

Technique

Scavenging Anesthetic Gas from a Membrane Oxygenator During Cardiopulmonary Bypass

Michael Homishak, CCP; Steven Widmer, CCP; Richard Stauffer, MD

St. Luke's Hospital, Bethlehem, Pennsylvania

Keywords: waste anesthetic gas, scavenging, cardiopulmonary bypass

ABSTRACT

Concerns remain about the acute and chronic effects on personnel of waste anesthetic gases in the operating room environment. This study demonstrates a simple and effective means of scavenging waste anesthetic gases when halogenated anesthetics are administered through the pump oxygenator during cardiopulmonary bypass. This technique safeguards workers' health by reducing ambient anesthetic levels below the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limits.

Address correspondence to:
Michael Homishak, CCP
Perfusion Department
St. Luke's Hospital
801 Ostrum Street
Bethlehem, PA 18015

INTRODUCTION

The administration of isoflurane during cardiopulmonary bypass via a vaporizer in the gas inflow line of the pump oxygenator is a commonly accepted means to provide anesthesia and/or vasodilation. During administration of the agent, the exhaust gas from the oxygenator contains trace amounts of the anesthetic and should be scavenged both to prevent contamination of the operating room environment and to protect the health and safety of its personnel. While studies on the effects of exposure to trace amounts of anesthetic agents such as isoflurane remain inconclusive (1), the literature suggests that exposure will compromise performance by decreasing vigilance and slowing reaction time (2). The National Institute for Occupational Safety and Health (NIOSH) recommends that occupational exposure to halogenated anesthetics be controlled so that no worker is exposed at a concentration greater than 2 parts per million (3) and that effective scavenging techniques be employed to comply with these recommendations. The purpose of this investigation was to evaluate the effectiveness of a technique for scavenging waste anesthetic gas from the Bentley Univox® membrane oxygenator.

MATERIALS AND METHODS

The extracorporeal circuit consisted of a Bentley Univox® IC membrane oxygenator with integrated cardiotomy and venous

reservoir, a Medtronic BioPump TM BP-80^b blood pump, a Bentley DuraflowII® arterial filter^a, and Bentley Bypass TM 70 tubing^a. The isoflurane was administered using an Ohio Fortec^c vaporizer in the gas in-flow line of the oxygenator. The scavenging technique consisted of a 3/8 x 3/8 x 1/4 inch "Y" connected to the gas vent port of the membrane oxygenator with a four inch piece of 3/8 inch tubing. The 1/4 inch leg of the "Y" was connected to wall suction regulated to -100mmHg while the remaining 3/8 inch leg of the "Y" remained open to the atmosphere (Figure 1). This was done to prevent oxygenator pressurization and gas embolization in the event of wall suction failure or obstruction of the connecting tubing. Testing by the Baxter Bentley Division revealed no change in oxygenator performance as measured by PaO₂ and PaCO₂ when -100mmHg suction is applied to the gas vent port of the Univox® membrane oxygenator using the 3/8 x 3/8 x 1/4 inch "Y" apparatus described above (Personal Communication).

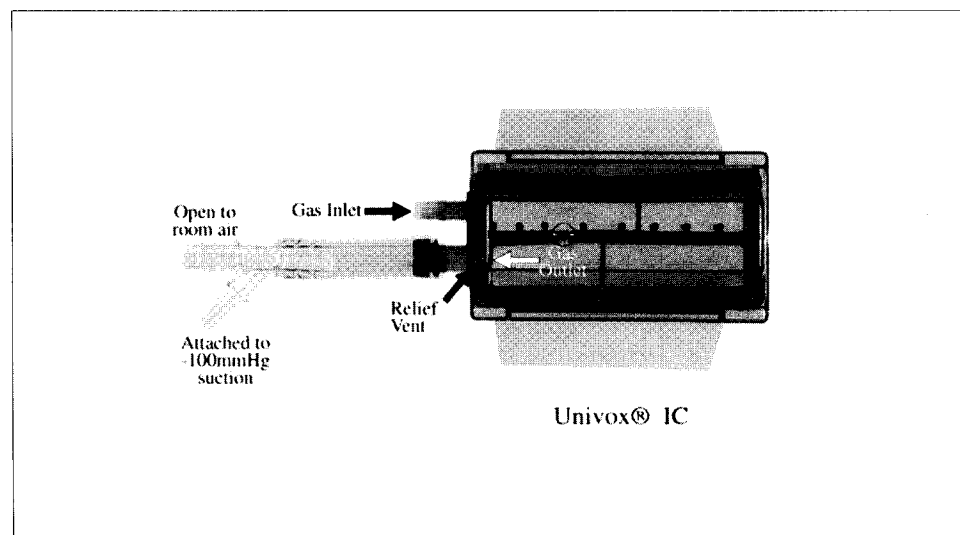
Cardiopulmonary bypass was conducted in the routine fashion with gas flow through the oxygenator at 3.5 L/min. Isoflurane was not used in the prebypass period and ambient room air sampling for isoflurane using the Miran 203 Specific Vapor Analyzer^d showed a level of 0 ppm. Suction to the scavenging device was turned on and regulated at -100mmHg. The isoflurane administration was initiated at 1%, which is less than one MAC (minimum Alveolar concentration) (4) and well below concentrations administered in a like investigation (5). After five minutes, gas analysis was performed at distances of 12 feet, 6 feet, and 1 foot from the gas vent port at heights ranging from 6-24 inches from the floor (Gas analysis courtesy of North American Drager, Telford, PA). To document the effectiveness of the scavenging technique and the proper functioning of the vapor analyzer, the wall suction was then turned off and the air sampled at one foot from the gas vent port after 30 seconds. The suction was then restarted and remained on for the duration of the isoflurane administration.

RESULTS

The level of isoflurane measured at 12 feet, 6 feet, and 1 foot from the gas vent port was zero (0) ppm while scavenging was employed. Thirty seconds after the wall suction was turned off, the isoflurane level at 1 foot from the gas vent port and 6 inches above the floor exceeded 8 ppm, the highest level the Miran 203 is capable of measuring (Figure 2).

- a Bentley Division, Baxter Healthcare Corp., Irvine CA 92714
- b Medtronic Biomedicus, Inc., Eden Prairie, MN 55344
- c Ohio Medical Products, Atlanta, GA 30336
- d Foxboro Company, Foxboro, MA 02035

Figure 1: Scavenging device



DISCUSSION

Failure to scavenge the gas vent port of a membrane oxygenator during the administration of halogenated anesthetics will contaminate the operating room environment. This contamination not only poses potential long-term health hazards to operating room personnel but it can also acutely compromise vigilance and reaction time (2,5). In view of these results we recommend routine scavenging of the gas vent port during the administration of volatile anesthetic agents during cardiopulmonary bypass. The study by McNulty et al (6) would suggest that scavenging be utilized when halogenated anesthetic agents are used immediately prior to cardiopulmonary bypass as well. This investigation documents an effective technique, like that devised by Springer et al (7), to scavenge waste anesthetic gas from a membrane oxygenator and keep anesthetic waste gas contamination in the operating room below NIOSH recommendations.

REFERENCES

1. Buring JE, Hennekens CH, Mayrent SL, et al. Health experiences of operating room personnel. *Anesthesiology*. 1985; 62:325-330.
2. Bruce DL, Bach MJ, Arbit J. Trace anesthetic effects on perceptual, cognitive, and motor skills. *Anesthesiology*. 1974; 40:453-458.
3. U.S. Department of Health, Education, and Welfare, Public Health Service Center for Disease Control, National Institute for Occupational Safety and Health: Criteria for a Recommended Standard...Occupational Exposure to Waste Anesthetic Gases and Vapors. 1-3.
4. Gilman AG, Rall TW, Niew AS, Taylor P (eds). *Goodman & Gilman's - The Pharmacological Basis of Therapeutics*. New York:McGraw-Hill. 1993; 256.
5. Justinson GA. Anesthetic waste gas management for hollow fiber membrane oxygenators. *AmSECT Proceedings*. 1988; 28-31.
6. McNulty SE, Bartkowski R, Schmitz T. Should the gas outlet port on membrane oxygenators be routinely scavenged during cardiopulmonary bypass? *J Cardiothorac Vasc Anesth*. 1992; 6(6): 697-698.
7. Springer JM, Murray BP, Romo R. Toxicity and management of waste anesthetic gases using the SciMed oxygenator. *J Extra-Corpor Technol*. 1982; 14(3): 368-370.

Figure 2: Level of isoﬂurane

