CASE STUDY

Hypoxic guard systems – how safe are they?

A brief interview with Dr. Jan Hendrickx, expert in kinetics of inhaled agents and carrier gases, on today´s deficient safety standards and possible solutions.

Flow Anesthesia Family | O_2 Guard

Hypoxic guard systems

Safety standards and solutions

What is the typical problem with hypoxic guard systems of anesthesia machines?

Hypoxic guard systems are one of the safety systems in anesthesia machines that are designed to avoid the risk of delivering a hypoxic gas mixture to the patient during general anesthesia. Unfortunately, the standards for anesthesia machines are not very clear regarding hypoxic guard systems, which allow the manufacturers to design a system that only prevents the formation of a hypoxic mixture (N_2O with an O_2 concentration less than 21%) in the fresh gas, but not in the inspired gas.

In our studies we have seen that these systems may fail to maintain the inspired O_2 concentration (F_iO_2) ≥ 21% when a second carrier gas is used, especially during low flow anesthesia. Failure can happen, despite a properly functioning hypoxic guard, because re-breathing can lower the F_iO_2 more than the machine standards anticipated. This means that it is easy for inspired hypoxic mixtures to be formed even when the set O_2 concentration is 21% or even 25% or higher!

What are the consequences for O_2 concentrations during low flow anesthesia?

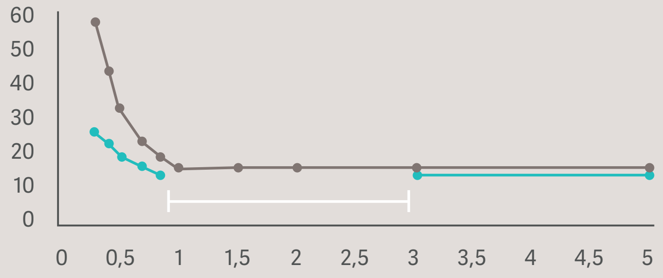
Lowering fresh gas flow in a circle system results in a difference between the delivered O_2 concentration (at the common gas outlet; F_D) and F_iO_2, if a second carrier gas is being used – the result of rebreathing. Consequently, F_iO_2 becomes lower than F_DO_2.[1,2] Unfortunately, this may not always be sufficiently recognized, and if settings are not adjusted, then hypoxic mixtures can develop.

Further reading

Clinical study *Hypoxic guard systems do not prevent rapid hypoxic inspired mixture formation*[2] shows the failure of a hypoxic guard system that is even more stringent than required by anesthesia machine standards. Access the article, including supplementary video, here: https://doi.org/10.1007/s10877-014-9626-y

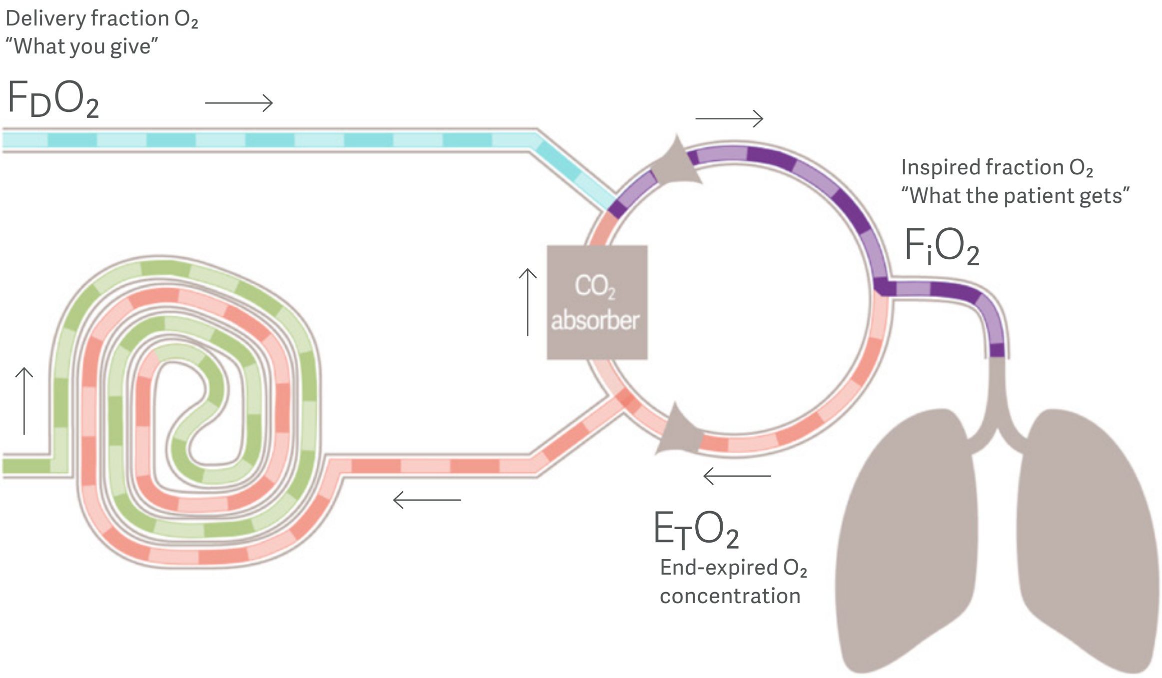
Do you think a F_iO_2 alarm would be enough for the anesthesiologists?

We think that the anesthesia provider may be confused about what causes an alarm, also because existing hypoxic guard systems give a false sense of security. That is why, when F_iO_2 < 21%, it is very important that the machine overrides the anesthesiologist's settings if no action is being taken by the provider.[4]



The unsafe zone

Hypoxic guard limits (gray line) did ensure F_IO_2 (blue lines) remained ≥ 21 % with FGF outside the white FGF area, but not when the FGF was in the "unsafe zone" between 0.7–3 L min.[2] The white line represents the zone where F_IO_2 might be lower than 21%.



Circle system illustrating the O_2 dilution effect. It includes a Volume Reflector for rebreathing. Other solutions could be bellows, piston etc.

What is the difference between the Flow Family's O_2Guard and the hypoxic guards of conventional anesthesia machines?

The O_2Guard is a smart hypoxic guard system that actively intervenes when $F_iO_2 < 21\%$. With the Flow Family, if F_iO_2 decreases below 21% for 18 s, the system will automatically increase the O_2 fresh gas flow and the F_DO_2 restoring F_iO_2 to at least 25% within 55 s after its activation.[3,4]

All in all, what is your impression of O_2Guard?

The Flow Family O_2Guard is the only commercially available active inspired hypoxic guard that limits the duration of inspired hypoxic episodes during anesthesia caused by shortcomings of existing delivered hypoxic guard systems.[4]

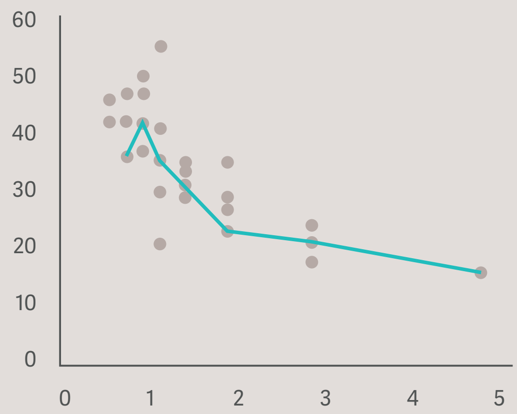
O_2Guard´s unique three step approach

Further reading

Clinical study *Performance of an active inspired hypoxic guard,*[4] with supplementary video, can be accessed here: https://doi.org/10.1007/s10877-015-9684-9.

Time from O_2Guard activation to F_iO_2 restoration to 25 %

Time (s) from O_2Guard (Flow-i) activation until F_iO_2 = 25 % for each F_DO_2 /FGF combination. Each symbol represents the values of one patient; the blue line connects the median values.[3]



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References

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2. De Cooman S, Schollaert C, Hendrickx JF, Peyton PJ, Van Zundert T, De Wolf AM. Hypoxic guard systems do not prevent rapid hypoxic inspired mixture formation. J Clin Monit Comput. 2014 Oct 1, published ahead of print.
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4. Hendrickx JF, De Wolf AM, De Hert S. O2, anybody? Eur J Anaesth 2015, 32:371–373.

Read more about O_2 Guard at www.getinge.com/o2guard

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