Preventable medical errors are a major source of morbidity, mortality, and financial cost to society. The frequently cited report, *To Err is Human: Building a Safer Health System* by the Institute of Medicine, estimated that between 44,000 and 98,000 thousand deaths can be attributed to medical error annually, with an annual cost of approximately $79 billion.1 This article and the one preceding it both focus on maintaining patient safety in the operating room. Whereas the current article focuses on both intraoperative and postoperative patient safety with specific emphasis on plastic surgery procedures, it also provides a general review on other aspects of operating room safety. The objective of the current article is to provide concise information on safety in the operating room. For detailed information on patient safety in the office-based setting, the reader is referred to the *Journal* article by Horton et al., as well as the articles by the American Society of Plastic Surgeons Task Force on Patient Safety in Office-Based Surgery Facilities.2–4

**DEEP VENOUS THROMBOEMBOLISM PROPHYLAXIS**

There is extensive evidence demonstrating that deep vein thromboembolism and pulmonary embolism are common and serious complications of surgical procedures. In general surgery, there is an estimated incidence of deep vein thromboembolism ranging from 16 to 30 percent5; and in orthopedic surgery, it is even higher, approaching 45 to 70 percent of hip surgery patients6 and 53 to 84 percent of knee surgery patients7 who have not received deep vein thromboembolism prophylaxis. Despite the known high incidence of deep venous thromboembolism, the authors of this article review methods to decrease these risks.

**Background:** The perioperative environment can be hazardous to patients and providers alike. Although many risks are best addressed preoperatively, some hazards require constant attention by the surgeon, anesthesiologist, and staff in the operating room. In a previous article, the authors discussed preoperative aspects of patient safety. In this article, the authors review intraoperative and postoperative risks and techniques to decrease these risks.

**Methods:** The authors reviewed the literature regarding operating room safety, both primary research and secondary reviews, via multiple PubMed queries and literature searches. Topics most relevant to inpatient plastic surgery were included in the final analysis and summarized, as a full review of each topic is beyond the scope of this article.

**Results:** Several intraoperative and postoperative risks were identified, in addition to methods designed to decrease the incidence of those risks, complications, and other adverse events among plastic surgeons and their patients.

**Conclusions:** In this article covering intraoperative and postoperative hazards, the authors build upon a previous article addressing preoperative risks to patients during inpatient plastic surgery. Although neither article covers an exhaustive list of potential risks, the goal is to provide the modern plastic surgeon with the means to prevent common adverse events, as well as the tools to research new hazards. (Plast. Reconstr. Surg. 130: 1048, 2012.)
vein thromboembolism in surgical patients, a recent survey demonstrated significant disparity among plastic surgeons regarding the use of deep vein thromboembolism prophylaxis. Depending on the procedure performed, including face lifts, liposuction, and combined procedures, only 45.7, 43.7, and 60.8 percent of plastic surgeons use deep vein thromboembolism prophylaxis all the time, respectively. A similar survey of head and neck surgeons demonstrated similar results, with 57 percent of respondents using no deep vein thromboembolism prophylaxis. Because of the potential fatal consequences of deep vein thromboembolism, a rigorous and consistent system of evaluating patients for risk factors as well as implementing prevention strategies is imperative to all plastic surgeons. We strongly encourage following the protocol published in Plastic and Reconstructive Surgery by Davison and colleagues and reviewed by Horton et al. This system entails a

<table>
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<tr>
<th>Exposing Risk Factors</th>
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<tbody>
<tr>
<td><strong>1 Factor</strong></td>
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<tr>
<td>Minor surgery</td>
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<tr>
<td>Immobilizing plaster cast</td>
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<td>Patients confined to bed for &gt; 72 hrs</td>
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<td>Central venous access</td>
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<th>Predisposing Risk Factors</th>
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<tr>
<td><strong>Clinical Setting</strong></td>
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<tr>
<td>Age 40 to 60 (1 Factor)</td>
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<td>Age &gt; 60 (2 Factors)</td>
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<tr>
<td>History of DVT/PE (3 Factors)</td>
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<tr>
<td>Pregnancy or &lt; 1 month postpartum (1 Factor)</td>
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<tr>
<td>Malignancy (2 Factors)</td>
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<tr>
<td>Obesity &gt; 20% IBW (1 Factor)</td>
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<td>Oral contraceptive / hormone replacement therapy (1 Factor)</td>
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Step I.

**Risk Assignment**

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<thead>
<tr>
<th>1 Factor</th>
<th>2 Factors</th>
<th>3-4 Factors</th>
<th>&gt; 4 Factors</th>
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<tbody>
<tr>
<td>Low Risk</td>
<td>Moderate Risk</td>
<td>High Risk</td>
<td>Highest Risk</td>
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**Fig. 1.** Risk assessment and stratification for the use of deep vein thromboembolism prophylaxis in surgical patients. (Reprinted from Davison SP, Venturi ML, Attinger CE, Baker SB, Spear SL. Prevention of venous thromboembolism in the plastic surgery patient. Plast Reconstr Surg. 2004;114:43e–51e.).
comprehensive system of risk assessment and following prevention guidelines based on the risks (Figs. 1 and 2).10

PATIENT TEMPERATURE AND MAINTAINING NORMOTHERMIA

Multiple studies clearly demonstrate that maintaining normothermia improves patient outcome and reduces the cost of complications caused by peroperative hypothermia.11 In a prospective multicenter study, Kurz et al. demonstrated that in patients undergoing elective colectomy, maintenance of normothermia resulted in statistically fewer wound infections, faster return to enteral feeding, and shorter hospital stays.12 Another systematic review on hypothermia and surgical outcomes identified consistent postoperative complications resulting from poor thermal control, including cardiac events, wound infections, pressure ulcers, and the need for blood transfusion.11 We recommend following the recently published recommendations by the American Society of PeriAnesthesia Nurses, summarized in Figure 3.13,14 In brief, these include identifying risk factors for hypothermia, instituting active warming measures if needed, and increasing ambient room temperature.13,14 In addition, we feel the surgeon should also be vigilant in the operating room, making sure the temperature remains at an adequate setting ensuring that the patient is normothermic at all times.

MALIGNANT HYPERTERMIA

Malignant hyperthermia is a rare, autosomal-dominant, life-threatening disease characterized as a hypermetabolic disorder of skeletal muscle. In the operating-room setting, malignant hyperthermia is typically triggered during or after the administration of inhalational anesthetics and involves the release of heat, release of calcium, glycogenolysis, and increased muscle contractility.15 In the past, mortality has been as high as 70 percent, but with increased awareness, it has now been reduced to as low as 10 percent. Mortality is attributed to acidosis, hyperkalemia, organ failure secondary to hyperthermia, disseminated intravascular coagulation, and renal failure secondary to myoglobinuria. Unfortunately, hyperthermia is a relatively late onset symptom of malignant hyperthermia, and only 30 percent of patients demonstrate hyperthermia (Table 1).16

Therefore, surgeons must be aware of potential high-risk patients, such as those with a positive family history of a “reaction” to anesthesia, history of heat stroke, hypokalemic periodic paralysis, and exercise-induced rhabdomyolisis, as the latter have been found to trigger malignant hyperthermia. Testing for malignant hyperthermia is exceedingly difficult. The caffeine-halothane contraction test is the only definitive laboratory study for malignant hyperthermia.15,16 This test, available at only six medical centers is at least 98 percent sensitive but has a high false-positive rate up

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**Fig. 2.** Recommended deep vein thromboembolism prophylaxis by risk category. (Reprinted from Davison SP, Venturi ML, Attinger CE, Baker SB, Spear SL. Prevention of venous thromboembolism in the plastic surgery patient. Plast Reconstr Surg. 2004;114:43e–51e.).
THERMAL MANAGEMENT FLOW CHART

Preoperative Patient Management
- Identify patient risk factors for hypothermia
- Measure patient’s temperature on admission
- Determine patient’s thermal comfort level (ask the patient if he/she is cold)
- Observe for signs/symptoms of hypothermia (shivering, piloerection, and/or cold extremities)

Patient Normothermic
- Institute preventative warming measures:
  - Passive insulation (apply warm cotton blankets, socks, head covering, and limit skin exposure)
  - Increase ambient room temperature (minimum 20°-24°C or 68°-75°F)

Patient Hypothermic
- Institute active warming measures:
  - Apply forced air warming system
  - Apply passive insulation
  - Increase ambient room temperature (minimum 20°-24°C or 68°-75°F)

Intraoperative Patient Management

Assessment
- Identify patient risk factors for hypothermia
- Monitor patient’s temperature (see guideline)
- Determine patient’s thermal comfort level (ask patient if he/she is cold)
- Observe for signs/symptoms of hypothermia (shivering, piloerection, and/or cold extremities)

Interventions
- Passive insulation (apply warm cotton blankets, socks, head covering, and limit skin exposure)
- Increase ambient room temperature (minimum 20°-24°C or 68°-75°F)
- Institute active warming measures: apply forced air warming system
- Warm fluids: intravenous and irrigants
- Humidify and warm gases (anesthetic)

Expected Outcomes
- The patient’s core temperature should be maintained at 36°C (96.8°F) or above during the intraoperative phase unless hypothermia is indicated

Postoperative Patient Management: Phase I PACU

Assessment
- Identify patient’s risk factors for hypothermia
- Measure patient’s temperature on admission
- Determine patient’s thermal comfort level (ask patient if he/she is cold)
- Observe for signs/symptoms of hypothermia (shivering, piloerection, and/or cold extremities)

Patient Normothermic
- Institute preventative warming measures:
  - Passive insulation (apply warm cotton blankets, socks, head covering, and limit skin exposure)
  - Increase ambient room temperature (minimum 20°-24°C or 68°-75°F)
  - Measure temperature prior to discharge
  - Assess thermal comfort level on admission and every 30 minutes (ask patient if he/she is cold)
  - Observe for signs/symptoms of hypothermia (shivering, piloerection, and/or cold extremities)

Patient Hypothermic
- Institute active warming measures:
  - Apply forced air warming system
  - Passive insulation (apply warm cotton blankets, socks, head covering, and limit skin exposure)
  - Increase ambient room temperature (minimum 20°-24°C or 68°-75°F)
  - Warm fluids: intravenous
  - Humidify and warm gases—oxygen
  - Monitor temperature every 30 minutes until normothermia is achieved

Expected Outcomes
- Patient’s minimum temperature will be 36°C (96.8°F) prior to discharge from PACU
- Patient describes an acceptable level of warmth
- Signs/symptoms of hypothermia will be absent.

Laboratory findings acknowledged by both the Joint Commission as

- Increased PaCO₂
- Metabolic (lactic) acidosis
- Evidence of rhabdomyolysis: hyperkalemia, increased plasma creatine kinase, and myoglobinemia and/or myoglobinuria
- Abnormal coagulation tests

Clinical signs
- Unexplained tachycardia (90% of patients)
- Unexplained tachypnea (85% of patients)
- Sudden increase in end-tidal CO₂ (80% of patients)
- Muscle rigidity, masseter muscle spasm or both (80% of patients)
- Cyanotic and mottled skin (70% of patients)
- Cola-colored urine
- Disseminated intravascular coagulation

Table 1. Clinical Signs and Laboratory Findings in Malignant Hyperthermia

<table>
<thead>
<tr>
<th>Clinical signs</th>
<th>Laboratory findings</th>
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<tbody>
<tr>
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<tr>
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<td>Abnormal coagulation tests</td>
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Table 2. The Immediate Clinical Management of Malignant Hyperthermia in the Operating Room

- Stop volatile inhaled agent
- Administer 100% oxygen
- Manually hyperventilate patient
- Replace breathing circuit
- Terminate surgery as soon as possible
- Maintain unconsciousness with an appropriate sedative-hypnotic
- Give dantrolene 1 mg/kg intravenously, then give 1–2.5 mg/kg every 10 min until malignant hyperthermia is under control (to a maximum dose of 10 mg/kg)
- Measure core temperature
- Give intravenous fluids to maintain a steady urinary output; insulin and dextrose may be given to reverse hyperkalemia; hemodiafiltration may be necessary in resistant cases
- Treat cardiac arrhythmias
- Cool the patient cooled by tepid sponging, cooled fluids, cooling blanket, and cool nasogastric lavage
- Admit patient to an intensive care unit for postoperative care

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Malignant Hyperthermia in the Operating Room

- Table 2. The Immediate Clinical Management of Malignant Hyperthermia

- Treatment for malignant hyperthermia includes proper recognition of the signs and symptoms (Table 1) and timely intervention (Table 2).

- Those with known or suspected malignant hyperthermia can safely be administered regional anesthetics (spinal, epidural, or nerve blocks).

- Malignant Hyperthermia: Clinical signs
  - Unexplained tachycardia (90% of patients)
  - Unexplained tachypnea (85% of patients)
  - Sudden increase in end-tidal CO₂ (80% of patients)
  - Muscle rigidity, masseter muscle spasm or both (80% of patients)
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- Laboratory findings
  - Increased PaCO₂
  - Metabolic (lactic) acidosis
  - Evidence of rhabdomyolysis: hyperkalemia, increased plasma creatine kinase, and myoglobinemia and/or myoglobinuria
  - Abnormal coagulation tests

- Preventing operating room fires and electrosurgical safety

- Fire is an inherent risk in the operating room acknowledged by both the Joint Commission as well as the Association of PeriOperative Registered Nurses. The Joint Commission recently released a sentinel event alert related to operating room fire prevention and the Association published a guidance statement. Although there is no centralized database regarding operating room fires, it is estimated that at least 100 cases occur each year, resulting in at least one or two deaths.

- The Association of PeriOperative Registered Nurses has promoted the concept of the “fire triangle” to promote fire prevention (Fig. 4). The three corners of the triangle are an ignition source, fuel source, and oxidizers. Any strategy aimed at preventing operating room fires should target all corners of the triangle simultaneously. We recommend following the Association’s guidance statement on fire prevention in the operating room (Table 3).

- The use of open-delivery oxygen (e.g., via nasal cannula) should also be limited to less than 30 percent oxygen. Cuffed endotracheal tubes prevent the buildup of oxygen in the nasopharynx and should be used in procedures involving the mouth and oropharynx. This, however, may not be possible in pediatric cases. Surgeons should be aware that 100 percent oxygen delivered via nasal cannula or other open systems may collect under surgical drapes and cause a significant oxygen-rich environment and can support a fire. Therefore, communication with anesthesia to decrease oxygen when using electrocautery near an open oxygen source is imperative.

- Since its original description by William T. Bovie and Harvey Cushing in the 1920s, electrocautery has revolutionized the field of surgery. Despite considerable technical advancements in power generators, electrode design, and the advancement of surgical procedures, there still remains significant potential for error when electrocautery is used. A national survey of practicing otolaryngologists revealed 324 complications over the previous year related to electrosurgical instruments, including 219 direct burns, 48 burns through a metallic retractor or instrument, 13 grounding pad burns, 11 fires, and 32 cases of electromagnetic interference of pacemakers. There are also cases of flash fires caused by eye lubricant, skin burns from DuraPrep (3M, St. Paul, Minn.), as well as numerous endotracheal tube fires caused by electrocautery. Because of these risks, in 2005, Association of PeriOperative Registered Nurses published extensive guidelines regarding the safety of electrocautery, which are summarized here. All devices should have audible activation tones, modern dispersive electrode...
pads, and be isolated units. Burns at the site of the electrocautery pad have historically been the most common electrocautery-related injury, and this occurs when dispersion fails due to a pad with dry gel, an improperly sized pad, moisture under the pad, or positioning the pad over a tattoo, metal prosthesis, or a hairy or bony prominence. Therefore, nonaltered single-use dispersive electrode of an appropriate size for the patient should be placed on clean, dry skin overlying a well-perfused large muscle on the same side and near the surgical site. The active electrode should be kept in a clean, dry, well-insulated safety holster when not in use. A nonmetal clamp should be used if securing the device to drapery. Electrocautery should never be used in the presence of flammable substances. Pooling of alcohol-based preparations under drapes, in hair, or in fabric is particularly dangerous and should be avoided.19

LASER SAFETY

Laser safety is imperative given the frequency of use in plastic surgery. Safety considerations when using lasers must include protecting the patient, physician, and all other members in the room. In a thoughtful article, Rohrich et al. attempt to further clarify CO₂ laser safety is investigated by experimentally testing the flammability of CO₂ lasers on objects common in the operating field during resurfacing procedures. The objects tested include endotracheal tubes, towels, sponges, eye protectors, and ophthalmic ointment. Although neither flame nor burn occurred in any of the moistened preparations, the objects, when dry, routinely produced flame. Their recommendations include (1) avoiding the use of supplemental oxygen, (2) using protective eyewear for both patients (metal corneal protectors) and staff (protective glasses with eye shields), (3) using a plume evacuator, and (4) using moist towels around the laser field.26 Although experimental data do not exist for other types of lasers used in plastic surgery, we strongly advise following the above recommendations by Rohrich et al. Specific guidelines have also been published by the Association of PeriOperative Registered Nurses. These include: (1) all personnel should receive proper training; (2) a hazard zone should be delineated with appropriate signs; and (3) protective eyewear, matte or anodized surgical instruments, and local exhaust ventilation should be in place, and high-filtration surgical masks should be worn.27

SURGICAL SMOKE AND LASER PLUME

The health effects of surgical smoke remain a controversial issue. Surgical smoke is created by electrocautery, laser tissue ablation, and ultrasonic and harmonic tissue dissection. It is known to contain over 600 organic compounds, including benzene, hydrogen cyanide, formaldehyde, and viruses.28 Studies have demonstrated that the particulate matter generated can cause pathological damage when deposited in mammalian lungs.29,30 Currently, there are no mandates for control of surgical smoke. Specific recommendations published by the Association of PeriOperative Registered Nurses include using a combination of general room and local exhaust.
Table 3. Preventing Operating Room Fires

Ignition management
- Bovie, lasers, and fiber optic cables
  - Use lowest possible power setting
  - Place grounding electrode on a large muscle close to the site
  - Always use a Bovie safety holster
  - Do not use electrocautery in presence of flammable solutions
  - Do not use near oxygen or nitrous oxide
  - Ensure audible Bovie alarm tone is present
  - Do not activate in close proximity to another metal object that could conduct heat or cause arcing
  - Use a laser specific endotracheal tube if performing head, neck, or airway surgery
  - Do not use uncuffed endotracheal tubes in the presence of a laser or Bovie unit
  - Place light source on standby, or turn off when cable is not connected
  - Place light source away from flammable items
  - Do not place light cable that is connected to light source on drapes, sponges or other flammables

Fuel source management
- Linens, preparative solutions
  - Assess flammability of all materials used in, on, and around patient
  - Do not allow drapes to come in contact with the Bovie
  - Do not trap volatile chemicals or chemical fumes beneath drapes
  - Moisten towels and sponges that will be in close proximity to ignition sources
  - Ensure that oxygen does not accumulate beneath drapes
  - If drapes or linens ignite, smother out small fires with a wet sponge or towel
  - Use all flammable preparative solutions with caution
  - After preparation is applied, allow it to dry and fumes to dissipate and avoid pooling
  - Do not allow drapes to absorb preparative solutions
  - Do not use alcohol-based solutions to prepare the scalp when the head has not been shaved

Oxidizer management
- Oxygen and nitrous oxide
  - Use with caution in the presence of ignition sources
  - Ensure anesthesia circuits are free of leaks
  - Consider using throat packs to help retard oxygen and nitrous oxide levels
  - Use suction to help evacuate any accumulation of oxygen in body cavities, such as throat or chest
  - Do not use electrocautery unit or laser near flowing oxygen or nitrous oxide
  - Stop supplemental oxygen for one minute before using electrocautery or laser for head, neck, or upper chest procedures

Specific smoke evacuation systems. Local exhaust ventilation systems should always be placed at least 2 inches from where the smoke is being generated.27

INSTRUMENT COUNTS AND RETAINED SURGICAL ITEMS

A recent article estimated that in hospitals where 8000 to 18,000 cases are performed per year, there is at least one yearly incident of a retained surgical item.32 The likelihood of a retained surgical item is increased for patients having emergency surgery, unexpected change in surgical procedure, or a higher body mass index. The American College of Surgeons statement on prevention of retained foreign bodies after surgery is very similar to the guidelines developed by the Association of PeriOperative Registered Nurses, including increasing communication among operating personnel and consistently practicing reliable and standardized counting practices.33,34

This includes counting all sharps and sponges both before and after all procedures, documenting the sponge count on the patient’s intraoperative record, methodically exploring all wounds before closure, and employing radiograph technology when necessary. When the count is incorrect, the wound should be reopened and thoroughly explored. The full length and depth of the wound should be examined, and if the item is still not found, a radiograph should be obtained and reviewed by a radiologist before the patient leaves the operating room.31 The policy at our institution (The University of Wisconsin-Madison), which is derived from multiple sources, states that mandatory radiographs are obtained for cases in which more than 50 laps are opened, patients with high body mass index (>60 body mass index or >400 pounds), cases in which there is an unexpected change in procedure, emergent cases, and cases with an operating room time over 10 hours.35–39

BODY PIERCINGS

A patient’s piercings and associated metal jewelry present risks in the perioperative environment. For example, tongue piercings may snag on intubation equipment, damage dentition, or become a free foreign body in the airway. Other body jewelry may retain bacteria, increasing the chances of a surgical-site infection. Metal jewelry may conduct the current of electrocautery, creating the potential for burns. Pooling preparative solution around piercings, in an attempt to sanitize the jewelry, risks chemical burns or combustion, especially with genital piercings. Ideally, all piercings should be assessed for flammability and removed before a surgical procedure.
tensions should be removed, especially those near the surgical site, except for genital piercings that do not interfere with the planned procedure. Piercings that cannot be removed and remain a hazard should be secured with surgical tape to eliminate contact with the skin.

TOURNIQUET SAFETY FOR EXTREMITY SURGERY

The pneumatic tourniquet, used regularly in both upper- and lower-extremity surgery, is a device when used improperly is fraught with potential complications. For example, there are specific case reports attributing tourniquets to deep vein thromboembolism, pulmonary embolism, hypotension, rhabdomyolysis, and nerve injury.\textsuperscript{40–47} Owing to the fact that there are multiple components to the tourniquet, including an inflatable cuff, pressure source, pressure regulator, connective tubing, and pressure display, there are multiple opportunities for error. Plans for tourniquet use involve coordination between the surgeon, anesthesiologist, and circulating nurse. Both the anesthesiologist and nurse should be alerted before exsanguinations, inflation, and deflation.

Pneumatic tourniquets are potentially contraindicated in patients with impaired circulation, previous revascularization of the extremity, extremities with dialysis access, and those with a known venous thromboembolism.\textsuperscript{31} Regarding tourniquet placement, upper-arm, thigh, and calf tourniquets should be positioned at the point of maximal circumference proximal to the incision. Forearm tourniquets should be placed mid-forearm. Ankle tourniquets should be placed over the lower third of the lower leg with the distal edge of the cuff proximal to the malleoli.\textsuperscript{31} There has been much written regarding the minimal inflation cuff pressure to prevent arterial inflow while reducing the risk to nerves, muscles, and decreasing postoperative pain. Technically, each patient should be individualized based on the limb occlusion pressure. Limb occlusion pressure is calculated by determining, at the level where the cuff will be placed, the minimum pressure needed to occlude the peripheral pulse usually at the radial artery in the arm or the posterior tibial artery in the leg. Limb occlusion pressure is measured after the induction of anesthesia and blood pressure has stabilized by increasing cuff pressure until a peripheral pulse is absent for several heartbeats. A safety margin should then be added to the limb occlusion pressure. There are commercially available tourniquets that measure limb occlusion pressure and add the appropriate safety margin. Although measuring limb occlusion pressure is ideal, it is recognized that many plastic surgeons and upper-extremity surgeons do not routinely do this and use pressures, such as 250 mmHg, anecdotally determined by experience that prevents bleeding in the surgical field. When limb occlusion pressure is not used, the Association of PeriOperative Registered Nurses recommends the following inflation pressures for adult patients: 50 to 75 mmHg above the patient’s systolic blood pressure for the upper extremities and 100 to 150 mmHg above the patient’s systolic blood pressure for the lower extremities. For pediatric patients, the Association of PeriOperative Registered Nurses recommends the following inflation pressure: 100 mmHg above the patient’s systolic blood pressure for upper-extremity surgery.\textsuperscript{48} Before inflation, the limb should be exsanguinated first by elevating the limb and then actively using an elastic or esmark bandage. Exceptions to actively exsanguinating the extremity include the presence of malignancy, foreign body, and infection. In these instances, the limb should be elevated for several minutes to allow blood to passively leave the arm. Although tourniquet time should be individualized per patient, it is generally agreed upon that for the upper-extremity occlusion time should not exceed 2 hours and if more time is needed, the tourniquet should be deflated for 5 minutes per 30 minutes of inflation time.\textsuperscript{48}

PATIENT TRANSPORT AND HANDOFF

The Institute of Medicine’s report Crossing the Quality Chasm: A New Health System for the 21st Century identifies patient handoff as a point in transition in a patient’s clinical care potentially fraught with error.\textsuperscript{49} In 2006, The Joint Commission mandated standardized patient handoff as one of the National Patient Safety Goals. Relative to the operating room, the Joint Commission spe-

Table 4. Key Components of Patient Handoff As Mandated by the Joint Commission

- Interactive communications allowing for the opportunity for questioning between the giver and receiver of patient information
- Up-to-date information regarding the patient’s care, treatment and services, condition, and any recent or anticipated changes
- A process for verification of the received information, including repeat-back or read-back, as appropriate
- An opportunity for the receiver of the handoff information to review relevant patient historical data, which may include previous care, treatment, and services
- Interruptions during handoffs are limited to minimize the possibility that information would fail to be conveyed or would be forgotten

Table 4. Key Components of Patient Handoff As Mandated by the Joint Commission
cifically states that standardized handoffs must occur between both the circulating nurse and anesthesiologist in the operating room to the receiving postanesthesia care unit nurse. Though the specific handoff mechanism can be defined by the institution, per the Joint Commission, the components of the handoff must include the components summarized in Table 4.50 Our institution has recently employed the SBAR model of handoff, originally developed for use in the military, which

![SBAR report to physician about a critical situation](image)

**Situation**
- I am calling about <patient name and location>.
- The patient's code status is <code status>.
- The problem I am calling about is ____________________.
  - I am afraid the patient is going to arrest.

**Background**
- Vital signs are: Blood pressure _____/_____, Pulse _____, Respiration _____ and Temperature _____.
- I am concerned about the:
  - Blood pressure because it is over 200 or less than 100 or 30 mmHg below usual
  - Pulse because it is over 140 or less than 50
  - Respiration because it is less than 5 or over 40.
  - Temperature because it is less than 96 or over 104.

**Assessment**
- The patient’s mental status is:
  - Alert and oriented to person place and time.
  - Confused and cooperative or non-cooperative
  - Agitated or combative
  - Lethargic but conversant and able to swallow
  - Stuporous and not talking clearly and possibly not able to swallow
  - Comatose. Eyes closed. Not responding to stimulation.

**Recommendation**
- I suggest or request that you <say what you would like to see done>.
  - Transfer the patient to critical care.
  - Come to see the patient at this time.
  - Talk to the patient or family about code status.
  - Ask the on-call family practice resident to see the patient now.
  - Ask for a consultant to see the patient now.

**Are any tests needed?**
- Do you need any tests like CXR, ABG, EKG, CBC, or BMP?
  - Others?

**If a change in treatment is ordered then ask:**
- How often do you want vital signs?
- How long do you expect this problem will last?
- If the patient does not get better when would you want us to call again?

entails precisely communicating the situation, background, assessment, and recommendation (Fig. 5). We also use an operating room checklist designed to facilitate accurate and consistent handoffs between members of the healthcare team (Fig. 6). Though it is too early to measure the impact of this system, such efforts are paramount in preventing medical errors during periods of patient handoff.

CONCLUSIONS

In this article, the authors reviewed intraoperative risks facing patients during inpatient plastic surgery, including deep vein thromboembolism prophylaxis, hypothermia, malignant hyperthermia, electrosurgical safety, retained foreign bodies, patient jewelry, tourniquet use, postoperative communication, and handoffs. They built upon a previous article addressing issues in communication, research into adverse events, and preoperative risk assessment.

It cannot be overstated that clear communication is essential to minimizing preventable adverse events. Indeed, the majority of medical errors occur due to miscommunication between a single transmitter and a single receiver. Therefore, the responsibility for promoting and maintaining a culture of safety should be distributed among the patients, clinicians, and support staff, whose lives and livelihoods depend on it.

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