



Oxygen First Aid for Scuba Diving Injuries



Oxygen Provider Registration

- **DAN Oxygen Provider Registration Form**
- **Statement of Understanding**
- **DAN Membership Form**
- **Other Administrative Procedures**
- **Introductions**
 - **DAN Oxygen Instructor & Staff**
 - **DAN Oxygen Provider Candidates**



Oxygen Provider Course Overview

- **What is DAN?**
- **Anatomy & Physiology**
- **Diving Injuries**
- **Oxygen**
- **Benefits of Oxygen**

DCS

CO₂

AGE

O₂

DCI



Oxygen Provider Course Overview

- **Oxygen Equipment**
- **Providing Oxygen First Aid**
- **Recommendations for Oxygen Providers**
- **Oxygen Provider Skills Development**
- **Exam and Review**



Oxygen Provider Course Overview

Upon completion of this course the DAN Oxygen Provider will be able to:

- **Recognize the signs and symptoms of diving injuries**
- **State the benefits of providing oxygen to an injured diver**
- **List the potential hazards of handling oxygen and oxygen equipment**
- **Demonstrate confidence and skills when providing oxygen first aid to simulated injured divers using the DAN Oxygen Unit**
- **Demonstrate the use of each mask option for both breathing and non-breathing injured divers**





What is Divers Alert Network?



The Mission of DAN

- **Divers Alert Network (DAN), a nonprofit organization, exists to provide expert information and advice consistent with current medical literature**
- **Provides emergency medical advice and assistance for underwater scuba diving accidents, works to prevent accidents and promotes diving safety**



The Mission of DAN

- **Promotes and supports underwater diving research and education, particularly as it relates to the improvement of diving safety, first aid and medical treatment**
- **Provides accurate, up-to-date, and unbiased information on issues of common concern to the diving public, and advocates for divers' concerns for diving safety**



DAN Services

- **DAN Medicine**
 - **Diving Emergency Hotline**
 - **Diving Medicine Information**
 - **Chamber Assistance**
- **DAN Training**
- **DAN Membership**
 - **DAN TravelAssist**
 - **Alert Diver**
 - **Dive accident insurance eligibility**
- **DAN Research**



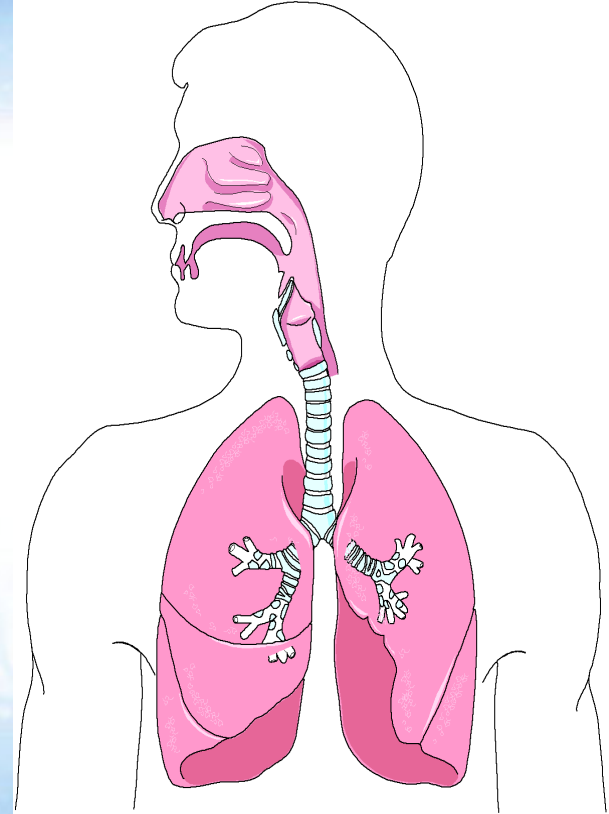


Anatomy and Physiology



Respiratory System

- **Consists of mouth, nose, airways, muscles between the ribs, diaphragm and lungs**
- **Function is to exchange gases between the body and the environment**



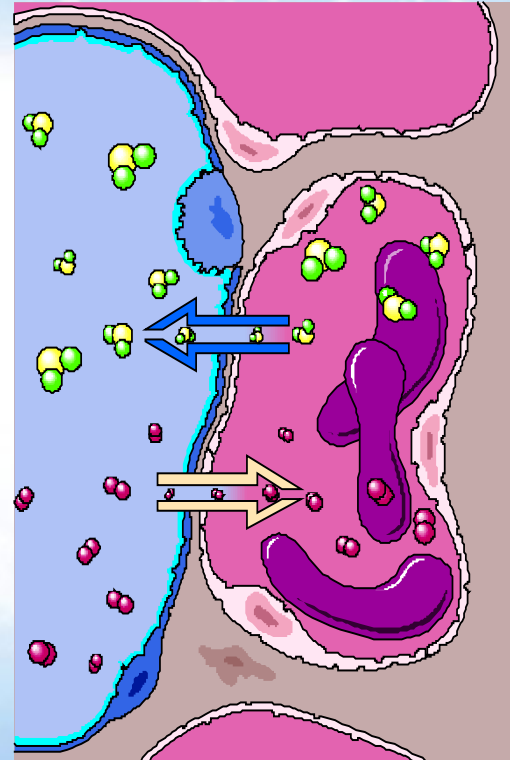
Respiratory System

- **Body requires a constant supply of oxygen to function**
- **Interruption of the supply of oxygen leads to hypoxia, or an inadequate supply of oxygen to the body tissues**
- **Brain and other areas of the central nervous system are the most affected by the lack of oxygen**

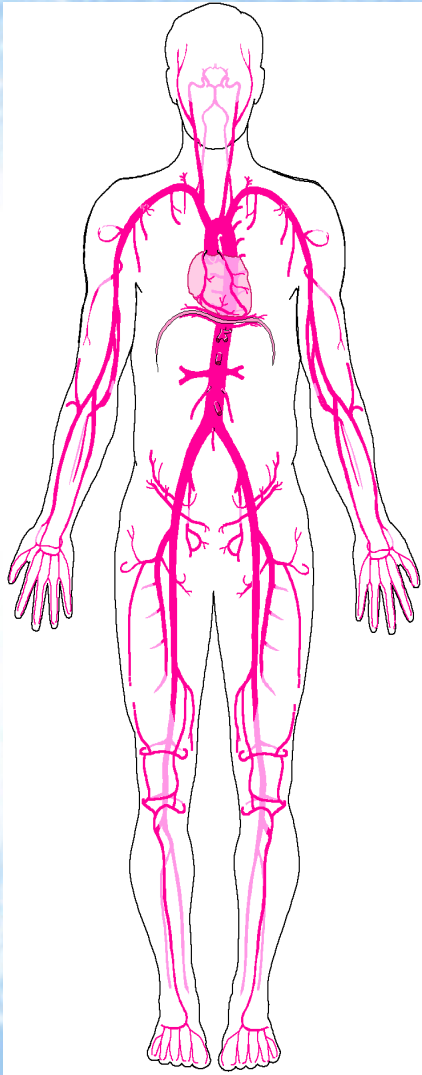


Respiratory System

- **Gas exchange is the uptake of oxygen from the air spaces in the lungs and the removal of carbon dioxide from the blood**
- **Gas exchange occurs through the alveoli in the lungs**



Circulatory System



- **Consists of the heart, blood and blood vessels**
- **Function is to transport blood which carries oxygen, carbon dioxide and other nutrients to cells of the body**



Respiratory and Circulatory Systems

- **Air contains approximately 21% oxygen and 79% nitrogen**
- **During respiration, the body uses only some of the oxygen inhaled**
- **Exhaled air contains approximately 16% oxygen**
- **The combination of the respiratory and circulatory systems provides the mechanism for gas exchange in the body**





Diving Injuries



The Nature of Diving Injuries

- **Recognition of a diving injury is based on**
 - **Recent history of scuba diving**
 - **Presence of signs and symptoms**
- **There is no definitive test or unique signs to confirm the existence of DCI for the rescuer**
- **Broad range of signs and symptoms**
- **Similar to many other illnesses and injuries**



Near-Drowning / Submersion Incident

- **Results from suffocation due to submersion in water**
- **Impairs the ability of the lungs to perform gas exchange**
- **May include aspiration of fluids into the lungs**
- **Results in hypoxia and possibly respiratory and cardiac arrest**
- **Contributing factors include diver panic and over-weighting**



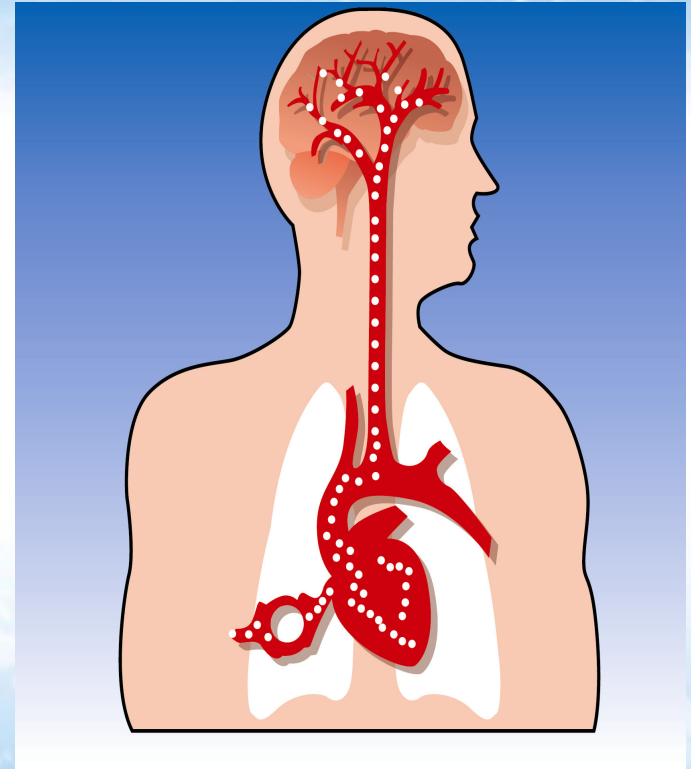
Decompression Illness

- **Decompression illness (DCI) is used to describe the signs and symptoms of an injury caused by breathing gas at depth**
- **DCI encompasses both arterial gas embolism (AGE) and decompression sickness (DCS)**
- **First aid treatment for both AGE and DCS is the same**



Arterial Gas Embolism

- **Overexpansion injury of lung**
- **Gas enters bloodstream**
- **Travels to heart and arterial system**
- **May block major arteries**
- **Cuts off supply of oxygenated blood**
- **Commonly affects brain**



Arterial Gas Embolism

- **Often has rapid and dramatic symptom onset**
- **Contributing factors include rapid ascent, breathholding, lung damage, lung congestion, asthma or other air-trapping mechanism**
- **May accompany other pulmonary barotrauma**
- **AGE is the most serious result of a lung expansion injury**



Decompression Sickness

- **Nitrogen is absorbed by the tissues during the dive**
- **Result of bubble formation and growth during and after ascent**
- **Effects can include distortion or tearing of tissue, reduction or stoppage of blood flow, and activation of blood clotting mechanisms**



Decompression Sickness

- **Usually has delayed symptom onset**
- **Contributing factors for bubble formation include excess nitrogen, rapid ascent, decreasing pressure such as flying after diving**
- **Bubbles as a result of DCS cause various signs and symptoms based on their location**
- **Any area of the body may be involved**
- **Since first aid for DCI is the same, avoid trying to differentiate between them and provide oxygen**



Common Warning Signs

- **Numbness**
- **Pain**
- **Headache**
- **Weakness**
- **Dizziness**
- **Unusual fatigue**
- **Nausea**
- **Difficulty walking**



Other Warning Signs

- **Altered skin sensation**
- **Rash and itching**
- **Difficulty breathing**
- **Visual disturbance**
- **Restlessness**
- **Paralysis**
- **Muscle twitching**
- **Unconsciousness**
- **Personality change**
- **Speech disturbance**
- **Altered level of responsiveness**
- **Bladder / bowel problems**
- **Hearing changes**
- **Coughing up blood or sputum**



Important Notes About Warning Signs

- **DCI usually involves multiple warning signs**
- **Onset time for DCI varies from during the dive up to 24 hours or more post-dive**
- **Most serious warning signs occur within the first two hours following a dive**
- **Any warning sign following a dive must be considered as potentially due to DCI**



Warning Sign Recognition

- **Warning sign recognition is the first step in managing a diving injury**
- **The injured diver is less likely to have residual symptoms when definitive treatment at a recompression facility is provided soon after the onset of signs and symptoms**
- **If you're not sure what to do or if you have questions, call DAN for referral to the nearest appropriate medical facility**





Oxygen



What is Oxygen?

- **Oxygen is the essential component of air that sustains life**
- **Oxygen is a colorless, odorless and tasteless gas**
- **Oxygen is also used for medical purposes to prevent or treat hypoxia in an emergency and for long-term medical care**



Oxygen Cylinder Filling

- **Oxygen grades**
 - **Use only medical or higher grade oxygen suitable for breathing**
- **Oxygen cylinder filling requirements**
 - **Prescription**
 - **Documentation of training**
 - **Other**
- **Oxygen laws and regulations**



Hazards of Breathing Oxygen

Breathing high concentrations of oxygen for extended periods can cause oxygen poisoning or toxicity

- **Two forms of oxygen toxicity**
 - **Central nervous system (CNS) oxygen toxicity**
 - **Pulmonary oxygen toxicity**
- **Oxygen toxicity is not a concern for the DAN Oxygen Provider rendering first aid**



Oxygen Safety

- **Extinguish all flames and smoking material**
- **Do not use in the presence of oils, grease or flammable substances**
- **Always use in well-ventilated areas**
- **Use only equipment designed for use with oxygen**
- **Maintain and service equipment as required**
- **Always secure oxygen cylinders during transport**



Benefits of Oxygen

- **Diving injuries or accidents may result in:**
 - **Blocked blood supply to various body tissues**
 - **Damaged tissues obstructing effective gas exchange**
- **Breathing high concentrations of oxygen increases the pressure gradient to facilitate elimination of nitrogen**
- **100% oxygen is recommended – provide the highest concentration of oxygen possible to achieve the greatest benefit for the injured diver**



The Benefits of Oxygen



Oxygen first aid may:

- **Reduce bubble size**
- **Oxygenate hypoxic tissues**
- **Reduce tissue edema**
- **Ease breathing**
- **Relieve symptoms**
- **May reduce the risk of residual symptoms after hyperbaric treatment**





Oxygen Equipment



Oxygen Equipment

General Rules

- **Demand system is preferable over a constant-flow system because**
 - 1) **100% oxygen may be provided**
 - 2) **Oxygen is not wasted**
- **Cylinder capacity should allow for oxygen to be provided from the dive site to the nearest medical facility**
- **Be trained for the oxygen delivery device you plan to use**
- **Check oxygen equipment and cylinder pressure before every dive outing**



Oxygen Equipment

An oxygen delivery system consists of:

- **Cylinder**
- **Regulator**
- **Oxygen tubing or hoses**
- **Oxygen mask**



Oxygen Cylinders

- **Types**
- **Material**
- **Valves**
- **Color-coding**
- **Labeling**
- **Maintenance**
 - **Hydrostatic testing**
 - **Storage**



Oxygen Regulators

- **Purpose**
- **Styles**
 - **Demand**
 - **Constant flow**
 - **Multifunction**
- **Features**
 - **Flow rates**
- **Adapters**



Demand Inhalator Valve

- **Provides 100 percent oxygen and 100 percent of the injured diver respiratory needs**
- **For use with breathing divers only**
- **Oxygen is not wasted making it the best choice for a breathing injured diver**
- **Must be used with an oronasal delivery mask such as**
 - **Oronasal mask**
 - **Oronasal resuscitation mask**



Non-rebreather Mask

- **Can be used with breathing divers only**
- **Recommended initial flow rate is 15 lpm**
- **Reservoir bag must be primed and kept inflated while providing oxygen to an injured diver**
- **Its use is recommended when there is:**
 - **Second injured diver**
 - **Demand valve is not tolerated**



Oronasal Resuscitation Mask

- **May be used with both breathing and non-breathing injured divers**
- **Recommended flow rate is 15 lpm**
- **Provides increased oxygen concentration up to 50 percent versus only 16 percent with only your expired breath**
- **It is also an effective barrier device**



MTV-100: Flow-restricted oxygen-powered ventilator

- **Can provide 100 percent oxygen for both breathing and non-breathing injured divers**
- **It uses a demand valve for breathing injured divers**
- **Manually triggered ventilator allows for use with non-breathing injured divers**
- **Additional training is recommended for its use**



DAN Oxygen Units

- **Provide 100 percent oxygen**
- **Can be used for both breathing and non-breathing injured divers**
- **Can provide oxygen to multiple injured divers at the same time**
- **Are housed in a waterproof case**
- **Various cylinder sizes and numbers are available based on time to definitive medical treatment**





Skills Development Session Overview



Scene Safety Assessment

Remember S-A-F-E

- **S - Stop**
- **A - Assess scene**
- **F - Find and secure first aid kit, oxygen and AED units**
- **E - Exposure protection**



Initial Assessment with Basic Life Support

- **Remember SAFE**
- **Assess responsiveness**
 - **Activate EMS**
- **Open airway**
- **Assess breathing**
 - **Look, listen and feel for up to 10 seconds**
 - **Provide 2 rescue breaths, if not breathing**
- **Assess signs of circulation for up to 10 seconds**
 - **If there are signs of circulation but no breathing, continue rescue breathing**
 - **If there are no signs of circulation, begin CPR**



Providing Care with an AED (Optional)

- **Assess ABCs**
- **Verify no circulation**
- **Attach the defibrillator pads**
- **Allow the AED to analyze heart rhythm**
 - **Don't touch the patient**
- **If shock required:**
 - **Follow the AED unit's prompts**
 - **Visually and physically clear the patient**
 - **Say "Clear"**
 - **Administer shocks**
- **If no shock required, begin CPR**



Demand Inhalator Valve

- **Remember SAFE**
- **Assure the ABCs**
- **Deploy the oxygen unit and check its function and cylinder pressure**
- **Give oxygen use statement**
- **Provide oxygen via demand valve and oronasal mask. Check for any leaks**
- **Monitor the injured diver**
- **Activate the emergency plan**



Non-rebreather Mask

- **Remember SAFE**
- **Assure the ABCs**
- **Connect mask to regulator**
 - **Set regulator flow rate to 15 lpm**
 - **Prime reservoir bag**
- **Place non-rebreather mask on the diver's face**
- **Check for leaks around the mask edges**
- **Monitor injured diver**



Oronasal Resuscitation Mask

- **Remember SAFE**
- **Assure the ABCs**
- **Prepare oronasal resuscitation mask**
 - **Attach oronasal resuscitation mask to the regulator using oxygen tubing**
- **Set oxygen flow rate to 15 lpm**
- **Maintain open airway**
- **Perform rescue breathing**



Proper Positioning

- **If the person is breathing and responsive:**
 - **Place in either the supine or recovery position**
- **If the person is breathing and unresponsive:**
 - **Place them in the recovery position**
- **If the person is not breathing:**
 - **Place them in the supine position**



Disassemble, Clean and Assemble the Unit

- **Follow these steps to disassemble, clean and assemble DAN Oxygen Units**
 - **Depressurize system**
 - **Refill oxygen cylinder if oxygen supply is depleted**
 - **Clean masks and other parts as directed**
 - **Air-dry the disassembled parts**
 - **Check oxygen washer**
 - **Reassemble the oxygen unit and store it ready for use**



Emergency Assistance Plan

- **Diver Information**

- **Name**
- **Age or Date of birth**
- **Address**
- **Emergency contact phone**
- **Current complaint(s)**
- **Past medical history including current medication**
- **Dive profile(s)**
- **Drug allergies**

- **General Information**

- **Emergency contact information (EMS, DAN)**
- **Initial contact phone number (Call back #)**
- **Directions to nearest medical facility**
- **DAN phone numbers**
- **Other**

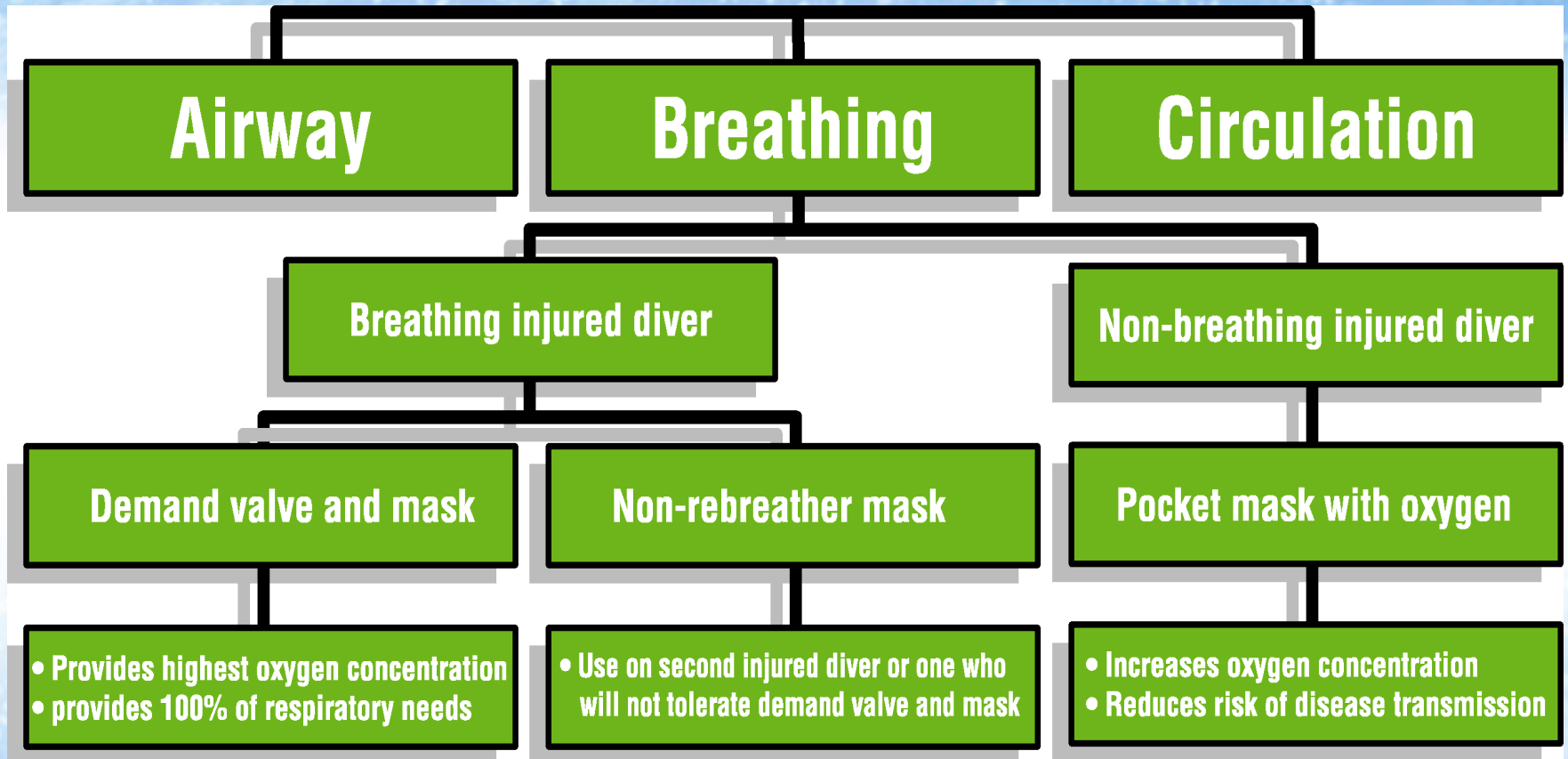




Recommendations for Oxygen Providers



Oxygen Provider Flowchart



Recommendations for Oxygen Equipment Use

- **Check oxygen unit and cylinder pressure before every dive outing**
- **Oxygen unit should remain assembled and turned off**
- **Carry extra cylinders, washers and masks**
- **Clean masks after each use**
- **Professionally service oxygen equipment every two years or according to manufacturer's recommendations**



Recommendations for Oxygen Providers

- **Remember scene safety assessment – SAFE**
- **Ensure the Airway, Breathing & Circulation – ABCs**
- **Provide the highest concentration of oxygen possible**
- **Have enough oxygen to supply high concentrations of oxygen until emergency medical services arrive**
- **Practice oxygen first aid skills frequently**
- **Place injured diver in the most appropriate position**



Oxygen and the Law

- **Good Samaritan Laws**
- **Providing oxygen to an injured diver improves the diver's chance of complete recovery**
- **Providing oxygen can cause no further harm to an injured scuba diver**
- **Local oxygen laws and regulations**
 - **Equipment requirements**
 - **Oxygen cylinder filling requirements**
 - **Other**



Oxygen Provider Skills Development Session

**Scene safety
assessment**

**Basic life support
review**

**Injured diver scenarios
using:**

- **Demand inhalator valve**
- **Non-rebreather mask**
- **Oronasal resuscitation
mask with
supplemental oxygen**

**Equipment disassembly
and assembly**



Oxygen Provider Course Summary

- **What is DAN?**
- **Anatomy & Physiology**
- **Diving Injuries**
- **Oxygen**
- **Benefits of Oxygen**
- **Oxygen Equipment**
- **Providing Oxygen First Aid**
- **Recommendations for Oxygen Providers**
- **Oxygen Provider Skills Development**

