# Correspondence

## Concepts of Arterial Oxygen Saturation in the Presence of Carboxyhemoglobin

*To the Editor*:

The letter by Hol and coworkers (1) serves as an example that the intricacies of carbon monoxide poisoning in conjunction with the various methods to measure arterial blood oxygenation are difficult concepts, and in their effort to clarify some of the issues, the authors may have left some readers more confused.

When a middle-aged male with a history of a past suicide attempt is found unconscious within an enclosed space in the presence of fuel-burning appliances, intentional CO poisoning should immediately come to mind. It should not require 3 days and the discovery of a dead canary to prompt the diagnosis.

While it may be true that mechanical ventilation (on oxygen) for 16 hours would clear circulating blood carboxyhemoglobin (COHb), it still may not be too late to make a diagnosis. One should call the lab to see if they saved an anticoagulated emergency department blood sample, as COHb can still be accurately measured on it. Carboxyhemoglobin is stable for at least a month in anticoagulated blood collection tubes used for routine tests in the emergency department, including those with light blue caps containing citrate and used for coagulation assays, and those with green caps containing heparin and used for plasma electrolyte measurements (2).

While CO poisoning is common in the United States, the citation used to support an incidence of 10,000 cases per year is quoting an estimate made in 1929 by the US Public Health Service (3). Now, over 80 years later, there exist more contemporary estimates of incidence that are substantially greater (4).

Regarding oxygen saturation, it is well known that it cannot accurately be measured in the presence of significant amounts of dyshemoglobin on a 2-wavelength pulse oximeter, nor can the proportions of dyshemoglobin be identified (5). When the authors write about the patient's "percutaneous oxygen saturation of 99%," they likely mean "transcutaneous" (noninvasive) oxygen saturation.

Finally, most new arterial blood gas analyzers sold today include spectrophotometry and measure COHb and methemoglobin automatically. I suspect that the instrument in Hol and colleagues' hospital does, too. Otherwise, I do not understand how a "reevaluation of the patient's initial blood gas analysis" could reveal a COHb of 25.4%. I suspect that the lab had the value but did not report it because the clinicians did not request it.

**Author disclosures** are available with the text of this letter at www.atsjournals.org.

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### References

1. Hol S, de Vooght KMK, van der Spoel JJI, van Solinge WW, Kemperman H. A 56-year old man with an apparently normal oxygen saturation and a dead canary [letter]. *Am J Respir Crit Care Med* 2013;186:928–929.
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## Reply

*From the Authors*:

We thank Dr. Hampson for his interest in our letter in which we discuss how reported oxygen saturation parameters can be misleading in diagnosing carbon monoxide (CO) intoxication (1).

We appreciate the suggestion to reanalyze, in similar cases, a stored anticoagulated blood sample drawn at admission, to get the initial CO-Hb result. However, if the initial blood gas was performed on a blood gas analyzer with a CO-oximetry module, as in our case, this is not necessary, since these analyzers measure all available parameters whether they are requested or not. In our case, the initial CO-Hb result could easily be retrieved from the data stored in the analyzer.

Dr. Hampson further mentions that it should not require 3 days to make the diagnosis of CO intoxication when a middle-aged male with a history of a past suicide attempt is found unconscious within an enclosed space in the presence of fuel-burning appliances. We agree that the diagnosis should have been made directly on arrival of the patient, if this information would have been available, but certainly after the first blood gas sample was analyzed. Therefore, to prevent such a delay in the future, we decided to automatically report all elevated CO-Hb results (>10%) even if the test was not requested. However, and we cannot stress this enough, this only works if all blood gas analyzers used within the hospital are equipped with a CO-oximetry module, which is often not the case.

Due to the use of pulse-oximetry and the widespread introduction of point of care (POC) analyzers, which often lack a CO-oximetry module, it is more important than ever before that laboratory staff and clinicians are aware of the limitations of the different analyzers and know how to interpret results from different types of analyzers. In our 1,042-bed academic hospital, we have three blood gas analyzers with a CO-oximetry module in the central lab and 60 i-Stat POC analyzers without CO-oximetry at different departments throughout the hospital. These POC analyzers can only report estimated saturations that are not affected by dyshemoglobins like CO-Hb.

Therefore, it is important that clinicians realize that whenever CO intoxication is suspected blood samples should be routed to and analyzed on a blood gas analyzer with a CO-oximetry module that always automatically reports elevated CO-Hb results or reduced $FO_2Hb$ results.

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1. Hol S, de Vooght KMK, van der Spoel JJI, van Solinge WW, Kemperman H. A 56-year-old man with an apparently normal oxygen saturation and a dead canary [letter]. *Am J Respir Crit Care Med* 2012;186:928–929.

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