

TABLE 1. Preoperative Serum Cholinesterase Activity in 22 Patients Undergoing Elective Cesarean Section (Normal Activity = 1.07–2.38 IU)

	Serum Cholinesterase Activity (IU)			
	More than 1.07	.81–1.06	.54–.80	Less than .54
Number of patients	9	6	6	1
Percentage of patients	40.9	27.3	27.3	4.5

serum cholinesterase activities in the patients exposed to methoxyflurane and those who received only nitrous oxide for cesarean section, but the absolute magnitude of this difference was insufficient to suggest a need to avoid methoxyflurane in obstetric anesthesia. Our failure to demonstrate significant depression of serum cholinesterase activity may have resulted from the low total dose of methoxyflurane administered and the resultant low serum fluoride levels. It is possible that longer durations of administration of methoxyflurane at higher concentrations may result in serum fluoride levels sufficiently high to result in clinically significant decreases in plasma cholinesterase. Harris and Whittaker<sup>4</sup> have shown that a fluoride concentration of 50  $\mu\text{M}$  will produce about 60 per cent inhibition of serum cholinesterase activity *in vitro*. Because of the renal dangers of high-dose methoxyflurane administration, it is undesirable to administer methoxyflurane in anything but low doses for short periods, as we used it during this study.

Our results for preoperative serum cholinesterase activity (table 1) agree with Shnider's finding of a

substantial number of parturients having below-normal levels.<sup>2</sup> Shnider, however, found that only 10 per cent of patients had low values during late pregnancy, while we found 59.1 per cent with values below the normal range.

In conclusion, the levels of inorganic fluoride achieved with the normal clinical use of methoxyflurane in obstetrics are insufficient to depress serum cholinesterase activity to a clinically relevant extent. The variable and sometimes quite low levels of serum cholinesterase activity that may occur in healthy parturients should serve to caution anesthesiologists who use succinylcholine infusion for relaxation during obstetric anesthesia that prolonged apnea may occur with lower total doses of succinylcholine than would produce it in surgical patients.

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## Anesthetic Death of an Experimental Animal Related to a Scavenging System Malfunction

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In response to the mounting evidence that chronic exposure to trace levels of anesthetic gases may constitute a health hazard,<sup>1–5</sup> clinicians and researchers alike have begun to scavenge excess anesthetic circuit gases. It has been demonstrated that scavenging alone can reduce anesthetic contaminant levels in an average 4,000-cu ft operating room approximately tenfold.<sup>6</sup> Scavenging apparatus, however, adds complexity, hence hazards, to the ad-

ministration of anesthesia. A scavenger system that captures the excess anesthetic circuit gases at the "pop-off" valve and conducts them to a remote disposal point is essentially a gas-tight extension of the anesthetic circuit. Thus, in a poorly designed system with no provision for positive-pressure relief, occlusion of the scavenger system can result in elevated breathing circuit pressures, potentially harming the patient. Several disposal routes are available for elimination of excess gases. They may be passive routes, where excess circuit gases are dumped at the exhaust grill of a non-recirculating air conditioning system, downstream of the recirculating portion of a recirculating air conditioning system or outside the building via a through-wall fitting. Excess gases may also be actively removed via the central vacuum system or high-flow-low-vacuum blower system. With active scavenging there is the potential that subambient pressures can be applied to the breathing circuit and patient. In an active evacuation system, then, there must be provision for negative-pressure as well as positive-pressure relief. With scavenger system malfunction then, due either to occlusion or to direct application of vacuum pressures, wide swings in anesthetic circuit pressure can develop, necessitating provision for positive-pressure and possibly negative-pressure relief.

The following incident illustrates a malfunction in a passive, through-wall scavenger system, similar to that which might be employed in the small hospital or dental operatory. In this system, excess circuit gases flow passively from the "pop-off" valve to the outside of the building, via tubing and a through-wall connection.

#### REPORT OF INCIDENT

A 280-g Wistar rat was anesthetized with intraperitoneal pentobarbital, tracheotomized, curarized, and ventilated with a nitrous oxide-oxygen mixture on a small-animal respirator (Harvard Rodent Respirator, Model 680). As both radioactive xenon and nitrous oxide were used for the experiment, the expiratory gases were led from the respirator through a hole in the wall, using plastic tubing, 3.2 mm in internal diameter. The tubing extended 15 cm beyond the wall.

Induction of anesthesia was uneventful, and the study progressed without problem; however, 45 minutes later it was noticed that the animal was becoming increasingly distended. The blood pressure fell rapidly, and the animal died. Resuscitation attempts were unsuccessful. Following the accident, the equipment was examined, and it was found that the scavenger disposal tubing was completely blocked *outside the building* by an ice plug. Outdoor temperature during the experiment had been  $-5^{\circ}\text{C}$ . As there was no positive-pressure relief valve or alarm in the system, occlusion by the ice block had led to unrecognized, extremely high circuit pressures, resulting in pneumothorax, subcutaneous emphysema and death.

This incident while involving techniques and equipment not completely analogous to those encountered in standard hospital operating rooms, is worth considering. The night preceding the experiment, there had been a freezing rain storm, followed by a temperature drop, so that there may well have been build-up of ice on the end of the tubing prior to induction of anesthesia. The small amount of water vapor from the anesthesia circuit presumably froze and led to the ultimate complete blockage of the outlet. The small internal diameter of the disposal tubing and the lack of outlet protection facilitated this event. In the absence of positive-pressure relief, extremely high circuit pressures resulted, leading to the animal's death. For most anesthesiologists, the index of suspicion for problems occurring downstream of the ventilator or "pop-off" valve is low. The animal research system employed here lacked a circuit-pressure gauge, thereby further limiting the anesthesiologist's ability to recognize circuit pressure elevation. This report underscores the fact that when scavenging systems that exhaust excess gases to the outside atmosphere are employed, protection from occlusion by ice, insects or other foreign matter must be provided. Additionally, in all scavenging systems, both active and passive, there must be a means of positive-pressure relief proximal to the "pop-off" valve or ventilator, so that occlusion of the disposal system will not result in high pressure's being transferred to the breathing circuit and the patient. Where vacuum systems are used as the disposal route, negative-pressure relief must also be provided.

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