Conclusion

The dial setting on an anesthetic vaporizer reflects the concentration of inhalation agent delivered into the patient breathing circuit.

The dilution effect of rebreathing describes some of the difference between the vaporizer dial setting and the inspired concentration presented to the patient.

Only an agent analyzer provides an accurate inspired agent concentration value.

Additional reading

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Clinical Focus

by Datex-Ohmeda

The Dilution Effect of Rebreathing

My vaporizer says 2%.

My analyzer says the inspired agent concentration is 1.2%.

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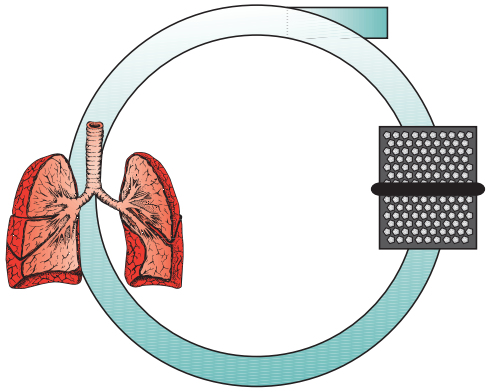

From the Breathing System Series

What happened to the other .8%?

The Dilution Effect of Rebreathing

This *Clinical Focus* , produced by the Department of Clinical Affairs, will describe the dilution effect of rebreathing seen in circle anesthesia breathing systems. Understanding the dilution effect of rebreathing will assist the clinician to understand the difference between the vaporizer dial setting and the anesthetic agent concentration actually presented to the patient.

Introduction

Recent advances in inhalation anesthetic agents, along with financial and environmental concerns, have combined to heighten interest in reducing fresh gas flows during inhalation anesthetic techniques.

With lower flow rates, the contribution that fresh gas flow and rebreathed gases make toward each breath is changed. This effect produces a difference between the inspired inhalation agent concentration compared to the vaporizer setting. This is the ***Dilution Effect of Rebreathing,*** which is seen in clinical anesthesia practice.

While the circle rebreathing system has been in use for some time, the fresh gas flow (FGF) rates that have commonly been used have allowed the dilution effect of rebreathing to remain un-noticed. When FGF is sufficiently high there may be little, if any, rebreathing of exhaled gases. Under these conditions, the dilution effect of rebreathing may essentially be absent and the inspired concentration more closely reflects the vaporizer dial setting.

Relationship of FGF, Minute Volume and rebreathing

The Minute Volume (MV) is composed of the FGF and the recirculated and rebreathed, exhaled patient gases. At higher FGFs, the major constituent of the MV is the FGF. As FGF is decreased, the exhaled patient gases contribute a more significant portion of the MV. The relationship between MV and FGF determines how much of the rebreathed gases are used for each tidal ventilation.

At higher FGFs less exhaled gases are breathed; at lower FGF more exhaled gases are required to provide the full tidal volume so more exhaled gas is rebreathed. Similarly, if the MV is increased for any reason there will be more rebreathing and, consequently, a greater dilution effect of rebreathing.

Changes during inhalation anesthesia

At the beginning of inhalation anesthesia, the clinician may elect to employ a high FGF. For some patients this high FGF may far exceed MV thereby reducing, or entirely eliminating exhaled gas rebreathing. In essence, the fact that all gases are composed of FGF makes the circle system function like a non-rebreathing system. Since inhaled gases are comprised mostly of the FGF and contain little rebreathed gases, the inhaled concentration of agent will closely reflect the vaporizer setting.

What is the actual inspired agent concentration?

The actual concentration of inhalation agent in the inspired gases is a physical mixture of agent concentrations in the fresh gas and the fraction of the exhaled gas which is rebreathed. The exact inspired concentration is difficult to compute mathematically since it depends on many subtle phasic aspects of circuit gas mixing with constant fresh gas flow and breathing cycles. With increasing dependence upon rebreathing (lower FGF or increased MV), the value of the inspired agent concentration will differ more from the setting on the vaporizer. The need for accurate agent analysis increases in these circumstances. An accurate, calibrated agent analyzer is invaluable and necessary.

How do I achieve the desired inspired agent concentration?

Assuming an accurate agent analyzer, the vaporizer setting must be titrated to achieve the desired inspired agent concentration. Depending on the FGF and the MV this may require higher vaporizer settings.

Additional factors

There are other factors, which may contribute to differences between vaporizer dial setting and reported agent concentration. Among these are:

- Tidal volume compensated ventilators
- Method of calibration used for the vaporizer (oxygen versus air)
- Vaporizer type (conventional versus electronic)
- Type of agent analyzer used (peak-to-peak versus mean inspired agent analysis)