fusion to this patient if the hematocrit were 35 volumes per cent or lower. The figures in table 3 show that, in all probability, in six of the eight instances the patient would receive an unnecessary blood transfusion as a result of sampling error.

Although hematocrit values are seldom the sole consideration for blood transfusions, inaccurate low hematocrits may lead to needless transfusions. The sampling technique used in this study certainly does not exactly duplicate that which might be used in clinical practice. The actual numerical results presented cannot, therefore, be directly translated into routine clinical guides. The intent is to illustrate the source and potential magnitude of error. Our general observation is that one can be assured of accurate results only after six times the deadspace volume has been withdrawn. Obviously this problem can be greatly reduced if one can sample directly from the arterial catheter, but this is not always possible. Further, it should be clear that any other quantitative determinations on blood so sampled are subject to the same source of potential error.

TABLE 3. Values for the Two Sampling Techniques Calculated from the Data in Figure 1*

| Arterial Lines Used | Measured Hematocrit (Vol Per Cent ± SEM) (Actual Hematocrit = 37 Vol Per Cent) | |
|---|---|---|
| | Sample A | Sample B |
| Cutter | | |
| Single length | 31 ± 1.7 | 37 ± 1.2 |
| Double length | 29 ± 3.1 | 36 ± 2.0 |
| Cobe | 15 ± 5.0 | 34 ± 3.3 |
| Pharmaseal | 6 ± 8.2 | 29 ± 4.5 |

* Patient's actual hematocrit is 37 volumes per cent. See text and figure 1 for explanation.

## Scavenging System for the Harvey Blood Oxygenator

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Because of the current interest in scavenging waste anesthetic gases, we recently began analyzing, by gas chromatography, air in our operating rooms. We discovered that during cardiopulmonary bypass, with 0.5 per cent halothane delivered to the blood oxygenator, the halothane levels in the operating room were as great as 2.59 parts per million (ppm). This level is five times the recommended maximum of 0.5 ppm, which can be achieved by using presently available scavenging apparatus designed for the circle anesthesia system.[1] A recent clinical report[2] describes a device for removing waste anesthetic gases from the Bentley Temptrol extracorporeal oxygenator. We describe a system that effectively scavenges the adult and pediatric models of the Harvey oxygenator.

The Harvey blood oxygenator emits spent gases through a circumferential series of openings around the top of the oxygenator. To scavenge this exhaust we designed a cylindrical hood that fits loosely over the oxygenator and extends two-thirds of the way down its side (fig. 1). Attaching the hood to the oxygenator creates an interspace in which exhaust gases will circulate upward as a vacuum is created at the suction port on the top of the hood. The enclosed hood top has a groove extending to its center, which facilitates attachment of the oxygenator to its spring-loaded mounting. In addition, two holes on the top of the hood allow access to injection ports on the oxygenator. These openings in the hood rest snugly against the top of the oxygenator to minimize waste gas leakage. The cylindrical hood is open at the bottom and has a radius approximately one centimeter

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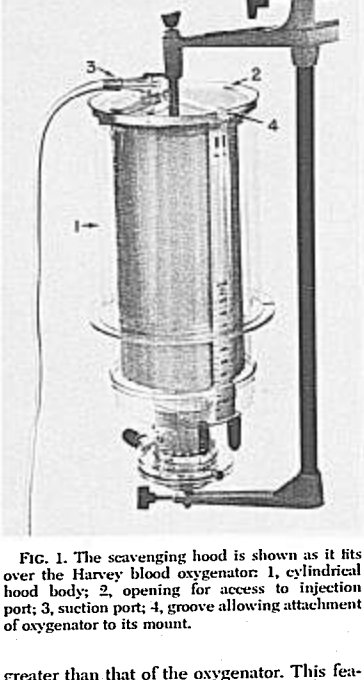


FIG. 1. The scavenging hood is shown as it fits over the Harvey blood oxygenator: 1, cylindrical hood body; 2, opening for access to injection port; 3, suction port; 4, groove allowing attachment of oxygenator to its mount.

greater than that of the oxygenator. This feature prevents applying subambient pressure to a closed system, which could disrupt the distribution of gases flowing through the oxygenator. The hood is made of transparent Plexiglas which is durable and provides an unobstructed view of the oxygenator and its contents. Scavenging occurs when gases and vapors expelled from the pump oxygenator spill into a confined space which is continuously vented into the wall vacuum system.

This scavenging hood effectively removes anesthetic gases exhausted from the Harvey blood oxygenator. Using this system with standard wall suction (35 l/min flow) we are able to reduce the level of halothane contamination next to the scavenged oxygenator to one-tenth or less of pre-scavenged levels. For example, during a recent procedure, serial measurements were made during an hour of halothane administration with 4 l/min of oxygen and 0.5 to 1.0 per cent halothane flowing through the oxygenator. At 10, 30 and 60 minutes during the hour, air samples were taken at two locations: immediately behind the anesthesiologist and also approximately 40 cm from the oxygenator where the pump technician sits. No detectable level (>0.005 ppm) of halothane was found. The efficiency of scavenging is demonstrated by the fact that concentrations as high as 600 ppm were obtained simultaneously from beneath the hood adjacent to the oxygenator exhaust ports.

In conclusion, if we are to be consistent in scavenging waste anesthetic gases, we must develop methods of retrieving those gases exhausted by blood oxygenators. We have described one system designed for the Harvey oxygenator. The scavenging apparatus is simply constructed, easy to use, does not hinder operation and monitoring of the pump oxygenator, and effectively scavenges waste anesthetic gases from the operating room.

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## REFERENCES

1. Whitcher C, Piziali R, Sher R, et al: The Development and Evaluation of Methods for the Elimination of Waste Anesthetic Gases and Vapors in Hospitals. U.S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Division of Field Studies and Clinical Investigations, Cincinnati, Ohio 45202, May 1975
2. Miller JD: A device for the removal of waste anesthetic gases from the extracorporeal oxygenator. ANESTHESIOLOGY 44:181–182, 1976