Empowering Nurse Executives to Advocate for Surgical Smoke–Free Operating Rooms

Rebecca Vortman, DNP, RN, CNOR and Janet Thorlton, PhD, MS, RN

Evacuating surgical smoke in the operating room protects patients and perioperative teams from the hazards associated with inhaling surgical smoke. States have passed bills mandating health care facilities and ambulatory surgery centers adopt policies to evacuate surgical smoke. We use a 5-step process for identifying options to reduce exposure to the harmful toxins found in surgical smoke and recommend executive nurse leaders collaborate with states and professional organizations to pursue smoke evacuation legislation. This strategy empowers executive nurse leaders and perioperative teams to work with professional organizations and state legislators to reduce exposure to the harmful health hazards associated from surgical smoke.

Surgical smoke is generated when using electrocautery, lasers, and ultrasonic devices during surgical procedures.[1] Findings from the Health and Safety Practices Survey of Healthcare Workers (N = 4500) indicated that only half of the respondents used local exhaust ventilation of surgical smoke during laser procedures and that they had never received training on its hazards.[2] Over 500,000 perioperative workers (i.e., surgeons, anesthesiologists, nurses, scrub techs, and others working in the perioperative area) are exposed to the hazardous byproducts of surgical smoke each year; however, precautionary practices incorporating standard use of smoke evacuation devices are lacking.[3] These byproducts can contain a variety of toxic chemical compounds (e.g., benzene, toluene, hydrogen cyanide), viruses, known carcinogens,[4] and hazardous particles that are not adequately filtered with regular surgical masks.[5] The same toxins found in surgical smoke are also found in unfiltered cigarettes.[6] Surgical smoke exposure is equated to smoking 27 to 30 unfiltered tobacco cigarettes,[7] with perioperative teams reporting twice as many respiratory health issues (e.g., headache, watery eyes, cough, rhinitis, sore throat, sneezing) as the general public.[8] An emerging concern from perioperative teams and executive nurse leaders is the unknown hazards found in surgical smoke during electrosurgery and laparoscopic procedures when caring for COVID-19 patients in the operating room (OR) suite. Because of this concern, the American College of Surgeons[9] released a statement recommending surgeons use surgical smoke evacuation devices during procedures using electrocautery.

In this paper, using Teitelbaum and Wilensky's policy analysis 5-step framework,[10] we define the problem. Next, we provide factual background information and discuss the overall context for the analysis by identifying key stakeholders and economic, legal, ethical, political, and practical factors for nurse executives to consider when analyzing the problem of surgical smoke in their facilities. We describe and analyze several options to address this problem and conclude with a recommendation for the best action for nurse executives to pursue (*Figure 1*). By conducting this

KEY POINTS

- **Surgical smoke exposure is equated to smoking 27 to 30 unfiltered cigarettes, and perioperative teams report twice as many respiratory health issues than the general public.**
- **Nurse executives should advocate for surgical smoke evacuation legislation and create policies at their facilities to mitigate surgical smoke.**
- **We recommend that states enact laws requiring facilities to adopt policies and procedures to evacuate surgical smoke.**

Figure 1. Five-Step Framework. Adaptation of Teitelbaum and Wilensky's 5-step framework for policy analysis.[10]

policy analysis, we are able to increase awareness of the problem perioperative team members are faced with and provide an analysis of the issue to nurse executives who are in a position to advocate for surgical smoke evacuation practice in their facilities.

PROBLEM STATEMENT AND BACKGROUND

Although surgical smoke exposure is not considered an immediate health hazard, perioperative team members should be aware of potential long-term risks associated with cumulative exposure.[11] Therefore, to protect the health of patients and perioperative teams, what actions should nurse executives and policy makers take to limit surgical smoke exposure?

The Association of periOperative Registered Nurses (AORN) recommends organizations provide a surgical smoke–free environment by using smoke evacuator systems.[12] In April 2020, the American College of Surgeons[9] urged physicians to use smoke evacuation devices when using electrocautery because the risk of COVID-19 exposure in surgical smoke is currently unknown.[9] Despite numerous studies linking the associated health problems faced by patients and perioperative teams,[2,7,11,13] the only standard for surgical smoke evacuation is described in the Occupational Safety and Healthcare Act of 1970, which indicates employers shall furnish a place of employment that is free from recognizable hazards that cause or are likely to cause death or serious physical harm.[14]

In a survey conducted by the National Institute for Occupational Safety and Health (NIOSH), investigators determined surgical smoke guidelines are not followed despite long-standing guidelines for best practice, implying surgical smoke evacuation may not be a priority.[2,3] Half of these respondents reported a lack of training on the hazards of surgical smoke, and only 15% reported that local exhaust ventilation was consistently used in electrosurgery procedures.[2,3]

LANDSCAPE AND KEY FACTORS

Professional health care organizations strive to keep patients and health care providers safe during the patient–provider care interaction. For policymakers and nurse executives to better understand the overall context of surgical smoke evacuation legislation, we next present key stakeholders and relevant factors necessary for making informed decisions about surgical smoke evacuation.

The Joint Commission

The Joint Commission (TJC) is a not-for-profit organization accrediting over 22,000 health care organizations and programs in the United States, for those demonstrating compliance with performance standards for delivering high quality, safe care.[15] TJC has environment of care standards requiring hospitals to minimize risks when using hazardous energy sources specific to those produced by ionizing (radiation, x-ray) and nonionizing equipment (lasers, magnetic resonance imaging devices).[15]

Association of periOperative Registered Nurses

AORN, and its membership of over 43,000 registered nurses, manage, teach, and practice perioperative nursing. The AORN is the leader in advocating for excellence in perioperative practice and health care. This organization establishes standards and guidelines, while advocating for perioperative teams and patients by lobbying for bills that promote safe surgical practices. The AORN Foundation recently partnered with the world's largest medical device company to launch the AORN Go Clear Award recognition programs for organizations committing to ensuring smoke-free surgical environments.[16] Figure 2 depicts the number of award recipients, by state, for the facilities receiving it, illustrating the influence of this organization.

American Nurses Association

The American Nurses Association (ANA) is the leading professional nursing organization, advocating for 4 million registered nurses across the United States.[17] The ANA advocates on issues that affect nurses and the public, and promotes high standards of nursing care and safe, ethical work environments, while encouraging the health and wellness of nurses.[17] The ANA believes every nurse has a fundamental right to work in healthy environments that include physical, mental, and social wellbeing for optimal health and safety.[17] In 2017, the ANA began the campaign Healthy Nurse, Healthy Nation Grand Challenge, which focuses on safeguarding the health of nurses who are caring for the nation and believes these nurses should not be exposed to ill health as a derivative of the nursing environment.[18]

Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA) is an agency of the US Department of Labor,

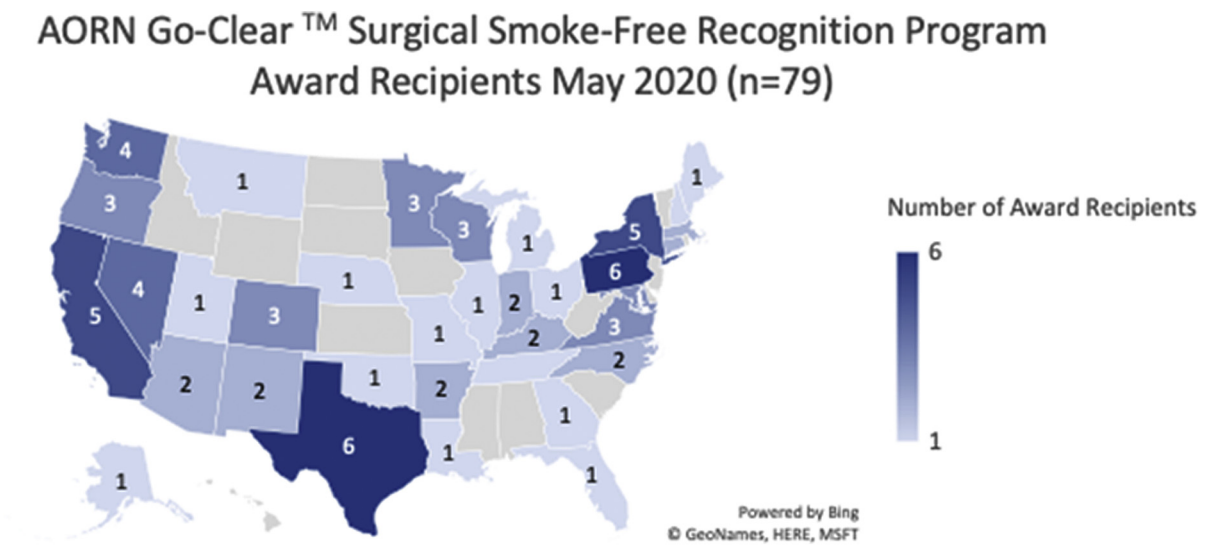

Figure 2. AORN Go Clear Surgical Smoke-Free Recognition Program Award RecipientsData are from AORN Safe Surgery Together.[16]

whose mission is to ensure employers provide safe and healthy working conditions for their employees.[19] Currently, OSHA does not have a specific standard addressing inhalation hazards of surgical smoke exposure; however, a general duty clause requires employers to provide a work environment free of recognized hazards that may cause serious physical harm or death.[14]

American National Standards Institute

American National Standards Institute (ANSI) is a not-for-profit organization whose mission is to enhance global competitiveness and quality of life by supporting standards and ensuring the safety of health care consumers and the environment.[20] ANSI released standards related to the safe use of lasers and recommends smoke evacuation devices be used during procedures involving lasers.[20]

National Institute for Occupational Safety and Health

NIOSH is the federal agency charged with conducting research and making recommendations for the prevention of work-related injury and illness.[2] NIOSH, a division of the Centers for Disease Control and Prevention, mandates that employees be provided safe and healthy working conditions. NIOSH supports and recommends local exhaust ventilation to control perioperative team exposure to surgical smoke.[2]

International Council on Surgical Plume

The International Council on Surgical Plume (ICSP) is a nonprofit, clinical advocacy organization focused on forming strategic partnerships to ensure a safe, smoke/plume-free environment for perioperative teams and patients, nationally and internationally. Their mission is to eliminate surgical smoke/plume exposure by supporting surgical smoke research, the development of standards and legislation, and developing effective surgical smoke mitigation strategies.[21]

Health Care Workers and Facilities

Some facilities execute policies enforcing the evacuation of surgical smoke for laser procedures, but omit polices for energy generating devices (i.e., electrocautery). Even with effective policies, procedures, and increased awareness, barriers to smoke evacuation compliance persist for perioperative teams, including lack of managerial support, surgeon refusal, personnel attitudes, inadequate amount of smoke evacuation devices, poor smoke evacuation system design, and limited education.[22] Smoke toxins generated from electrosurgery are equivalent to smoking 6 unfiltered cigarettes,[6] whereas smoke produced during plastic and reconstructive procedures was equivalent to smoking 27 to 30 cigarettes.[7]

Smoke Evacuation Market

This market is estimated to reach US$154 million by 2025.[23] Increased product availability, increasing preference for minimally invasive surgeries, and wider acceptance and availability of OR protocols/guidelines for smoke evacuation systems are the major factors driving the growth of this market. Smoke evacuation product companies are supportive and willing to educate perioperative teams on the hazards associated with surgical smoke and safe smoke evacuation device use.[23]

Consumers

Patients undergoing surgical procedures may be unaware of the harmful hazards associated with surgical

smoke. Although the perioperative team is exposed to surgical smoke for longer periods than patients, exposure remains a valid concern for patients undergoing surgery. A responsibility of the perioperative team is to provide safe care to patients, which can be partially accomplished by evacuating surgical smoke, thereby reducing exposure to harmful toxins found in surgical smoke. For example, during laparoscopic procedures, surgical smoke is absorbed through the patient's peritoneal membrane and can cause an increase in carboxyhemoglobin and methemoglobin, leading to reduction or depletion of the oxygen-carrying capacity of red blood cells.[24] In turn, the increased amount of carboxyhemoglobin and methemoglobin may cause false pulse oximeter elevation leading to unrecognized signs and symptoms of hypoxia.[25] Likewise, surgical smoke may cause the surgeon to experience loss of visibility in the surgical field and may lead to prolonged procedures and deadly patient outcomes.[26]

KEY FACTORS

Next, we examine economic, practical, political, and legal factors as they relate to the stakeholders described for policy makers and nurse executive awareness.

Economic Factors

The cost of using smoke evacuation devices is estimated at US$19 per surgical procedure.[13] Ultra-low particulate air filters found in smoke evacuators cost approximately US$25 per case.[27] A small hospital conducting approximately 80 procedures monthly reported costs associated with surgical smoke implementation. Electrosurgery pencils assembled with smoke evacuation tubing cost approximately US$20 in comparison to the US$5 cost of the standard electrosurgery pencil made without smoke evacuation tubing. Additionally, laparoscopic smoke evacuation tubing costs US$25 per device. The investigators reported US$27,000 in added expenses for implementing electrosurgery pencils and laparoscopic smoke evacuation devices.[28] The exact cost of health care–related expenses associated with the incidence of surgical smoke–related illness and lost days of work is unknown and worth exploring. The cost of implementing smoke evacuation supplies is a significantly small price to pay in comparison to sick days and health care–related expenses to treat illnesses associated from surgical smoke exposure. Illness related loss of productivity in the US workforce is estimated at US$530 billion annually.[29]

Practical Factors

Numerous countries such as Denmark, Canada, New Zealand, and Australia have adopted surgical smoke evacuation laws.[30] These laws help to ensure patients and the perioperative team experience the least amount of exposure to health hazards associated with surgical smoke. Rhode Island and Colorado recently enacted laws requiring facilities to adopt policies and procedures to evacuate surgical smoke and are anticipated to minimally increase staff workload.[31,32] Without laws mandating surgical smoke evacuation procedures, teams and patients may remain at risk for surgical smoke–related illnesses.

Ethical and Legal Factors

Perioperative teams working in states that have passed smoke evacuation laws are at an advantage compared to those who do not live in a state with these laws. National and international organizations supporting surgical smoke evacuation in every OR are making progress; however, it is up to each organization to mandate, unless legislation has been passed at the state level.[33] Perioperative teams working in underserved areas with scarce resources may have difficulty locating funding to purchase smoke evacuation equipment. The passage of surgical smoke evacuation laws propagates the inequality of those who are working in areas with limited financial resources; however, this does not mean surgical smoke evacuation should be halted.

Political Factors

In 2018, Rhode Island was the first state to enact a surgical smoke evacuation law, with Colorado following in 2019.[34] Between January and April 2020, a total of 8 states (Oregon, Utah, Iowa, Illinois, Kentucky, Tennessee, Georgia, and Connecticut) introduced surgical smoke evacuation legislation without bill passage.[34] Despite legislation being introduced in 8 states, most of the United States has not enacted laws designed to protect against the hazards of surgical smoke exposure. For example, Oregon's bill encountered hurdles because very few complaints and issues were reported to the Oregon Occupational Safety and Health Administration, which may have prevented the bill from passing.[34]

There may be a mix of supporters and opposers when considering political factors. For example, 1 orthopedic surgeon believes his 40-year exposure to surgical smoke to be the cause of his pulmonary fibrosis diagnosis requiring a double lung transplant.[35] This surgeon is advocating and spreading awareness of his condition and the dangers of outpatient surgical smoke exposure.[35] Findings from 1 study concluded there is no safe level of surgical smoke exposure, yet surgeons experienced practical difficulties (noise, distraction, limited space) when using smoke evacuation devices.[36] However, newer devices mimic standard pencils and offer reduced noise disturbance.[28] One physician opposed the Rhode Island law, stating it was reactionary and excluded costs and the learning curve

Table 1. Surgical Smoke Evacuation Policy Options

Criteria	Option 1: Health Care Facilities Adopt Individual Policies and Procedures	Option 2: Individual States Enact Smoke Evacuation Laws	Option 3: "Do Nothing" Approach
Ability to address the problem	+	++	–
Timeliness	+	+	–
Cost	++	++	++
Political feasibility	++	++	–
Score for each option	6	7	2

Note: This is the authors' assessment of options.
++, high or favorable; +, moderate or fair; –, weak or minimal.

experienced by surgeons adjusting to using smoke evacuation systems.[37] Researchers conducted a survey of surgeons in hospitals and outpatient facilities, and found the low response of surgical smoke evacuation practices are a result of lack of knowledge about surgical smoke, smoke evacuation practices, and disinterest in the issue.[38] Reasons reported for lack of use included a misconception among surgeons that surgical smoke is harmless and that past surgical smoke evacuation devices were loud and designed with bulky tubing.[34]

In Siegel v. California Pacific Medical Center,[39] an OR nurse with a history of surgical smoke exposure was diagnosed with asthma and received medical restrictions prohibiting future exposure to surgical smoke because it would exacerbate her respiratory condition. The plaintiff lost this case because the health care facility was found to be accommodating of the plaintiff's illness and work-related restrictions. Although there are few surgical smoke exposure court cases initiated by health care providers, employers and nurse executives must recognize the potential for litigation as surgical smoke evacuation becomes a priority for perioperative team members and consumers.

POLICY OPTIONS

Minor progress has been made for mandating surgical smoke evacuation in hospitals and ambulatory surgery centers. Rhode Island and Colorado have adopted laws; however, most states are lagging in adopting such laws, leaving it up to health care facilities to implement surgical smoke evacuation into their policies and procedures.[33] Next, we propose 3 options for addressing this important issue, and discuss pros and cons of each. Table 1 offers a matrix for comparing these options.

Option 1: Health Care Facilities Develop and Institute Surgical Smoke Evacuation Policies and Procedures That Promote a Safe Perioperative Environment

As states pass smoke evacuation laws this will be inevitable. Implementing the recommended guidelines for surgical smoke evacuation requires a time commitment for OR leaders. A variety of factors (e.g., awareness of the issue, perceived importance, facility size, surgeon preference, etc.) can impact the decision to independently adopt smoke evacuation policies. Even with policies and procedures in place, perioperative teams may opt to use standard electrosurgery devices instead of those designed to evacuate the surgical smoke.

Several reasons perioperative teams choose standard electrosurgery devices were explained in the HB 2901 Relating to Surgical Smoke hearing by the Oregon House Committee on Healthcare. Bill supporters discussed reasons to be lack of smoke device training and awareness, perioperative team resistance to change, and lack of regulatory bodies governing the practice.[40] Likewise, Scroggins[41] points out that perioperative team members and health care facilities may be against smoke evacuation devices because of refusal to accept the data and to overcoming the barriers and obstacles that exist to implement smoke evacuation devices. Option 1 does not feasibly address the problem in states that have not enacted surgical smoke evacuation bills designed to protect perioperative teams and patients.

One negative aspect for employers and nurse executives is the cost to purchase the equipment to evacuate surgical smoke. Equipment costs will vary by facility size; however, facilities should expect to spend US$25,000 minimum for the electrosurgery pencil, laparoscopic smoke evacuation tubing, and filters.[28]

Option 1 involves gaining buy-in from the perioperative team and facility administrators. Nurse and physician champions can assist with planning and implementing the project, providing data and educational resources to the perioperative team.[28] This option is reasonable for eliminating surgical smoke exposure for patients and the perioperative team; however, this option does not ensure every facility will implement surgical smoke evacuation–recommended practices.

Option 2: Individual States Enact Smoke Evacuation Laws

Rhode Island's HB 19-1041 and Colorado's H7082 serve as excellent exemplars for states wishing to propose similar bills. Enacting bills addresses the problem because it mandates health care facilities and ambulatory surgery centers to adopt and implement a policy requiring the use of surgical smoke evacuation systems during any procedure using energy-generating devices.[31,32]

In comparison to the 4 decades of research, recommended practices and standards, and spreading awareness to the health care community, the process of taking political action is achieved in a reasonable time frame. The political feasibility is appropriate considering surgical smoke evacuation is a safe and a recommended practice to ensure the perioperative team and patients are breathing clean air in the OR.[12] It is important to note that as health care facilities are required to implement smoke evacuation devices, the smoke evacuation device manufacturers may receive financial gain through increased sales of their products. Additionally, this option leaves it up to activist groups, such as state and national nursing associations with the support of engaged health care providers and nurse executives, to execute the process of getting a bill introduced. Perioperative teams are in the best position to advocate for smoke evacuation laws because they have a strong voice and testimonies to share with state legislators.

When looking at the time the bill is introduced to time of the bill passing, the process can move timely or slowly depending on when the general assembly adjourns and the proposed bill completing the legislative process, which varied when looking at Rhode Island and Colorado's smoke evacuation legislation. In Rhode Island, legislation was first introduced in 2017, passing on the Senate floors, except that the General Assembly adjourned before the bill completed the legislative process.[42] In Colorado, the process was timely because the bill was introduced in January 2019 and passed roughly 2 months later.[32] Likewise, in Rhode Island, the bill was introduced for a second time on January 10, 2018, and passed on June 2018.[31] Even if legislation is introduced, the proposed bill may not move through the entire legislative process.

Option 3: "Do Nothing" Approach

When organizations choose to "do nothing," this will result in an elimination of the expenses associated with implementing surgical smoke evacuation; however, the cost associated from surgical smoke–related illnesses may outweigh the expenses of surgical smoke evacuation devices. Health care facilities choosing to do nothing are refrained from shifting resources to train and educate perioperative teams on the usage of smoke evacuation devices. For individuals in opposition of surgical smoke evacuation, doing nothing may be viewed as a positive aspect because it requires no change in practice or need for additional resources to implement recommended practices. For example, in a newsletter published by Becker's ASC Review, a physician expressed opposition to Rhode Island's smoke evacuation policy because of the added cost to implement and the additional learning curve for surgeons who are required to use the surgical smoke evacuation devices.[37]

When government officials, health care administration, and perioperative teams follow the status quo of do nothing, this circumvents the ability to address the problem. When health care organization choose to follow the status quo, it will prolong the problem, making it more challenging to move recommended practices forward. The political feasibility of taking no action could be viewed as not a political and organizational priority. There is no harm linked with using smoke evacuation devices; however, there is the potential for harm to perioperative teams and patients when surgical smoke evacuation devices are not implemented during surgical procedures. Lack of policies and procedures at health care facilities may open doors for class action lawsuits associated with individual illness to perioperative team members and patients caused by exposure to surgical smoke.[27] The main point of evacuating smoke is to decrease risk of exposure to the toxins found in surgical smoke. Health care facilities and nurse executives should also consider the financial ramifications associated from litigation of injured health care workers from surgical smoke exposure.

RECOMMENDATION

We recommend Option 2: individual states enact smoke evacuation laws requiring facilities to adopt policies and procedures to evacuate surgical smoke. This option is feasible and potentially cost-effective, because evacuating smoke may reduce the number of illnesses incurred from surgical smoke. Moreover, perioperative teams, executive nurse leaders, administrators, and professional organizations are best suited to collaborate with state legislators, given their extensive knowledge and experience surrounding the challenges associated with surgical smoke. Perioperative teams are prime candidates to attend committee

hearings and share best practices and individual testimonies with legislators. Perioperative teams and leaders are knowledgeable about surgical smoke evacuation devices and can facilitate discussions in support of proposed bills. Before activist groups introduce proposed smoke evacuation bills, we recommend each state conduct a thorough review of Rhode Island and Colorado's bills and use both bills as a model when introducing smoke evacuation bills to state legislatures. We recommend each bill contain definitions of surgical smoke and surgical smoke evacuation systems, and to specify pertinent facilities (e.g., hospitals, ambulatory surgery centers). We also recommend the bill include a statement requiring either onsite inspections to ensure compliance and/or the health care facilities report to a specified state department their proof of compliance. The Rhode Island Act requires health care facilities to report to the Department of Public Health within 90 days of the signed Act showing policies are in accordance with law.[31] Oregon HB 2901 proposes onsite inspections to ensure compliance.[40] Rhode Island and Colorado laws offer clear definitions and specify the health care facilities that must be in accordance with the law.[31,32]

CONCLUSION

A plethora of studies have been conducted since the 1980s that illuminate the harmful toxins associated with surgical smoke. The hazardous toxins found in heat-producing energy devices (e.g., electrosurgery, lasers, ultrasonic devices) have been consistently confirmed; however, the incidence of the long-term effects are difficult to study and it is unethical to conduct studies that expose one group of subjects to surgical smoke and another group of participants in procedures with evacuation equipment. Two states have enacted smoke evacuation laws since 2018, and these laws may serve as models for other states. Enacting similar laws would eliminate perioperative team and patient exposure to surgical smoke where energy-generating devices are used. Additionally, this may prevent illnesses related to surgical smoke exposure and increase staff productivity by decreasing sick days for surgical smoke–related illness. Adopting surgical smoke evacuation laws should be a priority for every state legislator and nurse executive across the nation in partnership with professional organizations, regulatory agencies, health care facility administrators, and perioperative teams, and is needed now more than ever during the COVID-19 pandemic. In response to the ANA's Healthy Nurse, Healthy Nation campaign, health care facilities should strive to develop and enforce policies and procedures to protect health care providers. Therefore, the onus is on nurse executives who oversee operations in the OR to ensure evidence-based policies and procedures are implemented and evaluated to mitigate surgical smoke. The United States has historically fallen behind in adopting surgical smoke evacuation laws in comparison to neighboring countries, and perioperative teams should work in an environment that supports surgical smoke evacuation practices.

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Rebecca Vortman, DNP, RN, CNOR, is clinical assistant professor at the University of Illinois Chicago College of Nursing in Springfield, Illinois. She can be reached at rvortm2@uic.edu. Janet Thorlton, PhD, MS, RN, is clinical associate professor at the University of Illinois Chicago College of Nursing in Champaign, Illinois.

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