

Anaesthetic Gas Scavenging

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THE IMPORTANCE OF SCAVENGING IN THEATRE

Possible adverse health effects are an increased risk of spontaneous abortion in females, the increased likelihood of male anaesthetists to father daughters, decreased fertility, a potential increase in haematological malignancy, renal and liver dysfunction and decreased mental performance. One explanation for these effects is inhibition of methionine synthase by nitrous oxide, causing impairment of deoxyribonucleic acid (DNA) synthesis. However the evidence for these effects is not robust, with studies giving conflicting results.

The removal of waste gases is therefore an issue of health and safety and a legal requirement. Strict regulations are overseen by bodies such as the Control of Substances Hazardous to Health (COSHH) in the UK and the National Institute for Occupational Safety and Health (NIOSH) in the USA.

The maximum acceptable levels are usually given as an 8 hour time weighted average (TWA) and are listed in Table 1. Sevoflurane and desflurane have yet to be given limits but 50 ppm (parts per million) is recommended based on their similarity to enflurane.

SCAVENGING SYSTEMS

The scavenging system must be able to collect waste gases from the exhaust port of the anaesthetic circuit or ventilator, transfer them to a receiving system and from there dispose of them outside the working environment. Systems generally have four components which can vary in design and function (Figure 1). On modern anaesthetic machines they are designed for use with a central suction system, but the four components can equally be fabricated from basic materials for use in the resource poor situation.

Collecting system

This gathers excess waste gases from either the APL (adjustable pressure limiting) valve of a breathing circuit or from the exhaust port of a ventilator. To avoid accidental misconnection, the outlet fitting should be different to the 22mm and 15mm conical connections of standard breathing systems. The collecting system is usually a shrouded APL valve for use with Mapleson circuits A-D (Figure 2). One way valves can also be scavenged with either commercially available systems or, from personal experience, can easily be manufactured to fit over the expiratory port. The collecting system must not cause resistance to expiration and, for this reason, it is difficult

to scavenge T-piece systems for use with paediatric patients. A totally open system has previously been described, in which the expired gases are directed and entrained toward a scavenging dish with high flow suction. Alternatively the scavenging device shown in Figure 3 is available.

Transfer system

This usually consists of a length of tubing with a connector at either end. These

Summary

The use of anaesthetic gases, such as nitrous oxide and volatile agents, within the closed environment of the operating theatre may lead to the chronic exposure of staff with potential adverse consequences on health.

Certain agents, notably ether are potentially flammable and should not be allowed to accumulate.

This article describes the component features of anaesthetic gas scavenging systems.

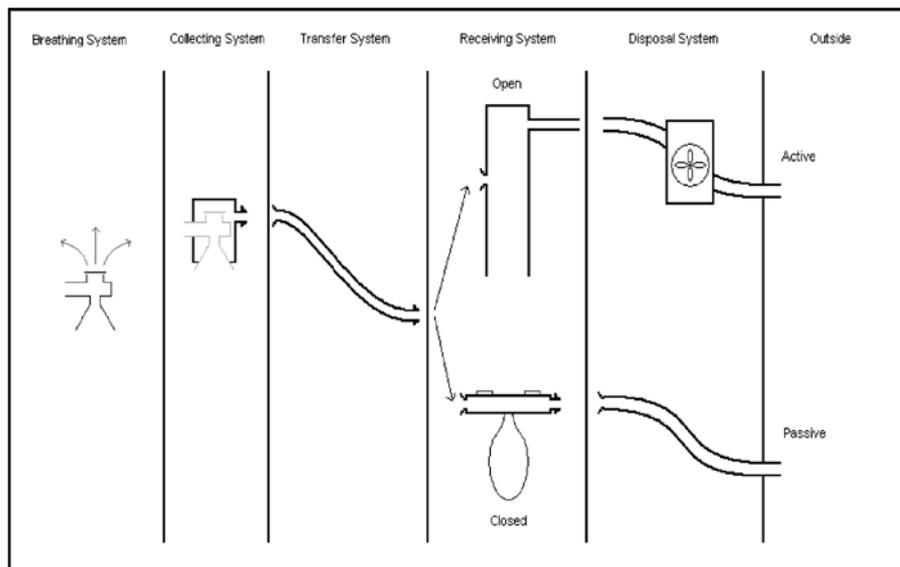


Figure 1. Components of a scavenging system showing the four components; collecting, transfer, receiving and disposal

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Table 1. Proscribed maximum levels for anaesthetic gases (TWA = time weighted average, ppm = parts per million)

Substance	Permitted Maxima in ppm as 8 hour TWA	
	UK	USA
N ₂ O	100	25
Isoflurane	50	2
Enflurane	50	2
Halothane	10	2

should also be of a different gauge to the breathing system to avoid accidental misconnection. The tubing should be less than a metre long to avoid the risk of kinking.

Receiving system

This is the main interface between the breathing system and the disposal system and must protect the patient from excessive positive or negative pressures. It also provides reservoir capacity to help cope with the peak expiratory flows from the patient circuit.

Receiving systems can be either open or closed. In a closed system, the reservoir is usually a distensible bag with positive and negative pressure release valves. This system is still popular in veterinary anaesthesia, but is much less common in developed world hospitals. In an open system, the reservoir is often a tubular structure open to the atmosphere, thus providing an air-break between the disposal system and the breathing system (Figure 4). The open system relies on an active disposal system to function.

Disposal system

These can be active or passive. In passive systems (driven by the patient's expiratory effort), exhaust gases pass along a tube through



Figure 2. The collecting system of a Bain circuit is a shroud (A) around the adjustable pressure limiting (APL) valve (B). The transfer system is labelled C



Figure 3. A scavenging device for the Ayres T-piece. Note that the reservoir bag has a closed end



Figure 4. An open receiving system; A - transfer system from breathing circuit; B - connection to wall suction

an outside wall or window and are discharged to the atmosphere. Tubing should be as short and wide as possible to minimise resistance. The outlet should be protected from the elements and should be covered with a mesh to prevent the ingress of insects. Care should be taken not to position the exterior tube in a windy position as high winds can create suction which could be transmitted to the patient. It is also possible to route a passive system via the air circulation system (if one exists), provided that it is not a recirculation system. Charcoal canisters are another passive device and are very portable. They act by absorbing halogenated gases but do not render them inert. If heated, the charcoal releases the gases. This method will not filter nitrous oxide and

they need to be refilled after every 12 hours of use, which can be a messy undertaking.

In active systems a fan or pump in the disposal system draws the anaesthetic gases through. Active methods are most effectively and safely used with open receiving systems and are the most common form of scavenging in the developed world, with hospitals now built with dedicated central vacuum systems. Fans can only function at low pressure and therefore should incorporate wide bore tubing, whereas pump systems can develop high pressures and can be used with narrow tubing. With all active systems it is mandatory to have a mechanism to protect the patient against negative pressures.

OTHER METHODS OF MINIMISING THEATRE POLLUTION

Other methods of minimising theatre pollution and reducing the impact of leaking scavenging systems, filling of vaporisers, bag-valve-mask draw-over anaesthesia, and patients in recovery areas (where expired gases are not scavenged) include adequate ventilation of theatres with 15 air changes per hour, if possible. Circle breathing systems utilising low flows will also help to reduce production of waste gases. Utilising total intravenous anaesthesia and loco-regional anaesthesia avoid the risks altogether.