

### CHAPTER 7 GAS AND VACUUM SUPPLIES

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#### Checklist

1. What should be the location and number of outlets for oxygen, air, nitrous oxide, vacuum, and scavenging?
2. Is there need for a second set of gas outlets at an additional location?
3. How will hoses be kept neat and off the floor?

#### Key Considerations

- At an absolute minimum, there should be at least two oxygen outlets, one medical air, one nitrous oxide, two vacuum outlets, and one evacuation (i.e., scavenging) outlet available at the head of the table. Additional outlets, particularly for oxygen, are strongly suggested.
- If perfusionists will be required, they will need additional gases, including oxygen, air, vacuum, and, possibly, carbon dioxide.
- Consider a second set of hose drops for different room set ups (reversed patient orientations) or future needs.
- Determine the desired connection option: simple hose drops from the ceiling, wall outlets, fixed columns, retractable hoses or columns, or multiservice articulated arms.
- Every location routinely used for administration of inhaled anesthetics should have a waste anesthetic gas disposal (WAGD) system that directly exhausts to the outside. This exhaust port must not be near any fresh air intake ports.
- The Centers for Disease Control (CDC) and National Institute for Occupational Safety and Health (NIOSH) recommend that the ventilation systems circulate and replenish the air in operating rooms (ORs) (at least 15 air changes per hour, with a minimum of three fresh air changes per hour) and in recovery rooms (at least six air changes per hour, with a minimum of two fresh air changes per hour).

Ideally, WAGD is handled by a dedicated system just for scavenged anesthetic gases that is independent of both the vacuum and ventilation systems. Due to concerns of environmental toxicity (e.g., smog/global warming), it is likely that emerging systems will allow for filtering and reclaiming the waste gases.

### Piped Gases

The anesthesia representatives on the design team must determine the number and location of outlets for gases that will be piped into the OR. At an absolute minimum, there should be at least two oxygen outlets, one medical air, one nitrous oxide, two vacuum outlets, and one evacuation (i.e., scavenging) outlet available at the head of the table. If wall-supplied nitrogen will be used to power equipment, then a pressure-regulated nitrogen outlet should also be included, not necessarily at the head of the table. Several vacuum outlets need to be located around the room for the surgeons. In addition, if the OR will be used for open-heart procedures, then the perfusionists will need additional gases, including oxygen, air, vacuum, and, possibly, carbon dioxide.

Providing only the minimum number of gas outlets may make it difficult to reconfigure the room layout if the function of the room changes, however. Once the gas outlets are installed, relocating or adding outlets will be a major expense that most hospitals will want to avoid. Long gas hoses draped around the room to accommodate a new configuration create a hazard of tripping and issues of contamination and cleaning.

In some roomers, there is a need to have the patient's head 180° from the normal position. In this case, the anesthesia machine will have to be moved to the opposite end of the room. Therefore, a second set of hose drops should be installed. Some facilities may prefer to install a second set of hose drops just for future contingencies. At an absolute minimum, it would be quite prudent to add one additional air outlet and one additional oxygen outlet, especially if there is ever the possibility to bring an intensive care unit ventilator or extracorporeal membrane oxygenation machine to the room.

Trying to determine gas line drops during the construction period is problematic. Room air handling and ventilation will have been designed by the mechanical engineers during the design phase. The gas line drops need to be incorporated into this design process because it is unlikely that the ventilation system can be changed once it is designed and accepted. Creating a mockup may be the best way to determine the drop placements. This also allows a variety of users to comment on the room setup. Graphical computer software is available to create models of a room design. However, being able to move in a space to test it out is nice.

The method by which the gas connections will be brought into the room must also be determined. The options include simple hose drops from the ceiling, wall outlets, fixed columns, retractable hoses or columns, and multiservice articulated arms.

There are advantages and disadvantages to each of these. Hose drops from the ceiling are very popular. They are cheap, easy to install, and flexible and require minimal maintenance. "Pigtails" with any of a variety of quick-connects can be easily provided so that the hoses can be quickly disconnected and the anesthesia machine moved to a different location.

**Figure 1.**



Hose connections from the wall have similar characteristics but frequently result in hoses that are lying on the floor. If wall-mounted outlets are used, then the hoses should be suspended in some manner that keeps them off the floor (or at least 3 feet away from foot and equipment travel paths).

Fixed columns were once very popular, but they tend to reduce flexibility and can be a hazard for tall individuals. Also, they must be opened or disassembled in order to inspect the condition of the piping or hoses. Future standards requirements may require routine inspection of hoses and other utilities housed in these columns. There are various methods that enable retraction of the hoses. Although this would appear to be a good idea, it is usually of little value. Also, the rolling and unrolling of the hoses can cause premature wear and possible rupture.

**Figure 2**



The multiservice articulated arm looks very impressive and has the potential to organize gas supplies, electrical outlets, and telephone and data links into one area that can be repositioned at will. These devices are very expensive, with a cost between \$10,000 and \$20,000 per room. The potential advantages of these multiservice arms are frequently overlooked once they have been installed. It is a good idea to include them in the initial budget request, however. In this way, they can be omitted later if they are found to be unnecessary; if the department is asked to reduce its equipment budget, they can provide a relatively painless, high-cost, “give back.” Again, future standards requirements may require routine inspection of hoses and other utilities in these articulated arms. In some designs, it is very difficult to add a new hose or cable or to replace an old one. The location of the columns will be limited not only by the room air handling equipment but also by the location of steel beams in the ceiling.

The multiservice articulated arm can also be designed for use by the surgeons and nursing staff. These arms can hold pieces of equipment that are normally placed on the floor, such as electrosurgical units, video monitors, light sources, and suction canisters. This eliminates many of the electrical cords from the floor and increases the usable floor space. Also, because the arms rotate through a nearly 360° arc, they can be located where needed for a given case. This use of the multiservice articulated arm seems to make more sense than just for the delivery of anesthesia gases. The movable, articulating column for gas and electric service sounds great, but, in practice, one may want to analyze whether the anesthesia machine can be easily located in the desired position. If not, the expense of the articulating, movable column may be saved. Individuals may want to consider columns that are attached to the anesthesia machines, totally minimizing the hoses getting in the way. The expense may not be justified, however.

In some European ORs, the anesthesia machine itself is mounted on a ceiling pendant. This approach is almost unheard of in the United States, however.

**Figure 3**



The exact location of the gas drop is critical. It is important that the hoses are not draped over the machine, damaging expensive monitors. Instead, the hoses should hang freely behind the machine and still allow personnel to walk behind it.

**Figure 4**



It is almost impossible to accurately locate the gas outlets on the blueprints. The best method is to tell the architect and contractor that the final position of the gas drops will be determined on site.

Then, before the ceiling is finished, the position of the lights and ventilation grates can be drawn on the floor and the exact position for the gases determined. In general, the hose drops should be placed at a 45° angle, approximately 6 feet from the top right corner of the OR table. Actual equipment or cardboard cutouts of the equipment's footprint can be brought into the room to determine how everything fits together. If a light fixture is in the position that the gas drops should occupy, then that fixture can be reduced in size (i.e., a 4-foot light can be reduced to a 2-foot light) or simply eliminated. There should be a more than adequate number of light fixtures, and eliminating one should be of no consequence.

Consideration should also be given to a location for storage of an oxygen tank and a self-inflating bag for emergency use in case of anesthetic machine or pipeline gas delivery problems. These items are required under the 2008 American Society of Anesthesiologists preanesthesia checklist. One solution is a cylinder rack mounted on the wall behind the anesthesia machine. The rack can be positioned at waist height and oriented at a 45° angle for easier insertion and removal of the cylinder.

### Scavenging/Waste Anesthetic Gas Disposal

Every location routinely used for administration of inhaled anesthetics should have a WAGD system that directly exhausts to the outside. This exhaust port must not be near any fresh air intake ports. Ideally, WAGD is handled by a dedicated system just for scavenged anesthetic gases that is independent of both the vacuum and ventilation systems. If the anesthetic gas scavenging system is combined with the room exhaust system, then the entire room exhaust must be vented outside and not used for recirculated air so that scavenged gases are not brought back into the rooms.

To prevent exposure to waste anesthetic gases exhaled by patients, the CDC and NIOSH recommend that the ventilation systems circulate and replenish the air in ORs (at least 15 air changes per hour, with a minimum of three fresh air changes per hour) and recovery rooms (at least six air changes per hour, with a minimum of two fresh air changes per hour). This degree of room ventilation will also protect against contamination from leaks in the anesthesia gas delivery or scavenging systems.

An emerging concern is the venting of halogenated anesthetics and nitrous oxide into the atmosphere and their possible effects as smog-producing agents and greenhouse gases that contribute to global warming. Anesthetic agents are the second-highest fluorocarbon pollutant— a distant second to the Freon compounds. As more and more Freon-based refrigeration systems are removed from service, however, we may anticipate that anesthetic fluorocarbons may become the highest fluorocarbon pollutant. Emerging systems will allow for filtering and reclaiming the waste gases. These future systems may be located within the OR suite, but if they operate in a central location, they will be at the termination point of the scavenging system.

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