stereo tape recorder provides a sound track for verbal description of events of interest and their management. By employing a combination of oscilloscope and ECG machine, portions of special interest may be located and paper tracings made. Should a patient suffer a cardiac catastrophe during the immediate postoperative period, the entire tracing may be reviewed in detail to see whether or not a recognizable cardiac insult occurred during operation.

To date, we have recorded tracings from about thirty patients. Two sample tracings are shown (fig. 3).

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Effects on Postoperative Sore Throats of Two Analgesic Agents and Lubricants Used with Endotracheal Tubes

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Because previous observations on the use of lubricant vehicles, specific local analgesic agents, and topical use of hydrocortisone have not shown significant decreases in symptoms of sore throats after endotracheal intubation, a study was undertaken to attempt to find whether the use of a light or viscous base with or without lidocaine or pramoxine would show differences in incidence of this symptom.

METHOD

One thousand twenty-five patients ranging from 5 to 75 years of age who underwent general anesthesia during which an endotracheal tube was used were studied over a four-month period. Four groups of approximately 200 each were composed of patients for whom one lubricant, either light or heavy base and with or without a local analgesic agent was used. An endotracheal tube was used for an additional group but no lubricant was employed. Because of schedule changes such as postponements, cancellations and emergencies and because the patients who might have nasogastric tubes were unknown at the time of premedication and selection, the assignment of various lubricants to specific patients in a statistically randomized manner was not attempted. Two hundred fifty tubes of lubricants used were coded by number which was recorded on an individual reference card. At the end of the study the unknown materials were identified. This was a double blind study except that those who performed the intubation knew whether a light or heavy lubricant was being used. They did not know whether an analgesic agent was included. Patients were interviewed by one of two third-year resident anesthesiologists. After several nonspecific questions concerning their postoperative course, the patients were asked directly about specific complaints referable to the throat.

The patients were included in the study on the basis of their consecutive arrival in the operating room, except for those who had preexisting upper respiratory infection, sore throat, hoarseness, operative procedures which would manipulate the endotracheal tubes such as radical neck procedures, or those with nasogastric tubes. No subjects were included in the results where multiple attempts were required for intubation, or if any blood appeared on withdrawal of the laryngoscope. The distribution of patients was comparable in each of the five groups, and included those having procedures in general, thoracic, urologic, gynecologic, neurologic, and orthopedic surgery. Patients were seen at least on the first postoperative day and until their complaints improved, if present. No attempts were made to evaluate the severity of their complaints and

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TABLE 1. Incidence of Post-Intubation Sore Throats

	Patients	Symptoms	Present (%)	
Controls				
No Lubricant on tube	114	26	22.8	
Heavy lubricant	216	45	20.8	N.S.
Heavy lubricant with lidocaine 5%	256	17	6.6	$P = 0.001$
Light lubricant	208	44	21.2	N.S.
Light lubricant with pramoxine 1%	231	50	21.6	N.S.

no examinations of the patients' throats were made.

Endotracheal intubation was performed by members of the Division of Anesthesiology who had varying degrees of technical skill, ranging from third-year medical students and surgical interns who spent six weeks in the Division, to anesthesiology residents in training and full-time staff members. In most instances, endotracheal intubation was accomplished by the oral route using a cuffed, clear plastic endotracheal tube (Davol), utilizing a stylette following induction of anesthesia with a sleep dose of thiopental and after having obtained muscular relaxation with succinylcholine. A MacIntosh laryngoscope blade was most often used and an oropharyngeal airway served as a "bite-block." The endotracheal tubes had been washed in soap and water, soaked in an organic iodine solution (Wesdocyne) for twenty minutes and thoroughly rinsed with water. They were kept in sterile paper wrappers until used.

RESULTS

In 114 patients for whom no lubricant was used on the endotracheal tube, the incidence of complaints was 22.8 per cent. By testing mean squares with expected mean squares as a method of statistical analysis, the only group in which the incidence of symptoms referable to the throat was significantly reduced ($P = 0.001$) was that in whom a heavy viscous lubricant containing a local anesthetic was used (lidocaine 5 per cent ointment). In this group 17 of 256 patients had specific throat complaints, or 6.6 per cent (table 1).

TABLE 2. Incidence of Symptoms Associated With Use of Topical Analgesic Agents

	Per Cent	Comment
Conway[1]	38	Nupercaine was of value.
Gard[2]	44	Topical spray was of value.
Hamelberg[3]	45	Hydrocortisone not valuable statistically.
Wylie[4]	46	
Baron[5]	100	
Wolfson[6]	18	
Hartsell	9	Topical anesthesia of little aid.

DISCUSSION

Table 2 gives the incidence of symptoms reported by other authors. The conditions of these various studies were essentially not comparable to ours or to each other, and many were not well controlled. The symptoms considered were not the same in the different series.

Our data indicate that if a potent topical analgesic agent is embodied in a viscous lubricant base, a significant reduction in the incidence of postoperative sore throats may be obtained.

SUMMARY

Endotracheal tubes used in a series of 1,025 surgical patients were coated with (1) nothing, controls, (2) a heavy viscous base, (3) a heavy base containing 5 per cent lidocaine, (4) a light foamy base, (5) a foamy base with 1 per cent pramoxine. Each group contained about 200 patients. The incidence of postoperative sore throats was nearly the same in groups 1, 2, 4, and 5 as in the controls. It was significantly less ($P = 0.001$) in group 3, where the tube had been lubricated with a heavy base containing 1 per cent lidocaine.

Abbott Laboratories and Astra Pharmaceutical Products, Inc., supplied the lubricants used in this study.

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Convenient Flows Using Flow-Metered Vaporizers

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It is common practice at our institution to use a 5 liters/minute total diluent gas flow (O_2 or N_2O O_2) when administering halothane via a flow-metered vaporizer (Copper Kettle, Vernitrol, etc.). The oxygen flow through the vaporizer in ml./minute then indicates, without further calculation, the approximate percentage delivered times 100 over the anesthetic range (*e.g.*, 100 ml./minute indicates 1 per cent). It is possible to derive a simple, somewhat general expression for such a diluent gas flow using any applicable agent.

$$\text{Total diluent gas flow (liters/minute)} = \frac{\text{Vapor pressure of agent} \times 10}{\text{Barometric pressure} - \text{Vapor pressure of agent}}$$

Typical values near sea level and room temperature are:

Halothane	5 liters/minute
Fluroxene	6 litres/minute
Chloroform	3 liters/minute
Ether	14 liters/minute

The expression assumes complete equilibrium in the vaporizer and negligible flow through the vaporizer compared to the total gas flow. The error introduced by this latter assumption is negative and directly proportional to the flow through the vaporizer (*e.g.*, with a 100 ml./minute flow using halothane 0.97 per cent would be delivered, 3 per cent *less;* with a 500 ml./minute flow 4.25 per cent would be delivered, 15 per cent less). Agents with very low vapor pressures (*e.g.*, trichloroethylene, methoxyflurane) require high flows through the vaporizer and thus introduce excessive errors. Total diluent flows can, when desired, be conveniently changed by multiples if the vaporizer flows are interpreted accordingly.

The expression is derived as follows:

Let: A = flow of anesthetic vapor from vaporizer (ml./minute)

P_V = anesthetic vapor pressure at room temperature (mm. Hg)

V = oxygen flow through vaporizer (ml./minute)

D = total diluent gas flow (ml./minute)

P_B = barometric pressure (mm. Hg)

Then the per cent agent from the vaporizer is

$$\frac{A}{A + V} \times 100 = \frac{P_V}{P_B} \times 100$$

(assuming complete equilibrium) (1)

and the final delivered per cent is

$$\frac{A}{A + V + D} \times 100$$

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