Diving Emergency Action plan

Rocket Frog Divers

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Introduction:

In an area of high practice of recreational diving like playas del coco, located in the north pacific coast of Costa Rica. There are multiples diving centers which give the service of training and recreational diving experience. The probability of an emergency event is directly proportional to the high number of divers in the area, especially in high tourist season which covers the months of December thru June.

Nowadays with SAR-COV-2 spread, and with the asymptomatic presentation of the condition, it is important for dive centers with high volume of customers to apply protocols and procedures regarding social distancing and disinfection of gear in order to keep security and trust of divers based on CDC (Center of Disease Control) and DAN (Dive Insurance Network) international guidelines. In this paper we establish a guideline to follow by Boat Staff, Instructors, Divemasters and DM interns of Rocket Frog Divers.

On the other hand, a diving emergency situation could occur independently if it's a beginner or an experienced diver, based on the application of the Haddon's Matrix model (1) and event can happen if an equilibrium is reached between the variables of the model at any given moment.

It is important for training divers, instructors and general diving personnel to familiarize with the matrix in order to predict and event and avoid it. Another important thing is that the diving center recognizes their limitations, capability of the personnel and stimulate continued training in regards to recognition and providing care of the most common diving emergencies that con turn a recreational diver into a victim.

Haddon's Matrix applied to diving (modified by author)

		Individual	Team /Equipment	Environment
Phase 1	BEFORE	-Age -Chronic Medical pathology -Medications or recreational drugs -Training level -Extreme behavior -on edge attitude -Anxiety/stress -temerity	-Trained first response personnel -Full first response equipment -Equipment in optimal conditions -Knowledge on equipment -Crisis management	-Currents, rain, winds -Visibility -Crisis management of personnel -Fully equipped vessel -Day/night -Available personnel
Phase 2	DURING	-Stress control -Physical condition -Knowledge and reliability on diving equipment -Medical pathology	-Application of action plan -Activation of EMS -Appropriate use of equipment -Most trained personnel managing crisis -Keep calm	-Distance from the boat -Surface, Deep event -Actions of personnel -Communications
Phase 3	AFTER	-Reanimation effective -Extension of lesions	-Application of guides and protocols -response of the patient	-EMS availability -Distance to adequate health care facility -Availability of resources

Even thou this matrix was designed to vehicle accidents its modified version helps the trained personnel to anticipate an event and know how to consider the variables involved in an emergency for them to consider them as RED FLAGS. The more common cause of an incident is poor individual judgement, so this variable is independent of the matrix an involves the diver itself or the actions of one or several parts of the personnel involved in the emergency (here is stated that poor judgement can come from both sides, victim and rescuer) As a rule, the suspicion of a potential risk (red flag) can be assessed and measures can be taken in order to avoid a crisis.

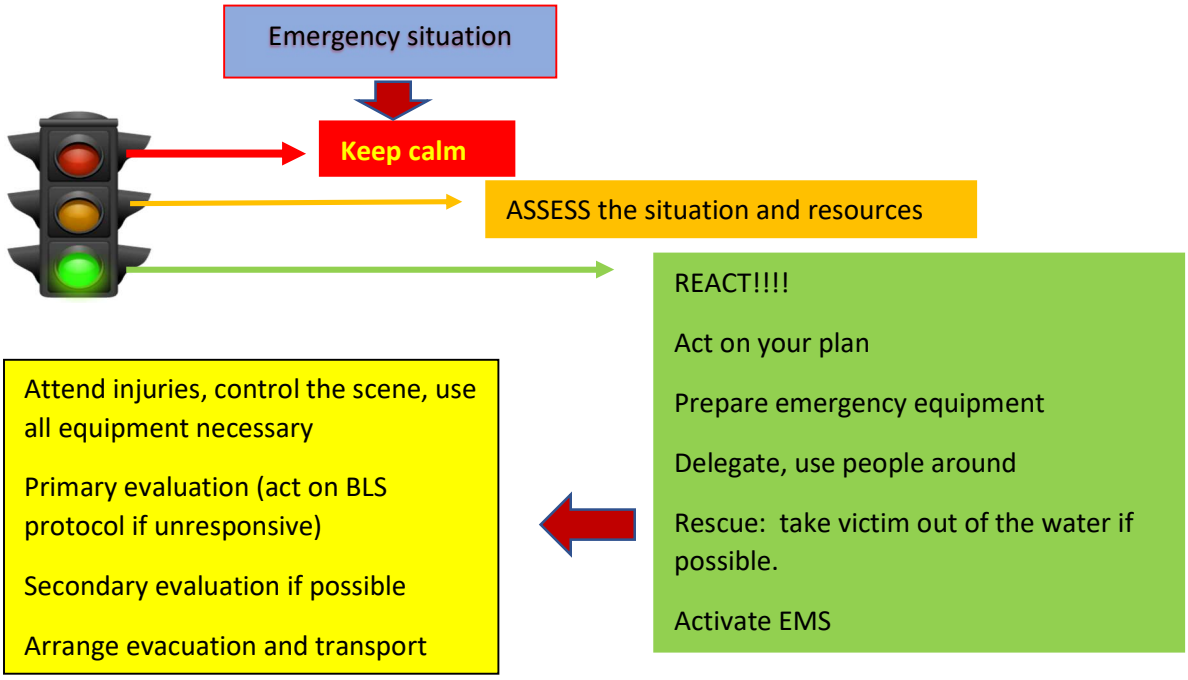
Management of an emergency situation:

An emergency crisis is unexpected even thou there are some variables that can give an index of suspicion. When an emergency occurs, the first rule is: KEEP CLAM followed by DO NOT expose yourself to a risky situation. (2) Keep in mind always be able to rescue yourself first and do not try skills and techniques beyond your capability and training.

If you are NOT trained as a rescue diver or EMS, do not try to manage the situation, be ready to assist in the order of your personal training and physical capabilities. Put yourself at the service of the team leader. You still can help holding equipment, securing the area or activating EMS, among other duties that can arise as the emergency develops. Remember an Emergency Scenario is always dynamic, changing second by second, the provider needs to be ready and trained to respond with this concept in mind. Because each situation is different the basic tenet of rescue is "Do and continue doing what works" always looking for the best to the victim without inducing more harm.

Diving emergencies can occur on deck (less common) and at sea (more common) and in this scenario two situations can arise; one can be an event on the sea surface or above surface. Each scenario has its complications and needs of management. The personnel proving care should take into consideration each scenario separately and asses the risks involved.

The general algorithm to approach an emergency is as follows



The first step to respond to an emergency is secure the scene and by this is making sure that there are no life treading situations for the personnel involved in the rescue and patient management operations. Applying this to the diagram in the first phase which is keep calm, the rescuer or EMS provider must reassure that he has all the equipment necessary to provide help without risking his own life, the rescuer must assess the most secure method to extract the victim out of the water. Once the

patient is on the deck the provider must take into consideration biological risks and control them with barriers against biological fluids like blood, vomit, etc.

Every rescue diver, divemaster and diving instructor must keep a proper physical condition, (2) constant training and analysis of medical and non-medical conditions related to diving. Propper training and up to date in Basic Life Support (BLS) equipment and protocols. And one thing to take into consideration is the ability to anticipate and detect a probable red flag that can turn a common diving trip to an emergency situation.

Any situation that generates stress or anxiety to a diver can turn into an emergency event, there are some signals that can raise the alarm on a trained crew. (2)

1- Signals for help (screams, waving hands, mask on the forehead, whistles)
2- An evident overexcretions on the surface or below.
3- Losing pieces of equipment at surface or at the bottom (mask, regulator, BCD)
4- Trying to climb desperately and object or person at surface, in order to have a false sense of reach out.
5- A total standstill, without any response to a call or help.

According to the diagram, here the rescuer must keep calm and asses which is the safest method to help this distressed diver avoiding first not to get in the water. There are some methods to apply (2):

A- Reaching and extensions assist: could be in a secure place at deck that the rescuer can reach the victims gear (tank, BCD) without losing grip or could be with an extension like a pole or bar.
B- Throwing assist: Could be a throw bag attach to a rope, tethered life ring, buoy or personal flotation device. It is important to consider that the object must be thrown past the victim and pull it slowly for its easy reach.
C- Watercraft assist: Use a small vessel or any other watercraft available to reach the victim.
D- Wading Assist: In shallow waters, the rescuer enters the water to chest level and tries to reach the victim, it has certain risks cause the entrance in the water can be dangerous depending on the behavior of the victim.

Again, the most important assessment as personnel giving assistance, is your level of training an experience, it is not recommended to make risky decisions based on good will. Prior to intent any rescue maneuver, the EMS system must be activated cause the basic maneuvers on the deck are not sufficient to any complication secondary to the diving emergency. Based on this principle, the emergency contact numbers in case of any emergency in the area of Rocket frog divers are as follow (table #1)

Table #1

Emergency Telephone Numbers in the area of Rocket Frog Divers

Service	Telephone
Coast guard Central office Flamingo	 2226-3228 2226-3238 2654-6193
Police of Guanacaste central Police of playas del coco Police of Flamingo BATS islands	2665-0616 2670-0258 2654-6193 2679_1151
BATS islands Rangers	2666-0630 ext. 214
Red cross of sardinal (BLS)	2697-1141
Red cross of Cartagena (BLS) Red cross of Santa Cruz (BLS-ACLS) Red cross of Liberia (BSL- ACLS)	2542-5004 2680-0330 2666 0994
Fire department of filadelfia (BLS)	2688-8733
National Hospital of Liberia National Hospital of Nicoya National Hospital of Puntarenas National central hospital Mexico (san jose)	2690-2300 2685-5066 2630-8000 2242-6700
San Rafael Arcangel hospital liberia (private)	2690-5500
DAN emergency hot-line	+19196849111
National Bureou of Investigation (OIJ)	2666-5656
Hiperbaric Chamber Clinica Catolica San Jose Hiperbaric Chamber Clinica Biblica San Jose	2246-3000 2522-1000
National Aeromedical Service of Police	2586-4000 / airport of Liberia: 2668-1119
Radio Channel for boats emergencies VHF	16
Radio Channel HF	8300 MHz
Dr Venegas ambulance service -Air Transport- (Flamingo) GP/BLS/ACLS	87771759
National Emergency Services System	9-1-1
Dr Gerald Smith (EMS physician)	83465033
SAAT Ambulance Service / air transport (BLS/ACLS)	88289468
Dr Mauricio Saldarriaga (EMS physician)	88356096
Dr Luis Carlos Huertas (EMS physician)	87189111

BLS: Basic Life Support, ACLS: Advanced Cardiac Life Support, EMS: Emergency Medical Services, GP:General Practitioner

As a general rule of information to give to the local authorities, the data must be objective, not suppositions or personal opinions in that regard (2). The general info. Should be given as follows (table 2):

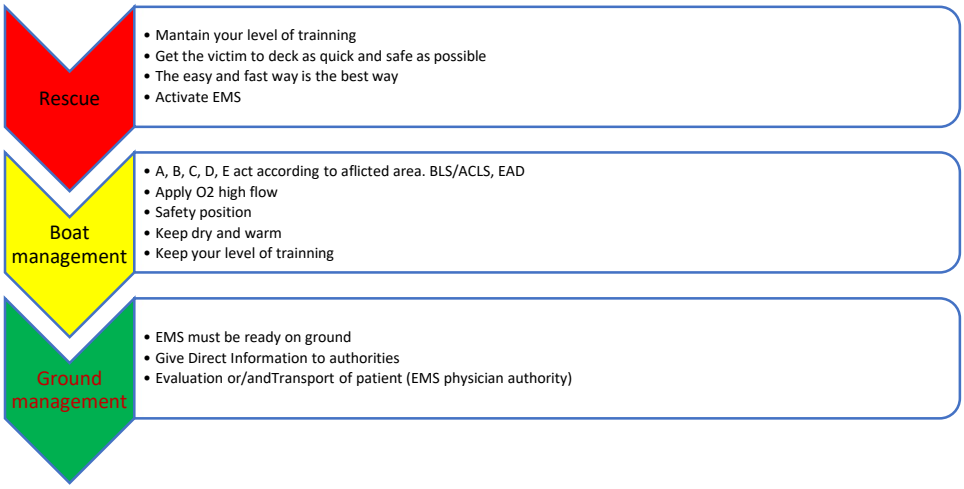
Table 2

Information to authorities

Hello, my name is:_____I'm trained in BLS/ACLS (if needed) we are on the boat named:____Number of registry:_____I need to report an emergency related to diving, our emergency condition is:_____We are located:___Lat,_____N,_____Long W. We are trying to arrive to:_____ETA:_____At the beach we need (ACLS unit, oxygen, medical personnel, paramedic, cardiac monitor, snake antivenom, transport to hyperbaric chamber) Besides the emergency condition of the patient he has a known medical history of:___. And takes the following medications:_____. Or any additional information the authorizes require.

The decision of aeromedical transport is an alternative that is not competitive to the rescue diver, divemaster or instructor. It lays in the physician in charge or that receives the case and manages the patient. It should be based on medical condition, stage of lesions, and weather conditions. In Costa Rica, there are air routes can be taken at 1000 feet is there is visual conditions for flying. An aircraft can fly at 1000 feet in a non-populated zone, and in a populated zone can fly at 1000 feet above the highest point (3). Night flying is not recommended at all (instrumental flying) If ground transport is going to be performed, the ambulance driver must know that ascending from sea level should be at a slow steady pace cause San Jose is at 4921 feet from sea level.

Steps in an emergency scenario



A: Airway, B: Breath, C: circulation, D: Neurological deficit, E: Exposure. BLS: Basic Life support, ACLS: Advanced life support, EAD: External Automatic defibrilator

Types of rescue scenarios (3):

1- Tired diver rescue:

A tired diver is a situation that can occur at any moment, and in this scenario a tired diver can turn into a panic diver at any moment; the trigger is unknown. Thou tired divers are usually beginners (he has too many information to process the first times he enters the water) and the overexcertion begins at the moment the touch water. Other causes can be underlaying medical problems (Arrytmias, Congestive heart failure, medications, diabetics, obesity)

The approach of rescuer must always be defensive. The steps are as follow:

A- Approach with caution, asses his response and level of calmness
B- Give direct instructions as to inflate the BCD to acquire proper buoyancy, reinforce to stay calm as the rescuer is approaching.
C- If the condition of the diver allows, approach and stablish contact thru the back, always speaking to the diver in a calm matter. Secure the divers buoyancy inflating the BCD
D- If the diver doesn't panic, help him rest, and explain that he is going to be towed to the boat if he wants it; if he can swim the rescuer will escort him to the boat. Assure the rescuer buoyancy by inflating the BCD.

As said, tired diver scenario can turn into panic diver, specially as evidence shows if the tired diver occurs at surface, its usually described that the victim was not getting enough air, it is decribed as a sensation of breathing through a straw.

If tired diver occurs underwater TIME is the key, rescuer must try to calm the diver as fast and steady as possible to be successfull.

2- Panic Diver Rescue:

In order to perform a proper panic diver rescue, the approach must be cautious and slow, always assessing the diver metal state in the same matter as a tired diver. The panic diver doesn't obey orders, tries to take out his equipment and is a dangerous victim cause this diver will try to hold on to whatever is near in order to keep buoyancy. The rescuer must be in control and secure when he approaches this scenario. The approach must be thru the back or from under the surface, grabbing his wrist and turning him, then holding the tank and securing buoyancy inflating the BCD, and then assuring buoyancy for itself. If it's impossible to approach to the panic diver, maintain a considerable safe distance an let the diver get tired or turn unconscious and make a cautiously approach. Always talk to the diver, assuring that the rescuer is there, and trying to calm him down. When on hold to the diver, toad him to the boat in the same matter as the tired diver.

If panic diver occurs underwater, DO NOT TRY TO KEEP regulator in mouth, if he can't breathe at the point of approach he will continue with difficulty breathing. TIME is definite concern, panicked diver tissues will continue to consume oxygen, even when he is not breathing. During the ascent, as oxygen

concentrations in lung decrease and gas expands the diver is at risk of losing consciousness (Hypoxia of ascent or “shallow water blackout”) risky situation of arterial gas embolism from lung overexpansion.

3- Unresponsive diver:

In this scenario the approach should be cautious, when in contact asses the level of consciousness of the diver, if his head is below the surface it should be turned up and secure the airway to assess airway permeability and breathing. If the victim is unresponsive, call for help with signals, whistle or yelling.

If the rescuer can transport the victim in less than five minutes to the deck, the rescues should give two rescue breaths every five seconds assessing permeability and swimming the victim to the boat. If the boat or secure area is more than five minutes away give rescue breaths during a minute and if he continues unresponsive swim as fast as possible to a secure area. Once on deck start BLS or CPR and emergency response protocol.

If diver is unresponsive underwater TIME IS THE KEY, if he has regulator on mouth hold and ascent on a pace not fast than 18mts / 60 feet per minute. If he doesn’t have regulator in mouth DO NOT TRY to put it back.

If diver is unconscious he may relax the pharynx and allow passive exhalation, this will allow air to vent out the lungs without over-pressurization and barotrauma. The opposite may occur an may experience laryngospam (a reflex spam that occurs when water enters throat) this can cause a partial or complete closure of the airway an during ascent this reflex presents the risk of arterial gas embolism.

4- Lost diver scenario

When a lost diver scenario appears during a dive, it is important to assess the situation as quickly as possible, the most probable condition will be death. So, every second counts. This scenario is resource dependent; the steps are as follow:

A- Alert EMS
B- Detect where was the last area the diver was seen
C- Delegate watchers on a high point to detect bubbles on the surface.
D- Try to find out if the diver came out first and left the diving site on his own (search for his equipment)
E- If divers are available, send them to the last area where he was seen
F- Mark with a buoy the last area he was seen
G- Send snorquellers to scan the area

A lost diver in the first minute without air cardiac complications appear, like arrythmias and syncope. At this stage the level of consciousness of the diver is lost. In between five to ten minutes irreversible brain lesion appear and death is a certain situation.

In this scenario the quickness of the team is a priority, always taking into consideration DO NOT risk unqualified personnel and don't take risks for a dead body.

Diving Emergencies

Start of the Dive

When a diver enters the water, his body responds to the change in temperature, including a reduction of peripheral blood flow to maintain core temperature. The reaction may also include a gasp for breath, which could, in extremely cold water, escalate into hyperventilation, overexcertion and drowning. Immersion can cause arrhythmias leading to syncope or death. Death is rare from the initial immersion, but if an emergency is developed at the beginning of a dive, a reaction to initial immersion should be kept in mind (4) In this regard it's important for the rescue diver, divemaster or instructor to assess the divers face and reactions at surface, asking a few simple questions could asses this condition. A foreign or local diver may not want to express his discomfort or peer pressure risking his dive day.

1- General Environmental Considerations: Hypothermia, Hyperthermia & Dehydration

Although divers take steps to keep warm while diving, heat loss will occur. Divers on vacation often make multiple dives per day and subject themselves to prolonged cooling over the course of the day. Further heat loss (and gain) can occur as divers are exposed to the sun or wind between dives (4)

Diving also causes "immersion diuresis," which can lead to dehydration and associated issues, including syncope and arrhythmias (4) Dehydration is exacerbated by other factors, including carrying equipment, exposure to sun, breathing dry, compressed air, airplane travel and taking diuretic medications as chronic treatment.

Hypothermia, hyperthermia and dehydration should be treated in accordance with your local protocols or recommendations of primary physician or EMT. Keep in mind that certain signs and symptoms of these conditions, such as nausea, are also associated with other diving injuries.

2- Barotrauma

In much the same way you may feel ear pain during take-off or landing during a flight due to pressure changes, the changes in pressure when diving can cause injury to ears, sinuses and other air spaces. Although decompression illness and other emergencies are dramatic, ear injuries are much more common.

a. Ears & Sinuses

Divers are trained to equalize the pressure in their ears to ensure that air enters the middle ear through the eustachian tubes (5) Pressure may be felt quickly, and a 10- to 12-inch descent can be sufficient to cause discomfort and pain. Barotitis media (middle ear barotrauma) occurs when pressure in the middle ear is lower than the surrounding pressure (which may occur during descent), forcing the eardrum inward and causing pain and bleeding. A pressure differential can also cause the eardrum to tear or rupture, which results in pain and bleeding. Water entering the ear may cause vertigo, which is very dangerous when it occurs at depth (6) The membranes in the sinuses can also be damaged by pressure. Note that sinus barotrauma and related injuries can occur both during descent and ascent. When ascending, the mechanism of injury is reversed as air expands called reverse block.

During ascent and descent, the rescue diver must observe the divers, asses if there is abnormal behavior, and assist any distress diver. If the afflicted diver can't correct problem abort the dive and asses.

An injury to the ears will manifest as a feeling of fullness, pressure or pain. There may also be a hearing loss or complaints of a "squeaking sound." Blood or other fluid discharge from the ear may be evident. A sinus injury can also cause fullness, pressure or pain (including pain in the upper teeth) with blood or other discharge from the nose.

Divers with suspected barotrauma should not return to the water. They need to be assessed by a physician for proper treatment, which may include antibiotics, antihistamines and in severe cases surgery.

3- Effects on the Lungs

The effects of the change in air volume and the other gas laws form the basis of decompression illness (DCI), which includes arterial gas embolism (AGE), and decompression sickness (DCS), commonly known as "the bends." (7)

If a diver takes a breath of air and starts to ascend while holding his breath (or with air otherwise trapped in the lungs), the air expands as the ambient water pressure decreases, much like air expanding in a balloon. This can damage the alveoli and bronchial passages.

Expanding air may rupture the lung and cause a pneumothorax. Mediastinal and subcutaneous emphysema can result from air that escapes from the lung. This condition is known as Lung Overexpansion injury (7).

AGE occurs when bubbles are forced into the bloodstream through alveoli, resulting in blockages when the bubbles reach smaller blood vessels. A cerebral arterial gas embolism (CAGE) results if the air embolizes in the brain.

AGE will usually occur either during a dive or within 15 minutes after a diver surfaces (7, 8) Symptoms include chest, torso or back pain, malaise (feeling unwell) nausea, coughing and shortness of breath, bloody or frothy sputum, headaches and/or dizziness, rash visual disturbances (including partial

or full blindness), numbness and/or tingling (in abnormal areas of body – nose tip, elbows, belly, knee) weakness or paralysis and loss of sensation in the body, and syncope (7).

Other atypical sings and symptoms (8, 9) are blochy skins -Livedo reticularis-, confusion, convulsions, difficulty passing urine, lack of coordination, itch, loss of baldder / bowel control, personality change, tinnitus (ringing in ears) speech disturbances.

Neurological symptoms are present aprox. 55% cases. Mixture of symptoms with neurological affectation occurs in 80% of cases (7,8).

ANY SIGN OR SYMPTOM THAT OCCURS WITHIN 24 - 48 HR OF DIVING should be considered diving related until proven otherwise. Especially if the depth-time exposure has approached or exceeded accepted procedures (8,9,10).

a. DCS: “The Bends”

As a diver descends, the increased ambient pressure forces inspired nitrogen into tissue. (10) When a diver ascends the pressure is reduced and nitrogen is released from tissue into the bloodstream. If a diver ascends too quickly, has been down too long or otherwise has excessive amounts of nitrogen in his body, bubbles may form in the bloodstream or remain trapped in tissue. (11)

Since bubble formation can occur in any tissue, there are many forms of DCS. Pain in recreational divers is more common in the arms, whereas in saturation divers the pains is in the knees. Either may occur in the limbs or joints. Central nervous system DCS can cause paralysis and loss of sensation. Cerebral DCS may produce headaches, visual disturbances, paralysis, unconsciousness and altered mental status. “Skin bends,” or cutaneous DCS, present with itching, burning or mottling of the skin (9,10).

The onset time of DCS varies within 24 hours of diving. In a recent report, half of all cases of DCS had symptom onset times of an hour and a half or less after a diver surfaced. Any symptoms that occur after 24 hours are probably unrelated to diving. In rare cases, divers exposed to altitude may exhibit initial symptom onset after 24 hours (9).

4- DCI Treatment

The treatment for suspected cases of any DCI, including AGE and DCS, are essentially the same, with the general algorithm of emergencies the assessment of ABCs is a priority. The importance of administering 100% oxygen cannot be over-emphasized in suspected cases of DCI or other diving NO CLEAR etiology incidents (9) (This is why all staff members should be familiarized with the O2 kit and the way it fully works) The reasons to apply 02 include the following:

Reasons and considerations using oxygen therapy (9)

1-	Breathing 100% 0xigen is the first aid for diving incidents
2-	High concentration oxygen flushes out dissolved nitrogen and nitrogen bubbles and supplies oxygen to hypoxic tissues a- This gives the advantage that if incident is not diving related clarifies the clinical spectrum of the patient rulling out nitrogen bubble formation
3-	Oxygen breathing should begin as soon as possible until a medical professional request it to be ceased
4-	It is important not to stop oxygen breathing to soon. Even if initial symptoms have disappeared, they can re-appear later and can worsen substancially
5-	If a demand valve with mouth piece is used on conscious diver, their nose must be blocked
6-	All dive operators should have suitable oxygen equipment for divers and staff trained and competent on its use.

In addition to providing respiratory support as it does in any emergency, oxygen promotes the elimination of inert gas bubbles in the tissues. Dive boats often have oxygen on hand, and someone may have begun administering oxygen prior to EMS's arrival. DCI can be life-threatening, and any suspected DCI requires immediate transport to a medical facility where a complete diagnosis and treatment, such as hyperbaric chamber therapy, can be done. Note that changes in altitude can exacerbate a case of DCI, so if the patient needs to be transported by helicopter, it should be at the lowest safe altitude possible. The current recommendation is 1000 feet' or lower (as seen later)

A physical exam, including a thorough neurological examination, should be performed and changes should be monitored carefully. NEVER ATTEMPT "recompression" by placing a diver back into the water(7,8).

Neurological test that can be fast performed on deck (9)

Finger nose movement	a- eyes open b- eyes closed
Ability to stand	a- eyes open b- eyes closed
Walking heel-toe short distance	a- front b- back
Ability to walk free	Walk on deck

Always perform test supporting patient, carefull with fainting and falling

5- Shock

To the BLS provider shock could be confusing, it's a myriad of signs and symptoms that are the Lobby to organ failure. Usually when data of shock appears, the physiological celular clock is suffering and the battle is 50% lost. The most common scenario for shock is bleeding, in which the patient enters to a state of hemorrhagic shock due to blood loss. The signs and symptoms of shock are as follows on table 3.

Table 3

Signs and symptoms of shock

Signs	Symptoms
Pale skin	Cold
Cold levels in extremities	Cold sweating / clammy skin
Anuria (don't urinate)	Dry mouth
Capillary filling more than 3 seg	Thirst
Radial pulse absent	Taquicardia / Palpitations / Arrythmia
Cyanosis (Purple color in fingernails)	Restlessness / irritability / Incoherence
Pulse 02 below 94%	Shivering
Taquipnea (rapid breath)	Dyspnea (sensation of shortness of breath)
Dazed look	Nausea / Vomiting
Syncope	Loss of consciousness

As BLS the most important maneuvers a rescuer can provide is control of bleeding, give oxygen in high percentage and control hypothermia. There's a triad in which the patient in shock should never get into that is called the triad of dead (Hypothermia, Acidosis and coagulopathy) So in a boat, ending a dive, the patient should be removed of all wet clothing, maintained warm with all the resources possible until it reaches ACLS care. If there's an ACLS provider on the boat, the most important thing to do (besides the latter) is apply IV fluids, raise systolic blood pressure and preserve kidney function in other to eliminate the metabolites that are produced in the shock state.

Breathing Dangers

1- Nitrogen Narcosis

Inert gases under pressure have an intoxicating effect. Nitrogen under pressure can cause nitrogen narcosis, which impairs the ability to think and reason. Divers can usually stop nitrogen narcosis by ascending until symptoms resolve. The danger of nitrogen narcosis lies in impaired judgment, causing divers to lose track of time, remaining air and depth limits and resulting in agitation, panic or confusion. This can lead to various problems, including drowning when they run out of air, or increasing the chances for serious injury or illness by ascending too rapidly. (11) Divers can recognize this state by watching the diver with erratic behavior.

2- Oxygen Toxicity

Divers run little risk of oxygen toxicity when they stay within recreational depth limits of 100 feet and use dive regular air, but it becomes a concern when they use mixed gases like enriched air nitrox (13) There are two types of oxygen toxicity. The first is central nervous system (CNS) oxygen toxicity. Signs and symptoms of CNS oxygen toxicity include convulsion, visual disturbance, tinnitus, nausea, tingling, twitching, muscle spasms (especially along lips and mouth), irritability, dizziness and/or dyspnea. CNS toxicity is the more dangerous form of oxygen toxicity due to the risk of having convulsions under water.

The second type is pulmonary toxicity, which can affect the lungs or other parts of the body. Symptoms include chest pain and discomfort, coughing and fluid in the lungs.

3- Carbon Monoxide Poisoning

Carbon monoxide poisoning can occur when the air in a scuba tank has been contaminated by fumes from an improperly maintained air compressor. This is why is important to assess the odor of the air prior to assemble the scuba equipment on the boat. Carbon monoxide poisoning often produces no symptoms before the diver loses consciousness, although there may be symptoms including headache, dizziness, nausea or altered mental status. There may also be excessive red or blue coloring of the lips, nail beds or skin. Patients with suspected carbon monoxide poisoning should be given oxygen.

It's important for the rescue diver, divemaster and instructor to know that there are going to be questions that a trained physician or investigator could ask On Scene

As in any other emergency, fact-gathering is important. Divers are trained to dive in a way that reduces the chance of DCI or other injury, but they may still experience problems even if they follow all the rules. In addition to medical history and other information you normally gather, there is information particular to diving that treating physicians will find useful.

Questions that could be asked and should receive an answer include:

a- "How long did it take the diver to ascend to the surface, and did he stop along the way?" A slower controlled ascent coupled with one or more stops helps the body off gas before bubbles form and also helps prevent barotraumas from air expansion.
b- "How deep and long was the dive?" There are recommendations on how long a diver may remain at various depths in order to minimize the risk of bubble formation.
c- "How long was it before the diver showed signs or symptoms?" DCI (including different forms of DCS) will present at various times based on severity and the type of DCI.
d- "What type of breathing gas was the diver using?" The gas mixture can help determine what illness or injury occurred. Divers are normally trained to dive with a buddy, who may be able to provide information.

As a legal concern, IT IS IMPORTANT TO don't interfere with the equipment the diver was using other than to close the valves on the tank and note the number of turns it took to close the valve. (15)

another important consideration is his diving computer. IT SHOULD NOT BE TOUCHED. There may be regional differences regarding what actions should be taken, including whether you should close the valves on a tank, so follow local procedures and defer to the judgment of law enforcement or other investigators on scene.

COVID 19 / SARS COV-2

This infectious disease is caused by a type of Corona virus and generates an atypical pneumonia than can progress to a acute respiratory distress syndrome in susceptible individuals and complicate to septic shock, secondary bacterial infections and death. Prevention is based in avoiding (16)

1- Direct contact with respiratory fluids of an infected symptomatic or asymptomatic patient.
2- Disinfecting hands and portables with soap and water.
3- Avoiding shaking hands, keeping prudent space between people.
4- Avoid touching eyes, mouth and nose without washed hands
5- Being carefull while coughing and having flu like symptoms

There is no direct evidence of the presence of the virus in dive gear, hoses, second stages or primary stages. By this DAN (divers alerts network) gives guidelines of cleaning gear with proven disinfectants (which can be found on CDC and EPA web page) (14, 16) that do not damage neoprene, plastic, metal. Like sodium Hipochlorite (Clorox) or quaternary ammonium, both diluted in water (16).

1- DAN recommends submerge gear for 5 min or more on water with Sodium Hipochlorite.
2- Clean and wash gear on a ventilated area
3- Mix active ingredient with cold water only (hot water damages active principle)
4- Use gloves, eye and mouth protection when mixing water with sodium hypochlorite or quaternary ammonium.
    a. 5% : 100 cc of Sodium Hypochlorite in 5 liters(5000cc) of water
    b. 10%: 50 cc of Sodium Hypochlorite in 4.9 liters (4900cc) of water (recommended)
5- When finishing cleaning gear with active principle wash thoroughly with clear fresh water.

On boats Rocket frog divers decided to maintain a diver in between when traveling to dive location. On board it is supplied a quaternary ammonium solution (14) for washing hands and masks as many times as costumer decides. This solution is hypoallergic and it has been used as defogger for many years in our operation.

As a rule staff must recognize a costumer with flu like symptoms and ask general questions to report to Course director, shop administrator or CEO:

1- Presence of fever
2- Cough, lost of taste or smell on last days
3- Muscle pain, diarrhea, dry throat
4- Using any over the counter medications

As everything with medical science guidelines and recommendations may change with time especially with a fast evolving condition like COVID19 / SAR-COV2.

Marine Life Injuries

Marine life injuries are incredibly rare, considering how many organisms in the marine environment can cause harm to humans. Usually, divers can prevent marine life injuries by adhering to the general diving rule, **"no touching, teasing or taking."** (13) Besides encouraging using gloves, wetsuit, and rash guard is a good preventable measure. Sometimes, however, contact with harmful flora or fauna underwater is either unexpected or unavoidable. In these cases, it's important to know how to react. In minor cases, delivering effective first aid on deck provides pain relief. In more serious cases it can vastly improve a victim's chances of survival. Here we'll take a look at four potential marine life injuries and the first-aid procedures required to treat each one (11).

1- Jellyfish stings

Of the myriad jellyfish species, some are stingless and some can be fatal. When stung by a jellyfish, the seriousness of the situation depends on several factors. These include the species, the anatomical location of the sting, the size of the affected area, and whether or not the victim is allergic to the animal's toxins. Many jellyfish stings do not require professional medical attention. But if the victim experiences severe symptoms, including chest pains and difficulty breathing, contact emergency medical services immediately.

If the victim is particularly old or young, or the sting covers a large area, call emergency services immediately (10,13). In general, however, first aid for all jellyfish stings follows the same guidelines. The victim should be treated out of the water, and kept as still as possible. This prevents more toxins from being released and spreading around the body (11).

If there are any visible tentacles on the victim's body, remove them using tweezers, forceps, or gloves to avoid further stings. After you have removed the tentacles, clear any remaining stinging cells, or nematocysts, by applying shaving cream. Use a razor or credit card to carefully scrape them from the skin. If you do not have these tools on hand, use salt water to flush the affected area. Never use fresh water, as it can cause unfired nematocysts to release their poison (2,13).

Contrary to popular urban myth, you should avoid urine for the same reason, as well as alcohol. Some sources (including DAN) recommend using household vinegar for sting relief. Others, such as the British National Health Service, advise not to for fear that the vinegar may also trigger remaining nematocysts. Instead, they recommend either applying an ice pack to the affected area or soaking it in hot water. This offers the victim pain relief after all tentacles and stinging cells have been removed (13).

2- Lionfish, scorpionfish and stonefish injuries

All three of these fish species are highly venomous. They all have spines on their dorsal, anal and pectoral fins, capable of injecting venom into a diver's skin. Typically, injuries from any one of these fish require emergency care. If you are stung by a stonefish, seek professional medical attention immediately (8). Of the three, the venom of this fish is the most potent and can be fatal. Victims will

require anti-venom injections as part of their treatment. First-aid care is the same for both lionfish and scorpionfish injuries.

Once the diver is safely out of the water and in a stable environment, use tweezers to gently remove any spine fragments embedded in the wound. Then, soak the wound in hot water. It should be as hot as the victim can tolerate without burning the skin. These species' venom is protein-based, and begins to break down and deactivate with the application of heat. Soaking the wound in hot water will not only relieve pain but also reduce the venom's effects (13).

If possible, immerse the affected area for at least 30 minutes. If the wound is located somewhere that makes immersion difficult, use hot washcloths. Hot-water treatment may also help in the case of stonefish injuries. Apply hot washcloths or immerse the wound while waiting for medical care to arrive. After soaking, disinfect the wound, apply antiseptic ointment and take over-the-counter pain medication to help alleviate pain. Divers should seek immediate medical attention after exposure to the venom of any of these species, as some complications may take time to manifest. Serious complications include anaphylactic shock as a result of an allergic reaction, shock, infection, tissue death and paralysis. These wounds can take weeks, or even months, to heal (10,13). Under medical supervision you can give antihistamines, paracetamol orally if not contraindicated.

3- Coral cuts and abrasions

These are perhaps the most common diver injuries. Coral scrapes can occur whenever a diver contacts the reef. Coral is often sharp, and those who get cut will find that they take a long time to heal, and often become infected. This happens because a thin film of living organisms covers the coral. They tear away from the main structure on contact and contaminate the victim's wound. To treat coral cuts and abrasions, first stem any significant blood flow using direct pressure. Once the bleeding has stopped, make sure to remove any remaining coral fragments by flushing with clean fresh water. Use antibacterial soap or hydrogen peroxide mixed with water to disinfect the wound. Finally, rinse again with fresh water (13).

After you have cleaned the wound, apply antibiotic cream. Cover with a sterile, non-adhesive dressing. Clean and re-dress the affected area twice a day until the wound has healed. Although victims won't usually require emergency medical care for coral injuries, watch closely for signs of shock or aggravated infection. Treat extreme redness, swelling, excess pus, swollen lymph glands or any other signs of fever or infection immediately.

4- Large animal bites

When it comes to marine life injuries, most people automatically imagine shark attacks. Truthfully, the likelihood of receiving a shark bite is infinitesimally small. But several marine species can inflict a nasty bite, including moray eels, barracuda and seals. Usually these species will only react aggressively in self-defense, or if they mistake a diver for prey. The severity of such injuries can range from the superficial to the fatal. In the case of more serious bites, first remove the victim from the water (11,13).

Contact emergency services immediately, and then focus on providing basic life support until the professionals can take over. Apply pressure to the wound to stem blood flow, remembering to protect yourself wearing protective barriers if possible (latex gloves, goggles). Do not release pressure to change bandages or cloths even if they become saturated. Instead, simply apply more bandages directly on top of the original ones (10). If the bleeding is excessive and you cannot stanch it, apply a tourniquet as close to the injury as possible. If not used properly a tourniquet can cause other complications. Tourniquets are an absolute last resort, and ideally someone with prior medical training will apply them (13).

If the bite is located on an extremity, raise it above heart level to help reduce blood flow. If the bite broke a bone, use a splint to support and protect the injured limb. If you don't have a purpose-made splint on hand, you should be able to improvise one quite easily. Often, the shock and trauma of a severe bite can cause a victim to have difficulty breathing; in this case, administer oxygen and monitor continued respiration until emergency services arrive. In the event of minor bites, the victim may not require emergency services. Simply use direct pressure until the bleeding stops, and then rinse gently with fresh water, clean with antiseptic and apply a non-adhesive, sterile dressing. Should any infection occur, or other symptoms arise, make sure to seek medical advice immediately (13).

5- Stingrays

Stingrays are generally docile creatures, but are equipped with a tail that has sharp barbs used for defense, most often on an unsuspecting person who has the misfortune to step on it. The tail inflicts a deep puncture and/or laceration together with an envenomation. The pain is often severe and accompanied by bleeding. Reactions include weakness, fainting and, in more extreme cases, anaphylaxis, paralysis and death. You should first establish the universal algorithm of assessing the ABCs, then rinse the wound with clean water and immerse in hot water (110°F-113°F/43.3°C-45°C) for 30 to 90 minutes. Extract obvious pieces of barbs, then conduct pain management as needed (13) As with any wound, there is a risk of infection from the puncture. Management under medical supervision with antihistamines, paracetamol and antiseptic soap is advised if victim is not allergic.

6- Marine Snake Bite

The Hydrophis platurus (yellow belied sea snake) an its variation found in the Golfo de Nicoya H. platurus xanthos, is a small headed snake of the same family of the Elapidae sp. or Coral snake. The venom is neurotoxic, there are no reports on medical literature of a Hydrophidae attack on humans. There is no antivenom for this snake, it is theorized that the anticoral serum on high doses could be a good therapeutic to this event, thou more evidence is needed. This snake is afraid of humans, not aggressive and usually runs away. But it should not be bother as any other marine life, she could attack on self defense and because her jaw is small, areas like hands, ears, nose and feet are probable targets.

Dive plan to prevent emergency events

Dive plans set out the way diving will be carried out to ensure the participant's health and safety. The dive plan should assist with the implementation of control measures that have been selected during the risk management process.

A single dive plan may be prepared for several dives when the risks of the dives are similar. When the risks of the dive vary (e.g. when there are different tasks, equipment used or significant environmental change), then a new dive plan should be prepared.

Example dive plan for diving work:

Dive plan			
Business legal name:	ABN:	Depart date:	Return date:
Dive supervisor:		Vessel master if applicable:	
Dive site locations:			
Dive plan prepared by: Date:			
☐ All persons briefed by dive supervisor			
Method of carrying out the task			
Type of diving	Tasks	Diving equipment/gas	
☐ Vessel - per ops manual	☐ Manual cleaning	☐ SCUBA air only - per ops manual	
☐ Shore - per ops manual	☐ Harvesting by hand	☐ SSBA air only - per ops manual	
☐	☐ Inspection	☐ Pre departure checks completed	
☐	☐ Scientific sampling	☐ Pre dive checklist available	
☐	☐	☐ Other (specify)	
Decompression management			
☐ Computer (specify)	☐ Tables (specify)	☐ Flying after diving	
☐ Other deco factors (specify)			

Task and duties (all members of dive team)			
Name	Competent	Medical	Duties
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	

	☐	☐	
Site specific hazards (in addition to controls in ops manual)			
Hazard	Risk		Control measures (site rules)
☐ Environmental hazards (specify)			
☐ Equipment hazards (specify)			
☐ Task hazards (specify)			
☐ Other (specify)			

Diving planned				
Date range	Location	Depth range	Max time	Task

Emergency procedures
☐ Emergency procedures available on site (as per ops manual)
☐ Emergency procedures reviewed and practiced by dive team Last drill date:

Applying to the plan and getting knowledge of it by all members of the crew reduces the incidence on events, and prevents an emergency.

Conclusions:

Medicine is an ever-changing scientific area, managements and protocols are changing day by day that's why continuous reading and updating is needed. In a vast area as diving, which has so much to investigate still, the science of injury and pathology is ever changing. The need for evidence-based studies and reports is of vital importance. As a high-volume dive center reports and incidence of cases could make a big difference toward the changing field of medicine and diving.

In regards to emergent infectious diseases people at high risk should follow health services recommendations, control their chronic stablished diseases and maintain strict hygiene measures. Rocket Frog divers in this regard, besides there is still not available evidence of the effect of COVID-19 in dive gear decided to take preventive protocol of disinfection and management of staff and rental gear.

On the other hand, cause of the high volume of divers Rocket Frog has, the continuous training, studying and applying the knowledge is imperative. Accidents and events occur proportionally to the volume of activity in a field.

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