Chapter 5.0:
Raft Safety [1]

The ACA materials combine safety with rescue. This chapter breaks out safety and the next chapter focuses on rescue. This chapter focuses on general safety principles that affect rafting but are not rafting specific. These principles include the rescue curve, physiology, hypothermia, hyperthermia, clothing, and signaling. The next chapter focuses on rescue techniques specifically associated with rafting. Group management and feeling comfortable in the water was moved to the trip leadership chapter.

Rescue Curve

The rescue curve describes rescue in terms of who does what when and what will happen if those attempts fail. The rescue curve states that once an incident occurs, "***without intervention, the probability of survival or avoiding injury, damage, or loss increase with time***." The rescue curve has been refined several times since it was first developed by Kauffman and Carlson (1992) (Figure 5.1). Although the model was originally developed in the context of outdoor activities, it has been generalized to non-outdoor activities (Kauffman, 2003).

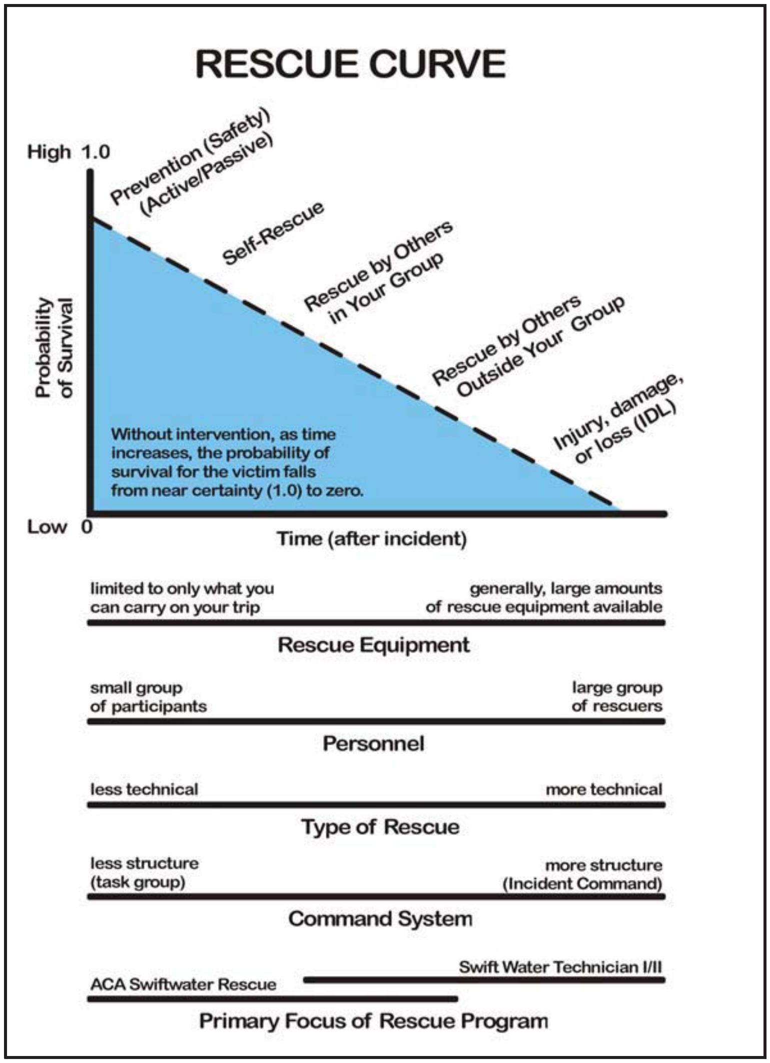

Figure 5.1: The Rescue Curve – The rescue curve suggests that once an incident occurs, without intervention the probability of survival decreases as time increases. The four stages of the rescue curve are prevention and safety, self-rescue, rescue by others in the group, and rescue by others outside the group. The differences in rescue equipment, personnel, type of rescue, and command structure are addressed with the curve. Source: Kauffman and Carlson, 1992, Kauffman 2003.

<b>**<u>Phases of the Rescue Curve</u>** – The rescue curve has five phases (Figure 5.1). These are safety and prevention, self rescue, rescue by other in your group, rescue by others outside your group including rescue squads and injury, damage or loss.

<c>***Safety and Prevention*** – According to the rescue curve, the first line of defense is safety and prevention. These include the active

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and passive measures that the participant should take to avoid a rescue situation or, if a rescue situation occurs, to better help survive the situation**.** ***Active measures*** are measures a participant takes to help prevent an incident from occurring. Boaters use their knowledge, skills, and abilities to avoid a situation in which a rescue is necessary. Their ability to know routes, avoid hazards, and maneuver the raft to avoid them are examples of active safety measures. ***Passive measures*** are measures that normally do not help prevent the initial incident from occurring but help during the rescue phase. Wearing a life jacket is the classic example. Wearing a wetsuit or drysuit are examples also. They don't prevent the incident from occurring, but help once an incident occurs.

<c>***Self-rescue*** – The first level of defense after an incident occurs is self-rescue, or what the victim can do to rescue himself. A passenger falls out of the raft. They swim to the raft and climb into the raft. Or, they swim to shore where they are picked up by a raft.

<c>***Rescue by Others in Your Group*** – The third line of defense is rescue by others in the victim's group is the next line of defense. The guide throws a line to the victim and hauls them into the raft. The raft pins and the group extricates it.

<c>***Rescue by Others Outside the Victim's Group*** – The next line of defense, rescue by others outside the victim's group, includes the rescue efforts of people passing by or the rescue squad. The company or rescue squad extricates the pinned raft. Another rafting group assists in the rescue of a foot entrapment.

<c>***Injury, Damage, or Loss*** – If no one rescues the victim, additional injury, damage, or loss usually occurs. Even if the climber is not injured by the initial fall, he will experience additional injury or even death without intervention. The paddler who is not rescued may eventually flush through the rapids and naturally wash up on the shore.

<b>**Available Resources and the Rescue Curve** (see Figure 5.1) – The rescue curve is useful in helping to explain the resources available to or influencing the rescuers. The rescue squad is in the business of performing rescues. As a general rule, the rescue squad has lots of personnel and equipment at their disposal to perform a rescue. In addition, they have trained extensively in rescue procedures. In contrast, people participating in the recreational activity are interested in performing the activity. Rescue is what happens when something goes wrong performing the activity. It is not that they are interested in rescue. They are. However, they are more interested in performing the activity. Often they think in terms of how they can adapt the equipment used in performing the activity to a rescue situation, or they will bring along with them simple devices as long as these items don't interfere with the performance of doing their activity. In terms of personnel, they are limited by who is in their group unless, of course, they are doing the activity alone. In that case, they bypass this phase for the next phase. The following example illustrate the differences in resources between participants in the activity interested in rescue, and the rescue squad who is prepared to rescue others. In a paddling group of 5 people, 4 people must conduct the rescue assuming that one person in the group is the victim; this is a small group for a whitewater rescue. In contrast, a rescue squad could have 20 to 30 trained rescurers available to them for a rescue.

Regarding equipment, climbers usually do not bring rescue pulleys and a Stokes litter with them; the rescue squad does. The paddler group might have two carabiners per person and several rescue bags. This makes any rescue involving a lot of carabiners or several hundred feet of rope difficult. In contrast, the rescue squad usually arrives with large amounts of specialized rescue equipment.

<b>**<u>911 Syndrome</u>** (Figure 5.2) – The 911 syndrome focuses on the difference between inexperienced and experienced participants. More experienced, specialized participants tend to begin their rescue efforts with safety and prevention. They focus on their equipment and on developing their skills and rescue techniques. They know that if a potential incident occurs, their first line of defense is self-rescue. If self-rescue does not occur, they can move very quickly through the stages of the rescue curve and run out of options. Experienced participants tend to front-load their activity with safety and prevention because they know their survival depends on it.

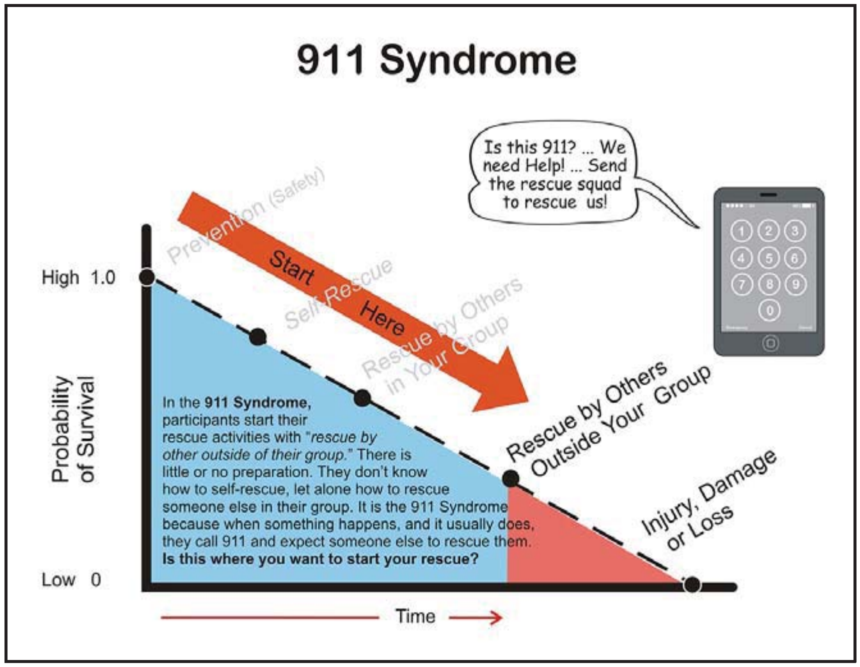

Figure 5.2: 911 Syndrome – In the 911 syndrome, participants begin their rescue efforts by calling the rescue squad (i.e. rescue by others outside your group). Source: Author – [file: \RK-911Syndrome.cdr].

In contrast, inexperienced or "activity for a day" participants usually do not have the necessary skill, knowledge, or training to perform a rescue, and they most likely do not possess or know how to use rescue equipment. They tend to quickly skip over the first three phases of rescue (i.e., safety and prevention, self-rescue, and rescue by others in the group) and immediately go to the fourth phase—rescue by others outside the group. They call 911 and hope that someone comes to rescue them. Usually, they believe that it is the responsibility of someone else to rescue them (Kauffman, 1992; Kauffman et al., 1991), and rely almost completely on the resource manager or the rescue squad for their survival.

Physiology Considerations

Man is a tropical animal. This means that in order to survive in temperate or polar environments (i.e. non-tropical) environments, man needs protection or insulation. Stated another way, the human body is designed to run within a narrow temperature range. Specifically, the body seeks to maintain the heart, lungs and brain (body core) at 98.6ºF mean temperature.

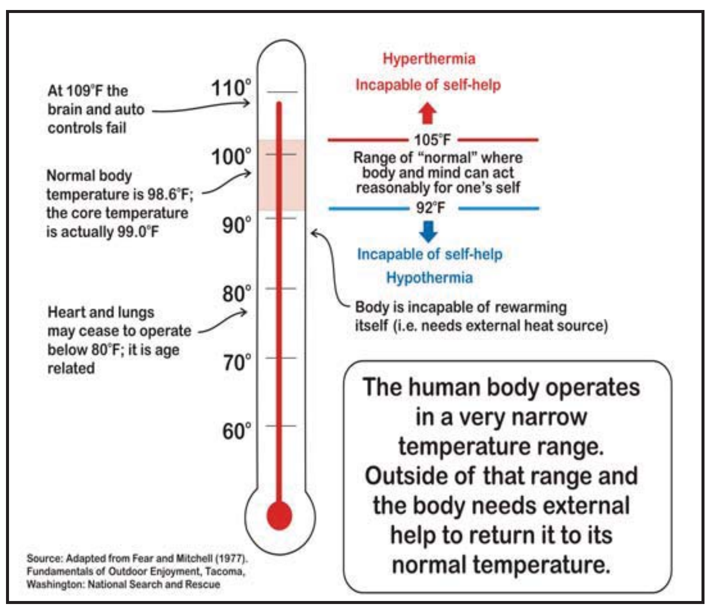

Figure 5.3: Narrow Operating Range – The body has a narrow operating range between roughly 92ºF to 105ºF. Source: Author – [file: \PH-TempRange.cdr].

Mean temperature means that some people operate at a slightly higher temperature and some people operate at a slightly lower temperature. On average, the operating temperature of the core is 98.6ºF (Figure 5.3).

There are three ways the body maintains core temperature and to heat the body: 1) generate heat through muscle contraction (e.g. shivering), 2) use an external source of heat (e.g. sitting in front of a car heater), and 3) insulate which reduces heat loss (e.g. wear a wetsuit). Conversely, there are three ways to cool the body: 1) sweat which cools the body through evaporation, 2) remove an external source of heat, and 3) remove insulation and allow for greater heat loss. Consciously and unconsciously, people use a combination of all three methods to maintain core temperature.

<b>**Methods of Heat Gain/Loss** – There are four ways the body gains or loses heat (Figure 5.4). These are conduction, convection, radiation, and evaporation.

<c>***Conduction*** is the transfer of thermal energy though a solid or between two solids in contact with each other. Touching a radiator in Figure 5.4 transfers the heat in the radiator directly to the fingers touching it. Sitting on a rock at ground temperature (55ºF), the person's buttocks will get cold. Actually, the body heat is lost through conduction to the rock or the buttocks is heating the rock.

<c>***Convection*** is the transfer of heat by the circulation of a fluid (e.g. water or air). The purpose of a convection current is to equalize the temperature differential between the hot and cold areas. The greater the differential between the hot and cold areas, the greater the potential for the creation of a convection current and the stronger the current.

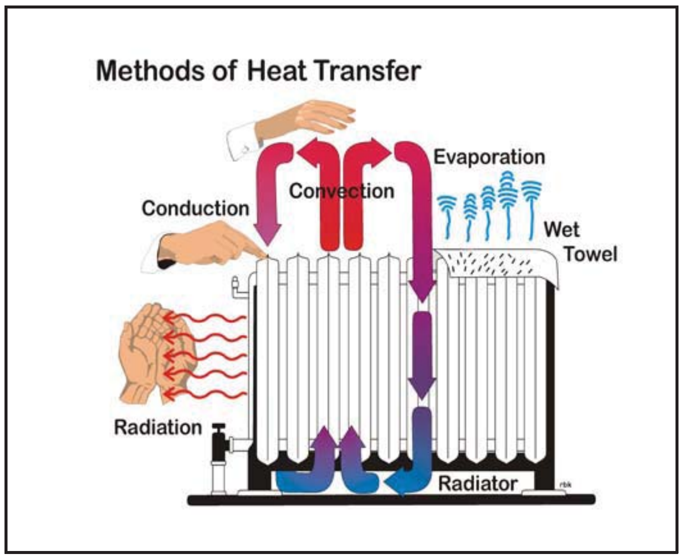

Figure 5.4: How the body gains and loses heat.

In a cold water setting, the differential between 50ºF or 60ºF water and the human body can set up a strong convection transfer of energy. Insulation is the primary defense. The primary method of insulation is to created dead air spaces that are sufficiently small, that they prevent the creation of convection currents.

Essentially, wetsuits (see Figure 5.10) and drysuits (see Figure 5.9) use different approaches to insulate against convection losses. Both create a micro-climate surrounding the body. Neoprene is a closed cell foam. The cells in the foam are sufficiently small to retard heat loss. The water and sweat trapped next to the skin creates a micro-environment protected by the neoprene wetsuit. In contrast, a drysuit creates a waterproof barrier that enables the garments worn underneath to create the dead air spaces.

<c>***Radiation*** is energy that is transferred through waves radiating from the emitting substance. The radiator in Figure 5.4 is the emitter. The waves cause the molecules in the object being heated to vibrate. The friction from their vibration generates heat in the object being heated. Microwaves cook food using this method. People sitting around a campfire are heated by the heat radiating from the campfire. Dead air spaces or even a vacuum has no effect on stopping or retarding radiating heat. The radiating energy passes through a dead air space or vacuum. The usual method to handle radiation losses is to

reflect them inward with a reflective surface. Addressing radiation losses in cold water environments has not had a major focus.

<c>***Evaporation*** is the conversion of a liquid to a gas. In order to do so, the liquid needs to absorb energy to convert it to a gaseous state. The energy is absorbed from the environment which results in cooling the environment. Evaporation of sweat is the method used by the body to cool itself and keep it within its proper operating temperature. Evaporation plays an important role in how the body cools itself which is discussed in the next section.

<b>**<u>The Sweating Process</u>** – Under normal situations, the sweating process is the primary method the body uses to cool itself. It should be noted that the body can lose heat through other functions including respiration, urination, and defecation. Of these, respiration can often become a significant contributor of heat loss.

The sweating process works as follows (Figure 5.5). Heat is produced by the body. It needs to be dissipated. The warm blood is shunned to the skin for cooling. The skin secretes water through the sweat glands. The water evaporates. In order to evaporate, the water absorbs energy. The energy is absorbed from the skin cooling the skin and cooling the blood in the capillaries. The cooled blood is transported back to the body's core or muscles where it becomes reheated. The process is repeated.

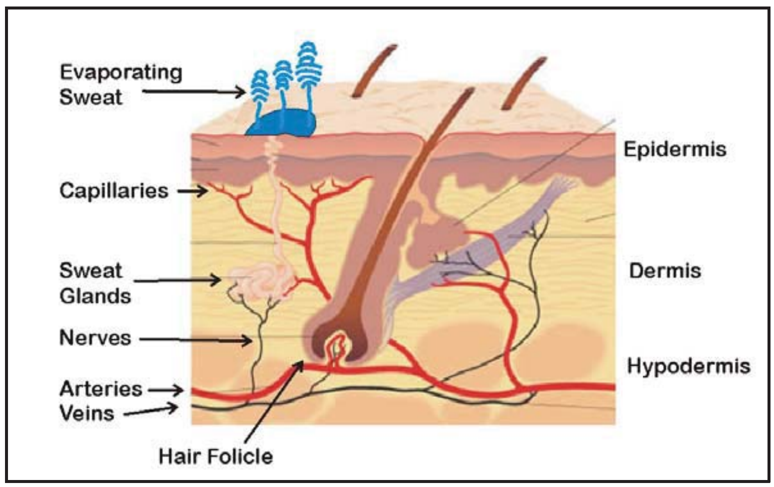

Figure 5.5: The skin sweating.

<b>**<u>Compensatory and Decompensatory</u>** – The thermoregulatory process described so far is a compensative process. *Compensatory* is when the body seeks to compensate and readjust to the stresses placed on the body, in this case the thermal stresses of hot and cold. As noted, it does this by increasing its heat production, by increasing or reducing energy received from outside sources, and/or by adding or subtracting insulation. Technically, the body seeks *homeostatus*. "Homeo" means "like" and "status" mean "state." The process just described is a process by which the body readjusts to changes in temperature and reaches homeostatus.

The body seeks to compensate. When the body is no longer able to compensate and maintain homeostatus, it shuts down. The shutting down process is *decompensatory*. In terms of thermoregulation, heat exhaustion and shivering are compensatory processes. Heat stroke and hypothermia are decompensatory. These processes are described in the sections on *Hypothermia* and *Hyperthermia*.

<b>**<u>Seeking Homeostatus</u>** – Thermoregulation is the body's process of attempting to maintain its operating temperature at a mean temperature of 98.6°F. Normally, it is a compensatory process where the body seeks homeostatus. The body gains and loses heat through conduction, convection, radiation and evaporation. Using these process, the body uses one or all three methods to maintain its optimum operating temperature. It can increase heat production. Exercise and shivering are examples of heat production. It can gain or lose heat due to external sources. Sitting in front of a campfire is a method of

gaining an external source of heat. Or the body can change the amount of insulation surrounding the body. This can be as simple as putting on or removing a hat or sweater as needed.

Hypothermia

Hypothermia results when the core temperature of the body (heart, lungs and brain) drops below 95ºF. "Hypo" means "low" and "thermia" refers to temperature. Hence hypothermia refers to low body temperature. It should not be confused with hyperthermia which is a high temperature or overheating of the body. Physiologically, the body is designed to handle cold stress and it results in a systematic shutdown of the body to maintain the core temperature of the body for as long as possible. If untreated hypothermia can cause death. Hypothermia is a secondary cause of death in that the actual or primary cause of death is usually something else such as heart failure or drowning. The key to preventing hypothermia is to spot it early and take appropriate action. This may seem simpler than it seems, but prevention is key because in the field there are often few options once hypothermia becomes advanced.

<b>**Types of Hypothermia** – Generally, there are two types of hypothermia. The first is *"chronic hypothermia*." Chronic hypothermia occurs over a long period of time. Typically, it is found in backpackers and the elderly. For the backpacker, the onset may occur over a period of a day or more and for the elderly, its onset may occur over several days or even weeks. The critical difference between chronic and immersion hypothermia is that with chronic hypothermia, the body undergoes physiological changes that result in chemical unbalances.

"*Immersion hypothermia*" results from a rapid onset of hypothermia. Perhaps a better title is "rapid onset hypothermia," but since most cases involve cold water immersion, it is referred to immersion hypothermia. Typically, the ship goes down. The passenger jumps into the fridge water. Within several minutes, the passenger becomes hypothermic and if untreated is dead within twenty or thirty minutes. Because of its rapid onset, the chemical balance of the body doesn't become significantly upset.

For boaters and water related activities, often, the participant initially experiences chronic or long-term hypothermia. Usually, its effects such as impaired coordination lead to immersion in the water and immersion hypothermia. Hence, the hypothermia is a combination of both types of hypothermia. It has some of the elements of chronic hypothermia, but it is eventually overshadowed by immersion hypothermia.

<b>**Symptoms** – The symptoms of hypothermia are listed in Figure 5.6. As a practical matter, the best symptom of the beginning stages of hypothermia is shivering. Shivering is the body's reaction to cold stress. Shivering is the involuntary contraction of the muscles. It is like running a marathon without going anywhere. The purpose of shivering is to produce heat and the heat produced is used to heat the body. The problem is that shivering consumes large amounts of energy. It is a temporary fix because if unabated, the body will quickly run out of energy to fuel the shivering process. This is why it is important to recognize the onset of hypothermia quickly and to take action to treat it.

Figure 5.6: Core Temperatures versus Symptoms of Hypothermia [1,2]	
Core Temperature	**Symptom/Comment**
98.6ºF to 96ºF	**Intense shivering at rest** – In terms of the hypothermic progression, the importance of this symptom cannot be over emphasized. Also, it is usually a good sign. The victim is capable of rewarming themself and hypothermia can easily be abated. At rest is added because activity creates surplus heat that can mask shivering.
95ºF to 91ºF	**Violent shivering, slurred speech and slurred thinking** (e.g. The victim claims that "I'm not hypothermic" when the symptoms indicate otherwise.)
90ºF to 86ºF	**Shivering stops or diminishes; with this there is a loss of muscular coordination and thinking.** – If rewarming efforts have not occurred, diminished shivering is not a good sign.
85ºF to 81º F	**Irrational, muscle rigidity, slowed respiration and pulse** – In the field, these symptoms are hard to assess. Usually, the symptoms manifest themself in lack of coordination, stumbling and not being able to perform simple functions like zippering a zipper.
80ºF to 78ºF	**Unconsciousness, failing reflexes, erratic heartbeat** – In the field, the victim becomes lethargic. They want to stop and rest, etc.
Below 78ºF	**Death** – Usually the heart stops, but at this point most internal functions have shut down. It is which cause is selected as the cause of death.

[1] Source: Adapted from Fear and Mitchell (1977). Fundamentals of Outdoor Enjoyment, Tacoma, Washington: National Search and Rescue.
[2] The key to the treatment and prevention of hypothermia is to identify the primary symptom of shivering early and taking action.

Shivering is a good symptom because if the proper steps are taken, the body will rewarm itself. Treatment is three-fold. First, increase the victim's insulation. Remove wet clothes and put on dry clothes. Insulate the head with a cap. Place them in a sleeping bag. Second, replenish the fuel in the human engine. Provide the victim with warm sugary food and liquids. Note that feeding the victim is not recommended in the later stages of hypothermia since the body shuts down the digestive tract in its attempt to conserve energy. Third, provide the victim with external heat. A campfire or car heater are examples of external sources of heat.

"At rest" is added for the following reason. As previously noted, physical activity produces heat that can temporarily mask the onset of shivering. Simply the body doesn't need to shiver because the heat produced as a by-product of activity heats the body. If working with groups, sit everyone down for a brief break and check to see if anyone begins to shiver. If they do, it is time to take action.

Physiologically, the body reacts to cold stress with a systematic shutdown of the body. First, it shuns cold blood to the extremities in an effort to keep the core warm. This can lead to "after shock" which will be discussed later. Coordination is adversely affected. Zippering a zipper may become a difficult task. Second, in its effort to conserve energy and keep the core warm, the body will begin to shut down bodily functions. The body will restrict blood flow to the digestive system and digestion will cease. Consumed food and water may simply sit in the digestive tract. Mentally, cold stress initially affects the higher levels of cognitive thought. The result is poor judgement and impaired rational thought. All of these events can easily lead to accidents and mishaps in and of themselves.

As the victim's core body temperature continues to lower, shivering will diminish and eventually stop. Essentially, the body runs out of fuel to feed the human engine used to create the heat for shivering. The brain is now cold and not functioning properly. High cognitive levels of rational thought are affected the most. Hence, the victim has bad judgement and makes poor decisions which can often result in additional harm. The more primitive autonomic nervous system is still functioning and slower in shutting down. At this point in the hypothermic process, the body is not able to rewarm itself and needs external assistance.

As the hypothermic process continues, the body continues its systematic shutdown. The victim becomes unconscious and eventually death results. Usually death is due to heart failure.

<b>**Treatment in the Field** – Treatment of hypothermia in the field differs from treatment in a clinical setting. In both settings, the patient is rewarmed. The difference is how this rewarming is performed. In a clinical setting, there are techniques available that can warm the core of the body more directly and reduce after-shock.

In the field, the best treatment of hypothermia is early detection. The best symptom is to look for shivering at while at rest. Shivering is the body's first line of defense. In addition, shivering is a good indicator that the body can rewarm itself. There are three strategies to aid in this rewarming. First, is to increase insulation of the body with warm dry clothes. Don't forget the head. Second, stoke the fuel tank to feed the human engine. Sugary foods and fluids are a good source for this energy. Third, provide an external source of heat such as a campfire or car heater.

Rewarm the hypothermic victim until they begin to sweat. Sweating is an indication of the body cooling a slightly overheated body. Small beads of sweat on the forehead are an indication that the victim is no longer hypothermic and that the person has been completely rewarmed. Technically, there are three key indicators of rewarming: return of subcutaneous blood flow, a bump in heart rate and beads of sweat. In the field, the first two indicators are difficult at best to determine. In addition, the rewarming person will often feel a flush feeling of warmth. This is a sign that rewarming is approaching conclusion, but not quite there yet. Continue to rewarm until beads of sweat appear on the forehead.

<b>**After-shock** – "After-shock" results when the body begins to rewarm. As a defense to protect the core, the body shuns cool blood into the extremities. As rewarming occurs, this cold blood is reintroduced and re-circulated back into the core of the body. The result is that the hypothermic victim's core temperature decreases further before it increases. After-shock refers to this effect where rewarming the victim actually results in a lower body temperature. In cases of severe hypothermia, it can result in death. In mild hypothermia, it should not present a problem. Again, in the field, it doesn't change the treatment which is to rewarm the victim.

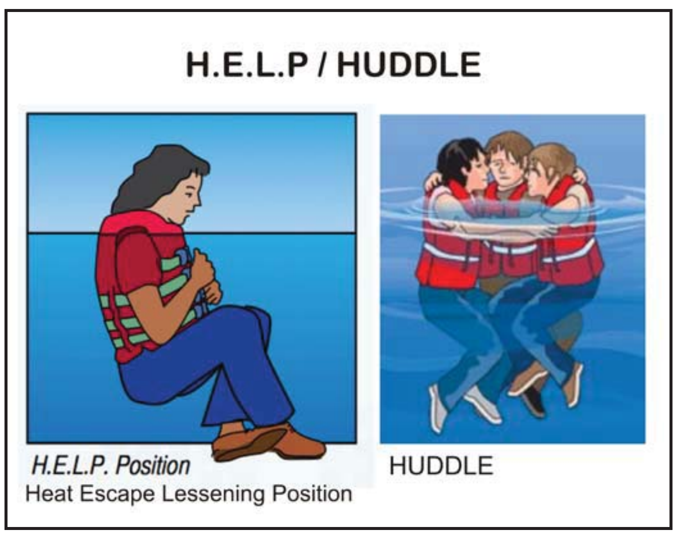

Figure 5.7: H.E.L.P and Huddle. Source USCG [file: \HELP_HUDDLE.jpg]

The more hypothermic the victim the greater the risks from after-shock and the more likely that death can result. In the field, there is little that can be done to prevent after-shock. This underlines the need for early detection and treatment of hypothermia. After-shock is also the reason for the differences in treatment in a clinical setting and in the field. Rewarming techniques in a clinical setting are specifically designed to reduce after-shock.

<b>**Alcohol and Hypothermia** – Alcohol dilates the capillaries. In the early stages of hypothermia, it increases blood flow to the extremities and accelerates the onset of hypothermia. Conversely, alcohol should not be given as part of the treatment. Again, it dilates the vessels which can enhance after-shock. In addition, it has no nutritional value.

<b>**Gag Reflex** – Quick immersion into cold water can cause a “gag reflex” which is an involuntary shutting down of the larynx and breathing. If the person is temporarily underwater, it can cause a dry drowning. A drysuit, wetsuit, paddling jacket with polypro garments and other thermal protection in the back area is the best protection against the gag reflex.

<b>**H.E.L.P/Huddle** (Figure 5.7) – For rafters, most rescue situations will involve pickup by a raft or swimming to shore. H.E.L.P and Huddle are open water techniques designed to reduce heat loss. H.E.L.P stand for Heat Escape Lessening Position. Essentially, the person balls up to reduce heat loss. Since the water transfers heat up to 25 times faster than air, the life jacket helps to conserve heat by keeping the head out of the water. As its name suggests, people huddle together in the water to reduce heat loss with Huddle. Again, these are open water techniques more so than swiftwater techniques.

Hyperthermia

Hyperthermia results when the core temperature of the body (heart, lungs and brain) elevates above 99.5ºF. “Hyper” means “elevated” and “thermia” refers to temperature. Hence hyperthermia refers to an elevated body temperature. It should not be confused with hypothermia which is a low temperature of the body. Physiologically, the body is designed to handle heat stress and it results in a systematic shutdown of the body to maintain the core temperature of the body for as long as possible. If untreated hyperthermia can cause death. Hyperthermia is divided into two phases: heat exhaustion and heat stroke. Heat stroke is life threatening and people who have survived heat stroke, often have permanent thermoregulatory damage.

<b>**Heat Exhaustion** (Figure 7.8)– Heat exhaustion is “compensative” meaning that the body attempts to compensate for the stress and return the body to normal operating temperature. Generally, heat exhaustion results when the body is above 99.5ºF and below 105.1ºF. Heat Exhaustion is caused by the body overheating. Usually, it is sun related.

Heat exhaustion and dehydration are closely related. They have similar symptoms: Prolonged and profuse sweating, muscle cramps, clammy skin, nausea and disorientation. The difference is that with heat exhaustion, the body is no longer able to control its temperature. Water losses are significant. The body in a “hot environment” can easily lose 3.5 quarts of water a day, mostly through sweating. Add exercise and water losses can easily exceed a gallon of water a day. In its attempt to cool the body, it is easy to see how the body can easily become dehydrated.

Figure 7.8: Core Temperatures versus Symptoms of Hyperthermia (i.e. Heat Exhaustion and Heat Stroke) [1]

Core Temperature	Symptom/Comment
105.1ºF	**Heat Stroke:** (Note: Heat stroke is life threatening) 1) Sweating stops 2) Victim's skin turns pink or red
99.5ºF to 105.1ºF	**Heat Exhaustion:** (Note: similar symptoms to dehydration) 1) Prolonged and profuse sweating 2) Muscle cramps 3) Clammy skin 4) Nausea 5) Disorientation

Source: Fear, G., and Mitchell, J., (1977). Fundamentals of Outdoor Enjoyment, Tacoma, Washington: National Search and Rescue.

Treatment for heat exhaustion is two-fold. First, remove the victim from the source of the overheating. Usually, this is the sun. This means moving the victim to the shade. Second, replenish water and electrolytes. As noted, water losses can be significant and need to be replenished.

A fever and heat exhaustion have overlapping temperature ranges. Heat exhaustion is caused by environmental factors, external to the body. Other than for the heat stress, the body is operating normally. In contrast, a fever is purposely caused by the body to kill pathogens. Normally, a fever is the result of an illness.

<b>**Heat Stroke** – Heat stroke usually occurs when the temperature of the body rises above 105.1ºF. Heat stroke is "decompensatory" where the body can no longer compensate and literally shuts down. In simple terms, it is crashing and crashing quickly. Heat stroke is life threatening and death can easily result. People who have experienced heat stroke and recovered often have permanent thermoregulatory damage.

The differences in symptoms between heat stroke and heat exhaustion are readily evident (Figure 7.8). With heat exhaustion, the victim is sweating profusely. Their skin is clammy. With heat stroke, sweating stops. The sweating mechanism has stopped. The victim's skin turns pink or red. This is due to the body shunning the hot blood to the extremities in an attempt to keep the core temperature cooler. Physiologically, it is a process similar to hypothermia. The victim is in a life threatening situation. They must be cooled down immediately with water, ice or whatever is available. Move them to shade and out of the sun. Since long-term damage can occur, seek medical assistance.

Clothing

As noted in the physiological section, one of the methods of regulating body temperature is by adding or subtracting insulation. Clothing provides this insulation. For boaters there is specialized clothing with wetsuits and drysuits. In addition, there is an issue whether to dress for the water or air temperature. Enter the 120 Degree Rule.

<b>**120 Degree Rule** – There is an issue whether to dress for the air or water temperature. As the spread between the two increases, the choice becomes more difficult. If the air and water temperature are the same, dressing for one is essentially dressing for the other. However, if the water temperature is 55ºF and the air temperature is 80ºF, the choice becomes more difficult. Does the boater dress for the air temperature and assume that he/she won't get wet? Or, does the boater dress for the water and sweat profusely in the 80ºF temperature? Consider a third element or the probability of getting into the water. For kayakers, the Eskimo roll and getting wet, is just another stroke and a way to cool off. In contrast, most rafters, don't expect to get wet and dressing for the air temperature is not uncommon. Or, one strategy is to dress *toward* the air temperature.

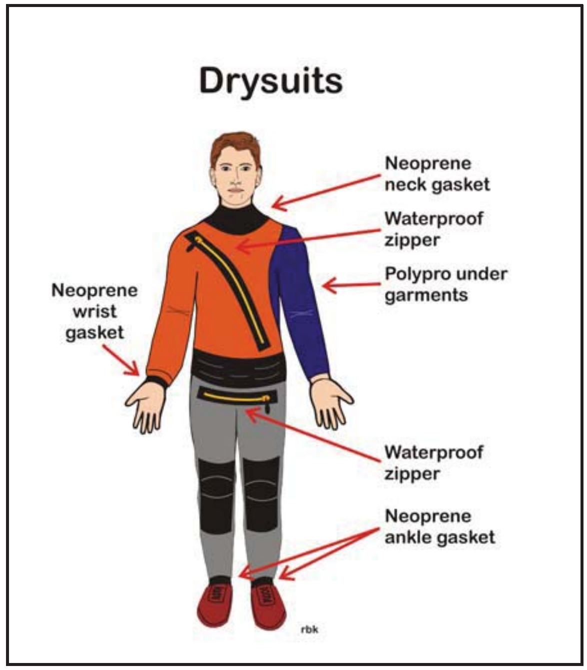

Figure 5.9: Drysuits –With neoprene gaskets around the wrists, ankles, and neck, drysuits allow wearing normal clothes in the water. Source: author – [file:\SH-Drysuit.cdr]

Within the context of the previous discussion, the 120 degree rule states that if the sum of water and air temperature is 120ºF, use a wetsuit, drysuit or similar form of protection. As noted this is not an absolute, but is subject to the probability of getting wet. As a historical footnote, the 120 degree rule originated as the 100 degree rule. The 120 degree rule is a little more conservative and has superceded the 100 degree rule although the 100 degree rule is still noted in the literature.

<b>**Drysuits** (Figure 5.9) – The use of drysuits and wetsuits are two common methods of protecting the body from cold water losses. The drysuit is a waterproof suit that is sealed at the wrists, ankles and neck with neoprene gaskets. With the water tight seals, the boater can wear normal clothing and remain perfectly dry in the water. Normally, people will wear polypro garments underneath. Conceptually, the drysuit is equivalent to putting on a windbreaker over a sweater except that it is also water tight.

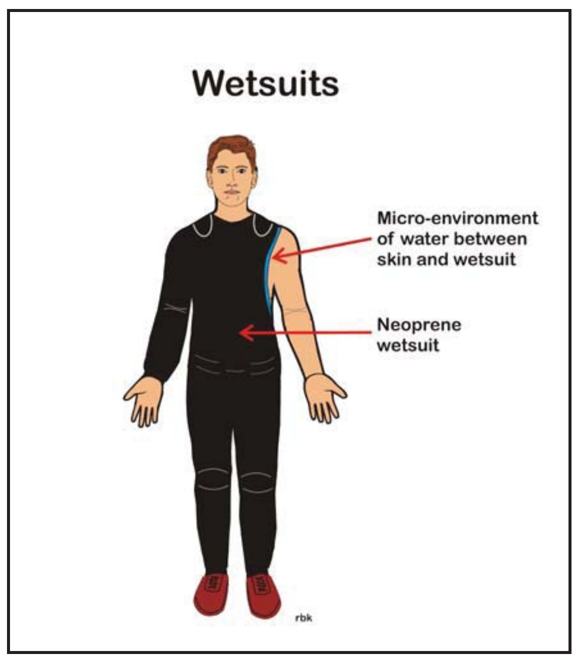

Figure 5.10: Wetsuits – Constructed from closed cell neoprene, wetsuits provide insulation for the body. Source: author – [file:\SH-Wetsuit.cdr]

<b>**Wetsuits** (Figure 5.10) – A wetsuit surrounds the body with insulating foam. Neoprene is a closed cell foam. This means that each tiny air cell is self-contained and not connected to adjacent cells. This prevents water infiltration into the foam which would reduce its insulating ability. The water and sweat form the micro-climate in contact with the skin.

An important sidebar with wearing a wetsuit is the following. Wearing a wetsuit out of the water and in the sun can lead to excessive dehydration. The body is heated by the sun. The body's temperature rises. The body sweats and expects the sweat to evaporate and cool the body. The wetsuit prevents evaporation resulting in the body's temperature rising. In response the body sweats more, but again the wetsuit prevents evaporation and cooling of the body. The result is that the body can overheat and the loss of water can lead to dehydration. The corollary is that when out of the water, open up the wetsuit to allow the natural cooling process of the body to occur. Or, be sensitive to becoming overheated.

It is worth noting that wearing wetsuits and even drysuits can easily lead to dehydration. For this reason, it is important to increase water intake.

<b>**Paddling Jacket** (Figure 5.11) – This strategy uses a paddling jacket and pants as a windbreaker and the layering of polypro undergarments in proportion to the air and water temperature. Essentially, it acts like the drysuit except that it isn't waterproof when immersion occurs. In the water, the garments will become saturated with water. However, because of the tightly fitting seals at the wrists, neck and waist and the windbreak effect, this approach maintains considerable warmth even when wet. This approach works well in shedding splashes from waves.

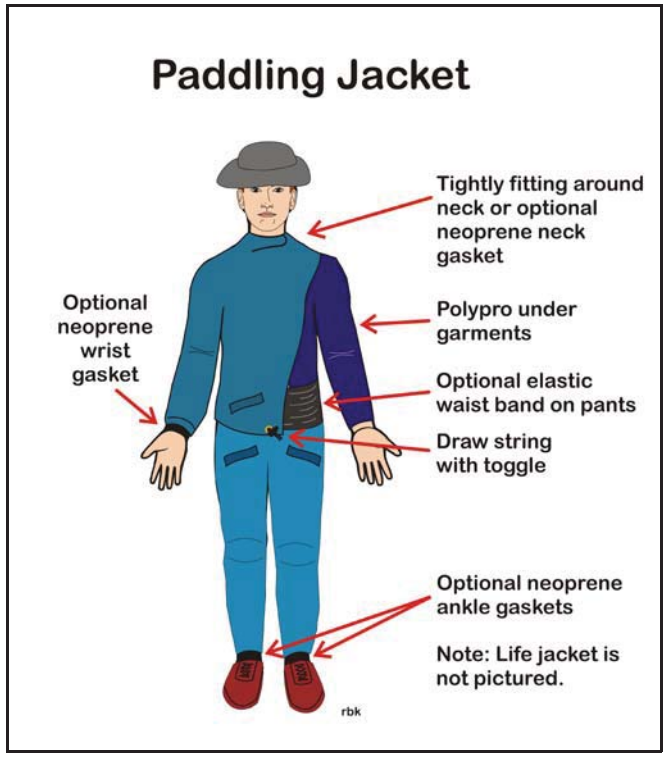

Figure 5.11: Paddle Jacket – Although it is not water tight, the paddling jacket offers many of the same benefits of a drysuit as long as the paddler doesn't become immersed. Source: author – [file:\SH-PaddlingJacket.cdr]

In Figure 5.11, the neoprene gaskets are optional. They are particularly useful if considerable wading is occurring. Also, they help maintain an air tight seal and reduce energy loss. In situations where the boater is not in the water, they are of less importance and velcro straps work equally as well.

Usually, this author wears a tightly fitting paddling jacket for its comfort, water shedding ability and flexibility of movement. It assumes a low probability of flipping the raft and being in the water. In addition, it is used in boating situations when there are less extreme conditions in terms of water and air temperature (see 120 degree rule). As always, the raft can flip too.

Signaling

Communications on the river is important. Usually, signaling involves the use of paddles, whistles, or hands. Signaling utilizes the recommendation of the American Whitewater Safety Code (Safety Code of American Whitewater, 2005). The code notes that a group can substitute signals that are agreed upon by the group.

<b>**<u>Universal River Signals</u>** (Figure 5.12) – The Universal River Signals utilize paddle, hand and whistles. The paddle signals are fairly straightforward. Obviously, in oar rigs, hand and arm signals can be used.

<c>***Stop*** **–** Holding the paddle horizontally above the head means **stop**. The same message can be conveyed by extending the arms horizontally. Usually, the arms are waived up and down. The code does not provide a whistle code for stop.

<c>***Help/Emergency*** **–** Extending the paddle vertical and rotating it in a circular pattern indicates **help/emergency**. The same message is sent with an arm extended vertically and rotated, or with three blasts on a whistle.

<c>***All Clear - Come Ahead*** **–** Hold the paddle vertical above the head. Be sure not to rotate the paddle because this is an indication of help or emergency. Unless the paddle lowers the paddle to an angle to indicate direction of travel, the signal means to come ahead in the main channel or center. The code does non provide a whistle code for all clear. The group may agree that a single blast is an indication of all clear.

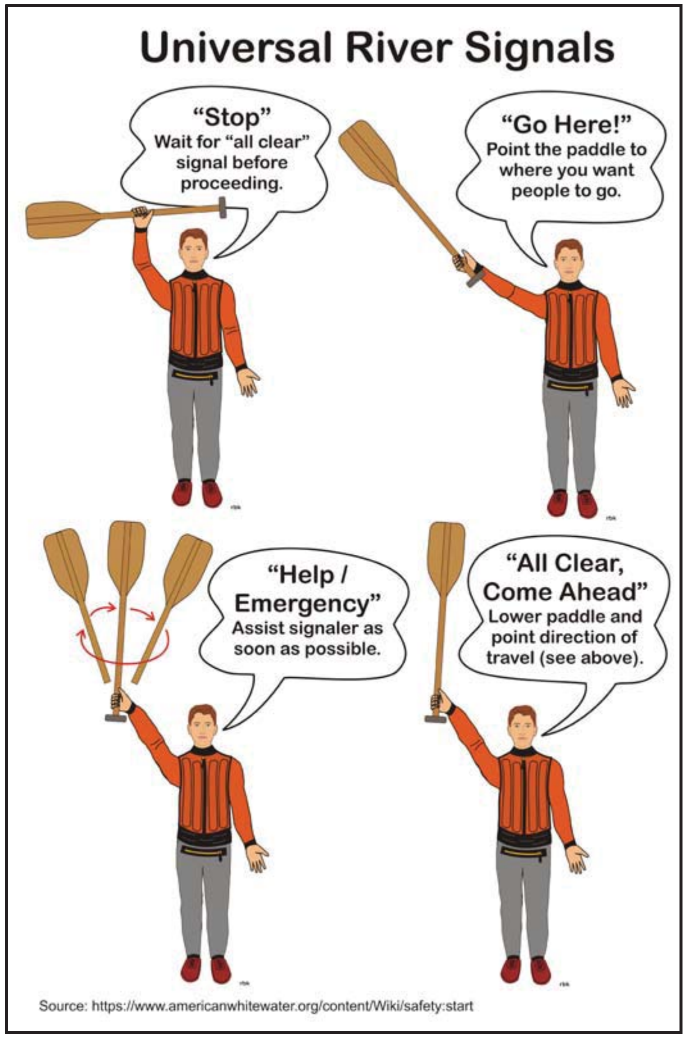

Figure 7.12: Paddle Signals – Developed by the AWA, the Universal River Signals using a paddle. Source: author – [file:\SA-Signals.cdr]

<c>***Go This Way*** **–** Lower the paddle to an angle of 45 degrees to indicate the direction of travel. Point the paddle in the direction of desired travel. Do not point at the object to be avoided. The boater can point direction of travel with their arm also. Again, there is not whistle code for direction of travel.

<c>***Hand Tapping on the Helmet*** (Not shown) – Derived from the diving community the hand tapping on the top of the helmet is a sign that you are okay. It works as follows. The rescuer looks directly at the potential victim and taps the top of his helmet three or four times. The rescuer is asking the question "*Are you okay*." If the victim is okay, he/she responds in kind by tapping the top of their helmet. The response indicates that "*I am okay*." No response indicates that they are not okay and need assistance.

Figure 7.13: Whistles –A pealess whistle, the Foxfire 40 whistle or similar whistles provide a good communication device for boaters. They are over 90 decibels. Source: author – [file:\SA-Whistles.cdr]

<b>**Whistles** (Figure 7.13) – Pealess whistles are a standard safety item. Pictured, the Foxfire 40 ® is one of several pealess whistles available. Whistles with peas should be avoided since getting the pea wet can impair its use. Caution should be used when using the Forfire 40 ® or similar whistles since they can easily generate over 90 decibels which is sufficient to cause harm to a bystander's hearing. Avoid attaching the whistle to the zipper on the life jacket since the water action against the zipper can unzip the zipper. If a string is used to fasten the whistle to the life jacket, keep the string short to avoid possible entanglement.

Summary

This chapter focuses on general safety principles rather than specific rescue techniques. Raft related rescue techniques are included in the next chapter. This chapter introduces the rescue curve. Well prepared boaters begin with safety and prevention measures and self-rescue. Then it focuses on the physiological aspects of river running with an emphasis on hypothermia and to a lesser extent hyperthermia. Since man is a tropical animal, boaters need protection in a cold water environment. This leads into a discussion of clothing including wetsuits and drysuits. Last, the chapter presents the American Whitewater Universal River Signals. It is important that everyone on the trip understand the signals and use them to communicate.

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