Electrical Safety in the Operating Room

Perioperative Staff Education 01/04

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Education

- Required by JCAHO
- Required during orientation
- Annual review required
Electrical Hazards

- Fires
- Burns
- Electrical shock
- Explosions
- Power failure
Outcomes

- Damage to or malfunction of equipment
- Possibility of patient and staff injury, disability, or death
Electrical Shock

- Shock occurs when a person becomes the final component that closes a loop in which electrical current flows
Electrocution

- Electrocution occurs when the amount or path of the current flowing through the individual becomes lethal.
- Electrocution usually involves use of cord-connected equipment, contact with ground, and a moist or wet environment.
Electrical Terminology

- **Voltage** – electrical pressure
- **Amperage** – electrical flow rate
- **Impedance** – restriction to electrical flow (pipe friction)
- **Circuit** – path of flow of electricity
- **Fault** – current flow through an unintended path
Basic Rules of Electrical Action

- Electricity is not live until current flows.
- Electrical current will not flow until there is a complete loop, or circuit.
Grounding

- What is grounding? – a method of protection from electrical shock
- A ground is a conductive connection – between electrical circuit or equipment and earth – or to a conductive body which serves in place of earth
- Grounding creates a low resistance path to earth
Grounding

- All sorts of things, including people, can be grounded, or not grounded
- Grounding may be intentional or accidental
- Grounding some things are intentional so that when other things are accidentally grounded, the outcome can be controlled or predicted
Reasons for Grounding

- Protection from high voltages brought into the facility (e.g. lightning) that could cause arcing and fires
- Inexpensive, reliable, passive, and effective method of controlling hazards resulting from use of electricity
- To enable use of protective devices (fuses and circuit breakers) which will trip upon accidental line to ground faults
Three wire plug

- Ground prong is slightly longer
- This insures the ground connection is the first made when plug is inserted and the last to be broken when the plug is removed
Current Flow in Properly Grounded System
Fault in Properly Grounded Tool
Shock from Improperly Grounded Tool
Myths:

- Electricity wants to go to ground
- FALSE: Electrical current must return to its source; ground may or may not be a path to the source
Myths:

- Electricity is drawn to water
- FALSE: Water does not draw electricity. However, it is a conductor and does lower skin resistance.
Circuit Breakers

- Designed to interrupt relatively large fault currents
- Protect property by preventing fires from starting
- Can be reset; fuses must be replaced
- Ineffective at preventing shocks
Electrical Shocks

- Produced by current, not voltage
- Amount of current dependant on body resistance
- Human body resistance can range between 1000 ohms and 1,000,000 ohms, depending on body mass, moisture content, and area of contact
How much shock current?

- 1 milliampere (mA) – threshold of perception
- 10-20 mA – muscle contractions
- 50 mA – pain
- 100 mA to 4 Amperes – ventricular fibrillation, death
- Over 4 Amperes – severe burns
Macroshock vs Microshock

- Macroshock current is distributed somewhat evenly through body parts
- Microshock current path is through a single point, usually the heart
- Microshock can be fatal at levels that would be imperceptible if applied to skin
Macroshock

- Electrical current that leaks from a broken cord or piece of equipment
- Can range from a slight tingling sensation to stopping the heart
Macroshock

- When passing from hand to hand, only about 5% of the current passes through the heart.
- When passing from leg to leg, no current passes through the heart.
Microshock

- Term used to describe the very low level shocks that go undetected
- Dangerous to an “electrically sensitive” patient – patient with breaks in skin like abrasions, wet dressings, pacemakers, or monitoring lines connected to a transducer
Microshock

- Path of current with an intra-cardiac electrode
Codes and Standards

- NFPA No. 99 – fire, explosion, and electrical safety in hospitals
- National Electrical Code (NEC) Article 517 – defines types of patient care areas: General Care, Critical Care, and Wet Locations
Isolated Power Systems

- Isolated, ungrounded electrical distribution system
- Isolating transformer is needed to convert from the grounded power distribution system in the facility to an ungrounded electrical distribution system
- Connected electrical devices and equipment work just as if they were connected to a grounded system
Isolated Power

Isolated Power: No shock even though person is grounded
Majority of Shocks

This is the setting for the majority of electrical shocks.
Isolated Power Systems

- Line to line fault: Large fault current flows, circuit breaker trips and interrupts power to the circuit.
- Single line to ground fault: Fault current does not flow, circuit breaker does not trip, and only a hazard alarm sounds.
- Hazard alarm also sounds when hazard leakage current reaches 5 milliamperes (5 mA).
Isolated Power Panel

- Isolated Power Panel with transformer
- Two in each OR
- Isolated Power Panel for Lasers in corridor
Isolated Power Panel

- In our Operating Rooms, all equipment in the patient vicinity is powered from the Isolated Power Panels.
- Other nearby equipment such as overhead fluorescent lighting is powered from the grounded normal and emergency systems.
Line Isolation Monitor

- Continuously monitors line to ground impedance to detect leakage currents
- Goes into alarm when potential hazard current reaches 5mA
Line Isolation Monitor
Newer style of Line Isolation Monitor
Line Isolation Monitor Alarms

- Alarm does **NOT** mean imminent danger
- LIM alarm does not interrupt electrical service
- LIM alarm does not mean hazardous current is flowing; it only predicts that 5mA or more **could** flow from one conductor to ground if a path is provided
- LIM alarm means one layer of shock protection has been removed
LIM Alarms – what to do

- Do not interrupt care of patient
- Alarm can be silenced
- If hazard current is low, unplug unused equipment
- If plugging in equipment dramatically increases hazard current level, equipment or cord needs to be repaired
Line Isolation Monitor Alarms

- Pegged meter indicates line to ground fault connection
- Meter reading between 5-10mA indicates excessive leakage current, usually because too many pieces of equipment are plugged in at the same time
- In all cases, critical patient care needs should be attended to first, then resolve LIM alarm
Emergency Power

- Emergency receptacles are marked with **RED** color
- Upon power failure, emergency generator will automatically start and transfer the load within 10 seconds
- All power in Operating Rooms is connected to the emergency system
Emergency Power
Do’s

- Do plug equipment into wall receptacles with power switches in the off position
- Do unplug equipment by grasping the plug, not the cord
- Do check for frayed, cracked, or exposed wiring on equipment cords
Don’t

- Plug in equipment with wet hands
- Plug in equipment when cord is wet
Don’ts

- Don’t block access to electrical panels with carts and equipment
- Don’t plug equipment into defective receptacles
Don’ts

- Don’t drape cords over hot or sharp objects
- Don’t run cords where they cause a tripping hazard
- Don’t use extension cords unless authorized
Questions??