Electrical Safety in The Operating Theatre

An Essay
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By
Rafik Samir Wasfy Nagib Migally
(M.B.B.CH)

Under Supervision Of

Prof. Dr. Nermin Sadek Nasr

Professor of Anaesthesia and Intensive Care
Faculty of Medicine – Ain Shams University

Dr. Khaled Hassan Saad

Assistant Professor of Anaesthesia and Intensive Care
Faculty of Medicine – Ain Shams University

Dr. Neveen Girgis Fahmy

Lecturer of Anaesthesia and Intensive Care
Faculty of Medicine – Ain Shams University

Faculty of Medicine
Ain Shams University
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List of Abbreviations

°C	Celsius
µA	Microamper
µm	Micrometer
A	Amper
AC	Alternating current
AEDs	Automated External Defibrillators
AEM	Active Electrode Monitoring
AHA	American Heart Association
AICD	Automated Implanted Cardioverter-defibrillator
AIDS	Acquired Immunodeficiency Syndrome
ANSI	American National Standards Institute
ASA	American Society of Anesthesiologists
BTE	Biphasic truncated waveform
CEM	CUSA Electrosurgery Module
CO	Cardiac Output
CO2	Carbon dioxide
CPR	Cardiopulmonary resuscitation
CRT	Cardiac Resynchronization Therapy
CUSA	Ultrasonic Surgical Aspirator Standard System
CVP	Central venous pressure
DC	Direct current
ECG	Electrocardiogram
EEG	electroencephalographic
ELISA	Enzyme-linked immunosorbent assay
EMS	Emergency medical services
ESIS	Electrical Surgical Interference Supression
ESU	Electrosurgical Unit
ESWL	Extracorporeal Shock-Wave Lithotripsy
GFCI	Ground Fault Current Interrupter
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HIV	Human Immunodeficiency Virus
HPV	Human Papillomavirus
Hz	Hertz

List of Abbreviations (Cont.)

I	The current
ICD	Implantable cardioverter-defibrillator
IV	Intravenous
J	Joules
JCAHO	Joint Commission on Accreditation of Healthcare Organization
kHz	Kilohertz
Laser	Light Amplification by Stimulated Emission of Radiation
LCD	Liquid-Crystal Display
LIM	Line Isolation Monitor
mA	milliAmper
MAP	Mean arterial pressure
MHz	MicroHertz
MIS	Minimally Invasive Surgery
ml/min	milliliter per minute
mm	millimeter
mrem	millirems
MRI	Magnetic Resonance Imaging
mV	milliVolt
Nd-YAG	Neodymium-yttrium-aluminiumgarnet
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
O.R.	Operating Room
OSHA	Occupational Safety and Health Administration
P	Power
PACU	Post Anaesthesia Care Unit
PCI	percutaneous injury
PEP	Post-Exposure Prophylaxis
PPM	Parts Per Million
PVC	Premature Ventricular Contraction
R	Resistance
REM	Return Electrode Monitoring
Rem	roentgen equivalents man
RF	Radio Frequency

List of Abbreviations (Cont.)

RMS	Root-mean-square average
SA	Sinoatrial
SARS	Severe Acute Respiratory Syndrome
SVR	Systemic vascular resistance
TENS	Transcutaneous Electrical Nerve Stimulation
TJC	The Joint Commission
UK	United Kingdom
V	Voltage difference, Volt
VF	Ventricular Fibrillation

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Abstract

Since safety practices are important to emphasize, this essay will cover some of the electrical hazards in the operating room and discuss what might be done to eliminate these hazards. Static electricity can be a source of ignition in anaesthetic explosion **(Paul & Gavin, 2003).**

Macroshock refers to disturbances in neural or muscular function, or both, caused by the application of high voltage or current. Problems can arise if macroshocks occur near the heart, as in a fatal case when a patient's ECG (electrocardiogram) leads were accidentally attached to a power cord. However, macroshock can also cause injury if contact is made at locations remote from the heart.

Microshock is a risk in patients with intracardiac conductors, such as external pacemaker electrodes or saline filled catheters, within the heart. A current as low as 10 MicroAmpers directly through the heart, may send a patient directly into ventricular fibrillation **(Gross, 2005).**

The anaesthetist is in daily contact with a large amount of equipments which are powered by mains supply electricity. Some of these equipments are: diathermy, laser, Ligasure, Harmonic, defibrillator, pacemaker, monitoring equipment and laparoscopy.

The anaesthetist must be familiar with the operating controls and the ways in which the apparatus may malfunction or, if a recording instrument, gives rise to artefacts. These equipments are classified according to the means of protection they provide against electric shock arising from contract with the mains electricity supply. There are three classes for electromedical equipment, class I, class II and class III **(Graham Smith et al., 2001).**

The risk of electric shock can be greatly reduced if equipment is constructed and maintained to a suitable standard . The electrical hazards include electrical ground which means intentionally connecting the power source to earth ground. The electrical power to the home is grounded but to O.R is usually ungrounded, the electrical equipment is usually grounded. Isolated power system is another strategy for ensuring safety against electrical hazards. It has been accomplished by means of isolation transformers **(Wills et al., 2010).**

It is impossible to practice anesthesia without exposure to a number of potentially harmful environmental factors. Exposure to inhalation agents, transmissible diseases, and radiation are unavoidable in the operating room environment. Fortunately, the past several decades have produced a number of technical advancements and guidelines that serve to minimize the adverse effects of these occupational exposures. Efficient gas scavenger systems, needle-less systems, protect intravenous and post-exposure prophylaxis protocols are now commonplace in contemporary anesthesia practice. But while these measures all serve to minimize occupational exposure and risk, they do not completely eliminate them.

Protection against accidental fires and explosions in the operating room is done by isolation of fire triad. Tremendous care should be given for implementation of the protocols to deal with evacuation of the operating room, how to deal with the anesthetized patient and when to leave the operating room **(Dorre and William, 2007).**

In addition to environmental exposures, the access to potent opioids, the tradition of extended work hours, and the unique role the anesthesiologist plays in critical clinical situations contribute to the anesthesiologist's risk of chemical dependence, fatigue, and emotional distress **(Litt, 2005).**

Dorre N and William P., Environmental Safety Including Chemical Dependency, of Miller's Anesthesia, Seventh Edition, Ronald D. Miller, MD, Lars I. Eriksson, MD, PHD, Lee A. Fleisher, MD, Jeanine P. Wiener-Kronish, MD, William L. Young, MD, Section IX , chapter 101,pages 7-15, 2007.

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Rafik Samir Wasfy Nagib Migally

INTRODUCTION

Since safety practices are important to emphasize, this essay will cover some of the electrical hazards in the operating room and discuss what might be done to eliminate these hazards.

Static electricity can be a source of ignition in anaesthetic explosion.

It is important to study the heat production with increased current which is utilized in fuses, as well to study the electrical burns and its hazards.

Electrosurgical equipments depend on the concept of current density which controls the heating effect of these equipments.

Studying the electrical concepts of defibrillators, pace makers, electrocardiograms, electromyograms, and electro-encephalograms are mandatory to maximize patient safety **(Paul & Gavin, 2003,A).**

Electrical safety in the operating theatre is often regarded as being of historical interest only. The reality is that the theatre environment is becoming more electrically complex by the year **(Graham Smith et al., 2001).**

It is important to study as well the regulations (as NAVY regulations) to prevent electrical mishaps in the operation theatre **(Vlessides, 1997).**

As well studying the correct methods of installation and location of electrical equipments is important to prevent sparks or high temperature **(Dorsche and Dorsche, 1994).**

Overview of Electricity in The Operating Theatre

Static Electricity and Electrical Potential:

The word electricity is derived from electron, the Greece word of amber. In amber as well as all substances, the atoms consist of a positively charged nucleus surrounded by negatively charged electrons (Figure 1). Rubbing amber against another material may lead to a transfer of electrons, so that one of the substances will have an excess of them and the other a deficit. This phenomenon is known as static electricity which can be a source of ignition in anaesthetic explosions. It may also occur with other substances e.g. plastics and rubber.

The electrons in the substances with the excess then possess potential energy in the same manner that the height of an object determines its gravitational potential energy. This is known as the electric potential difference between the subject with the excess and that with the deficit **(Paul & Gavin, 2003,A).**

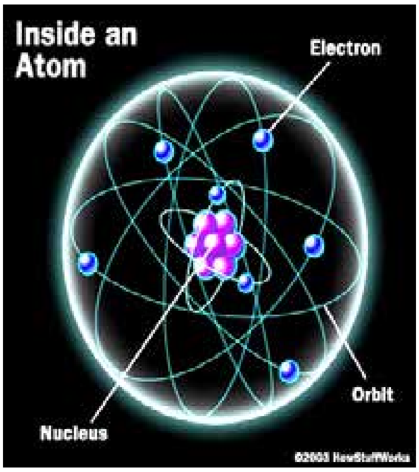

Figure 1: *Basic structure of an atom*

Properties of Electricity:

CURRENT =	Flow of electrons during a period of time, measured in amperes
CIRCUIT =	Pathway for the uninterrupted flow of electrons
VOLTAGE =	Force pushing current through the resistance, measured in volts
RESISTANCE =	Obstacle to the flow of current, measured in ohms (impedance = resistance)

Several properties of electricity must be understood in order to understand electrosurgery. Electrons orbit the nuclei of atoms. Current flow occurs when electrons flow from one atom to the orbit of an adjacent atom. Voltage is the "force" or "push" that provides electrons with the ability to travel from atom to atom. If electrons encounter resistance, heat will be produced. The resistance to electron flow is called impedance.

A completed circuit must be present in order for electrons to flow. A completed circuit is an intact pathway through which electrons can travel. In (figure 2), voltage is generated by the power company, providing the force to push electrons through the circuit. The original source of these electrons is the earth (ground). To complete the circuit the electrons must return to ground. Any grounded object can complete the circuit - allowing the electrons to flow to ground **(Graham Smith et al., 2001).**