ABSORPTION OF ISOFLURANE BY SILICA GEL

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SUMMARY

We have studied the capacity of the drying agent silica gel (SG) to absorb isoflurane from gas samples. When dry, SG was able to absorb 31 times its own volume of isoflurane vapour, which could be recovered almost completely from the SG by displacement with water vapour. However, we were unable to demonstrate any significant absorption of isoflurane by wet SG. Care must be taken, therefore, when using SG as a drying agent in the sampling line of an analyser during research involving volatile anaesthetic agents.

KEY WORDS


Silica gel (SG) is a drying agent with many applications in anaesthetic research. These include drying of gas samples before analysis of systems sensitive to water vapour, such as paramagnetic or katherometer-based analysers. An evaluation of a system to measure functional residual capacity during anaesthesia which used SG to dry the gas inflow to the helium and oxygen analysers indicated that the SG was removing the isoflurane present in the spirometer circuit. We have therefore undertaken a study of the absorption of isoflurane by SG.

METHODS AND RESULTS

Approximately 25 g of silica gel (6-20 mesh, self indicating, BDH, Poole, England) which had been dried by heating to 115 °C for 2 h, was poured into a 35-ml disposable syringe barrel and retained by a bung pierced with a cannula. This was connected to the output of a TEC 4 isoflurane vaporizer (Ohmeda, Keighley) set to 2% and supplied with dry nitrogen at a flow rate of 550 ml min⁻¹ (validated with a soap film bubble meter). Samples were taken every 5 min from both the inflow and outflow of the SG container, and the percentage isoflurane determined by gas chromatography against a standard prepared by addition of a known volume of liquid isoflurane to a fixed gas volume. Sampling continued until the outflow concentration was more than 95% of the inflow and the SG was then re-weighed. The experiment was repeated with the same conditions as above, but an increased nitrogen flow of 620 ml min⁻¹. Preliminary experiments had established that there was no detectable absorption of isoflurane by either the syringe and associated tubing, or a syringe containing anhydrous calcium chloride.

Despite a consistent inflow through the SG of approximately 2% isoflurane, none was detected in the outflow gas for 30 min with a flow rate of 620 ml min⁻¹, and 50 min with a flow rate of 550 ml min⁻¹. A sigmoid shaped curve showed gradual saturation of the SG, the curve being shifted to the left with the greater flow rate (fig. 1). In the first experiment the weight of SG increased by 8.2 g which is equivalent to 5.4 ml of liquid isoflurane or 1085 ml of vapour at 25 °C. From the area above the curve, we calculated the uptake of isoflurane by the SG as 5.0 ml of liquid isoflurane which compares well with the observed gain in weight. In the second experiment the weight gain was 7.4 g, equivalent to 5.0 ml liquid isoflurane (1000 ml vapour), with the area above the curve indicating an uptake of 4.23 ml.

The isoflurane was recovered from the SG by flushing with warm (60 °C) humidified air until the colour change indicated full hydration. The outflow was dried over anhydrous calcium chloride and any isoflurane in the gas flow was condensed by passage into a glass tube immersed in chippings of solid carbon dioxide (Cardice). The liquid that condensed was identified as...
isoflurane by gas chromatography and its characteristic odour. The volume collected represented recoveries of 96% and 92%.

The experiment was repeated using SG fully saturated with water and a flow of nitrogen 550 ml min⁻¹, also fully saturated at ambient temperature by a hot water humidifier. Isoflurane 2% was added to the nitrogen and allowed to flush the humidifier before being diverted through the wet SG. Outflow samples were taken every 1 min for 5 min, and the inflow sampled as before. Within 1 min, outflow concentration was 83% of the inflow, and by 4 min there was no detectable difference between inflow and outflow samples. Considering the washout of the air initially in the SG container, this represents negligible absorption of isoflurane.

COMMENT

We have shown that dry SG may absorb approximately 31 times its own volume of gaseous isoflurane, which can be recovered almost totally by displacement from the SG with a more polar compound such as water. The absorption of isoflurane is (predictably) abolished completely by hydration of the SG. These findings are not unexpected, as SG is known to absorb many organic compounds, including ethers [1], and halogenated hydrocarbons [2]. Absorption of halothane has been described previously, and SG has been used to collect atmospheric halothane over several hours to assess exposure of theatre personnel [3]. The cost of SG (£5.60 per 500 g) makes it unlikely to be of practical use for anaesthetic scavenging.

For research purposes, the absorption of iso-flurane by SG may be beneficial or detrimental, depending on the circumstances. For helium analysis in our system the removal of iso-flurane prevents its interference with the katherometer readings, but also alters the apparent helium concentration in the spirometer by an amount corresponding to the concentration of the anaesthetic. Care must be taken, therefore, when using SG in research involving modern volatile anaesthetic agents, and it may be appropriate to use calcium chloride as an alternative.

This study has not attempted to elucidate the mechanism of iso-flurane uptake by SG, or the effect of factors such as mesh size, container shape or iso-flurane concentration on our observations. We have simply demonstrated the general phenomenon, and how it affects gas analysis under the individual circumstances of our research.

REFERENCES