.

8.2. THE INCREMENTAL SHUTTLE WALK TEST (ISWT)

The test should be carried out twice in order to allow for a learning effect. The second test is used as the baseline distance. The patient is required to walk around two cones set 9 metres apart (so the final track is 10 metres) in time to a set of auditory beeps played on a CD.

Initially, the walking speed is very slow, but each minute the required walking speed progressively increases.

The patient walks for as long as they can until they are either too breathless or can no longer keep up with the beeps, at which time the test ends.

The number of shuttles is recorded. Each shuttle represents a distance of ten metres (i.e. each time the patient reaches a cone is 1 shuttle).

Record, heart rate, blood pressure and Rating of Perceived Exertion (RPE). Record recovery time to gain additional information. If the patient ceases the test prematurely, record the reason for stopping. The patient should remain in a clinical area for at least 15 minutes following an uncomplicated test.

The patient should remain in a clinical area for at least 15 minutes following an uncomplicated test.


Note: to access the test and for further information about the test and test protocol visit:
www.leicestershospitals.nhs.uk/aboutus/departments-services/pulmonary-rehabilitation/for-health-professionals/incremental-shuttle-walk/
8.3. BODE INDEX

The BODE Index, representing Body Mass (index), Obstruction, Dyspnoea and Exercise, is a 0-10 scale to estimate mortality in patients with COPD. It is a practical tool which considers the 4 components it represents and has shown to be a more accurate predictor of mortality than FEV1 alone.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Points on BODE Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>FEV1 (% of predicted) *</td>
<td>≥65</td>
</tr>
<tr>
<td>Distance walked in 6 mins (m)</td>
<td>≥350</td>
</tr>
<tr>
<td>MMRC dyspnea scale **</td>
<td>0-1</td>
</tr>
<tr>
<td>Body-mass index ***</td>
<td>&gt;21</td>
</tr>
</tbody>
</table>

The cutoff values for the assignment of points are shown for each variable. The title possible values range from 0 to 10. FEV1 denotes forced expiratory volume in one second.

* The FEV1 categories are based on stages identified by the American Thoracic Society.
* * Scores on the modified Medical Research Council (MMRC) dyspnea scale can range from 0 to 4, with a score of 4 indicating that the patient is too breathless to leave the house or becomes breathless when dressing or undressing.
* * * The value for the body-mass index were 0 or 1 because of the inflection point in the inverse relation between survival and body mass index at a value of 21.

8.4. STRENGTH TESTING

8.4.1 One repetition max (1RM)

Muscle atrophy and loss in strength and related function can be a significant factor in patients with COPD and associated co-morbidities. It may therefore be useful to gain an understanding of strength levels in the client. As you will see later on many exercise guidelines are set at %’s of 1RM, so in this instance you will need to know what the 1RM is to accurately set the intensity suggested.

Despite previous concerns, various 1RM tests have been shown to be a safe and reliable measure of strength in young children (6-12 years), adolescent athletes, healthy trained and untrained adult, untrained middle-aged individuals (50-52 years), post-menopausal women (54-60 years), patients with cardiovascular disease, and individuals aged 75+ as well as in patients with COPD (Zanini et al., 2015). As this test is simple, time effective, inexpensive, and reliable, it is a very popular testing protocol, however Zanini et al., found the 30 second sit to stand test as reliable at measuring muscle function in patients with mild to severe COPD, the sit to stand test was also more tolerable and quicker to administer. The sit to stand test only measures muscle function of the lower limbs however!

Before carrying out a 1RM test one must consider the population to be tested and the safety of carrying out particular exercises. A back squat for example requires a sound training base with skill and technique, indeed the use of free weights to test strength might best be avoided in elderly clients with no or minimal gym experience and those with chronic morbidity.

A 1RM test can be carried out on a resistance machine such as a chest press, leg extension or leg press machine and will be a safer option for the less experienced exerciser.
As this test is simple, time effective, inexpensive, and reliable, it is a very popular testing protocol.
Perhaps a more tolerable method of assessing 1RM is to use a co-efficient method such as that of Bryzicki formula. This method means 1RM can be calculated based on a sub maximal lifting outcome. The client must stop due to fatigue within 10 repetitions (again, there is an element of guessing the weight but this is much easier than the previous method). This formula first appeared in a paper entitled Strength testing: Predicting a 1-rep max from reps-to-fatigue, in a 1993 issue of the Journal of Health, Physical Education, Recreation and Dance and has since been validated as reliable. This formula is reasonably accurate, for many people for up to around ten reps.

Protocol

1. Estimate a weight which the client will fail on within 10 reps (this can be done by using the warm up or previous sessions.

2. Once you have the weight take the rep that failure occurred at and go to the table of co-efficient. Times the weight by the co-efficient of the rep which the client failed at, so, if the client lifted 20kg and failed at 8 reps you would times 20 by 1.242 (the co-efficient of 8).

<table>
<thead>
<tr>
<th>Reps performed</th>
<th>Multiplication coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000</td>
</tr>
<tr>
<td>2</td>
<td>1.029</td>
</tr>
<tr>
<td>3</td>
<td>1.059</td>
</tr>
<tr>
<td>4</td>
<td>1.091</td>
</tr>
<tr>
<td>5</td>
<td>1.125</td>
</tr>
<tr>
<td>6</td>
<td>1.161</td>
</tr>
<tr>
<td>7</td>
<td>1.200</td>
</tr>
<tr>
<td>8</td>
<td>1.242</td>
</tr>
<tr>
<td>9</td>
<td>1.286</td>
</tr>
<tr>
<td>10</td>
<td>1.330</td>
</tr>
</tbody>
</table>

So, another example, if you could use 200 lbs. for five reps then you would get around 200 x 1.125 = 225 lbs.
8.4.3 HAND GRIP STRENGTH TEST

An even simpler test would be a hand help dynamometer. Hand grip strength can be quantified by measuring the amount of static force that the hand can squeeze around a dynamometer. The force has most commonly been measured in kilograms and pounds. Many studies have found the test to be reliable at measuring a person’s overall strength and even to predict morbidity in later life (Bohannon, 2008).

Protocol
The subject holds the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer is adjusted if required - the base should rest on first metacarpal (heel of palm), while the handle should rest on middle of four fingers. When ready the subject squeezes the dynamometer with maximum isometric effort, which is maintained for about 5 seconds. No other body movement is allowed. The subject should be strongly encouraged to give a maximum effort (Topendsports.com).

8.5. OTHER MEASURES FOR CLIENT SAFETY

Although it is very important to gather information about your client by way of physical measures it is also essential that you know they are working at suitable intensities. This can indeed be done with RPE and Borg Breathlessness scale but simple observations can be used whilst your client is training.

Talk test
The client should be able to hold a conversation with you whilst exercising without having to pause for long moments. It is fine that the voice may be somewhat labored but significant breaks in conversation to catch breath suggests the intensity is too high. Of course, in COPD patient’s, breathlessness is expected so if you suspect it is unusual also use observation.

Observation
By simply observing the clients facial colour, general demeaner and posture/gait change you can assess whether the intensity is becoming too much for them. If you suspect this follow up your observations with another more quantitative test such as the BORG breathlessness scale or RPE.

8.6 QUESTIONNAIRES USED IN PULMONARY REHABILITATION

8.6.1 St Georges Respiratory Questionnaire and the Chronic Respiratory Disease Questionnaire

These two disease specific quality of life questionnaires are widely used in patients with COPD: the Chronic Respiratory Disease Questionnaire (CRQ) developed by Guyatt et al. in 1987 and the St George’s Respiratory Questionnaire (SGRQ) developed by Jones et al in 1991. The SGRQ is a self-administered questionnaire whereas the CRQ was developed to be interviewer-administered (at a later stage a self-administered version of the CRQ became available). Both questionnaires have been used to assess the effects of interventions such as drug therapies, oxygen therapy, and pulmonary rehabilitation or training programmes. The forms have been validated many times since their first development.

8.6.2 HOSPITAL, ANXIETY, DEPRESSION SCALE (HADS)

The Hospital Anxiety and Depression Scale (HADS), is a self-assessment scale, and was developed to detect states of depression, anxiety and emotional distress amongst patients who were being treated for a variety of clinical problems. The scale was not designed to be a clinical diagnostic tool (Whelan-Goodinson et al. 2009). Originally the scale consisted of eight questions relating to depression and eight relating to anxiety.

Initial findings indicated that one of the items on the depressions scale was weak, so it was removed. Remaining items on the scale had high correlations with strong significance.

8.6.3 SHORT FORM 36 (SF-36)

The 36-Item Short Form Health Survey (SF-36). SF-36 is a set of generic, coherent, and easily administered quality-of-life measures. These measures rely upon patient self-reporting and are now widely utilized by managed care organizations and by many departments in the NHS for routine monitoring and assessment of care outcomes in adult patients.

The form has been validated many times and has been deemed a useful, easy to use form of gathering relevant information on quality of life.
Although not a co-morbidity as such, ageing and the effects of ageing cannot be ignored when discussing COPD. As discussed, COPD is a disease most prevalent in the 60+ age group and so it is therefore beneficial that you have an understanding of how our physiological processes are affected by ageing and what considerations should be present when forming an exercise programme for the elderly. The older the individual the more impairment you can expect in terms of physiological demise, cognitive impairment and morbidities. Ensure the exercise is gradual and emphasises fun as well as physical aims. Social isolation is an important aspect to consider and introducing a new client to a group class or activity may help in more ways than you may think.

9.1. ADVANCING AGE

It is unlikely clients will present with just respiratory disease alone. Most, if not all will have multi-morbidity- a collection of diseases which may or may not relate to COPD. Many organisations, including the British Thoracic Society, state that those with more co-morbidities tend to have the least beneficial outcomes from pulmonary rehabilitation. It is therefore important to have an understanding of some of the common co-morbidities you will be exposed to on pulmonary rehabilitation.

9.1.1. THE CARDIOVASCULAR SYSTEM-

The greatest factor to reduced performance in the elderly is the inability of the heart rate to rise (HRmax). A Masters athlete can maintain the physiological performance of a younger person in terms of strength, VO2max and power, however cannot match their maximal heart rate.

This inability to raise the heart rate means aerobic capacity is naturally “capped” to that of the HRmax. There are many factors which contribute to this but the reduced availability of catecholamines and the slowing down of the hearts natural pace maker are possibly the 2 most significant. The heart becomes “stiffer” as cardiac cells are lost and replaced by collagen tissue, there can be enlargement of the heart as surviving cells enlarge in attempt to compensate.

This means the heart cannot stretch as it once could, and stroke volume and ejection fraction are lowered placing an impact on cardiac output. The vasculature stiffens through Arteriosclerosis and pulse wave velocity increases. The less compliant arteries increase systolic blood pressure and trauma to the intima of the arteries increases putting the person at increased risk of coronary heart disease. In a performance context however, oxygen perfusion from the coronary arteries is slower and less, meaning that for each cardiac cycle the heart receives less oxygen.
9.1.1. THE CARDIOVASCULAR SYSTEM

Peak bone mass occurs at around 25-30 years of age and the rate of bone mass loss then depends on several factors such as peak bone mass, lifestyle, exercise history, gender and family history. The balance of bone formation vs. bone degradation shifts to allow more osteoclast formation than osteoblast. Cartilage and connective tissue degrades and the person is put at risk of Osteoarthritis and Osteoporosis.

Considerations—Exercise range of motion should be controlled and not excessive. If at risk of Osteoporosis high impact exercise may be contra-indicated. Encourage weight bearing exercise for bone formation. Avoid ballistic exercise with uncontrolled movement.

9.1.2. SKELETAL SYSTEM

Peak muscle mass occurs at about 30 years of age and from there an average of 1.5% is lost per annum. Loss of satellite cells which regenerate muscle tissue means that trauma cannot be addressed as well and sarcomeres begin to be lost. Sarcopenia (muscle atrophy through advanced age) accounts for impairment of strength, power, balance and even VO2 max as well as a reduction in natural energy expenditure and weight gain. Fast twitch fibres are lost quicker and earlier than slow twitch, so strength is reduced first but in later life slow twitch loss will cause increased fatigue especially in the sedentary. The muscles become less elastic as muscle tissue is replaced with collagen and intra muscular fat.

Considerations—Warm up and cool down should be extended to 15 minutes of gradual exercise to allow for a slower cardiac response and to gradually increase oxygen perfusion to the heart and peripheral muscles. Use duration rather than intensity for progression in the early stages as sharp increases in intensity may cause an oxygen “lag” and quickly fatigue the client. Allow for breaks and self-pace the exercise. Ensure hydration is available.

9.1.3. MUSCULAR SYSTEM

Cardiac structural changes with advancing age
• Aortic inflammation and calcification
• Increased peripheral resistance/increased pulse velocity wave
• Increased afterload (pressure after contraction)
• Increased preload (pressure as volume of blood fills the heart/stretch)
• Increase LV pressure
• Myocyte death/larger myocytes in response
• Reduced elasticity of myocardium in response
• LV remodelling and fibrosis (cross-linking)
• Reduce number of micro vessels
• Reduced sympathetic activity

Considerations—Warm up and cool down should be extended to 15 minutes of gradual exercise to allow for a slower cardiac response and to gradually increase oxygen perfusion to the heart and peripheral muscles. Use duration rather than intensity for progression in the early stages as sharp increases in intensity may cause an oxygen “lag” and quickly fatigue the client. Allow for breaks and self-pace the exercise. Ensure hydration is available.

You’re with other people who help you to motivate yourself, where there’s diffusion of personal stories. If you’re in a group of people with similar lung problems, the support you get from that is incredible.

Professor Mike Roberts
COPD Audit Lead, Royal college of Physicians
SECTION 9- CO-MORBIDITIES

9.1.4 NEURAL

Perhaps the biggest effect is the loss myelin sheath and neuron number seen with advancing age. As with muscular system the biggest, fastest neurons perish first, gradually followed by those which control proprioception and posture. The ability to sense and react to change is slowed, therefore impairing co-ordination, balance and reaction time. Considerations- Patience in teaching new skills, take care in prescribing complex exercise. Encourage balance exercise in a safe way. Encourage reaction and co-ordination exercise but start easy and slowly progress difficulty.

Sensory
The subject holds the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer is adjusted if required - the base should rest on first metacarpal (heel of palm), while the handle should rest on middle of four fingers. When ready the subject squeezes the dynamometer with maximum isometric effort, which is maintained for about 5 seconds. No other body movement is allowed. The subject should be strongly encouraged to give a maximum effort (Topendsports.com).

9.2 HEART FAILURE

COPD and Congestive Heart Failure (CHF)
CHF exists in about 20% of COPD patients and the risk of developing CHF is 4.5 times greater in patients with COPD than in disease free controls after adjusting for age and other risk factors (Hawkins et al., 2013). Congestion within the lungs due to COPD creates back pressure as the right ventricle attempts to pump blood into the lungs. This causes an increase in mean pulmonary artery pressure (mPAP) and the result is accumulating fluid in the peripheral veins (peripheral oedema). Swelling of the legs and ascites is common and as the right ventricle attempts to compensate it weakens and remodels over time leading to lost compliance (Oize et al., 2013).

9.3. CORONARY HEART DISEASE (CHD)

Patients with COPD are at a greater risk of CHD due to cigarette smoking and other lifestyle factors, but aside from these independent risk factors, COPD alone is associated with increased prevalence of CHD and cardiovascular disease (CVD). COPD is associated with low grade systemic inflammation and increased C-reactive protein levels (an inflammatory marker in the blood) which suggests an influence on increased cardiac risk.

9.4. OVERLAP SYNDROME

Overlap syndrome is the combination of Obstructive Sleep Apnoea (OSA) and COPD. Sleep apnoea is a common condition which causes pauses in breathing when asleep. If untreated it can be serious and the sufferer can stop breathing hundreds of times in the night causing lost oxygen to the body and brain, leading to daytime fatigue and cognitive impairment. Overlap syndrome is the occurrence of sleep apnoea in conjunction with COPD and is associated with endothelial dysfunction, inflammation and increased rate of vascular damage (Atherosclerosis). OSA is also thought to cause insulin resistance, hypertension and other forms of cardiovascular disease (e.g. stroke).

Untreated Overlap syndrome has been shown to increase catecholamine activity, inflammatory cytokines and oxidative stress and cause death through CVD to a greater extent than those with COPD alone (Marin et al., 2010).

9.5. HYPERTENSION

As the heart pumps blood out of the aorta and around the body the force creates pressure on the artery walls, this is termed blood pressure. Blood pressure is described by two values:

Systolic- the pressure on the arteries following a cardiac contraction

Diastolic- the pressure on the arteries during the relaxation phase of the heart (when filling)

Systolic is always greater than diastolic as it has the force of contraction behind it and typical values are described below. Hypertension is when the blood pressure within the arteries is persistently higher than desired.

Hypertension is typically symptom free, unless very severe but living with undiagnosed hypertension can lead to numerous fatal diseases including stroke, heart failure, CHD and aneurisms.

It is estimated that 16 million or 30% of people in the UK have hypertension, but many of these are unaware of having the condition (NHS, 2012).

Hypertension is classified as either primary (essential) or secondary. Most (90%) of people with hypertension have essential hypertension, which means that there is not one single cause of their condition.
Perhaps the biggest effect is the loss of myelin sheath and neuron number seen with advancing age.
Blood Pressure Category | Systolic | Diastolic mm Hg (lower#)
---|---|---
Normal | Less than 120 | and | Less than 80
Prehypertension | 120 - 139 | or | 80 - 89
High Blood Pressure (Hypertension) Stage 1 | 140 - 159 | or | 90 - 99
High Blood Pressure (Hypertension) Stage 2 | 160 or higher | or | 100 or higher
Hypertensive Crisis (Emergency care needed) | Higher than 180 | or | Higher than 110

**Pathophysiology**
In essential hypertension, there is increased peripheral resistance to blood flow—accounting for the high pressure—but cardiac output remains normal. The increased peripheral resistance is mainly attributable to structural narrowing of small arteries and arterioles, although a reduction in the number or density of capillaries may also contribute. Hypertension is also associated with decreased peripheral venous compliance, which may increase venous return, increase cardiac preload and, ultimately, cause diastolic dysfunction.

There are often changes in cardiac output or vascular resistance; e.g., during exercise, the peripheral resistance falls due to dilation of the exercising muscles' arterioles, but the cardiac output increases so much, due to the muscles' increased oxygen demand, that the blood pressure actually increases. This increase is so consistent that it can be used as a measure of left ventricular function as, during exercise, if the blood pressure fails to rise, this is taken as evidence of poor left ventricular function. In the elderly systolic pressure typically rises, due to stiffening of arteries, however, diastolic remains normal.

**Symptoms**
As stated, previously, most patients with hypertension have no symptoms at all (asymptomatic). In some rare cases, where a person has very high blood pressure, they can experience symptoms including headache, blurred vision, nosebleeds, light-headedness, vertigo or shortness of breath.

**Causes**
In essential hypertension (over 90% of all people with hypertension) the cause is unknown but there are a number of clear associations have been identified between the following:

- Being overweight/obese;
- Excessive sodium intake;
- Increased alcohol consumption;
- Genetic predisposition;
- Being of African or Caribbean origin;
- Lack of physical activity/exercise;
- Smoking cigarettes;
- Stress;

**Treatment**
GPs will recommend patients with hypertension to take effective steps in their lifestyle (if blood pressure is slightly above 130/80mmHg) together with medication (if above 140/90mmHg). The lifestyle changes are as follows:

- Eat a healthy, balanced diet;
- Reduce salt intake to less than 6g per day;
- Be active;
- Reduce body-fat %;
- Cut down on alcohol;
- Drink less caffeine-rich beverages (than 4 cups of coffee per day);
- If a smoker, stop.
- Include relaxation therapies into daily life.

**Medication**
There are many medications used to lower blood pressure including beta blockers, calcium channel blockers, diuretics and vaso-dilators (ACE inhibitors). The medication works by impacting on the formula which describes blood pressure—Cardiac output x total peripheral resistance. A vaso-dilator will dilate the blood vessels thus reducing pressure within the arteries. A beta blocker will reduce the workload of the heart thus reducing cardiac output and a diuretic reduces blood volume, again, reducing the hearts workload as it has less fluid to move so can pump with less strain.
Breathlessness is one of the main symptoms that we deal with in pulmonary rehab for patients with COPD. The difficulty with dealing with breathlessness is everybody experiences breathlessness in a different way; what one person will perceive as extreme breathlessness, another will feel alright because they have been much worse.

Tom Lines
Cardiff and Vale University Health Board, Respiratory Physiotherapist
9.6 DIABETES

Type II Diabetes Mellitus is a common comorbidity of COPD. Epidemiological data suggest that Diabetes Mellitus is much more common in patients with COPD than in controls. A 2010 population-based study found a higher prevalence of type II diabetes in COPD patients than in COPD free people (10.5% in the general population vs. 18.7%) (Cazzola et al., 2010). Although quite an old study now, the observation took place on 900,000 people and similar observations are shown in other literature, so warrants discussion.

Diabetes is found in two forms, type I and type II. Type I Diabetes Mellitus is mostly diagnosed in young children (<15yo) and although not fully understood is thought to be the result of an auto-immune condition which destroys the pancreatic beta cells and renders them completely inactive. The result is the inability to produce insulin and the sufferer faces a life of self-administered insulin injections.

Type II Diabetes is brought on by lifestyle factors and is usually diagnosed in later life (>40yo), although, due to increased Obesity prevalence, people are being diagnosed at younger ages more and more. Over 85% of Type II Diabetics are Obese and treatment is given in the form of medication which aids the use of glucose and lifestyle adaptation to include regular physical activity and diet.

The condition is characterised by the bodies inability to use glucose and therefore blood glucose levels rise, thus encouraging the pancreas to produce more and more insulin. Ultimately the pancreas becomes desensitised to blood glucose levels as the muscle become less able to take glucose on board and insulin production slows or stops. It is not fully clear why the association between COPD and Type II Diabetes exists, however there appears to be a strong prevalence of Metabolic Syndrome in COPD patients suggesting a lifestyle and socio-economic link.

9.7. OSTEOARTHRITIS (OA)

OA is a degenerative disease of the cartilage within the joints. In 2012 there were approximately 10 million people in the UK living with OA (arthritisicare.org.uk). Primary OA is a consequence of wear and tear on the joints throughout one's lifetime and accounts for the vast majority of cases. This means that prevalence of primary OA increases with advancing age.

The ends of our bones are covered in a healthy smooth layer of cartilage ensuring smooth movement and a degree of shock absorbency, and this is further helped by production of a thick oily lubricant called synovial fluid, produced by the synovial membrane lining the joint capsule. As a result of the ageing process or trauma, the articular cartilage becomes thinner and the surface is roughened, further exacerbated by movement. The surface splits and the cartilage fragments. The bone beneath becomes thicker in response to decreased shock absorbency of the cartilage.

The underlying bone not only gets thicker and harder underneath the remaining cartilage, but also grows out at the sides of the joints producing bone spurs. This causes production of further inflammatory exudate into the joint making the joint swollen, hot and painful.

The process may be mild, moderate or severe. In severe cases, the underlying bone is exposed, calcification may take place in the remaining cartilage and synovium, which may fragment and float around in the joint. In some cases, the damage to the surfaces of the knee are sufficiently bad to require replacement.

During knee replacement surgery, the surgeon opens the front of the knee to gain access to the joint and replaces the femoral condyles of the femur (thigh bone) and the tibial plateau (top of the shin bone) with new articulating surfaces.

OA of the knees is more common in women. It is equal between the sexes in hips and spine, and affects the hands more often in women, often starting around the menopause. The base of the big toe, the lumbar and cervical regions of the spine are also key areas for OA, although often appearing on X-ray, the symptoms may be minimal.

OA in the fingers, thumbs and wrists reduces grip strength and the ability to perform everyday tasks such as writing, opening jars, picking small things up and doing up buttons.

Shoulder and elbow joints are also susceptible to arthritis, although this is much rarer. Some people may experience a grinding feeling in the shoulder and a reduced range of movement. Elbows are very sensitive to injury, so very mild arthritis here can lead to quite a significant loss of mobility.
Symptoms
The early signs of osteoarthritis are so mild that people may not recognise them or associate them being different from the norm.

The main symptoms of OA are:
• Pain and stiffness (especially when load-bearing, such as during walking);
• Short-lived stiffness in the morning, which improves after 30mins or less after ADLs, although the pain may develop at the end of the day, especially if the patient has been standing or weight-bearing through the day;
• Difficulty moving affected joints doing certain activities (client-dependent variability, as to which joints and which movements);
• Variability of the symptoms may occur during different times of the year: greater in winter (cold and low barometric pressure) and less in summer (heat and high barometric pressure);
• Knee-specific symptoms: likely to affect both knees over time, unless the OA has occurred as a result of an injury. Painful when walking, particularly uphill or going up stairs; sometimes the knees ‘give-way’. A soft, grating sound may be heard/felt when the joint is moved;
• Hip-specific symptoms: difficulty moving the joint and performing ADLs such as putting on socks and shoes, getting up and down stairs, getting in and out of a car, etc. Pain in the groin or lateral side of hip is common.
• Hand-specific symptoms: affects three main areas of the hand: base of thumb, joints close to fingertips and middle joints of your fingers. Stiffness, pain and swelling with the possibility of developing ‘bumps’ on the finger joints. Difficulty performing manual tasks, such as writing, opening jars or turning keys.

Causes
There isn’t one specific cause of osteoarthritis, but there are many contributory factors, as follows:

Age- OA usually develops in people over 50 years of age and can often remain undiagnosed. The general ageing process of wear and tear, degeneration of the Musculo-Skeletal system and a likely increase in body-weight (body-fat) all are contributory factors.

Gender- OA is more common and often more severe in women, especially in the knees and hands. It often starts after the menopause, although a larger Q angle (a measurement of the angle between the Quadriceps (Rectus Femoris and the patella tendon, providing useful information about the alignment of the knee joint, which if outside of normal ranges, can be a precursor for overuse injuries) in women increases the risk of developing OA in the knees.

The risk is further exacerbated during pregnancy, due to the extra weight-bearing load and the release of Relaxin: the ‘ligament-loosening’ hormone in the 3rd trimester.

Obesity- Extra weight-bearing force as a result of carrying excess body-fat has a direct influence on the general wear and tear on the ankles, knees, hips and lower spine, and is a significant contribution the risk of developing OA over the life-span.

Inactivity- Leading a sedentary lifestyle has two significant contributions to the risk of developing OA: firstly, reduced calorific energy expenditure leads to a negative energy balance and the consequent risk of developing obesity (see above). Secondly, not exercising the joints regularly reduces the ‘joint function’, by reducing the production of synovial fluid, weakening the ligaments and muscles that support the joints and increasing the viscosity of the synovial fluid.

Joint injury- Major trauma (in the form of a car accident or a fall when skiing, for example) or operation on a joint may lead to OA at that site later in life. Normal ADLs and exercise are good for joints, in general, and do not cause osteoarthritis. However, high-impact, repetitive activity may injure joints. Exercising too soon after an injury has had time to heal properly may also lead to OA in that joint later in life.

Genetics- Common forms of osteoarthritis are not directly influenced by genetic predisposition, but there are some rare forms of osteoarthritis that start at a young age and run in families, and these are linked with single genes that affect collagen, which is an essential component of cartilage.

However, some people who have led very similar lives, regardless of other causal factors, may have a good degree of joint function, whereas others may have severe OA? Therefore, it seems there may be a genetically-influenced susceptibility to, or protection against, osteoarthritis, yet to be fully explored.

Treatment
There’s no cure for osteoarthritis as yet, but there are a number of treatments that can help ease symptoms and reduce the chances of the condition becoming worse. The most common treatment for OA is pain-killing medication and anti-inflammatory medication (oral and topical). Lifestyle management particularly by losing weight is also a beneficial intervention but ultimately the patient will usually undergo a joint replacement.
Exercise and Arthritis

Exercise is a suitable form of management for both OA and RA. Weight management is important in both conditions as is the strengthening of the affected joints. Pain associated with OA is often the result of weak muscles and many studies show that a strengthening programme of between 6-8 weeks can significantly reduce pain in the arthritic knee. General strength and fitness is also a worthwhile effect of a well-considered exercise programme.

Although beneficial in many ways the following considerations must be followed to ensure effectiveness and safety:

• Exercise should be mostly avoided during flare ups

• Pain and discomfort should subside within an hour of the exercise session ending. If pain is still significant after an hour review the programme

• It is probably better to exercise without the ingestion of pain killers. Pain killers will mask exercise discomfort and the exercise may be too intense without the client noticing

• Flexibility training is useful but take care of range of motion. The joint should not be stretched beyond the point at which the stretch is felt and assisted stretching should be avoided

• If the joint is made sore by isotonic contractions (concentric/eccentric) isometric resistance training is advised. Consider however, co-morbidities such as hypertension and CHD and follow guidelines accordingly

• Often people with arthritis find it difficult to access machinery. Be careful not to put the client in an awkward, embarrassing situation by not being able to mount a piece of equipment

• Identify the time of day when pain is worse and avoid exercising at the painful times

• The warm up should involve cyclic motions which have weight supported such as rower, bike or chair exercise. Ensure the warm up is prolonged to 15 minutes and contains a significant component of mobility exercise to mobilise the joints properly

• In lower body arthritis high impact exercise should be avoided as should high intensity exercise.

Arthritis Research UK have an excellent website with a range of useful exercises and advise for Arthritis and other musculo-skeletal conditions and can be found at the link below:

The Ancient Greeks knew about it, so why do we still feel that we have a nation that could be more active?

Dr. Charlie Foster
Reader of Physical Activity and Public Health, University of Bristol
9.9. OSTEOPOROSIS (OP)

Osteoporosis is a disease which affects mainly post-menopausal women due to lost oestrogen during the menopause. It is sometimes called “brittle bone” disease due to the ease at which fractures and breaks can occur.

Osteoporosis affects over three million people in the UK. More than 500,000 people receive hospital treatment for fragility fractures (fractures that occur from standing height or less) every year as a result of osteoporosis (NHS, 2018). Although OP affects the whole body the main fracture sites are the vertebrae, the wrist and the hip.

Fractures of the hip, particularly in the frail, carry a relatively poor prognosis as the ability to weight bare, and therefore strengthen the bone is difficult. The probability of hip fractures tends to rise in conjunction with age.

A broken hip in the elderly becomes more likely for a few different reasons. One of the reasons is that the elderly are more likely to fall as they age because their bones aren’t quite as sturdy, they lose their balance more easily, and can lack the reflexes to recover if their momentum stars to carry them down. Hip fractures are much more likely to occur in women because they fall more often than men and also develop osteoporosis at a higher rate.

Pathophysiology

There are 2 types of bone, Cortical bone (compact) and Trabecular bone (spongy) and each part of the skeleton has varying amounts of each. For example, a long bone such as the femur will have a large component of Cortical bone (mainly down the shaft) and the ends will be composed of Trabecular bone.

The vertebrae for example are made mostly of Trabecular, spongy bone as they need to sustain less forces. Bone is formed by layers which create a compact matrix and it is how the cellular matrix is composed which determines whether a bone is compact or spongy.

Calcium makes up 80-90% of compact bone but only 15-20% of Trabecular bone, however spongy Trabecular bone as a larger surface area for metabolic activity and for muscle attachment area but undergoes many more remodelling cycles than cortical bone and is affected more severely by periods of bone loss (such as periods in space or when a bone is placed in cast).

Through the menopause women lose a large amount of oestrogen

Bone remodels continuously taking about 10 years to fully replace the skeleton, through a process of resorption (removal) and formation (replacing). Bone resorption is the responsibility of osteoclasts which remove old bone tissue, formation occurs through osteoblasts, bone building cells. When children we produce more osteoblasts than osteoclasts so our bones continue to grow as the balance is in favour of growth. During our peak adult years the balance will remain about equal and from the age of approximately 30yo we start to produce more osteoclasts than osteoblasts so our bones start to become weaker, particularly if we remain mostly sedentary. Through the menopause women lose a large amount of oestrogen. Oestrogen has bone protective properties, not least encouraging osteoblast formation and keeping osteoclasts at bay somewhat. Following the menopause this protective effect is lost and the balance significantly shifts towards bone resorption. There are several factors which will determine whether the woman, or man (a very small percentage of men develop OP) go on to develop OP.
**Risk factors**

- Physical inactivity;
- Long periods of inactivity, such as long-term bed-rest;
- Alcoholism;
- Cigarette smoking;
- Medical conditions such as celiac disease and Crohn's disease, which affect the way food is absorbed by the body;
- Rheumatoid arthritis;
- Poor diet lacking in calcium and vitamin D;
- Lack of exposure to sunlight;
- A low body mass index (BMI of 19kg/m² or less);
- Corticosteroid medication used for the treatment of asthma and arthritis;
- Insufficient production of oestrogen during menopause and post-menopause (oestrogen deficiency syndrome);
- A hysterectomy before the age of 45;
- No menstrual periods for more than six months, due to over-exercising or over-dieting;
- Eating disorders, such as anorexia.

**Treatment**

Medications can be prescribed to reduce the rate of bone loss ad come in the form of Bisphosphonates. Hormone Replacement Therapy can be used to make up lost oestrogen and Parathyroid hormone may also be prescribed if deemed necessary.

The patient is advised to maintain a healthy lifestyle, refrain from smoking and drinking too much caffeine or alcohol, include lots of calcium and vit D in their diet and exercise.

**Exercise and OP**

Weight bearing exercise is a good way to maintain bone mass however growth will only occur at the point of stress. Therefore it is great to use exercise which stresses the bone at different angles of torque. Badminton, for example, would do this as it involves lots of directional change.

Balance is a key exercise goal to prevent falls from occurring but remember if the client has poor balance or has fallen previously a specific falls prevention programme is needed. Although balance and directional change is good do not put the client at increased risk of falling.

The image above demonstrates a typical posture for an OP client. Kyphotic and Lordotic with a severe forward head carriage. Exercise should attempt to address this and although you may not be able to fix the posture deviations encourage free movement. With resistance training ensure the wrist if straight and strong so the force comes through the shaft of the bone and correct technique is crucial particularly joint angles not be too acute.

**Contra-indications**

- High impact exercise
- High intensity C.V.
- Spinal flexion (crunches, sit-ups)
- Rowing machine
- Poor footwear
- High steps
Medications can be prescribed to reduce the rate of bone loss and come in the form of Bisphosphonates.
Obesity is a growing epidemic that is essentially the product of excess fat accumulation and is ultimately determined by an amalgamation of environmental, genetic, and psychosocial factors which all affect energy intake and expenditure (Marti et al. 2004). Obesity occurs when energy intake is greater than energy expenditure. However, it is not simply a case of someone eating too much and not doing enough exercise as most might think, but rather a disease that needs to be treated appropriately and relevantly to each patient. It is not a single disorder but rather a heterogeneous group of conditions with multiple causations. Similarly, it is not the excess subcutaneous fat linked with rising mortality rates but rather visceral fat which accumulates in the central thoracic cavity, between the internal organs and is linked to increased risk of Heart disease, hypertension, Type II diabetes, and cancers of the breast and bowel (Cancer research UK (2016); Gastaldelli, 2008). Obesity costs the NHS an estimated 4.2 billion per year, 525 thousand admissions to NHS hospitals were due to obesity in 2015/16. Body mass index (BMI) is a measure used to assess a person’s health risk due to body fat. It is calculated by dividing your height (metres) by weight (metres sq.) BMI > 25 is classed as overweight BMI > 30 is classed as obese BMI > 40 is classed morbidly obese. (BHF. org 2016). However, BMI measurements can be unreliable and can differ in ethnic groups.

**Treatment**

Orlistat is currently the only drug available which is safe to use on prescription. Orlistat works by preventing the absorption of fat from the small intestine into the body (about 30%). Orlistat has some quite severe side effects however and can often not be tolerated. In severe cases surgery may be offered if the patient meets certain criteria. Surgery come in many forms including gastric band, gastric by-pass and lipo-suction. Possibly the least intrusive method of weight loss is in lifestyle adaptation including an overhaul of the persons diet and eating habits, exercise and behaviour change counselling. Due to its heterogenous nature however, Obesity is famously difficult to tackle and few can sustain weight loss and maintain it over several years.

**Exercise and obesity**

Exercise should be based on a gradual increase in intensity over time and the inclusion of both cardiovascular and resistance exercise. Increasing the persons resting metabolic rate is important as is the effect of 24-hour energy expenditure, therefore a combination of programmed exercise and activities of daily living is necessary. Exercise should be tolerable and designed to increase efficacy and therefore adherence. The following considerations should be taken into account:

- Progress slowly as the obese client is at risk of injury and musculo-skeletal morbidity such as OA and back pain
- Ensure you have good hydration, especially if working in a warm environment
- Make the exercise enjoyable to promote adherence
- Sometimes obese clients are unable to mount machinery so think about the equipment before you programme to avoid embarrassing the client
- Your programme should include aerobic exercise (progress to high intensity) and a good amount of resistance training
- Ensure you carry out a full health screen as obese client often present will multi-morbidities

**9.11. DEPRESSION AND ANXIETY**

Many people with chronic disease including respiratory disease suffer from depression and anxiety. 1 in 4 people in the UK will suffer from some form of poor mental health in any one day (MIND, 2018). These illnesses can be triggered of caused by many life factors including work, relationships, death and worry about finances. The Royal Society for Psychiatrists suggest that most people with depression will not have all the symptoms listed below, but most will have at least five or six.

**You:**

- Feel unhappy most of the time (but may feel a little better in the evenings)
- Lose interest in life and can’t enjoy anything
- Find it harder to make decisions
- Can’t cope with things that you used to
- Feel utterly tired
- Feel restless and agitated
- Lose appetite and weight (some people find they do the reverse and put on weight)
- Take 1-2 hours to get off to sleep, and then wake up earlier than usual
- Lose interest in sex
- Lose your self-confidence
- Feel useless, inadequate and hopeless
Only about one third of the patients who are eligible for pulmonary rehabilitation, who would benefit from pulmonary rehabilitation, are being referred.

Professor Mike Roberts
COPD Audit Lead, Royal college of Physicians
Avoid other people

Feel irritable

Feel worse at a particular time each day, usually in the morning

Think of suicide

https://www.rcpsych.ac.uk/healthadvice/problemsanddisorders/depression.aspx

General anxiety disorder is described as feeling anxious and worried about a wide range of issues rather than one particular thing. The anxiety is present on all or most days and once one worry is resolved the sufferer worries about something else.

Anxiety disorder can have no rationale or theme and often people have no idea why they get it. In some, the anxiety is so bad that the person experiences moments of blind panic, suicidal thoughts or thoughts of harming others, even loved ones. There can be physical manifestations in the form of palpitations, sweats and unease (NHS, 2018).

Exercise and Depression/anxiety

Exercise is good for those with mild/moderate disease but is less effective in more severe cases. The exercise session distracts the client from their woes and creates a feel-good factor in the form of endorphins. Exercise can also give a sense of achievement and well-being and can put positivity in the day, even if just for a short time.

The following considerations should be taken:

- Exercise must be fun and achievable but not repetitive and boring
- Frequent appointments should be made to encourage a routine
- Rewards should be immediate and task based
- Employ a social element. Buddy system or group class may be beneficial but consider the persons personality first, some people may bring the group down
- Check medication implications to exercise. Some can cause dizziness and fainting whilst other may increase HR and cause Tachycardia

RATE OF CO-MORBIDITIES IN COPD PATIENTS

Anxiety disorder can have no rationale or theme

Treatment

Medication can be prescribed in the form of Selective Serotonin Reuptake Inhibitors (SSRI’s), Tricyclic anti-depressants Anxiolytics and Monoamine-oxidase inhibitors.

Medications should be supported with self-help therapy such as cognitive behavioral therapy (CBT) or counselling from a professional.

Exercise is good for those with mild/moderate disease but is less effective in more severe cases.
Kapella et al. (2013) define functional performance as “activities people choose to do on a day-to-day basis.” Many authors have investigated the effects of COPD on functional capacity and quality of life and have reported impairment on varying levels for many reasons. Tudorache et al. (2017) observed increased inflammatory markers which significantly correlated to lower muscle strength and functional capacity in 62 patients with advanced COPD (risk class D). Age was significant with the older subjects (>70yo) showing greater demise in isokinetic knee strength and 6-minute walk test. They also observed a decline in cognitive function, measured by the Montreal Cognitive Assessment. Muscle weakness and fatigue is a common and well reported effect of COPD. Wust and Degens (2007) suggest that 40% of a patient’s reduced exercise capacity is through lost skeletal muscle mass rather than direct pulmonary limitations. As well as gross atrophy there is a common shift from slow twitch to fast twitch muscle fibre morphology meaning the patient relies on anaerobic pathways to carry out general physical tasks. This of course causes early fatigue rate and increased production of lactic acid at lower intensities than age matched healthy people. Power is another important function required in day-to-day life. Simple everyday tasks such as standing from a chair or climbing stairs are made more difficult due to reduced ability to rapidly contract the muscle under tension. During a ramp-incremental test, COPD patients reached a peak power of $72 \pm 34$ watts, and VO2peak was $1.2 \pm 0.4$ l/min. Controls produced a peak ramp power of $212 \pm 84$ W, and VO2peak was $2.6 \pm 0.9$ l/min, which were both greater than COPD patients. (Cannon et al., 2016).

Reduced strength and power and increased fatigue on general tasks (walking, housework etc.) results from several physiological adaptations at the muscle level. A reduction in capillary number is observed as is reduced oxidative capacity of the muscle fibre. The demise of slow twitch muscle fibres, as previously discussed, is also a significant contributing factor to lost function.
Muscle weakness and fatigue is a common and well reported effect of COPD
Reasons for muscle demise

In COPD patients there is a lack of amino acid availability as they are recruited to form anti-inflammatory agents to fight the inflammatory nature of the disease. This causes a shift in protein synthesis's degradation as protein synthesis is impaired as a result. Inflammation also causes an increase Tumor necrosis factor alpha (TNFα), a catabolic cytokine which causes necrosis of the skeletal muscle and connective tissue. COPD is a disease of the elderly and so sarcopenia (muscle loss through ageing) is already present on diagnosis, particularly if the patient has led a sedentary life. This, along with a lower efficacy to physical activity contributes the demise in muscle mass. It is common for patients with COPD to lose weight and have a low BMI. This is seen more in patients with recurrent exacerbations and in those who have a reduced or disrupted eating profile. The wasting can ultimately lead to Cachexia, a muscle wasting condition prevalent in COPD and cancer patients. Cachexia is a problem because it often leads to frailty and contributes to death in the latter stages of disease. The mechanisms of Cachexia are still poorly understood, however knowledge in the area is improving with recent research into its pathophysiology and mechanisms. The role of "pre-hab", the concept of exercise training before surgery is showing to be beneficial in limiting the rate of muscle demise following surgery and recent evidence is showing that a resistance training programme on diagnosis of COPD, and in some cancers, can maintain the patients muscle mass, maintain a better efficacy to activities of daily living and, as such, to an avoidance of future Cachexia. A multi-modal approach is suggested of exercise training, nutritional support and a maintenance of energy balance. (Sanders et al., 2016).

10.2. PAIN

Patients with COPD suffer from significant pain which impacts on daily function, psychological and emotional wellness and which leads to further sedentary behaviour, thus exacerbating symptoms and reducing mortality (HajGhanbari et al., 2013). Reports of 45% (Bentsen et al., 2011), 37% (Xiao et al., 2017) and between 32% – 60% (van Isselt et al., 2014) of COPD patients suffer from pain in varying areas and of varying severity. Borge et al. (2011) stated that 72% of the observed patients with COPD reported pain of varying severities which impacted significantly on quality of life. Disease related pain appears to manifest mainly in the chest (22-54% of patients), neck, shoulders, back and lower limbs. HajGhanbari et al. (2012) observed COPD patients to demonstrate 2.6 times more pain and 3.7 times more pain interference with daily activities compared to an age and a gender-matched healthy cohort. HajGhanbari et al. (2013) correlated pain in COPD patients with functional exercise capacity, quality of life, physical activity, BMI and co-morbidities. Pain severity was negatively correlated with the 6MWT (p < 0.05), and quality of life (p < 0.05), whereas it was positively correlated with body mass index (BMI) (p < 0.001), and the number of comorbidities (p< 0.001). Subjects with severe pain showed lower standing and activity times (p < 0.01), lower 6MWT distances (p < 0.05), higher BMI (p < 0.001), a higher number of comorbidities (p < 0.001) and lower quality of life (p < 0.01) compared to subjects with minimal or no pain. The study concluded that pain in COPD patients significantly correlates with lower functional performance, reduced activity levels and a poorer quality of life. Xiao et al. (2017) observed pain in different severities of COPD. Among 283 subjects, more than one third had pain problems indicated by the present pain intensity (PPI) scale. COPD patients aged <65 years with exacerbation in the past 12 months or a CAT score of ≥10 had a significantly higher score in affective dimension. Female sex, COPD severity, and length of disease were significantly related to higher scores of the sensory dimension. Those with moderate COPD or a CAT score of ≥10 had significantly higher scores of visual analog scale than those with mild COPD or a CAT score <10. Patients with moderate COPD had a higher rank of PPI than those with mild COPD (deemed lower severity). Concluding, the authors suggested that pain in patients with COPD is prevalent even at relatively low levels of severity and increases with disease progression and severity.

Pain in COPD patients is very prevalent with reports ranging from 22% - 72% of those studied in the research. Aetiology is multifactorial and includes length of disease, number of exacerbations, higher BMI, chest mechanical impairment, number of and type of co-morbidities, gender, age, activity levels, breathing muscle adaptations and gastroesophageal reflex disease (Bordoni et al., 2018). In patients with musculo-skeletal pain and co-morbidities such as osteoarthritis, pain may be the limiting factor to functional performance inhibiting the patient's ability to exercise sufficiently enough to challenge the cardio-respiratory and muscular systems. This means that reaching the desired exercise outcomes can be challenging. In an exercise setting the instructor should screen fully for pain and how pain affects the client's day-to-day activities and must be flexible in their programming to allow for pain whilst still achieving over load of the desired physiological systems. Increasing, worsening pain or pain which fails to respond to pharmacological aid should warrant advice of referral to the clients G.P. for further investigation.
10.3. PSYCHOLOGICAL AND EMOTIONAL IMPACT

Any diagnosis of a life threatening chronic disease can have a lasting impact on a person’s emotional and mental strength. One becomes more aware of their mortality and worries about the path which lies ahead of them, how they will cope and how their family and friends will be affected. It may be that, in some cases, the patient cannot work, or their work is affected, and this can cause financial burden and worry. In other cases, the disease symptoms can cause much distress. We have discussed pain in COPD and the functional effects of that but being in constant pain can leave the sufferer distressed, anxious and very frustrated. Some conditions require surgery and perhaps long-term bed rest or rigorous rehabilitation, while others, such as Stroke, can leave the victim paralysed, unable to speak and cognitively impaired. Although most chronic morbidity manifests themselves in physical form, they also carry an emotional and psychological burden which, in many cases, can progress to become more debilitating than the “obvious” physical effects. In patients with COPD it is no different.

The presence of anxiety and/or depression in COPD patients is associated with increased mortality, exacerbation rates, length of hospital stay, and decreased quality of life and functional status (Pumar et al., 2014). Observing 43 male COPD patients Kim et al., (2000) showed that anxiety and depression contributed significantly to the overall variance in functional status of COPD patients, over and above the medical burden and COPD severity. A 2016 review reported depression to be a strong co-morbidity in COPD patients and showed a relationship between smoking, COPD and depression, suggesting depression increases take up and maintenance of smoking which leads to COPD, which then leads to worsening of depression. Depression in COPD patients is seen to exacerbate symptoms and lead to earlier mortality although it is well reported that the prevalence of depression in COPD varies largely, from 10 to 57%, with the highest rates being reported in patients with more severe COPD, particularly in long-term oxygen users or in patients recovering from COPD exacerbation (Schneider et al., 2010).

Indeed, in their review Matte et al. (2016) reported that a third of reviewed articles concluded that the worst depression states existed in the most severe and advanced COPD patients. In their 2017 “National COPD Audit for Wales, the Royal College of Physicians reported that 30.5% of COPD patients suffered with Anxiety and 30.1% with Depression and 7.8% of patients lived with severe mental ill health. They go on to state that the most mentally ill were 19% less likely to have been referred to pulmonary rehabilitation and 27% less likely to have received a flu vaccination suggesting a general lesser degree of care. Despite these statistics only 17.5% had a record of screening for mental health despite NICE guidelines highlighting the need for vigilance of signs of mental ill health in COPD patients.

COPD is a social problem with the highest prevalence residing in the poorest areas of Britain and the world. Patients may be unemployed, be under financial stress, feel swept aside and turn to smoking and drinking to pass the time of day. It is characterised by a plethora of co-morbidities and pain which puts a burden on the patient’s quality of life and emotional well-being. COPD is a condition where fear negates physical activity and patients find themselves withdrawing from their usual activities and pleasures. Sufferers ruminate and become less active, more impaired and before long become anxious and depressed from their lifestyle. It is a disease of the older adult and as such carries the effects of ageing with it. Sarcopenia, musculo-skeletal impairment, lost balance and cognitive demise can leave the patient breathless, in pain and feeling low in their mood. It is important that the specialist instructor is aware of these issues and encourages activities of enjoyment to promote motivation and engagement. Social isolation is a major problem in the elderly and particularly in the morbid and a feeling of belonging and purpose has been shown to increase physical activity levels and reduce psychological ill health. Although a solid understanding of the training principles and guidelines discussed on this course are essential to help rehabilitate a client with COPD empathy toward emotional issues should be demonstrated and applied to help your clients live better and flourish.

“The evidence is huge. People who are physically fit from physical activity have a much lower instance of heart disease.”

Dr Brian Johnson
Honorary Medical Advisor to Public Health Wales
SECTION 10 - THE IMPACT OF COPD ON FUNCTIONAL PERFORMANCE AND EMOTIONAL WELL BEING

**PHYSIOLOGICAL LIMITATION TO EXERCISE**
- Cardiovascular limitations to exercise
- Altered respiratory mechanics
- Gas exchange abnormalities
- Respiratory and peripheral muscle dysfunction

**PHYSICAL SIGNS AND SYMPTOMS:**
- Dyspnea
- Impaired exercise capacity and fatigue
- Reduced physical activity
- Nutritional deficits
- Comorbid conditions
- Balance impairments
- Sleep disturbances

**PSYCHOSOCIAL SIGN AND SYMPTOMS:**
- Depression
- Anxiety
- Reduced

There's a lot of work going on at the moment to try and put physical activity within the medical school curriculum.

Dr Brian Johnson
Honorary Medical Advisor to Public Health Wales
We have previously discussed the pathology of respiratory disease and how day-to-day function is affected. In this section we discuss how the patient’s ability to exercise is affected and we investigate the physiological processes which cause an impairment in exercise performance. The vast majority of participants of pulmonary rehabilitation will have a diagnosis of COPD so this will be the main focus of our discussion, however the other specific conditions mentioned earlier will also be discussed.

It is true that pulmonary conditions have significant effects upon body systems outside of the lungs. Chronic airway obstruction over many years causes a state of chronic hypoxia which affects the functioning of the physiological systems throughout the body. The disease promotes inactivity and so atrophy and degrading of the anatomy can be expected. Exercise should target management of the whole body. It is unlikely that rehabilitation will produce significant changes in spirometry and most of the time the condition is irreversible and cannot be cured. Exercise, education and pharmacological management can slow down the disease progression however, and as discussed earlier, can significantly improve function and quality of life by targeting the gross physiology.

Focusing on the other systemic problems such as muscle weakness and disuse are key components of rehabilitation programmes that contribute to positive outcomes. Much of the new research into treating pulmonary disease is looking into targeting the systemic problems to help reduce the load on the pulmonary system. Cardio-respiratory conditions account for the majority of mortality worldwide and respiratory disorders alone, including COPD and lower respiratory infections account for a significant percentage of morality worldwide (WHO, 2014).

In patients with COPD dyspnoea is the most common symptom limiting exercise capacity and the major reason for referral to respiratory rehabilitation programs. To understand how exercise, particularly, causes dyspnoea we must first explore the work placed on the pulmonary system and respiratory muscle during physical exertion.
The physical, psychological and social effects respiratory disease has on patients is a heterogenous combination which impacts on all aspects of a person's life. At the pulmonary level effects include, hyperinflation and impairment of lung function (ventilation and gas exchange abnormalities), air trapping, hypoxia and hypercapnia, chest muscle weakness and pain which all cause a significant impairment in lung function. As discussed, muscle atrophy, weight loss in later stages and a reliance on anaerobic pathways, cause lost strength, power and endurance of the ambulatory muscles making activities of daily living difficult. Sleep disruption, nutritional deficits, and fatigue add to the daily struggle in patients (Lee and Holland, 2014). Patients with COPD present with a wide range of co-morbidities including obesity, osteoporosis, hypertension, coronary heart disease, heart failure and a range of mental health issues such as anxiety and depression and the burden often means lost efficacy to physical activity which has been associated with increased dyspnoea, exacerbations and hospital readmissions (Gimeno-Santos et al., 2014). Patients are mostly older adults and therefore age-related implications are often present in balance, bone strength and cognitive decline.

Pulmonary rehabilitation is the cornerstone of management in patients with respiratory disease, especially COPD, and along with medication is well accepted as a beneficial and cost-effective intervention to help patients relieve their dyspnoea and improve their quality of life (NICE, 2016). It utilizes a range of support interventions such as exercise, nutrition, smoking cessation and behaviour change support and has been defined as defined as a:

"Comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies that include, but are not limited to, exercise training, education and behaviour change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviours". (Spruit et al., 2013)

11.1. RECAP ON DISEASE EFFECTS

- Ensure long term exercise commitment
- Allay patient fear and anxiety
- Reduce exacerbation and hospital rate

11.2. AIMS OF PULMONARY REHABILITATION (BLF, 2016)

- Reduce dyspnoea
- Increase exercise tolerance
- Improve functional performance
- Improve muscle endurance (peripheral and respiratory)
- Improve muscular strength

11.3. ACUTE RESPONSES

COPD patients experience impaired ventilatory mechanics which make exercising a challenging prospect. During exercise, factors such as inefficient gas exchange, lactic acidosis at a low work rate, and exercise-induced hypoxemia, exacerbate dyspnoea, limiting the patients exercise capacity. Muscle ache, particularly in the lower limbs and musculo-skeletal morbidity often make ambulation painful, forcing the patient to cease the exercise before they have reached their full aerobic capacity potential. The survival prognosis of COPD patients with severely reduced exercise capacity is extremely poor, but the pathophysiology of these patients during exercise remains to be accurately established. Maekura et al. (2014) observed the acute exercise response of patients of varying severity of COPD and found those with the highest grade of severity to have quick and severe limiting physiological response to incremental cycle ergometry. These were among the most breathless of the subject cohort who found it difficult to increase ventilation, showed an impairment of gas exchange, showed steep declines in PaO2 and steep increases in PaCO2 and progressive acidosis. They did not however reach lactate thresholds at lower intensities. O'Donnell et al. (2006) showed the ability to increase tidal volume sufficiently was limited during acute exercise and described the mechanism of this limitation. They showed that dyspnoea increases steeply once the inspiratory reserve volume falls significantly, preventing further increase of the tidal volume during constant-work-rate exercise. They also revealed that dyspnoea increases with the disparity between the respiratory effort and reduced tidal volume response. The acute mechanisms and responses to exercise vary significantly between disease severity states, and the capacity to exercise undoubtedly declines with disease progression. Indeed Ritzk et al. (2015) reported that a 12-week pulmonary rehabilitation programme elicited such varying responses, but agreed that the core limitations we have discussed appear in patients from moderate (GOLD 2) disease severity and that this disparity of effects to acute exercise had impact on exercise “vigour” and adherence to the programme. Compared with continuous high intensity training, continuous training at ventilatory threshold (the point of lactate accumulation) was associated with lower respiratory exchange ratio,
SECTION 11- ACUTE AND CHRONIC RESPONSES TO EXERCISE

11.4. CHRONIC EFFECTS

The BTS report that following pulmonary rehabilitation exercise capacity is repeatedly shown to increase in the literature including several Cochrane reviews. Improvements are seen in cycling power and walking distance up to and beyond clinically important thresholds, as measured by 6-minute walk test and incremental shuttle walk test. In strength, quadriceps strength is reported to significantly increase across the evidence base and the BTS advise that pulmonary rehabilitation exercise interventions should contain a substantial component of RT to utilize these chronic benefits.

Investigations into the best type and mode of exercise to use for COPD patients have been increasing in recent years and the long-term effects of high versus low intensity, continuous versus interval, strength versus aerobic and walking versus cycling, have been reported. Salhi et al., (2011) and Gloeckl et al., (2012) have even shown vibration training to elicit beneficial outcomes in functionality and strength over and above strength training, have issued guidance for this mode of exercise and report that combining vibration training with resistance training (RT) has greater benefit than RT alone. There appears to be no adverse effects to using vibration training, however more evidence is required in this area.

Chronic adaptations of increased slow twitch fibre type, increased cross sectional area of both muscle types, improved work time and intensity, less dyspnoea, and improved quality of life have been reported. Gloeckl et al, (2012) reported a significant increase in exercise duration with reduced metabolic and ventilatory stress, as well as lower hyperinflation when using interval training compared with continuous (Gloeckl et al, 2012). The majority of literature does suggest that higher intensity interval training results in greater exercise capacity than lower intensity continuous exercise, however in a 2010 review involving 388 subjects Beauchamp et al. found no difference in exercise capacity between interval and continuous methods (Beauchamp et al., 2010) although later reviews will have the advantage of a larger and more current body of evidence.

Gloeckl et al, (2013) however reported significant benefit of an interval approach, particularly in advanced disease clients, and discussed that although evidence was strong for interval training some considerations should be taken into account before prescribing higher intermittent training:

Interval training may be more appropriate if the client presents with:

- A severe airflow obstruction (FEV1 40%)
- A low exercise capacity
- Total constant work time of <10 min
- SpO2 85%
- Intolerable dyspnoea during continuous exercise
- It may be advantageous to allow the client to choose which approach they prefer based on their experiences and how they are feeling.

The main goal is to make sure that all health professionals are equipped with the knowledge of benefits of physical activity. We didn't have that in undergraduate medical schools, or in allied health professional schools. We haven't been trained in it, and yet this is an important part of both primary prevention and the treatment and management of people with disease.

Dr Brian Johnson,
Honorary Medical Advisor to Public Health Wales
Chronic adaptations of increased slow twitch fibre type, increased cross sectional area of both muscle types, improved work time and intensity, less dyspnoea, and improved quality of life have been reported.
11.5.1. Dyspnoea
The BTS cite several reviews which have observed pulmonary rehabilitation as a beneficial intervention to relieve dyspnoea. Reports from the Chronic Respiratory Questionnaire and St Georges Respiratory Questionnaire across the literature show pulmonary rehabilitation has beneficial long-term effects of reducing breathlessness in participants against those who do not partake.

11.5.2. Physical activity (PA)
Increased levels of PA have been shown to reduce hospitalisation and improve a patient’s longevity. The BTS report only modest improvements in physical activity in pulmonary rehabilitation participants. The clinical significance of the findings is unknown.

11.5.3. ADL
Evidence into whether ADL’s are increased through pulmonary rehabilitation is sparse. Some studies have investigated the area but with fairly small cohorts and found that self-reported activity modestly increased in participants.

11.5.4 Psychological health
Several studies have reported significant reductions in anxiety and depression following pulmonary rehabilitation with strong level of evidence.

Self efficacy

Self-efficacy is one’s own belief that they are able to achieve a given task. It is an important characteristic in successful people and increases as a person achieves. Self-efficacy has been shown to increase in patients who attend pulmonary rehabilitation.

In summary pulmonary rehabilitation has been seen to bring many benefits to the participants. Acute responses to exercise include respiratory fatigue and ventilation difficulties, muscle weakness and pain and acidosis with drops in PaO2. Exercise can, however, acutely provide the client with a sense of vigour which may aid adherence to the programme. Longer term physiological benefits include an increase in muscle mass, strength power and cardiorespiratory function, with increased work capacity at lower ventilatory thresholds and VO2. There are many other benefits of pulmonary rehabilitation outside or physiological adaptations which have been summarised, along with strength of evidence (A = Rich body of evidence, B – limited evidence). The table is sourced from Corhay et al. (2014).

STRENGTH TRAINING RECOMMENDATIONS FOR COPD

<table>
<thead>
<tr>
<th>Frequency</th>
<th>2-3 dpw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target local muscular fatigue within a given rep range for all major muscle group upper and lower body.</td>
<td></td>
</tr>
<tr>
<td>2-4 sets of 6-12 repetitions to local fatigue both concentric and eccentric</td>
<td></td>
</tr>
<tr>
<td>Moderate - 2:2</td>
<td></td>
</tr>
<tr>
<td>Higher than 180</td>
<td></td>
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11.5. BENEFITS OF PULMONARY REHABILITATION

11.5.1. Dyspnoea
The BTS cite several reviews which have observed pulmonary rehabilitation as a beneficial intervention to relieve dyspnoea. Reports from the Chronic Respiratory Questionnaire and St Georges Respiratory Questionnaire across the literature show pulmonary rehabilitation has beneficial long-term effects of reducing breathlessness in participants against those who do not partake.

11.5.2. Physical activity (PA)
Increased levels of PA have been shown to reduce hospitalisation and improve a patient’s longevity. The BTS report only modest improvements in physical activity in pulmonary rehabilitation participants. The clinical significance of the findings is unknown.

11.5.3. ADL
Evidence into whether ADL’s are increased through pulmonary rehabilitation is sparse. Some studies have investigated the area but with fairly small cohorts and found that self-reported activity modestly increased in participants.

11.5.4 Psychological health
Several studies have reported significant reductions in anxiety and depression following pulmonary rehabilitation with strong level of evidence.

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When the person is happy and they’ve incorporated regular physical activity into their day, they’ll be able to espouse the benefits of being more physically active. They’ll be mentally healthier, they’ll start to report symptoms of being more physically able and improve their physical capacity.

Dr Richard Bracken
Associate Professor in Exercise, Physiology and Biochemistry, Swansea University

"
# MAIN OUTCOMES OF PULMONARY REHABILITATION IN COPD PATIENTS

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Improvement of exercise performance</strong></td>
<td>ACCP/AACVPR</td>
<td>High evidence and strong recommendation (1A)</td>
</tr>
<tr>
<td></td>
<td>ACP clinical practice guidelines</td>
<td>PR programs improve exercise capacity</td>
</tr>
<tr>
<td></td>
<td>Clinical practice guideline for physiotherapists</td>
<td>Strong recommendation</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>Evidence grade A</td>
</tr>
<tr>
<td></td>
<td>ACP systematic review</td>
<td>No clinically significant improvement in the 6-minute walk distance</td>
</tr>
<tr>
<td></td>
<td>Cochrane review</td>
<td>Clinically insignificant improvement in the 6-minute walk distance</td>
</tr>
<tr>
<td></td>
<td>Meta-analysis</td>
<td>No clinically significant improvement in the 6-minute walk distance</td>
</tr>
<tr>
<td><strong>Dyspnoea relief</strong></td>
<td>ACCP/AACVPR</td>
<td>High evidence and strong recommendation (1A)</td>
</tr>
<tr>
<td></td>
<td>Cochrane review</td>
<td>Effect on the dyspnea domain of the CRQ was a greater than the minimum clinically important difference</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>Evidence grade A</td>
</tr>
<tr>
<td></td>
<td>ACP systematic review Meta-analysis</td>
<td>Average effect on the dyspnea domain of the CRQ was clinically significant</td>
</tr>
<tr>
<td><strong>Improved health-related quality of life</strong></td>
<td>ACCP/AACVPR</td>
<td>High evidence and strong recommendation (1A)</td>
</tr>
<tr>
<td></td>
<td>ACP clinical practice guideline, ACP systematic review</td>
<td>PR programs improve health status</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>Evidence grade A</td>
</tr>
<tr>
<td></td>
<td>Clinical practice guideline for physiotherapists</td>
<td>Strong recommendation</td>
</tr>
<tr>
<td></td>
<td>Cochrane review</td>
<td>Effect on all domains of the CRQ were greater than the minimum clinically important difference</td>
</tr>
<tr>
<td></td>
<td>Meta-analysis</td>
<td>Pooled difference in health status scores on the SGRQ was clinically significant</td>
</tr>
</tbody>
</table>
## MAIN OUTCOMES OF PULMONARY REHABILITATION IN COPD PATIENTS

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<thead>
<tr>
<th>Outcome</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Psychosocial benefits</strong></td>
<td>ACCP/AACVPR</td>
<td>Moderate evidence and weak recommendation (2B)</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>Reduced anxiety and depression; evidence grade A</td>
</tr>
<tr>
<td><strong>Improvement of upper extremities performance</strong></td>
<td>ACCP/AACVPR</td>
<td>Unsupported endurance training of upper extremities: high evidence and strong recommendation (1A)†</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>Strength and endurance of the upper limbs improve arm function (evidence grade B IV)</td>
</tr>
<tr>
<td><strong>Cost effectiveness</strong></td>
<td>ACCP/AACVPR</td>
<td>Low evidence and weak recommendation (2C)</td>
</tr>
<tr>
<td><strong>Reduced health care utilization</strong></td>
<td>ACCP/AACVPR</td>
<td>Moderate evidence: weak recommendation (2B)</td>
</tr>
<tr>
<td></td>
<td>ACP clinical practice guideline</td>
<td>PR programs reduce hospitalizations</td>
</tr>
<tr>
<td></td>
<td>Meta-analysis</td>
<td>No material effect was observed on hospitalization rates</td>
</tr>
<tr>
<td></td>
<td>Meta-analysis, Cochrane review</td>
<td>PR after acute COPD exacerbations reduced hospitalizations</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>PR reduced the number of hospitalizations and the number of days in hospital evidence grade A</td>
</tr>
<tr>
<td><strong>Improved survival</strong></td>
<td>ACCP/AACVPR</td>
<td>Insufficient evidence and no recommendation provided</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>Evidence grade B II</td>
</tr>
<tr>
<td></td>
<td>ACP clinical practice guidelines</td>
<td>ACP systematic review, Meta-analysis</td>
</tr>
</tbody>
</table>

Notes
Abbreviations: ACCP/AACVPR, American College of Chest Physicians/American Association of Cardiovascular and Pulmonary Rehabilitation; ACP, American College of Physicians; COPD, chronic obstructive pulmonary disease; CRQ, Chronic Respiratory Questionnaire; GOLD, Global initiative for Obstructive Lung Disease; PR, pulmonary; rehabilitation; RCT, randomized controlled trial; SGRQ, St George’s Respiratory Questionnaire; 1A, High evidence and strong recommendation.
EVIDENCE STRENGTH OF PULMONARY REHABILITATION AT 3 STATES

**PR POST ACUTE EXACERBATION**
- Endurance training (cycling and/or walking) (level A)
- Interval or continuous mode (level A)
- Resistance training (UL and LL) (level B)

**PR IN STABLE CLINICAL STATE**
- PR in stable clinical state
- Endurance training (cycling and/or walking) (level A)
- Interval or continuous mode (level A)
- Resistance training (UL and LL) (level A)
- Inspiratory muscle training (level B)
- Water-based exercise (level B)
- Partitioning (level B)
- Balance training (level B)

**MAINTENANCE POST PR**
- Endurance training (cycling and/or walking) (level A)
- Interval or continuous mode (level A)
- Resistance training (UL and LL) (level B)

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**Effects** | **Evidence level**
--- | ---
Improved quality of life | A
Improved general physical performance ability | A
Improved strength and leg muscle mass | A
Improved strength and arm muscle mass | A
Reduction of resting and exertional dyspnea | A
Reduction in hospital admissions and days spent in hospital | B
Decrease in COPD-associated anxiety and depression symptoms | B

In previous sections we have discussed evidence which has looked at the benefits seen with various training approaches, and some guidance has been presented. This section aims to progress on this to look at the approach which is advised when programming for your pulmonary rehabilitation clients.

The aim of any exercise referral or rehabilitation programme is to safely improve the clients exercise capacity and reduce symptoms and co-morbidities. Safety must be the first concern and must be at the heart of every decision you make as a specialist exercise practitioner whatever medical condition you are working with. To help your client gain independence is another key factor which you should work towards. On any exercise referral scheme, clients will enter at varying levels of independence based on their available exercise capacity. Some will be able to manage 20 or 30 minutes of moderate, continuous exercise, while others may only manage 2 or 3 minutes, some will be around the middle, managing 10 minutes before needing a rest. Many things determine this, but the role of the exercise referral instructor is to, wherever possible, move their client to being able to fulfil at least 20 minutes of continuous aerobic exercise at a moderate pace/intensity. You have then given the client some independence and improved their quality of life. They can now walk to the bus stop, get the bus into town, walk around for a bit, find a cafe for a cup of coffee, do a little more shopping then catch the bus back home.

At level 4, when working with specific conditions it may be more difficult with some of the more severe clients however. Capacity then will largely depend on how advanced the disease has become and what limitations are in play. GOLD suggest that those diagnosed at stage 1 COPD should control their own exercise and do as much as they can (GOLD, 2017).

At stage 2 the exercise capacity may still be very good and by taking part in a well-designed and progressive programme, the exercise capacity can be improved significantly. Standing in a circle marching on the spot for 6 weeks will not bear fruit of significant exercise and fitness gains however, so the clients should be challenged and over loaded in all physiological systems including strength, cardio-respiratory, neural, cognitive and skeletal. A client at level 3 or 4 of the GOLD classification will get breathless quicker and with less intensity or load and may progress slower than stage 1 or 2 but that does not mean to say improvements cannot be seen, we have discussed the benefits in previous sections.
12.2. EXERCISE TESTING

Exercise testing is an important part of a pulmonary rehabilitation exercise programme. Many organizations suggest recommendations to include an assessment of pulmonary rehabilitation patients before beginning an exercise training programme. This should include pulmonary function testing, arterial oxyhaemoglobin saturation based on direct arterial oxygen saturation (SaO2) or indirect peripheral oxygen saturation measured by oximetry (SpO2), and dyspnoea monitoring using the Borg CR10 scale. Graded exercise testing to measure exercise lung function should ideally be used where available over a time span of 5 – 9 minutes in severe to very severe clients, however where not possible different methods of physical assessment can be used including the 6MWT, ISWT, hand grip strength test, co-efficient 1RM test and balance testing, whilst subjective measures can be taken with the St George’s respiratory questionnaire and the chronic respiratory disease questionnaire (BLF, 2013; Garvey et al., 2016).

12.3. ENDURANCE TRAINING

Traditionally, endurance training is carried out at a continuous intensity over a prolonged period of time. The most recent review of exercise training in COPD (Gloeckl et al., 2018) has shown that endurance training in this population group should be performed at higher intensities with an interval training approach. This has been shown to be more tolerable in more advanced COPD patients in particular. Compared with the continuous method, intensive interval training leads to a lesser degree of dynamic pulmonary hyperinflation, and this is one of the reasons why it enables a notably longer tolerated training period and, simultaneously, a lower degree of exertional dyspnoea (dyspnoea on a 0–10 point Borg scale: interval training 6.2 versus continuous method 7.2). There are advantages and disadvantages to walking versus cycling and either can be a beneficial way of exercising with pulmonary rehabilitation. Those with hip or knee arthritis or ambulatory difficulties may require a bicycle or indeed a rower, however walking is more conducive to normal day to day challenges and can be done with no equipment, thus encouraging physical activity outside or the pulmonary rehabilitation sessions.

In 2016 an official statement from the American Association of Cardiovascular and Pulmonary Rehabilitation (Garvey et al., 2016) advised that an aerobic training intensity of 30%-80% is seen as tolerable in the literature and also suggest incremental or interval training at higher intensities until longer ambulatory periods of exercise can be tolerated. They suggest that 30 minutes of continuous aerobic exercise should be the aim. An intensity of at least 60%-80% of maximal work rate is required in order to gain physiological improvements in aerobic fitness, endurance, and ventilation at sub-maximal loads. A duration of 20-60 minutes per session and an intervention of between 4-12 weeks (other authors suggest a minimum of 8 weeks is required) is required to manifest gains. Gloeckl et al. (2018) advise that a breathlessness level during endurance training of 4-6 on the Borg breathlessness scale is tolerable, effective and safe.

12.4. STRENGTH TRAINING

Strength training in combination with endurance training has been shown to elicit greater improvements in physical performance and quality of life. The trainer should aim to cause momentary muscular failure (MMF) in the muscle group, and to avoid an over exertion of the breathing system to achieve this in a single set is viable (Liao et al., 2015; Gloeckl et al., 2018). The lower limbs should be particularly targeted as this is where greater weakness and demise is evident, and the mode of exercise should be at the preference of ability and client choice. Resistance machines, free weights, body weight and bands and light equipment can all be utilized. Garvey et al. (2016) in their review stated no exact guidance existed for resistance training in COPD patients and suggested that the recommended format for resistance training exercises includes using resistance equal to 40% to 50% of 1 repetition maximum (1RM) for 1 to 4 sets with 10 to 15 repetitions per set on ≥ 2 days per week.

Some patients may be able to progress to moderate-intensity resistance training utilizing 60% to 70% of 1RM. This sort of training however may be very time consuming and may not encourage MMF (overload). It is important that the instructor keeps in mind the requirements of training adaptations and what is required to elicit muscular increases in strength and hypertrophy. The ACSM highlights the importance of overload and states that progression must be a key implementation as and when tolerated. Progression can be implemented by increasing the resistance, the sets, number of repetitions or making the sets “denser” (reducing the rest time between sets). Periodization can be used to maintain progression, but it must be noted there is no reference to the effectiveness or impact of this on COPD clients/patients. Summaries of suggested training guidance for pulmonary rehabilitations are highlighted below and are all based on peer Summaries of suggested training guidance for pulmonary rehabilitations are highlighted below and are all based on peer reviewed evidence.
PRACTICAL RECOMMENDATIONS FOR EXERCISE TRAINING IN PATIENTS WITH COPD

<table>
<thead>
<tr>
<th></th>
<th>Continuous endurance training</th>
<th>Interval endurance training</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>3-4 days - week</td>
<td>3-4 days - week</td>
</tr>
<tr>
<td><strong>Mode</strong></td>
<td>Continuous</td>
<td>Interval modes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 s of exercise, 30 s of rest or 20 s of exercise, 40 s of rest</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>Initially 60%-70% of PWR</td>
<td>Initially 80-100% of PWR for the first three to four sessions</td>
</tr>
<tr>
<td></td>
<td>Increase workload by 5-10% as tolerated</td>
<td>Increase workload by 5-10% as tolerated</td>
</tr>
<tr>
<td></td>
<td>Progressively try to reach 85-90% of baseline PWR</td>
<td>Progressively try to reach 150% of baseline PWR</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Initially 10-15 min for the first three to four sessions</td>
<td>Initially 15-20 min for the first three to four sessions</td>
</tr>
<tr>
<td></td>
<td>Progressively increase exercise duration to 30-40 min</td>
<td>Progressively increase exercise duration to 45-60 min (including resting time)</td>
</tr>
<tr>
<td><strong>Perceived exertion</strong></td>
<td>Try to aim for a perceived exertion on the 10-point Borg scale of 4-6</td>
<td>Try to aim perceived exertion on the 10-point Borg scale of 4-6</td>
</tr>
<tr>
<td><strong>Breathing technique</strong></td>
<td>Suggest pursed-lip breathing or the use of PEP devices to prevent dynamic hyperinflation and to reduce breathing frequency</td>
<td>Suggest pursed-lip breathing or the use of PEP devices to prevent dynamic hyperinflation and to reduce breathing frequency</td>
</tr>
</tbody>
</table>

PWR: peak work rate; PEP: positive expiratory pressure.


12.5. OTHER RECOMMENDATIONS

- The AACVPR advises:
- Monitoring SpO2 which should be maintained above 88% to 90% during exercise
- Long term adherence to exercise is a major priority in PR, with a goal of translating gains from PR into increased physical activity
- In the absence of one optimal exercise prescription strategy for COPD, health care professionals should be familiar with all major, evidence-based PR guidelines.
12.6. MANAGING A SAFE EXERCISE ENVIRONMENT

12.6.1. Legals

As workers in an exercise or clinical environment you have a duty of care to patients and clients to ensure that they are safe and not put at undue risk. Indeed, it is unlawful to ignore these responsibilities and the responsibility falls on the shoulders of both your place of work and you as an individual.

Respiratory disease clients are at significantly greater risk of infection and illness than most participants of exercise, even in an exercise referral sense. We have discussed the medico-legal issues involved in the referral process and the need for insurance. It is also important that all members of the team are suitably qualified to do the tasks they are asked to do. Too often are employees asked to carry out tasks they are not trained to do, and this puts the customer or client at risk.

12.6.2. Medications

Co-morbidities are a part of life in COPD and respiratory rehabilitation and it is essential that you are familiar with your client’s full health status and medications. Many medications have exercise implications and you should be fully aware of these. If you are unsure of what a particular medication is then go and find out. These are very complex conditions we work with and you are not expected to know everything that is medical. Ensure you use valid sources mentioned on this course or on your exercise referral qualification. Remember the issues with ageing; weak tendon strength, poor vision and hearing, osteoporosis and poor balance. Salmeterol and Formoterol are both long acting adrenoceptor agonists, which have been subject to research for a number of years. They are demonstrated to positively impact on the symptoms of asthma, increase lung function and improve quality of life when compared to a placebo but have side effects which can impact on exercise, these along with effects of other common medications in the pulmonary rehabilitation setting have been discussed earlier.

Principle concerns for the instructor are side effects that may impact upon exercise; these are tremor, headache, muscle cramps and palpitations. The instructor is required to ensure that the patient/client has their prescribed medication immediately available at all times. The British National Formulary (BNF) has an updated list of all medications for review. The instructor cannot comment on the use of medication or alter their use in any way.

12.6.3. The training environment

AYour facility must be clean and tidy at all times, with no slip or trip hazards and you must ensure transitions across the work space are clear. Check exercise machines cannot be bumped into, mats and dumbbells are not lying around, and steps are marked with bright tape or paint, so people can easily see them. Ensure you adhere to the Health and Safety guidance which will be made available to you by your employer.

Remember that COPD patients can easily dehydrate and get hot quickly so ensure the room is cool and that you have water available at all times.

A first aider should be present and a Defibrillator with a trained member of staff also available in case needed, ensure you have easy access to the gym or studio should you require an ambulance to be called. An accident book should be part of your work place health and safety policy and this policy should be brought to your attention when you take the job.

12.6.4. Data protection

Personal information must be kept in a secure place at all times under a password if on a computer or locked away if in hard copy. It is illegal and unethical to share people’s information to others without the person in question’s permission. Remember anxiety is a common feature so ensure you do not put your clients under undue anxiety. Use empathy at all times and if you suspect a client requires a referral back to their doctor or if you find an undesired result, for example if their blood pressure is high, be tactful with the information and don’t assume anything which may put the client at unrest and which may not be correct.

12.6.5. Oxygen

Some Pulmonary patient/clients may have ambulatory oxygen to supplement the amount of O2 they could otherwise take on board. Typically, this presents little risk as the unit is self-contained and the instructor is not permitted to interfere with this O2 supply in any way. Nevertheless, appropriate safety precautions should be in place. The smoking ban now in force throughout the UK removes the independent need to ban smoking in areas where bottled O2 exists. However, the use of any naked flame should be banned when there is a potential for O2 to be in the immediate area, as O2 is highly combustible and may explode if under pressure. While unlikely, an example of this may be contractors using hand held gas torches for soldering.
Specific attention needs to be paid to fire evacuation protocols, as it is unacceptable to ask a patient/client with bottled O2 to wait in an evacuation holding area in the event of a fire. Any additional guidance may be sought from the clinical referring team. The instructor is responsible for ensuring they remain aware of Health and Safety Executive (HSE) updates on ambulatory O2 for clinical patients as well as NICE and Department of Health updates on COPD. The British Thoracic Society (2013) Guideline For Emergency Oxygen Use in Adult Patients is another useful resource should you need further information.

What to do in an emergency

Although primarily your clients will have been referred for respiratory disease rehabilitation we have discussed the wide spectrum of co-morbidities and that many will be elderly and at increased risk of a cardiac event. It is important that you know what to do in case of an emergency such as an angina attack, heart attack, stroke other emergency. Your employer should place you on a first aid or basic life support course so that you can use the emergency defibrillator if required. If not, it is worth enquiring due to the higher risk of “events” in your workplace.

An emergency action plan should be set so you and your colleagues have a system of emergency action:

The Emergency Plan

• The key to emergency aid in the sport/exercise environment is the initial assessment of the casualty.
• The prime concern is to maintain cardiovascular function (ABC’s) and central nervous system function.

Emergency communication

• Telephones must be available
• Designate someone to call 999
• The right information must be communicated
  - Type of emergency situation
  - Type of suspected injury
  - Present condition of the patient/client
  - Current assistance being given
  - Location of telephone being used
  - Exact location of the emergency

Emergency Action Plan

• Transportation policies
• Treatment policies
• Keys to the appropriate gates
• Separate emergency plans should be developed for each area, location, facility etc.
• Co-operation with emergency care providers
• Next of kin notification

Heart attacks

Symptoms of a heart attack

One symptom is chest pain - often starting in the middle of the chest and perhaps moving to the neck, jaw, ears, arms and wrists. It can travel between the shoulder blades, back or stomach area. If there is no chest pain, it can be very severe, or it can start off as a dull pain or ache. It’s been described as a “heaviness, burning, tightness, constriction or squeezing sensation” or as a “heavy weight or pressure”. It can feel similar to indigestion or heartburn.

Symptoms which may indicate that you are having a heart attack include:

• Pain (sometimes travelling from the chest) in the arms, jaw, neck, back and abdomen
• Feeling or being sick
• Feeling sweaty and clammy
• Looking grey and pale
• Feeling generally unwell, restless or panicky
• Breathlessness, wheezing or coughing
• Feeling dizzy

There may be no chest pain at all, especially in women, the elderly or in Diabetics.
We’re talking about walking, cycling, running, dancing, for individuals that have motivational issues with doing traditional exercises – it’s basically incorporating a wide variety of activities that will go on to improve their overall fitness.

Dr Aamer Sandoo, Lecturer in Exercise Physiology, Bangor University

Don’t delay phoning 999 if you’re not sure or don’t want to make a fuss. The sooner you get emergency treatment for a heart attack, the greater the chances of survival.

Even if symptoms don’t match the above, but you think someone is having a heart attack, phone 999 immediately. You should then sit the client to rest while you wait for the ambulance to arrive.

Aspirin can sometimes help, so offer the client an aspirin. Check they have no allergies to aspirin and if they are not allergic to aspirin they can SELF ADMINISTER one adult aspirin tablet (300mg). Under no circumstances are you to give the client the aspirin, they must take it personally themselves.

Before the ambulance arrives
If you can, before the ambulance arrives, you can help the paramedics by doing the following:

• If you’re outside, stay with the patient until help arrives
• Phone 999 again if the patient’s condition worsens
• Phone 999 again if your location changes
• If you’re phoning from home or work, ask someone to open the doors and tell ambulance staff where they’re needed
• If you can, write down the patient’s GP details and collect any medication they’re taking
• Tell the paramedics if the patient has any allergies
• Tell the paramedics if the patient has taken an aspirin
• Stay calm

Many people survive heart attacks and make a good recovery. The heart is a tough muscle. Stress, shocks or surprises don’t cause heart attacks.

Symptoms of sudden cardiac arrest

Sudden cardiac arrest (SCA) is when the heart stops and person falls unconscious.

The person may:
• Appear not to be breathing
• Not be moving
• Not respond to any stimulation, like being touched or spoken to

This is a leading cause of premature death, but with immediate treatment, many lives can be saved. The heart stops because the electrical rhythm that controls the heart is replaced by a disorganised electrical rhythm. The quicker this can be treated, the greater the chance of successful resuscitation.

What’s the difference between a “heart attack” and a “cardiac arrest”?
A heart attack is a sudden interruption to the blood supply to part of the heart muscle. It’s likely to cause chest pain and permanent damage to the heart. The heart is still sending blood around the body, and the person remains conscious and is still breathing.

A cardiac arrest happens when the heart suddenly stops pumping blood around the body. Someone who’s having a cardiac arrest will suddenly lose consciousness and will stop breathing - or stop breathing normally. Unless immediately treated by cardiopulmonary resuscitation (CPR), this always leads to death within minutes.

A person having a heart attack is at high risk of experiencing a cardiac arrest.

Both a heart attack and a cardiac arrest are life-threatening medical emergencies and require immediate medical help.

What should I do in a sudden cardiac arrest?
Cardiac arrest is reversible, but it’s vital it’s recognised and acted upon in the first few seconds or minutes.

Seconds count - phone 999 FIRST.

You can save a life by trying chest compressions or using a defibrillator.

Chest compressions/hands-only cardiopulmonary resuscitation (CPR)
If someone is having a cardiac arrest, after phoning 999, you can give chest compressions to save their life.

Before you start chest compressions - or hands-only CPR - check the situation is safe to approach, like making sure the person’s not in a busy road.

To carry out a chest compression:

1. Place the heel of your hand on the breastbone at the centre of the person’s chest. Place your other hand on top of your first hand and interlock your fingers.
2. Using your body weight (not just your arms), press straight down by 5-6cm on their chest.
3. Repeat this until the ambulance arrives.

Try to do the chest compressions at a rate of 100-120 compressions a minute.

Defibrillator

The most common type of defibrillator is an automated external defibrillator (AED). If you have access to an AED, use it.

It’s a safe, portable electrical device that most large organisations keep as part of their first aid equipment. You can find them in some public spaces, like your local shopping centre, gym, train station or village hall.

The defibrillator provides a shock that stops the heart so it can naturally return to a normal rhythm. Once you open the defibrillator case, the instructions will talk you through exactly what to do. In between the shocks delivered, CPR should be continued.

Following defibrillation, continue to follow the instructions and keep the person as comfortable as possible. Once life is established, the person should be positioned into the recovery position. Stay with the person until the ambulance comes.

What should I do if I have angina and have chest pains?

Angina often feels like a heaviness or tightness in the chest, which may spread to your arms, neck, jaw, back or stomach. Some people describe a feeling of severe tightness, while others feel more of a dull ache. Some have shortness of breath too.

Unstable angina can be undiagnosed chest pain or a sudden worsening of existing angina with angina attacks occurring more frequently, with less and less activity.

These attacks may even happen at rest or wake you from sleep. They can last up to 10 minutes.

If the person has not been diagnosed with angina but have chest pains, phone 999. If the client has already been diagnosed with angina, they may experience angina pain or discomfort that can be managed by taking your glyceryl trinitrate (GTN) spray or tablets and resting.

There are four stages in what to do when a client experiences angina or chest pains or breathlessness:

1. Stop what you’re doing and sit down. Take one dose of GTN (spray or tablet) and wait five minutes.
2. If the pain or breathlessness remain, take a second dose of GTN and wait five minutes.
3. If the pain or breathlessness don’t ease,phone 999.
4. If the client is not allergic to aspirin, they can chew one adult tablet (300mg). If you don’t have any aspirin - or you’re not sure if they are allergic to aspirin - rest until the ambulance arrives.
Fig. 16 BASIC LIFE SUPPORT ACTION SCHEMATIC

UNRESPONSIVE?

SHOUT FOR HELP?

NOT BREATHING NORMALLY?

CALL 999

30 CHEST COMPRESSIONS

2 RESCUE BREATHS
30 COMPRESSIONS
AED SCHEMATIC

Fig. 17

UNRESPONSIVE

CALL FOR HELP

OPEN AIRWAY
Not breathing normally

SEND OR GO FOR AED
Call 999

CPR 30:2
Until AED is attached

AED ASSESS RHYTHM

SHOCK ADVISED

1 SHOCK
150-360 J biphasic or 360 J monophasic

IMMEDIATELY RESUME
CPR 30:2 for 2 min

NO SHOCK ADVISED

IMMEDIATELY RESUME
CPR 30:2 for 2 min

UNCONSCIOUS
Start CPR

SECTION 12- EXERCISE PROGRAMMING AND MANAGEMENT
Hypoglycaemia - Diabetes

Type II Diabetics are unlikely to experience hypoglycaemia however type I diabetics can frequently have drops in their blood sugars. If untreated this can cause fainting and possible coma. Signs include nausea, pallor, rapid weakness and sweating. You should immediately stop the exercise and take the client to a quiet place to sit down. Administer a fast-acting carbohydrate (CHO) snack or drink consisting of 15-30g of CHO, a small carton of pure apple or orange juice is ideal. The client should begin to feel better soon after taking the snack/drink. Wait 15 minutes then ask the client to measure their blood sugars. If they have risen to between 4.4-13.8mmol/l then send the client home and advise that they eat a full, balanced meal when they get home or 1 hour after they leave. Once a client has had a "hypo" they cannot continue the session.

Motivation and behaviour change

Building relationships

Even when challenged with diagnosis of COPD, it can still be hard for your patient to make the lifestyle changes necessary to change their behaviour and become more active and nutritionally balanced. It is good to have an understanding of some of the barriers that may face you and your patient. Understanding common concepts of motivation and behaviour change will help you to support your patient when their motivation is low, and to identify stages of behaviour change and what interventions can be brought in to tackle possible motivation relapse.

Why build relationships?

Having a trusting, working relationship with your patients aids adherence and facilitates behaviour change. It is important they have faith in your advice, and that it will work for them, or they will not be prepared to sacrifice and work hard for you. A patient likes to be familiar with the service they receive, they will not want to continue training with somebody they don't feel comfortable with or they feel has no genuine interest in them as a person. People talk and reputation is very important as a professional. By being compatible and having good relationships with your patients, your reputation will grow in a positive way and people will want to work with you.

Supporting patients with exercise goals and adherence

The increasing prevalence of lifestyle-related disease would suggest that the fitness industry is failing in their job to improve the health of our nation. It is also true, however, that over the last 20 years, the industry has been one of the fastest growing industries of all. So how does an industry continue to grow when essentially it is not working as it should? Part of the answer could be that exercise and fitness is appealing to people, so they commit to it but they don't realise how much commitment is actually required to achieve perceived goals and expectations. Exercise and increasing activity simply isn't enough to tackle what is required to get people results. Of course, in the case of pulmonary rehab patients, the goals and aims of training will be quite different, at to those of a disease-free individual. The aim of exercise in pulmonary rehabilitation is to firstly gain adherence. In this population, it is all about making the person feel better, reducing symptoms and gaining enjoyment.

As instructors you must realise that people have formed years of habitual behaviour, and this is more so in pulmonary patients where socio-economics plays such a strong role in prevalence. You don't become overweight overnight nor can you change the way you live your life in a few weeks or even months. People join gyms and start their training with enthusiasm but soon become dis-heartened when they stop getting results or realise they cannot commit as they initially thought they could. It is true that success breeds success and this is the biggest motivator for people, along with a health-shock, such as COPD. Essentially, it is being able to facilitate change and overcome barriers that will lead to successfully improving the health of your patients. As an instructor, you must have an understanding of the barriers that people face when intending on starting a regular exercise programme and lifestyle change:

Not enough time

Due to work and family commitments, this is a common barrier to regular exercise. It is important to attempt to fit in regular scheduled activity as part of the person's routine and combine it with increasing physical activity throughout each day.

Too tired

Often, this will be mental tiredness from a day's work or from minding the children. Often, the person will find new vitality if encouraged to do some exercise regardless of their tiredness. You must explain this and give the person the motivation they are lacking.

No willpower

Adherence is a huge problem and people would rather do other things than exercise. It may be useful to introduce a friend or family member to motivate each other. Another option is self-regulation, such as starting an exercise or food diary or record
of progression will make the person accountable and seeing that they have completed the weeks exercise in their diary will motivate them for the following week.

I don't like it, it's too hard
This does not need to be the case. It is the job of the instructor to find ways for the patient to enjoy their exercise sessions. Asking the patient their likes and dislikes will allow you to save time and effort planning sessions that the patient will enjoy. Draw on your patient's past experiences—especially when positive.

They may have enjoyed rugby at school, so you could incorporate some simple rugby drills, or they may like gardening so encourage them to get into the garden in addition to formal exercise sessions. It is important to regularly update and change the exercise and allow for occasional rewards.

Lack of self-belief
It may be that the patient has tried before and failed. Success is a mind-set and by developing a positive mind-set toward fitness and lifestyle is the key. Short-term ‘process-oriented’ goals should be set-up to give the patient challenges that they will succeed in. By breaking-down the long-term goal into short-term and medium-term goals, we can give our patients gratification along the way, which will increase motivation. Show them success stories, explain the achievements you have experienced and inform them that they cannot reach a place they don't believe exists.

In pulmonary patients, of course, barriers are even more complex, as they involve the physical and mental challenges that have been previously discussed in this manual.

Motivation
As specialist exercise professionals, it is important that you understand what motivation is and how to motivate people who are not motivated. There are strategies that can be used to increase somebody’s motivation, but the key is to realise that motivation must come from within. An individual cannot give another motivation, merely facilitate the development of that person's own motivation. When an event such as a diagnosis of COPD or heart disease is brought upon a person, the original shock can be staggering. It is important that interventions are positive and you can show examples of people who have been successful by sticking to the exercise and taught techniques, even after the rehabilitations has finished. Maintenance of behaviour is of paramount importance and currently a huge barrier as health services are rarely funded beyond the initial Rehabilitation Intervention.

Reacting to events
Everything we do is driven by thoughts and feelings. How we act will be determined by our initial thought process, which will evoke feelings and we act on those feelings. Life brings us things each day that will challenge and affect our thought process. Have we had a bad day? Are we delayed by traffic? Can we pay the bills? All these negatives can evoke negative thoughts. Essentially, it is now how we act that will determine the outcome of our success. It is usual that if we are delayed after a bad day at the office, to lose motivation and lose focus of our goal (to perhaps lose weight) and grab a quick, but unhealthy, takeaway meal. The takeaway meal may make us feel better as we sit on the warm sofa and let our bad day drift away. We know, though, that this behaviour is how we put on the body-fat in the first place, and it must stop. So how do we change years of habitual behaviour? We must re-train ourselves to either change the events causing the bad day or react to it differently. It is also true that positivity breeds positivity and success breeds success—this is what we must cling to.

The truth is that after the evening of eating an unhealthy takeaway meal and watching TV, the sense of failing to stick to the regime will haunt us and evoke further negative feelings, which again we may react to with more comfort and negative actions. If, however, the bad day was addressed differently, by going for a walk or releasing frustration with a spinning class, it is likely we will also go home and eat well and this will evoke further positive feelings and a sense of self-pride and success. As exercise professionals, it is important that we coach our clients this and outline to them that it is not the event that causes negative behaviour, but how we respond to the event.

Intrinsic and extrinsic motivation
People can be extrinsically or intrinsically motivated. Somebody who is extrinsically motivated acts because of external influence. For example, the individual will go to the gym because they know it makes them healthy. They may not enjoy it or do it for any other reason, but they do it anyway. An intrinsically motivated person acts due to some internal reason. They do it because they enjoy it, are learning a new skill or feel that, morally, it is the right thing to do. It is usual that intrinsically motivated people will have more success than extrinsically motivated people. It is by intrinsic
motivation that actions become habitual. If we can find ways for people to change their behaviour because they have a personal motivation to change, rather than simply because they are told they should, then more adherence to a new exercise regime would surely be the result.

Cues and rewards
It is good to reward our patients for their success in order to maintain motivation. It is also good to use prompts and cues to help them form habits.

Operant conditioning: Rewarding good behaviour or success. This is important as it reinforces motivation. It may be something small, such as a tangible prize, but it is the recognition that is the key and the positive feeling that the recognition evokes.

Forms of incentives:
• Free session after 10 successive sessions;
• Well-done card;
• Motivational text message;
• Towel or water bottle for joining;
• Discounts on sessions for reaching targets, etc.

Classical conditioning: Cues and prompts to call a person to action. This could be to leave the gym-bag by the door, notes on the fridge or text messages from the exercise instructor to go for a run or cycle, or read an article in a magazine, etc.

Forms of cues:
• Texts reminders;
• Sending class timetable;
• Notes on the fridge;
• Take gym kit to work;
• Re-assessments.

Facilitating behaviour change
Although it is the job of an exercise professionals to understand motivation and help clients with cues and rewards, etc., there is much research we can draw on in the area of behaviour psychology to help facilitate patient's change to better lifestyle. It is important that we encourage patients to take ownership of their training and lifestyle coaching and to take some responsibility in controlling it themselves.

This helps them in difficult times or in times when the instructor is not available. Those who take responsibility for their own actions become self-sufficient and learn not to rely on others, but to face challenges and overcome them themselves. This, in itself, is a powerful thing. If change can come from within, rather than from an external influence (being told they should), then adherence is more likely to occur.

It is thought that people go through phases of thought and action when changing their behaviour.

This is the case, whether it is starting an exercise regime or giving up an addiction, such as smoking cigarettes. All change starts at the same point, it is probably the mind-set that dictates long-term adherence or relapse and reverse. The Transtheoretical model for behaviour change, or the stages of change model, was developed by Prochaska and Di-Clemente (1983) to outline the process people go through when changing behaviour.
Goal-setting is an important part of patient support. We essentially set goals for ourselves every day. To complete a piece of work, to go to the gym, to buy a healthy lunch. The examples given here are relatively small, short-term goals, but our patient’s goals will be over a much longer timespan and are likely to be more complex.

Why set goals?

By setting ourselves and our patients clear, well-defined goals, we are visualising where we want to go. This aids motivation and if the long-term goal is broken down into smaller more achievable goals, it allows for regular success. We can see that we are progressing and that the intervention (exercise for example) is working. It also allows identification of areas that are not working, and, in this case, we can change the intervention early and address the lack of success.

With a pulmonary patient, of course, the reasons for goal-setting are largely dictated by the condition but it is certainly viable that your patient might also be motivated by performance or aesthetic goals, such as to be able to play with their grandchildren or to look better. The more focus and drive that is born-out of goal-setting the better but remember you must prioritise.

When you ask a new client what they want to achieve, they may reply with a rather vague answer; ‘I want to lose weight’. This tells us very little, and we need more insight. For one, we need to know how much weight (preferably body-fat, not lean body mass), so that we have a clear

<table>
<thead>
<tr>
<th>Stage of change</th>
<th>Characteristics</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-contemplation</td>
<td>No intention to change. May defend their position when pressured to consider. Changing behaviour.</td>
<td>Educate</td>
</tr>
<tr>
<td>Contemplation</td>
<td>Ambivalent about change: “sitting on the fence”. Not considering change within the next month. May have been affected by an incident and considering the advantages and disadvantages of changing</td>
<td>Decision balance. Weigh up pros &amp; cons</td>
</tr>
<tr>
<td>Preparation</td>
<td>Some experience with change and are trying to change: “testing the waters” Planning to act within 1 month. Change has not yet occurred but could soon.</td>
<td>Plan and set goals. Discuss barriers</td>
</tr>
<tr>
<td>Action</td>
<td>Practicing new behaviour. Person will be very keen and probably motivated but beware; the action stage usually lasts between 3-6 months and it is at this stage that relapse usually occurs</td>
<td>Focus on restructuring cues and social support. Bolster self-efficacy for dealing with obstacles. Combat feelings of loss and reiterate long-term benefits</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Beyond 6 months and the stage the instructor wants their patient to be at. A lot of work is still to be done however. The patient will be nervous of relapsing and much support is still required</td>
<td>Evaluate success so far. Plan for follow-up support. Reinforce internal rewards. Include variation to fend off boredom</td>
</tr>
<tr>
<td>Relapse</td>
<td>Failure coinciding with feelings of either anger toward the change “I hate exercise it’s too hard” or feelings of letting one’s self down. Relapse usually will drop back to contemplation</td>
<td>Evaluate trigger for relapse. Reassess motivation and barriers. Plan coping strategies.</td>
</tr>
</tbody>
</table>
vision of the task ahead. Secondly, the goal needs a time-based. Without being time-based, the goal has no meaning and a ’will do it tomorrow’ attitude may be adopted by the patient. Thirdly, the goal needs to be achievable. It would be silly to set a goal of losing 2 stone in 1 month, for example, as it is impossible to do in a healthy and maintainable fashion. Essentially, the goal has to be SMART:

• Specific;
• Measurable;
• Achievable;
• Realistic;
• Time-based.

Planning progression
Most goals in life involve a journey. We do not simply decide to achieve something one minute, then the next minute, it is so. We have to plan how to reach the long-term goal. We can do this in several ways. In sport and exercise training, a system called periodisation is used where the season or off-season training is split into segments, and at the end of each segment is a goal for that period until the pinnacle is reached. A good example would be a boxer. A boxer will rest for a few months then a fight will be arranged so training must begin. The trainer will have a periodised plan with regular shorter-term goals of what he wants the boxer to achieve until the fight day arrives and the boxer peaks in mental and physical preparation. Indeed, goal setting can be long-term, medium-term and short-term, which will help when programming for somebody’s event, career or whatever the reason.

An example of a performance goal programme is below. In a pulmonary rehabilitation setting however progression will be different but just as important. A lot of expertise, time and cost has gone into the treatment of the pulmonary patient. It is not sufficient then for you, as the exercise professional to just maintain that work, or even worse create reversibility. Marching on the spot every week or side stepping for 6 weeks will not progress the clients exercise capacity and will probably become very monotonous, causing boredom and relapse. The pulmonary client requires over load as in a healthy exerciser to assure progression and this is discussed in later chapters. Sure, to begin with it is wise to set comfortable exercise so as not to cause too much dyspnoea and put the client off, but once the client has attended a couple of sessions and is more familiar with the environment and instructors, a progressive programme of exercise is required based on sensible monitoring, valid guidelines and client feedback.

Medico-legal issues
As a Pulmonary Rehabilitation exercise professional, you, and your facility, will be bound by laws and morale responsibilities which will ensure you are providing your services with best practice. There are several areas that you must ensure are in place and abide by before you can set up your referral scheme:

Firstly, you must be aware of and abide by the REPs ethical code of conduct (www.exerciseregister.org) which sets out the 5 key principles of the code of ethical conduct, these include:

• Rights
• Relationships
• Personal Responsibilities
• Professional standards
• Safe working practice

Your role as an exercise professional is to identify and meet the needs of individuals, improve performance or fitness through programmes of safe, effective and enjoyable exercise; create an environment in which individuals are motivated to maintain their participation and improve their performance of fitness; act with integrity and respect; maintain and develop your personal competence.

It is essential that you as an individual, as well as your organisation, has sufficient insurance to cover liability and accident. A service level agreement should be in place which sets out what services you will provide, who you will work with and how much the services will cost.

This should be signed by the referring organisations and it is wise to include within this a risk stratification which highlights inclusion/exclusion criteria so the referrer is clear of who they can refer in to your scheme. Your referral form should be constructed alongside the referring parties and contain all aspects mentioned earlier in this manual.

Your scheme should be monitored and evaluated in a meaningful way. NICE are particularly keen to see examples of best practice and your evaluation should
include measures on physical activity levels of your clients. You should have a first aid policy in place to include emergency life support and a named first aider at all exercise sessions.

You must comply with the Data Protection Act (2018), which in brief states that information should be accessible to those who are authorised to access it (i.e., those with a direct and specific requirement) and nobody else;

- Protected by commercial password protection, firewalls and encryption technology on portable data sources;
- Used only for the purpose for which it was collected and destroyed when no longer required;
- Transferred from one place to another in anonymous format;
- Backed-up with the same level of security.

Your facility should be a place which is not intimidating to the clients but encourages adherence and long-term behaviour change. Changing and toilet facilities should be offered and the facility should be set up to accommodate the needs of the specific types of people you will be providing the service for.

You must work within your professional boundaries and not exceed services which are beyond your qualification or experience. You cannot give medical advice and medical advice cannot be given unless a suitably qualified clinician is available to offer it.

Interacting appropriately with pulmonary rehabilitation specialists

It is highly conceivable that in your role as a specialist exercise professional you will, and should, regularly interact with clinicians and people of field expertise. This could be at the start when you are building your referral base or throughout when receiving referrals or asking about patients and practices. It is important that from the start you agree a named link with a clinical individual or team from Pulmonary Rehabilitation that you can contact with questions and for details about patients/clients. It is important that you are aware of local protocols used when transferring patients from clinical rehabilitation to a long-term maintenance scheme and the support that is available to you. You must therefore present yourself in a respectable, professional manner and although you should not be intimidated, you should address the clinician with the respect they deserve and in turn you can expect the same. It is accepted that you are not a doctor or specialist but the medical professional will expect you to have some, appropriate, level of knowledge in the subject area and to be able to discuss in an appropriate level of dialect. The clinician maintains the clinical responsibility in your relationship but is not an expert in exercise testing programming or delivery and will therefore expect you to lead conversation in these matters. In the past clinicians and referrers have become frustrated with exercise referral schemes who have referred patients back to them unnecessarily.

Therefore, you must know appropriate times and circumstances to refer a patient back. Should the patient's condition worsen, should they form new symptoms or persistent medical complaint, should they psychologically deteriorate or should you suspect their medication is not doing what you would expect it to do (e.g. lower B.P.), then you are probably warranted to make a referral back to their G.P.

When communicating with your clinician ensure you do so in a professional and courteous manner. A letter or email should be written well, with a pleasant tone and should avoid common terminology such as “mate” or “cheers”! A letter or email can be used in a court of law as evidence, in such an appropriate occasion, depending on what its purpose and content is, so be careful when you are challenging or complaining about something not to leave yourself open for scrutiny.

The letter or email should contain your full name and place of work and job role and if appropriate display any academic post-nominal letters you have earned (BSc; MSc etc.). Letters and emails must not contain personal information, as recognised under the Data Protection Act (2018) unless you have the written approval of the person to whom the information pertains. Failure to comply with the Date Protection Act may constitute a criminal offence and attract significant legal penalties. Any letter that does contain personal information should be stored in accordance with the Data Protection Act; in simple terms, accessible to all those authorised to access it and nobody else. Letters that form part of an agreement should be kept for no less than 5 years in a safe environment. Letters that contain very important information should be protected from inappropriate access and fire.

Consultations and barriers to communication

Once you have received a referral you must then arrange an initial consultation to meet your new client and to
discuss their needs and plan the journey ahead. This is your opportunity to put the client at ease and make them feel welcome. They may be very intimidated and, in some cases, anxious of meeting you as they will not know that exercise referral is very different from the typical gym experience. You are essentially selling exercise to them but not in the traditional salesman approach. Going from a very clinical exercise environment where physio's, nurses and physiologists are present to look after them, to a gym-based environment can be daunting and barriers will have formed within the client about you and your intervention. In exercise referral personality is key to breaking down these barriers. A big smile and open, welcoming approach will go a long way but once in the consultation it is good to demonstrate a little of your knowledge to the client to show that you do actually understand their unique situation.

“I see your 6-minute walk test was very good and you managed 300 meters, well done. Do you get more breathless when you go up a slight incline or perhaps when the weather is colder?” This is a very simple statement to make and requires little complex knowledge but to the client, who is concerned about your understanding of their condition, it is relatable and demonstrates that you have insight into how their condition affects them from day to day. You can discuss their medications. “So, I see you have 2 inhalers, a blue and brown. Do you take your brown one in the morning and then the blue one as you need throughout the day?”

Again, this is not complex clinical terminology but demonstrates to the client that you have a level of knowledge and understanding, and this will help them to build their efficacy in you. The key thing is that they leave the first session having had a nice and fun time and are calmer than when they arrived. Although useful to demonstrate an understanding you must also take the persons feelings into consideration. Remember they may have never entered a gym before so it is important to be empathic and caring without patronising them. Try to pick up the persons personality quickly and address them accordingly. Are they very anxious? Are they impatient and frustrated that they have to be there? Are they confident and professional? Are they having a laugh and a joke from the moment they enter the room? All these personality traits warrant a different approach and by picking up on them you will help lower the barriers and form a meaningful and successful relationship. There are more helpful tips of how to form relationships and address barriers in the “motivation and behaviour change” section.


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Useful Websites

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www.bhf.org.uk
www.diabetes.org.uk
www.ersnet.org
www.goldcopd.org
www.mind.org.uk
www.nhs.uk
www.nationalobesityforum.org.uk
www.people.eku.edu/ritchison/301notes6.htm
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