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 (N₂O with an O₂ 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 O₂ concentration (F₈O₂) ≥ 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 F₈O₂ more than the machine standards anticipated. This means that it is easy for inspired hypoxic mixtures to be formed even when the set O₂ concentration is 21% or even 25% or higher!

**Further reading**

Clinical study *Hypoxic guard systems do not prevent rapid hypoxic inspired mixture formation* 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](https://doi.org/10.1007/s10877-014-9626-y)

**What are the consequences for O₂ concentrations during low flow anesthesia?**

Lowering fresh gas flows in a circle system results in a difference between the delivered O₂ concentration (at the common gas outlet; F₈) and F₈O₂, if a second carrier gas is being used – the result of rebreathing. Consequently, F₈O₂ becomes lower than F₈O₂. Unfortunately, this may not always be sufficiently recognized, and if settings are not adjusted, then hypoxic mixtures can develop.

**Do you think a F₈O₂ 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 F₈O₂ < 21%, it is very important that the machine overrides the anesthesiologist’s settings if no action is being taken by the provider.

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**The unsafe zone**

Hypoxic guard limits (gray line) did ensure F₈O₂ (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. The white line represents the zone where F₈O₂ might be lower than 21%. 

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CASE STUDY: ANESTHESIA FLOW-I O₂ GUARD
**What is the difference between the Flow-i’s O₂ Guard and the hypoxic guards of conventional anesthesia machines?**

The O₂ Guard® is a smart hypoxic guard system that actively intervenes when F\(_{I \ O_2}\) < 21%. With the Maquet Flow-i®, if F\(_{I \ O_2}\) decreases below 21% for 18 s, the system will automatically increase the O\(_2\) fresh gas flow and the F\(_{D \ O_2}\) restoring F\(_{I \ O_2}\) to at least 25% within 55 s after its activation.³,⁴

**All in all, what is your impression of O₂ Guard?**

The Flow-i O₂ 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

**O₂ Guard’s unique three step approach**

1. Low F\(_{O_2}\) alarm
2. O\(_2\) & FGF ↑
3. 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 O₂ Guard activation to F\(_{O_2}\) restoration to 25 %**

Time (s) from O₂ Guard (Maquet Flow-i) activation until F\(_{I \ O_2}\) = 25 % for each F\(_{D \ O_2}\) / FGF combination. Each symbol represents the values of one patient; the blue line connects the median values.⁵
References


