SURGICAL SMOKE

AORN
SAFE SURGERY TOGETHER

1007

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MEDICAL ABBREVIATIONS & ACRONYMS

AQI – Air quality index
BPV – Bovine papillomavirus
CO_2 – Carbon dioxide
dBA – A-weighted decibels
ESU – Electrosurgical unit
FDA – US Food and Drug Administration
HEPA – High-efficiency particulate air
HIV – Human immunodeficiency virus
HPV – Human papillomavirus
LASIK – Laser in-situ keratomileusis
µm - Micrometer
NIOSH – National Institute for Occupational Safety and Health
OR – Operating room
OSHA – Occupational Safety and Health Administration
PAH – Polycyclic aromatic hydrocarbon
PCR – Polymerase chain reaction
PPE – Personal protective equipment
RRP – Recurrent respiratory papillomatosis
SWPF – Simulated workplace protection factor
UFP – Ultrafine particle
ULPA – Ultra-low particulate air

GUIDELINE FOR SURGICAL SMOKE SAFETY

The Guideline for Surgical Smoke Safety was approved by the AORN Guidelines Advisory Board and became effective December 15, 2016. It was presented as a proposed guideline for comments by members and others. The recommendations in the guideline are intended to be achievable and represent what is believed to be an optimal level of practice. Policies and procedures will reflect variations in practice settings and/or clinical situations that determine the degree to which the guideline can be implemented. AORN recognizes the many diverse settings in which perioperative nurses practice; therefore, this guideline is adaptable to all areas where operative or other invasive procedures may be performed.

Purpose

This document provides guidance on **surgical smoke** safety precautions to help the perioperative team establish a safe environment for the surgical patient and team members through consistent use of control measures.

Surgical smoke is the by-product of use of energy-generating devices (eg, electrosurgery units, lasers, powered instruments).[1] When surgical energy devices raise intracellular temperatures to 100° C (212° F) or higher, the tissue vaporizes, producing surgical smoke.[2] This gaseous by-product is visible and malodorous.[3] Surgical smoke may contain gaseous toxic compounds (eg, **hydrogen cyanide**, toluene, benzene), bio-aerosols, viruses (eg, human papilloma virus [HPV], human immunodeficiency virus [HIV]),[3] viable cancer cells, non-viable particles (ie, lung damaging dust of 0.5 µm to 5.0 µm), carbonized tissue,[3] blood fragments, and bacteria. The water vapor content of surgical smoke ranges from 1% to 11%[4] and serves as a carrier for the compounds, viruses, and other substances. Researchers began analyzing the contents of surgical smoke in the early 1980s. In a 1981 study, Tomita et al[5] found that the contents of surgical smoke are similar to the contents of cigarettes, with known and suspected carcinogens and mutagens.

Electrosurgical devices use radio-frequency current to cut and coagulate. Heat is generated in the body tissue through which the current passes. The heat causes cell walls to explode, releasing the cellular fluid as steam and the cell contents into the air, forming surgical smoke. Lasers produce an intense, coherent, directional beam of light and also produce high heat, which raises the temperature within the cell, vaporizing the contents and releasing steam and cell contents.[1] Ultrasonic devices remove tissue by rapid mechanical action. Ultrasonic aspirators produce a fine mist, and ultrasonic scalpels produce a vapor.[1] High-speed electrical devices (eg, bone saws, drills) cut, dissect, and resect tissue. The mechanical action of the saw or drill combined with irrigation fluid used to cool the device produces aerosols that may contain viable bloodborne pathogens.[1]

The Occupational Safety and Health Administration (OSHA) has estimated that more than 500,000 health care workers are exposed to surgical smoke every year.[6] Perioperative nurses report twice the incidence of many respiratory problems compared to the general population.[7,8] Case reports have established the link between inhalation of surgical smoke during excision of anogenital condylomata procedures to transmission of HPV to health care providers.[9-11] For example, a laser surgeon developed laryngeal papillomatosis of the same virus type as his patient,[10] and experts at a virological institute confirmed a high probability of occupational exposure in a gynecologic perioperative nurse who developed recurrent and histologically proven laryngeal papillomatosis.[9]

Surgical smoke exposure is also hazardous to patients. Risks to patients include loss of visibility in the surgical field during minimally invasive procedures[12-18] with potential to delay the procedure,[19-22] port site metastasis,[23] exposure to carbon monoxide,[22,24,25] and increased levels of carboxyhemoglobin.[22,24]

AORN, the National Institute for Occupational Safety and Health (NIOSH),[26] and other professional organizations[27-31] have recommended surgical smoke evacuation for more than 20 years. Perioperative team members continue to demonstrate a lack of knowledge of the hazards of surgical smoke[32-34] and a lack of compliance in evacuating surgical smoke.[8,32,33,35] Even though smoke generated by electrosurgery[5] is more hazardous than laser-generated surgical smoke, there is greater compliance with smoke evacuation for laser procedures.[36,37]

Surgical smoke is often referred to as *surgical plume, smoke plume, bio-aerosols,* ***laser-generated airborne contaminants,*** and ***lung-damaging dust.*** For the purpose of this document, the term *surgical smoke* will be used unless another term has been specifically used in a reference source.

Evidence Review

A medical librarian conducted systematic searches of the databases MEDLINE®, CINAHL®, Scopus®, and the Cochrane Database of Systematic Reviews. Results were limited to literature published in English from January 1985 to November 2015. During the development of the guideline, the lead author requested additional articles that either did