DIVE MEDICINE

Paper – 1

1) **Factors you would take into account when assessing fitness to dive in order to reduce the risk of diving accidents**

Fitness to Dive is the physical fitness or the competency of a professional as well as a recreational diver, with which he can manage safely under the water, with appropriate equipment and a suitable underwater environment. Before a diver goes underwater, he/she is subjected to a battery of fitness tests including medical and legal examinations. All these procedures are performed for two reasons (Carl Edmonds, 2015)

1) To ensure the safety of diving
2) To eliminate any possible risks during the dive.

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The three major factors which are to be considered while assessing fitness to dive are the diver's physical condition, mental stability and medical fitness. In addition to meeting the fitness guidelines, the diver must not possess any condition that poses risk to diving. The factors that need to be considered for physical fitness testing are similar for both professional divers and recreational divers, the former being a little stricter than the latter.

Primarily, a written declaration statement of his fitness, previous medical history, and consent is provided by the diver.

The basic components of a physical fitness testing include

Factor	Parameters Assessed	Assessed by
Lung Functions Test	Lung volumes and capacities under varying pressures	Serial Spirometry
Cardiac Stress test	Cardiac Endurance under varying conditions	Treadmill, Bicycle Ergometer

In the screening of the mental stability of the diver, certain factors have to be considered, such as

Screening	**Relative Risk factors**	**Absolute Risk factors**
Mental Health	Previous Drug abuse – Anti-diabetic drugs, antidepressants, steroids, anti-histamine drugs	Dissent to dive, Suicidal Tendencies
	Depression	Bipolar disorders, Instability of mind
	Previous suicidal tendencies	Current Influence of drugs – Narcotics, antidepressants, steroids, anti-epilepsy drugs, sedatives

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There are certain conditions which temporarily disqualify a diver from diving. In these cases, after a period of recovery from the condition, the diver has to undergo tests to re-establish his fitness to dive. The recovery time differs with different conditions, and only on complete recovery will the diver be re-considered for any diving activities. There are also certain factors which permanently disqualify a diver from diving, as the risks posed by them could be fatal.

The below table lists the conditions that must be screened during the medical fitness examination, which could be either relative or absolute risks for the diver.

	Relative Risk factors	Absolute Risk factors
	Complicated Migraine Headaches	Epilepsy
Neurological	History of Head/Brain Injury	History of Cerebro Vascular accidents/ Stroke
	History of Spinal cord injury	History of serious residual Decompression sickness
	Nucleus Pulposus herniation	
	Pulmonary barotrauma	Spontaneous pneumothorax
Pulmonary	Bronchial Asthma/COPD	Impaired exercise performance
	Secondary pneumothorax	
	Exercise induced Bronchospasms	
	Previous cardiac surgeries	Cardiac Embolisms
Cardiovascular	Myocardial infarction	Valvular lesions
	Pacemakers	
	Hypertension	
	Amputation	Infective osteomyelitis
Musculoskeletal	Scoliosis	
	Back pain	
	Barotrauma affecting the ears	Barotrauma induced Facial Nerve surgery
Ear/Nose/Throat	Recurrent otitis externa/media	Inner ear surgeries
	Facial bone/ Skull fractures	History of decompression sickness
	TM Joint disorders	TMJ Perforations

Failure to reveal all possible information to the screening experts is not only a legal offense, but also would prove risky and even fatal if an unexpected episode of a contra-indicated illness appears during diving. Only if the diver is cleared of his fitness examinations, he might be permitted to proceed with the diving activities.

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Paper – 2

2) **Write short notes describing what factors you would take into account when assessing the diving environment in order to reduce the risk of diving accidents.**

Safety in diving is dependant not only on the diver's fitness to dive, but also the diving equipment and environmental conditions. According to Blumenberg (1996), the dynamic underwater environment is a major contributor to the diver's physical and mental fitness. Though the changes in temperature, pressure, and other factors underwater cannot be modified, they must be well analysed as they are decisive in the equipment preparation and the commencement of the dive. In the below table, the risks presented by the natural underwater environment are listed.

Factor	Risk
The Liquid state environment	Drowning, Near drowning
Collision with rocks/ boats etc	Lacerations, abrasions, fractures, bleeding, infected wounds
Underwater Entrapments	Running out of breathing gas as the diver is trapped, delayed rescue
Venomous sea inhabitants	Bite wounds, teeth lacerations, poisoning
Ultrasonic Waves	Heating up of the body
Water Contaminations	Leptospirosis infections
Getting lost	Invisibility, risk of exposure, drowning
Surf/Silt	Invisibility, Disorientation, Vertigo
Strong underwater currents	Dislodging of equipment, inability to oppose the currents

Underwater pressure is one of the major factors to be considered while diving, as the human lung is not suited to breathe normally in the high pressures of the sea. In the below table, the risks presented by the pressure changes in the underwater environment are listed.

Factor	Risk	Effects
Pressure changes during descent	Pressure difference over the eardrum	Inward Burst eardrum
	Pressure difference over the sinus	Rupture of blood vessels
	Pressure difference in the lungs	Lung damage
	Pressure difference in the teeth	Toothache
Pressure changes during ascent	Increased Lung pressure	Pulmonary barotrauma, pneumothorax, emphysema
	Increased sinus pressures	Rupture of blood vessels, bone damage
	Increased ear pressure	Outward burst eardrum
	Increased tooth pressure	Cracking of teeth
Exposure to high partial pressures of gases	Decompression sickness	Gas bubbles entering the body
	Nitrogen narcosis	Alerted consciousness, loss of steady state
	Oxygen toxicity	Epileptic seizures, Respiratory Distress
	High Pressure Nervous system	Visual disturbances, nausea

Underwater temperature is also to be considered while diving, as the temperatures drop as it gets deeper. In the below table, the risks presented by the pressure changes in the underwater environment are listed.

Factor	**Risk**
Exposures to cold temperature	Hypothermia
	Frost Bites
	Muscular cramps

Other factors that need to be considered are

1) The limit of sunlight penetration, as visibility reduces with reduced lighting
2) The buoyancy of water, loss of which can lead to uncontrolled ascent or descent in the waters.
3) Conductivity of sound, where sound navigation becomes difficult due to the lack of directional clarity.

The role of the diving equipment plays a very important role in managing the environmental hazards, such as

1) Delivering breathing gases at optimal pressure,
2) Managing the pressure differences,
3) Offering protection from natural dangers,
4) Providing insulation from cold temperatures
5) Enabling navigation by the use of sensors, in case of getting lost

If the above mentioned factors are looked into, and care is taken to equip the diver with precautionary measures, the diving experience can be made into a safe and adventurous one.

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Paper – 3

3) **Write short notes describing how you would assess and plan medical support for diving in a remote location where there is no chamber accessible within a reasonable timeframe.**

In diving, there is a great risk of accidents and a greater susceptibility of the diver to be impacted with an issue in the variations in pressures, underwater environment, the equipments, newly acquired or resurfacing dormant health conditions, etc. A major part of diving medicine concerns with taking care of the safety of the divers.

Usually, the diving procedures involve issues at varying atmospheric parameters, the most practical way in the medical management is stabilizing the diver until normal temperature and pressure levels are attained.

The sea covers more than 70% of the land, and expert medical care cannot be found at all its shores. There are areas where the diver dives in a remote location, and even a diving chamber is many hours apart. In these situations, the diver must be stabilized, and sustained for a longer period of time, before expert opinion is obtained. Ideally, when there is no chamber on site, the points to be considered by an onsite medical professional are (Pitkin, 2003)

1) Planning and advice to the diver on the type of diving according to the availability of emergency medical care.
2) Obtaining information of the local availability of breathing gases used for treatment, and other equipments used in life support from the hospitals nearby
3) Contingency evacuation planning must be made, with travel by air made possible
4) Stocking of emergency medications, or knowledge about their availability in near locations

5) Maintaining of a detailed documentation of

    a. Diver details
    b. Previous medical history
    c. Fitness records
    d. Type of diving
    e. Any known calamities known to occur in the waters of that location
    f. Time and date stamp of the diver's communication points

To suggest a medical management strategy in these cases, one must list out the possible complications that might occur to the diver, and then plan on how they can be addressed. A resurfaced diver would first be assessed for decompression sickness, barotrauma, and hypothermia.

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Pre-medical considerations of the diver:

The diver might present with certain pre-existing conditions that are of a relative risk to diving, but there are chances that it might aggravate during diving. (The Royal College of Surgeons of Edinburgh, 2016)

Emergency	Management
Cardiac arrest	i. Administration of aspirin ii. Administration of sublingual Glycerin Trinitrate iii. Transportation to a nearby facility
Dehydration	i. Ensuring adequate hydration before diving, ii. Rehydration after resurfacing
Fatigue	i. Adequate Hydration ii. Transportation to a nearby facility

The diver might also face certain serious complications from the dive, presenting with conditions such as

1) Decompression Sickness, where inert gas bubbles form in the body due to pressure differences, causing pain, neurological symptoms,
2) Oxygen Toxicity, where the partial pressures of oxygen are too high and breathing it in its molecular state leads to poisoning.
3) Arterial Gas Embolisms, where air bubbles enter the bloodstream, lodging in the blood vessels, causing cardiac or neurological symptoms.
4) Barotrauma, where the differences in pressures of the inside and outside environments cause tissue damage, in places like lungs, ears, sinuses etc.
5) Hypercapnia, where there is poisoning due to the excessive inhalation of too much of carbon-di-oxide
6) Immersion Pulmonary edema, where changes in the water temperatures alter the lung pressures, thus affecting the performance of the diver
7) Aspirations, either particular or water, when there is temporary dislodging of the breathing apparatus, leading to loss of breathing gas and choking

Administration of oxygen via cylinder is known to stabilize all the above mentioned major complications that occur in diving, and it is sustained till the transport of the diver to the nearest facility

In case of such emergencies, the basic procedures which medical personnel on site must be equipped with are

1) Administration of Oxygen via mask, a constant supply of oxygen cylinders must be made available
2) Administration CPR – In cases of unconsciousness, aspirations, loss of breathing and pulse, seizures etc
3) Neurological Assessments – For patency of the Higher mental functions
4) Basic nursing procedures
    a. To manage bleeding injuries
    b. To manage poisoning from bites of venomous organisms
    c. To administer intravenous solutions via drip
5) Administration of In-Water-Compression

In emergencies when the recompression is not available, In-water Recompression (Stipp, 2007) also known as underwater oxygen therapy can be performed. It works by sending the diver under water again with pure oxygen, allowing gradual resolution of the inert gas bubbles that have accumulated in the tissues. This is quite a risky process, which must be carried out only when there is no decompression chamber onsite. The divers who are in emergency situations needing immediate recompression usually are either unconscious, paralyzed, or have seizures; this process needs to be performed with utmost care.

In Water Recompression works on the principle of increasing the ambient pressure around the diver to reduce the bubbles in the tissues by improving blood flow, which is similar to the recompression in a chamber. The administration of oxygen further enhances the blood flow to the body, flushing out the inert gas bubbles.

The potential risks faced by this procedure are

1) Oxygen Toxicity
2) Asphyxiation of the unconscious diver
3) Drowning due to improper support
4) Exacerbation of the symptoms in rare cases (seizures, headaches)

The major factors that needed to be considered for IWR are

1. Proper equipment to handle the diver – the harness, ropes, weights, etc.
2. Proper oxygen delivery system
3. Monitoring of slow ascent and descent
4. Up-to-date communication with the diving instructors
5. Strict adherence to the IWR depth guidelines

Though IWR is not the preferred first line of management in cases of diving emergencies, it can be the only option available when a recompression chamber and transportation are not feasible.

The diver must be administered a dermal patch of hyoscine hydrobromide, the drug used to counter motion sickness, which would last for nearly 72 hours, before further proceeding to decompression. (DMAC, 2014)

It is always better to perform complex diving procedures in the presence of a diving chamber onsite, or at a nearby location, as not having a recompression chamber might disable the diver from further dives for long periods of time, and at times might also be fatal. In such places of absence of the chamber, low risk dives, mostly performed for recreational purposes are recommended.

Paper – 4

4. Write short notes describing how your assessment and planning would differ if there was a recompression chamber within an hour or so evacuation time.

In diving, there is a great risk of accidents and a greater susceptibility of the diver to be impacted with an issue in the variations in pressures, underwater environment, the equipments, newly acquired or resurfacing dormant health conditions, etc. A major part of diving medicine concerns with taking care of the safety of the divers. Of the emergencies that might occur, decompression sickness is a major issue, which calls for immediate recompression. However, recompression chambers might not always be present on site, and might be available within a span of few hours. Let us consider the effects of delayed recompression on the various manifestations of Decompression Syndrome.

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The effects of delayed recompression on the tissues are

Manifestations	Symptoms	Effects of Delayed Recompression
Initial Manifestations	i. Formation of Bubbles ii. Inflammatory cascade leading to ischemia of the tissues	i. Increase in existing bubble size ii. Exacerbation of the inflammation
Musculoskeletal	i. Pain in joints ii. Muscular pain	Increase in pain, beginning with dull throbbing pain and gradual increase
Neurological	i. Tingling and numbness of the extremities ii. Altered sensations iii. Ascending paralysis	If the impingement of the bubbles on the spinal nerve roots is increased, due to increasing bubble size, there will be increased sensory motor symptoms
Pulmonary	i. Retrosternal pain ii. Shortness of birth	Increase in pain, symptoms

What influences the bubble formations? Studies reveal that the rate of flush out of the nitrogen within the body cells plays an important role in the persistence of the bubbles, which is faster in recompression chambers. There is also theories of the immunological shell that s formed by the bubbles, which causes delays in the flush out. (Hadanny, 2015)

One major factor that needs addressal is the denial of the diver to possess decompression sickness, where many complications could be averted if timely intervention is made. There must be mandatory protocols for recompression to take place in cases of doubt.

As in this case, recompression therapy is delayed by a time span of an hour or so, there might not be any increase in symptoms due to the delay, as the exacerbations are reported in treatment delays of 24 hours or more. However, bubble formations can be minimized if the delay is prevented. (DeNoble, 2005)

The major risk factors for decompression sickness must be identified, which might be

1) The diver's age
2) Any pre-existing conditions presented
3) Rate of ascent and descent
4) Time spent under water

Eliminating risks would be the first step of management, and first line treatment of decompression sickness is administering 100% Normobaric Oxygen (Longphre, 2007), also known as First tissue oxygenation, which would reduce the decompression by increasing the blood flow and oxygen supply to the tissues, thus reducing the necrosis and initiating tissue healing. Routine administering of first aid, CPR, Neurological assessments, etc must be performed if necessary. Measures to transport a diver, in cases of loss of consciousness, must be made, and their equipment kept ready.

The diver must be administered chewable tablets of hyoscine hydrobromide, the drug used to counter motion sickness, which would last for 7-8 hours, before further proceeding to decompression.

Recompression, though performed with a time delay of a few hours could save the diver from numerous sicknesses.

Paper – 5

5. Write short notes describing how your assessment and planning would differ if there was a recompression chamber on-site.

In diving, there is a great risk of accidents and a greater susceptibility of the diver to be confronted with an issue in pressure variations, underwater environment, the equipments, newly acquired or resurfacing dormant health conditions, etc. A major part of diving medicine deals with taking care of the safety of the divers. Of the emergencies that might occur, decompression sickness is a major issue, which calls for immediate recompression. If a recompression chamber is available onsite, there would be many issues that would be avoided, and prevented.

Studies prove that immediate treatment with hyperbaric oxygen reduces the risks and complications associated with decompression sickness, especially the neurological manifestations. (Schröder, 2004) Let us consider the effects of immediate recompression on the various manifestations of Decompression Syndrome.

Manifestations	Symptoms	Effects of Delayed Recompression
Initial Manifestations	iii. Formation of Bubbles iv. Inflammatory cascade leading to ischemia of the tissues	iii. Decrease in existing bubble size iv. Prevention of the inflammation
Musculoskeletal	iii. Pain in joints iv. Muscular pain	Reduction of pain
Neurological	iv. Tingling and numbness of the extremities v. Altered sensations vi. Ascending paralysis	Release of the impingement of the bubbles on the spinal nerve roots, due to reduction in bubble size
Pulmonary	iii. Retrosternal pain iv. Shortness of birth	Reduction of pain, symptoms

One major factor that needs to be monitored in the management of decompression sickness with on-site recompression chamber is the diver’s nitrogen intake, which would be indicative of the symptoms manifested.

Even as there is no dearth in the availability of a chamber, one must not tend to rush the diver to recompression immediately after the dive. For this, the on-site medical personnel must have a full history of the dive profile as well as the diver profile. The contra-indications of immediate hyperbaric oxygen intake must be ruled out before commencement of recompression.

1) Cardiovascular diseases
2) Pneumothorax
3) Respiratory Tract Infections
4) Fever, in case of salt water aspirations
5) Existing Barotraumas

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Studies have revealed that treating the diver with 100% normobaric oxygen prior to hyperbaric oxygen administration could help enhance the effects of HBOT. (Longphre, 2007) The hyperbaric treatment schedules or tables, which are suitable to the diver, must be followed. For instance, the US Navy Recompression Treatment Table 5 is indicated for treating the pain of DCS, where oxygen is available, and the symptoms of DCS relieve within 10 minutes, at 18 msw. Here, the time of HBOT, inclusive of compression is indicated at 2 hours 16 minutes.

Thus, proper administration of decompression with an on-site chamber must be done by following the procedures, to ensure better results.

Paper – 6

Case 1

A 26 year old recreational diver using a closed-circuit set took 6 breaths from his equipment at the surface before diving and fell unconscious. When his mask and mouthpiece were removed he was tachycardic, tachypnoeic and pale. He made a rapid recovery.

Provisional Diagnosis: **Pulmonary Barotrauma induced Cerebral Arterial Embolism** (Clarke, 2002)

Rationale: The diver might have had insufficient ventilation of the lung due to prolonged breath holding. This could have caused pulmonary over-pressurization, leading to lung barotrauma. This would have caused embolism of the respiratory gases in the circulation. An embolus in the brain would have led to unconsciousness of the diver. As a rebreather, there would have already been a little retention of carbon dioxide within the mask and mouthpiece, thus leading to tachycardia and tachpnea. Though the recovery was rapid, there are risks of relapse.

Management – 100% Oxygen delivery via non re-breather, with recompression, to limit re-embolisms.

Case – 2

A 37 year old scallop diver was working hard at 35 msw on open-circuit SCUBA. His breathing rate was increasing, he developed a throbbing headache and his heart started pounding. He returned to the surface and removed his demand valve. His buddy commented that his face was red. He was tachycardic and tachypnoeic. His headache persisted but the other symptoms resolved spontaneously over the next 5 minutes.

Provisional Diagnosis – **Hypercapnia** (Earing, 2014)

Rationale – The diver was supposedly working heard deep underwater, where the gas exchange system of the lungs take place faster, thus producing carbon dioxide at a higher rate. Since the air at 35 msw is denser than at the atmospheric level, increased effort of breathing further increases the body's CO_2 production. The resultant increase in the breathing workload increases the heart rate and the respiratory rate (tachycardia and tachypnea). This is supported by the diver's symptoms of headaches and facial flushing, and spontaneous relief on resurfacing.

Management – Reducing the workload, breathing fresh air at atmospheric pressures.

Case 3

A 24 year old surface supplied compressed air diver spends 28 minutes at 43 msw. He ascends, completing all stops. 15 minutes after ascent he complains of a dull pain in his left knee and starts to limp. A quick examination reveals weakness in his left hip and knee, reduced light-touch and pin-prick sensation over left quadriceps. He is taken to a recompression chamber, by which time he has weakness and numbness in the whole of his left leg, weakness in this right knee and numbness over his right calf and shin.

Provisional Diagnosis: **Decompression Sickness with Neurological Manifestations** (Trout BM, 2015)

Rationale: The diver has spent a considerable amount of time in the deep sea, which might have led to the formation of nitrogen bubbles within his body, which might have impacted the lumbar peripheral nerve roots of the spinal cord. The time delay in the onset of the symptoms is within an hour of surfacing, which is the norm in nearly half of the cases. The gradual progression of the symptoms from proximal to distal is also characteristic of DCS.

Management: Recompression with 100% Oxygen,

Case 4

A 36 year old recreational diver uses a semi-closed nitrox set for a dive to 52 msw on a wreck. He swims along the long axis of the wreck working against a moderate current. After 15 minutes he feels uncomfortable, has difficulty catching his breath, notices tingling in his fingers and develops tunnel vision. He stops exploring the wreck and begins his ascent. He is recovered unconscious on the surface, he does not remember anything from leaving the bottom to the first few minutes after being recovered into the dive boat and he has urinated in his dry-suit. He complains of pleuritic retro-sternal pain and has haemoptysis. His voice has changed.

Provisional Diagnosis – **Oxygen Toxicity with Pulmonary Emphysema** (Byyny, 2015)

Rationale: The diver was at the deep sea level with a semi-closed nitrox set, which could have increased the risk of oxygen exposures at high partial pressures. The symptoms of discomfort, dyspnea, tunnel vision, parasthesia and loss of consciousness, and the time delay of the onset of the symptoms support this diagnosis. On ascent, the diver might have developed pulmonary barotrauma leading to pulmonary emphysema, with the symptoms of retrosternal pain due to gas descent, voice changes and hempotysis.

Management: Hyperbaric Oxygen therapy with 100% Oxygen delivered via mask, under normal atmospheric pressures.

Case 5

A 26 year old trainee SCUBA diver begins a dive breathing compressed air. He has difficulty descending and makes several forceful valsalva efforts in order to clear his ears. He eventually reaches 28 msw but, after 15minutes at depth, he begins to feel unsteady. He heads for the surface at the correct rate, observes his safety stop but his symptoms progressively worsen. On the dive boat he has vertigo, he is unable to walk and reports deafness in his right ear.

Provisional Diagnosis – **Burst Eardrum and Cold Exposure to Inner ear** (Levett, 2008)

Rationale: The diver might not have cleared his ears completely through the valsalva maneuvers, thus leading to pressure differences between the outer and middle ears. This explains the symptoms of unsteadiness; he blockage of air in the middle ear on ascent might have caused the deafness. On ascent, the inner ear is exposed to the cold waters, thus disturbing the equilibrium of the vestibular system behind the ear. This is explained by the vertigo and unsteadiness experienced by the diver.

Management – Avoidance of exposures to pressure, pain relievers, surgical procedures such as tympanoplasty, sealing of the leakage.

Case 6

A 29 year old recreational instructor is using a semi-closed circuit oxy-nitrogen set. He descends to 33 msw. After 21 minutes of finning against a strong current he begins his ascent at the correct rate, observing all stops as advised by computer. His buddy notices that he loses consciousness at 3 msw, and ensures that he keeps his mask on and mouthpiece in as he recovers him to the dive boat. The casualty slowly recovers consciousness. He feels well but has no recollection of the last 6 metres of his ascent.

Provisional Diagnosis: **Hypoxia of ascent** (Edmonds, 2015)

Rationale: The diver was diving at deep waters for a long period of time. On ascent, the partial pressures of oxygen in the lungs fall very low, and this pressure difference could have caused the hypoxia. However, the exact reason for the hypoxia of ascent or the "deep sea blackout" is unknown, with the speculations of self induced breathing control and pressure differences being researched upon. The diver also exhibited the characteristic symptoms of loss of consciousness close to the surface, and total amnesia of the event on recovery.

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Management: It is sometimes fatal or causes irreversible brain damage. On the event of any brain damage, oxygen therapy is provided.

Case 7

A 37 year old breath-hold diver takes a deep breath and descends to 17 msw. He swims along the sea-bed for 5 minutes, gathering coral. A colleague notices that he stops moving and recovers him to shore. He has a pulse but is not breathing. His colleague administers two rescue inflations. The casualty begins to breathe, coughs up a small amount of water and slowly recovers consciousness. He makes a full neurological recovery but, 3 hours later, he develops shortness of breath and pyrexia.

Provisional Diagnosis: **Salt Water Aspiration** (Carl Edmonds, 2015)

Rationale: The diver was in the seabed for gathering corals, there might have been a possibility of the interference sand particles, weeds or crystals in the diaphragm or the exhaust valve, blocking the air supply. This could have lead to dislodging of the equipment by the diver, resulting in aspiration of the deep sea water. When the colleague would have noticed the diver, he would have gone to a near drowning state; the water in the lungs dislodging upon rescue. The diver also presented with pyrexia, which is one of the classic symptoms of the condition.

Management: Administration of 100% Oxygen, Investigations to rule out any foreign body aspirations.

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Case 8

A 24 year old surface supplied compressed air diver trainee descends to 48 msw. He reports that he has reached the bottom and feels well. The supervisor makes a weak joke over the communications and the diver laughs uncontrollably, and then reports that he can hear a strange whining noise and comments that the fish aren't happy with the quality of his work. The supervisor brings the diver back to the surface where he feels completely well but has left a selection of tools at the seabed and cannot remember the joke or precisely what he has done underwater.

Provisional Diagnosis: **Nitrogen Narcosis** (Levett, 2008)

Rationale: The diver was at 48 msw, and is probably induced by the narcotic and anesthetic effects of the breathing gases at high pressures. This has led to euphoria, hysterical laughter, hallucinations (about the fishes complaining), and loss of memory (forgetting a set of tools underwater), followed by complete amnesia of the events that occurred underwater.

EssayCorp 5 years

Management: Though there were no physical issues with the diver, he must be constantly monitored, and his diving depth must be gradationally increased. Once such symptoms recur, the diver must be asked to ascend to shallower surfaces.

Case 9

A 17 year old recreational student is at 3 m in a swimming pool using compressed air SCUBA. After 2 minutes in the water he begins mask-clearing practice. He inhales water through his nose, panics and swims for the surface. Almost immediately he reaches the poolside he develops tingling and weakness in his left hand and leg. He is given oxygen at the scene while waiting for an ambulance. The weakness improves slightly but the numbness persists. When describing his symptoms he notices that he is having difficulty selecting the correct words.

Provisional Diagnosis: **Arterial Gas Embolism with neurological manifestations** (C. M Muth, 2000)

Rationale: The diver was breathing compressed air when she accidentally inhaled water and panicked, this might have led to air bubbles in the water enter the blood stream. The bubble would have been small, that it passed through the heart and would have lodged in the brain, causing a transient ischemic attack. The area most likely affected is the Broca's area of speech, as the diver seems to have difficulty selecting the correct words

Management: Oxygen rich breathing gas resuscitation, hyperbaric oxygen therapy (to reverse the ischemia)

Case 10

A 64 year old technical diver goes to Scapa Flow for a week of diving. He uses enhanced oxygen nitrox for every dive, high fraction oxygen mixtures for decompression and follows profiles generated by an air computer. Despite this, on the evening of day 5 he develops pain in his right elbow with tingling in the ulnar border of his right forearm, extending into his little finger.

Provisional Diagnosis: **Decompression Sickness with neuro-musculoskeletal impact** (DeNoble, 2005)

Rationale: Though the diver used enhanced oxygen Nitrox which reduces the risk of Decompression Sickness, the diver's increasing age could be a factor, which in this case happens to be 64. The slow onset of arm pain and neurological symptoms of the ulnar nerve such as a tingling sensation confirms this diagnosis. Apart from the diver's age, his male gender and his increased frequency of dives (5 consecutive days) might also be the reasons for DCS.

Management – Administration of 100% Oxygen, Recompression via Hyperbaric Oxygen Therapy

Case 11

A 24 year old diver decides to replace his ageing wet suit and buys a dry-suit. He descends to 24 msw and swims around to try out his new suit. He notices that he is reasonably warm, that the suit feels very snug but that mobility is more restricted and that considerably more effort is required to swim compared with his old wetsuit. He returns to the surface after 10 minutes at the bottom. While he is changing his friend points out a number of blue-red marks over his torso. Now a little more reflective, he notices that the markings are a slightly painful.

Provisional Diagnosis: **Suit Squeeze** (Hamilton-Farrell, 2004)

Rationale: The diver experienced increasing warmth, reduced mobility and increased effort of swimming during descent, which is characteristic of the abdominal skin being squeezed or pinched between the increasing air pressure trapped inside the suit. The blue-red markings on the skin might be the injuries caused due to the folds of the suit containing the air compressing the skin.

EssayCorp 5 years

Management: The injuries must be managed as lacerations would be. Prevention of further suit squeeze incidents must be ensured by wearing thermal innerwear, by proper equilibrations of air in the dry suit, and by using automatic air valves in the dry suit..

Case 12

A 45 year old student diver undertakes her seventh ever dive in a wetsuit, using compressed air SCUBA. She feels slightly cold but not too uncomfortable. She does not exceed 3 msw depth throughout. After 35 minutes of swimming, she feels short of breath at depth, so surfaces and leaves the water. The instructor notices that she is tachypnoeic and slightly cyanosed. She complains of a cough and notices a small fleck of blood in her sputum, although she is sure that she had no problems with her sinuses or ears at any time.

Provisional Diagnosis: **Immersion Pulmonary Edema** (Buwalda, 2014)

Rationale: The diver exhibits symptoms of shortness of breath, cyanosis, tachypnea, cough with hemoptysis, which are characteristic of Immersion Pulmonary edema, which occurs on diving in cold waters. The diver used a wet suit, which would not be an effective temperature regulator, and apotential risk for the condition. The cough and hemoptysis can be attributed to the hemodynamic changes in the body (elevation of pulmonary artery pressures and fluid infiltrations in the lungs) due to cold exposures.

Management: Delivery of 100% Oxygen by mask and diuretics. Prevention of pre-dive over hydration, and tight wetsuits must be avoided.

EssayCorp 5 years

Case 13

A 25 year old technical diver makes a dive to 38 msw. He has 2 cylinders of 30% nitrox & 1 cylinder of 80% nitrox for decompression, each with a separate demand valve. He descends breathing the 30% mixture. His demand valve starts to malfunction after 25 minutes so he changes over to another. Within minutes his buddy sees him convulsing and the demand valve has fallen out of the casualty's mouth by the time he reaches him. The buddy inflates the casualty's buoyancy compensation device to send him to surface. He is found at the surface and flown by helicopter to hospital. In the emergency department the casualty has recovered consciousness but complains of breathlessness and weakness and tingling in both legs. On examination he is tachypnoeic, tachycardic, distressed and has poor cerebration. He has reduced power and sensation in the limbs, crackles throughout his chest and is desaturated on 100% oxygen. His chest x ray is normal.

Provisional Diagnosis: Acute **Oxygen toxicity due to increased partial pressures** (Gill, 2004)

Rationale: The diver's initial presentation of convulsions and loss of consciousness, and his later presentations of breathlessness, distress, tachypnoea, tachycardia, crackles are signs of pulmonary oxygen toxicity. Though is not very common, it occurs on equipment malfunction and when the partial pressure of oxygen exceeds the depth limits, as in this case. The desaturation might have been due to the unconsciousness and seizure, and the presentation of weakness and tingling in both legs, and poor cerebration could be a manifestation of the "post-ictal" phase of the hyperoxic seizure.

Management: Hyperbaric Oxygen Therapy with the chamber pressurized upto 2.8 bar

Case 14

A 23 year old surface supplied diver completes a 5 minute task at 28 msw. He ascends towards the surface. At 5 msw he experiences sudden pain to the left of his nose and loses the supero-temporal field of vision in his left eye. Within seconds of surfacing he has an epistaxis from his left nostril and the pain gradually settles. His field of vision gradually returns to normal over the next 3 minutes.

Provisional Diagnosis**: Ethmoid Sinus Barotrauma with Optic Nerve compression** (Gunn, 2013)

Rationale: The symptoms of sudden pain in the nose, loss of vision and epistaxis on ascent, exhibited by the diver are characteristic of reverse squeeze ethmoid sinus barotrauma. The ostium maxillae of the diver would have been blocked; the pressure inside the ethmoid sinus would have increased, thus there is increased pressure on the Optic Nerve, which would have led to the temporary loss of vision. On surfacing, the sinus block had cleared, and so did the compression on the Optic Nerve.

Management: Topical Decongestants, Pain Relievers, Surgical measures like Functional Endoscopic Sinus Drainage.

Case 15

A 38 year old saturation diver completes a bell run and returns to storage depth at 160 msw. He is completely well when he goes to sleep in the living chamber. He wakes some 6 hours after the end of the bell run and, when he sits up, notices a severe pain in the L4 dermatome with weakness and numbness in his left leg.

Provisional Diagnosis: **Decompression Sickness due to Excursion** (Flook, 2004)

Rationale: Assuming the difference of the saturation diver's storage depth and the diving depth to be around 15 – 20 msw, there could be a change in the partial pressures of the gases in the tissues of the diver for about 6 hours. Usually, asymptomatic bubbles are formed and resolved, but in this case there might have been an accumulation of the residual gaseous bubbles, leading to decompression sickness. In this diver, the bubble would have affected the lumbar area, thus showing the symptoms of sciatic nerve impingement.

Management: Administering 100% Oxygen, Recompression with Hyperbaric Oxygen

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EssayCorp 5 years