ICU MANAGEMENT & PRACTICE

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Anaesthesia Units: Purchase Considerations

ECRI Institute Recommendations

Included in the accompanying comparison chart are ECRI Institute's recommendations for minimum performance requirements for anaesthesia units. The recommendations are listed in two categories: basic and high performance. ECRI Institute considers certain minimum safety measures necessary for all anaesthesia units. Among these measures are:

• O_2 fail-safe and hypoxic mixture fail-safe systems,

• Gas cylinder yokes for O_2 if central supplies fail, and

• An internal battery (for units with automatic ventilators) capable of powering the unit for at least 30 minutes.

The unit must be able to measure O_2 concentration, airway pressure, and either the volume of expired gas or the concentration of expired CO_2 ($ETCO_2$). (Note: ASA recommends monitoring of $ETCO_2$ in all intubated patients; this can be accomplished by the anaesthesia unit or by a separate device [e.g., capnograph, multigas monitor].)

Gas cylinders should be attached through hanger yokes with the proper pin index safety system and check valves. Each pipeline gas cylinder supply should have a pressure gauge with scale numbers large enough to be easily read. Gas hoses and machine receptacles should use DISS fittings to prevent misconnection. It is advantageous if the anaesthesia unit accepts medical-air input to allowdelivery of either air and/or N_2O as the gas carrier.

In the event of a partial or complete loss of O_2 supply, an undefeatable audible alarm should activate and the flow of N_2O gases should automatically shut off or decrease proportionately to the flow of O_2 to prevent a hypoxic condition. Also, flows and the mixture ratios determined from flowmeter settings should be accurate to within 10% of set values. Anaesthetic vapor concentration delivered to the common gas outlet should be accurate to within 0.2% vapor concentration of agent or 10% of the set value (whichever is greater) at any gas flow. It is preferable that ventilation rate and PEEP values be monitored. It should not be possible to silence or disable a ventilator monitor alarm for longer than two minutes.

Units should have a power-loss alarm, and the battery backup should have an automatic low-battery alarm. All units should include a backup battery to guard against power loss. The anaesthesia unit should automatically switch to the internal battery if line power is interrupted; also, the loss of line power should be accompanied by an alarm. The battery should also operate the anaesthesia unit and integral monitors for at least 30 minutes. A low-battery alarm should visually and audibly indicate when the battery voltage falls to a level below which the unit may fail to perform satisfactorily. The battery should not require more than 16 hours to recharge completely after depletion.

High-performance systems are distinguished largely by their ability to serve a wide range of patients and to operate with little or no supplemental equipment. Features that make this possible include ventilator modes and tidal volume ranges suitable for neonates and adults, as well as integrated gas and sometimes physiologic monitoring. (Although most models tend to include only a small number of standard ventilation modes, additional modes can typically be added via software upgrades following purchase.) High-performance units generally include more automated features, including storage of trends and self-tests at the beginning of each procedure. Basic systems include only the most vital monitoring capabilities (i.e., O_2 and CO_2 volumes or pressures) and have only one or two automatic ventilator modes. When equipped with appropriate stand-alone monitors, these units are adequate for treatment of most patients but may remain ill-suited for use on neonates and very sick patients, as well as for monitoring-intensive procedures (e.g., certain types of cardiac surgery). These fundamental systems may also include units designed for military or field use, which often lack ventilators and pipeline gas inlets.

Other Considerations

Some anaesthesia units require standalone physiologic monitors (modular approach) and/or anaesthetic agent monitors, while others have integrated monitors (preconfigured approach). The advantages of preconfigured monitoring include convenience and electronically integrated displays and prioritised alarms. Modular systems can be less expensive than preconfigured systems, especially if the facility already owns the monitors. Hospitals can purchase customised modular systems assembled from standard components, or they can assemble their own modular systems. These systems must meet all national and regional safety standards.

Advantages of the modular approach include flexibility in choosing and upgrading monitors and ease of service; drawbacks include assembling a system that may not be successfully integrated and thus has multiple alarms and/or displays.

Anaesthesia units and patient monitoring systems should be carefully chosen to ensure that all essential monitoring functions recommended by the American Society of Anaesthesiologists are obtained and to ensure optimal integration and an adequate standard of care. For legal reasons, the level-of-monitoring and anaesthesia-delivery capabilities for each anaesthesia station should be uniform so that all patients receive the same standard of care for the same surgical procedures. Integrated anaesthesia workstations, along with the gas/vapour dispensing subsystem and individual physiologic and equipment monitors, may also include a device for automatically dispensing injectable drugs. Consequently, the anaesthesia workstation can be viewed as an integrated monitoring system that dispenses anaesthetic drugs.

Hospitals should also consider the standardisation of anaesthesia equipment; that is, purchasing systems that are compatible with equipment already in operating rooms or other areas of the hospital (e.g., intensive care units). The purpose of standardisation is to allow a reduced parts inventory, minimize the number of suppliers and service personnel, and reduce confusion among the staff.

Pulse oximetry is considered a standard of care for monitoring arterial O_2 saturation in the operating room during procedures requiring anaesthesia and in intensive care units and recovery. Pulse oximeters non-invasively measure O_2 saturation of blood hemoglobin (SpO_2) and, along with O_2 monitors and CO_2 monitors, are increasingly being required for anaesthesia units by law. Hospitals should check with their department of health for any regulations that may apply to their area. Pulse oximeters provide a spectrophotometric assessment of hemoglobin oxygenation by measuring light transmitted through a capillary bed, synchronised with the pulse. The detection system consists of single-wavelength LEDs (light-emitting diodes) and microprocessors located within a sensor.

CO_2 monitors measure end-tidal CO_2 and can help identify leaks and misconnections as well as indicate when the trachea has not been properly intubated. Many features of anaesthesia systems are optional, allowing hospitals to choose those that best fit their needs. Among anaesthesia units with essentially equivalent mechanical gas/vapour dispensing subsystems, the monitors included in the system and the ways in which information is integrated and displayed are often the primary distinguishing features.

Cost Containment

Because anaesthesia systems entail ongoing maintenance and operational costs, the initial acquisition cost does not accurately reflect the total cost of ownership. The anaesthetic agents are the biggest ongoing expense associated with anaesthesia units. Therefore, a purchase decision should be based on issues such as life-cycle cost (LCC), local service support, discount rates, and nonprice- related benefits offered by the supplier. An LCC analysis should be conducted to determine the cost-effectiveness of all units that meet users' needs.

Although costs associated with many of the following may be similar for a number of anaesthesia units, they should still be carefully considered to determine the total LCC for budget purposes:

- Maintenance, service, and inspection
- Accessories, such as monitoring equipment, necessary to comply with standards
- Optional accessories
- Vaporisers (some have been offered at discounted prices or at no cost upon the introduction of a new anaesthetic agent)
- Gases, including O_2, N_2O, and anaesthetic agents
- Anaesthesia circuits
- Recording and storage of anaesthesiarelated data
- Disposables
- Utilities

Hospitals can purchase service contracts or service on a time-and-materials basis from the supplier. Service may also be available from a third-party organisation. The decision to purchase a service contract should be carefully considered. Most suppliers should provide routine software updates, which enhance the system's performance, at no charge to service contract customers. Purchasing a service contract also ensures that preventive maintenance will be performed at regular intervals, thereby eliminating the possibility of unexpected maintenance costs. Also, many suppliers do not extend system performance and uptime guarantees beyond the length of the warranty unless the system is covered by a service contract. Hospitals that plan to service their anaesthesia units in-house should inquire about the availability and cost of service training and the availability and cost of replacement parts. ECRI Institute recommends that, to maximize bargaining leverage, hospitals negotiate pricing for service contracts before the system is purchased. Additional service contract discounts may be negotiable for multiple-year agreements or for service contracts that are bundled with contracts on other similar equipment in the department or hospital. Buyers should make sure that applications training and service manuals are included in the purchase price of the system. Some suppliers offer more extensive on- or off-site training programs for an additional cost.

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