CASE STUDY

Flow Anesthesia Family | $O_2$Guard

# 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.

# 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?

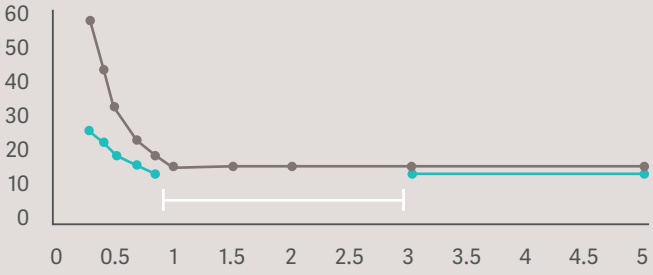
Lowering fresh gas flow in a circle system results in a difference between the delivered $O_2$ concentration (at the common gas outlet; FD) and $F_IO_2$, if a second carrier gas is being used — the result of rebreathing. Consequently, $F_IO_2$ becomes lower than $F_IO_2$.[1,2] Unfortunately, this may 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.

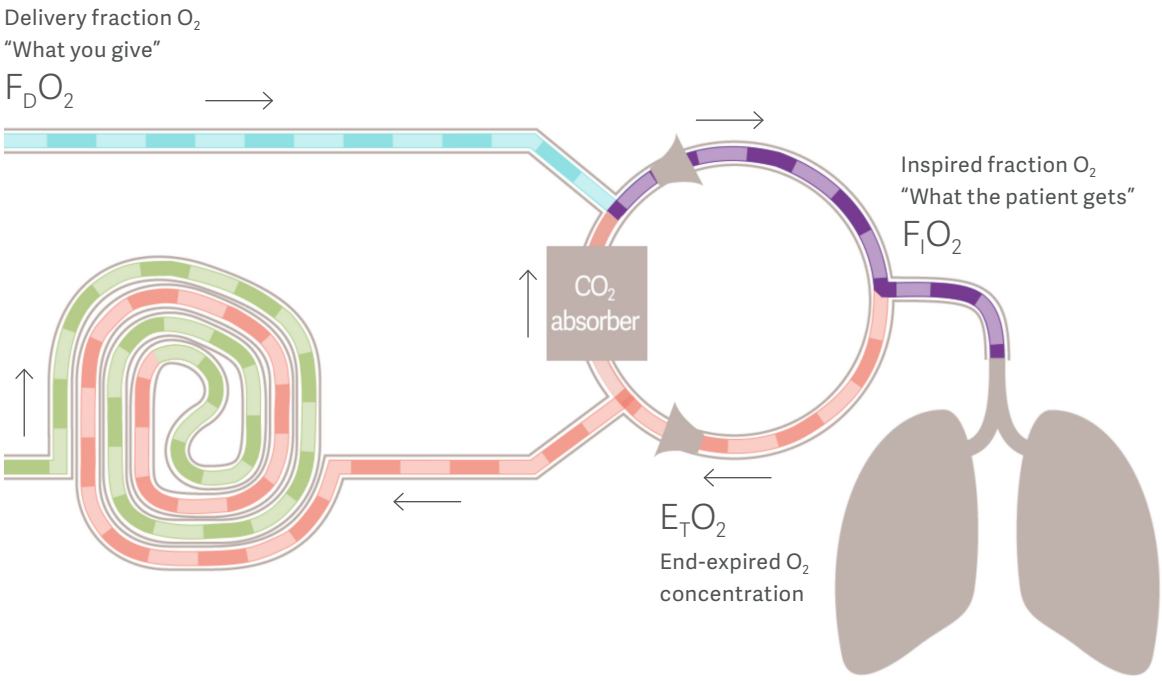
### Do you think a $F_IO_2$ alarm would be enough for the anesthesiologists?

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 $O_2$Guard and the hypoxic guards of conventional anesthesia machines?

The $O_2$Guard 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 sec., 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 sec. after its activation.[3,4]

## All in all, what is your impression of $O_2$Guard?

The Flow Family $O_2$Guard 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]

## $O_2$Guard´s unique three-step approach


Low $F_IO_2$ alarm

$O_2$ 60%
FGF 1 L/min.

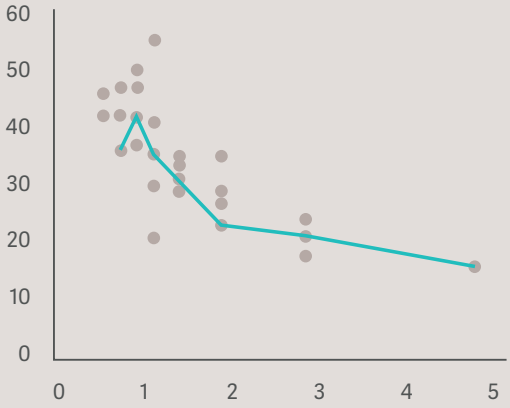
$O_2$ safety flush
FGF 3 L/min.

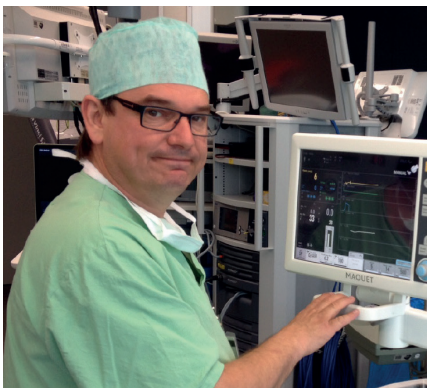
## Further reading

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 $O_2$Guard activation to $F_IO_2$ restoration to 25 %

Time (s) from $O_2$Guard (Getinge 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


1. Hendrickx JF, De Cooman S, Vandeput DM, et al. Air–oxygen mixtures in circle systems. *J Clin Anesth.* 2001 Sep;13(6):461-4.
2. De Cooman S, Schollaert C, Hendrickx JF, et al. Hypoxic guard systems do not prevent rapid hypoxic inspired mixture formation. *J Clin Monit Comput.* 2015 Aug;29(4):491-7.
3. Ghijselings IE, De Cooman S, Carette R, et al. Performance of an Active Inspired Hypoxic Guard. *J Clin Monit Comput.* 2016 Feb;30(1):63-8.
4. Hendrickx JF, De Wolf AM, De Hert S. O2, anybody? *Eur J Anaesth.* 2015 Jun;32(6):371-3.


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