Anesthesia Equipment for the Oral and Maxillofacial Surgery Practice

William L. Chung, DDS, MD

INTRODUCTION

The physical design of an oral and maxillofacial surgeon’s office is highly individualized and unique. Every office must incorporate certain essential equipment and features to safely deliver office anesthesia, regardless of the scope of anesthesia services provided. Furthermore, the office design and anesthesia armamentarium must take into account patient safety and comfort. This article discusses the necessary elements, ranging from preanesthesia assessment forms and intraoperative records to office design, anesthesia monitors, and equipment related to the safe and successful administration of office-based anesthesia by oral and maxillofacial surgeons and their staff.

MANIFOLD SYSTEM AND REMOTE GAS STORAGE

Specific building codes and local fire department regulations must be carefully adhered to before any plans are made to install remote gases. The gas manifold system is a piping network of valves, gauges, and regulators that allow a specific, desired gas to be released at the correct pressure. Most office manifold systems are located in an enclosure away from patient care areas (Fig. 1) to avoid potential injury from a possible fire, explosion, or sudden release of gas. During the soldering process of the copper pipes, nitrogen must be blown into the pipes to eliminate the oxidative by-products from within the pipes to avoid inadvertently delivering these harmful by-products to patients.

All gas tanks require easy accessibility by office staff to check the gauge and change it when the tank is empty. A minimum of 2 oxygen tanks needs to be connected to the system so that 1 tank can be activated if line pressure drops in the other. An audible or visible low-oxygen pressure warning device must be present if an automatic changeover system is used. The shutoff valves to each gas should be clearly labeled and easily accessible to any staff member in the event of an emergency (Fig. 2).

KEYWORDS

- Anesthesia
- Equipment
- Oral surgery
- Maxillofacial surgery
- Practice

KEY POINTS

- Consideration for emergency generator for lighting, suction, and monitors in event of a power outage.
- Portability of oxygen tank, lighting, and an aspiration unit essential during power outage.
- Multiple supraglottic airway devices available for office use and emergencies.
- Capnography capabilities mandatory for any planned deep sedation or general anesthetic.
- The surgical chair or operating table must allow for easy accessibility by surgeon and staff during an emergency.
NITROUS OXIDE EXPOSURE CONTROL AND INHALATIONAL ANESTHETIC EXPOSURE CONTROL

The American Association of Oral and Maxillofacial Surgeons Committee on Anesthesia refers to the Centers for Disease Control and Prevention for recommendations on controls for exposure to nitrous oxide and other potential chemical hazards (http://www.cdc.gov/niosh/topics/nitrousoxide/).¹ A manual of the recommendations can be printed and kept with other office safety manuals for office staff to reference.

OFFICE FIRE SAFETY PROTOCOL

The exact location of an office’s fire safety protocol (Rescue, Activate alarm, Confine the fire, Evacuate/Extinguish [RACE]) should be known by all staff and easily assessable for reference. If an office is not a free-standing facility, all other safety protocols should be clearly labeled and kept together.

COMMUNICATION EQUIPMENT

Telephone numbers of the local ambulance service and nearest hospital should be clearly displayed and their location known to all office staff. In larger office settings, an intercom system or call button facilitates communication between the surgical team and the office staff in the event of an emergency.

RECORD KEEPING/TIME-OUT FORMS

A preanesthesia assessment form is used to help identify any potential problems in a patient's medical history or physical examination prior to the administration of the anesthetic of choice (Fig. 3). The entire surgical team should be made aware of any potentially concerning history or examination findings before a patient even has an intravenous catheter placed.

Anesthesia records may vary in format but typically contain the same essential information (Fig. 4)—time and date, pertinent medical history, any patient medications and allergies, vital signs, type and amount of drugs administered, start and end times of anesthesia and surgery, surgeon and anesthetist names, and any complications. Vital signs are recorded every 5 minutes for deep sedation and general anesthetic cases. Cardiac rhythm, carbon dioxide levels, and temperatures are recorded during all general anesthetic cases until patients are extubated.

The consent form for surgery and anesthesia should be signed by the patient or responsible

---

Fig. 1. Manifold system (Centurion II [Matrix Medical, Minneapolis, MN]). Nitrous oxide and multiple oxygen tanks as well as a portable oxygen tank (arrow), stored in a closet.

Fig. 2. Gas shutoff valves easily accessible and clearly labeled for each gas connected to the manifold system.
party and be in plain view within the operating suite before a patient is placed under anesthesia. The Universal Protocol for Preventing Wrong Site, Wrong Procedure and Wrong Person Surgery must be performed before all surgeries. This information can be viewed at [http://www.jointcommission.org/standards_information/up.aspx](http://www.jointcommission.org/standards_information/up.aspx).
Peripheral venous access is commonly achieved with one of several different angiocatheters. (Fig. 5). One specific catheter system is the BD In-syte Autoguard (Becton Dickinson Infusion Therapy Systems, Sandy, Utah), which is a shielded intravenous catheter. This angiocatheter enables a surgeon to push a button on the catheter handle...
after the needle is inserted into the vein, instantly retracting the needle into the handle and reducing the risk of a needlestick injury.

A winged infusion set, or butterfly needle, can be used during venipuncture for phlebotomy in patients with thin blood vessels that roll. The butterfly needle is not routinely used for the administration of intravenous fluids. If a butterfly needle is available and used because of difficult intravenous access, it may require the use of an arm board to prevent the upper extremity or hand from bending at the site of venipuncture.

A surgeon may choose to use an infusion pump to deliver intravenous medications rather than pushing intermittent boluses of the same drug (Fig. 6). Most infusion pumps provide similar safety and programmable features, such as accurate rapid occlusion detection and automated piggyback or concurrent delivery of a given drug. Some infusion pumps can also be programmed to accurately deliver intravenous fluids or blood products.

AIRWAY ARMAMENTARIUM

Emergency airway equipment must be both readily accessible and familiar to anyone providing

![Fig. 6. Infusion pump.](image)

...anesthesia in the office. It is safe practice to keep airway equipment in both the operating suites and the recovery area. Airway equipment should include the following: a full face mask (preferably in multiple sizes with connectors); bag-valve-mask device with a pressure manometer, capable of providing positive pressure ventilation; oral and nasopharyngeal airways; a supraglottic airway; endotracheal tubes (various pediatric and adult sizes); laryngoscope in both pediatric and adult blades (with extra batteries and bulbs); and a cricothyrotomy kit.

Various supraglottic airway devices are available, and the specific device used in an office should preferentially be based on exposure and hands-on experience during a surgeon’s anesthesia training. The laryngeal mask airway (LMA) is the most common supraglottic device and is available in several types. The LMA Classic is the original design and is the only reusable LMA. The LMA Supreme has a built-in bite block and an esophageal ventilation port (Fig. 7). The LMA Fastrach (Fig. 8) is an intubating LMA, which has a specific insertion handle and an epiglottic elevating bar designed to lift the epiglottis as the endotracheal tube passes. Another supraglottic airways is the King Airway (Fig. 9), which has the ability to provide positive pressure ventilation and spontaneous breathing. It has 2 cuffs that isolate the hypopharynx and laryngeal inlet, thus minimizing gastric insufflation. It does not pass below the vocal cords, so it is not a definitive airway. The King is more commonly used in the prehospital setting by emergency medical

![Fig. 7. LMA Supreme.](image)
technicians and mobile intensive care practitioners and nurses.

A useful adjunct to airway armamentarium is an esophageal/precordial stethoscope. An array of precordial stethoscopes is available to anesthetists. These devices can be purchased with a custom molded earpiece for added comfort or even a wireless amplifier with Bluetooth technology to provide clear sound quality.

Another useful adjunct to airway armamentarium is transoral video laryngoscopy. Video laryngoscopy is a form of indirect laryngoscopy whereby a surgeon visualizes the larynx with a fiberoptic or digital laryngoscope. Two more common video laryngoscopes, the GlideScope (Verathon, Bothell, Washington) (Fig. 10) and McGrath (LMA North America, San Diego, California) (Fig. 11) both use a digital camera and rigid laryngoscopy to improve the view of the larynx.2,3 The GlideScope is available in both single-use and reusable sets, whereas the McGrath is the first fully portable video laryngoscope and does not require focusing or image adjustment during use.

EMERGENCY DRUGS

The 8th edition of the American Association of Oral and Maxillofacial Surgeons Office Anesthesia Evaluation Manual provides a list of medications considered helpful in the event of an anesthetic emergency. This list is not considered all-inclusive or mandatory; it can be modified based on surgeon preference and experience level based on previous training (Box 1). An office should have a separate, clearly designated refrigerator for those medications that require storage in colder temperatures.
The size of an operating room may be highly variable depending on surgeon preference and allotted floor space, but it must be able to readily accommodate an operating chair or table as well as an entire surgical team and anesthetist. Smaller operating spaces may make the resuscitation of a patient during an emergency unnecessarily challenging. The door width should be a minimum of 36 inches to allow for passage of any wheeled equipment and enable 2 adults to pass simultaneously through the doorway standing next to one another. Each suite requires electrical outlets in both the floor and wall for an operating table or chair as well as all anesthesia monitors.

Box 1
Suggested drugs for treatment of anesthetic emergencies

- Intravenous fluids
  - Sterile water—inject or dilute drugs
  - Various intravenous fluids (normal saline, lactated Ringer, and so forth)
- Cardiovascular medications
  - Oxygen
  - Atropine (0.4 mg/mL)
  - Nitroglycerin (0.4 mg; 1/150 gR)
  - Dopamine (250 mg/5 mL)
  - Epinephrine (1 mg) (10 mL of 1:10,000)
  - Epinephrine (1:1000 or 1:10,000) (1 mg = 1:1000)
  - Dobutamine (1, 2, or 4 mg/mL)
  - Ephedrine (50 mg/mL)
  - Phenylephrine (Neo-Synephrine) (10 mg/mL)
  - Lidocaine (Xylocaine) (20 mg/mL)
  - Propranolol (Inderal) (1 mg/mL)
  - Procaainamide (Procanbid) (100 mg/mL)
  - Verapamil (Calan) (5 mg/2 mL)
  - Amiodarone (Cordarone) (50 mg/mL)
  - Adenosine (3 mg/mL)
- Antihypertensive medications
  - Diazoxide (Hyperstat) (15 mg/mL)
  - Hydralazine (Apresoline) (20 mg/mL)
  - Esmolol (Brevibloc) (10 mg/mL)
  - Labetalol (Trandate) (5 mg/mL) (20-mL single-dose vial)
- Diuretics
  - Furosemide (Lasix) (10 mg/mL)
- Antiemetics
  - Prochlorperazine (Compazine) (5 mg/mL)
  - Ondansetron (Zofran) (2 mg/mL)
- Reversal agents
  - Naloxone (Narcan) (0.4 mg/mL)
  - Flumazenil (Romazicon) (0.1 mg/mL)
- Additional drugs
  - Dextrose 50%
  - Dexamethasone (Decadron) (4 mg/mL)
  - Hydrocortisone sodium succinate or methylprednisolone sodium succinate (Solu-Medrol) (125 mg)
  - Glycopyrolate (Robinul) (0.2 mg/mL)
  - Diazepam (Valium) (5 mg/mL)
  - Midazolam (Versed) (5 mg/mL)
  - Albuterol inhaler (Ventolin)
  - Succinylcholine (Anectine) (20 mg/mL)
  - Morphine sulfate (5 mg)
  - Dantrolene (Dantrium) (20-mg vials)
  - Lidocaine (10 mg/mL)
  - Nonenteric-coated aspirin (325 mg)
  - Famotidine (Pepcid)
  - Diphenhydramine (Benadryl) (50 mg/mL)


OPERATING SUITE

The size of an operating room may be highly variable depending on surgeon preference and allotted floor space, but it must be able to readily accommodate an operating chair or table as well as an entire surgical team and anesthetist. Smaller operating spaces may make the resuscitation of a patient during an emergency unnecessarily challenging. The door width should be a minimum of 36 inches to allow for passage of any wheeled equipment and enable 2 adults to pass simultaneously through the doorway standing next to one another. Each suite requires electrical outlets in both the floor and wall for an operating table or chair as well as all anesthesia monitors.

MONITORS

Monitors do not eliminate a surgeon’s need to directly observe patients during anesthesia. The ideal monitor enables a surgeon to analyze a patient’s intended vital sign with ease and accuracy. Each office must be equipped with certain standard monitoring capabilities to provide a safe anesthetic. Standard office monitors include a noninvasive blood pressure monitor, a pulse oximeter, an ECG monitor, a capnography monitor, and either a basic monophasic defibrillator or automated external defibrillator. Most of the these standard monitors can be purchased with storage and printing features and should have a built-in rechargeable battery to run on an alternate power source in the event of a power outage. Patient monitors are also available in an array of combinations, so that each physiologic parameter does not require its own separate monitor. A common combination includes blood pressure, heart rate, pulse...
oximetry, and temperature and may be with (Fig. 12) or without (Fig. 13) ECG capabilities. Temperature monitoring is indicated or desirable depending on the type of anesthesia administered.

**Capnography**

A capnogram is a monitor of the inhaled and exhaled concentration or partial pressure of CO₂ and an indirect monitor of the CO₂ partial pressure in arterial blood.

Capnography provides valuable information regarding CO₂ production, pulmonary perfusion, alveolar ventilation, and elimination of CO₂ from the anesthesia circuit. Capnography also provides valuable clinical information, such as the frequency and regularity of ventilation during sedation cases. When capnography is monitored in an open circuit, such as during sedation, a nasal cannula with an attached gas sampling line can be used to monitor end-tidal CO₂ (Fig. 14).

The maintenance schedule for all monitors should be recorded in a log book and located in a common location known to all staff. Calibration of any monitor should be performed only by properly trained individuals and in accordance to the manufacturer’s guidelines. During a loss of power in the office, the blood pressure monitor, pulse oximeter, ECG monitor, and defibrillator all need to be capable of being battery powered and portable.

**SURGICAL CHAIR OR OPERATING TABLE**

Many surgical chair and table designs are available to surgeons (Fig. 15). Surgeons must ensure that the surgical chair or operating table of preference has certain essential features. The design of the chair or table must allow surgeon and anesthetist ease of accessibility to patients to allow for positional changes and maintaining a patient’s airway. The chair and table should have a wide height range for the surgeon and staff, and both must be capable of resisting the pressure of performing cardiopulmonary resuscitation as well as placing patients in Trendelenburg position (Fig. 16). The headrest of a chair needs to have a secure, tight lock to avoid an unexpected release during the procedure, which could cause a...
potential cervical injury (**Fig. 17**). Surgeons may also want to consider purchasing a surgical chair that is not only wider for heavier patients but also one that is also handicapped accessible. Such chairs have a low starting height to allow for wheelchair accessibility and adjustable and/or removable arms to allow for easy access/egress by patients. Some chairs are designed as a prototypical examination chair, which is upright and has a base for a patient’s feet (see **Fig. 15**). These chairs can be adjusted to recline patients and also place patients in Trendelenburg during resuscitative measures. Lastly the chair or table should be made of a material that is easy to clean and maintain.

**OXYGEN AND SUPPLEMENTAL GAS DELIVERY SYSTEM**

Most oxygen and anesthetic gas machines are fairly similar in design and function. The most essential feature of any oxygen delivery system is that it can deliver metered oxygen under positive pressure to a patient. All gas delivery machines have standard fail-safe mechanisms that prevent the delivery of any gas if the concurrent amount of oxygen administered is below a level that would ultimately deliver a hypoxic amount of gases. Furthermore, the gas outlets must be pin-indexed to prevent accidental administration of an incorrect gas. These machines require periodic calibration by appropriately trained individuals, and any maintenance records should be properly documented and stored in a log book located in an area known to all office staff.

**LIGHTING SYSTEM**

Operating light systems are typically wall or ceiling mounted but are also available on a mobile stand. The specific lighting system must allow a surgeon
to accurately view the color of a patient’s skin and mucosa. Other desirable features for a given lighting system are its abilities to provide cool and color-corrected light; enable deep cavity illumination; allow focus control, pattern size adjustment, and shadow reduction; and enable easy positioning of the light heads. Surgeons may also choose to use a headlight for additional lighting. Auxiliary lighting is mandatory in the event of a power failure in the operating suite or entire office. Most outpatient offices do not have an emergency generator that activates immediately to provide lighting, such as in ambulatory surgical centers. Thus, any backup lighting should be battery powered, portable, and able to provide enough lighting to enable surgeons to complete the procedure or safely stop at a point where a surgery can be completed when power eventually returns.

**SUCTION EQUIPMENT**

An office suction system may operate through either a central suction installation or a portable unit. Most offices incorporate a central installation with the pump located remote from the operating room to reduce noise. During a power outage or pump failure, a portable aspiration unit must be readily accessible. These portable units can be battery powered. Portable suction should also be available in the recovery area during such emergencies. Office staff should adhere to a routine schedule and keep detailed records for maintenance of the suction system.

**TRANSPORT EQUIPMENT**

Patients typically are transferred from an operating suite to a recovery area by a portable chair. Desirable features of a transfer/recovery chair are capability of recliner positions and Trendelenburg position, transport handle on back, attached intravenous hanger, and construction with a material that is easy to clean and maintain. If a surgeon does not choose to fully recover a patient in the operating suite, then a surgical staff member must be present in the recovery area to monitor the patient’s airway and vital signs. The ideal recovery scenario involves patients who walk with assistance to the recovery area.

**RECOVERY ROOM**

The design of the recovery area must allow the staff to observe patients after an anesthetic in an unobstructed manner. The staff also requires clear access to the patient for resuscitation purposes in the event of an anesthetic emergency. Essential equipment and features that need to be available in any recovery area are oxygen under pressure, suction, sufficient lighting, a pulse oximeter, a cardiac monitor, and a defibrillator. All monitors require an electrical outlet, and battery-powered lighting as well as portable suction, and oxygen should be accessible during a power outage. Most offices design the recovery area to be located remote or at the opposite end of the corridor from the operating suites. Patients should also exit the office through a door that is situated nearest the recovery area and opposite that of the entrance to the operating suites.

**SUMMARY**

The surgical equipment and anesthesia-related monitors in an oral and maxillofacial surgeon’s
office are highly individualized. The specific floor plan is also variable and may be partly influenced by the availability of floor space. Regardless, certain features are required for the safe practice of office-based anesthesia. The blood pressure monitor, pulse oximeter, ECG, and defibrillator must each have a built-in rechargeable battery to maintain functionality in the event of a power outage. Portable oxygen, suction, and lighting are essential safe measures as well. Surgeons may opt to purchase an emergency generator to provide power during an emergency. Otherwise, battery powered equipment must be available.

REFERENCES