

Electrosurgical Considerations for the Patient with an Implanted Electronic Device

Implanted electronic devices (IEDs) are battery operated units placed within a patient's body to treat a physiological deficiency or replace a sensory function¹. Such technological advancements are utilized to improve the recipient's quality of life. Any malfunction or failure of the IED can result in injury or even death. Patients with IEDs provide a unique challenge to the perioperative team involved in their care, especially if a radiofrequency (RF) device is used during surgery.

The electrosurgical unit (ESU), a popular RF device and one of the most frequently used technologies in the operating room to cut, fulgurate and desiccate tissue, operates at radio frequencies in the 200 kHz to 3.3 MHz range. These high frequencies are required to avoid muscle and nerve stimulation, which cease above 100 kHz. By their nature of operation, ESUs have a high potential for interfering with other electromedical devices found in the operating room environment² and the potential to adversely affect IEDs.

Electromagnetic interference (EMI) is any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment³. The electromagnetic energy, especially associated with the high voltage coagulation mode, stemming from the ESU can result in the malfunction of some IEDs. As a result, the Valleylab Clinical Hotline frequently receives calls asking for guidance when the surgical patient presents with an IED. The goal is to provide optimal patient outcomes while maintaining a safe environment.

This newsletter will focus on general precautions and some

special considerations the perioperative team should consider when a patient with an IED is scheduled for surgery and it is likely that RF energy will be used. Due to the various types of IEDs currently available and rapid technological advancements, only the most common IEDs will be addressed.

Overview of Common IEDs

Examples of cardiac IEDs include permanent pacemakers used to treat profound bradycardia, ICDs used to treat life-threatening ventricular tachycardia or fibrillation, and ventricular assist devices (VADs) used to treat end-stage heart failure. Refer to the Clinical Hotline Newsletter, "Electrosurgery Safety Update—Pacemakers and Implantable Cardiac Defibrillators", Volume 7, Issue 3 for additional information on cardiac IED function and electrosurgical safety.

Neurological IEDs electrically stimulate the nervous system. Deep-brain stimulators (DBSs) treat movement disorders associated with Parkinson's disease. These devices use implanted leads in targeted areas of the brain that are connected to a programmable pulse generator.

A spinal cord stimulator (SCS) is a type of neurostimulator that employs electrodes implanted in the spine. It is used to control intractable pain, for sacral nerve stimulation to treat urinary urge incontinence or urinary retention, and for vagal nerve stimulation (VNS) to treat persistent seizures.

Another type of neurostimulator is a ventricular shunt that treats patients with hydrocephalus by transferring the excess cerebrospinal fluid from the brain to either the abdomen or



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chest. The programmable shunt allows surgeons to adjust the settings outside the body, thereby reducing the need for repeat surgeries.

There are a variety of implantable electronic hearing devices such as the cochlear implant, implanted bone conduction stimulator, implantable and semi-implantable hearing aids, and auditory brainstem implants, all of which assist in sound transmission. Many of these devices use both an implanted receiver/stimulator and an external component or processor.

The implanted infusion pump, another type of IED, delivers medication in specific dosages and intervals. These pumps are used to manage chronic pain, to administer chemotherapeutic agents, insulin and anticoagulants. The location of the infusion port and the implanted pump varies by patient and purpose of the treatment modality.

Osteogenic (bone-growth) stimulators are used to encourage bone growth in patients with recent fractures, with a non-union fracture or delayed healing of a fracture. Bone growth stimulators can be internal, external or a combination of the two, and use electrical, electromagnetic and ultrasonic energy.

The variety of IEDs can be overwhelming. Though functions differ, many devices share similarities, but are idiosyncratic in how they react to electromagnetic interference. The perioperative nurse should have a basic understanding of IEDs and their function, the potential safety hazards and appropriate interventions. In addition, it's important to know both general IED precautions and considerations and interventions specific to certain IEDs.

General IED Preoperative Considerations⁴

- **Ideally, the patient should disclose the presence of an IED during the interview when surgery is scheduled.** This allows for review of the IED product identification card and the opportunity to contact the surgeon who implanted the device. It is important to obtain and document on the medical record:
 - IED manufacturer, model and/or serial number
 - Location of the device
 - Date the device was implanted and last evaluated
 - Ability to turn the device off before or during surgery
 - Appropriate settings should the IED require reprogramming postoperatively
 - Contact information for implanting physician, who may request postoperative notification for IED evaluation
 - Anticipated use of electrosurgery (ES), monopolar or bipolar
 - If requested by the physician, notification of the IED representative that his or her presence is required before, during and after the procedure
 - Notification that the anesthesia provider was informed of the presence of an IED

General IED Intraoperative Considerations

- Inform perioperative team members the patient has an IED, review safety concerns, equipment interaction and possible interference.
- Ensure IED representative is present with access to programming device.
- Refer to the operator's manual supplied with the electrosurgical generator for contraindications and warnings.
- **Consult the IED manufacturer to determine if the device will be affected by the use of electrosurgery, and if so what are its recommendations. If the manufacturer cannot be contacted, such as in an emergency, use good nursing judgment and the following suggestions in order to provide the safest possible patient environment while minimizing damage to the implant or surrounding tissue.**
- If electrosurgery is necessary, suggest bipolar mode as opposed to monopolar. Bipolar uses low voltage and restricts the flow of current to between the two poles of the instrument, and does not flow through the patient. The disadvantage is that bipolar cannot spark to tissue, and the low voltage makes it less effective on large bleeders.
- If monopolar **must** be used:
 - Follow standard patient return electrode (PRE) placement guidelines
 - Place the PRE as close to the surgical site as possible, yet as far from the IED generator and wires as possible
 - PRE placement should maintain a perpendicular pathway for the current to travel. Make sure the current avoids passing through the IED and/or IED electrode array if present
 - Use low voltage waveforms such as pure cut, blend or desiccate with short activations
 - Avoid arcing the current between the active electrode and another surgical instrument (e.g., buzzing the hemostat), which can contribute to a higher incidence of EMI
 - Minimize the potential for interference resulting from leakage current, by keeping active cords and PRE cords away from the IED

General IED Postoperative Considerations

- Monitor the patient for signs of complications and/or IED malfunction possibly resulting from electromagnetic interference.
- If necessary re-establish function and/or appropriate program according to implanting physician, manufacturer or IED representative.
- Determine if postoperative function is the same as preoperative function. Have appropriate personnel adjust IED program as necessary.

IED Specific Electrosurgical Safety Considerations⁵

Implanted Device	Preoperative Patient Management	Intraoperative Patient Management	Postoperative Patient Management
Cardiac			
Pacemaker (PM) Implantable cardioverter defibrillator (ICD)	<ol style="list-style-type: none"> 1. Test programming, telemetry, thresholds and battery status if not done within the last six months. 2. If IED make and model is not known, a chest X-ray may help identify. 3. If PM-dependent, reprogram device to asynchronous mode unless otherwise directed. 4. PM and ICD adaptive-rate device features, should be programmed off. 5. PM magnet-activated testing should be programmed off. 6. Tachycardia sensing should be programmed off. 	<ol style="list-style-type: none"> 1. Bipolar electrosurgery is recommended. 2. Establish perpendicular current pathway to the PM lead system when possible, if monopolar ES must be used. 3. ESU may interfere with electrocardiogram (ECG) monitoring. Consider arterial line for monitoring blood pressure (BP) and heart rate. Check ECG monitor for arrhythmias or PM function when ESU is not in use. 4. If use of asynchronous mode is not possible and the ESU is adversely affecting the pacemaker, activate the ESU for one second at a time with 10 seconds between activations. 	<ol style="list-style-type: none"> 1. Inform patient's cardiologist that ESU was used during the surgical procedure. 2. Evaluation of IED should be done postoperatively and repeated at 24 and 48 hours.
Ventricular Assist Device (VAD)	<ol style="list-style-type: none"> 1. Refer to #1 and #2 above. 	<ol style="list-style-type: none"> 1. Refer to #1-3 above. 2. Place device in the fixed-rate mode for the duration of the surgery unless otherwise instructed. 3. Activate ES current for one second at a time with 10 second off cycle before reactivation. 4. Closely monitor cardiac output. 5. Have external hand pump immediately available. 	<ol style="list-style-type: none"> 1. Refer to #1 above. 2. Inform surgeon or cardiologist caring for the patient of any damage to the device.
Neurological			
Deep brain stimulator (DBS) Programmable ventricular shunt Vagal nerve stimulators (VNS) Spinal cord stimulator (SCS)	<ol style="list-style-type: none"> 1. Refer to general considerations. 	<ol style="list-style-type: none"> 1. Bipolar ES is recommended. 2. The device should be programmed off by the patient. If this is not possible, notify appropriate medical personnel or IED manufacturer. 3. If monopolar ES must be used, use low voltage waveform, low settings and short activations. 4. Place PRE as far away from IED as possible. 	<ol style="list-style-type: none"> 1. Reactivate the device if programmed off. 2. Confirm IED is functioning properly.
Sacral nerve stimulator	<ol style="list-style-type: none"> 1. Determine how the device functions and whether it can be turned off. 	<ol style="list-style-type: none"> 1. In addition to recommendations mentioned above, keep ES active electrode six inches from the implanted device including cables, metallic electrodes and all electrical components. 2. Large, reusable, capacitively coupled return electrodes should not be used. 	<ol style="list-style-type: none"> 1. Refer to #1 and #2 above.

IED Specific Electrosurgical Safety Considerations⁵, continued

Implanted Device	Preoperative Patient Management	Intraoperative Patient Management	Postoperative Patient Management
Implantable hearing devices			
Cochlear implants Auditory brainstem implant (ABI) Bone conduction stimulators	1. Refer to general considerations.	1. Remove any external devices after anesthesia induction. 2. Bipolar ES is recommended. 3. Bipolar instruments should be kept more than 10 cm from extracochlear electrodes. 4. Monopolar ES should not be used in the head and neck area. 5. For a patient with an ABI, keep the bipolar electrode from directly contacting the implant, Also keep it at least 1 cm from the ground electrode of the ABI.	1. Confirm device is functioning properly.
Implantable infusion pumps			
	1. Refer to general considerations.		
Osteogenic stimulators			
	1. Externally worn spine stimulators should be removed before the surgical procedure.	1. Monopolar ES is not recommended. 2. With the totally implanted bone growth stimulation system, electrode should remain connected. The generator should be removed from the tissues and placed outside the body until the procedure is complete. Replace following the procedure. 3. Ultrasonic scalpel is considered safe.	

Electrosurgery is a versatile and powerful tool used for a variety of surgical effects. When used safely, electrosurgery has the potential to contribute to positive patient outcomes. Conversely, electrosurgery has the ability to adversely affect IEDs meant to improve the patient's quality of life. In order to provide the patient with a safe environment, perioperative team members should be adequately trained in the use of electrosurgical equipment and knowledgeable about the specific IED and the associated precautions that need to be implemented.

Due to the number of IEDs currently available and the rapid introduction of new technology, this document is not comprehensive. To review the history, application, function and safety issues of the different IEDs, refer to the 2007 AORN Standards, Recommended Practices and Guidelines; Guidance

Statement: Care of the Perioperative Patient With an Implanted Electronic Device. To ensure the most accurate information with regard to the IED patient and the use of electrosurgery, it is **essential to contact the IED manufacturer for their recommendations governing their technology.**

- 1 Corexcel. 2 March 2007 http://www.corexcel.com/rw/html/body_electrosurgery_page4.htm
- 2 Valleylab Clinical Information HOTLINE News, Vol, 6, Issue 1, March 2001: "Electromagnetic Interference."
- 3 AORN Guidance Statement: Care of the Perioperative Patient With an Implanted Electronic Device; AORN Standards, Recommended Practices and Guidelines; (Denver: AORN, Inc, 2007) 273
- 4 Ibid., p. 274-275, 291.
- 5 Ibid., p. 275-295