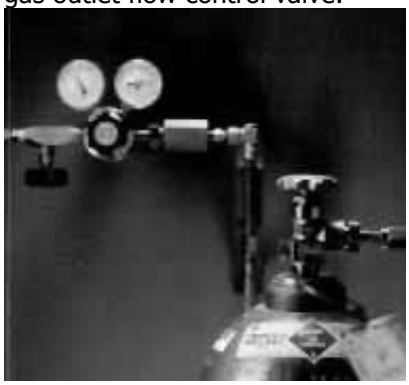
2.18 Bottled Gases

2.18.1 Clinical Use and Principles of Operation

The clinical use of bottled (pressurized) gases can range from anesthesia machines to spectroscopy. The most common bottled gas in the developing world is oxygen. However, anesthesia gases, dry air and carbon dioxide are all seen occasionally. Bottles of high pressure gas can be explosive and flammable. Therefore, handling the bottles must be done with care.

The components of a bottled gas. (1) The main cylinder valve, (2) The cylinder pressure gauge, (3) the pressure regulator and pressure regulator valve, (4) The gas outlet pressure gauge and (5) the gas outlet flow control valve.



A bottled gas has a few components: the cylinder, the main cylinder valve, the cylinder pressure gauge (the gauge closest to the cylinder), a pressure regulator for reducing the pressure, the gas outlet pressure gauge and typically a gas outlet flow control valve. The pressure regulator usually has an adjustment control. This control may have a large knob, or it may require a crescent wrench to adjust the outlet pressure. The entire assembly is often referred to as the regulator.

When not in use, gas cylinders should have a cap that screws onto the top of the cylinder to protect the gas cylinder valve from being cracked off, should the cylinder be dropped. This cap should always be used when the gas cylinder is being transported.

In the United States, oxygen cylinders are green, with a specific hose fitting, and feature a main cylinder valve with a reverse thread (counterclockwise to tighten). However, most of these standards are different around the world, and are not followed in the developing world. Even in one hospital, oxygen tanks may be of different colors and have different types of regulators. Oxygen bottles are sometimes seen in a small size which uses a different pressure regulator. However, these are rare in the developing world.

2.18.2 Common Problems

The most common problem in the developing world is a missing or broken regulator, followed by a hosing set which does not match the standards of the regulator. Mismatched hosing sets need to be adapted with whatever parts and tools are available. This type of patching can only be accomplished after the pressure regulator (on the low pressure side). Clearly label the outlet of the hose after adaptation, in the local language, if possible.

If the regulator is broken, it may be impossible to repair. The pressure gauges for both high and low pressure readings are removable, by simply unscrewing them. Replacements can often be

found in the developing world. Use a Teflon pipe thread tape when replacing the gages, if at all possible, as it will seal much better than the metal-to-metal seal required without the tape. The outlet flow control valve is not typically very important, and can be replaced with any valve which can be made to fit into the system. If the pressure regulator is broken, there is little that can be done. This piece cannot be repaired.

If you must move a cylinder in order to repair it, or the regulator, place the cap on the cylinder before beginning. Moving a gas cylinder is dangerous and difficult. Always ask for help. Before moving the cylinder, check the cap again to insure that it is secure. The best way to move a cylinder is to slowly roll it on its bottom, with the cylinder tilted a few degrees. Highly experienced staff may move cylinders at high speed this way with seeming ease. However, if you are not very experienced at moving cylinders, you can easily lose control of the cylinder. Have a friend stabilize the cylinder while you tilt it and roll it. Check the cap frequently while moving the cylinder.

If you must work on the cylinder, do not empty it entirely (by leaving the cylinder valve open). This may allow ambient air to enter the cylinder and cause moisture to build up in the cylinder. The moisture can ruin the cylinder and contaminate the next filling.

Pipes and tubing leaks, while not exactly a problem of the cylinder, are common. Rub some soapy water over the pipe to check for bubbles and locate the leak. Try to cut out the leaky section of tubing and shorten the tube, if the leak is near the beginning or end of a long run. Otherwise, epoxy can serve as a temporary fix for a leaky pipe.

When you are placing the cylinder back on line, do not simply connect the regulator and open the cylinder valve. This can place unnecessary stress on the pressure regulator, can introduce contamination, and can stress the downstream system. The typical reconnection sequence is to first "crack" the main cylinder valve. Cracking the valve means quickly opening and closing the cylinder valve a very small amount to briefly allow the passage of a very small amount of gas. The gas will be high pressure and velocity. So, stay clear of the gas stream. This cracking clears debris in the valve outlet. Next connect the regulator to the system. Now crack the main cylinder valve again. This will pressure the regulator, but not stress it excessively. Finally, open the cylinder valve again to begin using the system.

Beyond that which has already been discussed for gas cylinder care and maintenance, further attention must be paid to the specific gas used. Oxygen has already been discussed. Carbon dioxide is a nonflammable gas. However, take care to ensure proper ventilation when using carbon dioxide as any leaks may be hazardous. A concentration of CO_2 as low as 10% can cause unconsciousness.

Nitrous Oxide is sometimes used for anesthesia, though its use is rare in the developing world. Any cylinders containing such a mixture must be stored above 10° C or the nitrous oxide will separate out. Warm and shake any such mixture before use. When mixed with oxygen, nitrous oxide can be explosive.

Butane, Propane and Acetylene are highly flammable gases which are not used in medicine. However, they are often seen at the hospital. Butane and propane are liquids under high pressure and are used for cooking and heating, including clinical laboratory heating. Acetylene is mostly used for cutting metal with a flame torch. However, it is rarely used for atomic absorption spectroscopy, a procedure which is already rare in the developing world. Acetylene will ignite explosively in air.

2.18.3 Suggested Minimal Testing

Gas cylinders are intrinsically simple devices that need very little calibration. The only apparatus that should be checked are the pressure gauges and the piping. Pressure gauges can be checked by attaching a second gauge (that is known to be accurate) in series with the first and assuring that both gauges give the same reading. If this is not possible, the outlet gas may be connected directly to a mercury manometer which will allow pressure checks at relatively low pressures, ranging from 0 – 300 mmHg typically (up to 40 kPa). Leaks may be checked by passing dilute soapy water over piping connections and looking for bubble formations. If the outlet gas is at the correct pressure and there are no leaks, the cylinder is ready for use.