stage of a condition. Patients may eventually leam how to swim or become confident enough in the water to continue with exercise at their local swimming baths.

As with many areas of physiotherapy there is a paucity of good-quality research providing hard evidence of the effectiveness of hydrotherapy as a treatment modality. In a recent review by Geytenbeek (2002), however, it was found that there is a balance of high- to moderate-quality evidence supporting the use of hydrotherapy witii particular reference to 'pain, function, self efficacy and affect, joint mobility, strength and balance particularly among older adults, subjects with rheumatic conditions and chronic low back pain'. Many of the problems mentioned above are experienced by patients with orthopaedic conditions and so it would seem that hydrotherapy can be a useful modality for us to use in these situations.

You must remember that, even though most of us enjoy the water, it is essentially an alien environment for humans. As a physiotherapist working in the hydrotherapy setting you need to be conscious of this fact at all times. If you are to work safely and effectively in this area, you need an additional set of knowledge and experience to that which you might gain in any other area of physiotherapy practice. The knowledge underpinning hydrotherapy can be broken down into a number of themes:

- Physical principles of water (hydrostatics/ hydrodynamics) and how they arc used in treatment
- Physiological effects of immersion
- Therapeutic effects
- Contraindications to pool treatment
- Health and Safety issues in the pool environment
- Pool management
- Advantages and disadvantages of pool therapy.

The rest of the chapter will now take you through these themes, applying them to the orthopaedic setting as appropriate.

PHYSICAL PRINCIPLES

When treating patients in a pool, you need a clear understanding of hydrostatic and hydrodynamic principles as these underpin every activity and exercise. It is not appropriate to transfer land-based exercises into the pool, as this neglects the unique properties of water and consequently will not produce optimum results. It is vital that you appreciate the difference between exercise carried out on land and that performed in water.

This section does not cover all aspects of physics that come into play when you enter the water: for these we recommend that you refer to a basic physics text. The aim here is to introduce you to those physical principles that will enable you to plan and explain the rationale behind a reasoned pool treatment. This includes the progression of exercise, which differs to that on dry land because of the additional factors involved with your patients being immersed in another medium.

Buoyancy

An immediately obvious effect when entering the water is that of buoyancy - the apparent reduction in the weight going through our lower limbs. Gravity acts downwards on body mass and the resultant effect is our perception of weight. The buoyancy or upthrust we experience when in the water supports the body and acts to counterbalance gravity, so we feel lighter.

Archimedes' principle states: When a body is partially or wholly immersed in a fluid, it will experience an upthrust that is equal to the weight of the fluid displaced.

Density and specific gravity

Density (the relationship between the mass of an object and its volume) and specific gravity (SG) (which allows comparison of the densities of different substances, with water as the standard at a SG of 1) are important in relation to Archimedes' principle. If an object is placed in water and it comes to rest in a position where its weight is neutralized by the upthrust and part of it remains above the water line, then it has a SG of less than 1 The greater the proportion of the object below the water, the nearer its SG approaches to 1. If the whole object sinks, then its SG is greater than 1.

These factors apply to the human body but, as we arc varied in our make-up - i.e. different percentages of fat (less dense) and muscle (more

dense) - some people float better than others. Various parts of the body have different SGs: the thorax includes the lungs, which reduces overall SG; the legs tend to be more muscular, which increases the SG. This means that the legs usually float lower in the Water than the trunk. On average, the SG of the human body is between 0.93 and 0.97, but there are natural 'sinkers' and 'floaters'. Do you know which you are? Many people do float but with the majority of the body below the surface. This may be inappropriate for treatment and so you can add floats to bring the appropriate parts higher in the water.

The SG of the body varies with age. In general children have a lower SG and so float well. Young people, who have a greater ratio of muscle to fat and a higher bone density, have a higher SG and so may tend to be natural 'sinkers'. Later in the life *cycle* we often have a larger ratio of fat to muscle. This, along with reduced bone density, decreases the overall SG, so older people tend to be better 'floaters'.

Self-assessment question

- SAQ 11.1 Why is it inappropriate to use land exercises in the pool?

Percentage weight bearing during immersion

As mentioned earlier, we feel lighter when standing in the water. Harrison & Bulstrode (1987) found that percentage weight bearing when immersed in water is as shown in Table 11.1.

The percentage weight bearing at the different levels of immersion will vary slightly from person to person and does differ a little in men and women, but it is a good rule of thumb. It is extremely useful when you treat patients who are partial or non-weight-bearing, e.g. following lower limb fracture or knee/hip replacement. They can move more easily in the pool and will be able to use a reciprocal gait pattern earlier than would be possible on dry land. If your pool has different depths, the weight passing through the patient's lower limbs can be progressed in a controlled manner (Reid Campion 1990). The risk (and fear) of falling is also reduced because of the support of the water and this can greatly improve confidence.

Table 11.1 Percentage weight bearing when immersed to different levels in standing

Level of immersion	<¥o weight bearing
C7	Approximately 10
Xiphlstemum	Approximately 30
Anterior superior iliac spines	Approximately 50

General uses of buoyancy in hydrotherapy

Support. Because of the effect of the upthrust as described above, buoyancy can be used as a support. This can be global support of body weight in standing or float lying or it can be local support of a particular part of the body during specific exercises.

Resistance. If you push down in the water against the upward force of buoyancy you can feel the resistance to your movement. This can be used as a resistance during strengthening exercises. The effect of the upthrust, i.e. the amount of resistance, can be modified by changing the length of the lever (shorter lever = less resistance; longer lever = more resistance) and/or by adding floats.

Assistance. Conversely, the upthrust can be used as an assistive force to enable greater amounts of movement. This can be used in mobilizing exercises for patients with stiff joints and/or where they have decreased muscle strength. Care needs to be exercised here to ensure that the upward force of buoyancy does not take the patient beyond available range, i.e. a forced passive movement. You need to bear this in mind, especially if you add a float to the part.

Self-assessment question

- SAQ 11.2
  a. Approximately how much weight goes through the lower limbs when a person is immersed to C7, the xiphisternum and the anterior superior iliac spines respectively?
  b. How can this reduction in body weight be used to advantage in patients with orthopaedic problems?

Moment of buoyancy

A moment is a measure of a force that tends to rotate the body on which it is acting. If a force is applied to a body that has a pivoting point through which the line of force does not pass, then the body will tend to rotate about that point. Buoyancy is a force that acts on bodies immersed in water and the moment of buoyancy will result in rotatory movements of the limbs or segments of limbs around the joints, which act as the pivot points. This is an important principle to be aware of when you work in the pool, in both treatment and safety contexts.

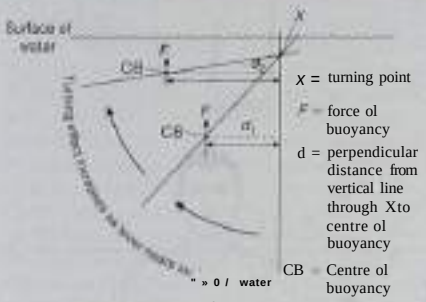


Figure **11.1** The moment of buoyancy increases as the lever moves further from the vertical (as the value of *d* increases).

The moment of buoyancy can be represented by an equation:

Moment of buoyancy = *F* x *d*,

where *F* = force of buoyancy (upthrust) and *d* = perpendicular distance from a vertical line through X (X = point about which turning effect is exerted) to a vertical line through the point at which the force is exerted (e.g. the line of force; Fig. 11.1).

Given that the upthrust remains constant (unless a float is added) it is the perpendicular distance (if) between the vertical line through X and the line of force that has the most influence on the magnitude of the turning effect. For instance, during shoulder abduction, as the arm moves away from the side of the body, *d* increases (Fig. 11.2). In this case, as the arm gets nearer to the surface of the water the turning effect increases. This would provide either more assistance to die shoulder abductors as the arm nears 90° or, conversely, more resistance to the adductors.

The effect of the turning force can be modified in two ways. First, you can change the length of the lever, e.g. bending the elbow, so decreasing *d*, which consequently decreases the magnitude of the turning effect (Fig. 11.3). Second, you can add a float, which increases the amount of upthrust both by increasing the value of *F* in the equation

Figure **11.2** Moment of buoyancy in shoulder abduction.

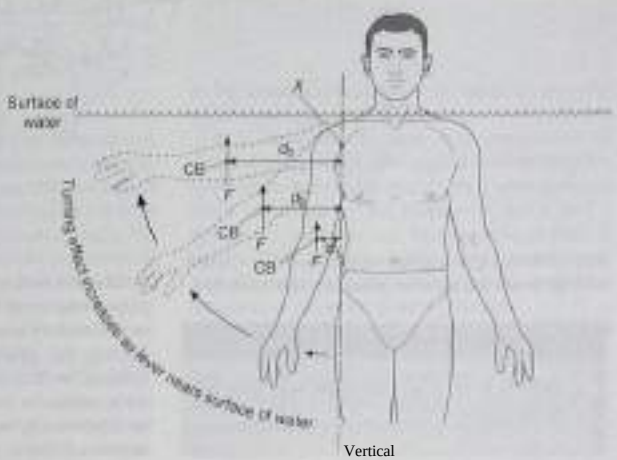


Figure **11.3** Shortening the lever (bending the elbow) decreases the value of d so reducing the magnitude of the turning effect.

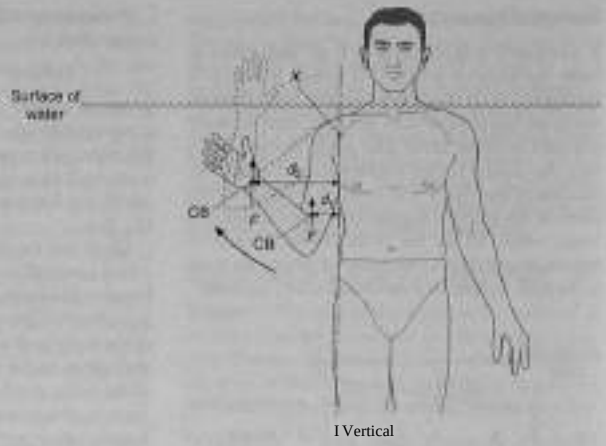
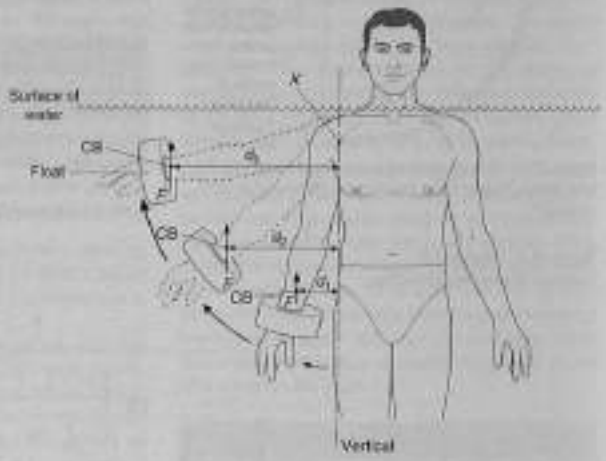


Figure 11.4 Adding a float moves the point at which the force acts further down the limb so increasing the value of *d* and consequently the magnitude of the turning effect.



and by moving the point at which the force acts further down the limb, so increasing the value of *d*.

The effect of adding floats can be modified at yet another level by changing the size of the float or the amount of air that you put into it and/or by altering the position of the float. For example, holding the float in the hand provides greater assistance/resistance to movement than putdng the float around the elbow, which provides less assistance/resistance (Fig. 11.4).

Self-assessment question

SAQ **11.3** What are the three main uses of buoyancy?

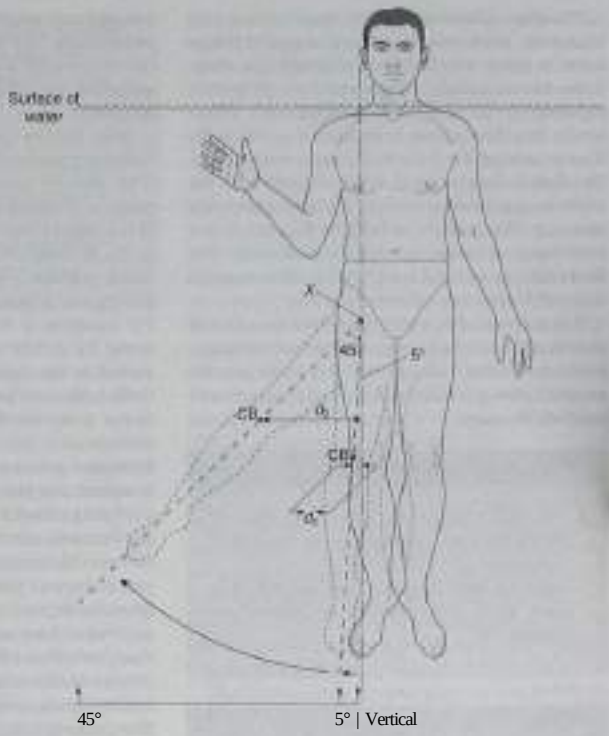


Figure 11.5 Because of the increase in magnitude of the turning effect with an increase in the value of d, the hip adductors work six times harder when the hip is in 45° of abduction than when it is abducted only 5°.

Practical implications

This has a number of implications in the treatment setting. First, when moving the body or body segment up and down in the water, the amount of assistance/resistance varies depending on where in range the part or segment is positioned. Using hip abduction as an example, because of the increase in *d* as the leg moves away from neutral, the adductors will need to work approximately six times as hard to hold the leg in position at 45° of abduction as they would at 5° of abduction (Fig. 11.5). Second, using changes in lever length and floats of different sizes or containing different amounts of air, and placing those floats in different positions on the limb, you can provide an almost limitless variation in the amount of assistance or resistance you provide to particular movements.

It is important to note that progression of assisted movements with regard to lever length is opposite to that on dry land. A long lever provides more assistance so the exercise is easier and a short lever provides less assistance so is slightly harder. With respect to buoyancy-resisted exercises the principle is the same as on dry land, i.e. a longer lever provides more resistance.

Purely buoyancy-assisted/resisted movements are quite slow. As soon as you ask the patient to move more quickly through the water, you are introducing increased levels of resistance into the equation because of the effects of turbulence - see later.

The effect of buoyancy can be used to carry out hold-relax techniques to increase range of movement in joints where there are shortened structures. As an example, if knee extension is limited, a patient can be positioned in sitting with a float on the foot. The patient is instructed to allow the float to extend the knee to its maximum extent. The foot is then pushed down slightly into the water to carry out a static contraction against the upthrust. This position is held for 2 seconds and then the muscles are relaxed for 6 seconds. The float will then take the knee further into extension as the tight structures reciprocally relax.

It is essential that you ensure that you do not provide excessive buoyancy assistance/resistance, particularly when using floats. This could take the patient's joint and soft tissues beyond the safe and comfortable range.

Self-assessment questions

- SAQ 11.4 How can you modify the effect of the turning force produced by the moment of buoyancy?
- SAQ 11.5 What happens when you introduce more speed into buoyancy-assisted/resisted movements?

[redacted]

Imagine a patient who has reduced range of hip abduction. How could you use buoyancy in a progressive manner to increase abduction?

Metacentre

The metacentric principle concerns balance in the water. As we mentioned earlier, a body immersed in water is acted upon by two opposing forces - gravity acting downwards through the body's centre of gravity and buoyancy acting upwards through the centre of buoyancy (this is located at the centre of the body of water that has been displaced by the immersed object). If these two forces are equal and opposite then the body is balanced and there is no movement. If the two forces are unequal and out of alignment, however, then movement occurs. The movement is always rotatory and continues until a state of balance is once again achieved, i.e. when the two forces are back in alignment.

This applies to ourselves and our patients. Imagine a patient floating in a symmetrical position with arms by the side and legs together. This is a position of balance, with no movement occurring. If the patient changes the position of part of the body, whether above or below the surface of the water, rotation will occur because the centres of gravity and buoyancy are no longer in alignment. For example: if the left hand is lifted out of the water, the patient will roll to the left; if the head is turned to the right the patient will roll that way (both horizontal rotations); if the head is lifted out of the water the feet will sink (vertical rotation). Alterations in shape due to disability can also cause rotation, e.g. an amputation or the limbs being held in a particular position because of spasticity.

During activity in water, therefore, it is important that you are aware of these rotational effects and are able to act to control them if necessary. As you assess your patient prior to treatment, pay some attention to body symmetry and shape so that you are aware of any rotation that may occur and can be ready to instruct the patient in ways to counteract rotational effects (Reid Campion 1990).

Conversely, you can use the small movements that cause misalignment of the centres of gravity and buoyancy in order to teach people how to initiate movement in the water. The Association of Swimming Therapy (AST) uses rotation in the water as a basis for much of their input with disabled swimmers. Teaching balance in the water, how to regain safe breathing positions and to use rotation to initiate movement form the foundation for good water confidence, independence in the water and eventually swimming. The AST promote all aspects of swimming for disabled people and use the Halliwick method to achieve these results (Association of Swimming Therapy 1992).

Problem-solving exercise 11.2

Next time you go swimming or have a moment to spare in the hydrotherapy pool, experiment

with changes in body shape. See what happens when you move part of the body out of the water or away from the trunk; try bending one arm or knee; lift your head.

Can you control the rotation?

If so how do you do it?

How safe do you feel?

How do you think this might affect the patient's level of confidence?

How do you think you might be able to use these effects in treatment?

Hydrostatic pressure

'Fluid pressure is exerted equally on all surface areas of an immersed body at rest at a given depth' (Pascal's law).

Hydrostatic pressure represents the weight of the column of water from the point in question to the surface. The pressure exerted on the body at a given depth is equal and opposite in all directions but it increases both with depth and with the density of the medium.

Probably the most important implication of hydrostatic pressure is that it causes a redistribution of the fluid volume within the body. In standing, a person of average height immersed to neck level will be subjected to a pressure of around 120g/cm^2 at mid-calf. Because of this greater pressure on the lower limbs, approximately 700 ml of fluid is redistributed from this region into the thorax. This effect is responsible for most of the profound physiological effects that occur during head-out water immersion (HOWI; see later).

Self-assessment question

I • SAQ 11.6 What is the metacentric effect?

The pressure exerted on the calf by the water is between two and nine times greater than the pressure that is exerted by a crepe bandage newly applied to the same area (Davis & Harrison 1988). This means, therefore, that oedema may be reduced by the pressure but only during the immersion period. This temporary reduction may, however, enable the patient to exercise more effectively while in the pool, causing a longer-term reduction in swelling and subsequently aiding mobility.

The thorax and abdomen are also subjected to an increase in pressure (around 30g/cm^2 and 40g/cm^2 respectively) during immersion, resulting in some increase in resistance to anteroposterior, transverse and vertical chest expansion. This, coupled with a slight internal increase in pressure due to the redistribution of approximately 700 ml of fluid from the legs to the thorax, will result in a small decrease in vital capacity. While this decrease undoubtedly takes place, its clinical significance should not be exaggerated. You should remember to carefully monitor patients with low vital capacity in case of problems but this is by no means a contraindication to treatment in the pool (Davis & Harrison 1988, HACP 2000).

Movement through water

This is the basis of most pool therapy and it is therefore essential that you are familiar with the physical principles that govern it. When you move in water you meet resistance to that movement. The total resistance comprises a number of factors but the two that are of most importance to you when treating patients are the bow wave and the wake.

The bow wave is positive pressure that builds up in front of a moving object as a result of the displacement of the water. This makes up approximately 10% of the overall resistance. The wake is an area of negative pressure that forms behind the object and causes a drag effect. The negative pressure is produced by turbulent water flowing into the area immediately behind the object, causing eddy currents (see below). The wake makes up approximately 90% of the resistance to movement (Fig. 11.6).

The other factors involved in offering resistance to movement through the water are friction, the viscosity of the fluid and the cohesive and adhesive forces that occur at the skin-water interface. The effects of these components of resistance are, however, minimal when compared to the total.

Turbulence

Bernoulli's theorem defines the relationship between fluid velocity and fluid pressure along a

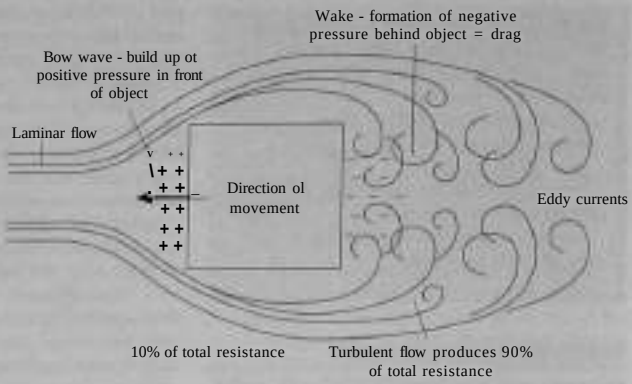


Figure 11.6 Resistance to movement through water.

streamline in the steady flow of a frictionless fluid that has a constant density. Part of this theorem addresses the relationship between the various types of energy contained within a water particle. The total energy of the particle is a sum of three types of energy:

- Pressure energy
- Potential energy
- Kinetic energy (Reid Campion 1990).

The amount of energy in the universe has always been the same - energy cannot be created or destroyed. When we say that energy is used, it does not disappear, it is just converted into other forms of energy and these conversions or changes are occurring all the dme (Oxlade & Parker 1999). In relation to water particles, therefore, if the level of one of the energies increases, then the level of the others must decrease. The two of most relevance to us in relation to water movement are kinetic and pressure energy.

Turbulence is the term used to describe the eddy currents that follow an object that is moving through the water. The degree of turbulence depends partly on the speed of movement; in other words, faster movement creates more turbulence, slower movement creates less turbulence and the flow of water is more streamlined. Faster movement, with many eddy currents being formed behind the object as it moves through the water, indicates the presence of high levels of kinetic energy in the water particles. As a result of this the level of pressure energy goes down, so causing an area of low pressure behind the object, resulting in the drag.

There are three variables that can affect the amount of turbulence produced by an object moving through the water; these are:

- Speed
- Shape
- Size.

You can change the shape and size by altering the length of lever, changing the aspect of the limb that is leading the movement (e.g. the edge of the hand produces a more streamlined flow than the flat of the hand) and/or by adding apparatus (e.g. bats, flippers, webbed gloves). In general terms these changes increase or decrease the surface area that is presented to the water. But, as you can see from the equation below, the most significant factor here is the speed of movement:

$$\text{Drag} \propto \text{area} \times \text{speed}^2.$$

The drag is proportional to the area of the object leading the movement multiplied by the speed of movement squared.

You can use streamlining and increase in turbulence to vary resistance to exercises and so produce a progressive exercise programme.

Drag can be used to both resist and assist movement in the water. You can use changes in shape,

size and speed, either in isolation or combination, to increase the difficult}' of a movement. You can, however, also assist a patient's movement. In the same way that a mother duck uses the drag she creates while swimming to draw her ducklings along behind her, you can create turbulence in the water in front of the patient or part of the body to enable easier movement. You can create this turbulence either by using your hands or by moving through the water in front of the patient. For example, you walk together; you going backwards so you can observe and steady the patient if necessary and the patient walking forwards. This same technique of creating turbulence can be used to resist movement or to encourage stability. To increase resistance, add your turbulence behind the moving part. For stabilization, ask the patient to maintain a particular position while you produce turbulence in different areas of the water around the body.

Remember that, as described above, when you move through the water you produce turbulence and drag. If you move past a patient who is unstable it could cause a loss of balance, Coping with the effects of turbulence demands co-ordination and balance. You can utilize these principles when designing treatment programmes to develop co-ordination and balance skills in appropriate patients.

Self-assessment question

1 SAQ 11.7 Why are the effects of hydrostatic pressure important?

Problem-solving exercise 11.3

Describe a progressive strengthening programme for weak knee flexors using buoyancy and movement through the water.

Refraction

Refraction occurs whenever light passes from one transparent medium to another. The rays are bent or refracted at a certain angle from the normal depending on the two types of media. As light passes from water (more dense) to air (less dense), the rays bend away from the normal. The effect of this is to make anything in the water appear nearer than it actually is.

This physical property of water has two implications for us. First, it is important to warn patients that the floor of the pool and any steps will look nearer than they actually are, so care needs to be taken. Second, it is not recommended that you attempt to assess the patient's movement while in the pool. There is distortion as you look into the water and you will see the 'apparent' image as opposed to the 'real' image. Your assessment is likely to be incorrect - do it on dry land.

Problem-solving exercise 11.4

You were introduced to Mr Kingston in Case study 5.2 in Chapter 5. He sustained a fractured shaft of femur that was treated with internal fixation. He was discharged non-weight-bearing. How could you use hydrotherapy in his rehabilitation?

PHYSIOLOGICAL EFFECTS OF IMMERSION

Immersion in water has marked physiological effects, many of which are due to the hydrostatic pressure. As mentioned earlier, these pressure gradients cause a redistribution of fluid that shifts 500-700 ml of the blood pooling in the legs to the cardiothoracic space. This in effect causes an increase in blood returning to the heart. The relative hypervolaemia stimulates cardiopulmonary receptors, which go on to provoke a series of physiological reactions. Much of the initial work in this area was carried out by NASA, as immersion is the nearest that we can get on Earth to the weightlessness of outer space. This environment was used for both experimental procedures and astronaut training. Most of the work on HOWI has been carried out in thermoneutral water (35°C) with subjects seated with the water to the level of the sternal notch. This temperature of water has no effect on the core temperature of the body. Any increase in

water temperature can cause substantial alterations in circulation (Hall et al 1990).

Self-assessment questions

- SAQ 11.8
  a. What factors offer resistance when moving through the water?
  b. Why does turbulence produce resistance?
  c. What are the variables that can affect the amount of turbulence produced by an object moving through the water? Which of these is the most significant?
- SAQ 11.9 Why do you need to know about refraction?

Cardiovascular system

In the cardiovascular system, the increased venous return to the heart seems to be the basis for all of the physiological changes associated with immersion (Hall et al 1990). Cardiac output, described as a function of stroke volume (the amount of blood ejected from the left ventricle each time the heart contracts) and heart rate, increases by 34% in thermoneutral water but the heart rate remains fairly stable, or occasionally a slight bradycardia occurs. With water at higher temperatures the effect on cardiac output is more pronounced and the heart rate tends to rise, with tachycardia occurring when the water reaches 37°C. In water at 39°C cardiac output rises as much as 120% and heart rate can increase to 113 beats per minute (Weston et al 1987). The general effect on the blood pressure is that it either remains the same or falls during immersion, which suggests a decrease in peripheral resistance (Davis & Harrison 1988, Hall et al 1990). These cardiovascular changes also occur when a subject is in the supine position, but to a slightly lesser extent.

It is important for you to be aware that these changes are occurring in the cardiovascular system, not just in your padents' bodies but in yours as well. This is prior to any exercise being undertaken. The temperature of hydrotherapy pools used to regularly exceed the thermoneutral temperature stated above (some sHll do) but the Chartered Society of Physiotherapy Service Standards (CSP 2001) now recommend that 'the pool water temperature is maintained within a range 32-36°C, with die opHmum being thermoneutral, i.e. 34—35.5°C. If the pool you work in is maintained to the recommended standard, therefore, neither you nor your patients will experience the magnified physiological effects of immersion at higher temperatures.

Mrs Jones is the 77-year-old lady with a fractured neck of femur treated with a dynamic hip screw (Case study 5.3 in Chapter 5). How do you think that management of this patient in the hydrotherapy pool would vary from that you decided upon for Mr Kingston?

Haemodilution

It has been noted that, during the first 30 minutes of immersion, haemodilution occurs, but this generally returns to normal over the following 2 hours. It has been speculated that this haemodilution effect could be of use in diseases, such as rheumatoid arthritis, where blood viscosity is higher than usual (O'Hare et al 1984). You will usually take patients into the pool for periods of 20-30 minutes and so this effect may be of help to some of your rheumatology patients.

Renal function

Immersion has a marked effect on renal function, particularly a profound diuresis due to the suppression of antidiuretic hormone. This causes the distal tubules and collecting ducts of die kidney to become less permeable to water, so less is reabsorbed, resulting in more urine being produced. The kidney usually filters 120 ml/minute and produces 1 ml of urine. When immersed the rate of urine production increases up to 7 ml/minute after 3 hours. Along with the increased urine production there is an increase in the excretion of sodium and to a lesser degree potassium, calcium and phosphate.

The natriuresis is thought to be brought about by the increased amount of atrial natriuretic peptide released by the atrial muscle fibres of the heart in response to the hypervolaemia (Hall et al 1990).

It is therefore not just 'all in the mind' when you feel you need to go to the loo after being in the pool for a while. This is due to actual physiological changes occurring in the body. It is a good idea therefore to ensure that you and the patients use the toilet before entering the pool and also that you drink regularly to avoid becoming dehydrated.

Self-assessment question

- SAQ n.10 What happens to your cardiac outpuKduring head-out water immersion in thermoneutral water? How is this modified in water that is warmer than thermoneutral?

Stress and anxiety

There is some evidence to suggest that blood levels of stress hormones (such as noradrenaline (norepinephrine)) are reduced during immersion. It is also hypothesized that there is a reduction of sympathetic nervous system activity (Coruzzi et al 1988). This may provide some explanation for the reports of improved mood after swimming. Berger et al (1983) reported significantly less tension-anxiety, depression, anger and confusion in subjects after swimming. Levine (1984) noted reduction in anxiety in subjects after they had participated in hydrotherapy sessions. More work is being carried out on the blood levels of stress hormones during immersion. If evidence shows reduction in these levels, this could be an exciting development for hydrotherapy, especially in the treatment of patients with chronic disorders who experience stress and anxiety as a result of the nature of their disease. It could also be important for patients with conditions such as mental health problems, fibromyalgia or chronic fatigue syndrome.

Exercise in water

Relatively little work has been carried out on the physiological effects of exercise in water. Of those studies that have been done, most have concentrated on the cardiovascular effects. It was thought that exercise would dissipate the central hypervolaemia that occurs during immersion but in fact the end-diastolic volume of the left ventricle remains larger during mild to moderate activity in water, when compared with similar exercise on land. This does not, however, seem to alter the normal cardiovascular adaptation to aerobic exercise training (Sheldahl 1986). Kirby et al (1984) also found that oxygen consumption during graduated exercise in a heated pool increased similarly to that during activity on land. They suggest that the more vigorous exercises stress aerobic capacity heavily but not excessively. Hall et al (1990), however, cite studies showing that increased depth of water causes subjects to experience more resistance, resulting in greater energy expenditure. When, comparing walking on a treadmill on land to doing-! the same in water, heart rate and oxygen consumption responses were significantly greater during the immersion exercise.

These studies were all carried out on healthy subjects. When in the pool, therefore, you should keep this extra energy expenditure in mind, as patients are often debilitated because of their condition. It is advisable to begin treatment with short sessions including only a few exercises in order to gauge each person's reaction to being in the water.

Self-assessment questions

- SAQ **11.11** Why do you feel that you need to go to the loo after being in the pool for a period of time?
- SAQ **11.12** Why might hydrotherapy be helpful for patients who experience stress and anxiety?

THERAPEUTIC EFFECTS OF HYDROTHERAPY

Hydrotherapy is an extremely versatile treatment modality and is used for a wide variety of conditions. The most important point in today's climate, which is firmly focused on finance and outcomes, is to use the pool to treat those patients who will benefit the most. It is still the case that some

activity for the frail elderly'. It provides buoyancy that acts as a support for the body weight, allows full range of movement and eliminates much of the jarring that occurs with exercise on dry land. It is also a very enjoyable way of keeping active. The social and enjoyment aspects need to be emphasized, as people are much more likely to continue with activities they enjoy than those they perceive to be unrewarding. If they also actually feel better afterwards they will be more willing to repeat the experience. Rissel (1987) notes that the majority of subjects reported increased fitness, improved body tone, decreased stiffness, were more relaxed and calm, had fun, socialized and made new friends.

These results are supported in a study carried out by Jackson (1996). Participants reported immediate positive effects on entering the pool such as being able to do things that were impossible on dry land, finding it easier to relax and being more confident. Communication and the social aspects were again important to the patients. Overall, patients felt that hydrotherapy enabled them to cope better and to feel more in control of their bodies and lives. There were physical, psychological and functional improvements.

Treatment of whole patient

The pool is an excellent medium for treatment of the generally debilitated or immobile patient as the whole body is immersed. Independence is immediately enhanced. Although you will often teach patients exercises that relate to particular areas, depending on their specific problems, the whole body still moves through the water and there is not such a focus on one area as there often is with dry-land treatments. As mentioned in the previous paragraph, there are also psychological benefits that can be gained from treatment in the pool, so it could be described as an excellent 'all round' modality resulting in improved function, increased levels of well being and better quality of life.

Problem-solving exercise 11.6

John Brown, a 24-year-old man with a sprain of the medial collateral ligament of the knee and

James Low, a 46-year-old man with a total rupture of the lateral ligaments of his ankle are both discussed in the Chapter 6 (Case studies 6.1 and 6.3). Review these cases and think about why you might use hydrotherapy with these patients as part of their rehabilitation.

CONTRAINDICATIONS TO POOL THERAPY

As discussed earlier, treating patients in the pool demands a specific set of knowledge with which you need to be familiar in order to be safe and effective. This also applies to the contraindications to pool tiierapy. Most contraindications to hydrotherapy are relative and should be determined on die basis of informed assessment findings. If you have any doubts about whether a particular patient is suitable to come into the pool, then you should exercise caution. The Hydrotherapy Association of Chartered Physiotherapists standards of practice state that 'the physiotherapist has knowledge and understanding of contraindications to hydrotherapy and has the ability to identify them' (HACP 2001). This indicates that, if you are working in the pool environment, you need to be aware of the factors that might preclude a patient from entering the pool and you must be able to identify these during your assessment. But this does not mean that you are not able to check out your thoughts with the physiotherapist who manages the pool, or contact the HACP if you have any doubts. This is especially the case if you are a student or newly qualified.

Absolute contraindications

The following situations are considered to be absolute contraindications to pool therapy:

- Uncontrolled cardiac failure - the patient is unable to lie flat without becoming dyspnoeic
- Resting angina
- Shortness of breath at rest
- Medical instability following an acute episode, e.g. cerebrovascular accident, deep vein thrombosis, pulmonary embolus, status asthmaticus
- Acute vomiting and/or diarrhoea
- Proven chlorine sensitivity.

Relative contraindications

Patients with the following problems may be considered for hydrotherapy if it is felt that the benefits of treatment outweigh the small amount of risk involved. These decisions should be made by senior therapists with input from the medical team if this was felt necessary. Patients should be closely monitored while in the pool with follow up to ensure no ill effects.

Open infected wounds

This type of wound may benefit from immersion in the disinfected water. Often, physiotherapists place waterproof dressings over such wounds but these rarely keep all the moisture out. If you are concerned about the risk of infection to others, however, you could treat the patient at the end of a morning or afternoon session. Pool turnover time is usually 1-1.5 hours, so this would allow the pool water to go through the disinfection and filtration systems prior to other patients being immersed. This is usually only necessary if there are particularly vulnerable patients being treated at the same time.

Poorly controlled epilepsy

It is important that you make sure the patient is monitored while in the water. If a patient experiences a seizure when in the pool it is less of a risk to them to leave them in the water as long as they are in a safe breathing position. It is easier to evacuate them from the pool once the seizure has passed.

Acute systemic illness/pyrexio

It would be unlikely that you would want to take patients into the pool who are feeling so ill. The heat and humidity would probably add to their discomfort and so it might be advisable to wait until symptoms have diminished.

Radiotherapy

Some patients are not taken into the pool during a course of radiotherapy if the irradiated area of skin is to be immersed. The practices regarding hydrotherapy treatment of patients undergoing radiotherapy vary from place to place. If the hydrotherapy is felt to be particularly beneficial, it may be possible to treat the patient. This is often negotiated with the local oncologist and radiotherapist.

Unstable diabetes

Patients with diabetes are often taken into the pool. If, from your assessment, you are aware that a particular patient is prone to collapse (e.g. hypoglycaemic attack) but you also feel that hydrotherapy is the treatment of choice, it is advisable to monitor this person closely and perhaps even to carry out one-to-one treatment to guard against unexpected submersion.

Known aneurysm

This situation may need to be carefully considered given the cardiovascular changes that occur during immersion. Individual cases need to be considered with regard to how useful you feel hydrotherapy would be in the circumstances. If, during your assessment, you discover that the patient has regularly been swimming with no ill effects there should be no reason for excluding them from hydrotherapy. The reason that patients are referred to the pool may have no connection with their vascular condition.

Situations where precautions should be taken

If you discover any of the following problems when you assess patients presenting for hydrotherapy, they should not be excluded from pool treatment.

- *Hypertension/liypotension:* monitor
- *Epilepsy:* as previous section
- *Haemophilia:* gentle exercise, protect from unexpected knocks and bumps
- *Poor skin integrity:* careful handling and not too long in the water to avoid waterlogging of skin

- *Impaired sensation:* careful introduction to pool, monitor either until you decide the patient is safe or at all times depending on the situation
- *Widespread melhicillin-resistant Staphylococcus aureus (MRSA) infection:* pool disinfection can cope with this microorganism. If necessary see the patient at the end of a pool session as described under 'Open infected wounds'
- *Invasive tubes in situ:* ensure tubes are clamped off securely
- *Behavioural problems:* you will need to assess each situation individually. You may need to see the patient at a quiet time and you might need a one-to-one session. Conversely, some patients respond better in a group setting
- *Fear of ivater.* this does not usually stop patients coming for hydrotherapy; most will gain confidence with your support and reassurance. You will discover any acute fear of water during your assessment and it may be necessary to refer the patient elsewhere
- *Gross obesity:* monitor the patient for ill effects from immersion. If the patient is uncomfortable about appearing publicly in a swimsuit it may be possible to offer a time when there are fewer patients in the pool at the beginning or end of a session
- *Incontinence of urine/faeces:* pool disinfection can cope with urine and formed stools being released into the pool. Stools can be removed easily with a net and disposed of appropriately
- *Hearing aids/grommets:* the patient should not put the head into the water. If the hearing aid is removed it may make communication more difficult
- *Contact lenses:* patients should be notified if you intend to carry out exercises where you might expect them to immerse their faces. This will enable them to remove the lenses if they wish.

Self-assessment question

- SAQ 11.13 Review the absolute contraindications to hydrotherapy treatment.

Problem-solving exercise 11.7

Steve Morris (Chapter 6, Case study 6.6) has a long history of back pain and eventually has an operation to decompress his S1 nerve root. Read about his problems on assessment and how he is after surgery. How might hydrotherapy be of use in this case?

HEALTH AND SAFETY

As mentioned earlier in the chapter, water is an alien environment for humans and as such has various inherent dangers. Because of this, guidelines for safety in and around water are essential in each situation. As a physiotherapist you have a duty of care towards all patients under your supervision and one aspect of this is the responsibility to make sure that they are safe at all times. This is why you must be familiar with safety and legal issues, as there are particular environmental points to be addressed. Although in general the patient is the focus for this, it is also important to remember that other staff working in the area, such as inexperienced physiotherapists, students, assistants or porters, need to be aware of safety matters and risk situations, in order to protect both themselves and any patients with whom they interact.

The plant room, where the heating, filtration and disinfection of the pool water are carried out, is another area that needs to be considered. The day-to-day running and maintenance of the plant machinery and the handling of potentially dangerous chemicals must be closely monitored. The amount of time that individual physiotherapists spend in the plant room varies greatly depending on the local arrangements. It is, however, extremely important that you have at least outline knowledge of the procedures and possible risks to health and safety that can occur in this area.

There is no doubt that there are hazards inherent in working in a hydrotherapy/pool department but, if care is taken and the recommended guidelines followed, both staff and patients can operate safely in this setting. Detailed guidelines can be found in specific publications from the Health and Safety Commission (responsible for developing the law

and formulating general policy on health and safety matters) and the Health and Safety Executive (a separate body appointed by the Commission to implement policy and enforce legal requirements).

Self-assessment question

- SAQ 11.14 With regard to contraindications to hydrotherapy treatment, in what situations might you need to monitor patients while they are in the pool and why?

When you start work in a hydrotherapy department, your senior therapist or the local health and safety representative should provide information on general and local safety issues. Your employer has an obligation to ensure your health, safety and welfare but you will find it useful to have prior knowledge of the general risks associated with working in this environment. These can be considered in three sections: patient related, staff related and general issues.

Patient related

Accidental submersion

Accidental submersion occurs rarely. Even so, everything possible must be done to avoid this, as it can be very frightening for all concerned. At the least, being unexpectedly submerged could severely affect the patient's confidence and at worst it could result in drowning. It is therefore a very important issue for you to address. The following precautions should help to avoid accidental submersion:

- During the land-based assessment, you should routinely ask patients pertinent questions about any medical condition that could cause distress during treatment. If you are concerned then you might consider it more appropriate to refer them for land-based therapy.
- Patients found suitable for pool therapy should be supervised at all rimes while in the water. Depending on your professional judgement (including the type of patients and their particular conditions) this supervision may range from one-to-one contact with patients throughout treatment sessions to you being present at the pool side during group work.
- Flotation equipment must be used appropriately and checked regularly for faults.
- Your knowledge will avoid the occurrence of unwanted hydrodynamic effects, e.g. drag from turbulence that could accidentally disturb the equilibrium of the patient.

Acute fear of water

This can be a contraindication to treatment in the pool if patients are so nervous that they find it impossible to co-operate with you. Patients should be asked how they feel about going into the pool during the assessment, and this should avoid potential problems. If a patient does enter the pool in a state of high anxiety it could constitute a hazard. In this case a dry-land approach would probably be more appropriate. Often, patients' fears can be overcome with reassurance and careful handling.

If patients tell you they are afraid of water but, in your opinion, hydrotherapy would be an invaluable treatment, it may be possible to have short, supervised trial sessions to see how they cope.

In general, many patients are apprehensive when first attending for hydrotherapy. On first treatments you should remain with patients throughout if necessary. If they are very apprehensive, it may be wise to use standing holding on to the bar as the initial starting position and only move on to less stable positions such as sitting and float lying in subsequent sessions when confidence has increased. This is not always possible, especially if patients enter the water lying on a hoist stretcher. To reduce anxiety and for ease of handling, some floats can be put on before getting into the water and you must be there to receive the patient. You should provide extra reassurance and manual support until patients feel more confident.

At first you should assist patients to take up different starting positions. Help may be necessary in putting on and removing floats, flippers and other equipment. You should carry out these manoeuvres slowly, using firm, supportive grips. Later on, once confidence is gained, patients will probably be able to perform these tasks independently. Before leaving patients in new starting positions,

you should ensure that they feel comfortable and safe and know how to attract attention in case of difficult}'. If these simple precautions are followed, patients will be safeguarded against mishap or injury in this treatment environment.

Slips and falls poolside

This is a hazard in all areas of physiotherapy but particularly in hydrotherapy because of the added risk of water pooling on the floor surfaces. The following precautions should mitigate the problem:

- « Supervise patients at all times, with staff present to support if necessary
- , Provide advice to patients on the safe use of walking aids
- Check walking aids, especially the ferrules
- Use handrails wherever available
- Inspect the pool and surrounding areas regularly for accident hazards such as slippery or rough surfaces
- Ensure that the pool concourse is kept dry and clear of obstacles
- If you have any doubts about patients' ability to walk safely to and from the pool, you should ensure that they are supervised or that a wheeled chair or trolley is used.

Fainting and fitting in the pool

The likelihood of fainting or fitting can be minimized by careful screening during assessment. This rules out a percentage of people who may be at risk. It is important to avoid patients fainting or fitting while in the pool as it could lead to accidental submersion. Aside from screening, the most important safety precaution is to ensure that all staff members are familiar with emergency evacuation procedures and that these are practised regularly. Resuscitation equipment should be available and easily accessible in case of need and there must always be at least two members of staff present in the pool area.

Cardiac arrest in the pool

Because of die profound physiological changes that occur during immersion, there is a small risk of cardiac arrest in some patients who have cardiovascular disease. You should carefully screen all patients to check for any contraindications that could predispose them to cardiac arrest during treatment in die pool. As before, all staff members must be prepared for emergency evacuation and resuscitation procedures. They should also be aware of the position of the alarms and know what they sound like. If the alarms do not automatically alert the crash team (in the hospital situation) the number must be displayed in prominent positions near the telephones. Pool rescue drills must be conducted at least four times a year for staff likely to be involved in the emergency procedures (HACP1992).

As mentioned in the section on contraindications, many patients with problems such as high blood pressure, diabetes, epilepsy or cardiac disease who could in some circumstances be distressed by exercise in water are not totally excluded from pool therapy. If these conditions are well controlled there should be no reason for barring the patient from hydrodierapy, particularly if you feel that it would be particularly beneficial. This decision does depend on your professional opinion, which in turn will depend on your level of experience. If you have any doubts you should check with more senior colleagues, medical staff or the clinical interest group (Hydrotherapy Association of Physiotherapists) before taking a patient into the water.

Spread of infection

The hydrotherapy pool is an ideal environment for the proliferation of bacteria and fungi - wet, warm and humid. The filters in die plant room through which die pool water passes can harbour pockets of bacteria. Patients and staff can also bring infection into the hydrotherapy area. The disinfection process normally deals with these bacteria and levels are insignificant. The following precautions should be taken to ensure low risk of the spread of infection:

- Regular microbiological testing
- Correct pool disinfection
- Assessment of all patients prior to treatment.

All wounds should be checked for signs of infection. It will be your decision as to whether patients with infected wounds should be allowed in the pool. As mentioned earlier, if you feel that hydrotherapy is particularly important then they can be

taken in at the end of a session when the other patients have vacated the water. This means that the water will have passed through the disinfection system many times overnight before anyone enters the pool the next day. An alternative is to temporarily boost the amount of disinfection to combat the presence of any microorganisms.

Plantar warts (verrucas) and athlete's foot do not preclude patients from treatment. In the case of verrucas they should be asked to wear verruca socks. For athlete's foot they should wear flip-flops and not walk barefoot on the poolside and surrounding areas. This avoids skin flakes from the affected area coming into contact with other patients' skin, so reducing the risk of spread. The verruca sock/flip-flops are kept specifically for each patient and disinfected as necessary. Patients can also be advised on appropriate foot hygiene.

Patients who are HIV-positive or are known to have hepatitis can attend for hydrotherapy as long as they have no open wounds.

Fatigue

The heat and humidity levels in the hydrotherapy department are very tiring. Patients may be debilitated before coming to the pool and performing activities in the water may add to their fatigue. To avoid any risks, patients should be supervised at all times during treatment to ensure that they adhere to set time limits and only exercise as you instruct them.

Unfamiliarity with the pool surroundings

There are marked differences between land and pool settings. In order to reduce the risks, patients should be informed of and shown the pool geography, including the location of toilets, showers and handrails. They must be shown how to safely enter and exit the pool under supervision and warned about the effects of refraction. The edges of any steps should be clearly marked.

Staff related

Storage and handling of chemicals

In the UK the Control of Substances Hazardous to Health Regulations 1988 (COSHH) are in place and must be strictly followed. All chemicals and hazardous substances must be stored and handled in accordance with these regulations (CSP 1994). COSHH does not set out specific requirements for each separate circumstance but gives a basic system for managing risk to health. You may not come into direct contact with the chemicals used for pool disinfection, as generally the maintenance/engineering department will deal with all functioning of the plant room. In some situations, however, you may be responsible for part or all of the pool dosing. In either circumstance it is strongly advisable that you have a working knowledge of the regulations governing the safe handling of chemicals, and you need enough information to be able to discuss issues regarding the overall management of the pool.

In summary, the regulations cover the following points:

- A COSHH assessment must be carried out and reviewed on a regular basis. Changes in proce-v-dures should then be made as necessary as a l result of the assessment or review.
- All chemicals must be stored and handled separately in strict accordance with COSHH.
- Chemicals must never be mixed as some combinations are explosive or can produce toxic gases.
- Inhalation of chemicals and contact with the skin should be avoided. If any chemicals do come into contact with the skin, anyone administering first aid must avoid contamination. Any clothing not stuck to the skin should be removed and the area flushed with clean, cool water for 10-15 minutes. A sterilized dressing should be applied to exposed, damaged skin and the person should be sent to hospital for treatment (Health and Safety Executive 1991).
- Any chemical spillage should be flushed with water immediately.

Fatigue

Staff in the hydrotherapy department can easily be fatigued as they are working in a warm, humid environment. There is no specific legislation regarding working in high temperatures or humidity. The following precautions should be taken, however,

to avoid risks to both staff and patients as a result of fadgue:

- Staff working in the pool on a daily basis should not be immersed for longer than 2 hours in one session or 3 hours in one day
- Breaks should be taken and drinks must be available to avoid dehydration
- If the water temperature is higher than 35-36°C or the humidity above 60%, then both breaks and drinks should be taken more frequently.

Staff members working poolside should be advised to wear light clothing, in natural fibres if possible (i.e. low thermal resistance, which allows sweating) and to take rests whenever practicable. This will reduce activity levels, which in turn will reduce the internal heat production in the body.

Skin problems - dry skin, irritation and rashes

For staff working in the hydrotherapy pool, the main problem when it comes to skin irritation is that we are immersed for long periods. We need water that is as kind as possible to the skin but safe for immunocompromised people. There are a number of predisposing factors to be taken into consideration but 'wetting' is one of the most important.

Problems with this are related to the frequency and duration of wetting of the skin. Frequency is in fact the more important issue, in that four immersions of 1 hour each is a worse situation than one immersion of 4 hours. Frequent wetting/drying cycles are stressful for the skin. The pool water also degreases the skin and chlorine contributes to this. The skin is not designed to be immersed for long periods, there is a limit to the amount of wetting it can take and it has a cumulative effect. People with fair hair and skin are affected more. Younger skin can deal with effects of wetting better than older skin but generally you should only be immersed for a maximum of 3 hours per day. After immersion, you must let the water dry out of your skin before regreasing, otherwise the creams (E45/Nivea/emollient cream) will just seal the water into the skin.

Self-assessment question

- **SAQ 11.15 What are the main patient-related health and safety risks when in the pool environment?**

The Chartered Society of Physiotherapy (2001) recommend the following as best practice for staff working in hydrotherapy:

- Limited immersion (as above)
- Early reporting of any rash symptoms. A visit to the GP or occupational health may result in therapists being advised to stop immersion for a period of time although they could still work poolside
- Shower effectively and remoisturize regularly
- Shower before entering the pool. Unless there is a pre-existing skin condition there should be no need to pre-grease die skin
- Wash thoroughly with a moisturizing agent at the end of hydrotherapy sessions, dry thoroughly and apply a non-perfumed moisturizer (this should be provided by the employer)
- Treat any rash that develops with a mild steroid cream.

General

Poorly maintained/incorrect pool chemistry

The pool should be a safe and comfortable environment for everyone entering the water. This will only be the case if the chemical balance is correct and maintained properly. A poorly maintained pool can lead to a variety of problems ranging from spread of infection and skin irritation to turbid water and corrosion of metal fittings. The correct parameters for hydrotherapy pools are covered briefly in the next section. The following precautions should be followed to avoid any risks to health and safety:

- All staff must have a working knowledge of the recommended parameters for correct chemical balance specific to their own pool
- Chemical parameters (disinfection and pH levels) must be tested daily to ensure the maintenance of

safe chemical levels. All results of tests must then be noted in a log book to act as a record, which can be referred to as necessary. If a physiotherapy assistant, engineer, maintenance worker or student physiotherapist performs these tests then the physiotherapist in charge of the pool should check the levels or be informed if they are outside acceptable limits. If they are, this may have a bearing on whether staff and patients will be allowed into the water.

Generally all chemical parameters should be within acceptable limits, with occasional exceptions. If there are recurrent problems then the dosing of the pool should be investigated thoroughly to pinpoint the fault.

Poorly maintained pool environment

If the overall pool environment is poorly maintained then again there could be risks to health and safety such as spread of infection. If you are in charge of the pool it will be your responsibility to ensure that the whole pool environment is macroscopically clean. This includes all areas: toilets, kitchen, storage area, showering facilities, changing and waiting areas, the pool concourse and the pool itself. This may involve liaison with cleaning and maintenance staff to ensure that the correct cleaning methods are used. You will also need to ensure that other users of the pool (such as physiotherapists bringing in their own patients from other areas or outside user groups) follow correct pool procedures, e.g. use of overshoes, hosing down of the pool concourse, patients showering before entering the water.

Poorly maintained equipment

This could be a risk to both staff and patients. Faulty flotation equipment may cause distress for patients while in the water and could result in accidental submersion. For staff, if the hoist is not functioning this will add unnecessary strain to any manual handling operations when helping patients in and out of the pool.

In order to prevent such problems occurring, equipment must be regularly checked for faults. Defective flotation equipment must be discarded and replaced. It is advisable to have maintenance contracts in place for the hoists and alarm systems - if this is not possible, then they should at least be tested regularly and any faults rectified immediately.

POOL MANAGEMENT

The most important point to make is that an effective team approach is necessary to keep a pool functioning well. A senior physiotherapist should have overall responsibility for the pool, but it is essential that all physiotherapists working in the environment have background knowledge of the factors involved in keeping the water quality high and the pool safe for both staff and patients. It is also a good idea to visit the plant room and to liaise regularly with the engineer and/or any other staff involved in controlling and monitoring the pool.**Sf**

Pollutants

Various forms of pollution are introduced into the pool almost continually. If left untreated, these pollutants build up in the water, increasing the risk of infection from bacteria and other microorganisms. There is also a reduction in safety through loss of clarity of the water due to suspended particulate matter.

Pollution from bathers

Many substances are introduced into water by bathers, both staff and patients. These pollutants include:

- Material from bathers such as mucus, saliva, sweat, hair, skin flakes, urine and faecal matter
- Material collecting on the body before bathing, such as general dirt
- Materials such as powders, creams, lotions and oils applied to the body before bathing.

It is difficult to entirely avoid these pollutants but pre-cleansing facilities and good hygiene on the part of bathers can help to reduce the amount going into the pool.

Pollution not derived from bathers

A number of products may contaminate the pool, particularly cleaning materials from the surrounds. Care should be taken in the use of such products and ideally the pool surrounds should drain away to waste or to die circulation system of the pool prior to filtration to minimize the possibility of contamination.

Self-assessment question

• SAQ 11.16 What are the main staff-related health and safety risks when working in the pool environment?

Pool plant and maintenance

The aim of pool maintenance is to provide high-quality water for maximum safety and protection of bathers in accordance with valid regulations. The pool should be safe and pleasant to use. It should be clean, should look inviting and be free from irritant/toxic substances, algae and micro-organisms. In order to achieve this, attention must be given to physical (macroscopic) and biological (microscopic) cleanliness.

This is dependent upon filtration and disinfection, which need to be adequate to deal with the likely levels of pollution/contamination. The systems put in place will avoid accumulation of pollutants that can be a risk to health and/or make the pool look unsightly.

Filtration

This is the absorption and retention of mechanically removable particles from the water by some sort of filtration system. Pool water cannot be regarded as satisfactory for use, however well disinfected, if it lacks clarity because of excess turbidity. This can be caused by:

- excessive pollution from bathers
- inadequate filtration and circulation
- contamination from external sources
- inadequate disinfection
- incorrect use of water treatment chemicals
- bubbles of air.

Filtration reduces turbidity by removing particles. A good test is to drop a coin into the centre of the pool. If your water is of an acceptable level of clarity you should be able to see the face of die coin from all angles and positions around die pool. If not, you probably need to look at your filtration system.

In the filter, water passes through a permeable membrane and solid particles are removed by progressive dilution. The effectiveness of the filter depends on:

- the size of the particles of the filter bed
- pool turnover rate, i.e. how long it takes for the whole volume of water in the pool to pass through the filters once. In a public pool this is approximately 2-4 hours, in a therapy pool approximately 1-2 hours and in a whirlpool approximately 0.5-1 hour.

Backwashing

This is an important process that cleans the filter medium by reversing the flow of water through the filter. The water used goes to waste along with the particles it removes from the filter. The back-washing is determined by the pressure in the filter bed and it can be manual or automatic. In many pools now, it is automatic.

There is a 'sight glass' in the waste water line and through this you can see the water going to waste after it comes from the filter. This can indicate the cleanliness of the water, i.e. when the majority of trapped particles have gone.

Pool pipework

This is high-density PVC; the only metal is in the heating coils. The changes in acidity/alkalinity (pH) of the water can have a corrosive effect on metal so it is not suitable. The pipe sizes should be determined by a hydraulic engineer to ensure that the flow rate matches the pump size and filter.

Water should drain out from the top of the pool via skimmer boxes, scum channels or ideally a wet deck. The placement of water return lines should be through the floor of the pool or in the walls at different levels to ensure there are no 'dead spots' in the water.

Disinfection systems

The pool water is treated with a disinfectant agent maintained at a level that protects bathers from microorganisms (CSP 2000).

Chlorine

The most common type of disinfectant agent is chlorine, through the use of liquid sodium hypochlorite. This method is economic and effective and it can be used in manual or automated systems. Calcium hypochlorite granules and tablets are also available, but these are not suitable for all pool systems. Stabilized chlorine - chlorinated isocyanurates - are not as effective and there is a problem with the build up of cyanuric acid. Salt chlorination provides chlorine by means of an electrolytic chlorine generator.

Hypochlorous acid is the most effective sanitizing agent. Bathers introduce pollutants into the water. Oxidation occurs, which transforms these pollutants into harmless, inactive substances and the disinfection kills pathogens. Tine result of the reaction of the hypochlorous acid with the nitrogenous compounds in the water (i.e. the pollutants) causes the formation of chloramines. These are poor sanitizers and are irritants. The most common are the monochloramines and then the dichloramines. These two compounds react to release nitrogen. If further chlorine is added then trichloramines are formed. Trichloramines have a characteristic chlorine-like odour, are aerated out of the water by agitation and are responsible for eye irritation. The formation of the trichloramines is most pronounced if there is a low pH (i.e. if the water is more acidic). It is important to note that the odour and eye irritation are often thought to be due to the chlorine levels - this is not the case: they are due to high levels of trichloramines, i.e. in a pool with a poorly controlled disinfection system. It is more difficult to keep the levels of trichloramines low if there is an increased bathing load.

The bathing load relates to a number of factors:

- Number of bathers using the pool at any one time
- The volume and surface area of the pool
- The pool turnover time
- The pollutants released by individual bathers.

Disinfection should be calculated to accommodate bather load and fluctuations in the numbers of bathers.

Ozone

Ozone is the best oxidizer and it is a disinfectant. It has a short active life in water and it is toxic in excess of 0.1 mg/I (above this the level is illegal). An ozone generator with chlorine residual gives the best water quality levels. Less chlorine is necessary and the water 'feels good'. The drawback with this system is that it doubles the cost!

Bromine

Over the last few years the Chartered Society of Physiotherapy has received an increasing number of calls relating to physiotherapists having skin problems when working in brominated pools. There is concern over the possible link between the use of, bromine as a cleaning agent and skin rash amongst pool users, especially hydrotherapists, who spend more time in the water (CSP 2001). The Pool Water Treatment Advisory Group (1995) describes skin rash as a 'complicated subject' with it being difficult to tell whether a rash is due to the water and its disinfectant or whether other factors in the individual's physical make-up and environment are contributing factors. It does, however, make reference to 'bromine itch', where some people develop an 'intensely itching contact dermatitis' after immersion in a brominated pool. This is unusual in children and more common in bathers over 50 years of age. It is also described as being 'more frequent and severe with prolonged exposure' and so hydrotherapists may be concerned about this (Pool Water Treatment Advisory Group 1995). For more information on this issue you can refer to the Chartered Society of Physiotherapy's Health and Safety Briefing Pack no 12: *Hazards in Hydrotherapy Pools.*

Self-assessment question

- SAQ 11.17 What is the reason for backwashing?

Pool chemistry

We shall only consider chlorine here as this is die disinfection system you are most likely to come across in clinical practice. You should test the pool for disinfection levels and pH two or three times a day (Table 11.2). If disinfected using cldorine only, the levels are as follows:

- Free chlorine (i.e. that available to combine with pollutants) should be within the range 1-4 parts per million (ppm)
- Total chlorine should be within the range 1.5-5.0 ppm
- Combined chlorine should never be more than 1.0 ppm.

There should always be two to three times more free chlorine than combined.

If the pool is being disinfected with ozone and chlorine residual or ultraviolet and chlorine, the levels do differ and you will need to learn about these locally.

pH control

It is extremely important that you have good control of the pH of the water, as it involves a number of factors:

- Protection of the pool plant
- Bather comfort
- Effectiveness of the disinfection system.

Table 11.2 Tests carried out on pool water, the reagent used and frequency

Tests	Reagent	Frequency
Free chlorine	DPD 1	2 X daily
Combined chlorine	DPD3	
Total chlorine	DPD 1 + 3	3 x daily (hand dosed)
PH	Phenol red	2 x daily
TA	Acid solution	Weekly
CH	Standardized reagent	Weekly
TDS	Electronically tested	Monthly
Bacteriological	Laboratory	Weekly

CH = calcium hardness; TA = total alkalinity; TDS = total dissolved solids.

The optimum range is 7.2-7.8 (pH is a logarithmic scale from 0-14. 7 is neutral, so pH 6 is 10 times more acidic, pH 5 is 100 times more acidic, pH 8 is 10 times more alkaline, pH 9 is 100 times more alkaline, etc.).

pH below 7.0 (acidic). There is the possibility of rapid loss of chlorine, eye irritation due to the rapid formation of chloramines, destruction of cement grouting and corrosion of metal components. The water will feel uncomfortable, sometimes described as 'prickly', as it takes minerals from the skin.

pH above 7.8 (alkaline). There is the possibility of reduced chlorine efficiency and so a need for increased chlorine, eye irritation and dry skin, cloudy water and scale formation in plant and pool.

Total alkalinity

Total alkalinity (TA) is a measure of the total amount of dissolved alkaline compounds in the pool water. This acts as a pH buffer without which it is difficult to balance the pH (pH bounce). If TA is low you can add sodium bicarbonate.

Calcium hardness

Calcium hardness (CH) is a measure of the amount of dissolved calcium compounds in the water. If it is low, add calcium carbonate.

Self-assessment question

- SAQ 11.18 Why might there be a strong chlorine odour in the pool area and why is this a negative sign?

Total dissolved solids

Total dissolved solids (TDS) is a measure of the amount of dissolved solids in the water. If the TDS is increased there is a loss of sparkle, with flat, dull-looking water. To adjust this, empty or partly empty the pool and refill with fresh water.

Recommended values

- TA: 100-150 mg/1
- CH: 100-300 mg/1
- TDS: <1250mg/l (indoor).

Water balance tests

Langelier index: pH + TF + CF + AF = 12.1 ± 0.5. If the index is increased then the water is scale-forming and if the index is decreased then the water is corrosive.

Taylor's watergram

This illustrates the relationship between total alkalinity, pH and calcium hardness. It assumes conditions of temperature 27°C + 5°C and TDS <1000mg/l.

Emptying schedule

There are situations in which hydrotherapy pools may need to be partially or totally emptied. If there are excessively high levels of chloramines or TDS then the pool can be partly or totally emptied as required. The pool would need to be totally emptied if the water was contaminated or for major maintenance.

On emptying a number of routine and maintenance checks can be carried out:

- Check functioning of the hydrostatic valve
- Disinfect the main drain
- Check rails, tiles, steps
- Descale, scrub floor/walls.

Note: If there is no hydrostatic valve there is a risk of structural damage from the pressure of the surrounding earth fill. When empty, the natural water table pressure may dislodge the whole pool.

Self-assessment question

- SAQ 11.19 What is the importance of having pool water at the correct pH level?

ADVANTAGES AND DISADVANTAGES OF HYDROTHERAPY

Advantages

- The warmth of the water has the effect of decreasing pain and so helps to decrease muscle spasm and promote relaxation. The warmth is also present throughout treatment and not just before or after exercise, as with many other pain-relieving modalities.
- The whole body is actively involved in the treatment and there is less focus on one particular area. It is also very useful for patients with wide-ranging problems and many weak muscles. More of the body can be treated in less time. Large numbers of joints and muscles can be exercised in different planes with minimal change in starting position, which is a definite advantage for patients who find changing position on dry land difficult or painful.
- Buoyancy supports the body and decreases weight bearing. Walking re-education can begin sooner than on dry land and the patient will be able to do more especially if weight bearing causes pain under normal circumstances. Buoyancy can be used to support starting positions and to assist or resist movement. It also means that movement is much easier in the pool, not only giving the patient more freedom but also making it much easier for you to handle and manoeuvre the non-mobile patient.
- There is no pressure on bony points and no friction to cause damage to the skin.
- Water allows an infinite range of resistance and is therefore suitable for patients at any stage.
- Generally the patient can do more in the water than on dry land, which may boost morale and increase confidence.
- Hydrotherapy has a social aspect, as there are usually several patients in the pool at one time or there may be classes of patients with similar problems. This allows for interaction and mutual support and the treatment is more enjoyable.
- Patients may learn how to swim or become confident enough in the water to then continue with the exercise at their local swimming baths.

Disadvantages

- The main disadvantage of hydrotherapy in today's financial climate is the great expense of the installation and upkeep of the facilities. As well as the pool room itself, other areas are necessary for waiting, changing, examination, resting, storage of linen/towels, washing and drying of costumes and so on. Office space is also required for administrative activities. This all adds to the cost, as does the day-to-day running of the pool and plant room. Staffing is also a factor. For safety reasons there must always be at least two members of staff present in case of emergencies. There should be a senior physiotherapist and an assistant or porter available at all times.

- As explained in earlier sections of the chapter, the hydrotherapy department is a potentially dangerous environment and so safety standards must be extremely rigorous.

» Occasionally the more debilitated patients find that, with travel to and from the pool, they are too tired to benefit fully from the treatment.

Because of the effects of buoyancy it is occasionally difficult to gain adequate fixation to isolate particular movements.

Because movement in water is very different from that on dry land, final rehabilitation may need to be carried out either on the ward or in the physiotherapy department. This is not always necessary, however, if the patient is given a comprehensive set of home exercises to carry out as an adjunct to pool treatment. This will of course depend on individual patients and their particular problems.

Patients sometimes become very dependent on the pool as they are able to do so much more in the water.

As with any type of physiotherapy treatment, there are contraindications, but those for hydrotherapy rarely apply anywhere else. These issues have been discussed previously but, as you will remember, there are few absolute contraindications to pool treatment.

Self-assessment question

SAQ 11.20 Which tests of pool chemistry need to be carried out and how often are they done?

After briefly reviewing the case studies in Chapter 7, formulate a list of reasons why you might use hydrotherapy in the management of patients with rheumatic conditions. Are there any disadvantages?

How would hydrotherapy for a patient with rheumatoid arthritis vary from that for a patient with ankylosing spondylitis?

Problem-solving exercise 11.9

In Chapter 9 (Case study 9.1) you were introduced to Mrs Bell, a 58-year-old lady with osteoporosis. Review her case and think about how hydrotherapy might be used as part of her management.

SUMMARY

This chapter has given you an overview of hydrotherapy and its application with patients who have orthopaedic conditions. It includes relevant hydrostatic and hydrodynamic principles and their application in the development of exercise programmes in water, physiological changes that occur in the body as a result of immersion, contraindications to pool therapy, therapeutic effects, health and safety issues, pool management, the benefits, disadvantages and appropriate use of hydrotherapy.

It is impossible to cover all aspects of hydrotherapy in one chapter, but by now you should feel that you have a basic understanding of the important elements. This is, of course, all theoretical. The best advice we can give you is to get into a pool to try out the principles we have discussed for yourself.

Above all, remember to use the water, do not transfer your land-based exercises into the pool.

As emphasized in many chapters of the book, this chapter has covered the principles of hydrotherapy intervention and has given some specific examples. These illustrate that a sound understanding of the treatment modality you are using and competence in your patient assessment will enable you to apply the principles successfully. Again it is your decision-making process that is the key to effective patient management.

On reading this summary, do you feel you have grasped the above points? If not, perhaps you should go back and re-read any appropriate parts of the chapter before moving on.

ANSWERS TO QUESTIONS AND EXERCISES

Self-assessment question 11.1 (page 314)

- SAQ 11.1 Why is it inappropriate to use land exercises in the pool?

Answer It is not appropriate to transfer land-based exercises into the pool, as this neglects the unique properties of the water and consequently will not produce optimum results.

Self-assessment questions 11.2 (page 314)

- SAQ 11.2
  a. Approximately how much weight goes through the lower limbs when a person is immersed to C7, the xiphisternum and the anterior superior iliac spines respectively?
  b. How can this reduction in body weight be used to advantage in patients with orthopaedic problems?

Answer
a. C7-10%
Xiphisternum - 30%
Anterior superior iliac spines - 50%.
b. In two main ways. First, if a patient experiences pain on weight bearing then this reduction in body weight will relieve the pain and make movement much easier while in the water. Second, if a patient is partially or non-weight-bearing then exercise can be carried out in the water to improve the reciprocal gait pattern before this could be done on dry land. If the pool has a range of depths then weight bearing can be gradually progressed.

Self-assessment question 11.3 (page 316)

- SAQ 11.3 What are the three main uses of buoyancy?

Answer Assistance to movement, support of the body or body segments and resistance to movement.

Self-assessment question 11.4 (page 318)

- SAQ 11.4 How can you modify the effect of the turning force produced by the moment of buoyancy?

Answer This can be modified in a number of ways (remember the equation: moment of buoyancy = force (F) x distance (d) and *d* is the most significant because *F* remains constant):

1. Change the length of the lever
2. Add a float
3. Change the amount of air in the float
4. Change the position of the float, i.e. move it nearer to or further from the body
5. Change the position of the part in relation to the surface, i.e. nearer the surface = greater turning effect.

Self-assessment question 11.5 (page 318)

- SAQ 11.5 What happens when you introduce more speed into buoyancy-assisted/resisted movements?

Answer Purely buoyancy-assisted/resisted movements are quite slow. As soon as you ask the patient to move more quickly through the water, you are introducing increased levels of resistance into the equation because of the effects of turbulence. This means that you need to think carefully about your progressions of exercise and about exactly what you are asking the patient to do. The best way to check it out is to carry out the movements yourself.

Problem-solving exercise 11.1 (page 318)

- Imagine a patient who has reduced range of hip abduction. How could you use buoyancy in a progressive manner to increase abduction?

Answer After your assessment you will have a good idea of how much hip abduction the patient has and what the reduction in range is caused by. We will assume that it is due to stiffness and shortened structures on the inner aspect of the thigh and that there is minimal pain (obviously, if the patient was experiencing pain, you would modify your treatment accordingly). Repetition should be used in each step described below.

1. In standing (facing side of pool, holding bar) with legs straight, allow buoyancy to lift the affected leg to the side (ensure toes point forward and the hip does not go into flexion or extension).

2. Place a float around the limb, start with a small amount of air and the float positioned more proximally. Perform the movement as in step 1 but because of the float there will be more assistance. If this is comfortable you can progress by adding more air to the float and then moving it more distally to gradually increase the turning effect of buoyancy. This might need to be done with caution as the float could take the leg further into range than is comfortable.

3. In the same position, instruct the patient in hold-relax using the upthrust as resistance to the isometric contraction. On relaxation the patient allows the float to take the leg further into abduction.

You may be able to move through these stages in one treatment session or you may need to spread them over a number of sessions as part of an exercise programme.

Problem-solving exercise 112 (page 318)

- Next time you go swimming or have a moment to spare in the hydrotherapy pool, experiment with changes in body shape. See what happens when you move part of the body out of the water or away from the trunk; try bending one arm or knee; lift your head.
  Can you control the rotation?
  If so how do you do it?
  How safe do you feel?
  How do you think this might affect the patient's level of confidence?
  How do you think you might be able to use these effects in treatment?

Answer As suggested above, the best way to carry out this exercise is in a practical setting - in the water. As described in the text, it is very useful to teach patients to control their movement and rotation in the pool - if you feel this yourself you will be able to teach it much more effectively.

You will notice that even a very small asymmetry can cause you to work hard to maintain your position. If you don't work hard to stop the movement, you will roll. As you may imagine, this can make patients feel rather unstable and apprehensive. This is why you need to be able to reassure them and show them how to work with the water. They can actively use the rotation to get into another position in the water, correct the rotation and so maintain equilibrium, or use isometric muscle work to prevent the rotation from occurring. If patients can grasp these basics then they will feel much more confident when in the pool. Of course, many patients will already be water-confident and will be doing some of these things automatically, but you can still use the principles to improve balance and co-ordination or as stabilization techniques.

Self-assessment question 11.6 (page 319)

- SAQ **11.6** What is the metacentric effect?

Answer The metacentric principle concerns balance in the water. A body immersed in water is acted upon by two opposing forces - gravity acting downwards through the body's centre of gravity and buoyancy acting upwards through the centre of buoyancy (this is located at the centre of the body of water that has been displaced by the immersed object). If these two forces are equal and opposite, then the body is balanced and there is no movement. If the two forces are unequal and out of alignment, however, then movement occurs. The movement is always rotatory and continues until a state of balance is once again achieved, i.e. when the two forces are back in alignment.

Self-assessment question 11.7 (page 321)

- SAQ **11**.7 Why are the effects of hydrostatic pressure important?

Answer Probably the most important implication of hydrostatic pressure is that it causes a

redistribution of the fluid volume within the body. In standing, a person of average height immersed to neck level will be subjected to a pressure of around 120g/cm² at mid-calf. Because of this greater pressure on the lower limbs, approximately 700 ml of fluid is redistributed from this region into the thorax. This effect is responsible for most of the profound physiological effects that occur during head-out water immersion.

Problem-solving exercise 11.3 (page 321)

- Describe a progressive strengthening programme for weak knee flexors using buoyancy and movement through the water.

Answer: For this problem we will assume there is full range of movement in the knee.

1. If the muscles are extremely weak you can use buoyancy as assistance. With the patient in standing, facing the side of the pool and holding the bar, ask him/her to take the heel to the buttock (keeping the hip in extension). Buoyancy will assist the movement. If more assistance is necessary, a float could be added. In this case you must ensure that the knee extensors are strong enough to extend the knee back to the starting position against the resistance of the float.

   To progress, take air out of the float and then remove the float altogether.

2. To make the exercise a little harder you can then use buoyancy as a resistance. Place the patient in sitting with the leg outstretched. The heel is pushed down into the water so bending the knee against the upthrust. A float can then be applied proximally and subsequently moved distally to increase resistance, and more air added as necessary. In this position you can only get the patient working against resistance up to 90° of flexion. After this point buoyancy starts to assist the movement as the heel moves up towards the buttock (this can however, be useful if you are working on both strengthening and mobilizing which is often the case).

   Remember that these movements should be performed slowly in order to be resisted only by buoyancy. As soon as you increase the speed, turbulence is produced and this increases the resistance to movement.

3. To provide the greatest resistance in the sitting position you could add a float and a flipper to the foot and ask the patient to perform the movement quickly, thus working against both buoyancy and turbulence. Flexion with a float and flipper in this position can be a very strong exercise but again only up to 90° of flexion. Because the patient is working hard you will need to give some attention to fixation to ensure you are getting the action you require.

4. You can now position the patient in side lying, either in floats or on a half plinth. The heel is taken towards the buttock, slowly at first so producing little turbulence and then the movement is speeded up to increase the amount of resistance. To progress further a flipper can be applied to the foot - this will produce even more resistance - and then add speed.

An advantage of this position is that the patient can move further into the range of knee flexion and still be working against the full resistance. This is unlike the sitting position, where the resistance offered varies depending on where in range the joint is. A disadvantage of side lying is that it is more difficult to stabilize the movement so you may need to use your hands to fix the thigh/hip region.

When you try these exercises out for yourself you will notice that there is some overlap: the last exercise we described in the sitting position (with float and flipper) is actually harder than the first exercises against turbulence that we described in side lying. So for a pure progression you may need to alternate the patient's starting position.

Although, for clarity we have talked about buoyancy and turbulence separately and strengthening and mobilizing as separate techniques, in reality you will often be using the principles in tandem and, as mentioned earlier, many patients need help to both strengthen and mobilize an area.

Problem-solving exercise 11.4 (page 321)

- You were introduced to Mr Kingston in Case study 5.2 in Chapter 5. He sustained a fractured shaft of femur that was treated with internal fixation. He was discharged non-weight-bearing. How could you use hydrotherapy in his rehabilitation?

Answer This patient was required to have active knee range from 0-70° and grade III strength in the quadriceps prior to discharge. If hydrotiierapy was available while he was an inpatient, this would be an ideal environment in which to work on these areas, especially as he was non-weight-bearing. Depending on his ability, Mr Kingston might be able to get into the pool independently using the handrails or you might need to lower him in using the hoist. As mentioned a number of times, the whole body is treated while the patient is in the pool and this helps with general fitness and can stave off the negative effects of bed rest and the relative immobility of the inpatient environment.

On looking back at the treatment objectives for Mr Kingston, hydrotherapy can be used to address many of these:

- Increase range of movement using buoyancy and turbulence in an active exercise programme using a wide range of starting positions.
- Strengdien knee flexors/extensors and muscles around the hip (as well as general strengthening and fitness) through strong but non-weight-bearing exercises and pool circuit training using the principles mentioned above.
- Regain full soft tissue length through the exercises above, specific stretching exercises and hold-relax techniques. The pain relief and general/local relaxation that occurs while in the pool may also help with this problem.
- Gait and locomotor activities can be worked on in the weight-free environment of the water, concentrating on reciprocal activities that can be performed more easily in the pool than on dry land. Once partial weight bearing is allowed at 6 weeks, progression can occur in the pool with the patient working in shallower water to increase the percentage of weight going through the lower limbs.
- Return to playing football - the patient can carry out medium- to high-intensity exercise in the pool while still non-weight-bearing and so will return to full fitness more quickly once weight bearing on dry land commences.
- In conjunction with hydrotherapy, Mr Kingston should be carrying out a comprehensive set of home exercises and may also be attending the physiotherapy gym, depending on available resources. Final rehabilitation will need to be carried out on dry land.

Self-assessment question 11.8 (page 322)

- SAQ **11.8**

a. What factors offer resistance when moving through the water?

Answer

- Bow wave (positive pressure in front of the object)
- Wake (turbulence producing negative pressure/ drag behind the object)
- Viscosity of the water
- Friction
- Adhesive/cohesive forces.

b. Why does turbulence produce resistance?

Answer Turbulence is the term used to describe the eddy currents that follow an object that is moving through the water. The degree of turbulence depends partly on the speed of movement, i.e. faster movement creates more turbulence, slower movement creates less turbulence and the flow of water is more streamlined. Faster movement with many eddy currents being formed behind the object as it moves through the water indicates the presence of high levels of kinetic energy in the water particles. As a result of this, the level of pressure energy goes down, so causing an area of low pressure behind the object resulting in the drag.

c. What are the variables that can affect the amount of turbulence produced by an object moving through the water? Which of these is the most significant?

Answer Three variables affect the amount of turbulence produced by an object moving through the water, speed, shape and size. The most significant is the speed of movement - Drag a area x speed^2.

Self-assessment question 11.9 (page 322)

- SAQ **11**.9 Why do you need to know about refraction?

Answer:

- Safety - it is important to warn the patients that the floor of the pool and any steps will look

nearer than they actually are, so care needs to be taken
- Incorrect assessment - it is not recommended that you attempt to assess the patient's movement while in the pool. There is distortion as you look into the water and you will see the 'apparent' image as opposed to the 'real' image. Your assessment is likely to be incorrect - do it on dry land.

Problem-solving exercise 11,5 (page 322)

- Mrs Jones is the 77-year-old lady with a fractured neck of femur treated with a dynamic hip screw (Case study 5.3 in Chapter 5). How do you think that management of this patient in the hydrotherapy pool would vary from that you decided upon for Mr Kingston?

Answer: As noted in Chapter 5, the main focus for Mrs Jones is her return to functional independence. The more specific range of motion and strength around the hip is the secondary consideration. Given the differences in function between the two patients prior to injury, Mrs Jones will not need to increase strength and range of motion to the same extent as Mr Kingston.

You may need to provide more support and reassurance for this lady when she first comes to the pool. It is possible that she may not ever have been swimming, or at least not for a very long time. It is also important to remember that her injury occurred as the result of a fall and so she may be nervous, particularly in the very different environment of the pool. If this is an issue you could bring her into the pool area using a wheeled chair and lower her into the pool using the hoist. She may also feel rather self-conscious about appearing in front of others in a swimsuit. You can check these points out in your assessment and modify your approach accordingly.

Your treatment programme needs to be less vigorous than that of Mr Kingston. Start with gentle exercises for the hip in standing, checking for compensatory movements. If she has enough confidence in you, you may be able to put Mrs Jones in float lying or on to the half plinth in order to carry out hip and knee movements (e.g. alternate knee/hip flexion/extension, gentle cycling action, bilateral abduction, hip extension against buoyancy). For the more functional activities you can ask the patient to walk in the pool - forwards, backwards, sideways, gradually increasing stride length. She can practise sitting to standing and, if you have steps in the pool, she can do step-ups - buoyancy will assist these activities.

Depending on the patient's progress you might go on to use floats and flippers to increase resistance.

Being in the water and moving around will improve general mobility, flexibility, fitness and endurance. Mrs Jones will be able to move more easily than on dry land and this will help to improve her confidence and her ability to cope. Coming to the pool will also provide the opportunity to meet others, so providing social interaction.

Self-assessment question 11.10 (page 323)

- SAQ **11.10** What happens to your cardiac output during head-out water immersion in thermoneutral water? How is this modified in water that is warmer than thermoneutral?

Answer Cardiac output increases by 34% in thermoneutral water but the heart rate remains fairly stable, or occasionally a slight bradycardia occurs. With water at higher temperatures the effect on cardiac output is more pronounced and the heart rate tends to rise, with tachycardia occurring when the water reaches 37°C. In water at 39°C cardiac output rises as much as 120% and heart rate can increase to 113 beats per minute.

Self-assessment question 11.11 (page 323)

- **SAQ 11.11** Why do you feel that you need to go to the loo after being in the pool for a period of time?

Answer Immersion has a marked effect on renal function, particularly a profound diuresis due to the suppression of antidiuretic hormone. This causes the distal tubules and collecting ducts of the kidney to become less permeable to water, so less is reabsorbed, resulting in more urine being produced. The kidney usually filters 120 ml/minute and produces 1 ml of urine. After 3 hours of immersion the rate of urine production increases up to 7 ml/minute.

Self-assessment question 11.12 (page 323)

- SAQ **11.12** Why might hydrotherapy be helpful for patients who experience stress and anxiety?

Answer There is some evidence to suggest that blood levels of stress hormones (such as noradrenaline (norepinephrine)) are reduced during immersion. It is also hypothesized that there is a reduction of sympathetic nervous system activity. This may provide some explanation for the reports of improved mood after swimming.

Problem-solving exercise 11.6 (page 326)

- John Brown, a 24-year-old man with a sprain of the medial collateral ligament of the knee and James Low, a 46-year-old man with a total rupture of the lateral ligaments of his ankle are both discussed in the Chapter 6 (Case studies 6.1 and 6.3). Review these cases and think about why you might use hydrotherapy with these patients as part of their rehabilitation.

Answer John Brown injured the medial collateral ligament of his knee while playing football. He is a keen sportsman and so will want to get back to activity as soon as possible. It is noted in the case study that he is perhaps not as fit as he could be. As with the other case studies mentioned, hydrotherapy can be used in order to allow earlier exercise in a warm, weight-relieving environment. Both the reduction in weight and the warmth of the water will reduce discomfort and enable greater activity levels.

Fitness levels can be worked on both in the pool and on dry land, but it may be easier to carry out vigorous exercise initially in the water. Some examples of exercises are given below:

Sports therapy rehabilitation

- Sitting on float - pelvic control. Add breaststroke with arms forward and backward while sitting on board. Progress by creating more turbulence and then change the patient's position to kneeling on the board and finally to standing on it while performing the same arm movements
- Supported by floats or swim jacket - cycling movements and deep water running
- Jumping to walk standing, jump together, jump feet apart, jump together. Add floats to feet and repeat
- Stand on one leg (with or without float on foot). Move other leg in all directions, then switch to other leg. Good exercise for stabilizing stance knee. Can add floats for extra resistance
- Barbell in each hand, hold down in water (using latissimus dorsi). Kick legs from the hips. Progress by adding flippers to feet
- Jumping with arms raised above the head (so the patient cannot use the arms to do the work) in deep water and progress to shallower water. Change from right leg to both legs to left leg in different order. Jump for 2 minutes then have 30-second rest. Add moving forward, backward and sideways. Emphasize quick response time
- Jogging forward, backward, to right and left, and then add diagonal directions
- Jumping with skiing action on either side of line on bottom of pool. Add posture control
- Large kickboard - doing 'kickboard clocks'. Can keep foot on board by adding two rubber bands and sliding the foot underneath them
- 6 o'clock and 12 o'clock - dorsiflexion and plantar flexion
- 3 o'clock and 9 o'clock - inversion and eversion
- Progress by adding in the diagonals and progress further by asking patient to move to all 12 points of the clock
- Can use repetitions and/or changes in speed to progress further
- Cool down - walking or jogging.

These are some examples that will help with general fitness and lower limb strength and mobility. You can think up more for yourself.

James Low has ruptured the lateral ligament of his ankle joint and has been in plaster for 4 weeks. His main problems are swelling, decreased range of movement and decreased mobility. Hydrotherapy will enable him to carry out early reciprocal lower limb activities, especially as he is initially partial weight bearing.

The hydrostatic pressure may help to reduce the swelling around the ankle. He could do lots of walking activities in different directions, practise going up and down the steps in the pool, active ankle and foot movements while wearing a flipper, balance work - e.g. patient stands on the affected leg while you produce turbulence in different places around him and he has to maintain his position, or he has to maintain his balance while carrying out strong movements with the arms. In this way it

is possible to work on range of movement and strength in the ankle region to a certain extent, although this would need to be augmented by a land-based programme. The 'kickboard clocks' exercise described above would be helpful in increasing range of movement, concentrating particularly on inversion and plantar flexion.

Generally, Mr Low is unfit and unused to using his body because of his sedentary lifestyle. The hydrotherapy pool is the ideal environment to introduce him to gentle all-round exercise. Depending on his progress he could move on to some or all of the above sports therapy rehabilitation exercises to improve his fitness and then possibly to swimming, which he could continue on his own at his local pool.

You will need to modify your approach to patients depending on their priorities. In the end, if Mr Low is unwilling to exercise beyond the rehabilitation of his ankle problem then that is his choice - you can only offer advice and support.

Self-assessment question 11.13 (page 328)

- SAQ 11.13 Review the absolute contraindications to hydrotherapy treatment

Answer Absolute contraindications:

- Uncontrolled cardiac failure - the patient is unable to lie flat without becoming dyspnoeic
- Resting angina
- Shortness of breath at rest
- Medically unstable following an acute episode e.g. cerebrovascular accident, deep vein thrombosis, pulmonary embolus, status asthmaticus
- Acute vomiting and/or diarrhoea
- Proven chlorine sensitivity.

Problem-solving exercise 11.7 (page 328)

- Steve Morris (Chapter 6, Case study 6.5) has a long history of back pain and eventually has an operation to decompress his SI nerve root. Read about his problems on assessment and how he is after surgery. How might hydrotherapy be of use in this case?

Answer It is well recognized that the effects of warm water and the gravity-free environment assist in promoting generalized relaxation. In addition, the suppression of the sympathetic nervous system leads to a reduction in muscle tone, a reduction in level of pain and an elongation of the spinal column. These benefits of immersion, combined with the variety of principles we can use to mobilize joints, stretch tight structures and strengthen muscles, all contribute to creating an ideal medium in which to treat back pain.

As with any exercise programme, the regimen you design for Mr Morris should be developed on an individual basis following a full assessment on land. There are numerous ways in which we can treat low back pain, but even those experiencing more acute pain can benefit from relaxation and isometric exercises in the pool. This patient should be finding that the acute pain has diminished but he will be feeling stiff and sore after the operation and bed rest. Because of the long-standing nature of his back problem, Mr Morris will probably be generally decondiHoned.

The following exercises are a sample of those that can be used in this context:

1. Relaxation

Starting position - supine, supported in floats

Exercise/activity: 'Seaweeding' through the water. The therapist walks backwards supporting the patient at the chest or between the patient's knees at the same time slowly moving the patient's body from side to side so it moves like a piece of seaweed in the water. This provides excellent therapist control and an ability to determine the degree of specific and generalized relaxation.

Starting position - in deeper water in vertical supported by a buoyancy vest or by a ring under each arm

Activity: Passive 'hanging'. This activity can be performed independently.

2. Isometric exercises

Starting position - supine, supported by floats

a. *Exercise for abdominals:* Apply pressure on both shoulders in a downward direction, graded to gain contraction without movement.
b. *Exercise for obliques:* Apply pressure on one shoulder at a time. This can also be done by

applying pressure on one hip at a time. This exercise can be used to detect unilateral weakness and determine muscle balance.

c. *Exercise for erector spinae.* Apply pressure under both scapulae to lift the body upwards.

With all of these the patient is asked to resist the pressure applied by the therapist.

Storting position - supine, supported by floats

d. *Exercise for obliques:* Padent is asked to lift one hand out of the water while maintaining the trunk in a straight position (resist the resultant body roll). Alternate with the other hand.

e. *Exercise for side flexors:* With the therapist standing between the patient's knees, hands on the outer aspect of the thighs or hips, patient is moved from side to side and has to maintain the trunk in a straight line. Progress to therapist holding between the patient's feet. Further progression can be provided by standing at the patient's head with hands under scapulae and around thorax so holding at chest level. Increasing the speed of the turn will also increase the difficulty.

f. *Exercise for trunk rotators and extensors:* As above with the patient's legs rotated to the right or the left.

All the above exercises utilize drag to obtain an isometric contraction.

g. *Exercise for extensors:* With a float on both feet, depress the float into the water and hold the position.

h. *Exercise for abdominals:* Turn into prone. With a float on both feet, depress the float into the water and hold the position. Repeat this with the legs rotated to left or right to exercise the obliques.

These exercises use buoyancy to gain an isometric contraction.

3. Mobilizing exercises

Starting position - supine, supported in floats holding the rail with both hands

a. *Rotation:* With bent knees and thighs under the water, tum the feet from side to side, bringing the ankle towards the surface on each side alternately.

b. *Side flexion:* With straight knees, take both legs together to one side and then the other, by bending at the waist. Rotation can be added by turning the legs to the left or right before taking them from side to side.

Starting position - facing the rail, no floats, hold rail with forearms (front of body against pool side), bend knees, keeping hips in extension

c. *Rotation:* Keeping the body vertical (do not side flex), turn the ankles from side to side to bring alternate lateral malleoli towards the wall.

d. *Rotation with flexion:* Bend the hips and knees while bringing them up to the left-hand side of the body, push the hips down into extension and repeat to the opposite side by bending at the hips and bringing the knees up on the right-hand side of the body.

e. *Side flexion:* Keeping the knees bent and the hips in extension, bend at the waist, allowing the water to lift the legs to the side. Repeat to the other side.

Starting position - standing at the rail holding with both hands

f. *Extension:* Facing the rail, take one leg back as far as possible without leaning forwards. Repeat with the other leg.

g. With back to the rail, push hips forwards and rise on to toes, allowing the buoyancy to lift into lumbar extension. A small float can be used in the hollow of the back.

h. Flexion - with back to the rail as above, lift both knees towards the chest. A small float can be used under both feet. This would increase the mobilizing effect of buoyancy but also add strengthening activity for the extensors when returning to the starting position.

4. Strengthening exercises

The isometric exercises described above become strengthening exercises through range when movement is added, rather than maintaining a static hold.

5. Mobilization of the nervous system

Starting position - standing at the rail and holding the rail with both hands

a. *Sciatic nerve:* With back to the rail, with straight knee, lift leg forwards as far as possible (a small float can be used on the foot). Flex the head forward and then lift head up.
Caution: before attempting this, the degree of irritability must be assessed on land.

b. *Femoral nerve:* Facing the rail, take the leg into hip extension and bend the knee. Take head into flexion.
Caution: as above.

Other components with either of these nerve stretches can be added as in land-based treatments.

6. Posture and balance

a. Use turbulence in different places to facilitate the use of abdominals or back extensors, or maintain pelvic tilt. Varying the depth of water will increase the difficulty. The deeper the water the greater muscle effort is required to maintain a position. Patients can create their own turbulence by moving their arms forwards and backwards.

b. Balance on one foot with and without turbulence.

c. Balance on one foot while holding a float under the other foot just above the floor of the pool. Move the foot with the float in different directions, keeping it just off the floor at all times. Repeat with the other foot.

7. Functional activities

Activities such as walking in different directions, exaggerated reciprocal walking, and using steps. Increase the walking difficulty by increasing the speed and/or by adding bats in the hands to unstreamline the body and increase the resistance to movement.

The above exercises/activities are not exhaustive. There are many others that can be included in a back treatment programme.

Consideration should also be given to general fitness activities that could be done in the pool, as improving fitness is known to improve self-esteem. Many patients report benefits in terms of improved well-being and self-efficacy. The psychosocial aspects of exercising in a pool cannot be ignored, particularly when exercising in a group.

It is therefore important to design a programme that will ultimately allow Mr Morris to take control of his own treatment and carry out the exercises without supervision.

Self-assessment question 11.14 (page 329)

- SAQ 11.14 With regard to contraindications to hydrotherapy treatment, in what situations might you need to monitor patients while they are in the pool and why?

Answer Open infected wounds, poorly controlled epilepsy, unstable diabetes, known aneurysm, gross obesity. Patients should be closely monitored while in the pool, with follow-up to ensure no ill effects. This is particularly important with those patients where there is a slight risk of collapse in the pool, which could lead to accidental submersion.

Self-assessment question 11.15 (page 332)

- SAQ 11.15 What are the main patient-related health and safety risks when in the pool environment?

Answer
- Accidental submersion
- Acute fear of water
- Slips and falls poolside
- Fainting and fitting in the pool
- Cardiac arrest in the pool
- Spread of infection
- Fatigue
- Unfamiliarity with the pool surroundings.

Self-assessment question 11.16 (page 334)

- SAQ 11.16 What are the main staff-related health and safety risks when working in the pool environment?

Answer
- Storage and handling of chemicals
- Fatigue
- Skin problems - dry skin, irritation and rashes.

Self-assessment question 11.17 (page 335)

- SAQ 11.17 What is the reason for backwashing?

Answer This is an important process that cleans the filter medium by reversing the flow of water through the filter.

Self-assessment question 11.18 (page 336)

- SAQ 11.18 Why might there be a strong chlorine odour in the pool area and why is this a negative sign?

Answer The result of the reaction of the hypochlorous acid with the nitrogenous compounds in the water (i.e. the pollutants) causes the formation of chloramines. These are poor sanitizers and are irritants. The most common are the monochloramines and then the dichloramines. These two compounds react to release nitrogen. If further chlorine is added then trichloramines are formed. Trichloramines have a characteristic chlorine-like odour, are aerated out of the water by agitation and are responsible for eye irritation. The formation of the trichloramines is most pronounced if there is low pH (i.e. if the water is more acidic). It is important to note that the odour and eye irritation are often thought to be due to the chlorine levels - this is not the case, they are due to high levels of trichloramines, i.e. in a pool with a poorly controlled disinfection system.

Self-assessment question 11.19 (page 337)

- SAQ 11.19 What is the importance of having pool water at the correct pH level?

Answer It is extremely important that you have good control of the pH of the water as it ensures: protection of the pool plant, bather comfort and effectiveness of the disinfection system. With pH below 7.0 (acidic), there is the possibility of rapid loss of chlorine, eye irritation due to the rapid formation of chloramines, destruction of cement grouting and corrosion of metal components. The water will feel uncomfortable, sometimes described as 'prickly' as it takes minerals from the skin. With pH above 7.8 (alkaline), there is the possibility of reduced chlorine efficiency and so a need for increased chlorine, eye irritation and dry skin, cloudy water and scale formation in plant and pool.

Self-assessment question 11.20 (page 338)

- SAQ 11.20 Which tests of pool chemistry need to be carried out and how often are they done?

Answer See Table 11.2.

Problem-solving exercise 11.8 (page 338)

- After briefly reviewing the case studies in Chapter 7, formulate a list of reasons why you might use hydrotherapy in the management of patients with rheumatic conditions. Are there any disadvantages?
- How would hydrotherapy for a patient with rheumatoid arthritis vary from that for a patient with ankylosing spondylitis?

Answer Reasons might include:

- *Pain relief.* All patients with rheumatic conditions will have some degree of pain because of the disease process in general, often more specifically on weight bearing. The warmth and weight relief are helpful therapeutic effects enabling greater freedom of movement because of decreased pain and spasm. The pain relief, although temporary, is present throughout the treatment, unlike many other modalities.
- *Wliolc-body treatment:* Many patients with rheumatic conditions have widespread problems. When moving in the water, the whole body is treated and there is less focus on a specific area - again unlike other modalities used in physiotherapy. This is particularly important for both Mrs White (RA) and Mr Smith (AS), who both have widespread problems. Large numbers of joints can be treated in less time. Different planes of movement can be used with minimal change in starting position, which is an advantage for those patients who find changing position on dry land painful or difficult.
- Gait can be re-educated earlier in the pool. This will be helpful to Mrs Stamford (OA knee) and more particularly to Mr Nicholls after his total knee replacement.
- Patients with RA often have delicate skin. In the water there is no friction to cause damage. There is also no pressure on bony points, so this could be important for a patient who is very immobile

such as Mr NichoUs. Movement and exercise in the water will help to reduce problems over pressure points that may have arisen during periods of bed rest.

- As water provides an almost limitless range of resistance to movement, patients at any stage and with a wide variety of problems can still be treated effectively in the pool. The resistance will never be more than they can manage if you choose your exercise programme carefully and tailor it to the individual patient.

- Rheumatic conditions are chronic and so have associated psychosocial problems. The greater freedom of movement in the water can boost morale and increase confidence. The social aspect of the treatment can also help to lift mood and provide mutual support. Patients report physical, functional and psychological improvement, better quality of life and feelings of increased well-being.

- *Lack of major adverse effects:* This is quite different from other forms of therapy that many of these patients have to undergo, especially drug treatments.

Possible disadvantages:

- Fatigue
- Dependence on treatment
- Doing too much in the water and experiencing post treatment pain. This should be avoided with careful monitoring of the patient's activity levels.

The main difference in hydrotherapy for the patient with RA and that for the patient with AS would be the intensity of the exercise. For Mrs White the treatment would be gentler, taking note of pain and not pushing too far into range. This is to avoid aggravating symptoms and to prevent further joint damage. You would ask her to perform low- to medium-intensity exercises and functional activities.

For Mr Smith the pool treatment would be much more vigorous as exercise is necessary to improve the pain and stiffness experienced as a result of the condition. The following exercises are examples of those that can be used in the management of AS.

Supine lying

Neck collar; hip float; ankle float (some patients prefer not to wear a collar and this may in fact allow more cervical extension). Ensure correct posture in float lying and ensure that you keep giving posture reminders throughout the session.

- With feet together and legs straight, rotate legs so that lateral (outer) surface of thigh is uppermost and then rotate to the other side. Avoid hip flexion by pulling heels back.
- Hip hitching, keeping legs straight.
- Pendulum swing both legs from the right to the left with knees straight and at the surface of the water. Stabilize the pelvis as needed.
- Press right leg down into the water, keeping the left leg just under the surface of the water to help stabilize the pelvis. Repeat with the other leg.
- Abduction of hips with legs straight and heels just under the water. Add hold-relax technique as necessary.
- Alternate knee bends with ankles at 90°.
- Extend back and hips by pushing heels down into the water with both legs together, knees straight.
- Bend knees towards the chest and roll both knees from side to side. Stabilize the pelvis as needed.
- Floating free of the bar, arms out sideways, palms up. Press arms down into water then relax as they return to the surface (could float with toes tucked under bar, head to centre of pool to give some stability).

While neck and shoulders are warmed, the patient should stand with back to the wall with shoulders under the water, start with shoulder muscle relaxation exercises and then do neck exercises.

Standing

Ankle floats as necessary. Repeat exercises on both sides.

- Facing side of pool, both hands on bar starting with body in an inclined position - press-ups.
- Standing sideways to wall, keeping ankle float slightly behind the knee, bend the knee up and then press the foot downwards to the floor trying to get the knee as straight as possible.

- With the leg straight, take forward and up towards the surface then draw leg backwards with the heel leading (ensuring that there is movement in the trunk), then pull leg strongly forward and up, keeping both knees straight. Add hold-relax technique as necessary.
- With knee straight, take leg into abducdon going as high as possible (keep toes pointing forwards). Add hold-relax as necessary.
- Stand with back to the wall, bend right knee and rest right foot on to left knee. Take right knee round towards the wall and then across to the left as far as possible.
- Squat with feet wide apart, holding a float in both hands, push the float round to the right and tiien the left. Maintain neck retraction throughout.
- Feet wide apart, keeping arms straight and out to the side just under the surface of the water, thumbs pointing to the ceiling. Bring palms together in front of body and then push arms back to try and touch wall behind.
- Position as before, arms at shoulder level and at side, push palms down into water to touch body and return to starting position.
- Stand facing the wall, with the right arm straight holding on to the bar. With a float in the left hand, push it down from the surface of the water to sweep under the right arm and across to try and surface on the other side. Control the movement at all times.
- Strides across pool, backwards, forwards and sideways, aiming to decrease the number of strides taken each time.
- Blowing a float across the pool.

As you can see, these exercises focus on rotation and extension using active movements, isometric contraction and stretching but being aware of correct posture at all times. You can also work on improving vital capacity by doing aerobic work and encouraging swimming underwater if the patient is able.

Problem-solving exercise 11.9 (page 338)

- In Chapter 9 (Case study 9.1) you were introduced to Mrs Bell, a 58-year-old lady with osteoporosis. Review her case and think about how hydrotherapy might be used as part of her management.

Answer. There are a number of factors that make hydrotherapy a suitable treatment modality for patients with osteoporosis.

- Patients feel safe, as there is no fear of falling. This is important for confidence, as some of these patients may have sustained fractures or other injuries as a result of falls
- Relaxation caused by the support and warmth of the water helps to reduce pain
- The reduction in pain plus the support of the water enables both active and static muscle contraction
- As the level of exercise tolerance increases, the pull of muscle on bone promotes bone strengthening
- There are many ways of statically strengthening the anterior and posterior spinal muscles in the pool
- Activities in the pool can facilitate normal movement
- Re-education of functional movement in the pool can lead to increased dry land activity
- It is possible to use the water to increase cardiovascular and respiratory fitness levels
- Improvement in postural control
- Improvement in thoracic expansion and respiratory function
- Many patients report psychological effects such as an improvement in well-being when undergoing pool therapy and exercise
- Group social interaction
- The pool can be used to prevent associated problems once fractures have occurred.

A regimen of hydrotherapy is performed with repetitions gradually increasing from 15 to 30 over a 6-week period. The regimen used is very precise and specific, needing correction and input from the physiotherapist. Treatment does however, take place in a group situation - thus it is cost-effective.

Stability trunk exercises for the pool

Begin all exercises with a gentle warm up of walking either on the spot or through the water. All exercises should be done with water at shoulder height if possible. Begin with 10-15 repetitions

of each exercise and gradually build up to a maximum of 30.

- Standing - hold float in front of you resting it on the water. Press float into water with both arms so the water just passes over top of float. Keep posture upright. Hold for 5 seconds.
- Standing - hold float to side with one arm and press into water at side as above. Keep posture upright. Hold for 5 seconds and repeat with the other side.
- Standing - hold float behind you in the water with both arms straight. Press on float with arms and hold, then relax but do not let arms bend up.
- Sit into water - hold float vertically in front of you, push it away and pull back. Keep body posture as upright as possible in the sitting position. Keep movement flowing forwards and backwards as long as you don't fall over.
- Sit into water - hold float vertically in front of you and move it side to side - small movements. Keep body stable.
- Standing - face the side of the pool and hold on with finger tips keeping both legs straight. Move one leg forwards and backwards in a small arc of movement. Repeat with the other leg. The aim is to be able to do this exercise without holding on to the side of the pool.
- Standing - stand sideways on to the side of the pool, hold on with fingertips of one hand. Keep legs straight and move one leg out to side and back - small movements. Again aim to do exercise without holding on to the side.
- Standing - position as for exercise above. Bend one hip and knee up in front and stretch leg out straight behind. Repeat with other leg.
- Sit into water - push both arms up and out to side and then pull back down and in towards the body. Repeat with speed. Do not let body move out of the water.
- Sit into water - start with both arms up to the surface at the side. Take arms across surface of water until hands meet in the middle and then back out to the side. Repeat with speed. Do not allow body to move in the water.
- Stride standing - swing both arms in opposite directions backwards and forwards at side with speed. Keep body as still as possible, do not twist.
- Standing - face wall as described earlier and hold on to bar. Feet approximately 15 cm away from wall. Keeping elbows in position, push hips forward to touch the wall then let the rest of the body follow. Relax and return to starting position, then repeat.
- Standing - position as above. Keeping legs straight, push one leg behind you as far as you can and return to starting position. Do not allow your trunk to move forward as your leg moves back.

References

Association of Swimming Therapy (1992) Swimming for people with disabilities, 2nd edn. A & C Black, London

Berger BG, Owen E, Owen DR (1983) Mood alteration with swimming - swimmers really do 'feel better'. Psychosomatic Medicine 45: 425-133

Coruzzi P, Ravanetti C, Musiari L et al (1988) Circulating opioid peptides during water immersion in normal man. Clinical Science 74: 133-136

CSP 1994 Health and safety: safety representatives' information manual. Chartered Society of Physiotherapy Industrial Relations Department, London

CSP 2000 Standards of Physiotherapy Practice. Chartered Society of Physiotherapy, London

CSP 2001 Hazards in hydrotherapy pools. Health and Safety Briefing Pack 12. Chartered Society of Physiotherapy Industrial Relations Department, London

Davis BC, Harrison RA 1988 Hydrotherapy in practice. Churchill Livingstone, Edinburgh

Geytenbeek J 2002 Evidence for effective hydrotherapy. Physiotherapy 88: 514-529

HACP 1992 Hydrotherapy. Standards of good practice. (Hydrotherapy Association of Chartered Physiotherapists.) Chartered Society of Physiotherapy, London

HACP 2001 Contraindications to hydrotherapy. Hydrotherapy Association of Chartered Physiotherapists, London

Hall J, Bisson D, O'Hare P 1990 The physiology of immersion. Physiotherapy 76: 517-521

Harrison RA, Bulstrode S (1987) Percentage weight bearing during partial immersion in the hydrotherapy pool. Physiotherapy Practice 3: 60-63

Health and Safety Executive 1991 First aid at work - Health and Safety (First Aid) Regulations 1981. HMSO, London

Jackson A 1996 Hydrotherapy as experienced by outpatients in a general hospital. British Journal of Therapy and Rehabilitation 3:601-608

Kuroda PK 1963 What is water? In: Licht S (ed) Medical hydrology. Elizabeth Licht, Connecticut, p 1-23

Levine BA 1984 The use of hydrotherapy in reduction of anxiety. Psychological Reports 55: 526

O'Harc P, Heywood A, Dodds Pel al 1984 Water immersion in rheumatoid arthritis. British Journal of Rheumatology 23:117-118

Oxladc C, Parker S 1999 Pocket science. Parragon. Bath

Pool Water Treatment Advisor)' Group (1995) Pool Water Guide. Greenhouse Publishing, Diss, Norfolk

Reid Campion M (1990) Adult hydrotherapy: a practical approach- Heinemann Medical. Oxford

Rissel C 1987 Water exercises for the frail elderly: a pilot study. Australian Journal of Physiotherapy 33: 226-232

Shcldahl LM. Tristani FE, Clifford PS et al (1986) Effect of head-out water immersion on response to exercise training. Journal of Applied Physiology 60:1878-1881

Weinstein LB 1986 The benefits of aquatic activity. Journal of Gerontological Nursing 12: 6-11

Weston DFM, O'Hare JP. Evans JM, Corral! RJM 1987 Hacmodynamic changes in man during immersion in water at different temperatures. Clinical Science 73: 613-616

Index

Page numbers ending in b refer to boxed text; page numbers in bold refer to major discussions; page numbers in *italics* refer lo figures or tables.

D

E

Q

R

S

X

Y

SECOND EDITION

Physiotherapy in Orthopaedics

A PROBLEM-SOLVING APPROACH

The second edition to this successful textbook is for all physiotherapy students and newly qualified physiotherapists working in orthopaedics at both undergraduate and postgraduate levels. The authors have drawn on their many years of experience and clinical work in various orthopaedic settings to help students with clinical reasoning when faced with apparently diverse patient problems.

The content of this book moves from normal to abnormal and from simple to complex. Case studies and self-assessment sections encourage participation by the reader to help students develop a reasoned and logical approach towards the management of their orthopaedic patients.

FEATURES

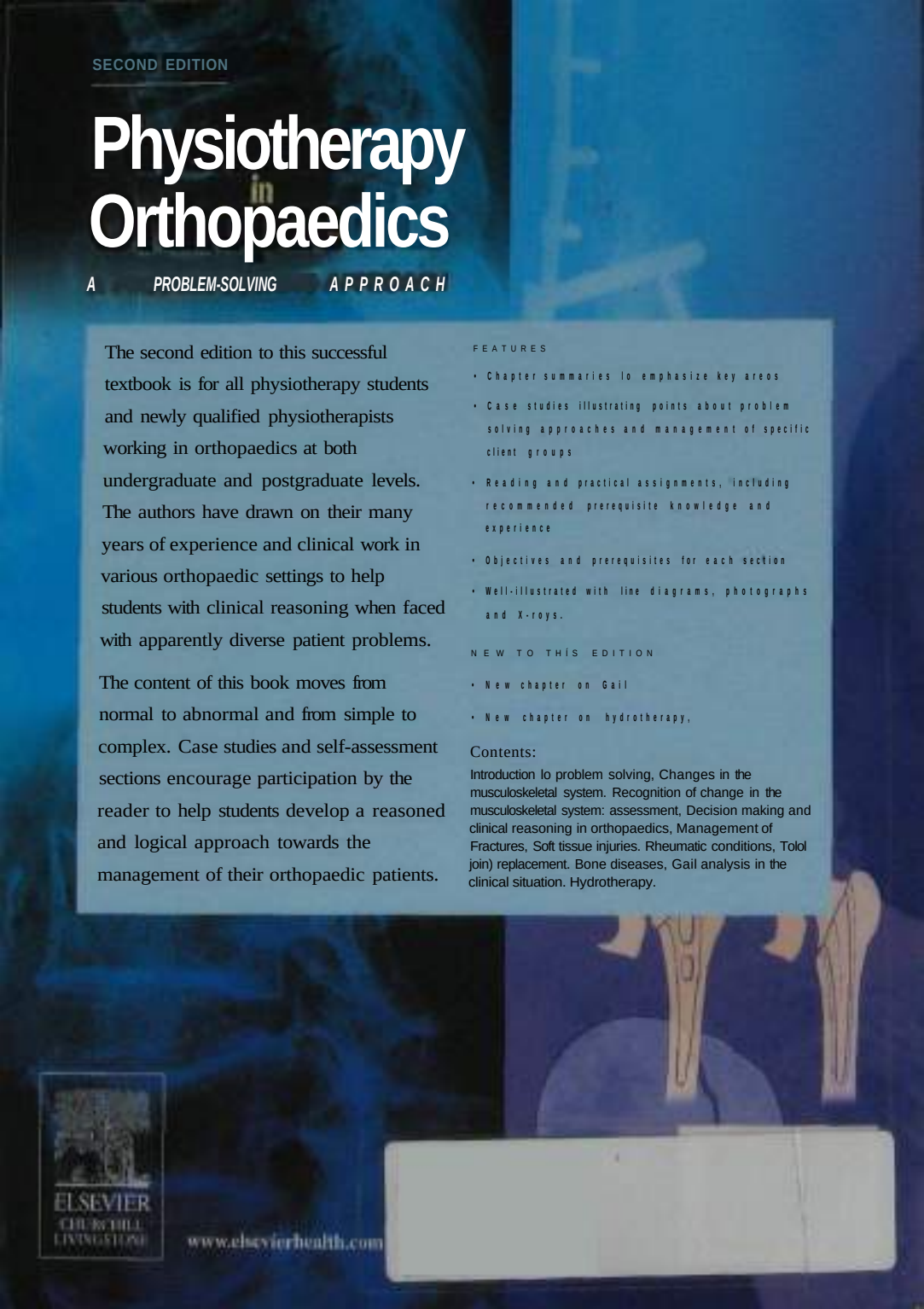
- Chapter summaries lo emphasize key areos
- Case studies illustrating points about problem solving approaches and management of specific client groups
- Reading and practical assignments, including recommended prerequisite knowledge and experience
- Objectives and prerequisites for each section
- Well-illustrated with line diagrams, photographs and X-roys.

NEW TO THÍS EDITION

- New chapter on Gail
- New chapter on hydrotherapy,

Contents:

Introduction lo problem solving, Changes in the musculoskeletal system. Recognition of change in the musculoskeletal system: assessment, Decision making and clinical reasoning in orthopaedics, Management of Fractures, Soft tissue injuries. Rheumatic conditions, Tolol join) replacement. Bone diseases, Gail analysis in the clinical situation. Hydrotherapy.



ELSEVIER
CHURCHILL
LIVINGSTONE

www.elsevierhealth.com