

Intraoperative Electrosurgical Smoke During Outpatient Surgery: A Survey of Dermatologic Surgeon and Staff Preferences

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PRACTICE POINTS

- Growing evidence suggests that the surgical smoke plume generated during electrosurgery may be harmful if inhaled.
- Our survey indicates that this information may affect clinician and staff perceptions about exposure to electrosurgical smoke and its remediation.

Electrosurgery generates smoke that may be harmful. We created a survey to evaluate perceptions of electrosurgical smoke and how information on the harm it potentially causes changes these perceptions. We distributed the survey to the membership of the American College of Mohs Surgery and the American Society for Dermatologic Surgery and received 437 useable responses. Results indicated that many dermatologic surgeons were aware of and bothered by surgical smoke, and these reactions were more prevalent after being educated on the potential hazards of electrosurgical smoke.

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A growing body of evidence shows that electrosurgical smoke contains both harmful chemicals as well as live material, including blood particles, bacteria, and viruses.¹ Both human immunodeficiency virus and human papillomavirus have been identified in surgical smoke plumes, and bacterial colony growth has been demonstrated from electrosurgical smoke specimens, specifically *Staphylococcus*, *Corynebacterium*, and *Neisseria* species.²⁻⁸

Treating 1 g of tissue with electrocoagulation produces chemical by-products equivalent to burning 6 unfiltered cigarettes,⁹ which is twice the amount of chemical by-products produced by CO₂ laser vaporization of the same quantity of tissue. It is a common misconception that electrosurgical smoke is less hazardous than smoke produced by ablative CO₂ procedures.⁹ Many chemicals are present in electrosurgical smoke plumes, including nitriles, benzenes, carbon monoxide, hydrogen cyanide, indoles, phenols, pyridine, pyrrole, styrene, toluene, and xylene.¹⁰⁻¹² In animal model studies of rat lungs exposed to surgical smoke, pathologic changes, including interstitial pneumonia, bronchiolitis, and emphysema, have been shown in a dose-dependent manner.^{1,13-16} Diseases and symptoms linked to inhalation of electrosurgical smoke in humans include anemia, eye irritation, hypoxia, dizziness, nasopharyngeal lesions, vomiting, sneezing, throat irritation, and weakness.^{1,8,17-19} A study of 153 dermatology residents found that more than 70% reported receiving no formal education on the hazards of electrosurgical smoke.²⁰ Approximately 45% were unaware if they had access to smoke evacuation in rooms where electrosurgery was performed. More than 76% were concerned with the infectious risk of electrosurgical smoke, and more than 71% were concerned with its potential carcinogenic risk.²⁰

We surveyed dermatologists who perform skin surgery as well as staff members with respect to their experiences with electrosurgical smoke and to observe any difference that information on the potential hazards of electrosurgical smoke may have on their attitudes and preferences.

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Materials and Methods

Survey Instrument—We developed a REDCap survey consisting of 17 questions that was approved by the executive committees of the American College of Mohs Surgery and the American Society for Dermatologic Surgery for distribution to their dermatologist memberships. It was emailed to eligible participants using their mailing lists. Although the survey was sent directly to member physicians, it was recommended that they forward the survey to their clinical staff to complete.

After responding to an initial set of survey questions, respondents were informed that there is growing evidence of potential harms of inhalation of surgical smoke. They then were asked the same series of survey questions in light of this information.

Statistical Analysis—Statistical analysis of the survey responses was then completed, and free-text responses as a final question of the survey were assessed for themes. Preintervention responses of staff and clinicians noticing smoke and being bothered by smoke were assessed using proportions and 95% confidence interval (CI) estimates of the proportions. On most questions, respondents could answer on a scale of 1 to 10. Responses of 5 to 10 on noticing smoke and 5 to 10 on being bothered or troubled by the smoke smell were grouped for analyses. A cross-tabulation using the Bhapkar test for marginal homogeneity was used to assess if information presented on potential smoke hazards changed responses. A Cochran-Mantel-Haenszel test for ordinal responses was used to determine differences between surgeons and staff. A McNemar test was used to determine statistical significance of change in responses to cost. Statistical analysis was performed using SAS version 9.

Results

There was a total of 443 responses to our questionnaire. Two respondents answered that they did not work in an office where skin surgery was performed, and 4 respondents did not answer any questions and were therefore excluded, leaving a total of 437 responses (402 physicians and 35 staff members). A summary of the characteristics of the respondents is shown in the Table. Some respondents did not answer each question, leading to fewer than 437 answers for some questions.

Two hundred eighty-two respondents (64.5%) never or very rarely used smoke evacuation during skin surgical procedures, and only 85 (19.5%) used smoke evacuation with nearly every case. The remaining respondents sometimes used smoke evacuation (Figure 1).

Prior to being presented with the potential dangers of electrosurgical smoke and using a value of 5 to 10 to determine if respondents noticed smoke, 54.4% (95% CI, 49.5%-59.1%) did notice intraoperative smoke during procedures. Using a value of 5 to 10 to indicate if respondents were bothered or troubled by the smoke smell, 35.5% (95% CI, 31.0%-40.2%) were bothered or troubled by intraoperative smoke prior to potential hazards being presented.

Baseline Respondent Characteristics

Question	Responses
No. of respondents	
Surgeons	402
Staff members	35
Years at a skin surgery practice, n (%)	
0-1	26 (5.9)
1-5	108 (24.7)
>5	302 (69.1)
Amount of time spent on skin surgery involving electrocautery, n (%)	
Some time: 1-3 cases/d	87 (19.9)
Much of the time: 4-10 cases/d	181 (41.4)
All of the time: >10 cases/d	169 (38.7)
No. (%) who use smoke evacuation during skin surgery	
No, never or very rarely	282 (64.5)
Yes, sometimes	68 (15.6)
Yes, with nearly every case	85 (19.5)

Regarding acceptable increase in cost per procedure for smoke evacuation at baseline, 68.9% of respondents favored additional cost; 57.8% of respondents chose the lowest cost grouping of \$1 to \$30. After being presented with information about the potential harm of intraoperative smoke, the respondents in favor of additional cost increased to 71.5%, which was a small but statistically significant change ($P=.0075$) (Figure 2).

Respondents were sorted into groups consisting of those who never used smoke evacuation, those who used it occasionally, and those who used it with all smoke-producing procedures. The degree to which respondents noticed intraoperative smoke was strongly correlated with their use of smoke evacuation; those who never used smoke evacuation noticed the presence of smoke more, and those who always used smoke evacuation noticed it less ($P=.0002$). Similar trends were noted regarding if the smoke smell bothered or troubled respondents ($P=.0014$).

After being presented with the potential risks of electrosurgical smoke, 29 more respondents answered that they were severely bothered by electrosurgical smoke, whereas 45 fewer respondents selected that they were not bothered or troubled at all by electrosurgical smoke (Figure 3). This difference was statistically significant ($P<.0001$). Fifteen more respondents answered that they would be much more likely to choose to work at a

FIGURE 1. Responses for question “Does your office use smoke evacuation during skin surgery?”

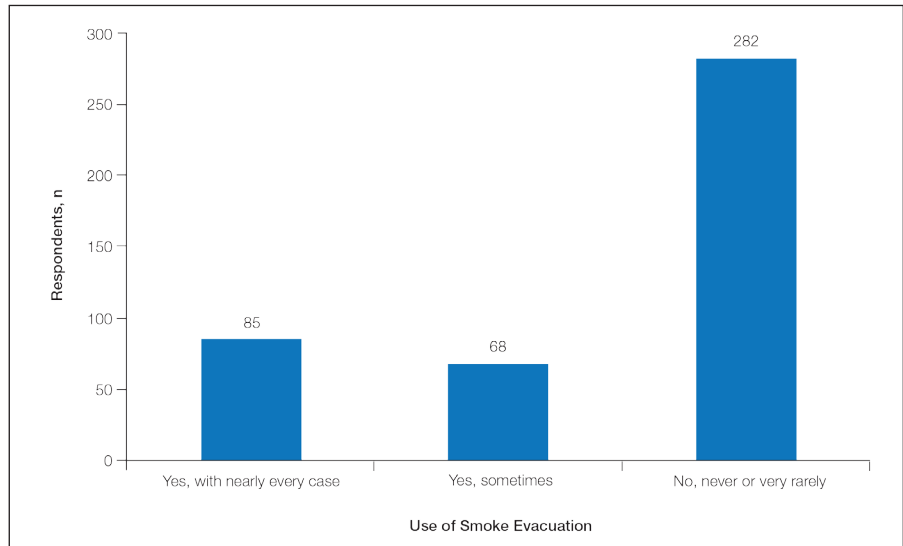


FIGURE 2. Responses for question “How much additional cost per procedure do you think would be acceptable to have the smoke smell eliminated in your work environment?” (overall change in response following intervention across all response ranges, $P = .0075$).

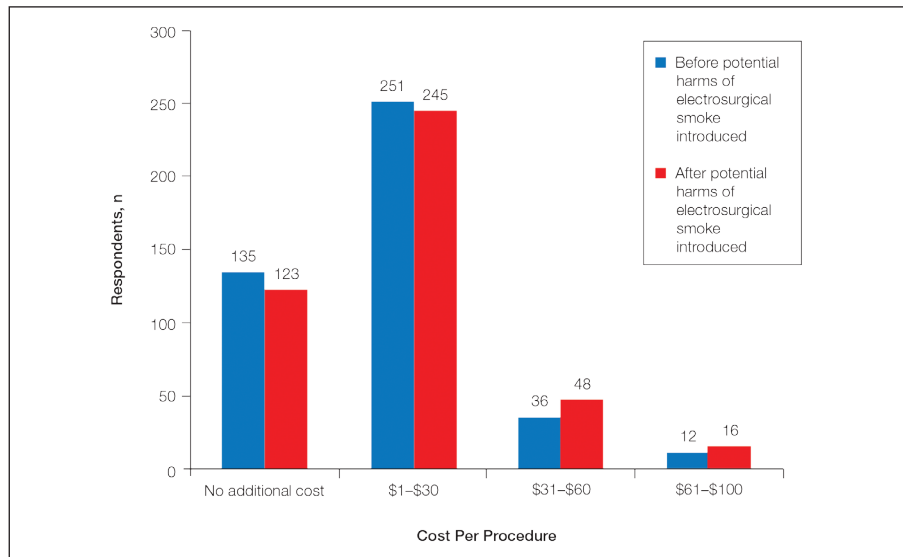
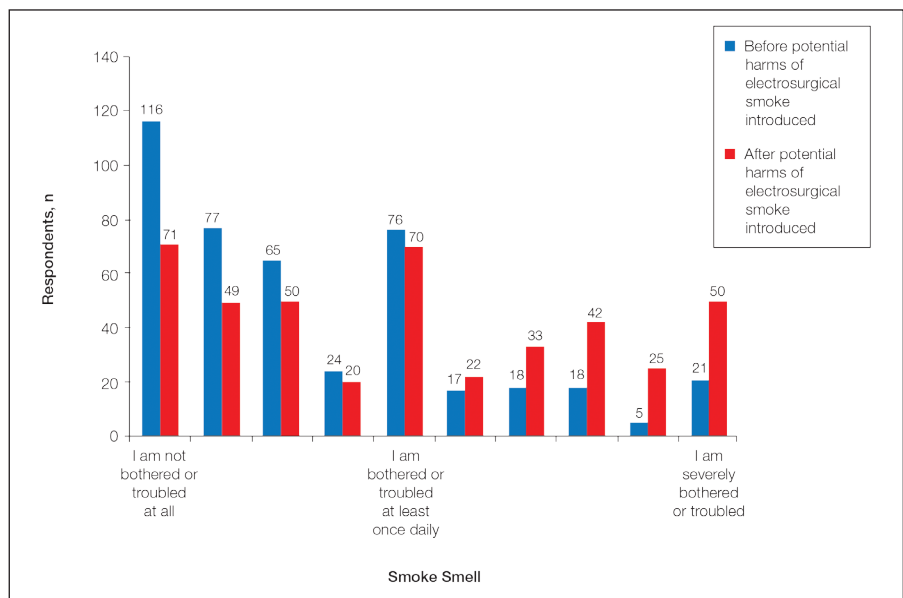


FIGURE 3. Responses for question “Did the smoke smell bother or trouble you in any way?” (overall change in response following intervention across all response ranges, $P < .0001$).



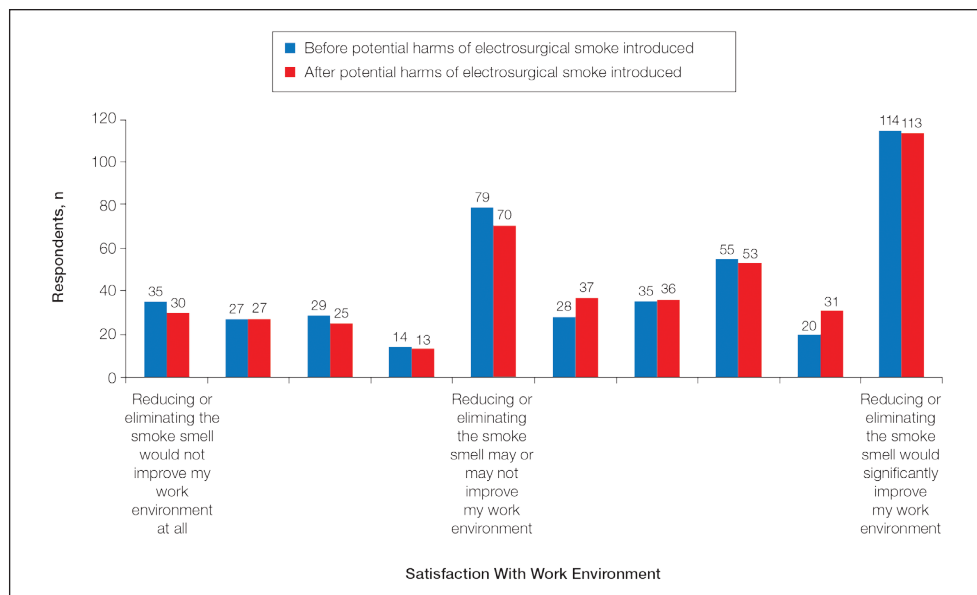


FIGURE 4. Responses for question “If the smoke smell could be reduced or eliminated completely, would that make you more satisfied with your work environment?” (overall change in response following intervention across all response ranges, $P=.3139$).

practice with smoke evacuation once the potential harm of electrosurgical smoke was introduced, and 11 were somewhat more likely to choose a practice with smoke evacuation ($P<.0001$).

Information about the potential harm of electrosurgical smoke did not statistically significantly affect satisfaction with work environment ($P=.3139$) (Figure 4).

There were no statistically significant differences between surgeon and staff responses on any questions.

Comment

Developing evidence of health risks associated with electrosurgical smoke plumes has led to an increasing interest in the use of smoke protection or remediation tools during surgical procedures. High-filtration face masks and smoke-evacuation devices protect physicians, staff members, and patients, as well as improve the patient’s clinical experience.

Our study was designed to query dermatologists who perform skin surgery as well as staff members with respect to their experiences with electrosurgical smoke and to observe any difference that information on the potential hazards of electrosurgical smoke may have on their attitudes and preferences. We received 437 responses to our survey (Table). At baseline, 54.4% of respondents noticed and 35.5% were bothered or troubled by the smoke smell produced during skin electrosurgery. These data were intuitively associated in a statistically significant manner with the use of smoke evacuation for respondents; those respondents who more commonly used smoke evacuation were bothered less by electrosurgical smoke, and those respondents who used smoke evacuation less often were more likely to notice and be bothered by surgical smoke.

Once our respondents were presented with the potentially harmful effects of electrosurgical smoke, they became significantly more likely to be bothered by electrosurgical smoke and to want to work in a practice where smoke evacuation was available. This information, however, did not change respondents’ satisfaction with their work environment, and no statistically significant differences were noted between physicians and staff.

At baseline, 68.9% of respondents favored additional cost for smoke evacuation, with approximately 58% favoring the lowest cost category we presented (\$1–\$30). After being presented with information about the potential dangers of electrosurgical smoke, 71.5% were in favor of increased cost for smoke evacuation, which was a small but statistically significant increase.

The open-comment section of the survey provided interesting insight into the opinions of our respondents on smoke remediation. It is important to note that statistical analysis cannot be performed with these data, and firm generalizable conclusions cannot be drawn from them; however, they reveal topics that may guide further research and policy and certainly merit mention. Of 437 respondents, 108 left free-text comments. Twenty-six percent were categorized as unqualified proponents (in favor of smoke remediation) and 45% as qualified proponents (defined as an individual who verbalized a desire for smoke remediation but also cited a factor limiting their ability to use it, such as cost or staff availability). Only 12% were firmly against smoke remediation, while the remaining 17% did not comment discernibly for or against smoke remediation, indicating that a majority (71% of our comment section respondents) were in favor of some type of smoke remediation, especially if obstacles such as cost could be addressed. Only a small minority was firmly against smoke remediation.

The comments section of our survey highlighted some of the concerns that dermatologic surgeons and their staff have with electrosurgical smoke evacuation. Thirty percent cited cost as an obstacle to use of these devices, and several comments raised concern about increasing overhead and regulatory demands placed on practices. Many indicated that, without sufficient evidence of the harm caused by electrosurgical smoke, regulation that forces use of smoke remediation devices would represent a costly unfunded mandate. Others referenced the logistical challenges of smoke evacuation and the need for staff assistance. Newer smoke-evacuation wands built into cautery pens address much of this concern regarding logistical and staff challenges and further allow the evacuator tip to be located where it is most effective: 1 cm to 2 in from the point of cautery.^{21,22}

Additionally, 12% of commenters noted that their patients were bothered by the smell of electrosurgical smoke, which is a point that requires further research and is the focus of a current randomized trial at our institution (ClinicalTrials.gov Identifier NCT02958826).

Our current study is limited in that it is a survey and therefore is subject to response bias. Further, some may assert that the hazards of electrosurgical smoke are not settled science, and although we agree with this point on some level, the study aim was not to prove risk but rather to assess current attitudes and see if awareness of a potential risk influenced those attitudes. Additionally, most responses were from physicians—only 35 responses were from nonphysician staff—so it may be difficult to generalize the findings of this study to staff. The large number of physician respondents, however, can be seen as a strength, and the findings are likely much more generalizable to providers who routinely perform clinic-based surgical procedures involving electrosurgery.

Conclusion

Our study shows that most dermatologists who perform skin surgery notice and are bothered by the smoke produced by electrosurgery to at least some extent. When presented with the possibility that inhaling electrosurgical smoke may be harmful, dermatologists were more likely to be bothered by electrosurgical smoke, more likely to prefer a practice environment where smoke evacuation was available, and more likely to be willing to bear additional cost for smoke evacuation. The free-text comments on our survey highlighted that many dermatologic surgeons are proponents of smoke evacuation but have concerns about cost and potential regulatory challenges associated with smoke evacuation, especially if the potential risks are not settled science. Many logistical concerns for smoke evacuation are addressed with

the use of integrated devices. More research is needed to determine the health effects of the surgical smoke we are exposed to daily and the optimal way to limit any risk.

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