

# Spinal Injuries in the Aquatic Environment

## Part 1: Prevention

by Gerald M. Dworkin

One hot Sunday afternoon, a family was enjoying a leisurely barbeque around their new backyard swimming pool. The children played a game of tag in the pool, while the father cooked on the grill. The mother was carefully watching the children as she sat along the pool edge.

Suddenly, the 12-year-old boy quickly climbed out of the pool, in order to avoid being tagged, and immediately dove back in. In the boy's effort to keep away from his sister, who was trying to tag him, he dove too deeply into the water and struck his head on the pool's bottom. The child floated motionless to the water's surface. The mother quickly jumped into the pool and supported the boy by placing one arm under the child's neck, and the other arm under the child's knees. She then lifted the boy onto the pool deck.

In the mother's attempt to rescue her child, she actually further aggravated a spinal cord injury that occurred when the boy dove into the water and struck his head on the pool's bottom.

Each year, doctors identify and treat approximately 10,000 new spinal cord injuries in this country. The average age of onset is 28.7, and the most common age is 19. Fifty percent of the injuries occur in the 15- to 24-year age group. Eighty-two percent of all spinal cord injuries occur in males.

The following statistics represent the etiologic causes of spinal cord injury in this country: Motor Vehicle 36.5%; Falls 15.8%; Gunshot 11.6%; Diving 10.6%; Other Causes 24.5%.

The major cause of these devastating traumatic injuries is, as you probably expected, motor vehicle accidents. However, the second leading cause are those injuries resulting from sports and recreation activities. Water-related activities are the number one cause of spinal cord injuries resulting from sports and recreation activities.

Each year, approximately 13,000 diving-board-related injuries are sufficiently serious to be brought to hospital emergency rooms; diving accidents cause approximately 800 spinal cord injuries. The Consumer Product Safety Commission (CPSC) estimates that this is a yearly occurrence.

According to the CPSC, "... one of the major accident patterns associated with swimming pools was striking the bottom or sides of the pool because of insufficient depth for diving or sliding..." Further, "... in addition to striking the bottom of the pool, people are injured when they hit protruding waterpipes, ladders, or other objects in the pool."

Diving should be strictly prohibited in shallow water. Over half of the swimming pools in the United States are above-ground vinyl swimming pools, most of which have a constant depth of three to three and-one-half feet. In order to gain entrance into a pool of this type, most pools provide a ladder or platform. Many injuries occur each year when children or adults attempt to dive into the pool from these ladders and platforms.

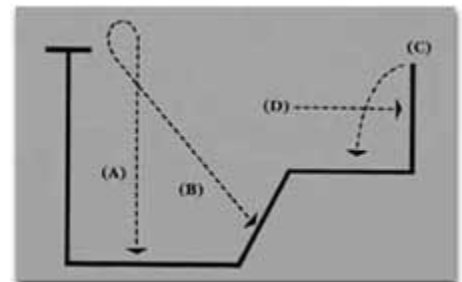
There are four major factors which can cause spinal injuries in aquatic facilities. By realizing this, you can develop or adopt prevention and training strategies and activities to reduce or prevent these injuries from occurring. These factors include:

(A) Diving too deeply off a diving board and striking the bottom before leveling off.

(B) Diving too far out off the diving board or sliding too far out off the slide and hitting the bottom incline of swimming pools.

(C) Diving or sliding into shallow water and striking the bottom.

(D) Striking an object underwater( i.e. side of the pool, obstacles, or another swimmer.



Diving or sliding injuries result from the victim propelling into head contact with some part of the pool or facility bottom. The position of the head and neck, the impact site, and the victim's direction all determine the resulting spinal injury.

You should suspect any victim of a diving or sliding accident of having a spinal injury and handle the victim accordingly.

There are several nationally recognized spinal injury prevention programs you can integrate into your school curriculum or community swim program. The two largest programs are the National Swimming Pool Foundation's Learning How to Dive program, and the Feet First, First Time, Inc. program.

The National Swimming Pool Foundation (NSPF), in cooperation with the National Spa and Pool Institute (NSPI), produced an eight minute film, "Learning How to Dive," on safe diving techniques, and accident prevention principles. Using this film is an ideal way to instill the importance of proper diving techniques; you can use it in a school classroom setting, or at any social, recreational, or educational gathering of youth groups. You can also integrate the film into organized progressive swimming courses conducted through such organizations as the American Red Cross, the YMCA, and the Boy Scouts of America.

"Learning How to Dive" presents the story of a young boy who broke his neck when diving into shallow water. The film instructs proper diving techniques with the help of Olympic Gold Medal Diving Champion Greg Louganis, U.S. Olympic Coach Ron O'Brien, and actor Patrick Wayne. (You can obtain "Learning How to Dive" from the National Swimming Pool Foundation, 10803 Gulfdale, Suite 300, San Antonio, Texas 78216; 512-341-5153, or through your local NSPI chapter or regional office.)

Another program that you can easily implement within your school or community recreation setting is a diving accident prevention program called, "Feet First, First Time." This is a proven prevention program for teenagers and adults. The program aims to convince swimmers to check the depth of the underwater area by jumping, not diving head-first, even if they are certain it's safe to dive.

Feet First, First Time, Inc. provides a marketing guide to help you start safe diving and prevention programs. The booklet contains an explanation of how the program began and useful ideas to promote prevention activities. The complete marketing guide follows proven techniques used by advertising agencies and public relations firms.

(You can get the Feet First, First Time marketing guide from Feet First, First Time, Inc., North Davis Highway, Pensacola, Florida 32523-8900; 904-478-4460.)

The following sections contain various prevention principles and activities you can implement to help reduce or eliminate spinal cord injuries in the aquatics environment. All aquatic facilities should enforce these principles.

### **Principles of Safe Diving**

Know the water depth before you dive. Be sure there are no submerged obstacles or surface objects. Don't dive into an aboveground pool or into the shallow end of a swimming pool. Don't dive into unfamiliar bodies of water.

Plan your dive path. Don't dive from the edge across the narrow part of a swimming pool without having at least 25 feet of clear dive path in front of you. Don't run and dive.

When you dive, you must steer up. Hold your head and arms up, and steer up with your hands. Keep your arms extended and head and hands up during the dive.

Practice carefully before you dive. Test the diving board for its spring before using it to dive. Don't do back dives or fancy dives, or dives with straight vertical entries without proper guidance and instruction, and then only in pools designed for diving.

Don't dive from retaining walls, ladders, slides or other pool equipment. Don't dive from rooftops, balconies, ledges, or fences.

Don't dive from racing starting blocks without proper training and direct supervision from a qualified coach.

Don't dive at or through objects such as inner tubes.

Don't swim or dive alone. Do so only with a "buddy" and preferably under qualified supervision.

Don't drink or take drugs during or prior to participating in aquatic activities. The slowing effects of alcohol or drugs on reaction time can be extremely dangerous in diving.

### **Principles of Safe Sliding**

Do not allow any slider to slide headfirst at any time. Allow only sitting slides.

Allow only one slider on the slide at a time. Clear the landing area before you allow the next slider.

Prohibit other people from using the water landing area in front of the slide.

Maintain a minimum water depth of five feet in the slide landing area.

### **Reducing Springboard Diving Accidents**

The following recommendations minimize or eliminate springboard diving accidents. Unfortunately, there is no legislation in most states that mandates that the swimming pool industry follow these standards. The safest pool design provides a pool for springboard and platform diving, and a separate pool for swimming. Where this is not feasible, divide the diving area from the rest of the pool by a bouyed line.

A minimum water depth of 12 feet in the landing area is necessary for safe diving from competitive diving boards, which are usually 16 feet long, and placed either one or three meters above the water's surface.

Recreational diving boards (12 to 14-foot long) should have a landing area with a minimum water depth of ten feet. However, we still recommend the 12-foot minimum.

Extend the maximum of water immediately below the tip of the diving board forward for a distance of 16 feet before the bottom slopes upward.

Carry the maximum depth of water laterally ten feet on either side from the center line of the board.

Do not permit recreational divers to manipulate the adjustable fulcrum on springboards, unless they have been trained to do so. During recreational swimming periods, the adjustable fulcrum should be locked in a fixed position, preferably in its most forward position, in order to reduce the spring of the board.

Provide water surface agitators to provide greater visibility of the water's surface and help reduce the potential for injury.

### **Factors Contributing to Springboard Diving Accidents**

The following are contributing factors of springboard diving accidents. By identifying the causes, facility managers can reduce or completely eliminate these factors.  
Inadequate underwater and overhead lighting. This condition can prevent the diver from seeing the pool bottom.

Cloudiness (turbidity) of the water. This condition is usually caused by a chemical imbalance, or a faulty filter system.

Lack of any markings, lines, or targets on the pool's bottom fails to provide divers with a visual reference for judging the bottom's profile and water depth.

Glare on the water's surface, caused either by the sun or from lights which are improperly located.

Impaired vision of the diver, caused by the need to remove eye glasses before diving.

## **Recommendations for Open Water Areas**

In addition to the recommendations and principles previously mentioned in this article, you should place warning signs, lifeguards, and fencing at sites where the water depth is insufficient for diving, or where the bottom contains dangerous obstacles. Diving should be strictly prohibited in these areas.

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## **Spinal Injuries in the Aquatic Environment Part 2: Emergency Procedures**

All public and semi-public aquatic facilities should be equipped with appropriate spinal immobilization devices (SIDs), in addition to cervical collars, lateral stabilization items (i.e. blankets, towels, sand bags, and so forth), and appropriate immobilization material (i.e. straps and bandages). Aquatic personnel should be well trained in using this equipment, as well as in appropriate response procedures should a spinal emergency occur. Backyard swimming pool owners should also know what to do to stabilize a victim with a suspected spinal injury until they can obtain emergency medical services personnel.

### **A. Handling Victims in Shallow Water**

If you find the victim face down in the water, you must carefully rotate the victim to a supine position. To do this, you must be careful to avoid any bending or twisting of the victim's neck and torso to avoid aggravating existing injuries.

Place one forearm along the length of the victim's sternum with the hand of that arm supporting the bony structure of the victim's lower jaw. Simultaneously place your other forearm along the length of the victim's spine, supporting the victim's head at the base of the skull with your hand. Then support the victim's head and torso with your forearms and hands with an inward and upward pressure. As you do this, submerge, while maintaining this support position on the victim, and rotate the victim to a supine position.

Once the victim is in a supine position, you must then continue to support the victim from the side by placing one hand behind the neck and the other hand along the victim's back. This technique will maintain proper alignment of the victim and will keep him/her in a supine position. Additional rescuers should bring the necessary equipment (i.e. SID, straps, lateral head/neck restraint, and so forth, and position a cervical collar around the victim's neck.

To place a spinal immobilization device under the victim, rescuers should position themselves at each end of the device, which is floated alongside the victim in the water. On command, the rescuers lower the SID beneath the victim and allow it to come up slowly until the victim is completely supported. Care must be taken during the ascent of the SID to properly align it with the victim. The first rescuer is responsible for maintaining the victim in alignment, in a supine position, until this is accomplished. Once the SID is in place and the victim is adequately resting on it, the first rescuer may then begin immobilizing the victim to the SID.

Place head and neck lateral immobilization restraints along both sides of the victim's head in order to reduce the risk of any lateral movement. Once you accomplish this you may begin immobilization of the victim to the SID.

I recommend the following sequence for securing the victim to the SID using traditional straps and cravat bandages:

1. Across the chest.
2. Above the waist to include the arms at the sides.
3. At the hips to include the hands at the sides.
4. Above the knees.
5. Below the knees.
6. Across the forehead.
7. Other - to include feet or other areas for additional support.

This technique of immobilization allows for the greatest mass of the body to be secured prior to securing the head. This procedure reduces the risk of aggravating injury to the cervical spine should the body move because of wave action.

## **B. Handling Victims in Deep Water**

If you suspect a spinal injury in deep water, you should turn the victim from a prone to a supine position and then float the victim to shallow water, where you can then immobilize him/her onto an appropriate SID. However, in aquatic facilities which have a uniform deep water area (i.e. diving wells) or those facilities where the deep water is divided from the shallow water by a buoyed line, bulkhead, or other obstruction, you must bring the SID to the victim. First attach flotation collars or other suitable flotation devices to the SID. Place the flotation device/collar on the upper half of the SID only, to allow the rescuers to submerge the lower half under the victim.

The flotation device-collar should be attached to the SID at all times, but still be easily removed while you immobilize the victim to the SID for transportation by ambulance to the medical facility.

Rotate a victim in deep water from the prone to the supine position in the same way you would in shallow water. You can also use this same technique for a victim who is submerged and who may be lying on the bottom of the pool or open water facility. You must use extreme caution when recovering the victim in order to assure that the victim is maintained in alignment while being brought to the surface. To do this, support the victim as previously described and swim diagonally to the surface while rotating the victim to a supine position.

Placing the flotation SID under a victim in deep water requires two to three rescuers. It is preferable that the rescuers wear some type of personal flotation device (PFD) during the rescue to lessen their fatigue.

Rescuer #1 rotates the victim to, or maintains the victim in, a supine position. Rescuer #2 places a cervical collar around the victim's neck while Rescuer #3 positions the flotation SID in preparation for placement under the victim. One rescuer places the foot end of the flotation SID at the victim's head. Rescuer #1 supports the victim's head and neck with one hand and guides the flotation SID with the other hand in order to prevent the SID from hitting or making contact with the victim. Rescuers #2 and #3 grab the victim's upper arm near the armpit, and slide the victim onto the flotation SID. Because the lower half of the flotation SID has no flotation attached, it is easily submerged for this purpose. The support provided by the water and the flotation SID provides sufficient support for the entire body.

Once the rescuers have placed the victim appropriately onto the flotation SID, they temporarily immobilize the head with a lateral restraint device (i.e. rolled blanket or sandbags) and secure the torso and extremities. Cravat bandages are then used to immobilize the head.

After the rescuers immobilize the victim onto the flotation SID, they should float the victim along the long axis of the body to the platform or deck for removal from the water, then pull the head of the flotation SID onto the platform while allowing the foot of the device to drop deeper into the water.

To expedite the handling of suspected spinal injuries in open water areas where additional protection of the victim may be required, you can use a flotation basket stretcher. This device consists of a standard basket stretcher with a suitable SID secured within it, and a flotation collar attached around the upper half of the stretcher. The SID should be secured to the basket stretcher at the head and foot so that you can easily remove it from the basket stretcher once the victim is placed on shore. The victim immobilization straps are attached to the SID and not to the basket stretcher.

The flotation basket stretcher is especially beneficial in white water rescue operations and when the victim is being handled in surf, moving water, or cases when the victim will be transferred from the water to a boat or helicopter.

Placing the flotation basket stretcher under the victim and immobilizing the victim into the device are very similar to the techniques used to immobilize the victim onto the flotation spinal immobilization device. However, after removing the flotation basket stretcher from the water, you also remove the two straps securing the head and foot of the SID to the basket stretcher. This allows you to remove the SID, with the victim attached to it, from the basket stretcher for emergency transport to the medical facility.

### **C. Handling Victims in Backyard Swimming Pools**

Once you have turned the victim from a prone to a supine position in the water, you should maintain the victim in a horizontal position until emergency medical personnel arrive. If a rigid support is available, such as an ironing board or picnic bench, place it under the victim and then raise it until the victim is resting adequately on the support. This will help immobilize the victim's spine until the EMS personnel arrive. If a rigid support is not available, you should support the victim on the surface of the water until additional medical help arrives.

### **D. Rescue Breathing and CPR**

In all cases, once you have turned the victim from a prone to a supine position in the water, you should determine whether or not the victim is breathing. To do this, keep the head and neck in a neutral position, place your cheek directly above the victim's mouth and nose and look at the chest. If the victim is breathing, you should be able to observe chest movement and hear and feel the victim's breath against your cheek.

If the victim is not breathing, you should provide two slow, full breaths to the victim and then check the victim's pulse. If the victim is not breathing, but has a pulse, then perform rescue breathing with the victim maintained in the water until he/she can be immobilized onto an SID and removed from the water. If the victim is not breathing and does not have a pulse, you must immediately remove the victim from the water to a firm flat surface and administer CPR. When removing the victim, attempt to keep the victim from twisting or bending.

## **SUMMARY**

To reduce or eliminate spinal cord injuries in the aquatics environment, general principles for safe behavior must be practiced by the public, and must be enforced by the facility management. Recreation personnel-responsible for providing aquatic recreational opportunities must implement and enforce every safeguard possible to eliminate or minimize the risk of injury which may lead to spinal injury.

Families with backyard swimming pools should know proper first aid, CPR, and basic water rescue skills. This training is offered by such organizations as the American Red Cross, YMCA, American Heart Association, as well as many others. First aid kits should be available with sufficient dressings and bandages to stop bleeding and prevent infection from cuts, scrapes, and so forth. A telephone should be available with the local emergency medical services (EMS) telephone number posted near it so that these services can be contacted if needed.

The same principles apply to recreation personnel. Lifeguards need to know first aid, CPR, and lifesaving techniques. Spinal immobilization, first aid, and water rescue equipment must be readily available for use during an emergency. And, the lifeguard personnel must be proficient in its use.

Recreation agencies and personnel can play a crucial role in educating the public in preventing spinal cord injuries. Whenever possible, spinal injury prevention programs, such as the Feet First, First Time program and the Learning How to Dive program mentioned in Part I of this article July, 1987, PARKS & RECREATION) should be implemented and integrated into school and community settings in order to educate the public, especially pre-teenagers, about the dangers of diving into unknown bodies of water or shallow water. These educational programs should also include basic principles of how to dive properly.

**Lifesaving Resources Inc. - [www.lifesaving.com](http://www.lifesaving.com)**