# Emergency Oxygen Administration

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About the Course
The *Emergency Oxygen Administration* course is designed to give an overview of the safe and effective administration of supplemental oxygen during an emergency. The course can be taught as a stand-alone course or as an optional component of *CPR and AED for Professional Rescuers* or *Advanced First Aid* courses.

The *Emergency Oxygen Administration* course will define emergency oxygen, and explain when emergency oxygen is recommended, how to assemble and store emergency oxygen, how to deliver oxygen, and oxygen safety.

**Outline, Methods, Certification Requirements**

**Course Outline**

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*Workbook page numbers noted in the above table refer to the stand-alone *Emergency Oxygen Administration* student manual. Emergency Oxygen Administration information is also located in the student manuals for *CPR/AED for Professional Rescuers* and *Advanced First Aid*, with different page numbers for those titles.

**Training Methods**

- Lecture/PowerPoint Discussion
- Workbook Review
- Skills Demonstration and Practice
- Written and Skills Testing

**Certification Requirements**

- Participate in entire course
- Complete all practice sessions
- Pass written exam with minimum score of 80%
- Pass skills exam according to the EMS Safety Emergency Oxygen Skills Sheet
- Certification valid for 2 years after training

**Instructor-to-Student Ratio**

- 1 to 12

**Conducting Skills Practice**

There are 3 practice sessions for the Emergency Oxygen Administration training course:

- Practice Session 1: Patient Assessment
- Practice Session 2: Connect the Pressure Regulator
- Practice Session 3: Delivery Devices

*Recommended* equipment for practice and testing include:

- At least one full oxygen cylinder with pressure regulator, o-ring and oxygen wrench
- A nasal cannula for each student
- A non-rebreather mask for each student
- An adult bag mask assembly for each pair of students

To conduct the practice sessions:

- Demonstrate each skill using a student volunteer or manikin.
- Group students in pairs.
- Ensure each student has a Practice Sheet. It is not part of the course records. Use it to guide students.
Conducting Written and Skills Testing
In order to be certified in emergency oxygen administration, students must pass both a written and skills exam.

Provide each student with a written exam and answer sheet. While students are taking the written exam, privately test students in pairs.

One student will take the skills test, and the other will be the ‘victim.’ Using the same equipment for practice, test the students in the following skills:

1. Connect the Pressure Regulator and use a Nasal Cannula
2. Use a Non-Rebreather Mask
3. Assemble a Bag Mask for Use with Emergency Oxygen

Provide feedback to each student and mark off the skills on the answer sheet (and optional skill sheet if used).

Correct the written exams after skills testing is completed. Have students swap exams and correct as a group. Remediate and retrain as needed until proficient for certification.

Recordkeeping
Maintain course records for three years. Course records for Emergency Oxygen Administration include:

- Training roster
- Written Exam Answer Sheet with skills check-off
- Skills sheet (optional; keep as part of course record if used)

Introduction
Every cell in the human body needs oxygen to survive. During an emergency, the body may deliver or inspire (inhale) lower than normal levels of oxygen (O₂), which can lead to organ and brain damage, and cardiac arrest.¹ The use of supplemental oxygen may delay damage to vital organs, stabilize the heart, and even save a life.² ³

It’s important to note that the air we breathe every day is not 100% oxygen; in fact, our atmosphere is composed of several different gasses: 21% oxygen, 78% nitrogen, and 1% other elements.⁴

Oxygen perfusion is when the cells of the body receive oxygen-rich blood.⁵ Depending on the patient’s condition, he or she may be able to breathe, but not perfuse an adequate supply of
oxygen. Supplemental or ‘emergency’ oxygen, which is provided to the patient during an emergency, contains a higher concentration of oxygen than is found in room air.

Administering emergency oxygen has been shown to increase the oxygen concentration in the lungs, which allows more oxygen to be absorbed into the bloodstream.iii

Although emergency oxygen has been used for years by EMS responders and healthcare providers, recent studies have not proven the benefit of emergency oxygen administration by a first aid provider, except to treat a diving decompression injury.i,iv

**Respiration and Lung Function**

Respiration is the exchange of carbon dioxide (CO$_2$),vi the waste product from breathing, with fresh air from the atmosphere. Ventilation, the process of moving air in and out of the lungs for respiration, is accomplished by the lungs, which are the primary organs for breathing. The diaphragm, a flat muscle below the lungs, is the primary muscle for breathing.

There is a right and a left lung. The right lung has 3 lobes (areas): upper, middle and lower. The left lung has 2 lobes: upper and lower. Alveoli, which are small air sacs, are present in the lower lobes.

Alveoli are important because that is where the exchange of O$_2$ and CO$_2$ is accomplished.vi The alveoli, which are shaped like miniature broccoli stems, are intertwined with capillaries. The exchange of O$_2$ and CO$_2$ occurs through fenestrations (tiny holes) along the alveoli and capillary beds.

The lungs receive blood from the body for two reasons:vii

- **Exchange of CO$_2$ for O$_2$:** Each breath we inhale brings fresh oxygen into the lungs. As we exhale, we blow off CO$_2$. When the heart beats, it circulates deoxygenated blood to the alveoli of the lungs, where CO$_2$ is exchanged for O$_2$. From the lungs the freshly oxygenated blood is pumped back to the heart, then out to the rest of the body.

- **Lung survival:** The bronchial arteries are the blood supply to the lungs that keeps them alive and functioning.

Any condition or injury that affects air or blood flow to the lungs, the actual functioning of the lungs, or the delivery of oxygenated blood to the tissues, may result in hypoxia. Some examples include the following:

**Illness:** Disease affecting respiration (asthma, emphysema, bronchitis); stroke; ACS/heart attack

- **Asthma:** A condition that causes wheezing and shortness of breath due to narrowing of the airways and increased mucus production.
• **Emphysema**: A condition of the lung characterized by progressive distension and irreversible loss of elasticity of lung tissue, coughing and difficulty breathing

• **Chronic bronchitis**: Inflammation of the bronchial tubes, with excess mucus production

• **Chronic Obstructive Pulmonary Disease (COPD)**: A group of lung diseases, including chronic bronchitis and emphysema, which limit the flow of air into and out of the lungs

**Injury**: Trauma to the chest, airways, lungs or diaphragm; blood loss; head or spinal injury affecting muscle and neurological function; anaphylaxis

• **Pulmonary embolism (PE)**: A clot of blood, fat, air or tumor cells that has travelled to the bronchial arteries, blocking blood flow and impairing lung function. It is usually caused by a blood clot in a vein of the leg (deep vein thrombosis, or DVT). Signs of a PE can include sudden shortness of breath, cyanosis (bluish color in the skin, lips and fingernail beds from low oxygen levels), and sharp chest pain. Cyanosis due to PE may not be relieved with the administration of emergency oxygen.

• **Open pneumothorax**: An opening in the chest cavity that impairs the lungs’ ability to expand and contract.

**Shock**: Inadequate perfusion to the vital organs. Can be caused by blood loss, inadequate heart function, anaphylaxis, psychological shock, and spinal injury

### What is Emergency Oxygen?

Supplemental oxygen for patient use is a compressed gas. It is classified as a drug and is regulated by the Food and Drug Administration (FDA). The concentration of supplemental oxygen stored in a cylinder is 100%. People who provide supplemental oxygen must be trained in its use and storage.

Oxygen sold for patient use is categorized as either ‘Medical Oxygen’ or ‘Emergency Oxygen.’ Although the concentrations are the same, medical oxygen requires a prescription for use. Oxygen delivery is calculated by the number of oxygen liters per minute (LPM). **Medical oxygen** is delivered at a rate of less than 6 LPM or for a duration of less than 15 minutes. 

**Emergency oxygen** is used by trained rescuers and does not require a prescription. It is delivered at a minimum rate of 6 LPM for at least 15 minutes. Also, it must be clearly labeled as ‘Emergency Oxygen’ per the FDA and packaged with the appropriate delivery device.

Guidelines for the use of emergency oxygen may differ at the state and local level, so be sure to contact your local medical control or EMS agency to identify any local practices or guidelines that may differ from this training.
When to Use Emergency Oxygen

Emergency oxygen is used primarily to correct mild to moderate hypoxemia (inadequate oxygenation of the blood), and reduce cardiopulmonary effort. Use oxygen to treat breathing difficulty based on the patient’s condition and respiratory rate. Rescuers can consider the use of emergency oxygen to treat the following:

- Respiratory rates that are too fast or too slow: vii
  - Adult: Less than 12 or more than 20 breaths per minute
  - Child: Less than 15 or more than 30 breaths per minute
  - Infant: Less than 25 or more than 50 breaths per minute
- No breathing
- Cyanosis
- Diving decompression injury

During a critical situation or life-threatening emergency, however, the use of emergency oxygen should not delay life-saving treatments, such as chest compressions or applying direct pressure on a bleeding wound. viii Only use emergency oxygen after EMS (9-1-1) has been activated, and when there are additional trained rescuers available to provide emergency oxygen without interrupting life-saving activities.

EMS and Healthcare Providers

For a citizen rescuer, first aider, or certain first responders, oxygen is used to treat abnormal respiratory rates, the absence of breathing, or signs of difficulty breathing. Professional rescuers, including EMTs, paramedics and healthcare providers, may provide oxygen based on additional signs and symptoms, or if certain medical conditions are suspected. iii, iv, v, ix, x, xi, xii

In addition to the uses for emergency oxygen listed above, and depending on local protocols, EMS responders and Healthcare Providers may consider the use of oxygen for the following emergencies:

- Heart attack or other acute coronary syndrome (ACS)
- Stroke
- Severe asthma
- Pulmonary embolism
- Shock
- Drowning
- Pregnancy-related emergency
- Exacerbated COPD (narrowed airways due to chronic bronchitis and emphysema)
- Hypothermia
  - Can be treated with warmed, humidified oxygen
  - Many providers do not have the equipment or time to adequately assess core body temperature or to institute re-warming with warm, humidified oxygen
EMS and Healthcare Providers should use pulse oximetry at the earliest opportunity to titrate oxygen delivery to the lowest level possible while maintaining oxygen saturation levels between 94-99%. iv, vii

**Patient Assessment**

When administering emergency oxygen to treat difficulty breathing, assess the patient’s work and effort of breathing, and then calculate the number of respirations per minute (RPM).

Normal breathing: vi

- Regular rise and fall of both sides of the chest
- Slight movement of the abdomen
- Regular rhythm
- Silent and effortless

Signs of breathing difficulty can include:

- Labored breathing: using accessory muscles in the neck and back, heaving chest, speaking in broken sentences
- Noisy breathing: coughing, wheezing
- Tripod position: sitting up position supported on arms
- Cyanosis

To calculate a patient’s RPM:

- Use a stopwatch, second hand or other timer
- Calculate the number of breaths by watching the patient’s chest for 15 seconds
- Multiply the number of breaths in 15 seconds x 4
- E.g. 5 breaths in 15 seconds = 20 breaths per minute. This is within the acceptable range for adults.

**Oxygen Equipment**

Emergency oxygen is delivered from a cylinder, through a pressure regulator and oxygen tubing, and into a delivery device such as a mask, cannula, or bag mask. The following information covers equipment used to deliver emergency oxygen.

**Oxygen Cylinder:** The emergency oxygen cylinder, also known as a ‘tank’ or ‘bottle,’ is typically green or has green markings. It should be labeled “U.S.P” (for United States Pharmacopeia), and marked with a yellow diamond and the following statement: “For emergency use only when
administered by properly trained medical personnel for oxygen deficiency and resuscitation. For all other medical applications, Rx only. \textsuperscript{iv xiii x}

Cylinders are made of metal, aluminum or composite material and have a built-in valve at the top. The oxygen in the cylinder is highly pressurized. The valve is the most vulnerable part of the cylinder. Dropping or mishandling an oxygen cylinder can damage the valve, turning the cylinder into a potential missile as the compressed gas escapes and propels the cylinder at a high rate of speed.\textsuperscript{iv} A regulator can be attached to the valve at the top of the cylinder.

Oxygen cylinders come in different sizes. Each is filled up to about 2015 pounds per square inch (PSI), which is seriously high pressure. Cylinder sizes include:\textsuperscript{iv}

- D cylinder: up to 425 liters
- ‘Jumbo’ D cylinder: up to 640 liters
- E cylinder: up to 680 liters
- M cylinder: up to 3,000 liters
- G cylinder: up to 5,300 liters
- H cylinder: 6,900 liters

Emergency oxygen brought to the scene is usually stored in a D, Jumbo D, or E cylinder, which is small enough to be carried by one person and secured on the cot, stretcher or gurney with the patient during transport.

**Oxygen Wrench:** The oxygen wrench should accompany the cylinder. It is used to open the valve and allow oxygen to flow from the tank, through the valve, and into the pressure regulator. Some cylinder valves have a thumbscrew so that an oxygen wrench is not needed.

**Pressure Regulator:** The pressure regulator, which connects the cylinder valve to the oxygen tubing, controls the rate of oxygen flow, or LPM. Two common types of regulators for emergency oxygen are the dual flow and the full control.

The dual flow regulator has only two settings: high and low. The full control regulator can dial in the desired flow of oxygen from 2 LPM up to 25 LPM. Some pressure regulators also include a high pressure port for use with a demand valve or oxygen-powered suction device. Full control regulators are typically reserved for professional rescuers.\textsuperscript{iv}

The pressure regulator will have a gauge that displays the amount of pressure inside the cylinder in PSI.

- 2,000 psi = a full cylinder
- 1,000 psi = half full
- 500 psi = needs to be refilled

If the pressure in the cylinder is lower than 200 psi, do not use it. To be sure there is enough oxygen for an emergency, the cylinder should be refilled at 500 PSI.\textsuperscript{iv vii}
**O-ring:** The o-ring is a gasket that creates a tight seal between the cylinder and pressure regulator. Over time the o-ring may require replacement, especially if the tank seems to have a leak. Without an intact o-ring, air will escape in the small space between the valve and pressure regulator. A newly charged/filled oxygen cylinder will usually be accompanied with a new o-ring.

**Oxygen Tubing:** Oxygen tubing connects the regulator to the delivery device (e.g. mask). Oxygen tubing comes in varying lengths, depending on the needs of the patient and the environment. Most delivery devices for emergency oxygen are packaged with oxygen tubing attached.

**Delivery Device:** The delivery device is used by the patient to breathe in the oxygen. It is usually a mask that fits over the mouth and nose, and is connected to the cylinder by the oxygen tubing and pressure regulator.

**Demand Valve:** Some professional rescuers may use a demand valve. It is also known as a flow-restricted, oxygen-powered ventilation device (FROPVD). The demand valve is attached to a specially-configured, rigid mask and is pre-connected to the pressure regulator by a thick, flexible tube.

The demand valve is triggered by a patient inhaling (must wear a tight-fitting mask) or by the rescuer activating the button or lever on the device. It will provide 100% oxygen at a rate of about 40 LPM.

Because of the amount and force of oxygen delivered through a demand valve, they are only recommended for use on adult patients by licensed or certified professional rescuers. Responders should receive training specifically in the use of a demand valve if this device is used in their workplace.

**Humidifier:** Supplemental oxygen can dry out the mucous membranes of the nose, causing irritation and sometimes nosebleeds. Use of an oxygen humidifier can moisten the delivered oxygen, reducing dryness and irritation. An oxygen humidifier is a container of sterile water that is connected between the oxygen cylinder and the delivery device. It causes oxygen to pass through the sterile water and pick up tiny water molecules. An oxygen humidifier is typically used in the hospital or ambulance and is not normally used on an emergency scene.

**Pulse Oximeter:** A pulse oximeter is a small, portable electronic device that uses red and infrared light to estimate and monitor the patient’s blood-oxygen level, or percentage of oxygen saturation. A normal reading is between 95% and 100% \( \text{SpO}_2 \).

To use a pulse oximeter:

1. Turn on the pulse oximeter and connect monitoring probe.
2. Place monitoring probe on finger, earlobe, or foot (follow manufacturer’s instructions).
3. Allow the pulse oximeter to register the patient’s oxygen saturation level and pulse rate.
4. Verify the pulse rate on the oximeter with the actual pulse rate of the patient.
5. Monitor and record the patient’s saturation levels while providing emergency oxygen.
6. Follow local protocols regarding decreasing the flow rate or changing to a low-flow device if the patient’s saturation level reaches 100%.

Pulse oximetry should be used as an additional assessment tool. In certain conditions, it can provide less accurate readings. Remember to assess the patient’s condition as a whole. In other words, don’t treat the pulse oximeter, treat the patient. vii

Factors that may impact the reliability of a pulse oximeter include: vii

- No breathing/cardiac arrest
- Poor perfusion: shock, low blood pressure
- Fingernail polish: remove before monitoring if possible
- Excessive motion by the patient
- Hypothermia/cold temperatures
- Carbon monoxide poisoning/some cigarette smokers
- Sickle cell disease or anemia
- Swelling in the extremity being monitored
- Time lag: a delay in detecting a change in the patient’s condition

Connecting the Cylinder and Pressure Regulator

Before using emergency oxygen, connect the pressure regulator and cylinder. Once connected, open the valve and test the flow of oxygen to ensure no leaks are present between the cylinder valve and pressure regulator. To connect the pressure regulator to the valve: iv, xvi

1. Remove protective seal over the cylinder valve, and set the new o-ring aside, if present.
2. Inspect the valve; ensure it is dry and clean.
3. Slowly open and close the valve to expel particles. Use an oxygen wrench if needed.
4. Inspect the o-ring in the pressure regulator. If it is missing or worn, replace it with a new o-ring.
5. Line up the pins on the regulator with the holes on the cylinder valve, and slip the pressure regulator over the valve.
6. Attach the pressure regulator by using the thumbscrew until hand tight.
7. Turn the pressure gauge away from you and anyone else present and open the valve (counterclockwise) one full turn.
8. Read the pressure gauge to determine the pressure (amount of oxygen) in the cylinder.
9. Listen to the tank to ensure a tight seal between the pressure regulator and cylinder valve and that no air is leaking.

Once the regulator is attached and the oxygen pressure is determined, the cylinder is ready for use. After use, close the cylinder valve and turn on the flowmeter to bleed the pressure regulator.
Follow your local or workplace guidelines regarding the regular inspection and storage of oxygen cylinders.

**Delivery Devices**

A delivery device is connected to the oxygen tubing, which is then attached to the nipple of the pressure regulator. The delivery device is then applied to the patient. When using emergency oxygen, there are four basic delivery devices: the non-rebreather mask, nasal cannula, bag mask and CPR face mask (with oxygen inlet).

The non-rebreather mask and nasal cannula are used for patients who are breathing on their own. The CPR face mask and bag mask are used to provide oxygen during rescue breathing.

Different sizes of delivery devices are available for adult, child and infant patients.

**Non-Rebreather Mask:** The non-rebreather mask, also known as ‘high-flow’ device, is the preferred device because of its capacity to deliver high concentrations of oxygen with each breath. It consists of a clear mask, one-way valve, oxygen reservoir, and oxygen tubing to connect the device to the pressure regulator. iv

The non-rebreather mask works best with a liter flow of 15 LPM. When applied properly, it can deliver oxygen concentrations between 90% and 100%. iv Because the mask is not air tight, some ambient air will mix with the emergency oxygen. iv

To apply a non-rebreather mask: iv

1. Confirm that rescue breathing is not required.
2. Tell the patient that you are going to provide some oxygen.
3. Select the right size mask (adult, child or infant).
4. Connect the oxygen tubing to the emergency oxygen source; ensure the valve is open and adjust the liter flow on the pressure regulator to 15 LPM.
5. Listen for the sound of oxygen flowing through the mask.
6. Place your thumb or finger over the one-way valve inside the mask to speed up filling the oxygen reservoir.
7. Place the mask over the patient’s face, starting at the bridge of the nose, so that it fits over the mouth and nose.
8. Apply the elastic band over the patient’s head and use it to secure the mask snugly to the patient’s face.
9. Instruct the patient to breathe as normally as possible.

Monitor the oxygen reservoir to ensure it does not completely deflate and has enough time to refill between breaths. Increase the liter flow if needed. iv

The mask will cover the patient’s mouth and nose, which can make the mask intolerable to some people. They may complain of feeling that the flow of oxygen is restricted, even when
they are breathing almost 100% pure oxygen. Ensure the liter flow is at least 15 LPM, oxygen is flowing, and the reservoir is not deflated. Rescuers may have to help patients get used to the mask and reassure them that they are getting more oxygen than normal.

**Nasal Cannula:** The nasal cannula is a low-flow oxygen device. It can only provide a liter flow between 2 LPM and 6 LPM, and a maximum concentration of about 44% oxygen.³

The nasal cannula consists of a loop of oxygen tubing with two prongs that are inserted into the nostrils of the patient. The tubing is looped around the ears, and then secured under the chin with an adjusting band that works like a drawstring.

Use the nasal cannula when a patient is non-critical or cannot tolerate a non-rebreather mask.⁴

To apply a nasal cannula:⁴

1. Confirm that rescue breathing is not required.
2. Tell the patient that you are going to provide some oxygen.
3. Select the right size (adult, child or infant).
4. Connect the cannula tubing to the emergency oxygen source; ensure the valve is open and adjust the liter flow on the pressure regulator to 6 LPM (for emergency oxygen).
5. Listen for the flow of oxygen from the prongs.
6. Fully open the cannula loop by sliding the adjusting band away from the prongs.
7. Hold the loop with your thumb and forefinger on either side of the prongs.
8. Explain the procedure to the patient. Explain that the prongs won’t hurt.
9. Carefully insert the prongs into the patient’s nostrils. While supporting the prongs in position, slide your fingers along the loop and wrap each side around the patient’s ears.
10. Slide the adjusting band up towards the chin. Be careful not to overtighten or pinch the skin.
11. Instruct the patient to breathe in through his or her nose.

The nasal cannula is designed to provide no more than 6 LPM. The non-rebreather mask is a much more effective choice to deliver emergency oxygen to a patient who is breathing.

**Bag Mask:** The bag mask, also known as a bag valve mask or BVM, is used for a patient who needs rescue breathing and/or CPR. It can deliver almost 100% oxygen. During resuscitation, the bag mask can increase the amount of oxygen delivered with rescue breathing and reduce rescuer exposure to pathogens. It can be used with or without emergency oxygen. The bag mask requires training to be used effectively.

The bag mask consists of a rigid face mask and self-inflating bag attached to an oxygen reservoir. Tubing connects the bag mask to the oxygen tank. During cardiac arrest, the bag mask uses positive pressure ventilation to push air into the lungs when the rescuer squeezes the bag.
To use a bag mask with emergency oxygen:

1. Confirm the victim is not breathing. Follow the guidelines for CPR, AED use and activating EMS. When an additional trained rescuer is available and not performing essential patient care, assemble the bag mask.
2. Select the appropriate size (adult, child or infant).
3. Connect the bag mask tubing to the oxygen regulator. Deliver oxygen at 15 LPM, or follow your local or workplace guidelines for oxygen flow rate.iv
4. Use the bag mask to give rescue breaths. Ensure there is a complete seal between the patient’s face and the mask. Watch for chest rise with each breath. Do not over-ventilate.

The bag mask can also be used as an oxygen delivery device for a patient who is conscious and breathing. Maintain a flow rate of 15 LPM and have the victim hold the mask to his or her face. Rescuers may assist breaths for a conscious breathing victim by squeezing the bag as the patient inhales.

For a conscious breathing victim with an abnormal breathing rate:

- Less than 10 RPM: Squeeze the bag between each breath
- Greater than 30 RPM: Squeeze the bag every second breath

CPR Face Mask with Oxygen Inlet: A CPR face mask may be used for rescue breathing. When the face mask has an oxygen inlet, emergency oxygen can be used to increase the concentration of oxygen delivered with rescue breaths. CPR face masks are available in adult, child and infant sizes. Select the correct size mask in order to create a seal and give effective rescue breaths.

To use the CPR face mask with oxygen inlet for rescue breathing:

1. Confirm the victim is not breathing. Follow the guidelines for CPR, AED use and activating EMS. When an additional trained rescuer is available and not performing essential patient care, assemble the face mask if not previously done.
2. Select the appropriate size (adult, child or infant).
3. Insert the CPR face mask’s oxygen inlet into the oxygen tubing.
4. Connect the tubing to the oxygen regulator. Deliver oxygen at 15 LPM, or follow your local or workplace guidelines for oxygen flow rate.
5. Apply the mask with the narrow end on the bridge of the nose, not covering the eyes. The wide bottom of the mask should not extend past the chin.
6. Press the mask firmly to the face and open the airway.
7. Breathe into the mask and watch for chest rise. Do not over-ventilate.

The CPR face mask with oxygen inlet can also be used as an oxygen delivery device for a patient who is conscious and breathing. It can deliver an oxygen concentration of 35-55%. Use a flow rate of 6-15 LPM, and have the victim hold the mask to his or her face.
**Oxygen Blow-by for Infants and Young Children:** An infant or young child may be afraid to have an oxygen delivery device on his or her face. If an oxygen delivery device is not tolerated, use the ‘blow-by’ oxygen technique. Using an oxygen mask with high-flow, keep the mask about 2 inches from the child’s face, and wave it slowly from side-to-side. This action allows emergency oxygen to pass over the child’s mouth and nose and be inhaled. vii

**General Guidelines for Emergency Oxygen**

**Monitor Oxygen Delivery:** Scientific research suggests that emergency oxygen delivery should be based on a target saturation level rather than a fixed flow rate.

Using oxygen to treat *breathlessness*, rather than *signs of hypoxia*, has not been shown to relieve the feeling of breathlessness. Current recommendations include the use of a pulse oximeter in the field to monitor blood oxygen saturation, and to only provide oxygen if levels are less than 94%. ii, viii, xiv, xii, xvii

Since a pulse oximeter is usually not available until EMS arrives, this recommendation may be impractical for most private and commercial (non-medical) sites. Trained rescuers may provide emergency oxygen to patients who may benefit from it. As soon as a pulse oximeter is available, a trained responder should titrate the oxygen flow rate to achieve a target saturation level and avoid possible oxygen toxicity.

**Emergency Oxygen and Resuscitation:** Science does not support or refute the use of oxygen during resuscitation. Studies have shown that the use of emergency oxygen does increase the level of oxygen in the blood. The risks of delivering too much oxygen during CPR and causing oxygen toxicity are small, so the use of oxygen with rescue breaths is reasonable. xi

Ensure that resuscitation efforts are never delayed in order to use emergency oxygen. After the return of spontaneous circulation, titrate emergency oxygen to the minimum level required to maintain a blood oxygen level between 94% and 99%.

**Training Emergency Oxygen Providers:** The organization’s medical authority should review and approve the use and training methods for emergency oxygen delivery before equipping and training staff. Facilities should maintain at least one staff member trained in the use of emergency oxygen at all times. Training should be ‘certification’ level from a nationally-recognized organization. i

**Follow Regulations:** Delivery devices, equipment and signage should be in compliance with the Federal Occupational Health & Safety Administration (OSHA), state and local regulations as they pertain to the presence and use of emergency oxygen and compressed gasses. Regularly inspect equipment and document inspections according to national and local standards and manufacturer specifications. i
Risks Associated with Oxygen Delivery

Oxygen is classified as a drug, and as with any drug, there are risks involved. In general, the benefits of emergency oxygen for an acute patient outweigh the risks.iii Potential risks include the following:

**Oxygen Toxicity:** Oxygen toxicity occurs when there is too much oxygen in the blood. It is caused from prolonged exposure to high concentrations of oxygen. It may be associated with high concentrations of oxygen for more than 24 hours.iii Use a pulse oximeter as soon as one is available, to titrate oxygen to the lowest effective level.

Signs of oxygen toxicity can include:

- Seizures
- Vision changes, tunnel vision
- Ringing in ears (tinnitus)
- Nausea
- Twitching
- Irritability
- Dizziness

**Retinopathy of Prematurity:** Retinopathy of prematurity only occurs in premature infants, so it is not a problem associated with the normal use of emergency oxygen. The retinas are immature before 34 weeks gestation, so they can be damaged by high concentrations of oxygen.iii

**Denitrogenation (or Absorption Atelectasis):** Denitrogenation occurs when the naturally-occurring nitrogen in the lungs is replaced with oxygen from over-saturation. It can cause the alveoli of the lungs to collapse and severely impair lung function.iii Because the duration of using emergency oxygen is relatively short, this is generally not a concern.

**COPD and Hypoxic Drive:** Normally, sensors in the brain stimulate ventilation when high levels of CO₂ are detected. The brain also has sensors looking for low oxygen levels. The brain’s CO₂ detectors are much more sensitive than the low oxygen sensors, which are the brain’s last line of defense to keep us breathing. Stimulation to breathe based on low oxygen levels (rather than high CO₂ levels) is known as hypoxic drive.vi

The term ‘hypoxic drive’ is also associated with conditions that cause COPD, such as emphysema. Unlike most of the population, a person with COPD is stimulated to breathe when there are lower oxygen levels and to NOT breathe when there are higher oxygen levels. A concern is that emergency oxygen can eliminate the hypoxic drive of a COPD patient and cause the person to stop breathing.

The general rule is to always give emergency oxygen to someone who needs it, including a person with a history of COPD. The cause of difficulty breathing may be related to a condition
other than COPD, and the condition known as hypoxic drive (associated with COPD) is rare, so do not withhold emergency oxygen administration. iii, xvii

Oxygen Safety

Using Oxygen with a Defibrillator

Rescuers trained in the use of an automated or manual defibrillator must take additional precautions when using the device near emergency oxygen.

Before shocking a victim, rescuers are taught to ensure that no one is touching the patient or the patient’s clothing by saying, “Clear.” An oxygen delivery device should also be ‘cleared’ before the shock.

Oxygen is combustible. Good electrode-to-skin contact is essential to prevent the trapping of oxygen between the electrode and the skin. Poor pad placement could cause a small electrical arc that has the potential to ignite a pocket of oxygen.

Before shocking a patient, move any oxygen delivery device at least 3 feet from the patient and loudly state, “Oxygen clear.” Only shock when everyone and the oxygen delivery device are clear from the patient. After the shock, the use of emergency oxygen with rescue breaths can be resumed.

Storage and Handling of Cylinders

Always treat cylinders as if they are full, being careful not to drop or mishandle them.

- When on scene, lay the oxygen cylinder on the floor so it does not get knocked over accidentally.
- If transporting the oxygen cylinder with the patient, secure it to the cot, stretcher or gurney so that it does not slip or get knocked off.
- Store cylinders upright, secured in a rack or by some other method to prevent falling.
- Do not use a cylinder that appears damaged.
- Never subject cylinders to temperatures greater than 125°F, prolonged exposure to direct sunlight, or exposure to other heat sources (e.g. radiator, space heater).
- Do not slide, drag or roll cylinders.
- Avoid storing different types of compressed gasses in the same area.
- Do not use oil or grease on oxygen equipment.
- Use a pressure gauge to check contents; do not rely solely on a tagging system (Full, In-Use, Empty).

Because oxygen is combustible, cylinders should be kept away from heat sources and flammable or combustible items such as alcohol, aerosol sprays, solvents, perfumes and petroleum
products. Combining highly concentrated oxygen and a flammable or combustible item with an ignition source, such as a lit cigarette, could start a fire.

### Optional Topics

These topics are not required, but many rescuers may encounter various types of oxygen-related equipment and should be familiar with airway adjuncts and suction equipment.

The content in this section is not tested, but only discussed as an overview.

### Suction Devices

An unresponsive or incoherent patient may need assistance clearing his or her airway of an obstruction. Suctioning may be required to remove fluids from the airway.

Suction devices are designed to remove blood, secretions, or vomit from the victim's airway. EMS personnel use both manual and battery-operated units. Either a rigid suction tip or a flexible suction catheter will be used with the device.

**Prior to performing suctioning, measure the distance from the corner of the victim's mouth to the earlobe.** This is the maximum distance the rigid or flexible catheter is inserted into the mouth. Inserting too deeply may stimulate the gag reflex, compromising the airway.

To provide suctioning:

1. Turn patient to side-lying position (follow local protocols on spine precautions) or turn patient’s head to the side.
2. Measure distance from corner of mouth to earlobe to identify maximum catheter insertion depth.
3. Remove CPR mask from the patient’s face.
4. Wipe out any large debris with a gloved hand.
5. Insert the catheter, and observe for fluid traveling up the tube.
6. Provide suction as the catheter is removed from the mouth.
7. Use sterile water to clear the suction catheter if it becomes obstructed.

### Airway Adjuncts

Airway adjuncts are used by EMS providers to establish or control a patient’s airway when a person is unresponsive and having signs of difficulty breathing. Airway adjuncts are used by both basic and advanced responders who are specially trained in their use.

**Simple airways** are inserted by certified, basic responders. **Types include oral and nasal airways.** When simple airways are used during CPR, they do not change the delivery of CPR. Continue cycles of compressions and ventilations, pausing compressions briefly to deliver rescue breaths.
Advanced airways are inserted by licensed and specially-trained advanced rescuers, including some EMTs, paramedics, respiratory therapists, RNs and physicians. Basic rescuers may be called upon to assist in the insertion and use of an advanced airway.

**Oral Airway: xix**

- Known as an oropharyngeal airway or OPA
- Most commonly used airway adjunct.
- Keeps the tongue off the back of the patient’s airway.
- Used for unresponsive patients without a gag reflex.
- Rescuers must select the correct size:
  - Adult, child or infant
  - Measure from the front teeth to the angle of the jaw or the earlobe.
  - Oral airways that are too large may actually block the airway.
- To insert: Place along the roof of the mouth and rotate 180° into position so it is pointing down towards the tongue.
  - Rests at the back of the throat.
  - The end rests on the lips.

**Nasal Airway: xix**

- Known as a nasopharyngeal airway or NPA
- Used for a patient who is semi-conscious or has a gag reflex.
- Is tolerated more easily than an oral airway.
- Does not control the airway as well as an oral airway.
- To insert:
  - Select the correct size: measure the distance from the base of the nose to the base of the ear.
  - Lubricate the tip; do not obstruct the tube.
  - Insert into nostril up to measured distance.
  - Ensure ring at end is clearly visible at the nose.
- DO NOT USE a nasal airway if there is severe facial trauma or suspected fracture to base of the skull.

**Advanced Airways: xix**

- Used to establish and secure the airway.
- Block vomit or fluids from entering trachea when properly inserted.
- Many types:
  - Endotracheal Tube (ETT)
  - Esophageal Tracheal Combitube (ETC)
  - Esophageal Obturator Airway (EOA)
  - Laryngeal Mask Airway (LMA)
• The end of an advanced airway attaches to the elbow of a bag mask, with the mask removed.

• **Modify CPR when an advanced airway is in place:**
  - Provide continuous CPR compressions; do not pause compressions to give breaths.
  - Deliver 1 breath every 6-8 seconds (8-10/min).

**Glossary**

**Airway adjuncts:** Simple and advanced airways which are inserted to establish and/or control a patient’s airway.

**Alveoli:** Air sacs in the base of the lungs in which O₂ is exchanged for CO₂.

**Asthma:** A more serious condition that causes wheezing and shortness of breath due to narrowing of the airways and increased mucus production.

**Bag mask:** Bag valve mask (BVM); an oxygen delivery device that uses positive pressure ventilation to push air into the lungs of a patient who is not breathing.

**Bronchitis:** Inflammation of the bronchial tubes, with excess mucus production.

**Chronic obstructive pulmonary disease (COPD):** A group of lung diseases, including chronic bronchitis and emphysema, which limit the flow of air into and out of the lungs.

**Cyanosis:** Bluish color in skin, lips, and fingernail beds due to low oxygen levels in the tissues near the skin surface.

**Diaphragm:** A thin, flat muscle under the lungs; the primary muscle for breathing.

**Diving decompression injury:** Occurs when dissolved gases turn into bubbles inside the body upon depressurization; may occur when an underwater diver ascends to the surface too quickly.

**Emergency oxygen:** Supplemental oxygen that is delivered at a minimum rate of 6 LPM for at least 15 minutes. It must be clearly labeled as “Emergency Oxygen” and does not require a prescription.

**Emphysema:** A condition of the lung characterized by progressive distension and irreversible loss of elasticity of lung tissue, coughing and difficulty breathing.

**Hypoxemia:** Inadequate oxygenation of the blood.

**Hypoxia:** Inadequate oxygen supply to the organs and tissues of the body.

**Hypoxic drive:** Stimulation to breathe based on low O₂ levels, rather than high CO₂ levels; may be present in a patient with COPD.
LPM: Liters per minute; used to describe the rate of oxygen flow through a pressure regulator.

Medical oxygen: Supplemental oxygen that requires a prescription, and is delivered at a rate of less than 6 LPM or for a duration of less than 15 minutes.

Nasal cannula: A low-flow oxygen delivery device; use for a patient who is non-critical or who cannot tolerate a non-rebreather mask.

Non-rebreather mask: A high-flow oxygen delivery device; the preferred device to provide emergency oxygen.

O-ring: A gasket used to create a tight seal between a cylinder and a pressure regulator.

Open pneumothorax: Trauma that has penetrated the chest wall, resulting in the accumulation of air in the chest cavity, collapse of the lung, and the flow of air through the wound, causing a sucking sound.

psi: Pounds per square inch; used to describe the pressure contained in an oxygen cylinder.

Pulmonary embolism: The sudden blockage of an artery in the lung.

Pulse oximeter: A small, portable device that estimates the blood-oxygen level, or percentage of oxygen saturation ($\text{SpO}_2$) in the blood.

Regulator: Attaches to an oxygen cylinder; controls the rate of oxygen flow from the cylinder.

Rescue breathing: The ventilation component of CPR.

Respiration: The process of breathing; the exchange of carbon dioxide ($\text{CO}_2$) with oxygen ($\text{O}_2$) from the atmosphere.

Shock: A life-threatening condition in which the body’s organs and tissues don’t receive enough oxygenated blood, leading to a dangerous drop in blood pressure.

Suction devices: Remove blood, secretions, or vomit from the airway.

Tripod position: Upright, rigid sitting posture with arms locked and supporting body weight.

Ventilation: The process of moving air in and out of the lungs for respiration.
References


