Sport for Athletes with Physical Disabilities: Injuries and Medical Issues

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**Introduction**

Sport is a term that encompasses a broad spectrum of experiences that include the social, recreational, and competitive. Physical activity is widely accepted as a necessary component for individual health. Over recent years, there has been increased emphasis on the role of sport and physical activity in enhancing health and quality of life of individuals with disability and chronic illness (Goldberg, 1995). Individuals with disability can generally receive the same health benefits from exercise and sport training as their able-bodied counterparts. These benefits include: (a) physical benefits – general fitness, cardiovascular conditioning, cardiopulmonary endurance, muscle strength, flexibility, postural control, balance, adaptation to impairments, optimal musculoskeletal functioning; and (b) psychological benefits – improved motivation, self-confidence and self-esteem, personal adjustment, competitive spirit, reduced anxiety, and reduced tendency to withdraw (Goldberg, 1995; McCann, 1987). Sport participation and intensive training has also been shown, similarly, to benefit individuals with neuromuscular impairment of cerebral origin (Richter, Gaebler-Spira and Mushett, 1996). Individuals with amputations who participate in sports have improved proprioception and increased proficiency in the use of prosthetic devices (Malanga, Filart and Cheng, 2002).

Sport participation also has an impact on general health. Persons with a disability who are active have been shown to have fewer cardiac risk factors, higher high-density lipoprotein (HDL) cholesterol (good cholesterol), and smoke less than their disabled and non-active counterparts. Athletes with paraplegia are less likely to be hospitalized, have fewer pressure ulcers, and are less susceptible to infections than non-active individuals with paraplegia (Malanga, Filart and Cheng, 2002).

During the last decade, sport for athletes with disabilities has moved away from a medical rehabilitation model and towards a competitive sports model. The relationship between sport and rehabilitation, however, continues to have relevance. Sport and physical activity can help in addressing some of the health and wellness needs of children and adults with disabilities. Sports can, and often do, provide appropriate physical interventions which reduce the incidence of medical complications and the onset of secondary disability, promote social integration, and enhance the quality of life of people with disabilities.

Sport opportunities for athletes with disabilities range from recreational to highly competitive to elite Paralympic Sport. Athletes are classified or categorized by degree of impairment to ensure equitable competition. For example, athletes with visual impairment compete in three classes which vary in the amount of residual sight. Athletes with physical impairments such as spinal cord injury, cerebral palsy, or amputation, are evaluated and placed in a sport specific classification for competition. For competition, many sports, such as swimming, wheelchair basketball and table tennis, use functional or integrated systems which allow athletes with a variety of disabilities to compete with each other. Some sports such as athletics, soccer, and cycling rely on disability specific classification systems which evaluate both function and etiology of disability.
People with a Disability in Sport

In 1998, the President’s Council on Physical Fitness and Sports issued a research report which clearly identified several important findings related to sport and physical activity. Highlights include the following:

- Exercise and sport can be used as a therapeutic or preventative intervention for enhancing physical and mental health for adolescents;
- Regular physical activity helps reduce symptoms of stress and depression;
- Sport participation enhances mental health in a variety of ways.

Implications of Disability on Sport

The Pre-Performance Exam (PPE)

Prior to sport participation the athlete must be cleared by a physician who will verify an athlete may participate in training and competition based on a medical history and physical exam. The medical history form should be thorough and include information on health conditions, medications, and immunizations including tetanus. The form should also include the signature of the athlete/parent, physician with contact information (addresses and phone numbers). The medical forms should be available on-site whenever the athlete is participating (Malanga, Filart and Cheng, 2002).

The tests performed in the PPE are determined by the requirements of the sport, the level at which the athlete will perform, the requirements of the sport organization, and the clinical findings. The PPE must respond completely to the medical requirements of the particular governing body of the sport. The exam must also provide information to direct the athlete, trainer, coach, and team physician toward safe participation, activity limitations, and disability-specific training (Malanga, Filart and Cheng, 2002).

According to Malanga, Filart and Cheng (2002) the objectives of the PPE include the following:

- Identify conditions that 1) may require further medical evaluation before the athlete enters into training, 2) require close supervision during training, and 3) may predispose to injury.
- Determine the athlete's general health to assess fitness level and performance
- Counsel on health-related issues and methods for safe participation
- Provide referral for identified conditions that require further evaluation and/or monitoring to physicians familiar with the disability and the management of the identified conditions (Malanga, Filart and Cheng, 2002).

A PPE should be repeated at least every 2-3 years and follow-ups, prior to each sport season, may be necessary if the athlete's health condition changes (Malanga, Filart and Cheng, 2002).

Medical Staff Coverage (Program, Practice, & Event)

Medical planning is always done best through a team approach. In the ideal situation, a complete team could include a Physician, Athletic Trainer, Physical Therapist, Trained First Responder, Prosthetist, and Wheelchair Repair Specialist.
Every program should have a team physician with a specialty in orthopedics, physical medicine, or family practice, preferably with a background in sports medicine. The physician will serve as an excellent guide and resource for addressing athlete injuries, planning and providing on-site coverage for competitions. Local high schools, college/universities, or professional sports programs provide the best contacts for physicians with an interest in sport.

Programs should develop strong relationships with licensed professionals who are trained and enjoy working with athletes in training and competition. These individuals are the primary on-site personnel for the team during practice and competition. A licensed athletic trainer and member of the National and State National Athletic Trainers Association (LAT/ATC) or a licensed physical therapist/athletic trainer or sports specialist (PT, LAT/ATC) are recommended. A licensed physical therapist who is a member of the American Physical Therapy Association working in orthopedic and sports medicine settings is also an excellent staffing option.

The minimum qualified level of medical staff coverage at practices or competition is to have one or more coaches or staff in the program who have current training in first aid and CPR and receive a certification as an American Red Cross First Responder and CPR.

A prosthetist or orthotist is a professional who fits, repairs, and builds artificial limbs and orthoses, respectively. Likewise, a wheelchair repair and service technician fits, repairs, and builds sports wheelchairs. This technology is quite sophisticated and can have a profound effect on the athlete's training, performance, and safety.

Basic levels of equipment and supplies need to be available for medical coverage for any sport program (practice or competition). Quantity and quality is dependent on the size and scope of the program.

- Water
- Cups
- Plastic Bags (large)
- Universal Tool Kit
- Athletic Training Kit (fully stocked)
- Ice
- Straws
- Towels
- Tire pump and repair kit
- Cell/Mobile Phone: verify battery power and signal strength reception prior to event

Once cleared for participation by a physician, physical fitness and conditioning is the single most important aspect of injury prevention in sport. This starts with proper assessment of each of the basic components of fitness. These are the general areas of 1) cardiovascular or aerobic fitness; 2) muscular strength, endurance, flexibility, and 3) motor ability. Once general conditioning activities take place then sport-specific activities are incorporated to enhance performance and readiness in that sport. Knowledge of these elements should be basic to any individual performing coaching or training of an athlete.

- **Cardiovascular or Aerobic Fitness** - is the ability of the body to take in, transport, and utilize oxygen during physical activity.

- **Muscular Strength** - is the ability of a muscle or muscle group to create force, typically performed with high resistance and low repetitions.
• **Muscular Endurance** - is the ability of a muscle or muscle group to sustain activity without fatiguing, typically the activity being performed offers low resistance and high repetition.

• **Muscular Flexibility** - is the ability to move a joint/segment through a range of motion where the surrounding muscles/tendons/connective tissues are lengthened.

• **Motor Ability** - is measuring of basic functional static and dynamic tasks like speed, balance, and agility. Evaluating abilities in this area will help determine readiness for a sport, position, or need for training focus.

**Practice and Competition Warm-up/down**

An important aspect of injury reduction in sport is a proper warm-up and warm-down during practice training and competition. The best habit for all athletes in training is to do a properly progressed warm-up and warm-down. Every coach should be well-prepared to structure this into training and competition. This usually includes stretching, jogging, and sport-specific skills.

**Medical Concerns in Sport Participation**

Clearly, sport and physical activity are widely accepted and actively encouraged for athletes with disabilities; however, when training, one must consider the etiology and implications of the individual's disability (Richter, Sherrill, McCann, Mushett and Kaschalk, 1998). The position statement of the American Academy of Orthopaedic Surgeons (1992) warned that when participating in sport, individuals with physical disabilities may need to take precautions. However, these precautions should be appropriate and without needless restrictions. There has been considerable confusion over the medical aspects of an athlete's disability and their implications on sport. Some of this has been due to a lack of research. However, important facts are emerging which sport medicine professionals, coaches, and athletes need to know. The following highlight key sport medicine concerns, which, depending on the athlete's disability, may warrant special consideration.

**Medical Emergency Awareness/Procedures**

**Medical Emergencies**

Recognizing a medical emergency is first and foremost. The staff person who responds to the incident first should quickly assess the type and extent of injury, call 911 and initiate first aid and CPR as necessary. If transport is required a designated person should be in attendance with athlete with appropriate medical insurance and release information documents. There also should be a designated staff member for contacting parents/guardians of the injured.

A incident report should be completed with any incident/injury.

**Weather Emergencies**

This includes thunder with lightning, tornado, and extreme heat conditions. Guidelines and procedures should be established for discontinuation and evacuation for all sports activities including training and competition tailored to the site in use. Staff training with regard to evacuation procedures is imperative.
Athletes by Disability Classification

Wheelchair Athletes
Athletes with disabilities experience athletic-related injuries that are specific to the demands and risks of their sport. The most common injuries were strains and muscular injuries of the upper extremity (Curtis & Dillon, 1985; Ferrara & Davis, 1990). Many of these injuries are understandable. Because hands are used continuously for propulsion, blisters of the fingers and thumbs may develop. Overuse entrapment syndromes may occur (Jackson et al., 1996), although their risk does not seem to be high when compared with their occurrence in non-athletes with disabilities (Boninger et al., 1996). A major concern is overuse injury cumulative trauma disorders, particularly of the shoulder. Wheelchair propulsion is increased by increasing the speed and force of the impulse supplied to the hand rim. Wheelchair design changes (lowering the seat height to allow for a lower center of gravity) may contribute to more injuries because the decreased seat height may place the elbow and upper arm in contact with the wheel, where a friction burn can occur. Fractures of the metacarpals and phalanges are possible from falls and collisions with other wheelchairs that may occur in sports such as wheelchair basketball. Researchers have estimated that although stroke technique may vary, the hands of some athletes are in contact with the hand rim for 270 degrees (Gehlsen et al., 1990). The rotator cuff is vulnerable from overuse injuries, which result in tendinitis or impingement syndrome. Many of these injuries may be prevented through the use of not only reasonable training programs with appropriate progression and periodization, but also special attention to the balance of the shoulder girdle musculature. In wheelchair athletes the anterior musculature often needs to be stretched, and the posterior musculature, especially the external rotators and the scapular adductors, need to be strengthened (Burnham et al., 1993). By the nature of wheelchair propulsions, the wheelchair athlete tends to overdevelop the anterior musculature with a relatively weak posterior musculature. Therefore, exercises that strengthen posterior musculature, such as a rowing machine, may be beneficial in preventing this injury from occurring.

Athletes with an Amputation
Although there is still some unfounded concern that an athlete with an amputation should not be having stress resistance developed through the prosthesis (Disabled sports training book, 1995; Richter, 1996), experience clearly shows that this is not a valid concern. The amputee is at risk of developing various skin irritations or breakdowns from sports. However, with the use of appropriate padding within the prosthesis and friction eliminating material, such as silicone liners, over these irritated areas, sports can be performed safely.

Athletes with Cerebral Palsy
Seizures are relatively frequent in individuals with cerebral palsy. Fifteen percent of the athletes on the US Paralympic team had seizure conditions (Richter, 1989) although in actuality seizures have not turned out to be a problem. As outlined in a previous section, participation in sports tends to cause an increase in lactic acid (particularly if it is an aerobic sport), which lowers pH and leads to more stable membranes and less risk of seizure (Richter, 1989). Athletes with cerebral palsy who use wheelchairs have shoulder and upper extremity injuries that are similar to those of spinal cord-injured athletes (Ferrara & Buckley, 1996), whereas ambulatory athletes tend to have more knee injuries, as is common in all ambulatory athletes (Ferrara & Buckley, 1996).

Athletes with Visual Impairment
Athletes with visual impairment do not have the visual cues in relation to road surfaces and conditions that could lead to injuries, such as walls, curbs, etc. Many events use a guide runner to assist the
athlete with a visual impairment. However, the athletes may have different biomechanics because of changes in stepping frequency, stride length, and a prolonged stance phase, and excessive break in acceleration forces have been noted (Ferrara et al., 1992). Athletes with a visual impairment may expend more energy performing a task because of a lack of visual cues. This can lead to earlier fatigue and the potential of overuse injuries.

**Athletes with Mental Impairment**

Although few athletes with Down syndrome compete in the Paralympics, there is an increased awareness of sports concerns for individuals with this condition (Fernhall et al., 1997). Due to the physical appearance of the athletes, it is the most recognized form of mental retardation. However, many orthopedic problems, often unrecognized, must be addressed. These include pes planus, patella instability, and atlantoaxial instability (Hudson, 1988). Cervical instability has generated the most discussion and concern. In 1983, Special Olympics International (SOI) issued directives to all medical personnel, coaches, parents, and athletes restricting participation of athletes with Down syndrome until they had received medical examinations for atlantoaxial instability. This concern arose after detecting collagen and subsequently ligamentous laxity in a number of athletes. Researchers noted a prevalence of 10% to 20% of cervical spine instability (Diamond et al., 1981; Hreidarsson et al., 1982; Special Olympics, 1995, Physician and Sports Medicine, 1984). It either can be completely asymptomatic or can result in myelopathic changes including pain and motor deterioration. The Special Olympics in general now restricts these athletes from participating in activities that could produce hyperextension, hyperflexion, or direct pressure on the upper spine (Special Olympics, 1995). Radiographic evidence must be presented to demonstrate normal atlantoaxial stability and no bony abnormalities for athletes to participate without any sports restrictions. Permanent sports restrictions are placed on athletes who illustrate positive radiographic evidence for cervical instability.

**Other Medical Issues**

**Multiple Sclerosis**

The key sports restriction in athletes with multiple sclerosis is not to induce overfatigue and especially not to allow undue increases in the body core temperature because these may lead to an exacerbation of the condition (Olgiati, 1986). In this light it is advisable to counsel athletes with multiple sclerosis not to participate under conditions where core temperature will increase. Swimming is a particularly good sport for the individual with multiple sclerosis because the relative cool water temperature with a high specific heat actually tends to cool the athlete and therefore prevents increase in body core temperature. In people with MS, exercise has health benefits (Seawata et al., 2002).

**Diabetes**

Exercise increases insulin sensitivity in all individuals and therefore is a key component in the treatment of insulin-dependent and non-insulin-dependent diabetes mellitus (Perseghin et al., 1996). There are however potential problems such as the loss of glycemic control with regular activity. Insulin may need to be decreased 1 to 2 units and or carbohydrate intake may be increased by 10 to 15 g of additional carbohydrates for every half hour of exercise (Nathan et al., 1985). It is recommended for diabetic athletes that 60% of calories consumed come from carbohydrates (ADA/CDA, 1993). For prolonged activities, 5 to 20 g of carbohydrates should be consumed for every 20 minutes of exercise. Individuals should be encouraged to eat 30 to 60 minutes before initiating activity. Because exercise may lower blood sugar levels for 24 to 48 hours after completion, additional carbohydrate should be consumed after completion of the activity. For prolonged and or exhaustive exercise, individuals should consume 1.5 g of carbohydrate per kilogram of body weight within 30 minutes post-exercise and follow up with 1.5 g of carbohydrate per kilogram body weight 1 to 2 hours later (Ivy et al., 1988). Blood glucose
levels should be monitored before, during, and after exercise. Consideration should be given not only to
the level but also to the rate at which blood glucose levels may change. An increase or decrease of
blood glucose level in a short period of time may represent an unstable condition for exercising
(Ruderman & Devlin, 1995; Hall, 1997). If hypoglycemia occurs during exercise, the athlete should
ingest a high-glucose drink or food and, if necessary, discontinue the activity (Horton, 1988). Frequently
hypoglycemia may occur due to escalated absorption of insulin that has been injected into an active
muscle. This is especially true when using short-acting insulin. The best injection sites are the buttocks
and abdomen, where there is more adipose tissue and less active muscle being used (Horton, 1988).

Hyperglycemia is another complication that may occur during exercise. If blood glucose levels are over
250 mg/dl, the individual should monitor urine output for the presence of ketones (Wilberg-Henriksson,
1992). If ketones are present, exercise should be postponed. Individuals participating in prolonged
cardiovascular activity may find that if glucose levels are over 200 mg/dl and no ketones are present,
blood glucose levels may increase due to inadequate insulin absorption. These individuals may find it
necessary to inject additional short-acting insulin before exercise at a rate of 2 units per 50 mg/dl over
200 mg/dl.

Diabetic athletes are more vulnerable during exercise in excessive heat. This may lead to dehydration,
which should be avoided by drinking plenty of water. Because the body’s thirst mechanism is lessened
with exercise ((Ruderman & Devlin, 1995), cool, plain water should be consumed before, during, and
after exercise. For activities lasting longer that 60 to 90 minutes, a fluid-replenishing drink such as
Gatorade or diluted fruit juice may be necessary (Ruderman & Devlin, 1995).

Individuals with diabetes should be encouraged to wear proper footwear and practice good foot
hygiene. It may be helpful to obtain several pairs of exercise footwear and alternate shoes periodically
to redistribute pressure points (Ferrara et al., 1997). Injuries to the foot, such as blisters or infections
should be treated immediately. The diabetic athlete should always carry easily accessible glucose as
well as medical alert information identification when exercising. If glucose levels are unstable, the
individual should be encouraged to exercise with a partner who can provide or call for assistance
(ACSM/ADA, 1997).

An individual with diabetes should avoid prolonged isometrics or heavy resistance exercises, which
increase blood pressure if retinopathy is present (Horton, 1988). Physicians should be aware that an
individual on beta-blockers may be unable to experience symptoms of hypoglycemia and/or angina.

**Obesity**

Obesity is a common condition in American society. Unfortunately, it is a common cause of primary and
secondary disabilities (Hu et al., 2001; Rosenbaum et al., 1997). A high level of success is noted with
an exercise program that increases caloric expenditure when joined with a decrease in caloric intake
(Bennett, 1995; Rosenbaum et al., 1997). It has been shown that one should not only decrease total
calories consumed but also concentrate on reducing dietary fat to 20% to 30% of total calories for the
most success (Ruderman & Devlin, 1995). Exercise for the obese population should concentrate on the
frequency of sessions. Initially, low-intensity, high-duration exercise should be performed five times a
week to yield the best results. Low-intensity exercise may be more effective in decreasing fat stores
than more intense exercise because at lower intensity, lipid mobilizing systems provide energy whereas
the carbohydrate system is used during intense exercise. Intensity should be 50% of maximum for 45
to 60 minutes (Ruderman & Devlin, 1995). Appropriate types of exercise include walking, recumbent
cycling, and water exercise, as well as using a stair climber and rowing machine. The goal of exercise
for this population is to increase caloric expenditure while decreasing problems such as joint and orthopedic trauma. Although water activities and cycling may be easier on the joints, water activities are often a good choice for conditioning but not for weight loss compared with land exercise because of the relatively low increase in core temperature; therefore, the metabolic rate increases little (Pate et al., 1997). Research suggests that adherence to an exercise program and compliance with exercise are more likely when individuals are involved in a supervised exercise program (Ruderman & Devlin, 1995). Although more intense exercise may have more health benefits (Lee et al., 1995), the greatest health benefits may be observed in previously sedentary individuals who begin to practice any kind of exercise.

Prosthetics and Orthotics

The use of specialized prosthetics and orthotics designed for specific activities significantly can increase the quality of athletic experiences for athletes who are disabled. These devices allow these individuals to be more physically active and perform at higher proficiency levels. Development of prosthetic limbs has been significant over the years, with introduction of many variations for different activities. The correct choice of a prosthetic limb is essential for optimal performance. For example, many people who ambulate throughout the household and community can use a solid-ankle cushion heel (SACH) prosthetic foot efficiently, while most athletes use the newly developed dynamic response prosthetic foot. The dynamic response foot deforms under a load but retains the memory of its pre-stressed configuration to return it to its original shape upon removal of the load. These dynamic response feet are subdivided further into articulated and non-articulated groups. Articulated feet use axial joints to provide articulation, rather than only on heel deformation. They can accommodate uneven surfaces better than unarticulated feet and, therefore, are useful in sports such as golf (Malanga, Filart and Cheng, 2002).

Temperature Regulation

Dysfunction of the sympathetic nervous system, which is of particular concern for athletes with a spinal cord injury above the eighth thoracic level, may cause significant problems with the regulation of internal body temperature. These athletes may not sweat effectively or have vasodilation below the level of injury. This can result in the inability of the body's thermoregulatory system to cool itself through sweating or warm itself through shivering and vasodilation. Consideration should also be given to athletes with significantly reduced body surface such as an athlete with a bi-lateral amputation. Medications often used by individuals with disabilities, such as anticholinergics, sympathomimetics, diuretics, certain muscle relaxors, and thyroid replacement drugs can also cause increased vulnerability to heat (Richter, Sherrill, McCann, Mushett and Kaschalk, 1998).

Guideline for Hydration in Hot and Humid Environments

An extensive search of the scientific literature indicates that no research has been undertaken to establish heat-fluid guidelines for athletes who have a disability. It must be recognized, therefore, that the purpose of this review is to cultivate an awareness and sensitivity within the disabled sport community that effective and safe athletic competition may be impacted by temperature and humidity. Distribution of this information to medical and coaching staffs associated with teams and individual athletes will support their efforts in dealing with the heat and hydration issues athletes will face.
Acclimatization
Regular exposure to hot and humid environments results in a number of adaptations that serve to reduce the potentially negative impact these conditions have on exercise performance. The magnitude of the adaptation to heat is closely related to the degree of heat stress to which the individual is exposed. The primary determining factor for adaptation to hot and humid conditions is related to maintenance of core body temperature through increased sweating volume (Millard-Stafford, 1992). Adaptation is dependent on the intensity and duration of the exercise and on the environmental conditions in which the exercise is performed. Some adaptation to hot and humid environments is seen within the first few days, and the acclimatization process is essentially complete for most individuals within 7 to 14 days (Brouns, 1991). Based on these data, the major issue in adapting athletes with disability for competition is providing a sufficient amount of time (7 to 14 days) in the location of the competition prior to the competition to allow an opportunity for acclimatization. If arrival and departure schedules do not provide this amount of time, then a provision in the athletes’ training regimen should be made to allow for some degree of acclimatization to the particular environment.

Hydration Guidelines
Increasing physical activity results in an increase in heat production from greater energy expenditure and a greater sweat production in response to the heat produced. Therefore, even in a relatively cool environment, exercise increases the rate at which water is lost (Maughan & Leiper, 1994). At high sweat rates (> 1 liter/hour) it is difficult for athletes to replace fluid at the same rate of loss (Noakes, 1993). This will place an increased burden on the athlete to consume adequate fluids so as to maintain a sufficient sweat rate and body temperature.

Water loss through sweat increases by approximately 13% for each 1-degree increase in temperature (Celsius) (Pugh, Corbett, and Johnson, 1967). This increase in water loss, which may amount to over 5.7 liters or 6 quarts of water per hour in highly-trained athletes (Gisolfi, 1983), can cause a 6% reduction in body weight within 2 hours of training in high heat and humidity (Maughan & Keiper, 1994) This level of fluid loss has the potential to easily place athletes at risk for heat stress if fluids are not adequately replaced, and can also harm performance through reductions in strength, power, endurance, and aerobic capacity (Armstrong, Costill & Fink, 1985; Burge, Carey & Payne, 1993).

There are well-established guidelines for replacing fluids that may help to reduce the risk of dehydration and related disorders. In general, these guidelines encourage a frequent consumption of fluids and, because the thirst sensation is blunted during exercise, there should be a diminished reliance on thirst as an indicator of when to drink (Hubbard et al., 1984; Costill et al., 1975)

These guidelines are (Benardot, 1993; Murray, 1987; Plombok and Benardot, 1993; Gonzalez et al., 1992; Gisolfi & Duchman, 1992):

1. Drink plenty of water or fluid-replacement (sports) beverages before, during, and after exercise. If tolerated, the following recommendations should be followed:

   - Drink at least 240-480 ml or 8 to 16 ounces of fluid 2 hours before exercise.
   - Drink 240-480 ml or 8 to 16 ounces of a 6-8% carbohydrate beverage pre-event (0 to 15 minutes prior to event beginning).
• Drink at least 120-240 ml or 4 to 8 ounces of fluid every 15 minutes during exercise. For events lasting longer than 1 hour, the fluids should contain carbohydrate (6-8%) and electrolytes (10-20 mEq sodium). For events lasting longer than 3 hours, the fluids should contain carbohydrate (6-8%) and electrolytes (30-40 mEq sodium).
• Drink at least 240-480 ml or 8 to 16 ounces of fluid immediately after exercise.

2. Don't rely on thirst as an indicator of when to drink. Thirst is a symptom of dehydration, and does not occur until approximately 1.5 liters of water has already been lost.

3. Drink cool beverages, 7-10°C or 45-50°F. Cool beverages are absorbed more quickly, and the temperature of the fluid helps to maintain body temperature.

4. Drink 480 ml (16 ounces) of fluid for every 0.45 kg lost in exercise or competition. Ideally, this amount of fluid should be consumed during the activity so that significant (> 2 lb or > 1kg) weight loss does not occur.

5. Begin replacing fluid losses immediately after exercise to speed recovery. If body weight on the day following exercise or competition is not within 1% of the pre-exercise/pre-competition weight, the athlete is at increased risk of heat-related illness.

6. Sports beverages should have a carbohydrate concentration of between 4 and 8 percent. This level of carbohydrate enhances fluid absorption and also provides needed fuel for activity. Common beverages (caffeinated colas, etc.) are less effective as re-hydration beverages than water or sports beverages.

**Dehydration**
Body fluids and electrolytes are lost in sweat. Unless these body fluids are restored, hypovolemia, hypoglycemia, hyponatremia, hyperthermia, and dehydration can result, with a significant negative impact on performance (Gisolfi & Duchman, 1992). It can occur as a result of a single exercise bout or from a chronic failure to adequately replace fluids over a period of time. As little as a 1% loss of body weight resulting from a failure to adequately replace lost fluids meets the definition for ‘dehydration’ (Kristal-Boneh et al., 1988). Even in the presence of abundant fluids to consume, dehydration (ranging from 1% to 4% of lost body weight) is commonly reported in many sports, including cycling and running (Wells et al., 1987; Carter & Gisolfi, 1989; Noakes et al., 1988, Myhre et al., 1985). Besides the health implications of dehydration, there is a reduction in exercise performance with even a 1% to 2% loss of body weight (Pugh et al., 1967; Murray, 1987; Armstrong & Pandolf, 1988; Sawka, 1988).

**Heat Exhaustion and Heat Stroke**
Heat exhaustion and heat stroke represent the most serious, potentially life-threatening aspects of heat stress with dehydration. When heat stroke occurs, sweating generally ceases (the skin feels hot and dry), the athlete feels faint, and body temperature rises to dangerous levels (Burge, Carey and Payne, 1993). The earliest signs may include unsteady gait and mental confusion (Richards et al., 1992). Heat exhaustion will exhibit signs of the athlete sweating profusely, and the skin will be pale, cool and wet. Without immediate treatment for either condition, circulatory failure, central nervous system damage, and death may occur. If an athlete is found to be suffering from heat exhaustion or heat stroke, he/she should seek medical attention immediately and be cooled immediately.
Making a conscious effort to consume ample fluids on a regular basis could dramatically reduce the risk that severe dehydration will occur. However, even frequent drinking in an extremely hot and humid environment may cause some athletes to feel the effects of heat stress. Therefore, an acute awareness of how one feels during an exercise bout, and a willingness to take appropriate steps to avoid heat-related injury is needed by all athletes performing in a hot climate.

**Athletic Events and Conditions with Increased Risk of Heat Stress**
The nature of certain sports may place athletes at increased risk of heat stress. These sports are mainly those where the athlete has extensive exposure to environmental heat and humidity over a prolonged period of time, and/or where movement is continuous. The table below categorizes the Paralympic Sport events as high, intermediate, and low risk for heat-related illness. This categorization is based on exercise intensity and duration, availability of fluids, and duration of environmental exposure.

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<td>Powerlifting</td>
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<td>Shooting</td>
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The following list provides examples of how certain conditions may increase the risk of heat-associated problems. While this list is not comprehensive, it is intended to create an awareness of what to look for in determining risk in an athlete with a disability. Consideration should be given to:

- Ingestion of medications that impart a diuretic effect. These medications could cause an increase in urinary fluid loss.
- The synergetic effects of medication and heat may cause a reduction in performance.

A dysfunctioning sympathetic nervous system may lead to difficulties with internal temperature regulation.

- Athletes with T8 or higher lesions may not sweat effectively due to loss of control of the peripheral dilating and sweating response.
- Athletes who have less body surface from which to sweat naturally (for example, the athlete with bi-lateral amputations).
• Those athletes who need support to obtain liquids, namely those who need assistance with daily living needs, to access appropriate drinks whenever necessary whether an enabler is present or not. Heightened sensitivity is required to the frequent provision of fluids by both the athlete and their coaches.
• The effect of prolonged exposure to the sun, especially for those people with decreased sensation and burning of the skin when exposed to the sun for long periods (those athletes with very fair skin and light hair coloring including albino).
• The effect of dehydration which may increase the possibility of seizure activity.
• Those athletes who have developed a regime of liquid intake in conjunction with the length and time of their events and the pre-race emptying of catheter bags who may have their preparation complicated by taking in additional liquid.
• The effect of heat exposure on athletes, especially some athletes within the Les Autres group, whose exposure to heat may temporarily or permanently exacerbate their condition, an example includes those with multiple sclerosis.
• Muscle tone in athletes with cerebral palsy may be affected with excessive exposure to heat.
• Athletes who exhibit an unsteady gait and confusion (for example, impairment in perceptual activity) may be confused with exhibiting the early symptoms of Heat Exhaustion and Heat Stroke.

In summary, the thermoregulatory and performance difficulties that arise from dehydration should encourage athletes to take whatever steps are necessary to adequately replace lost fluids. As heat acclimatization usually takes up to 14 days, it is imperative that athletes arrive already acclimatized to the expected environmental conditions of the competition locale. The hydration and rehydration guidelines presented in this document will not ensure against heat-related illnesses. However, with proper intake of fluids prior, during, and immediately following competition, athletes will minimize their risk of developing serious heat stress.

Seizures

For more than twenty years, controversy has surrounded the issue of sport participation by athletes with seizure disorders. Seizures, a hypersynchronous discharge of the cerebral neurons, manifest in a variety of ways which range from Petit Mal to Grand Mal seizures (Richter, 1989). Athletes with motor dysfunction of the cerebral origin, such as cerebral palsy, traumatic brain injury, and cerebral vascular accident may also have a seizure disorder. Stress, hypoglycemia, dehydration, electrolyte imbalance, and hyperventilation have been found to trigger or increase the incidence of seizures (Richter, 1989; Richter, Sherrill, McCann, Mushett and Kaschalk, 1998).

Factors Increasing Incidence of Seizures

- Dehydration
- Stress
- Hypoglycemia
- Hyperventilation
- Electrolyte Imbalance

The athlete with a neurological injury has a lowered threshold for seizure activity. However, there is a decrease in seizure activity among athletes due primarily to increased stability of neurological membrane in an acidic pH rather than in an alkaline pH. Aerobic exercise results in a metabolic acidosis. The decrease in pH typically results in a decrease in seizures (Mushett, Wyeth and Richter, 1995; Richter, 1989). Clearly, however, appropriate nutritional and fluid intake, adequate
rest, and compliance with prescribed anti-seizure medications are important factors in controlling seizure activity.

**Spasticity**

Considerable discussion and debate has also surrounded the appropriateness of strength training and intense physical activity of individuals with spasticity of cerebral origin (Mushett, Wyeth and Richter, 1995). There is a long held concern that sport is inappropriate for people with spasticity of cerebral origin. The fear has been that intense sport or aggressive exercise will worsen the spasticity. Experience and research, however, has not found this to be true (Richter, Gaebler-Spira, Mushett, 1996). In fact, it has been observed that the challenge of sport training seems to lessen the impact of the participants’ spasticity. This could be due to a resetting of the spasticity receptors, both centrally and peripherally, but further research is needed to investigate this area.

Although athletes with spasticity may experience a transient increase, evidence does not substantiate a permanent or long-term increase in spasticity (Richter, Sherrill, McCann, Mushett and Kaschalk, 1998). Flexion, especially in the upper extremities, often dominates over extension in athletes with cerebral palsy. Therefore, since muscular balance is important, strength training should focus primarily on extension and minimize flexion exercises (Mushett, Wyeth and Richter, 1995).

**Autonomic Dysreflexia/Boosting**

Typically, individuals with high spinal cord injury have a low baseline blood pressure with systolic often below 100 mm Hg. Autonomic dysreflexia is a syndrome which can occur in individuals with spinal cord injury higher than T6 and is characterized by marked elevation in blood pressure (Freed, 1990). In a person with an intact spinal cord, the vasoconstriction reflexes are regulated by inhibitory impulses from the higher brain centers. However, in an individual with a high thoracic or cervical spinal injury, the injury blocks the descending regulatory impulses, allowing the blood pressure to go unchecked. The baroreceptors in the aortic arch and carotids may try to compensate; but, since the sympathetic pathways are blocked in the injured spinal cord, only the vagus can act. This may result in a bradycardia but cannot regulate the blood pressure. Headache, decrease in heart rate, goose pimples, shivering, and flushing result. During autonomic dysreflexia, the risk of seizures, cerebral hemorrhage, and even death exists (Freed, 1990).

Boosting refers to the “intentional induction of autonomic dysreflexia among quadriplegic athletes for performance enhancement” (Burnham et al., 1995, p. 1). Athletes with high spinal cord injury have reported the use of tight leg straps, sharp objects, and, most commonly, over-distension of the bladder, in attempts to improve their sport performance. The practice of boosting has been compared to the use of performance enhancing drugs, or “doping,” because of the potential danger and the difficult ethical issues.

The International Paralympic Committee (IPC) does not allow athletes to compete while in a boosted state. Competitors may be checked at the start of a race, but, for obvious reasons, not during competition. According to Dr. Michael Riding, former Medical Officer of the International Paralympic Committee, the objective of the IPC’s ban was to protect the competitors from the risks. However, he also points out that “we are deluding ourselves if we think that hypertension is solely the property of the boosted” (Riding, 1999). Some argue that boosting may be “only giving back to the competitors what they lost” and that “we have extrapolated a hospital situation to a sport situation” (Riding, 1999). At the VISTA ’99 Conference in Germany, Dr. Riding emphasized that the
current IPC rules are an appropriate first step, but that additional research, which includes input from affected athletes, is essential.

**Pressure Ulcers**

Pressure ulcers are a common, yet preventable, problem for many athletes with spinal cord injury (SCI). The National Pressure Ulcer Advisory Panel defines a pressure ulcer as “an area of unrelieved pressure over a defined area, usually over a bony prominence, resulting in ischemia, cell death, and tissue necrosis” (O'Connor and Kirshblum, 1998, p. 1057). Pressure ulcers can develop as a result of prolonged or excessive time in one position. Incidence of pressure ulcers found in individuals with SCI is reported to be thirty percent during the five years post injury. The incidence is highest in individuals with complete quadriplegia and paraplegia (O'Connor and Kirshblum, 1998). Key factors affecting the level of risk include intensity, duration, and tissue tolerance. That is to say that intense pressure over a short duration can do as much or more damage as less pressure over longer periods (O'Connor and Kirshblum, 1998). Athletes with SCI experience skin damage from both shearing forces and friction. The sacrum is the most common site of severe pressure ulcers. Other common problem areas include hips, buttocks, and heel (O'Connor and Kirshblum, 1998).

Prevention is the athlete’s best defense against pressure ulcers. Wheelchair positioning for maximal sport performance often does not allow for proper distribution of pressure. When designing one’s wheelchair for competition, athletes need to distribute weight and allow for weight relief. Support surfaces should also promote redistribution and reduction of pressure while minimizing shearing and friction.

**Hydrocephalus**

Hydrocephalus occurs in approximately 90% of individuals with spina bifida and often requires surgery to implant a CSF stunt. Hydrocephalus is an excessive increase in the amount of cerebrospinal fluid within the cranial cavity that causes expansion of the cerebroventricles and enlargement of the skull. Although advances have been made in medical technology related to shunts, malfunctions may occur if the shunt becomes occluded. Athletes may complain of headaches, blurred vision and experience vomiting. Athletes with hydrocephalus should regularly communicate with their neurosurgeon and in the case of symptoms of shunt malfunction contact their physician immediately.

**Sport Injuries**

The key to continued participation and recreational enjoyment is remembering that safety is integral to good training and play. Therefore, strategies to prevent injury are emphasized. Musculoskeletal injury is the most common injury reported among athletes who are disabled. A prevailing preventive strategy for musculoskeletal injury is sports-specific conditioning, along with pre-exercise stretching and warm-up as well as post-exercise cool-down and stretching. Musculoskeletal injuries, as well as fatigue and exhaustion, can be reduced by assuring adequate nutrition and fluid status. Instruction in the use of proper protective and adaptive equipment and clothing also is important. In addition, the location where the sporting event is to be held should be evaluated prior to each training and play for potential hazards, such as falls, and for access and maneuverability of adaptive equipment (Malanga, Filart and Cheng, 2002).
Training athletes who are disabled on specific fall techniques (i.e. safe methods for falling and recovering from a fall) can prevent potential injuries. This part of the athlete's education can be performed by a trained physical therapist. For example, an athlete who uses a wheelchair should be taught techniques for how to protect the head and neck in the event of a fall from a wheelchair, how to prevent ejection from the wheelchair upon a fall, and how to recover to an upright position in an energy-efficient way with a locked wheelchair (Malanga, Filart and Cheng, 2002).

Musculoskeletal injuries
Musculoskeletal injuries are the most frequently reported medical problem within the competitive arenas. The shoulder was the most commonly injured area of the body in the Paralympic 1996 summer games for the athletes of the Disabled Sports USA and the Wheelchair Sports USA. Overall, from 1990-1996, among US athletes with disabilities participating the Paralympics and World Championship Games, the most commonly reported musculoskeletal injuries were the thorax/spine (13.3%), the shoulder (12.8%), and the lower leg/ankle/toes (12.0%). For athletes with amputations and other ambulatory athletes, LE injuries were the most commonly treated condition. For athletes using wheelchairs, UE injuries were the most commonly treated condition (Malanga, Filart and Cheng, 2002).

Little information has been published regarding the prevalence of injury among participants in all winter sports. Depending on the sport and the nature of the athlete's disability, as well as the method of reporting, varying prevalences of anatomic sites of injury are indicated in the literature.

Osteoporosis
Significant loss of bone mass occurs with immobilization and biochemical changes associated with aging, particularly for women. Exercise and physical activity helps to maintain bone mass and promote bone growth/density. Athletes with paralysis and those that use wheelchairs are particularly vulnerable to fractures from osteoporosis. Fractures may be painless therefore erythema (redness as in inflammation), fever, or limb deformity should be noted and physician appraisal/treatment sought.

Benefits of a Fitness Program
This specific type of conditioning provides the athlete with an individualized program that prepares him/her for the sport's unique metabolic and biomechanical demands, injury risks, and level of fitness. The overall program goal is to improve performance and prevent injury. The conditioning program begins with the identification of the athlete's goals and choice of sport. Each program is geared to the individual's level of fitness upon entry (Malanga, Filart and Cheng, 2002).

With general sport fitness as the foundation, training for the higher level of fitness needed for that given sport incorporates flexibility, muscular strength, muscle balance, aerobic endurance, speed, agility, and sports-specific skills. Conversely, for individuals with neurologic disabilities, overtraining is a major concern. These athletes are predisposed to chronic repetitive strain and overuse injuries because of the reliance on the remaining functional limb(s). For athletes with SCI using wheelchairs, chronic shoulder injuries are common occurrences that may, in large part, be due to overuse and overtraining. Hence, it is important to strike a balance between carrying out the appropriate training program and overtraining. Precautions to prevent fatigue also are presented for athletes with MS and neuromuscular disorders (Malanga, Filart and Cheng, 2002).
The training program is divided into phases (eg, off-season, preseason, early season, late season). The program may be gradual in intensity and of longer duration for the elite athlete, in comparison with the recreational athlete whose play season is often shorter (Malanga, Filart and Cheng, 2002).

Sport participation in general, and intense training for elite competition in particular, bring inherent risk of injury to the athlete. Many believe that athletes with disabilities are at greater risk than their non-disabled counterparts. However, epidemiologic studies of sport related injuries reveal that athletes with disabilities experience injury rates similar to athletes without disabilities (Richter, Sherrill, McCann, Mushett and Kaschalk, 1998). The Athletes with Disabilities Injury Registry reported an injury rate of 7.23 per 1,000 exposures which is consistent with rates reported in similar studies on athletes without disabilities (Ferrara, Richter and Kaschalk, 1998). Ferrara and Davis (1992) reported that half of the sport related injuries to wheelchair athletes were strains and muscular injuries to the upper extremities. The repetitive motion required for wheelchair propulsion puts repeated stress on the athlete’s shoulder, wrist, and elbow. Wheelchair athletes are particularly susceptible to rotator cuff injuries and overuse injuries, such as impingement and bicipital tendinitis.

In addition to injuries typically sustained by athletes without a disability, amputee athletes may experience skin breakdown or irritation during training. Athletes with lower-limb amputations may need specialized padding to protect the stump from injury. However, improvements in the design, materials, and technology of prosthetic devices have reduced the number and severity of sport related injuries to amputee athletes (Richter, Sherrill, McCann, Mushett and Kaschalk, 1998).

**Pregnancy**

Although there are unique issues of pregnancies in women with disability (Pischke, 1993) and pregnancy has impact on able-bodied women in sport, the literature is bereft of any data on the impact of sport and exercise in pregnant women with disabilities. Disabled women, such as women with high spinal cord injuries, may have difficulties with pregnancy such as autonomic dysreflexia and precipitous labor (Charlfue, Gerhart, Menter, Whiteneck & Manley, 1992) Able-bodied women have been reported to use pregnancy as a sport enhancing technique (Warren & Shangold, 1997). Most able-bodied women are encouraged to exercise (Artal & Sherman, 1999) however the interrelationship of pregnancy for women with disabilities has not been studied. One of the reasons for this may be the barrier to women with disabilities that prevent them from participating in sport, as well as the small numbers of women with disabilities who actually do participate in sports. Although speculative, it is possible that pregnancy may be added as a last barrier to women with disabilities which prevents participation in sports. Further research in this area is needed to clarify these issues, but one would expect that most women with disabilities would benefit from proper exercise during pregnancy, as their able-bodied counterparts do.

**Conclusion**

Athletes with disabilities represent a fast growing group who are challenging old beliefs and assumptions about the appropriateness of sport participation training. Each year more and more opportunities in sport and physical activity are available for children and adults with disabilities. The benefits are numerous and with proper care and precautions many, if not most, can safely pursue active, sporting lifestyles.
### Disabled Sport Organizations

The following sport organizations for athletes with disabilities are recognized as governing or coordinating bodies by the United States Olympic Committee:

#### United States Olympic Committee - US Paralympics Division
US Paralympics is the National Paralympic Committee of the United States and represents the US interests in the International Paralympic movement.

- **One Olympic Plaza**
- **Colorado Springs, CO 80909**
- **719-866-2030**; fax: **719-866-2029**
- e-mail: [paralympicinfo@usoc.org](mailto:paralympicinfo@usoc.org)

#### Disabled Sports USA
DSUSA is a multi-sport organization providing year-round sports and recreation opportunities for people with disabilities.

- **451 Hungerford Dr., Suite 100**
- **Rockville, MD 20805**
- **301-217-0960**; fax: **301-217-0968**
- e-mail: [information@dsusa.org](mailto:information@dsusa.org)

#### Dwarf Athletic Association of America
The DAAA promotes and provides quality amateur level athletic opportunities for dwarf athletes in the United States.

- **708 Granenstein Hwy, North, #18**
- **Sebastopol, CA 95472**
- **888-598-3222**
- e-mail: [daaa@flash.net](mailto:daaa@flash.net)

#### National Wheelchair Basketball Association
NWBA provides oversight, development and opportunities for basketball participation and elite competition for wheelchair athletes.

- **1130 Elkton St.**
- **Colorado Springs, CO 80907, USA**
- **719-266-4082**; fax: **719-266-4876**
- Web site: [http://www.nwba.org](http://www.nwba.org)

#### United States Association of Blind Athletes
USABA provides opportunities for sports participation and elite competition for blind/visually impaired athletes.

- **33 North Institute Street**
- **Colorado Springs, CO 80903**
- **719-630-0422**; fax: **719-630-0616**
- Web site: [http://www.usaba.org](http://www.usaba.org)
United States Quad Rugby Association
USQRA provides oversight, development and opportunities for rugby participation and elite competition.
Web site: www.quadrugby.com

United States Tennis Association
USTA is the National Governing Body for tennis in the US and provides oversight, development and opportunities for tennis participation and elite competition.
70 West Red Oak Lane
White Plains, NY 10604
914-696-7000; fax: 914-696-7029
Web site: www.usta.com

Wheelchair Sports USA
WSUSA provides individuals who use wheelchairs the opportunity to participate in both recreational and competitive sports. WSUSA promotes competition at the regional, national, and international levels for athletes with permanent disabilities affecting mobility.
P.O. BOX 5266
Kendall park, NJ 08824-5266
732-266-2634; fax: 732-355-6500
e-mail: office@wsusa.org
Web site: http://www.wsusa.org/

Special Olympics International
SOI is a year-round sports training and athletic participation organization for children and adults with mental retardation.
1133 19th Street, NW
Washington, DC 20036
202-628-3630; fax: 202-824-0200
e-mail: info@specialolympics.org
Web site: http://www.specialolympics.org

USA Deaf Sports Federation
The USADSF (formerly American Athletic Association of the Deaf) provides organized competition for adult deaf and hearing impaired athletes.
P.O. Box 910338
Lexington, KY 40591-0338
605-367-5760; fax: 605-782-8441
TTY: 605-367-5761
e-mail: HomeOffice@usdeafsports.org
Web site: http://www.usdeafsports.org/
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BlazeSports Injuries and Medical Issues


