UNIT 10
INJURY PREVENTION, MANAGEMENT & REHABILITATION

Warm Up

By Michael Dalgleish

Athletes typically perform warm ups and stretching activities to prepare for more strenuous exercise. These preliminarily activities are used to enhance physical performance and to aid the prevention of sports related injuries. Warm ups are generally classified into three categories:

(a) Passive warm ups
(b) General warm ups
(c) Specific warm ups
(d)

It has been generally regarded, that specific warm ups are best, though the intensity and duration are very much sports specific and individualised.

Passive warm ups include such modalities as diathermy, heat pads, hot showers and massage. Such modalities except massage, have a questionable effect on deep muscle temperature and blood flow. None of the above appear to greatly, enhance performance physiologically and, in fact, massage has been shown to decrease eccentric ham-string strength. Certainly this would be an undesired effect for any athlete who wishes to resistance train immediately following massage.

General warm ups are the most widely used concept and aim to increase overall body temperature through active movements of major muscle groups. Activities such as jogging, callisthenics, skipping rowing, bionic and stationery bicycle. Obviously these activities are easily adapted to the gymnasium/weight room setting. Deep muscle temperature is elevated far more effectively and thus physiological benefits are augmented. This type of warm up should provide the initial warm up phase for all weight room sessions, proportional to the physiological system being trained in the session. It maybe of significant physiological detriment prior to a maximal weights for quadriceps/gluteals/hamstrings to complete a fifteen minute session of high intensity stepping. Conversely an easy five minute low intensity session augmented with thorough, effective stretching and skill specific rehearsal may be extremely useful both physiologically and in the prevention of injury.

Specific warm ups concentrate on the neuromuscular portions of the body which will be used in subsequent more strenuous activities. (Of significance, all movement are similar to the athletic activity/exercise but at a re-duced intensity.) It is not hard to appreciate that wide grip front pull down at 50% of our body weight could be a specific warm up for wide grip chin ups. Specific warm ups, both, increase *the* temperature of specific body parts and provide a rehearsal of the events which is to take place. Its major advantage *is* in the physical performances involving skills or co-ordination because practice alone may aid in the improvement of the activity.

Intensity and duration of warm up must be specific to the intensity of the event and the level of the athlete. Elite athletes have thermo regulatory systems which respond more efficiently to the heat produced during exercise and therefore may need longer warm ups – more relevant to elite aerobic athletes. It still holds that greater absolute resistance *is* required in elite strength trained athletes to augment physiological benefits of specific warm ups. It is of paramount importance that intensity and duration are not too severe as to impair physical performance. Optimising these components often takes some time to gauge for each individual and will change, to some degree, with continuous resistance training.

During resistance training 'The warm up* continues throughout the session as rehearsal sets should be completed prior to each individual exercise in the programme. This may be augmented with specific stretching for the appropriate prime mover muscles to be loaded with the following exercise.

Effective physiological warm up *is* achieved by a 1-2 deg rise in core temperature. The most

obvious indicator of this is a mild to moderate perspiration which *is* a benchmark in aerobic activity. There is no reason physiologically that this should not be used as a benchmark prior to rehearsal sets in our specific warm ups.

The ability of the body to meet physical work demands is improved at elevated temperatures. It has been shown that effective warm up *is* particular advantageous for maximal efforts in short duration 'power' activities particularly, weight lifting and throwing events.

The physiological effects of warm up include:

1. A more rapid and complete dissociation of oxygen from haemoglobin and myglobin
2. Lowering of activation energy at which critical-metabolic reactions occur
3. Muscle contractibility is improved
4. Muscle contractions appear to be more rapid and forceful
5. Nerve conduction velocity is augmented
6. Stimulated vasodilation, thus improved blood flow
7. Improves blood shift to working areas of the body from the viscera

Stretching *is* an integral part of all warm ups and should follow the general component to maximise the physiological effects gained therein.

Contrary to possible opinion, resistance training requires high levels of flexibility for effective and superior performance. Evidence suggests that stretching improves flexibility and therefore will be a paramount importance in preparation for resistance training. Stretching should aim to maximise both dynamic and static flexibility of all joints involved during the training session.

Static flexibility refers to:

"Degree to which a joint maybe passively moved to the end-point in the range of motion."

Dynamic flexibility refers to:

"Degree which a joint can be moved as a result of a muscle contraction, usually through the mid-range of movement."

Dynamic flexibility is a poor indicator of joint stiffness or as a reproducer of musculoskeletal pain or symptoms. So, static flexibility and stretching provide a valuable benchmark to reflect injury predisposition.

Three major methods of stretching have been isolated:

1. Ballistic
2. Static
3. Proprioceptive-Neuromuscular Facilitation

Though conjecture reigns as to the most effective from for improving range of motion, there *is* no doubt that a combination of both, initial static, and latter ballistic, as a component of warm up is essential. Also ballistic stretching may well be an integral component of the technique rehearsal in resistance training.

Analysis of the current research leads to a number of conclusions regarding warm up and stretching:.

1. Warm up is an essential component of all pre resistance training or competition
2. General and specific warm ups are mandatory
3. The role of passive warm up except massage is likely minimal
4. General warm up alone does not increase special flexibility but does improve physiological preparation for training
5. General warm up should be followed by specific joint/muscle stretching and specific warm up
6. Specific warm up should involve technique specific rehearsal and could involve ballistic type activities (if Indicated)
7. Intensity of warm ups must be specific for duration, intensity, ambient temperature, energy system, eccentric/concentric timing
8. A moderate perspiration is indicative of a good warm up threshold
9. Warm up should be a minimum of twenty-five minutes…..?
10. The emphasis of the relevant components varies?

The correct balance of components in warm tips should lead to an optimally * tuned' athlete who will maximise the resistance work-out for both volume and intensity. In addition, the down time due to injury will be minimal further contributing to optimal training for all athletes.

Warming Up Routine for Dynamic Sports

By Adrian Faccioni, University of Canberra

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Whilst the warm up for participation in any sporting or exercise activity is accepted as being essential for minimising injuries and improving performance, the methods by which many sports attempt to achieve this are less than ideal.

The warm up method used by many dynamic sports (both team and individual) usually includes an initial jog around the field or court, followed by 10-15 minutes of static stretching. This is then followed by a few drills, and the athletes then begin their training session or game. Whilst the basis behind this methods may appear to be the sound application of current training principles, a closer-analysis reveals major limitations with this method of preparing an athlete for a dynamic sport activity.

The main physiological reason for a warm up include; to increase core temperature (an increase in rectal temperature of a least one to two degree Celsius appears to be sufficient) (deVries 1980); to increase heart rate and blood flow to skeletal tissues, (Karvonen 1978) which improves the efficiency of oxygen uptake and transport (deVries 1980) carbon Dioxide removal (Karvonen 1978), and removal and breakdown of anaerobic byproducts (lactate) (Karvonen1978); to increase the activation of the central Nervous System (therefore increasing co-ordination, skill accuracy and reaction time) (Hill 1927 cited in Shellock and Prentice 1985, deVries 1980); to increase the rate and force of muscle contraction and contractile mechanical efficiency (through increased muscle temperature) (Bergh 1980 and deVries 1980); and to increase the suppleness of connective tissue (resulting in less incidence of musculetendonous injuries) (Lehmann et al 1970, Sapega et al 1981).

The result of the above responses lead to an athlete's increased ability to do physical work (Bergh & Ekblom 1979), which is extremely important for sports requiring short duration high intensity work bursts such as sprinting and jumping (Bergh 1980, Karvonen 1978). The improvement in the nervous system is especially helpful for athletes involved in sports that demand high levels of complete body movement, such as team sport athletes.

The major criticism against the "TYPICAL WARM UP" is that it does not adequately prepare the athletes for the demands placed upon them in the ensuring session. Generally the initial jog is at a pace that has a minimal effect upon body temperature, and usually consists of jogging forwards, and in a straight line.

The stretching performed is usually that of static stretching, with most stretches performed slowly and with the athletes sitting on the ground. This method of stretching has been shown to be beneficial for the increase in limb range of motion (Beaulieu 1981,Sapega et al 1981, Shellock & Prentice 1985, Taylor et al 1990), and aims to relax the muscles so that they are less resistant to passive stress for stretching. But this type of stretching does not prepare the muscle and connective tissue for the active contraction - relaxation process that will occur with any running, jumping or kicking movements as required in a dynamic sport training or game situation.

During this 10-20 minutes stretching period, the body is very efficient in removing excess body heat, so the small increase in body temperature from the initial jog is quickly lost if the athlete does nothing but statically stretch for this time. This is even more prevalent in cold climates or cold seasons (Autumn & Winter) which is when many team sports competitions are held. Many injuries occur at the beginning of a competition due largely to an

inadequate preparation for the activity (Lehmann et al 1970, Sapega et al 1981). A poor warm-up can be one factor to be blamed for such injuries occurring, and can easily be corrected with a modification to warm-up procedures by the athletes involved.

Inadequate warming up can lead to less than optimal speed and skill levels that could result in quick scoring by the opposing by the opposing team or individual early in the game leading then to athletes having to catch up placing more pressure on the player(s) involved.

To make changes to the way a warm-up is performed, the aim of the warm-up for a dynamic sport should be altered, such that the warm-up should be:

the *complete* physical and mental preparation for the dynamic actions to follow. The athlete should be able to begin the game or training session totally ready to perform at maximal intensity if required.

The alternative warm-up procedure that I am suggesting is a variation of the above traditional method. With more active jogging and stretching techniques, the athlete will be better prepared for the ensuring session or game, In training situations the athlete will spend less time in the warm-up phase therefore allowing more time for the main body of the session where all the learning takes place.

The initial jog is now replaced with a more dynamic series of running exercises that include regular alternation of running forwards, backwards, sideways, high knee drills, butt flicks, crossovers, bounding,, jumps and progressive sprints. This component will only take 2-4 minutes depending on the climate. It is expected that the athletes are breathing quite heavily at the end of this short series of exercises.

With the stretching component, static stretching is still included in the program, as many of the athletes still feel they need some static stretching to really prepare themselves (with time it would be ideal to phase static stretching out of the warm up routine and place it only in the warm down period). One muscle group is stretched between each run or drill, Eg. the hamstring group, and the athletes are given approximately 30 seconds to stretch both hamstrings statically (this also has the affect of decreasing talk time between athletes which can be a major time waster, especially with younger athletes). The athletes are then directed to perform either an easy run through for 20-40m or if running drills have been taught, they perform variations of skipping and running drills and butt kick drills.

Warm-up sequence

- Jog forward, backwards, sideways, etc.
- Bounds and jumps
- Static stretch of hamstring group (30 seconds)
- Run-through (forwards and backwards) or running drills (A's, B's etc)
- Static stretch of quadriceps group (30 seconds)
- Run-throughs/drills (higher intensity)
- Stretch adductors (groin) (30 seconds)
- Run-throughs/drills (higher intensity)
- Stretch calves (30 seconds)
- Run-throughs/drills (near maximal)
- Stretch (athletes' choice)
- 100% intensity sprint
- Start of training session

Once the athlete has attained a mild sweat in normal ambient conditions, and is able to perform speed runs and drills at maximum (this process is progressive), the athlete should now be considered warmed up for the ensuring training session or game.

The dynamic stretching component is very important for the specific preparation of the musculature to dynamic movements. Dynamic stretching is defined as repetitive contractions of an agonist muscle to produce quick stretches of the antagonistic muscle (Kurz 1990), so any active callisthenic movement can be classified as dynamic stretching.

This method very specifically prepares the muscle tissue for active muscle contraction and relaxation as required in a sporting situation. There is limited ability by this method to cause long term increases in range of motion due to the limited time that a muscle is held in a stretch. This short stretching time is not long enough to allow time dependant stress relaxation to occur, leading to minimal flexibility improvements (Taylor et al 1990), Therefore it is important to include some static stretching in the warm down to continue to improve; joint range of

motion (Beaulieu 1981, Sapegaetal 1981,Shel-lock and Prentice 1985, Taylor et al 1990); removal waste products such as lactic acid (Bale and James 1991 deVrivs 1980); and to increase the athlete's rate of recovery (Mickelson and Hagerman 1978, Hagerman 1981, Ka-men 1984, Bale and James 1991).

The total time for this type of warm up routine is approximately 10-15 min-utes, with the athletes fully ready to perform as required by the coach at the end of this time. If compared to the many sports that have athletes warm up for 20-25 minutes, this is a saving of approximately 5-15 minutes every session that could then be used for more work in the main body of the session. Assuming that due to an inadequate warm up the athlete takes another 10-15 minutes to warm up properly during the main body of the training session there could be a saving of up to 25-30 minutes per session. If the athlete trains 3 times per week for 40 weeks this is a total increase in quality training time of 50-60 hours per year. Since one of the biggest limitations in coaching is the lack of time to develop all the attributes in the athletes you work with, to be able to add an extra 50-60 hours per year to the training program without adding any more sessions, may make the difference between your athletes achieving or not achieving the level of excel-lence that they and you as the coach are striving for.

The key to this type of warm up is to make the dynamic portion of the warm up progressive and ensure that the limbs are taken through at least the ranges of motion that will be required in the game situation. The time for static stretching is after the game or training situation as this leads to more rapid recovery for insuing sessions.

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Minimising the Risk of Injury While Resistance Training

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Resistance Training Causing Injuries.

In a four year study Zemper (1990) examined the incidence of injuries caused through weight training in US College football teams. The study revealed that weight training possessed one of the lowest rates of injury among strenuous forms of exercise and sport. This researcher reported that there were approximately 0.13 injuries per 1000 hours of athlete exposure, or 3.5 injuries per 1000 players per season, independent of the training methods used. Thus using free weights were just as safe as using various strength training machines.

It is important to note that it is often difficult to ascertain exactly how injuries are caused. This is due to the fact that often injuries are the result of the accumulation of stressful occurrences over a relatively long period of time. For Example, it is not unusual for a manual labourer to injure themselves while at home doing the gardening or lifting up relatively light shopping bags. In such instances the injury has most likely been developed over a long period of stressful occurrences at work, and the gardening was the final straw that broke the horses back, so to speak. To give a personal example, I ruptured my anterio cruciate ligament when playing basketball. I simply jumped up and ping the ligament was ruptured. While it is difficult to attribute the cause, it probably had more to do with performing thousands of deep squats with maximal loads then the simple manoeuvre I performed on the basketball court.

The above discussion has important implications for the injuries that may occur from performing resistance training. While resistance training is a relatively safe pursuit there are some exercises that can be particular injurious if continually performed incorrectly. Typically these injuries occur when poor technique is used over a prolonged period of time. Often individuals will perform exercises with poor technique for a period and experience no problems and therefore feel that there is no problem with their technique. However, if the poor technique continues their probability of becoming injured increases greatly.

Perhaps the most serious injuries that are associated with weight training occur during the performance of maxima! loaded exercises involving the strong muscles of the legs and lower back. For example, squats, bent-over row, dead lifts, clean, high pulls etc. When weight training Hence a few factors should be taken into account. The back is much better at handling compressive forces as opposed to shear forces. For example, a normal back will generally be able to handle a compressive force approximately 12000 N prior to the occurrence of serious disk problems, whereas a limit of approximately 2000 N applies to shearing forces / when standing upright compressive forces are those in the vertical plane, while shear forces are in the horizontal direction. Thus when performing an exercise involving lower back support, such as squats or dead-lifts, it is important to keep the trunk upright so that the imposed forces are dominantly compressive, rather than shear forces.

Shear Forces can be reduced by:

- Maintaining an upright posture;
- Wearing an effective belt, which has support around the back and abdomen;
- Possessing strong abdominal muscles; and
- Taking a small breath prior to lifting

Further, when performing exercises involving lower back support, such as squats, deadlines, bent-over row etc, it is important

to adopt a hollow back posture, whereby the spine is in its normal anatomical position. This hollow back posture involves a slight hyperextension of the lower back, whereby it maintains a slight inwards curve. Thus, generally, when performing squats, dead lifts, bent-over rows etc, the lower back should be slightly curved inwards with the shoulders pulled back and the buttock pushed out (Harmann, 1994). This posture serves to take the stress off the ligaments of the lower back and places it on the muscles, reducing the likelihood of the occurrence of back injury. In the interests of minimising the potential for injury I will outline the correct technique for two of the more problematic exercises. Squats and dead lifts.

Correct Technique for Squats and Deadiifts

Squats

This exercise is performed while standing erect with a bar placed on the upper back.

- The bar should be located on the trapezius muscle and not on the cervical spine. If the individual feels that the location of the bar is • uncomfortable; a rubber mat or towel should be placed between the bar and the back. The bar should be held against the body firmly by the hands. For safety reasons the squat exercise should be performed in a power rack that has bottom safety stops so that the bar can be rested upon these stops if the lift cannot be completed. Further, heavy loads require two spotters to be available to lend assistance if required.

- The feet should be positioned slightly further apart than shoulder width, with the toes facing forwards.

- The movement commences from an upright posture and the individual lowers the body mainly by flexing the thighs about the knee joint and, to a lesser extent, the lower legs about the ankle joint, • until a knee angle of approximately 120 degrees is achieved. At this point the bar is raised by extending the thighs at the knee joint to achieve an upright posture.

- Throughout the lift the shoulders • are pulled back, the elbows rotated to a forward position, the head held up, and the trunk, though angled forward, should be relatively straight. In fact the lower back should be curved slightly inwards i.e. hollowed out.

- Generally it is best to perform squats without looking into a mirror. Optimally the head should look upwards and not directly forward into a mirror. When looking directly into a mirror it tends to lead to the individual leaning forward and tending to • fall towards the mirror, resulting in excessive forward rotation of the trunk.

- The degree of inclination of the trunk will determine the extent to which the major muscle groups are stressed during a squat. If there is a large forward lean, it causes the line of action of weight to be closer to the knees and hence reduces the *stress* placed on the quadriceps muscles. However, it increases the distance from the weight to the hip axis and as such increases the contribution of the gluteal, hamstring and back extensor musculature.
  Conversely an upright trunk will increase the contribution of the quadriceps musculature and decrease the contribution from the gluteal, hamstring and erector spier muscle groups. To decrease the potential shearing forces imposed on the spine it is strongly recommended that an upright trunk position be adopted during the squat exercise.

- During the squat movement the knees should not deviate from the vertical plane, and turn inwards or outwards, as this results in particularly high forces imposed on the knee joint increasing the likelihood of injury to this delicate joint.

- Squats are very popular among athletes, however they are often performed incorrectly. The most common problem involves leaning too far forward during the exercise, which greatly increases the stress placed on the

lower back via increasing the shearing force on the spine; Athletes must keep the trunk very rigid and basically upright throughout the lift. It is vitally important that the upper back remain rigid and athletes should be encouraged to look upwards, keep the shoulders back and rotate the elbows into a forward position.

- The technique in the squat can be readily assessed by watching the individual from the side. The weight should be located almost directly above the hips and ankles throughout the lift. If the individual has a tendency to fall forward during the lift then the exercise should be performed on a Smith machine so the bar remains in the vertical plane.

- Squats can sometimes be difficult for many athletes in lower body dominated sports, as their lower bodies are developed to a far greater extent than their upper bodies, and thus the limitation to performance is generally the ability of the upper body to stabilise the load on the back. The problem can also be reduced by use of a Smith machine or by performing the hack squat exercise instead.

- This exercise should be avoided if the individual has a history' of lower back problems.

- The squat exercise strengthens the quadriceps, hamstrings and gluteal muscle groups as well as the erector spinae muscle, When performed correctly it is undoubtably the best exercise for the quadriceps muscle group.

Deadlifts

- The lift commences with the individual crouched over the bar, with the feet spaced slightly closer than shoulder width and the bar positioned very close to the individual. The bar is gripped with one palm facing downwards and the other facing upwards and then hands spaced approximately shoulder width apart. This type of grip greatly increases the load that can be held.

- It is important that prior to the commencement of the lift, the individual is dominantly flexed about the knee and that the trunk is slightly flexed forward, but relatively straight. In fact the lower back should be slightly curved inwards, i.e. hollowed out, so that the shoulders are pulled back, the head looking up and the buttocks pushed out.

- The bar is lifted to waist height in one coordinated movement of the legs, thighs and trunk. The arms should be straight throughout the lift and not contribute to the upward movement of the bar. The arm musculature *is* simply too weak to lift the loads encountered during deadlifts, and their attempted contribution can result in tears to the biceps brachia and brachialis muscles.

- Throughout the lift the bar should be kept close to the body. In fact the bar should be in contact with the lower limbs throughout the entire movement and should be lifted upwards and backwards as the individual leans slightly back at the completion of the lift.

- Heavy deadlifts are a test of grip strength as much as thigh and trunk strength, and in order to enhance the effectiveness of the grip it is often necessary for the individual to apply chalk rosin (magnesium carbonate) to the hands.

- The bar should be lowered to the floor in a reasonably controlled manner. Again during the eccentric phase the movement occurs mainly due to the flexion of the legs and thighs. The trunk will be slightly flexed but must remain straight.

- It is recommended that the lift be performed with a belt that serves to increase the support given to the lower back and abdominal region. The use of a belt can reduce the shearing force on the vertebral column by increasing the intra-abdominal pressure

- If performed incorrectly, the dead lift exercise can cause major injury to the vertebral column, particularly when heavy loads are used- Common mistakes include insufficient use of the legs and consequently, excessive flexion of the trunk. Thus the movement almost becomes a stiff-legged dead lift. Further, sometimes the bar is lifted with the shoulders in a forward position with the head down, which results in a humped appearance in the upper back, increasing the likelihood of injury in the region.
- This exercise should be avoided if the individual has a history of lower back problems.
- This exercise strengthens the erector spinae, quadriceps, hamstring, gluteal, upper back and forearm musculature.

Blood Pressure Considerations

The performance of heavily loaded squats, leg presses, deadlifts etc will result in extreme acute increases in blood pressure. Thus individuals susceptible to blood pressure related disorders, such as stroked, cardiac events etc should avoid these exercises. Further, relatively simple isolated exercises such as knee extensions and leg curls can also involve large acute increases in blood pressure if performed in conjunction with a whole body isometric contraction of the upper body by securing one's self to the machine too tightly. In such instances the lifter should endeavour to reduce the magnitude of the isometric contraction and ensure that they do not hold their breath for extended periods of time while exercising.

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A Rehabilitation Program for People with Severe Lower Back Injuries : Part A Flexibility and Swimming Exercises

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Over thee past year I nave been
supervising rehabilitation training for a number of individuals who have severely injured themselves at work and require extensive rehabilitation. I have found this work to be quite challenging in that each case is very individual and thus one needs to formulate very specific programs for each individual scenario.

Nevertheless the people I have been working with have responded quite well and it has been a very rewarding experience. Further, unlike many other areas of the fitness industry, it is quite well funded by the insurance companies. I feel it is an area that strength and conditioning specialists are very well suited to contribute within, and wish to share my initial experience in this area. Therefore, this two-part article details the programs I have developed in training three clients who presented with severe lower back injuries. Part A details the flexibility and swimming exercises prescribed. While part B details the specific strength training exercises employed in the program.

Case Histories

The three clients I have trained with lower back injuries were all male annual workers, between 29 and 36 years of age, and each presented with carious case histories. One had experienced a lifting injury at work while attempting to move a large object in a twisting motion involving the lower back. This injury required corrective spinal surgery (Laminectomy L4/L5) and he presented to me upon recommendation from his neurosurgeon five months after surgery for rehabilitative strength training. This was in face the second time he had undergone spinal surgery, having had a similar operation six years prior, after injuring his lower back from slipping over. After the first injury he had not performed and rehabilitative strength training. The other two clients had very large objects that weighed in excess of 100kg fall on them that resulted in a variety of injuries, the most problematic being to the lower back region. One of these clients lad also sustained head injuries From the accident that affected his balance and coordinated an his progress was much slower than the other two clients. He presented for strength training approximately 4 /ears after his accident. The other client did not sustain any injury to the head from his accident and presented for rehabilitative strength training 18 months after the accident. Neither of these two clients had surgery, though medical specialists had recommended strength training for their conditions

Medical Clearance

It is very important to note that prior to any training all clients have been referred to me specifically for
rehabilitative strength training from appropriately qualified medical people. There are undoubtedly a large
number of people with severe back injuries whose conditions would not benefit from the performance of the exercises I am going to outline, and whose conditions may in fact deteriorate as a results of the performance of the exercises. In face a study conducted by Kendall and Jenkins (citied in Hooker and Prentice, 1999) reported that one-third of the patients from whom hyperextension exercises had been prescribed worsened as a results. An outcome that is entirely acceptable. Hooker and prentice (1999) recommend that hyperextension exercise should be used cautiously with clients who have facet joint degeneration or impingement of the vertebral foramen borders on neural structures. Also, the conditions of spondylolysis (a split in the vertebral arch) and spondylolisthesis (slippage of one vertebra on another) should be approached cautiously with an end-

range movement exercise using either flexion or hyperextension. These authors further suggested that flexion exercises should be avoided in most cases of acute disk prolapse and when a laterally shifted posture is present. While such information is very useful for the rehabilitative strength training practitioner to know, I would strongly advise that the practitioner does not simply go it alone with the program development, and always attempts to seek input from the referring medical specialists who have dealt with the specific client, as each individual case may be quite different. Thus it is very important to obtain referrals and clearance for specific strength rehabilitation training from suitably qualified medical specialists who have referred the client for strength training, and to inform the specialists of the proposed exercises prior to the performance of any training. It is really very easy to simple send the referring medical specialist a copy of the proposed training program and ask for any comments. I feel that this is very important point, and it is worth remembering that often these clients spend as much time with their lawyers as they do with their doctors. Thus one must cover all possible bases and implement a training program that is as defensible and well supported as humanly possible, and also have good insurance coverage.

Each of the three routines that I developed for these clients have some important differences that reflect factors such as the nature of the injury, the motivation of the client, the amount of time available for training, their current work demands, their state of conditioning, level of co-ordination etc. However, there are quite a lot of similarities in the basic structure of the programs, and hence I will present a generalized overview of my work in the area drawing on my specific experience with these individuals and detail the training performed over the initial six month rehabilitation training period. Nevertheless, I must stress quite strongly that the suggestions outlined with likely need to be modified depending on the specifics of the individual concerned.

The programs I have developed are designed to improve the mobility and strength of the lower back and abdominal regions, and to strengthen and condition the entire body. The programs generally involve basic mobility and strengthening exercises that can be performed at home, swimming, and specific strength training exercises that are performed in the gym. In a recent Position Stand on Resistance Training, issued by the American College of Sports Medicine, it is stated that the use of a comprehensive exercise program incorporating aerobic endurance activities, resistance training and flexibility exercises has been shown to reduce the risk of several chronic diseases, including low back pain. Some of the basic mobility exercises I employed were adapted from a list of exercises for low back care that was outlined in a book by Vivian Hey ward (1998). Other exercises included were adapted from exercises listed in a book on rehabilitation techniques by William Prentice (1999).

LOWER BACK CARE EXERCISES

Mobility Exercises

1. Pelvic Tilt: Client lies with their back on the floor with knees bent at about a 70-degree angle, feet flat on the floor, and arms at the side. The instruction is to try and flatten the arch in the lower back against the floor by contracting the abdominal and lower back muscles and rotating the pelvis. Hold the flattened position for a couple of seconds, focus on developing a strong degree of co-contraction by the abdominal and lower back muscles, and then relax for a few seconds and repeat. This is fairly simply, small movement but some individuals may initially find it difficult and to help them it is often useful to place your hand under the arch of their lower back and ask them to push against your hand. While most people have little difficulty in flattening the only be able to achieve a very small movement and not make it to the floor. This is fine and one must always operate within the pain threshold of the individual. You will probably find that within a couple of weeks their back has loosed up to be able to complete the entire range of motion without undue distress.

2. **Double Knee to Chest:** Client lies with their back on the floor with knees bent in the same position as above. Raise both knees and clasp with

hands over the knees. Pull the knees towards the chest, hold the position of maximum flexion for a few seconds and the release the position and relax for several second and repeat. Generally I find that during the relaxation phase the client still holds the knees in the relaxed position with the feet off the ground. However, the client may lower the feet to the floor if desired. Once the client is accustomed to performing exercises 1 and 2 they can be very effective in reducing pain in the lower back region and clients may wish to perform them several times a day to reduce their tension in this region.

3. **Foot Flexion/Extension:** Client lies with their back to the floor with knees bent, feet flat on the floor. Extend one leg and place it on top of the knee of the other leg. Extend and flex the foot, holding each maximal position for a leg couple of seconds. Swap the leg position over the repeat using the other leg.

4. **Trunk Flexion:** The exercise commences in the standard car posture i.e. on hands and knees with hands positioned under shoulders and with knees positioned under the hops and lower legs resting on the floor. The chin is tucked in and the upper back arched as the client slowly moves their bottom towards their heels, letting the shoulders drop towards the floor. Hold maximum flexed position for several seconds and repeat.

5. **Car and Camel Stretch:** The exercise commences in the standard cat posture i.e. on hands and knees with hands positioned under shoulder and with knees positioned under the hops and lower legs resting on the floor. Arch the back moving the head downwards towards the floor flexing the spine to its maximum position of flexion, hold for a few seconds. Then reverse the movement, scooping the back in, pushing the bottom out and raising the head looking in an upward direction. Hold this position for a few seconds and then repeat. This is quite a difficult exercise that serves to develop the mobility of the spine. Initially only very small movements of the spine may be possible, and this can be gradually increased over time. In clients whose condition is very deteriorated this exercise may initially be too advance and quite painful for them to perform. In this case the exercise needs to be included later in the rehabilitation process, perhaps after 3 or 4 weeks of training, depending on the progress of the individual.

• Basic Strengthening Exercises

6. **Stomach Crunch:** Client lies
on the back with knees bent,
feet flat on the floor, and arms
crossed over the chest. Keeping the middle and lower back firmly on the floor, raise the head and shoulders off the floor by contracting the stomach muscles and hold for a few seconds, return the floor, relax then repeat. While the above five exercises are dealing primarily with improving the flexibility of the back, this exercise and the following one are basic strengthening movements for the abdominal and lower back musculature, respectively.

7. **Single Leg Extension:** Client lies on the stomach with legs completely extended, heels together and arms folded under chin. Slowly lift one leg about 5 to 10 cm off the ground without bending it, hold for a couple of seconds, lower the leg down to the floor and repeat with the other leg. This exercise requires activation of the musculature of the lower back and thus should be performed with care and gradually progressed. Some clients may initially find it quite painful to perform and thus for these individuals the exercise should be introduced further down the rehabilitation track. Once the client is comfortably able to perform this exercise it should be modified to include the lifting of the opposite arm. The exercise is then commenced with the arms out stretched and one arms and the opposite (i.e. contralateral) leg are lifted at the same time and then repeated on the other side. The inclusion of the arm movement involves the action of the opper back and shoulder musculature and is often able to be introduced approximately 4 weeks into the rehabilitation program, depending on the progress of the specific client.

Progression of Low Back Care Exercises

As a general recommendation these mobility and basic strengthening exercises are initially performed three times per week (e.g. Monday, Wednesday,

Friday) for 1 set of approximately 6 repetitions depending on the condition of the client. By the second week of the program 1 set of 8-10 repetitions may be able to be performed. By the third week 2 sets of 10 repetitions should be able to be performed and the client should be moving through a greater range of motion. However, under all conditions the movements should not involve severe amounts of pain and progress dependent upon the specific feedback given from the client, and there may be some exercises that a client either cannot perform at all, or may only be able to perform for a few repetitions through a limited range of motion and that is fine. The client may experience some tension in the back and a degree of discomfort is quite likely to be experience during the performance of some of the exercises. Further, as the client adjusts to the exercise routine the back may become a little unsettled for a time and be moderately sore between training sessions. These are normal and natural responses to the training process and the client should be prepared to experience them. However, the client should not be trying to break through the pain barrier and push it too far. Further, any exercise that causes the back pain to radiate or spread over a larger area should not be included in the program (Hooker and Prentice, 1999). I always stress to my clients that time is on their side and far better off to gradually progress over time rather than aggravate the situation further by pushing it too hard. Even with this somewhat conservative approach I have found their progress to be quite repaid over a period of several months. However, if it took twice as long to achieve these gains it really is not a big problem. The clients are not preparing for an athletic competition but attempting to return back to normal life, and generally after what they have been through a few extra months of training is relatively insignificant, fn general I feel that from a severe back injury a 12-month period of active rehabilitation is a reasonable period to expect to return to more normal functional abilities.

By the fourth week of rehabilitative training the client should be able to perform these low back care exercises 5 or 6 times per week and continues performing these exercises on an almost daily basis thereafter. By this stage, i.e. week 4 the client should be able to perform the single leg extension exercise with the alternate arm action. The exercises can be performed anytime during the day. However, I typically recommend that they be performed in the afternoon or evening as the body is well warm up from the days* activity and greater mobility may be achieved.

During each of the exercises the client should breath in a normal and natural manner. For the mobility exercises I recommend that the client inhale during the stretching phase and exhale during the relaxation phase of the exercises. This serves to reduce the likelihood of them over-exerting themselves during the stretching phase, and also aids the relaxation phase after the completion of the stretch. Over the course of the rehabilitation program several other stretching exercises should be progressively include into the daily mobility and general strengthening program.

Additional Mobility Exercises

8. Sit and Reach: The client sits on the floor with the legs outstretched, heels together. Using a slow movement the trunk is flexed forward and the hands moved towards the feet without bending at the knees. Hold the maximum flexed position for several seconds, come back up to the upright position, relax then repeat. Often clients will initially only achieve a small range of motion with their hands progressing to about the shin region. However,

within a month or two quite dramatic improvements may occur and the client may be inching towards their toes. Reaching the toes is really quite an achievement for many of these individuals.

9. **Cat Twist:** The exercise commences in the standard cat posture i.e. on hands and knees with hands positioned under shoulders and with knees positioned under the hops and lower legs resting on the floor. The exercise involves only small lateral movements of the spine so that the right shoulder and right hip are rotated towards each other. The position of maximal lateral flexion is held for a few seconds and then

repeated on the opposite side of the body.

10. **Tiger Stretch**: The exercise commences in the standard cat posture i.e. on hands and knees with hands positioned under shoulder and with knees positioned under the hops and lower legs resting on the floor. One knee is lifted from the floor and by flexing the trunk the knee is moved towards the chin. The whole trunk is flexed so that as the knee is being brought forward towards the chin the head is also being flexed down towards the knee. Once position of maximum extended position whereby the back is scooped in, the head is directed upwards and the leg lifted up above the level of hips if possible. The maximum extended position is then held for a few seconds and repeated. Once the appropriate number of repetitions has been performed the other leg used.

11. Spinal Twist: the exercise commences with the client sitting on the floor with the legs extended. Place the right leg over the left leg so that the right ankle is sitting on the top of, and slightly to the left of, the left ankle. Place the left hand to the outside of the right knees, and then right hand directly behind the body. Slowly rotate the torso to the right. Hold the maximum rotated position for a few seconds and then swap the leg position over and repeat on the other side.

12**. Cobra Stretch**: This exercise commences with the client lying face down on the floor, legs together, with the hands positioned just in front of the shoulders. Using the arm muscles the client lifts their upper body off the floor while keeping the hips and lower body on the ground. The upward movement of the upper body should be conducted quite slowly and deliberately. As the upper body is lifted the spine is extended. Have the client start by lifting off the ground 5 to 10 cm, hold for a couple of seconds and return to the ground. Over time,- as the clients mobility improves, have them increase the distance the upper body is lifted off the ground. Optimally the client may continue to improve until they can fully extend their arms without lifting their hips from the ground. However, the achievement of full extension may not always occur, and the client should be instructed to move through the range of motion that is possible for them. This is quite an advanced stretch and should be introduced after the client has made some initial progress in the rehabilitation program.

These additional mobility exercises should be progressively introduced into the daily low back care routine between weeks 6 and 14, depending upon the specific progress of the client. For example, the Sit and Reach exercise may be introduced in week 7, the Car Twist in week 8, the Tiger Stretch in week 9 or 10, the Spinal Twist in week 11 or 12, and the Cobra Stretch in about week 13 to 14. As each exercise is progressively introduced begin with 1 set of about 6 repetitions and gradually increase to perform 2 sets of approximately 10 repetitions. As the client progresses the range of motion should gradually improve and in the course of several months the improvement is often quite dramatic.

Prevention of Back Injury

While I have used these low back care exercises to facilitate the rehabilitation of severely injured individuals, they could be used for less serious cases and also may be very effective if used on individuals wish to prevent the possible occurrence of lower back injury. They may in face be very effective in this regard if used on older individuals and those involved in manual occupations that tend to results in a high likelihood of lower back injuries, such a labourers, roofers, carpenters, mean workers etc. The exercises require no specialized equipment, can be performed in one's own home and require approximately 25 minutes of time in a circuit type manner. Given that it is estimated that 80% of all individuals will experience back pain in some form during their life, and that this pain can be quite severe in many instances, the regular performance of preventative exercises should be viewed as a very worthwhile investment of time and energy in one's overall health maintenance plan.

SWIMMING

In addition to the low back care exercises, I generally advise my clients to swim three days per week (e.g. Tuesday, Thursday & Saturday). As with all forms of training this starts very

slowly and is progressively built up. Optimally the swimming should be performed in a 15 to 25m heated pool that is a depth of about 1 meter throughout the whole length so that one can comfortable stand at any time if desired. For the first week of rehabilitation the client can simply walk several length of the pool and familiarize themselves with the water and the pool. Thereafter, assuming the client knows how to swim, the client should perform the freestyle stroke using their upper body entirely and not involve the legs in the stroke. This is achieved by place of flotation device between their legs to eliminate the motion of the legs whilst swimming. The client may start with only a couple of laps, resting between each lap. After this kicking action is exclusively done by holding onto a floatation device with the hands and kicking for the entire length. Again a couple of laps can be performed, resting between each leap. Each week the total distance swam should be increased by several laps depending upon the specific progress of the individual. The leg and arm actions are done separately initially because the twisting movement of the legs in combination with the rotation of the upper body may be problematic for the back. After about 1 month the leg and arm actions can generally be combined, however, the use of the legs should be quite moderate initially and the swimming motion dominantly sustained by the upper body action. Several months down the rehabilitation track, the client may have progressively built up their swimming to be able to swim for 30 minutes completing about 20 laps and at this stage the leg action may be employed in a more intense manner. This level of swimming should thereafter be maintained throughout the entire rehabilitation program.

In the next article the specific strength training exercises used in this rehabilitation program will be outline.

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A Rehabilitation Program for People with Severe Lower Back Injuries : Part B Strength Training Exercises

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In the first part of this article I detailed the flexibility and swimming components to this rehabilitation program. In this article I will outline the strength training component to the program. I would strongly encourage the reader to review the first part of this article prior to reading the strength training section, as the program is *very* holistic in nature and therefore the strength training portion should not be applied in isolation without regard to the flexibility and swimming components of the program. Further, the initial article outlined Important considerations in regards to medical clearance and individual specific factors that must be thoroughly taken into account in the development of rehabilitation programs.

STREGTH TRAINING

In addition to the low back care exercises and swimming, which were outlined in the previous article, the clients also engage in strength training exercises three times per week (e.g. Monday, Wednesday & Friday). Initially these exercises are performed exclusively using variable resistance hydra-gym typed equipment. This equipment involves concentric only muscular actions and is performed using a variety of machines that provide resistance through the use of fluid or air cylinders. It is a very gently and safe form of exercise that is well suited to rehabilitation. Its advantages include variable resistance settings, concentric muscular actions only, a client may stop a movement at any stage during the action, requires no lifting of weights, low impact exercise, easy to learn and perform the exercises and hard to injury yourself while performing the movements.

The specific exercises I employ are dependent upon the equipment I have available. The hydra-gym circuit I currently use possesses 9 stations that generally train the muscular of the entire body. The exercises include:

General Strength Training Exercises

1. Supine Bench Press/Bench Pull: Client lies down on the bench and performs a concentric bench press using their pectoralis major, deltoid and triceps brachii muscles, and then pulls the bar down against the resistance completing a concentric bench pull action using their latissimus dorsi and biceps brachii muscles. The most problematic aspect of this exercise is getting into and out of lying position. The clients will often initially need assistance to lie down on the bench and generally require and additional bench to place their feet on so that they do not have to arch their lower back to place their feet on the ground. They may also initially need assistance to get up from the bench at the completion of the exercise. A horizontal bench press/bench **pull** machine in which the clients could sit in an upright posture would be preferable if available.

2. **Standing Squat:** Performed in a standing position against the pads of the machine. Have the client descend to a half squat position keeping their trunk very upright, stomach and lower back muscles co-contracted, and then using their quadriceps and gluteal muscles they push themselves back up to the standing position. All my clients have been able to initially perform squats on the easiest hydra-gym resistance setting (No. 1), which is quite pleasing. There is not way that they could perform this exercise using a normal free weight bar given the nature of their injuries.

3. Seated Should Press/Pull down: In a seated position the client pushes the bar up above their hands and then pulls it down, using their deltoid and latissimus dorsi muscles, respectively.

4. Step Ups: On this machine I employ a short-range movement of approximately 10cm and try to encourage a very fluid movement between the alternate steps. Often, initially the clients will be a little jerky and slow and this machine can help them develop co-ordination. I use one of the higher resistance settings (no 8-11), depending on the body weight of the client, so that they do not bottom out on the machine as this can cause a jarring effect that may be problematic for the spine.

5. Seated Pec Dec/Reverse Pec Dec: Sitting in the machine the client horizontally flexes and then extends the arms about the shoulder joints, working the pectoralis major and upper back musculature, respectively.

6. Seated Leg Extension/Leg Curl: This is performed using an alternate leg action working both the quadriceps and hamstring muscle groups. Initially the client may like to only extend about half way through the movement and gradually build up to full extension progressively throughout the rehabilitation program. Often full extension may initially pull on the lower back and cause problems for the client.

7. Seated Arm Curl/Arm Extension: Sitting in the machine with the upper arms supported on a bench, the client flexes and then extends the forearms about the elbow joints working the biceps brachii and triceps brachii muscles, respectively.

8. **Seated Leg Adduction/Abduction:** Sitting in the machine the clients adducts and then abducts their thighs about the hip joints. I recommend only a short-range motion on this machine initially and gradually increase the range of motion throughout the rehabilitation process.

9. Standing Upright Row/Pushdown: In a standing position the client lifts the bar with their hands thumbs distance apart, using an overhand grip, making sure to keep their elbows high throughout the lift. The lift is achieved dominantly through use of the deltoid and trapezius muscles. Once the bar reaches the level of the chin it is pushed down by the client.

These exercises are designed to generally improve the strength and condition of the entire body and are not designed specifically to improve the strength of the back or abdominal musculature. In this regard other exercises could easily be used depending upon available equipment. However, I would strongly advise that one consider the logistics of any exercise chosen. For example, an inclined dumbbell press exercise may appear an acceptable exercise for this type of client, and the actual exercise may cause little problem for them. However, picking the dumbbells off the weights race, getting over to the bench and then lifting and lowering the weights back to the floor from the exercise position may initially cause some problems with these clients and hence such exercises should be initially avoided until later in the rehabilitation process. Another example would be the inclusion of an exercise such as triceps pushdown. At first glance this may seem like a good exercise to include in the general strengthening program, and one that does not directly impact upon the lower back injury. However, this exercise does require the person to strongly contract the abdominal musculature to stabilize the body while the exercise is being performed. This can cause problems for the lower back region in the initial rehabilitation period and thus should be initially avoided.

The client should be encouraged to breath in a normal and nature manner during the performance of all the exercises. For the strength training exercises I advise clients to exhale at the hardest phase of the exercise, which is generally the upward (concentric) phase of the lift, and inhale during the easiest part, generally the lowering (eccentric) phase of the exercise.

Progression of General Strength Exercises

As a general recommendation for the first two weeks of training 1 sets of 10 repetitions per exercise of the 9 station hydra-gym circuit should be performed using a resistance set at approximately levels 4 to 5, except for the Step Ups exercise which should

always be on a high setting to prevent jarring. Depending upon the specific response of the client the program should be increased to 2 sets of 10 repetitions at week 3, performed in a circuit type fashion and then resistance is individual for each client. Once 15 repetitions can be comfortably performed for an exercise then the setting should be increased to the next level. As a general goal the resistance settings should be increased by 1 value every two weeks. This implies that by the end of the twelfth week of training the client should be on maximum setting (No. 11) for most of the hydra-gym equipment. At this stage the client is ready for the inclusion of more traditional machine and free weight raining strengthening exercises and the hydra-gym equipment can be progressively phased out of the program.

The specific exercises that the client will progress to once the hydra-gym equipment has exhausted its' capacity to provide sufficient overload, is dependent upon the equipment available and the individual characteristics of the client. I have tended to initially use machine weighted exercises such as much bench press, lat pulldown, leg extension, leg curl, machine hack squat, machine weight-assisted chine ups and dips etc. Over the course of the next couple of months of rehabilitation I progressively substitute these exercises for their free weight equivalents where applicable, and introduce other more dynamic functional exercises such as lunges while holding dumbbells, unassisted chin up and dips, push ups, seated press behind next, seated row, triceps pushdown etc.

During this period I also generally introduce the client to boxing, performing jabs, crosses, hooks and upper cuts against a heavy bag. As with all other exercises it is slowly and progressively introduced into the program. The boxing serves to develop functional rotation ability of the trunk musculature in a multi-planar movement and is usually a bit of fun for the client.

Co-contraction of the abdominal and lower back muscles

When performing the strength training exercises it is important that the client is able to stabilize their trunk region by co-contracting their abdominal and lower back muscles. This increases the stability and strength of this region reducing the likelihood of injury to the client while performing the exercises, and further adds to strengthen this vital region. In many cases the client has already been taught how to co-contract these muscle through initial rehabilitation session with physiotherapists and/or occupational therapists that often occur prior to the commencement of the strength training phase of their rehabilitation. Nevertheless it is important for the strength trainer to be aware of this requirement, and thus to quote directly from a physiotherapy textbook on this matter, Richardson and colleagues (1999) stated: "The concept of the exercise strategy was based historically on gaining a co-contraction of the key local muscles, the transverse abdominis and the lumbar multifidus. The aim was to effect local spinal segmental support either by the action of these muscles in increasing tension in the thoracolumbar fascia and increasing the intra abdominal pressure (IAP), or through their direct attachment to the lumbar vertebrae. The exercise is an isometric contraction of the transverse abdominis elicited by drawing in the abdominal wall combined with an isometric contraction of the segmental levels of the lumbar multifidus.

Biomechanically it would be beneficial for these muscles to co-contract, and there is clinical and preliminary evidence that this occurs. This muscle co-contraction can be likened to activating a deep muscle corset to support the spinal segments and lumbopelvic region, (p 94).

As the client is performing exercises such as hydra-gym squats, triceps pushdown, lunges, hack squats, etc it is useful to remind them of the need to co-contract their abdominal and lower back muscles to stabilize their trunk region. The trained can periodically check the co-contraction by gently feeling the tension in these muscles while they are performing these exercises. If the client has difficulty achieving this feat then additional co-contraction practice should be included using the first mobility exercise, the pelvic

tilt, outlined in the previous article, to further develop this ability.

Specific Strength Training Exercise

As the rehabilitation process develops it becomes possible t more directly and intensely train the functional core stability musculature of the trunk that are so vital to the integrity and function of the lower back area. Four specific exercises are progressively introduced into the program to further this goal and they become the most important exercises performed by the client and thus should be performed at the start of the strength training session.

10. Double Abdominal Crunch:

This exercise is similar to the Stomach Crunch exercise that is preformed as part of the daily low back care exercises. However, it involves a small movement of the thighs in addition to the movement of the head and shoulders. Lying on the back with the knees bent and feet lifted off the floor so that the knees are directly above the hips, lift the head and shoulders off the ground towards the knees while simultaneously moving the knees towards the chin. Hold for several seconds and then gradually lower the body back to the floor and repeat. Provided that the floor and repeat Provided that the client is making good progress with the other exercises this can generally be added into the program at about week 4. Initially start off with 1 set of 6 repetitions and gradually increase to perform 3 sets of 20 repetitions.

11. Upright Knee Raises:

Using the knee raise machine have the subject position themselves in the machine and attempt to lift their knees up. This exercise is a little daunting initially for many clients and simply holding themselves in the upright position for a few seconds can be quite a challenge. Very small upward movements of the knee of only several centimetres may be achieved initially and only a few repetitions preformed. However, overtime the client will progressively feel more comfortable in the machine and greater ranges of motion and more repetitions gradually achieved. I generally include this exercise in about week 5 or 6, which often appears a little early for the client. However, in the first couple of weeks I am just familiarizing them with the initial position and over their knees through a reasonable range of motion. By week 10 often a full knee raise can be performed for several repetitions and this is a major achievement for the client and reflects a substantial strengthening of the abdominal musculature. Once the knee raise has been comfortably performed for 3 sets of 10 repetitions through the full range of motion (i.e. knees to the same vertical level as the hips) then the exercise should be performed with straight legs to further increase the loading. Once 3 sets 3 sets of 10 repetitions can be performed with straight legs the client is ready to progress to hanging knee raises performed while holding onto a chin up bar. Once this is mastered for 3 sets of 10 repetitions the handing raises should be performed with straight legs. By this stage the client has developed excellent
abdominal strength that should serve them well in performance of normal functional movements.

12. Reverse Back Extensions:

The client lies on a horizontal back extension machine face down with the opposite manner to that while is normally used to perform Back Extensions (hence the name reverse back extensions). One leg is lifted in a fully extended position from the ground as high as possible, lowered, and then the other leg is lifted. Typically only small movement are initially achieved and the leg may only be lifted 5 to 10 cm off the ground approaching about a half way rang of motion from full extension, where full extension is defined as lifting the heel to the same vertical level as the hips. Depending on specific individual progress I would typically introduce this exercise initially at about week 6. When the individual can fluidly lift each leg individually through the full range of motion for 10 repetitions I then get them to lift both legs at the same time to increase the loading. This typically happens about week 10, through large individual differences in the timing of this development do occur. Once the double leg reverse back extension exercise has

been performed through the full range of motion for 10 repetitions without undue hardship, it is time to perform the normal back extension exercise. This typically happens about week 12-16, though there are large individual differences by this stage of the rehabilitation process. The performance of the back extension is a major milestone in the rehabilitation process, a point that most clients could not have even imagined at the right way round, initially have them support their body weight with their hands on the ground until a full range of motion (i.e. head level with hips) is achieved without the use of the hands. Once the client can perform 3 sets of 10 repetitions of the back extension exercise have them pause for 2 s at the top position of the exercise to increase the muscular action required by the lower back and leg musculature. At this point it truly is a time for celebration and a substantial strengthening of the lower back musculature has been achieved. I currently have a client who has just achieved this milestone after 6 months of consistent rehabilitation training. He has experienced two previous major back injuries, both of which have required corrective surgery, and is very determined to ensure that he develops his back musculature to such an extent so as to prevent any further problems in this area.

13. Prone Functional Core Endurance Hold:

The client lies face down on the floor with their body completely extended, legs together and their hands placed near their head. From this position the clients lift their body from the floor and supports the weight of their body with their elbows, forearms and knees. The elbows are placed directly under the shoulders with the forearms facing forwards towards the head. The only contact points with the floor are the knees, lower leg, elbows, forearms and hands. The client looks straight ahead and holds the position with the body in the straight horizontal line for 10 to 60 s. The exercise requires strength and endurance from the functional core stability muscles of the abdominal and lower back. It is important that the body is maintained in a straight horizontal line. As clients tire there is a tendency for them to allow the lower back to droop down placing it in a position of hyperextension, which is quite stressful for the spine. Thus clients must keep the body in a straight horizontal line and stop the exercise when they can no longer maintain this position. Depending on the specific progress of the client this exercise can generally be introduce into the program between weeks 8 to 10. Initially have the client perform 1 set of holding the position for about 10 s. Gradually build up over the course of the next month or two to holding the position for 3 sets of 60 s. When this can be achieved without undue hardship then have the client progress to performing the exercise off their toes, rather than their knees. At this stage go back to performing the hold for only 10 s and gradually build up until 3 sets of 60 s can be performed. Ensure that the body is held in a straight horizontal line and does not sag as the client tires. This exercise is quite difficult for tall individuals with long legs as their structure increases the mechanical difficulty of this exercise and thus it may need to be introduced later into the program for these people. Conversely, individual who possess a short stocky stature may find this exercise relatively easy to perform and hence it may be able to be introduced earlier in the rehabilitation process. This exercise is well suited to development of a very strong ability to co-contract the abdominal and lower back muscular, providing for a stable strong trunk region from which pursue normal daily activities.

The Use of Swiss Balls

During the initial six month rehabilitation period I do not use Swiss Balls in my strength training rehabilitation programs. I find that the balls are simply too unstable and dangerous to be used, and the risk of the client falling off them and further injuring themselves too great to justify their use in the initial phase of rehabilitation. Further, if I have a client in the initial phase of rehabilitation perform the back extension or abdominal crunch exercise on a Swiss Ball, rather than a machine or off the floor, I find that the client can not perform to the same degree of intensity in the exercise thus compromising their development of size, strength and endurance. The additional requirement for stability and the unstable nature of the

Swiss Ball exercises tend to reduce the number of repetitions performed. To some extent this is probably due to a greater degree of inhibition within the client's neural system when performing the exercises in an unstable environment. Personally I prefer to initially develop their basic size and strength in a very safe and stable environment, and then proceed to apply these capabilities in an unstable environment further down the rehabilitation track. Thus once a client is capable of performing 3 sets of 10 repetitions in the back extension exercise using a machine, then the back extension exercise can be performed using a Swiss Ball to further develop the stability of the system. Similarly once the client can perform the prone functional core endurance hold for 3 sets of 60 s off the floor, then this exercise could be performed off a Swiss Ball to further development the client's functional stability in an unstable environment. Of course by this time of the rehabilitation process, a client has developed their trunk musculature to such an extent that they are far more robust, and less likely to be injured if they happen to fall of the ball.

RELAXATION/RECOVERY

It is quite common for clients to come into the gym, perform a training session and feel quite good only to go home cool down and feel very stiff and in some pain. This occurrence greatly hampers the rehabilitation process. Thus it is vital that methods and strategies are employed to aid the recovery process. In the facility that I currently work in we have heated therapeutic jet spa, a sauna and steam room and for each client I strongly encourage them to spend a good 20-minutes plus between these facilities to aid their recovery after a workout Some clients initially feel that this is simply a training reward, however, it is often a very good way of enhancing the recovery process and reducing the incidence of post-exercise cramping and soreness. Some clients further augment the recovery process by regularly receiving therapeutic massages and this seems to assist their development. The use of these recovery strategies are particularly important during the first two months of the program when the body often has difficulty in initially adjusting to the exercise routine due to the face that it has generally been in a extended state of rest.

PROGRESSIVE RETURN TO NORMAL DAILY ACTIVITIES

Between 3 to 6 months of rehabilitative training, I generally encourage my clients to gradually take on normal daily activities such as light house duties and, if applicable, commence a gradual return to work program. The return to work program is typically facilitated by an Occupational Therapist, and may commence with a few hours of light duties per day and progressively build up over, eventually going back to a full workload. Further, the clients are often ready to commence performing a brisk walk or a slow jog on a low impact surface such as grass, wearing good shock absorbent footwear. They may commence such an activity by first going for slow walks, progressing up to a brisk pace over time, and then gradually progressing to perform a slow jobbing action for brief periods. All of these developments are very dependent upon the progress of the specific client and should be gradually and progressively introduced into the rehabilitation program on a case by case basis in consultation with the client and any other relevant specialists contributing to the rehabilitation of the individual.

THE OVERALL PROGRAM

Monday/Wednesday/Friday
Warm up - Stationary Bike 5 to 10 minutes
Low Back Care Exercises-1 set, 10 minutes (outlined in previous article)
Strength Training Exercises - 30 to 60 minutes
Low Back Care Exercises - 1 set, 10 minutes (included at about week 3)
Spa/Sauna/Steam room
Tuesday/Thursday/Saturday Low Back Care Exercises - 1 set (included at abut week 4)10 minutes
Swimming - progressing up to 30 minutes (outlined in previous article) Low Back Care Exercises - 1 set (included at about week 4) 10 minutes

As with all training programs it is good to have a couple of days off from time to time to facilitate the recovery progress if required, and after the first 12 week training period perhaps up to full weeks

rest is advisable, depending upon how the specific client is progressing.

This program is based on the face that the human body is an adaptive organism and will attempt to adapt to the imposed stress placed upon it. Thus the real art for the trained is to apply a stress to the system, in the form of stretching or strengthening exercises that will encourage the body to adapt, improve mobility and strength, without being too great and further aggravate or inflame the injury. At times it may seem like a fairly narrow tightrope to walk. However, if one takes little steps, progressively incrementing bit by bit, week by week, it is quite incredible what can be achieved. I have seen clients go from being in considerable pain just sitting still in a chair, to progress through to being able to perform hanging leg raises, back extensions and a range of normal daily activities without pain within a year of the commencement of training. It really is quite literally amazing how well the body will respond to series of appropriately presented stimuli place before it.

CONCLUSIONS

I have written this two-part article to share my initial experience in the field of rehabilitation. I do not imagine that this program will be appropriate for everyone with a severe back injury. However, hopefully some of the information may be of use in some aspect of program development I believe that the field of rehabilitative strength training is very exciting one to be in and that benefits of such training will grow dramatically in the years to come producing a good source of worthwhile employment to people in the field and facilitating the return to normal life for those individuals who have suffered a major injury.

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Heat Illness – Prevention and Management

By Chris McLellan, B.Ex.Sc., M.Phty., CSCS is the performance coordinator of the Kobe Steel RFC in Japan

INTRODUCTION

Competitive sport at any level in Australia will invariably require athletes to perform at optimal levels in arguably the most demanding environmental conditions from a physiological standpoint, that of exercise in the heat. Accordingly, to prevent exertional heat illness it is imperative that athletes, parents, coaches, training and medical staff be educated with respect to factors associated with the prevention and management of the common forms of heat related illness.

As homeotherms, humans must maintain a body temperature within a relatively narrow range in order to function and to this effect all forms of heat illness can be attributed directly or indirectly to the body's attempt to maintain its normal temperature of 37.0°C (+/- 0.5°C) (1-4).Body temperature is physiologically regulated via an integration of afferent non-thermal and thermal input to the anterior and pre-optic areas of the hypothalamus and corresponding efferent signals to alter heat loss or gain via circulatory and or thermoregulatory responses (1,4,5). Despite the relatively complex nature of body temperature regulation it is essentially a fundamental process of balancing heat production and heat loss (1).

MECHANISMS OF HEAT GAIN AND LOSS

Heat is produced by endogenous and exogenous sources with a requirement for heat gain to be equaled or closely matched by heat dissipation to enable an athlete to perform at a consistent level throughout their particular event or sport (5,6). Exogenous factors that contribute to heat gain include ambient temperature, wind speed, solar radiation, ground thermal radiation, clothing and humidity, whilst the predominant endogenous factor is metabolic heat from contracting muscle (2,5,7,8). During exercise metabolic substrates are broken down to provide energy for cellular metabolism however as little as 20% of this energy is used to accomplish work resulting in the remaining 80% of energy that becomes heat that must be dissipated to prevent excessive elevations in core temperature (1,6). The body attempts to balance internal temperature via four heat dissipation pathways in the form of radiation, convection, conduction and evaporation (2,3,6,7,9,10). The body is in thermal balance if the algebraic sum of all avenues of heat gain (from exogenous and endogenous sources) and loss equals zero and can be expressed in the partitional heat exchange equation as +/-S = *(MAN)* +/- C +/- K +/- R -E, where S= body heat storage, M = metabolic heat production, W = external work and C, K, R and E represent convection, radiation and evaporation respectively (3,9,11).

During exercise in hot dry environments, evaporation of sweat from the skin surface may account for as much as 98% of heat dissipation whilst in hot wet or humid environments this contribution may still be as high as 80% thereby making the sweating response crucial to body temperature maintenance during exercise in the heat (2,6,10). The loss of water and electrolytes via the sweating process however constitutes the precipitating factor in all forms of heat illness (2).

TYPES OF HEAT ILLNESS

The three major forms of heat illness are, in order of increasing severity, heat cramps, heat exhaustion and heat stroke whilst heat syncope and dehydration hyponatremia constitute additional exercise-heat stress related illnesses (1,2,8).

HEAT CRAMPS

The least serious of heat illnesses that may occur at rest or during or after exercise in any environmental condition and are specific to neither exercise or exercise in the heat (6).

Cause / Predisposing Factor

Unestablished however reportedly associated with heavy and prolonged sweating and dietary inadequacies (1,2,8,12). sweating and dietary inadequacies (1,2,8,12).

- Low serum electrolytes (NaCl deficit).
- Intense pain not associated with muscle strain.
- Muscle twitching, cramps and spasms generally in the arms, legs and abdomen (1,8,12,13,14).

Treatment

- Mild cramps: reestablish normal hydration status and replace sodium losses via oral administration of 0.1% salt solution.
- Rest in cool environment
- Eat salty foods
- Light stretching and massage of involved muscles.
- Severe cramps: intravenous saline infusion (1,6,12,13,14)

Prevention

- Acclimatisation
- Provide extra salt at meals
- Adequate conditioning, rehydration practices.
- Know signs and symptoms of heat illness (1,6,8,12)

HEAT EXHAUSTION

The most common form of heat illness that generally occurs when unacclimatised individuals exercise strenuously in the heat losing profuse amounts of water and electrolytes through heavy prolonged sweating (8).

Cause / Predisposing Factor

Reduced cardiac output

- due to loss of blood volume resulting in an inability of cardiovascular system to meet demands of thermoregulatory muscular and visceral blood flow.
- Water and or salt depletion due to heavy prolonged sweating
- Inadequate fluid and or salt intake.
- Diarrhea and or vomiting.
- Inadequate acclimatisation and conditioning.
- Heat production exceeds environmental heat loss (1,2,8,12,14)

Clinical Features / Diagnosis

- Fatigue, orthostatic dizziness, ataxia, hypotension.
- Headache, nausea, vomiting or diarrhea.
- Elevated skin and core temperatures.
- Piloerection.
- Excessive thirst, dry mouth and tongue.
- Syncope
- Stomach / intestinal cramps or persistent muscle cramps.
- Tingling in hands or feet.
- Weak rapid pulse, low blood pressure.
- High hematocrit, serum protein and sodium.
- Weak, loss of coordination, decreased mental alertness.
- Profuse sweating (1,2,8,12-16).

Treatment

- Remove athlete from play and immediately move to rest supine in cool / shaded environment with legs elevated above heart level.
- Remove excess clothing or equipment.
- Cool athlete until rectal temperature is less than 38.3°C.
- Monitor heart rate, blood pressure, respiratory rate, core temperature and CNS status.
- Rehydrate orally with water or sports drink if not nauseated, vomiting or experiencing CNS dysfunction.
- Transport to emergency facility if rapid improvement is not noted (1,2,8,12-16).

Prevention

- Provide adequate fluids: pre, during and post exercise
- Acclimatise
- Adjust work rate according to environmental conditions.
- Provide opportunity for adequate cooling, rehydration and rest periods.
- Know signs and symptoms of heat illness (1,8,16).

HEAT STROKE

This form of heat illness constitutes a medical emergency and may occur in the absence of significant dehydration as a result of thermoregulatory overload due to intense exercise usually in a hot climate (1,6,8).

Cause / Predisposing Factors

- Reduction of blood volume due to sweating reaches critical point.

- Further reduction in blood volume results in circulatory collapse.
- Sweating mechanism is turned off and body temperature soars
- Heat production exceeds heat dissipation resulting in dangerous hyperthermia.
- Blood becomes hypertonic due to excessive loss of sweat and when coupled with excessively high body temperatures may damage the CNS and precipitate ventricular fibrillation, heart failure and death (2,6,12).

Clinical features and diagnosis

- Hot dry skin
- Weak rapid pulse, decrease in blood pressure or hyperventilation.
- Body temperature >40°C
- Nausea, vomiting or diarrhea.
- Headache, dizziness or weakness.
- Combativeness, irrational behavior, confusion, incoordination, decreased mental acuity.
- Seizures, altered consciousness, collapse, coma.
- Dehydration (1,2,6,8,13-18.)

Treatment

- Active whole body cooling - cold / ice bath immersion (Gold Standard)
- Ice packs to neck, axillae, proximal femurs and behind knees.
- Medical emergency - call 000
- Maintain airway, monitor and treat hyperkalemia.
- Keep record of core temperature and cease cooling at 38.3°C
- Treat secondary disorders (1,2,8,12-21).

Prevention

- Education with respect to individual susceptibility, including: skin disease (sunburn), obesity, dehydration, advanced age, poor physical fitness, previous heal injury and excessive fatigue.
- Acclimatise.
- Adjust work rate when exercising in hot temperatures and high humidity environments.
- Provide adequate fluids.
- Provide adequate opportunity for intermittent cooling, rehydration and rest.
- Know signs and symptoms of heat illness.
- Have whole body cooling equipment and supplies on hand.
  Have a plan to manage heat illness should it occur (1,8,16-18).

HEAT SYNCOPE

Cause / Predisposing Factors

- Inability to maintain blood pressure.
- Peripheral vasodilation and blood pooling.
- Circulatory instability and loss of vasomotor tone.
- Hyperventilation.
- Inadequate acclimatisation (1,16

Clinical Features / Diagnosis

- Hypotension.
- Weakness and fatigue.
- Pallor, elevated core and skin temperatures.
- Loss of consciousness (1,6,16).

Treatment

- Remove from activity, rest in cool environment in supine position with legs elevated above the heart.
- Keep record of blood pressure and body temperature.
- Rehydrate (1,6,16).

Prevention

- Acclimatise.
- Avoid prolonged static standing.
- Know signs and symptoms of heat illness (1,6).

ACCLIMATISATION

The predominant physiologic adjustments associated with exposure to hot conditions include:

- Increased blood volume
- Altered cardiac output distribution to the skin and working musculature to meet the demands of thermoregulation and metabolism.
- Lower body temperature threshold for the onset of sweating.
- Increased rate / amount of sweating.
- More even distribution of sweating over the body.
- Dilution of sweat (contains less electrolytes & has lower sodium concentration) (2,6,8).

Considerable dispute exists regarding the ideal amount of time required for heat acclimatisation. Armstrong and Dziados, 1986 (21) report heart rate, plasma volume and perceived exertion changes are generally completed within 3 to 6 days whilst core temperature and electrolyte concentration alterations may take several additional days. Increased sweating rate appears to be the final adaptation to plateau, taking up to 2 weeks when relocating from a cool climate to a hot or humid climate (6,8).

Recommendations associated with heat acclimatization include:

1. Develop adequate levels of fitness in cool environments prior to commencing the process of heat acclimatisation (22).
2. Exercise in the heat at low intensities (>50% V02max) and gradually increase exercise duration up to 90 min/day and intensity of training sessions during the first 2 weeks (22).
3. Exercising in hot conditions at either low intensity (>50% V02max) and long duration (60-100mins) or moderate intensity (75% V02max) and short duration (30-35mins) increases the capacity to sweat and reduces electrolyte loss (23).
4. Perform highest intensity training sessions during cooler morning or evening hours and other training during the hottest time of the day (22).
5. Monitor body weight to ensure adequate hydration status is maintained as sweat rate increases (2,22).
6. Monitor core temperature to ensure body temperature remains within safe limits (22).
7. Ensure athletes are exposed to the environmental conditions 24 hours a day to facilitate the acclimatisation process (ie the effectiveness of acclimatization is reduced if the only exposure to hot conditions is during training and then the athlete returns to an air conditioned hotel (6).
8. The use of heat chambers and impermeable clothing may be used as adjuncts to the acclimatisation process rather than as a replacement for full acclimatisation (6,22).

PREVENTION OF HEAT ILLNESS

Most episodes of heat illness can be prevented via adequate education of athletes, coaches and medical staff of risk factors (Table 1) and can be successfully treated if properly recognized and appropriately managed in a timely fashion.
Guidelines for the prevention of heat illness should include:

1. Ensure athletes and officials are well educated in terms of the aforementioned risk factors, signs and symptoms of heat illness, the importance of adequate hydration and the need to avoid excessive environmental conditions.
2. Perform adequate conditioning prior to participation.
3. Undergo acclimatisation if competing in unaccustomed heat or humidity.
4. Ensure that preparticipation screening has been completed and including questions regarding: fluid intake, weight changes during activity, medication and supplementation and a history of cramping and or heat illness.
5. Avoid adverse conditions: WBGT 26-28°C (80-82°F) constitutes high risk heat illness conditions and the training / competitive environment should be red flagged accordingly.
6. Alter training times to avoid exercise at the hottest time of the day unless acclimatising.
7. Wear appropriate clothing such as loose fitting, light coloured open weave or mesh tops to facilitate heat loss.
8. Hydrate appropriately in the 24 hours prior to a training session or event: Consume 400-600ml of cool fluid in the 30mins prior to exercise followed by 100-200ml every 15-20mins during exercise and 30ml for every min of exercise post exercise.
9. Have a plan should heat illness occur and organize whole body cooling equipment and supplies.
10. Provide proficient medical support (2,6,10,13-15,25,26).

Understanding the basic concepts of heat gain and loss, types of heat illness, features of acclimatization and preventative strategies is imperative for all training staff, coaches and sports medicine professionals to ensure the optimal performance of athletes in a low risk training and or competitive environment.

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Table 1 : Risk Factor Associated with Heat Illness (8, 15,20,24)

INCREASED RISK	**DECREASED RISK**
Increased age	Adequate hydration
Obesity	Adequate sleep / rest
Alcohol consumption	Improved physical fitness
Drug Abuse	Acclimatisation
Skin conditions	Frequent rest / rehydration breaks during exercise
Previous heat illness	Decreased Wet-Bulb Globe Temperature (WBGT)
Increased exercise intensity of duration	Presence of sports medicine support staff

UNIT 11
NUTRITION & DRUGS IN SPORT

Nutritional Supplements and the Strength and Conditioning Coach Part 3 : Glutamine

By Ian King, Brisbane, Australia

The following is the third of a series of articles about nutritional supplements provided by Ian King, the former long-serving Executive Director of the ASCA. These articles are modified extracts from his recent book The 1998 Australian Sports Supplement Review, co-authored by Darron Haworth.

INTRODUCTION

In the most recent article of this article series a controversial topic was selected - HMB. The topic to be discussed in this series is perhaps less 'hot\ It is simply an amino acid. But then again, HMB is simply **a** breakdown of an amino acid....Whether the claims about glutamine find support down the track is unknown, but they have certainly served to elevate this humble supplement - from being a 'non-essential amino acid' to be a 'conditionally essential amino acid'.

GLUTAMINE

What is the purpose of **this supplement?**

Glutamine is credited with an amazing number of functions including (2,5,3):

- a cell volumiser
- anti-catabolic (prevents muscle wasting)

  maintaining proper function of your immune system kid-

  -neys, pancreas, gallbladder and liver
- an essential nitrogen transporter
- a building block for the formation of glutathione, a powerful antioxidant
- important for proper muscle glycogen deposition
- causes extra growth hormone release

Of greatest importance to most athletes, glutamine (along with the amino acid alanine) is described as one of the keys to anti-catabolism (2).

How **long has** this supplement been **around?**

The focus on amino acids in nutritional supplementation has been on-going through the 70's, 80's and 90's. However the awareness and focus placed on the role of glutamine has occurred over the last few years.

Which category/s **do** we **include** it **in?**

Immune system enhancer Muscle mass enhancement Body fat lowering ? Strength/power enhancement Recovery enhancement Injury prevention/rehabilitation?

What *is* it **derived from?**

Glutamine is the most abundant free-form amino acid in the body. The level of glutamine is suggested to be highly correlated with muscle protein synthesis (2). Col-gan (2) describes glutamine as a non-essential amino acid, but Klatz (3) and Phillips (5) categorise it as a 'conditionally essential' amino acid, as the body may not be able to synthesise adequate amounts under conditions such as the stress of intense physical training.

Is *it* formed **naturally** in the **body?**

Yes. It can be synthesised in the body from a number of other amino acids, such as glutamic acid, valine, and isoleucine (5). However it is believed that the body cannot produce enough glutamine to replace that lost in time of stress such as intense exercise, which creates the need for supplementation. If the body runs short of glutamine, and synthesis in the body or dietary intake do not meet this shortage, it is believed that glutamine is 'robbed' from muscles to support other organs (eg. gut) and functions (eg. immune system).

How is it proposed to work?

Glutamine is proposed to perform it's many functions in the following ways:

- a cell volumiser : *glutamine helps to maintain proper cellular hydration; when gluta-mine levels fall, the cell*

volume decreases, which is catabolic

- anti-catabolic (prevents muscle wasting) : *prevents catabolism of muscle during and post-exercise by preventing acidosis; is being used in medical situations in European hospitals to prevent muscle wasting in post trauma eg. burns, surgery, disease (5); and by maintaining cell volume;*
- maintaining proper function of your immune system, kidneys, pancreas, gallbladder and liver : *glutamine is required in large quantities by these organs*
- an essential nitrogen transporter ; *glutamine can carry two nitrogen molecules, and is involved in removing ammonia from areas such as the brain and lungs, depositing it in other areas, such as the intestines and kidneys*
- **a** building block for the formation of glutathione, a powerful antioxidant : *glutamine combines with cysteine and glycine to form glutathione*
- important for proper muscle glycogen deposition : *even the author who proposed this Junction is unsure how it achieves this (5)*
- *causes extra growth hormone release : a recent study (6) showed that a surprisingly small oral dose of 2 grams raised growth hormone levels more than four times over that of a placebo*
- *Does it **work?***
- *Glutamine has gained significant scientific support from both those involved in sport and those involved in life extension -the latter being a good sign -their battle against aging is very similar to the battle athletes face when stressing their body with training. We have also had very good feedback from athletes who have used this supplement -they claim to feel more full in the muscle, and to gain strength and size more quickly. It is similar to creatine in that they just 'feel good' on it. The more recent claims of it stimulating growth hormone release are exciting, but we are unable to add our thoughts to this yet.*

Which athletes may find it of use?

Any athlete concerned with maintaining or building muscle mass or strength. Keep in mind that during exercise glutamine and alanine are released from the muscles in larger quantities than any other amino acid. Not many athletes should want to lose muscle mass. In fact one of the biggest challenges facing the endurance athlete is maintaining muscle mass under the catabolic stress of their training. Remember that glutamine helps to maintain proper cellular hydration - and when glutamine levels fall, the cell volume decreases, which is potentially catabolic. Maintaining glutamine levels is one critical way to prevent muscle wasting in ALL athletes.

What form** is **it** available **in?

Powder, tablets and capsules.

What is it's availability?

Over the counter in Australia.

***How much should** be taken?*

Mindell (4) recommends the following dosages for the average, not-active person : 1-4 gm/day in divided doses. Phillips (5) recommends bodybuilders consume 10 grams of supplemental glutamine a day, in at least two divided doses.

Should it be taken at any particular time of day?

Phillips (5) recommends intake times of right after training and just before bed.

Are there any foods/ supplements that it should **or should not** be **taken with?**

You could combine glutamine with insulin releasing carbohydrates to increase transportation to muscle cells.

Is this supplement commonly combined with any other supplements?

It is becoming popular with recent products to add glutamine eg. *Myoplex* by EAS, *Glutamine EFX* by Victory.

Any other user suggestions?

Phillips (5) suggests trying a seven day loading pattern of increased glutamine to saturate the muscle, then reducing to standard daily dose. We would recommend cycling this substance as you would any supplement.

Are there any side-effects?

The only caution we could find was by (4) who suggests that people who are sensitive to monosodium glutamate (MSG) could experience an allergic reaction and should consult a doctor prior to taking glutamine. Also, if you took too much any one time you may suffer gastrointestinal distur-bances.

Is it banned?

We have not found any reference to this supplement as being a banned or a permitted medication/ substance as per the lists provided by the *IOC (IOC List of Prohibited Classes of Substances and Prohibited Methods,* 31 January

1998) or the ASDA (in the third edition of the *Drugs in Sport Handbook* [1]) at the time of writing.

Our correspondence with the ASDA failed to clarify the status of glutamine - therefore to be safe we describe it as unsure. Whilst it is unlikely to be necessary - because it is simply an amino acid (then again HMB is only a metabolite of an amino acid and ASDA's advice is that it may elevate testosterone levels - see discussion HMB re this), make sure if you intend to use glutamine you make the relevant inquiries with ASDA or your sporting body before using this supplement.

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The 1998 Australian Supplement Review is available from King Sports International, P.O. Box 680 Toowong, Qld, or fax 07 3374 0959 or email : kingsports@b022. aone. com. au., AUD $39.95 + $5 P&H.

IMMUNE SYSTEM	MUSCLE MASS	BODY FAT	STREN/ POWER	ANERO POWER	AEROB POWER	RECOV ERY	SLEEP	INJURY PRE/ REH
✓	✓	?	✓		✓			?

Nutritional Supplements and the Strength and Conditioning Coach Part 1 : Introduction

By Ian King, Brisbane, Australia

The following is the first of a series of articles about nutritional supplements provided by Ian King, the former long-serving Executive Director of the ASCA. These articles are modified extracts from his recent book ***The 1998 Australian Sports Supplement Review,*** *co-authored by Darron Haworth.*

Nutritional supplements have been the subject of intense media scrutiny in Australia of recent. For example,a competitor in the Australian Foot ball League (AFL) admitted to taking a substance that he was un aware had been recently added to the International Olympic Commit tee (IOC) and Australian Sports Drug Agency (ASDA) banned sub
stances list. This admission resulted in much-publicised media coverage. Then there was the competitor in the
National Football, League (NFL) who, upon testing positive for elevated testosterone levels, claimed
that his use of the supplement Antrib (which contained androstened one and tribulus terrestris) was to blame. And then of course there was the media stir about HMB Cbeta-hydroxy beta methylbutyrate'), interestingly enough focused mainly in Queens-land, where the author is based.

Remember, the opinions expressed are those of the author.

Foreward

Nutritional Supplements have become a 'hot' topic of late.

Mixed between the emotions and facts is the reality that peoples values are being added to the confusion. At the centre of the issue for many is whether athletes should be allowed to use any substance, natural or otherwise, if it enhances their performance. The purpose of these articles is not to answer this question. Rather, faced with the reality that most strength and conditioning coaches will be approached by ath-letes, coaches and or administrators for advice on this topic, it is believed that the most important step that can be taken is to educate. To educate in the absence of bias from interest groups - be they the manufacturer, the rule maker, the moralist. The purpose of this series of articles is to educate. From there the reader can make their own decisions.

Nutritional Supplements : An Introduction

The 1998 Australian *Sports Supplement Review* is about nutritional supplements that **enhance sports performance.** The criteria for inclusion in this book was that the supplement was currently popular (or soon to become popular when more people know about it) and that the supplement has promoted *feedback* ***from at least some of the users*** *that it* <u>*may*</u> *work in the manner intended.* In brief we selected what we believed to be the 37 leading nutritional supplements at this time.

All the supplements listed are available without prescriptions. That is they are available 'over the counter'. This does not mean they are available over the counter in Australia, the most recently produced supplements are invariably from America, and not available for sale in Australia for some years after their entrance onto the US market. This does not mean they are illegal in Australia (ie. the use or possession of them). The availability of each supplement is indicated. They may however be listed by the International Olympic Committee (IOC) and the Australian Sports Drug Agency (ASDA) as a banned substance for athletes competing under conditions subject to drug testing by ASDA. This is also indicated in the discussion of each supplement.

The decision to include supplements that are banned by the IOC may be criticised by the politically correct. However we believe that avoiding the issue will not solve the problem. The inclusion of

the banned substances is not an encouragement to take them. But ignorance is not always bliss. Their inclusion provides clarity to the athlete who is subject to IOC/ASDA guidelines.

Very few supplements work (ie. enhance performance) for all athletes in all situations. Perhaps the supplement that most closely achieves this is creatine monohydrate, yet even creatine monohydrate has been described as having no effect on performance in some athletes, and even a negative effect on performances in some others.

Will the supplement work for you?

In the early days of nutritional supplements we were only able to access information on a product via manufacturer's claims. There is now a larger body of research from which to assess specific supplements, and there is a growing market trend by manufacturers to encourage or create research to support their supplements. Is all this research objective? No - in our opinion much of the research conducted on nutritional supplements is commercially driven. Ultimately we believe that a product needs to be on the mass market for about three years before we can really tell whether it works with an adequate number of athletes to conclude that it provides more than just a placebo effect

In reality the only way to determine whether a supplement will enhance performance in an athlete in a specific situation is to try it. Then the athlete, assuming they are in touch with changes that occur in their bodies and their performance, can determine the supplements effectiveness.

They deal way for an athlete to assess the effect of a supplement is to take that supplement either in isolation (ie. no other supplements) or only with other supplements that they have used before and are familiar with their effects. When time is limited, athletes often choose to use more than one new supplement, negating the likelihood of them really knowing the specific effect of each supplement.

It is questionable whether anyone can say to an athlete "This supplement will work for you in V manner". More appropriately it may be said "I believe that this supplement may work for you in V manner", or "Other athletes have reported this supplement has done V for them"; or "Research suggests that this supplement may have 'x' effect on you." Ultimately only the user can be the judge.

We also recognise the placebo effect that a supplement can have ie. it may not have actually worked, but the athlete believed it worked. Whilst this situation is often criticised, it can be argued that psychological benefits may also act to enhance performance.

Direct vs Indirect enhancement of performance

The enhancement of performance from nutritional supplements can be described as direct or indirect. For example, the potential of creatine monohydrate to increase anaerobic power could be described as a direct enhancement of performance. Alternatively, carnitine's potential for lowering body fat, which then has a positive effect on performance, could be described as an indirect enhancement. Most vitamin and minerals are considered to be indirect in their contribution to athletic performance, as you can rarely feel an immediate effect upon commencement.

In Chapter 1 - The Selected Supplements - we introduce the thirty seven (37) supplements that have been included in the book. In Chapter 2 - The Categories of Supplements - we introduce the nine (9) categories that each of the selected supplements can be placed in - some in more than one - based on their effects. In **Chapter** 3 – The in their Categories - we place ' each selected supplement into the ' categories in which we believe they • contribute.

In Chapter 4 -The A-Z of Selected Supplements - we discuss each supplement individually, alphabetically. At the top of the first page for each : supplement we have displayed a quick reference table indicating to which category we believe the supplement contributes to. Below that there is a circle with a letter inside - this is used again as a quick reference to indicate it's status with the International Olympic Committee (IOC)/Australian Sports Drug Agency (ASDA), using the following code:

B	=	Banned
R	=	Restricted to certain limits
U	=	ASDA describe it as a category they are unsure of, or no information available *
P	=	Permitted **

from what we understand,

ASDA usually advise athletes against using substances/supplements in this category ** from what we were informed, ASDA only give this status to a substance/supplement where it is in a pure form (ie. not mixed with other supplements), and where it is manufactured in Australia

We then ask and answer a series of questions, aimed at providing brief and to the point answers. These include the following questions :

What is the purpose of this supplement? Here we simply state why it is used as a supplement.

How long has this supplement been around? Here we give an indication of how long this supplement has been on the market.

Which category/s do we include it

in? Here we again list which category/s we believe this supplement contributes to. The more categories a supplement is placed in, the broader the application to the athlete. Note that if we use a tick (V) this indicates we agree with or have found adequate information to support the claims that this supplement can achieve the common purpose of it's category. Alternatively, if we show a question mark (?) it indicates that we are either not convinced that this supplement does achieved the purpose of it's category, or we feel that the claim of it's potential should be noted, but lacks in support - may require further scientific and empirical evidence.

What is **it** derived from? This section gives a background on what the supplement is derived from. This may include foods that are good natural sources of this supplement.

Is it formed naturally in the body? This section indicates whether it is a substance formed in the body naturally, and by what means.

How is it proposed to work? In

this section we provide a brief description of how the supplement is proposed to achieve each of its claimed benefits.

Does **it** work? Here we do our best to indicate whether it does in fact work. In doing this we draw upon research conclusions, ours and other expert's opinions, and feedback from athletes and coaches. In brief, we believe a supplement needs to be on the market for at least three (3) years before we can make cone I u-i sions based on a large sample ol athletes.

Who should use it? Once you have read the relevant pages you should be forming an idea as to whether you may benefit from using the supplement. Here we tried to clarify that for you. Ultimately you have to make the decision.

What form is it available in? We have taken time to discuss not only what forms it is available in (ie, powders, tablets etc.) but in the case where there are various types of the supplement, we provide further information about this here.

What is it's availability? If it is available in Australia over the counter, we say so. If not, we indicate how it may be obtained -invariably by mail order from an American company.

How **much should** be taken? In

this section we describe common practices relevant to the supplement in question. Note this is descriptive, not prescriptive. You need to consult more individualised advice to ascertain what your individual requirements are.

Should it be taken at any particular time of day? If there is any information as to whether benefits arise from intake at specific times of the day, we discuss that in this section.

Are there any foods/supplements that it should or should not be taken with? In some cases there will be foods and/or supplements that should / should not be mixed with the supplement - where this information is available we pass it on in this section.

Is this supplement commonly combined with any other supplements? in many instances supplements are mixed with other supplements - either to enhance it, to broaden the spectrum, or to stay in touch with commercial trends. Fri those athletes subject to drug testing • we strongly advise you read the label

very closely - and cross reference any additional supplements (no matter how small a quantities the) appear in) with the guidelines pro-vided by your sport or testing body. It is possible that not all the substances included in the supplement are permitted. In particular be care ful with herbs, as their potency may vary greatly, irrespective of what thelabel says.

Any other user suggestions?

Where there is any other user information that did not fit into the above question/answers, we discuss that here.

Are there any side-effects? Side-effects are reviewed to the best of our best ability. However we en-courage each athlete to investigate the supplement relative to their own unique medical/physical conditions prior to commencing them.

Is it banned? Here we review the lists provided by the *IOC (IOC List of Prohibited Classes of Substances and Prohibited Methods,* 31 January 1998) and the ASDA (in the third edition of the *Drugs in Sport Handbook,* 1997) to see whether the supplement is banned or permitted medication/ substance.

For further clarity on this we wrote to ASDA asking them to confirm our interpretations on each of the supplements we list. We do stress however that the list of banned sub-stances is continually being upgraded and changed. We strongly encourage you to seek more up-to-date information before determining the status of the supplement you intend to take. In other words check it out yourself, and on a regular basis -things change!

The ASDA hot-line number is 800-020-506, and their reference guide, the *Drugs in Sport Handbook,* is available from their office for only $5.

We also pass on a point stressed by ASDA - the claim that the status of permitted applies only to supplements in their pure form (ie. not when they are mixed with other sup-plements), and only for those supplements manufactured in Australia.

We cannot stress enough – make it your responsibility to do the following before using any supplement:

- buy only reputable brands -even with these there can be potency variation
- read the label, noting each and every substance included
- check each and every substance listed by ASDA.
- And check again every few months – the banned list is being continually updated

Are there any good books which can be read to learn more about this supplement?

Here we give you some book titles that extensively cover the supplement in question, should you wish to pursue more information on the topic. Of course there are many journal, magazine and newsletter articles also available, some of which are included in the reference list at the back of the book.

The 1998 Australian Supplement Review is available from King Sports, P.O. Box 680 Toowong Qld, or fax 07 3374 0959, AUD $39.95 + $5 P&H.

Nutritional Supplements and the Strength and Conditioning Coach Part 2 : HMB

By Ian King, Brisbane, Australia

The following is the second of a series of articles about nutritional supplements provided by Ian King, the former long-serving Executive Director of the ASCA. These articles are modified extracts from his recent book ***The 1998 Australian Sports Supplement Review,*** *co-authored by Darron Haworth.*

Nutritional Supplements have perhaps always been associated with some degree of controversy. The initial issues began with arguments that they were not needed. Whilst some are still caught up in this debate, it is apparent that most athletes have gone beyond this, wanting more specifically to know what if any supplements will benefit them. However every so often a supplement surfaces that attracts more than it's fair share of attention, and not always for what could be argued are the.'right' reasons. HMB is such a supplement. For reasons that would entertain a conspiracy theorist for weeks, HMB was subject to intense media scrutiny during 1998. Interestingly enough, the supplement sponsor to the sport that appeared to be driving the media inquiry recently released on the Australian shelves a product that they promote as containing HMB. During the height of the media attention certain institutions saw fit to distance themselves from use of HMB, some providing media releases such as "we direct our athletes not to use HMB". However, unless HMB is banned by the IOC or ASDA, and if athletes perceives that it is effective, HMB use will continue irrespective of whether certain sports want it discouraged. The purpose of this article is not to enter the moral de bate about HMB - rather to provide the strength and conditioning coach with up-to-date information on the subject.

HMB

What is the purpose of this supplement? HMB is the abbreviation for a compound called 'beta-hydroxy beta-methyibutyrate. This supplement is promoted and used to improve muscle mass and strength, and lower body fat.

How long has this supplement been around? The supplement in this form entered the market only in the last few years.

Which category/s do we include it in?

Muscle mass enhancement Lower body fat Strength/power enhancement Recovery enhancement ?

What is it derived from? HMB is a metabolite of the essential amino acid leucine. HMB is present in small quantities in both plant and animal foods.

Is it formed naturally in the body?

Yes. But it is also absorbed from our diet.

How is it proposed to work? HMB is promoted as an anti- catabolic agent. It is suggested that HMB may help decrease stress-induced muscle protein breakdown. In doing so, it is claimed that when used in conjunction with strength training it accelerates muscle mass and strength increases, and the lowering of body fat.

More recent research suggests that HMB may enhance endurance and recovery (1).

Does it work? A number of US studies have been published to support the above claims. Nissen et al (2) used three groups in his study -one using no HMB, the second using 1.5 gms of HMB/day, and the third using 3 gms/day. The results of the three groups respectively for increases in lean body mass were : 0.88 lbs, 1.76 lbs, and 2.64 lbs. The strength gains in this study were also measured for the three groups and were respectively : 8%, 13% and 18.4%.

In addition to research support, we have received feedback of from athletes

that they 'feel leaner' when using HMB.

Miller's 1997 study (1) showing increased endurance and enhanced recovery may need more support before conclusions are reached.

In summary, HMB sounds promising but we maintain our stance - we like to see a supplement on the market for 3-4 years before we can really judge athlete responses from a large enough sample size.

Who may consider using it? This may be an excellent option for any athlete wanting to increase their strength, muscle mass, and / or lower body fat. And athletes simply wanting to retain muscle mass under catabolic training conditions may also consider this supplement.

Be mindful that ASDA appear very wary of this supplement, and that this supplement has been promoted by some in Australia as being related to elevated testosterone. Interestingly enough we have failed to fin any written evidence or justification of what appears to be an "Australian generated myth". Another argument that is being used to discourage HMB use here in Australian sport is the claim that as there have been no long term studies of side effects, the issue of possible side effects is a concern. This final criticism is hard to refute, but we suggest that it also applies to many other nutritional supplements. You, the user, will need to make your own mind up on these issues. '

What form is it available in? The most common form is a capsule. A : powder form is also available.

What is it's availability? At the time of writing, HMB is not avail- I able over the counter in Australia, but is in America. Most Australian athletes using HMB buy it mail order. ft is rumoured to be on the Australian shelves in the near future.

How much should be taken? The standard recommendation is to take 3 gms per day. However 5 gms a day has been recommended by Poliquin (4) as being more effective. The study by Miller (1) used 10 gm/day (in horses) but all other studies appear to use 3 gm/day. Phillips (3) speculates that as most studies conducted were on college students carrying less muscle mass than the average bodybuilder, *It* may take up to 6 gms per day to achieve maximum results with the heavier athlete.[2]

Should *it* be taken at any particular time of day? Phillips (3) believes that an ideal dose pattern would be to take a gram with each meal, and then 2-3 grams immediately following your workout.

Are there any foods/supplements that it should or should not be taken with? Phillips (3) believes that the post-workout HMB intake should be combined with a high-glycemic carbohydrate source. He theorises that since HMB probably acts at the site of the muscle cell, insulin (whose release is stimulated by the high-glycemic carbohydrate source) might help carry more HMB into the muscle cell - and therefore enhance the result. Poliquin (4) claims that you should be getting at least 1.5 gms of protein per pound of bodyweight to opti with a high protein diet.

Another speculation by Phillips (3) that may be worth trying is consuming a gram of HMB and a gram of vitamin C one hour prior to training - with the aim of minimising muscle soreness and enhance recovery.

Is this supplement commonly combined with any other supplements? Creatine is a very popular supplement to be used with HMB. Creatine has similar aims, but achieves them in a very different way to HMB. Therefore the combination of the two is covering more bases, Poliquin (4) suggests that HMB and creatine taken together have a synergistic effect.

Any other user suggestions?

Poliquin (4) provides a further two points regarding HMB use

1. HMB may be more effective in trainees who train with higher intensity ie. most of their efforts are over 85%

2. after 3-4 wks, cycle off HMB and use a different supplement for a while

A point we recommend which is supported by Phillips (3) is to cycle HMB - after 4-8 weeks on, take a similar period off this supplement -perhaps using an alternative supplement in the interim.

Are there any side-effects? No side-effects have been documented yet, but as many would remind

us, "no long term studies have been conducted"!

Is it banned? We have not found any reference to this supplement as being a banned or a permitted medication/ substance as per the lists provided by the *IOC (IOC List of Prohibited Classes of Substances and Prohibited Methods,* 31 January 1998) or the ASDA (in the third edition of the *Drugs in Sport Handbook,-* 1997) at the time of writing.

However information provided by ASDA in the form of 'Extra Substance Information' shows HMB as **Unsure** in the status column. They add the following:

"...Although the product is probably permitted, there have been suggestions that it is anabolic. Callers should be told we are seeking further clarification ". From what we understand the ASDA perspective is based on advice received from one Australian doctor that HMB may cause testosterone levels to be raised in excess of the 6:1 testosterone:epitestosteron e ratio, which has been established as the point of a positive test. In our correspondence with ASDA they describe HMB as 'disturbing', a situation they are 'monitoring'.

ASDA have suggested that HMB may be anabolic. However our understanding of even the manufacturer's claims are that it is promoted as 'anti-catabolic' (preventing muscle tissue breakdown) - not anabolic.

Not convinced with this information, we wrote to internationally recognised drugs and drug testing in sport expert, Mauro Di Pasquale (author of texts on this topic), and asked his opinion on this matter. In personal communication, he confirmed our understanding of HMB when he replied that he couldn't i believe the hysteria over HMB; that it was just a nutritional supplement, not an anabolic hormone; and that he would be interested in where the Australian doctor got his information from because he was unaware of any scientific evidence that shows ' HMB increases testosterone. He went one step further and said that an as yet unpublished study shows that HMB has no appreciable effects on testosterone metabolism.

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	✓	✓	✓			?		

Dietary Analysis : Determining Your Total Energy Intake

By Dr. Greg Wilson, PhD, Heath and Recreation Section, North Coast Institute of TAFE NSW, Kingscliffe Campus

In the last issue of Strength and Conditioning Coach we determined how to measure total energy expenditure. In this issue we will look at the other side of the energy equation and determine total energy intake. To do this we will need to accurately determine the amount and type of food consumed in a typical day, and acquire a calorie counter book or the use of a computer program. Similar to last issue, this will require some mathematical effort to perform and attention to detail in the diet. At times it may become a little tedious, however, it is a very important exercise to perform and will allow a full appreciation of what the value of different foods really are. as well as an understanding of how closely the energy expenditure is matched with the-energy consumed.

Total Energy **Consumed**

The first step in determining the total energy consumed is to complete a dietary log of all the food that is consumed in a typical day. including the type of food and quantity consumed. Rather than trying to estimate what you typically eat. 1 recommend that you simply write every piece of food down as you eat it. Then a calorie counting book needs to be consulted to determine the grams of fat. carbohydrate, protein and total calories of each food consumed. Calorie counting books are reasonably cheap and available from most bookshops and even some important to document the total breakdown of the diet so that we can assess not only the total number of calories, but also the relative proportion of carbohydrate fat and protein in the diet. Therefore, ensure you acquire a book that lists of all these factors. For the purpose of the analysis outlined in this issue. I will be using the data provided by Dr Art Ulene in the The Nutribase Complete Book of Food Counts. published by the Avery Publishing Group in 1996. This book lists the nutritional facts for over 30.000 food products. However, there are a number of similar books that are just as good, and main computer packages that can perform the entire calculations for you. Similarly on the Internet there are a number of sites that provide calorie counting functions, such as the Nutrition Diary section of: www.cyberdiet.com.

In many instances the suppliers of the food provide a full listing of the nutrient value on the packaging of the food. Given recent changes in legislation for food producers, this will be increasingly the case in the future. Use this data when it is provided. If the energy is give in kilojoules (kj) divide the number by 4.2 to convert to kcals. If this information is not provided then consult your calorie counting book or computer program.

To give you an example to follow I have documented the total amount of food 1 consumed in a normal day. and listed the amount of carbohydrate, protein and fat in grams. and the total calories of each portion. To make this example pharmacies. However, many of these books only include the total calories and the amount of fat. and neglect to document the amount of carbohydrate and protein for most of the foods. For our purposes it is easier to follow I will provide a separate table for each section of the day. Table 1 lists the foods consumed for breakfast and morning snacks. Table 2 is a record of the foods eaten for lunch and afternoon snacks, while Table 3 documents the foods consumed for dinner. Typically for breakfast I eat some fruit and cereal and often have some more fruit later in the morning. The full listing of calories, and the grams of carbohydrate, protein and fat are details in Table 1.

Breakfast is quite a large meal. 1 typically start the day with about 1 hour of

aerobic type exercise prior to breakfast, and am quite hungry' upon completion of the exercise. I general!} eat the fruit first, then get myself ready for the day. shower, dress etc and the eat the cereal about 30 minutes later. For lunch I generally eat some fruit, typically a rockmelon with some yoghurt on it and have a roll with salad and a soy slice as filling. 1 use soy slice in preference to ham or chicken. In preparing the salad and soy roll 1 generally use avocado as the spread in preference to butter or margarine. With lunch I generally drink a large glass of milk with milo mixed in. The rest of the day I generally only drink water. As an afternoon snack I often have 2 slices of toast with margarine and honey, and some more fruit. The full listing of calories. and the grams of carbohydrate, protein and fat are outlined in Table 2. While I tend to eat more or less the same food for breakfast, snacks and lunch, dinner is more variable. Typically I tend to eat either steamed fish, with a varietv of vegetables or salad, and pasta: or often I have a brown rice dish mixed with vegetables and soy sausages. For the purpose of today's exercise I will calculate the energy input from the fish, salad and pasta meal. The full details are listed in Table 3.

The vast majority of people eat different foods and amounts on a day to day basis. Consequently, to gain a good estimate of the average energy intake from food, it is recommended that one records and measures the foods consumed over several days. Hence the above procedure should be repeated over a 3 to 5 day period.

Once all the foods consumed are recorded, and the various amounts of calories, proteins, carbohydrates and fats are calculated for each meal, then an overall total needs to be determined. The following totals are important to calculate:

> Overall total calories consumed

> Overall total, protein, carbohydrate and fat consumption.

> Relative percentage of protein, carbohydrate and fat in the diet.

All of these values have been calculated in Table 4. The first two simply involve adding up the relevant values in each meal. To calculate the relative percentage of protein, carbohydrate and fat a little more mathematics is required, as the percentages are based on the energy of the foods, not their weight in grams. One gram of protein contains about 4.3 kcal of energy, 1 gram of .carbohydrate contains about 4.1 kcal of energy: and 1 gram of fat contains approximate!} 9.3 kcal of energy. Consequently one needs to multiply the grams of protein by 4.3. and carbohydrate by 4,1: while the fat intake needs to be multiplied by 9.3. Hence the reason for keeping fat intake under good control, it is a very high energy food.

To establish the relative percentages. the calculated energy amounts of protein, carbohydrate and fat are divided through by the overall energy intake. Notice that when the energy is calculated from the protein, carbohydrate and fat values, the total energy value is different than that directly given from tables (3709 kcal compared to 3388 kcal, see Table 4). The direct measurement from the tables should be the more accurate value. How-ever, despite the most careful measurement systems, one should always be aware that the values calculated are only estimates and will be subject to errors.

Dietary Analysis

While it has taken some considerable effort to arrive at the point where we have determined average energy expenditure and average energy intake, these data are very useful and can be used in a number of very practical and helpful ways. The first comparison to make is to compare the total energy expended with the total energy intake. In the last issue of Strength and Conditioning Coach we determined the total energy expenditure for a typical week, and for the example given, it involved energy expenditure values of between 3858 to 4417 kcal per day, depending on the type and amount of exercise performed on the given day. Realising that these values are only estimates, it is perhaps prudent to suggest that the typical daily energy expenditure is about 4000 kcal.

The estimates for total energy intake outlined above vary from 3388 to 3709 kcal. While the first figure is probably more accurate, it is worth

remembering that these figures are also not complete!)' accurate and subject to changes depending on the amount and type of food eaten on any given day. However, it is perhaps reasonable to conclude that the typical daily energy consumption is about 3500 kcal. This means that on average a caloric deficit of about 500 kcal(3500kcal - 4000 kcal = -500 kcal) per day is currently occurring. Over time, this deficit will result in a loss in body weight. To lose 0.45 kg (1 pound) of fat it requires a calorie deficit of about 3.500 kcal. Therefore if the 500 kcal deficit is maintained it should result in a fat loss of approximately 0.45 kg per week (-500 kcal x 7 = -3,500 kcal). As I check through my body-weight records I actually have been losing this amount of body weight over the past few months, which is a good way to validate the accuracy of the above calculations. However, at this point in time I feel that I am at a good body weight value and hence will need to either increase my food intake by about 500 kcal per day, or decrease the amount of exercise performed by a similar amount to prevent further weight loss.

Looking through the energy expenditure values in Table 2 of the last issue of strength and Conditioning Coach, the caloric deficit could be largely eliminated by removing the aerobic type activity that is performed first thing in the morning. Alternatively, as I typically enjoy my morning exercise. more food could be consumed. perhaps in the form of a desert after dinner.

Weight Loss

In terms of losing body weight, a caloric deficit needs to be achieved. and thus more energy must be expended than is consumed. The maximum caloric deficit that is recommended to safely lose body fat is no more than 1000 kcal per day. This should result in a fat loss of 0.9 kg (2 pounds) per week (Heywood, 1998). The deficit is best achieved through a combination of dieting and increased exercise. While dieting alone can be used to achieve a negative caloric balance, severe caloric restrictions tend to result in the lost of both body fat and lean body mass. This result in the reduction of resting metabolic rate, which serves to be counterproductive to the long term maintenance of a caloric deficit. By including exercise in the weight loss program. lean body mass, and thus resting metabolic rate, tends to be maintained, and this serves to assist the long term viability of the caloric deficit and hence the continued loss of body fat. A further recommendation is to always maintain an energy intake of at least 1200 kcal per day for women and 1500 kcal per day for men. as this is the minimum energy required for the health} functioning of the body.

It is my experience that once people decide to try and lose weight that they are in an incredible hurry to achieve this. Consequently the} summon up all of their motivation and try extreme measures of dieting and exercise only to find that the} cannot maintain these efforts in the longer term and thereby fail miserably. Given that it has typically taken main years of over eating and under exercising to initially gain the weight, it is reasonable to expect that a similar time course is required to get into shape. Hence people should be counselled to set long term achievable goals, and realise that once the}- have a well developed diet and exercise plan, that time is on their side. The development of a caloric deficit of 50 kcal per day, for man} people could be achieved with a little additional daily exercise (eg a 30 minute brisk walk first thing in the morning), in combination with a little attention to dietary detail (eg drinking water instead of soft drink; removing margarine, butter, sugar, snacks and sweets from the diet etc). These simple measures could conceivably result in the development of a caloric deficit of 500 kcal per day. promoting a fat loss of about 0.45 kg per week. Over the course of a year, these simple measures may result in a total fat loss in the order of 20 kg. a very-considerable amount indeed.

Weight Gain

Many individuals engaged in strength sports often wish to increase their muscle mass to improve their performance. To achieve this the} must take in more energy in their diet than they expend in their activities. Further, the} must perform intense strength training. To gain 0.45 kg of muscle it takes an energy intake value about 3.500 kcal greater than the energy expended. A positive caloric balance

of 500 kcal per day will result a 3.500 kcal excess over the course of a week, and thus allow the correct energy balance to facilitate the safe and effective increase in lean body mass. This positive energy program should be obtained from using a balanced diet, with sufficient quantities of protein, carbohydrate, fats and other nutrients, such as vitamins and minerals etc. If this is pursued in combination with an effective weight training program, and plenty of recover} time, then the individual is in a position to gain about 0.45 kg of lean muscle tissue per week. While this amount may not sound overly exciting in the short term. Over the long term it does provide for substantial improvements in muscle mass, and is believed to be the safe upper limits for effective gains in lean body mass. A larger positive caloric balance, for example of 1000 kcal per day, tends to result in the excessive accumulation of fat mass for most individuals.

To effectively gain weight it is of vital importance to consume sufficient protein, which represent the building material of muscle tissue. The amount of protein required for the optimal development of muscle tissue is current!} an area surrounded by much controversy. With much of the controversy developed by the manufacturers of protein supplements who are keen to convince many individuals of the merits of protein supplementation in their diet.

For the average active individual, the protein requirement in the diet is about I gram of protein per kilogram of body weight per day. For individuals engaged in intense weight training, who are attempting to increase lean body mass, this value should be increased to an upper limit of between 1.6 to 1.8 grams of protein per kilogram of body weight per day. The 1.8 value being relevant for adolescent weight trainers who may require higher levels of protein during a growth spurt. The further consumption of protein beyond this level is not helpful in gaining lean body mass.

If one is consuming a well balanced diet, then a sufficient quantity of protein is generally provided by the food consumed, and protein supplements are therefore not necessary. For example, my diet listed in this article is not a high protein diet. It really is a high carbohydrate diet. Nevertheless, it does provide for 149 g of protein (see Table 4). Given my body weight is 85 kg. 1 currently consume 1.75 g of protein per kilogram of body weight (149g/85kl). A value that would be more than satisfy my body's protein requirements, even though I perform 5 intense weight training sessions per week. Therefore. in most instances. provided one is consuming a well balanced diet with an adequate overall energy intake, protein supplements are not necessary to satisfy the protein requirements of the body. However. Such supplements often contain amino acids, such as arginine and ornithine. which may serve to stimulate the body's production of growth hormone, insulin and glucocorticoids, facilitating muscular growth. Research in this area is conflicting at this time and the interested reader is directed to examine a recent review paper on this area by Richard Kreider (1999) on "Effect of Protein and Amino-Acid Supplementation on Athletic Performance" which is available from the nutrition section of the sport science Internet web site: www.sportsci.org.

It is very common for athletes engaged in strength sports and pursuits to consume huge amounts of protein and carbohydrate in the quest to get big. Indeed the culture *of* power!ifting and body building is filled with the ritual of the consumption of enormous quantities of protein laden foods, such a steaks, combined with man) protein drinks filled with copious amount of eggs, bananas, ice cream, protein power, milk and a variety of other compounds. Often the consumption of such large quantities of food results in a positive caloric balance that is well in excess of recommended 500 kcal per day, and tends to result in the accumulation of large amounts of body fat over the longer term. To gain quality muscle, such individuals should be encouraged to pursue a more modest energy intake, consisting of a well balanced diet with an overall energy consumption that exceeds energy output by about 500 kcal per day.

A Balanced Diet

Most sources of dietary information suggest that a well balanced diet consists of a wide variety of nutritious foods comprising more than 55% of carbohydrates, 12-15% of protein and less than 30% of fat (Deakin and Brotherhood, 1995). The exact percentages of protein, carbohydrate and fat that make up a well balanced diet will be depended upon the purpose of the diet the type of activities that are typically performed, and the overall total energy consumed. For the majority of individuals involved in strength ad conditioning type pursuits, my recommendations would be a diet that consisted of approximate!} 65% carbohydrate. 15% protein and 20% fat:

The vast proportion of carbohydrates consumed should be complex carbohydrates, for example whole grain breads, cereals and pastas; potatoes and brown rice. Further. large quantities of fresh fruits and vegetables should be consumed. In a previous issue of Strength and Conditioning Coach, I documented the finding that the lack of consumption of fresh fruits and vegetables was responsible for 1 1% of the total cancer burden in Australia in 1996 (see Wilson, 2000). The current recommendation is to consume 7 serves of fresh fruit and vegetables per day.

Fat as been given such a bad rap in the popular media that main health conscious people have tended to greatly restrict the fat content in their diet. It is true that main people tend to over-consume fat, particularly unsaturated fats such as animal fats, with the average Australian diet consisting of about *33%* of the total calories from fat (Wilson. 2000). This excessive consumption of fat. in combination with a lack of physical activity, are the main causes of obesity within our society. However, it is vital for health} body functioning to consume sufficient amounts of fat. For example. cholesterol serves as the starting material for the synthesis of the sex hormones of testosterone and oestrogen, as well as the adrenal hormones, such as cortisone, that regulates metabolism. It is also of vital importance in the production of oil glands that protect the skin from dehydration and other environmental stress (see Weil. 2000) Therefore, it is essential that the body receive a sufficient quantity of fats in the diet. The vast proportion of fat should be from polyunsaturated and mono-unsaturated fats, such as avocados. soybeans, nuts such as cashews, pistachios, walnuts and macadamias. and olive oil. Also fats should be consumed which contain high sources of omega-3 and omega-6 fatty acids, such as free range eggs soybeans, and oil fish such as salmon or sardines, and walnuts. In examining the relative percentages of carbohydrates, protein and fat in my diet, listed in Table 4, it is evident that my personal consumption of fat is too low. Further, given that 1 wish to maintain by body weight at its current level, I am eating too few overall calories. The easy way for me to achieve a well balanced diet is to increase the amount of fats that I consume. For example, one large size avocado weighing 300 g contains 320 kcal of energy and some 32 g of fat, the majority of it mono-saturated. This could easily be added to the salad consumed at dinner to increase the overall consumption of fat and total calories. Further, 30 g of Walnuts contain 185 kcal of energy and some 16 g of fat, rich in the important omega-3 fatty acids. This also could be added to the dinner salad. The overall effect would be the addition *of* 505 kcal to the total energy intake and a 48 g increase in the total fat consumed. These small additions to the diet would serve to eliminate the caloric deficit, thus allowing body weight to be maintained. and increase the percentage of fats from their current low level of 10.5% to the more reasonable and healthy value of 19.8%.

Of course there are a number of other ways that the above diet could be brought into balance. In fact one of the great benefits of performing this analysis is that is bring to your attention the relative value of different types of food, and the value of different forms of exercise, and the various options at your disposal. Thus one tends to be much more conscious of the type of food and exercise choices one makes, and this can be a very useful development in the formulation of an effective and health) lifestyle management plan.

I hope I have inspired you to get out the pens, calculators and books and thoroughly investigate your personal energy balance. While the whole exercise of counting calories is a little tedious at times, I think you will find is very useful and enlightening task, and one that may greatly assist in achieving your training goals.

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Table 1: Total energy Consumed in the Morning

Breakfast

2 medium Oranges (124 kcal: 2.4 g Protein 30.8g. Carbohydrate. 0.04 g fat

One half medium Papaya – 8.8 cm diameter (60 kcal: 1 g Protein. 14.9 g

Carbohydrate. 0.2 g Fat)

1 Mango medium – 339 g (135 kcal: 1.1 g Protein, 35.2 g Carbohydrate. 0.6 g fat)

Cereal

- 3 Organic Vita Brits (150 kcal: 5.2g Protein. 35.6 Carbohydrate. 0.8 g Fat)
- 1 cup (30 g) of Dick Smith's NutraBites (107 kcal: 5 g Protein 21 g Carbohydrates. 0.2 g fat)
- 1 Banana medium (105 kcal: 1.2 g Protein. 26.7 g Carbohydrate. 0.6 g fat)
- 40 m of Diploma Instant Skim Milk (140 kcal: 15 g Protein. 20.4 g Carbohydrate)

Morning Snacks
1 Peach medium 128 g (37 kcal: 0.6 g Protein. 9.7 g Carbohydrate. 0.1 g Fat)
1 Apple medium (81 kcal: 0.3 g Protein. 21 g Carbohydrate. 0.5 g Fat)
1 Nectarine medium (70 kcal: 1 g Protein. 16 g Carbohydrate. 1 g Fat)

Total Calories = 1019 kcal
Total Protein = 32.8 g
Total Carbohydrate – 231.3 g
Total Fat = 4.4 g

Table 2: Total Energy Consumed for Lunch and Afternoon

Lunch

1 Rock Melon small. 12 cm diameter (186 kcal. 4.6 g Protein. 44.6 g Carbohydrate. 1.6 g Fat) with 100 g of Yoghurt (88 kcal. 4.7 g Protein. 15 g Carbohydrate. 1.2 g Fat)

1 Large Whole meal roll – 80 g (188 kcal: 6.2 g Protein. 36 g Carbohydrate. 3.2 g Fat) using Avocardo as a spread – 16 g (23 kcal: 0.03 g Protein, 1 g Carbohydrate. 2.1 g Fat)

Sanitarium Soy Slice (34 kcal: 2.8 g Protein. 1.7 g Carbohydrate. 1.8 g Fat) and salad fill the roll.

- ½ Tomato medium (13 kcal: 0.05 g Protein. 2.8 g Carbohydrate. 0.02 g Fat)
- 3 Slices of Cucumber (3.5 kcal: 0.02 Protein. 0.7 g Carbohydrate. 0.05 Fat)
- ¼ Carrot medium (7.8 kcal: 0.02 g Protein. 1.8 g Carbohydrate. 0.02 g Fat)
- 1 slide Kraft extra light cheese 21 g (41.4 kcal: 5 g Protein, 0.08 Carbohydrate. 2 g Fat)
- Lettuce 32 g (5 kcal: 0.04 g Protein. 1 g Carbohydrate. 0.1 g Fat)
- 1 slice Pineapple (41 kal: 0.03 g Protein. 10.4 g Carbohydrate. 0.02 g Fat)

500 ml of skim milk. (176 kcal: 18.8. g Protein. 25.2 g Carbohydrate. With 2 teaspoons. 40 g Milo (168 kcal: 5.2 g Protein. 27.4 g Carbohydrate. 4 g Fat)

Afternoon Snacks

2 slices of Pritikin Wholewheat bread (140 kcal: 5.1 g Protein. 27.6 g Carbohydrate. 1.1 g Fat)

Margarine 10 g (58 kcal: 0.04 g Protein. 0.08 g Carbohydrate. 6.6 g Fat)

1 Tablespoon 21 g Honey (67kcal: 0.01 g Protein. 17 g Carbohydrate)

1 Peach medium 128 g (37 kcal: 0.06 g Protein. 9.7 g Carbohydrate. 0.01 g Fat)

1 Apple medium (81 kcal: 0,03 g Protein. 21 g Carbohydrate. 0.05 g Fat)

1 Pear Medium (51kcal: 0.06 g Protein. 13 g Carbohydrate. 0.03 g Fat)

Total Calories = 1409 kcal

Total Protein = 55.9 g

Total Carbohydrate = 256.8 g

Total Fat = 25.1 g

Table 3: Total energy Consumed for Dinner

Dinner

Steamed Fish, cod, in microwave. 200 g (186 kcal: 40.5 Protein. 1.6 g Fat)
Golden Egg Pasta 65 g (192 kcal: 2.4 g Protein. 44 g Carbohydrate. 1 g Fat)
Salad:

- 1 Tomato medium (26 kcal: 1 g protein. 5.6 g Carbohydrate. 0.04 g Fat)
- Lettuce 100 g (15 kcal: 1.2 Protein. 3 g Carbohydrate. 0.03 g Fat)
- 1 Carrot medium (31 kcal: 0.07 g Protein. 7.3 g Carbohydrate. 0.01 g Fat)
- 6 Slices of Cucumber (7 kcal: 0.04 g Protein. 1.4 g Carbohydrate. 0.01 g Fat)
- Pineapple 2 slices (82 kcal: 0.06 g Protein. 20.8 g Carbohydrate. 0.04 g Fat)
- 1 sweet yellow Corn ear (77 kcal: 2.9 g Protein. 17.1 g Carbohydrate. 1.1 g Fat)
- Low fat Cheddar Cheese 25 g (84 kcal: 7.3 g Protein. 6.2 g Fat)
- 1 Mango medium – 339 g (135 kcal: 1.1 g Protein. 35.2 g Carbohydrate. 0.06 g Fat)
- 1 Banana medium (105 kcal: 1.2 g Protein. 26.7 g Carbohydrate. 0.06 g Fat)
- 2 stalks Celery (20 kcal: 1 g Protein. 4 g Carbohydrate)

Total Calories = 960 kcal
Total Protein = 60.3 g
Total Carbohydrate = 165.1 g
Total Fat = 12.4 g

Table 4: Overall Total energy Intake and Percentage Breakdown of Protein, Carbohydrate and Fats

Overall Total:

Total Calories – 1019 + 1049 + 960 = 3388 kcal (direct calculation from tables)

Total Protein = 32.8 + 55.9 + 60.3 = 149 g

Total Carbohydrate = 231.3 + 256.8 + 165.1 = 653.2 g

Total Fat = 4.4 + 25.1 + 12.4 = 41.9 g

Energy from Protein, Carbohydrate and Fats

Protein = 149g x 4.3 = 641 kcal

Carbohydrate = 653.2 g x 4.1 = 2678 kcal

Fat = 41.9 g x 9.3 = 390 kcal

Total Calories calculated indirectly from Protein, Carbohydrate and Fat intake = 641 + 2678 + 390 = 3709 kcal

Relative Proportion of Protein, Carbohydrate and Fat in the diet:

Total Protein = 641/3709 = 17.3% total

Total Carbohydrate = 2678/3709 = 72.2%

Total Fats = 390/3709 = 10.5% total