COMPREHENSIVE CARE OF THE DROWNING VICTIM

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I would like to preface this article by stating that it is being written for the medic squads, nurses, people with advanced paramedic training, IV therapy and medicine therapy, and people in the allied medical professions with advanced training, although I believe that much can be derived from the article even by that particular person who may be involved only with primary first aid and primary squad/rescue care. Some parts of the article are clearly technical. Physiology and chemistry are dealt with here, as is anatomy; however, I think anyone reading the article can derive some very useful information from it despite the technical aspects.

The subject of comprehensive care of the drowning victim is not exclusively a seasonal topic, but I think this is a very good time to present it. In addition to the first aid and medical assistance to the drowning and near-drowning victim, we will examine the pathophysiology of fresh water drowning as well as some of the biochemical changes that take place in a victim of fresh water drowning or near-drowning. Some of the statistics of drowning will also be presented.

It was felt for some time that very great differences were present between fresh water drowning and salt water drowning. These included the influx of very large amounts of water to the blood stream in fresh water drownings and the drawing of very large amounts of water out of the blood stream in salt water drownings. Although the facts are true concerning the influx and efflux of water and electrolytes in and out of the blood stream in the two different types of drowning, over the past several years there have been conclusions drawn that the amount of water taken in by victims and the exchanges of water and electrolytes in and out of the blood stream may not be as great as researchers once thought, and therefore the treatment of both of these types of drownings actually is the same.

In the United States, drownings rank fourth as the cause of accidental death. Many predisposing factors enter into the picture, such as ingestion of alcohol, exhaustion, and the fact that sometimes the victim has periods of reflex apnea (no breathing) due to aspiration of small amounts of water. Hypothermia (low body temperature) may also have an effect. Victims with coincidental illness, such as epilepsy, diabetes, or asthma, also succumb to drowning. There is also breathholding drowning, or victims who hyperventilate trying to hold their breath for long periods of time under water until they lose the urge to breath because their body is purged of carbon dioxide and they become hypoxic (low blood oxygen) and pass out, thereafter inhaling large amounts of water. Mechanical injuries are sometimes involved, such as being struck by a boat or the propeller of a boat. States of panic can be causative factors, usually involving scuba divers and skin divers; another factor that enters is the suicide attempt.

Four types of drowning are now recognized. One is the classic wet drowning. This occurs when the victim, usually exhausted, goes below the water and has a voluntary or involuntary inhalation, taking a large quantity of water into the lungs, becoming anoxic (loss of blood oxygen), passing out and drowning. Dry drowning occurs when the victim becomes exhausted in the water, has a spasm of the glottis (muscles of the throat) and therefore cuts off any entrance of water into the lungs, but becomes asphyxiated because he prevents the exchange of oxygen and carbon dioxide and consequently succumbs to drowning. The third type is what has been called a secondary drowning. This is a delayed death from drowning also caused by asphyxia, usually due to the build-up of protein and protein-like materials in the lungs which prevent the exchange of oxygen and carbon dioxide. This usually occurs anytime from ten minutes to several days after a victim is supposedly recovering from a near-drowning accident. The fourth is called the immersion syndrome. This is a sudden death due to a victim falling into cold water and having a sudden inhibition of the vagus nerve, causing a cardiac arrest. All of these will be discussed in detail.

Researchers and statistics bear out that the classic wet drowning occurs in approximately 80-90% of all drownings that are accounted for. As stated previously, the victim is in water; perhaps some predisposing or causative factor is present. He has either a voluntary or involuntary urge to inhale and as he does, he inhales a massive amount of water, which is taken into the lungs, and from there various physiologic and biochemical changes take place. As fresh water enters the lungs of the victim, the water is of less tonicity than the blood; that is, there are not the salts present that there are in the blood. I guess we could say that the water is a littler thinner; therefore, the circulation, in an attempt to equalize the water in the lungs and the water in the blood stream, takes in amounts of water from the lungs into the blood stream, causing an increase in the total intravascular water present in the blood stream. This was once thought to be one of the main causes of death in drowning. Researchers thought the increased amount of water in the blood stream (and this does occur in fresh water drowning to some extent) caused the release of potassium into the blood stream from the ruptured blood cells, which in turn caused ventricular fibrillation in the victim and was the main cause of death.

Along with the taking in of water into the lungs of the victim, the victim also

aspirates mud, micro-organisms, algae, chlorine, and any number of other chemicals and particulate matter, and this also comes in contact with the lungs. This is what is thought to cause some of the intense inflammatory reaction when it comes in contact with the most distal portions of the lungs, the alveoli, where the actual gaseous exchange of carbon dioxide and oxygen take place with the blood. When these materials come in contact with the lining of the alveoli, large amounts of a protein-like material are put out from the blood stream into the alveoli of the lungs in response to the inflammatory reaction set up because of the foreign material that has come in contact with the cells of the alveoli. This protein material now fills the alveoli of the lungs. There is no oxygen being exchanged because of the water and the protein material in the alveoli; therefore, there are areas in the lungs where the blood is still profusing the lung (that is, if the victim is not in a circulatory collapse), but they are not being oxygenated because the oxygen cannot get to these areas.

There is also a material that lines these alveoli called surfactant. The surfactant helps to reduce the surface tension of the alveoli during expiration so they do not collapse when the normal person exhales. The alveoli will retain their supposed spherical shape and not collapse, but in a drowning victim, with the intense inflammatory reaction set up by the inhalation of the water and foreign material, the surfactant in the alveoli is broken down; when the victim exhales he has no surfactant in the alveoli and therefore the alveoli collapse. Because they are difficult to re-expand, blood is still profusing the alveoli but the victim is not ventilating them and therefore he has no gaseous exchange. As a result of the protein material being passed into the lungs, most fresh water drownings will present pulmonary edema and a very frothy, pinkish sputum around the mouth, which is secondary to this protein material.

The dry drowning, which accounts for about 10-20% of drowning victims, happens when the victim gets a reflex glottic spasm closing off the top of the trachea and therefore does not take in any water into the lungs. These victims, if they do not have circulatory collapse or any diffuse brain damage secondary to the anoxia, usually have the best chance of recovering because they do not go through the phenomenon of the pulmonary edema and the pulmonary collapse secondary to the protein material being taken into the lungs, because they do not have any inflammatory reaction.

We will just mention secondary drowning in passing. You will not see this in any rescue attempts, since it usually happens in the hospital and occurs from a few minutes to a few days following the primary event of a near-drowning. This again presents the classic symptoms of a wet drowning. Usually there is frank pulmonary edema. There are infiltrates in the lung on chest x-ray. The patient has a problem of oxygenation of the blood because he has areas of collapse of the alveoli, known as atelectasis. Therefore, he can profuse those areas with blood but he cannot ventilate them and he has problems with hypoxia even though he is in the hospital and even though he may be on oxygen. He may go into acute respiratory or circulatory collapse several minutes or several days following the event because of a build-up of pulmonary edema, atelectasis and anoxia.

The immersion syndrome is an interesting phenomenon. There have been articles out of Canada about this, probably because of greater experience with extremely cold water. This is a sudden death, usually resulting from someone falling into cold water. This sets up an intense reflex with the vagus nerve causing very profound slowing of the heart and cardiac arrest. Researchers in Canada have reported that this at times may be life-saving in drowning, particularly in young children who fall face first into very cold water. This immersion syndrome with its stimulation of the vagus nerve may slow the heart down to as slow as six beats, ten beats or fifteen beats per minute, and cool the body rapidly enough to prevent the intense cycle of anoxia, brain damage, and circulatory collapse. There have been reports of young children having been immersed face first in cold water for thirty minutes and being revived with no problem of brain injury or cardiac injury following resuscitation. This is just mentioned in passing; I am sure it would be difficult to see a drowning death and actually say it was an immersion syndrome.

We have mentioned the pulmonary effects of drowning. I would like to mention some of the other effects on organs and systems of the body. Of course we know that with prolonged hypoxia, neurologic complications can evolve. If victims are hypoxic more than four minutes they can develop neurologic manifestations, and these manifestations are varied in their duration, their severity, and their quality, depending upon the length and the severity of the hypoxia.

The effects on the heart are also many and varied. It was thought that all drowning victims expired as a result of ventricular fibrillation, although this is not really documented in studies of near-drowning victims or drowning victims where resuscitation was attempted in the Emergency Room. There are actually very few victims who demonstrate ventricular fibrillation. As stated earlier, it was thought at one time that death resulted from the massive influx of potassium into the blood stream from ruptured red blood cells. From the anoxic and hypoxic state, there is a release of potassium ions from the cells of the body and whether this actually causes ventricular fibrillation or not cannot really be documented. We cannot accurately say how many victims who are pulled out of the water two, three or four hours later, unable to be resuscitated, actually did die of ventricular fibrillation.

Many different arrhythmias are seen in the drowning victim. Atrial fibrillation is one of the more common ones. Usually it is untreatable and will resolve with treatment of the hypoxia and all of the other manifestations of drowning and near-drowning. Also, there will be ST segment elevation in victims and frequent episodes of premature ventricular contractions; these again are of no real consequence and clear up spontaneously with oxygenation.

There may also be kidney complications following drowning or near-drowning and resuscitation. Because of the rupture of red blood cells, hemoglobin is poured through the kidneys, and because of the shock that may occur there may be a circulatory and vascular collapse of the kidneys causing episodes of acute renal failure. This is usually transient but must be watched during in-hospital care and treated when the situation does arise.

The treatment of drowning and near-drowning victims is quite simple and quite straightforward. 1) Of course the victim has to be removed from whatever liquid medium he is in and oxygenation *must* begin at once. I would like to stress that even though the victim has been submerged for five minutes, for ten minutes, for twenty minutes, and even for thirty minutes, you must make all attempts to resuscitate the victim. There have been instances where victims have been submerged in cold water for thirty minutes and have been resuscitated. In water temperatures that we are more accustomed to, people have been submerged for up to twenty minutes and had full recovery with no vascular, circulatory, respiratory, or neurologic complications. So you *must* remove the victim from the liquid medium and you *must* begin oxygenation immediately. 2) You should then begin assisted respiration with a bag mask under high flow oxygen, usually

10-12 liters per minute. If you have the facilities and the technical know-how available, and if the victim is unconscious, he should receive endotracheal intubation and again respiratory assistance by way of a bag mask. One thing should be stressed. Don't try to drain any water from the lungs of the victim. Usually this water is so rapidly taken into the blood stream that you are just wasting your time trying to drain it and you should not let anything whatsoever impede your efforts to oxygenate the victim, although if there is evidence of vomitus in the mouth or pharynx, this should be removed. One thing I should caution you on: as mentioned earlier, a great amount of pulmonary edema will take place and you will notice a large amount of frothy sputum coming up into the mouth and out of the mouth, but this in no way should impede your respiratory efforts. It may present some difficulty in trying to intubate the victim, but if you have a medic unit and you have suctioning available, just suction the victim and then try to get an endotracheal tube in.

If circulatory collapse is present or imminent, measured usually by detectable or no detectable femoral or carotid pulses, closed cardiac massage should begin immediately. Electrocardiographic monitoring should take place. If the victim is in ventricular fibrillation, defibrillation should then be done. Bizarre cardiac arrhythmias may take place and these usually do not have to be treated except with re-oxygenating the victim.

An intravenous line should be established using 5% Dextrose and water to maintain the vein. The mainstay of treating drowning and near-drowning victims is the correction of the acidosis that takes place secondary to the anoxia and hypoxia. Therefore, the victim should receive sodium bicarbonate, usually 1 ampule for every 4-5 minutes that the victim has been known to have been submerged. This may very readily correct some of the respiratory difficulties and may also correct some of the cardiac arrhythmias taking place.

The victim should be transported immediately to the nearest medical facility, again with respiratory assistance by way of a bag mask or an endotracheal tube. If you have the facilities, an IV should be in place and the patient should have received sodium bicarbonate.

I will briefly go over some of the things that take place in the Emergency Room and after hospitalization of a drowning victim. When the victim arrives in the Emergency Room, endotracheal intubation will be performed if it has not already been done. An intravenous line will also be established if necessary and the victim will receive sodium bicarbonate as the situation dictates. Then arterial blood gas studies will be made to determine the extent of hypoxia that is present and how much carbon dioxide is being retained by the blood; the exact status of the acid in the blood will also be determined, and if necessary, more sodium bicarbonate will be given to correct it. Usually a nasogastric tube is inserted into the stomach for gastric decompression and suctioning will take place to prevent recurrent vomiting and to remove the massive amounts of air and water that have been taken into the stomach. The victim is then placed on a respirator. If he shows good cardiac activity without any arrhythmias, but is unconscious, he will remain on a respirator and usually will use what is called positive end-respiratory pressure. This is a pressure that stays in the respirator system at the end of expiration. This pressure keeps all the alveoli expanded, which is necessary because of the loss of surfactant which holds the alveoli open. Pressure is left in the respirator system equalling 3-10 cm. of water pressure, and this keeps all or most of the alveoli open, thereby permitting an exchange of oxygen and carbon dioxide with the blood. The patient is usually put on cortisone or steroid therapy to combat the inflammation that takes place in the alveoli of the lungs, and depending upon exactly what material has been inhaled, the victim may or may not be put on antibiotics. Usually the victim will receive various drugs to combat the bronchospasm that may be taking place in the lungs secondary to the inflammatory reaction and the hypoxia that is taking place.

Many of these victims are discharged from the hospital in six to eight days. Generally, all near-drowning victims, even though they are brought in conscious and having no respiratory difficulties, are kept in the hospital for 24 hours. There may be the occasional victim who has suffered some brain damage and therefore will require a longer hospitalization than the appropriate rehabilitation therapy.

One thought I would like to leave you with: Before terminating any resuscitory efforts on a drowning victim, remember that most drowning victims are young and usually they are initially in good health, unless they have some predisposing illness to cause their drowning, and they are very, very well able to tolerate the effects of the anoxia and hypoxia. So even if the victim has been submerged for fifteen or twenty minutes, very vigorous, brisk respiratory efforts should be tried.

I hope this brief resume of the emergency treatment for drowning and near-drowning victims has been helpful. I really hope you never have the occasion to use it.

WARNING ISSUED ON DIABETES

Diabetes is increasing sharply among Americans mostly because they are too fat, according to the outgoing president of the American Diabetes Association.

"The more fat you have on board the more insulin you need," Dr. George F. Cahill of Boston told the association convention which was held in San Francisco in June.

Cahill said excess fat often triggers the most common form of the disease, "adult onset diabetes," the third leading cause of U.S. deaths. Diabetes is increasing by 6 percent a year in the United States.

Some 10 million Americans are diabetics. Their bodies process sugar poorly because they don't have enough of the harmone insulin from the pancreas. Of that number, 90 percent suffer from the adult onset form, which has a strong hereditary link, Cahill said.

Adult onset diabetes is controllable with special diet or pills that stimulate natural insulin production. "Juvenile diabetes" (which can affect persons of any age) strikes faster, is more severe, and requires insulin medication.

Many potential diabetics can ward off the disease, Cahill said, by losing weight and avoiding fat, starchy or high sugar foods.

He said diabetes is increasing at a "meteoric" rate in some groups, especially American Indian and black women, who tend to be fatter because they can't afford lean high-protein foods. They tend to eat the cheaper fat and carbohydrate-laden foods.

Calling diabetes "the nation's No. 1 health problem," Cahill urged Congressional passage of a bill that would increase annual federal spending for research of the disease from the current $38 million to about $70 million.

He told Congress in a report last year that a major funding target must be education of diabetics and the general public about proper eating habits.

Mrs. Paul Revere: "I don't care who you say is coming. It's my night to use the horse."

To All The People Who Voted For Me In Columbus

THANKS MUCH!

David F. Stahley
District Two Trustee