CANADIAN
# Operating Room Nursing Journal

Volume 7, Number 3, June/July, 1989

Published by Health Media Incorporated



Canadian Operating Room
Nursing Journal
214 Merton St. Suite 202
Toronto, Ontario M4S 1A6
(416) 481-2244
(416) 483-5116

| Subscription Rates: | 1 Year | 2 Year |
|---|---|---|
| Canada | $14.00 | $22.00 |
| United States | $20.00 | $30.00 |
| Other Countries | $24.00 | $38.00 |
| Single copy orders | | $4.00 |

I.S.S.N. 0712-6778
Second Class Mail Reg. No. 5934

## Feature Articles



## Departments



**Acknowledgement:**
The Journal wishes to acknowledge the kindness and support of Siemens Electric for the front cover photography and the illustrations found on pages 14, 15 and 16.





# The laser plume:
## Is it a health hazard?

**By Agnes Jacques, R.N., B.Sc.N.**

The controversial issue of second-hand cigarette smoke has taken on added significance since research has shown it to be harmful to individuals who do not smoke but who are exposed to it on a secondary basis. In this instance, segments of society have decided to take action and fight for their right to a smoke free environment.

In a similar vein, why should operating room staff be subjected to smoke-polluted air, and even more so, to air that contains diseased particles that are potential health hazards?

This smoke in the operating room, produced during laser surgery, is called the laser plume.

Although there are a number of safety measures to consider during laser surgery, the main concern in this submission will focus on the plume aspect. The content will also examine how the laser plume is produced, the composition of the plume, and the possible effects that contact with the plume may produce. This will be followed by laser safety measures that focus on smoke evacuation. We will also look at what is on the market for protection against laser plumes, what is used and how it is used.

The response to a questionnaire on laser plumes which was prepared for the operating room staff at the Hotel Dieu Hospital in Kingston, Ontario will also be discussed.

### The laser plume

The laser plume is defined as the smoke produced from vaporized tissue during laser surgery. The laser beam creates intense heat which is delivered to a precise area of tissue. The heat built up is so intense that cellular explosion occurs and the tissue is vaporized, thereby producing the smoke. Surface cells can be blown into the air from the explosion and could be inhaled by the OR team and the patient as well.

Researchers have identified the particles in the laser plume as being the same size as the dust particles that cause black lung (chronic lung disease/pneumoconiosis). There is potential for OR personnel, when breathing in this particulate matter, to develop viral lesions, as they are too small to be filtered by the standard mask. Therefore "the viral transfer from laser plume cannot be conclusively ruled out." (AORN, 1988, p. 462).

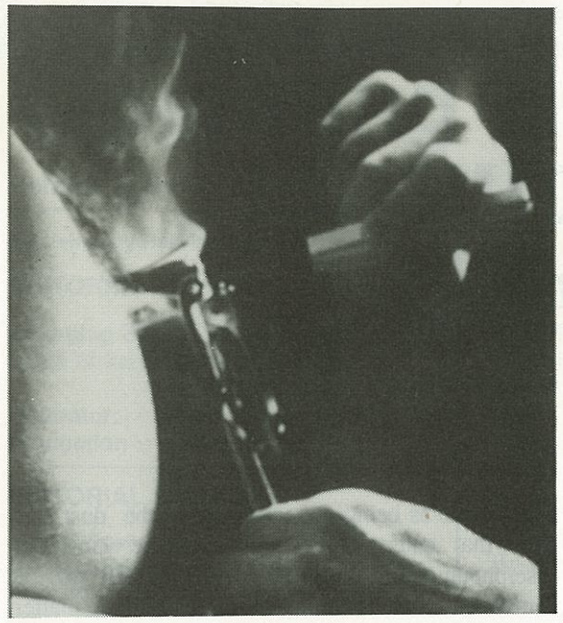
In a recent study, "scientists found that plumes of debris and smoke created during laser surgery can contain hazardous bacterial viruses." (Office of Science and Technology, 1989, p. 619). Among the less harmful products "laser plume consists of water, carbonized particles, morphologically intact cells, and a distinctive odor." (Ball, 1986, p. 4).

Laser plume contents also depend on the type of laser used for the procedure. The carbon dioxide ($CO_2$) laser, for example, causes a different tissue reaction than the Nd: YAG or Argon lasers. The difference lies in the tissue reaction to the specific laser being used. (Ball, 1986, p. 4).

### Effects of plume

A study was undertaken to determine the effects of laser smoke on the lungs of rats. A $10cm^2$ by $10cm^2$ of planed pigskin was vaporized with a 1.5 to 2mm diameter $CO_2$ laser beam delivered to the target via a micromanipulator. (Baggish et al., 1987, p. 1260). The study was done in three phases in which smoke exposure was increased with the second group, then increased again for the third group of rats.

The results showed that the first phase rats developed a remarkable pulmonary inflammatory response. The lungs were grossly and microscopically congested. The microscopic pattern was consistent with the congestive phase of interstitial pneumonia. The pulmonary vessels were dilated and congested,



**Photograph of a laser plume from a hand held $CO_2$ laser during surgery**

and the terminal bronchioles were thickened and showed hypertrophy and hyperplasia of the ciliated epithelium. The alveolar ducts were distended, and a large mononuclear inflammatory infiltrate filled the walls of the alveoli.

The animals treated in phase two showed accentuated features of the lungs described in phase one. In addition, peripheral areas of the lungs demonstrated emphysema and extensive peribronchiolar and interstitial lymphocytic infiltration. Pulmonary capillaries were also thrombosed.

The animals treated in phase three showed even more extensive emphysema and tremendous bronchiolar mucosal proliferation. Numerous goblet cells were seen. The bronchiolar lumina were narrowed by the epithelial proliferation, and an acute and chronic inflammatory cellular exudate was observed. Lymphoid follicle formation around the bronchioles accentuated the findings. (Baggish et al., 1987, p. 1261-1262). It is apparent that with increased exposure to the laser plume, there are more severe effects. Even in short-term plume exposure, the study demonstrated harmful pathologic response in rat lungs.

## Laser safety

It is accepted that eye protection is of utmost importance during laser surgery. Many articles have been written on the damage that can occur if the laser beam is directed into someone's eyes without protection. Thus, eye protection is recognized and understood as an area where major laser safety precautions are slavishly adhered to. Warning signs are placed at all entrances requiring that protective eye glasses must be worn beyond this point.

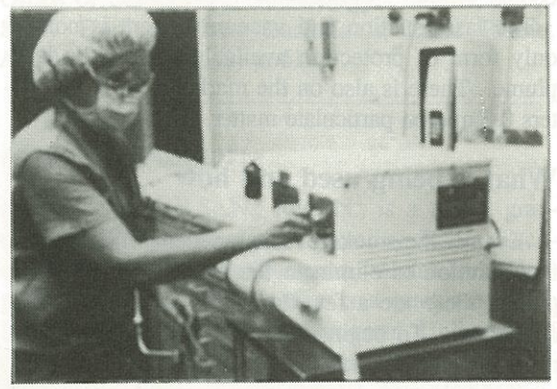
However, it has only been since January of this year (1989) that proposed recommended practices mention that "health care workers should be protected from inhaling fumes associated with laser use." (AORN, 1989, p.286). People are starting to realize that the laser plume is not something to be brushed aside and that the problem needs to be dealt with more seriously.

## Air pollution

During an experiment in Japan, Shigenoby Mihashi vaporized 1 gram of excised canine tongue with a $CO_2$ laser and found the amount of plume within the immediate surgical area to be 52 times greater than that allowed by the government's environmental standards. This finding indicates that the air is definitely polluted by the smoke that is produced by laser irradiation. (Ball, 1986, p. 4).

To offer some protection from the noxious laser fumes, a smoke evacuation machine is utilized. There are different kinds of evacuation systems on the market and... "various types of filtration methods must be considered... The filter should remove particulate matter efficiently down to at least 0.5mm in size." (Ball, 1986, p.8) The frequency of the filter change should be written in the guide manual and should be followed accordingly.

Keeping the filter clean is important for effective elimination of plume. Only clean air should be redistributed into the room, otherwise it would defeat



**An OR nurse prepares suction equipment for use during laser surgery**

the purpose of the evacuator. In cases where only a small amount of laser plume is produced, a wall suction with a laser filter would be sufficient. This method must be monitored carefully as the filter can get quickly clogged with large amounts of plume.

There are also guidelines as to the type of evacuation needed for the different types of laser surgery. These recommendations are set by a number of organizations in the health care field, the Occupational Safety and Health Administration, and the courts.

The laser suction and vacuum system is not the only form of protection available against the laser plume. There is also on the market a mask that filters 0.3 micron particulate matter. (Kapsar, 1988)

## What is being used and how

Even if the smoke evacuator seems like the perfect solution to eliminate the problem of the laser plume, there are a few downfalls where its use is concerned. To begin with, the hand piece releases nitrogen gas to cool the hand piece and to blow away debris from the operative site. This of course scatters the plume in the room, thus making smoke evacuation more difficult.

Quite often the smoke evacuator is not used properly as when the hose tip is not held close enough to the tissue being lasered. Obviously, the further away the hose tip is from the site, the greater the amount of plume allowed to escape into the air. When the vacuum is not being used properly, the person responsible for holding and keeping the hose tip close to the operative site is either unaware that the wand is not close enough, or unaware of its potential hazard. Possibly, the attendant does not even care if the smoke escapes in the room, only to be inhaled by the operating room staff.

## The questionnaire

As this scenario was envisioned, it brought to mind questions as to how harmful the vaporized tissue was to individuals who were exposed to it. If there is some truth to its hazardous effects, why are people not more cautious when handling the smoke evacuator? It is hard to imagine that something that poses a threat to our health can be taken so lightly. Thus, the questionnaire was prepared in order to provide answers to these and other questions. The purpose of the questionnaire was to find out what individuals (who are part of the OR staff) knew about laser plume, its effects, if they believed it was harmful and if they cared about protecting themselves.

Select individuads were asked to identify themselves according to their line of work at the hospital. The respondents were: nursing staff, surgeons, anaesthetists, and residents. The questionnaire was given to the nursing staff in an informal manner by placing the questionnaire, with the individuals name written on it, in the nurse's lounge. The purpose of the study was explained. Those not present at the time were approached on an individual basis. There was over an 80% response from the nursing staff.

Results show that almost everyone knew the answer to the first two questions concerning the harmful constituents and effects of the laser plume. Only one nurse did not believe the laser plume could be harmful and everyone cared about protecting themselves from inhaling the smoke. Less than 10% knew a special mask, that offers protection from laser smoke, existed and no one has ever worn that mask. When asked if they would wear the mask even if it was difficult to breath through, all responded positively, except one, whose answer stated that it depended on the degree of difficulty.

Five residents either from anaesthesia or surgery were approached with the questionnaire. Three responded. In this category the answers varied from knowing all about plumes and caring about self-protection from the smoke, to having no knowledge about it and not concerned with protection.

In the anaesthetic group, 50% responded to the questionnaire. The questionnaire was sent to them through the hospital inter-departmental mail system. They were all aware of the plume's effects and cared about protecting themselves, but one said he would not wear the mask anyway. Here again, one of the respondents questioned the difficulty of breathing with the special mask on.

In the surgical group, 40% responded. The questionnaire was sent as above by the hospital mailing system. The results show they were all knowledgeable of the laser plume effect and they all cared about protecting themselves. Half of the surgeons did not know a special mask existed, but they would all wear one if it was available. Here again one questioned the degree of difficulty in breathing through the mask. Why no one has ever worn the special mask that offers protection against laser plumes by filtering 0.3 microns of particulate matter, lies in the fact that they are not currently available in the hospital.

## Questionnaire conclusions

It was concluded from the questionnaire that the majority of the people do care about protecting themselves from laser smoke. However, had all the surgeons and anaesthetists responded, the results may have been different. The surgeon has considerable influence on surrounding co-workers. If the surgeon does not believe the laser plume is harmful, and does not want to fuss over the proper use of the smoke evacuator, the staff may be more amenable to the surgeon's influence.

## Future laser use and conclusion

Current literature emphasizes that laser use and laser technology will increase at a considerable rate. Predictions state that the cost of surgical lasers will be reduced and therefore will attract more users.

"According to Dr. Pierre Blais of the Bureau of Radiation and Medical Devices, Health and Welfare Canada, the field of laser therapy in Canada as applied to surgery will increase fourfold by the beginning of the next decade." (Fagan, 1986). We should also expect a growing number of laser surgery cases involving other procedures than the cases already being performed today. More hospitals and institutions will use the laser and it will become an indispensable tool.

Laser technology is evolving and new laser techniques are constantly being introduced. This means an increased need for protection since we can expect to be exposed to the laser plume more frequently.

Additional research is needed to determine the viability of the cells with the laser plume. At this point no one can assume the laser plume is safe to the environment and caution should be taken to protect both the patient and the staff involved. ■

## References


AORN Subcommittee Members, (1985, Dec.). Recommended Practices: Radiation Safety in the OR (including lasers), *AORN Journal*, 42, (6), p. 920.

AORN Subcommittee Members, (1989, Jan.). Proposed Recommended Practices: Laser Safety in the OR, *AORN Journal*, 49, (1), p. 284-293.

Baggish, M., Elbakry, M., (1987, May). The Effects of Laser Smoke on Lungs of Rats, *American J. of Obstetrics and Gynecology*, 156, (5), p. 1260.

Ball, Kay, A., (1986, Oct.). Laser Safety, *Today's OR Nurse*, 8, (10), p. 10-14.

Ball, Kay, A., (1986, Dec.). Controlling Smoke Evacuation and Odor During Laser Surgery, *Today' OR Nurse*, 8, (12), p. 4-10.

Ball, Kay, A., (1987, Feb.). Legal Aspects of Laser Surgery, *Today's O.R. Nurse*, 9, (2), p. 23-28.

Ball, Sharon, (1986, April). Laser Safety: Using the $CO_2$, Argon and Nd:Yag Lasers, *Canadian Operating Room Nursing Journal*, 4, (2), p. 11-15.

Bunch, Pat, (1986, Oct.). Beaming on ENT, *Nursing Times*, 82, (40), p. 67-68.

Fagan, F., (1986, Sept.). Health Care Industry to Feel Impact of Laser Technology, *Canadian Operating Room Nursing Journal*, 4, (4), p. 33-38.

Hicks, Susan, (1988,, Dec.). A Full Service Laser Center, *Today's OR Nurse*, 10, (12), p. 22-29.

Kapsar, Patricia, (1988, Feb.). Hazards of Laser Plume Questioned, *AORN Journal*, 47, (2), p. 462.

Office of Science and Technology, (1989, Feb.). Study Findings Show Bacteria in Laser Plume, *AORN Journal*, 49, (2) p. 619.


## About the Author:


Agnes Jacques, B.Sc.N., Reg. N., is a recent graduate of the Post Graduate Operating Room Technique and Management Program, Hotel Dieu Hospital, Kingston, Ontario. She is a graduate of the Bachelor of Nursing Science program, University of Ottawa School of Nursing, Ottawa, Ontario.


## Laser plume questionnaire

**Definition:**
Laser plume is the smoke produced from vaporized tissue in laser surgery.

**1.** Researchers have identified that the particles in the laser plume are the same size as the the dust that causes black lung. Are you aware of this? Yes___ No___

**2.** Research shows there is the potential for personnel breathing in the particulate matter to develop viral lesions as viruses are too small to be filtered by the standard surgical mask. Are you aware of this? Yes___ No___

**3.** Do you believe laser plumes can be harmful? Yes___ No___

**4.** Do you care about protecting yourself from inhaling laser smoke? Yes___ No___

**5.** Do you know that a mask that filters 0.3 microns of particulate exists? Yes__ No__

**6.** Have you ever worn a special mask to protect yourself from laser smoke? Yes__ No__

**7.** If that mask was available would you wear it, even if it was difficult to breath through? Yes__ No__