TECH TUESDAY Tip of the Week

Medical Gases

What Are Medical Gases?

Oxygen

Oxygen may be used for patients requiring supplemental oxygen via a mask. Usually accomplished by a large storage system of liquid oxygen at the hospital which is evaporated into a concentrated oxygen supply, pressures are usually around 380 kPa (55 psi). In small medical centers with a low patient capacity, oxygen is usually supplied by multiple standard cylinders.

Medical oxygen is used:
For virtually all modern anesthetic techniques as well as pre-and post-operative management. Oxygen provides life support by restoring tissue oxygen levels in a range of conditions, including:

- Cyanosis as a result of cardio-pulmonary disease
- Surgical trauma, chest wounds and rib fractures
- Shock, severe hemorrhage and coronary occlusion
- Carbon monoxide poisoning
- Hyperpyrexia
- Major trauma, such as road accidents and gunshot wounds.

Oxygen plays a vital role in the management of sudden cardiac and respiratory arrest - whether drug induced or traumatic - and in the resuscitation of critically ill patients when circulation is impaired. It is also used in neo-natal resuscitation.

Nitrous Oxide

Nitrous Oxide is supplied to various surgical suites for its anesthetic functions during pre-operative procedures. Delivered to the hospital in standard tanks and supplied through the Medical Gas system. System pressures around 345 kPa (50 psi).

Medical nitrous oxide is used:

- For the relief of severe pain, usually in emergency situations, by inhalation with 50% oxygen
- During induction and maintenance of anesthesia, in controlled situations

Nitrous Oxide and Oxygen

A mix of nitrous oxide 50% and oxygen 50% is a medical anesthesia gas, commonly known as Entonox (a registered trademark of BOC) or Nitronox, or colloquially as “gas and air”, and is frequently used in pre-hospital care, childbirth and emergency medicine situations by medical professionals such as doctors, nurses, midwives and paramedics.

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Nitrogen

Nitrogen is typically used to power surgical equipment during various procedures. Pressures range around 1.2 MPa (175 psi) to the various locations.

Carbon Dioxide

Typically used to inflate or suspend tissues during surgery, and also used in laser surgeries. System pressures are maintained at about 345 kPa (50 psi).

Medical carbon dioxide is used:

- To increase the depth of anesthesia rapidly when volatile agents are being administered. It increases depth of respiration and helps to overcome breath-holding and bronchial spasm
- To facilitate blind intubation in anesthetic practice
- To facilitate vasodilation, and thus lessen the degree of metabolic acidosis during induction of hypothermia
- To increase the cerebral blood flow in arteriosclerotic patients undergoing surgery
- To stimulate respiration after a period of apnea
- In chronic respiratory obstruction after it has been relieved
- To prevent hypercapnia during hyperventilation
- For clinical and physiological investigation.

Medical Air

Medical Air is supplied by a special air compressor to patient care areas using clean outside air. Pressures are maintained around 380 kPa (55 psi). Medical air can be used as surgical air when the pressures are raised to 7 Bars. Surgical air is majorly used in driving pneumatic tools like dental hand pieces. Medical air should never be used as oxygen.

Medical air is used:

- As a replacement for atmospheric air when the atmosphere is contaminated by noxious fumes, vapors or gases
- In anesthesia as a carrier for volatile anesthetic agents
- As a power-source for pneumatic equipment
- In ventilators and incubators to provide uncontaminated and controlled air flow.

Medical Test Gas Mixtures

There are many gas mixtures used for clinical and medical applications. They are often used for patient diagnostics such as lung function testing or blood gas analysis. Test gases are also used to calibrate and maintain medical devices used for the delivery of anesthetic gases.

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Medical Culture Growth Mixtures

Culture growth applications include controlled aerobic or anaerobic incubator atmospheres for biological cell culture or tissue growth. Controlled aerobic conditions are created using mixtures rich in oxygen and anaerobic conditions are created using mixtures rich in hydrogen or carbon dioxide.

Quick Facts:

Air (AIR)
Colorless, odorless, tasteless. Chemical composition is 78% nitrogen, 21% oxygen, and 1% trace elements.

Oxygen (O_2)
Colorless, odorless, and tasteless medical gas. Not flammable but does support combustion

Carbon Dioxide (CO_2)
Colorless, odorless and tasteless medical gas. Does not support combustion or life.

Helium (He)
Colorless, odorless and tasteless medical gas. Normally used as heliox in a 80/20 or a 70/30 mixture

Nitric Oxide (NO)
Colorless and has a faint taste and smell. Used as a vasodilator and used more in the neonatal unit

Nitrous Oxide (N_2O)
Colorless, odorless and tasteless medical gas. Used as an anesthetic

Ways to Manufacture O_2
Fractional Distillation, Electrolysis of H_2O, Chemical Decomposition, Physical Separation

Fractional Distillation
Cheapest and most common method to manufacture O_2. Air is filtered to remove pollutants, H_2O and CO_2. Air is then liquefied by compression and cooled by rapid expansion. The resulting mixture is heated in a distillation tower and then transferred to cryogenic storage cylinders

Electrolysis of H_2O
Separates oxygen from water

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Chemical Decomposition
Heating of oxygen to remove impurities

Physical Separation
Uses oxygen concentrators to extract oxygen from ambient air; produces the least amount of oxygen

Most Frequently Used Cylinders in Care Settings
H, G, and E cylinders

Color Coding for Cylinders

Air Yellow or black/white	**Oxygen** Green or white *green used most frequently*	**Carbon Dioxide** Gray	**Carbon Dioxide/Oxygen** Gray/green
Helium Brown	**Nitrogen** Black	**Nitrous Oxide** Light blue	

Gas Safety Systems
PISS
DISS
not universal systems
Pin Index Safety System - PISS
Diameter Index Safety System - DISS

Types of Pressure Relief Devices Used for Gas Cylinders
Rupture disk (frangible disk)
Fusible plug
Spring loaded

Medical Gas Distribution Systems
Bulk systems
Portable cylinders
Liquid systems

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Central Supply Systems
Continuous
Alternating

Continuous Supply System
2 or 3 tanks that are consistently running
Alternating Supply System
1 backup tank in place at the care setting used in case the continuous supply systems fail

Working Gas Pressure
50 pounds per square inch gauge (psig)

Piping Systems
Gas delivery system from the central supply units to sites or zones within the hospital; allows for the quick isolation of all independent areas in case of fire with the shut off valves

Determining Duration for Flow for a Gas Cylinder
CF×PSIG ÷ LPM
cf= cylinder factor
psig= pounds per square inch gauge
lpm= liters per minute

Medical Air Supply
Piston air compressors
Diaphragms
Rotaries

Reducing Valve
Device that reduces high pressure gases from cylinders or bulk storage units to lower the working pressure

Flowmeters
Device used to control and indicate gas flow, usually in LPM
Thorpe Type
Bourdon
Flow Restrictor

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Thorpe Tube
Most commonly used. Uses a float and a needle valve to control the flow of a gas

Bourdon Flowmeter
A reducing valve that controls the pressure gradient across an outlet with a fixed orifice. So long as the pressure distal to or downstream from the orifice remains atmospheric, the indicated flow is accurate

Flow Restrictor
Operates on the same principles as the Bourdon flowmeter. Gas flow can be increased by raising driving pressure across a fixed resistance
used for lpm of ½-3

Oxygen Adder
Consists of 2 flowmeters; the flow is directed through a humidifier and then to the patient. The FiO_2 rate is dependent on the air entrainment ratio
simplest method

Oxygen Blender
Uses working pressure source (50 psig) of air and oxygen to deliver precise FiO_2. Works pneumatically
compact and convenient

Components of an Oxygen Blender
Alarm module
Pressure-balancing module
Proportioning module

Problems with Oxygen Blenders
Contaminated gas sources, H_2O, particulate matter, corrosion (prevents check valves from seating properly and diaphragms from properly moving), uses filters at inlets

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