Mini Review

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Why hemolysis detection should be an integral part of any near-patient blood gas analysis

Abstract: Blood gas analysis at or near the patient’s bedside is a common practice in acute medicine and plays a crucial role in the diagnosis and management of patient’s respiratory status, metabolites, electrolytes, co-oximetry and acid–base balance. Pre-analytical quality aspects of the specimens are getting more and more attention, including the presence of potential interferences. Central laboratories have implemented technologies to detect interferences such as hemolysis, lipidemia or hyperbilirubinemia in blood samples to ensure the highest possible quality in results provided to routine care. However, systematic detection for interference due to hemolysis is currently not in place for blood gas analysis at the point-of-care (POC). To apply hemolysis detection solutions at the central laboratory, but not at the POC for blood gas analysis, is a clear contradiction when novel hemolysis detecting technologies are available. The introduction of a system that systematically detects hemolysis in connection to POC blood gas analysis would be imperative to patient safety and costs associated with potential clinical malpractice (leading to wrong, missing and/or delayed treatment) and would also ensure better compliance to CLSI guidelines and ISO standards, and be beneficial for patient and staff.

Keywords: blood gas analysis; hemolysis; patient safety; point-of-care (POC); pre-analytical errors.

Topical background

Blood gas analysis at or near the patient’s bedside is a common practice in acute medicine and one of the most used point-of-care tests (POCT) in laboratory medicine. It plays a crucial role in the diagnosis and management of patient’s respiratory status (pO₂, pCO₂, sO₂), metabolites (glucose, lactate etc.), electrolytes (sodium, potassium etc.), co-oximetry (tHb, O₂Hb etc.) and acid–base balance (pH, HCO₃⁻). This is especially true in settings which require quick analytical results such as the emergency departments and intensive care units (ICUs). Modern blood gas analysis provides rapid evaluation of traditional blood gas elements and acid–base as well as some clinical chemistry parameters. The pre-analytical quality of the specimens are getting more and more attention, including the presence of potential interferences, such as hemolysis (elevated free hemoglobin due to the lysis of red blood cells) [1].

Arguments and related evidence why hemolysis detection should be an essential functionality in blood gas analyzers

In the following, we present arguments and related evidence why hemolysis detection should be an essential functionality in blood gas analyzers, giving supplementary information in the result report produced by the blood gas analyzer.

(1) Hemolysis can frequently be found in heparinized blood gas samples. The body of evidence is growing which indicates that the prevalence of clinically relevant hemolysis in POC blood gas analysis is just as

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common as in blood samples sent to central laboratories for analysis. One large study has e.g., shown that 8% of blood gas samples in an ED were hemolyzed above the laboratory threshold for potassium [3–6]. Certainly, it can be assumed that in the ED the rate of hemolysis is higher than in normal wards due to the given circumstances.

(2) Blood gas analyzers produce results for measurement that are affected by hemolysis which has clinical relevance, e.g. pO₂, pCO₂, Ca²⁺ and potassium [8]. Hence, clinicians base their clinical decisions on distorted data when hemolysis occurs.

(3) Patients with cardiovascular and renal diseases that require emergency care and have abnormal biochemical results, which are sensitive to hemolysis, have longer hospital stays and higher mortality rates [9–12]. These frail patient populations are common in the ED and laboratory diagnostics is fundamental for optimal patient treatment.

(4) Many physicians distrust the results produced by blood gas analyzers, given the inconsistencies and absence of an objective control function [13]. Hence, the time value gain might be lost if physicians arbitrarily order new blood gas analyses or need to wait for central laboratory results, before clinical decisions are made. Thus, finally the use of patient-near blood gas analyses depends on the degree of subjective trust that the individual physician has in the device.

(5) The Clinical and Laboratory Standards Institute (CLSI) C46-A2 guideline advises against processing unsuitable specimens for blood gas analysis, given the above-mentioned interferences [14]. The measurement of decayed samples, however, can only be avoided if the problem (here: hemolysis) has been clearly identified. Additionally, ISO 22870 requirements, being accreditation standard for POCT used by medical laboratories, are likely not fulfilled. E.g., it states that the laboratory shall have a procedure to prevent the release of patient results in the event of quality control failure, and that harmonization between main laboratory equipment and POCT devices, also with regard to pre-analytical issues, is essential, etc.

(6) There are technologies available in the market that can measure hemolysis based on whole blood samples. Earlier, the lack of hemolysis detection capability had to be accepted by clinicians since there were no good options in the market. In later years this has changed and there are now options in the market. E.g., the Hemcheck concept is a CE-marked POC hemolysis test with official performance claims of a sensitivity of 80% and a specificity of 95% based on the standard cut-off setting of 0.5 g/L (HI 50) free hemoglobin concentration. Performance evaluation studies based on a cut-off of between 0.5 g/L (HI 50) and 1.0 g/L (HI 100) free hemoglobin concentration show sensitivities of 80–90% and specificities of 97–99.9%.

Summary and outlook

Globally, central laboratories have implemented technologies to detect hemolysis in blood samples, for comprehensible reasons given the important analytical interferences and faults that can arise. To apply hemolysis detection solutions at the central laboratory, but not at the POC for blood gas analysis, is a clear contradiction when novel hemolysis detecting technologies are available.

In view of the above, we believe it is imperative to patient safety and costs associated with potential clinical malpractice (leading to wrong, missing and/or delayed treatment); to introduce a system that systematically detects hemolysis in connection to POC blood gas analysis. It would also ensure better compliance to CLSI guidelines and ISO standards, as well as be beneficial for patient and staff. The ultimate goal is always to ensure better quality of care and higher safety for the individual patient.

It is important for clinicians (users) and purchasers of blood gas analyzers to know that there are suppliers in the market with CE marked solutions for the hemolysis problem. We believe that by making hemolysis detection a requirement in blood gas analysis, this will also force manufacturers to speed up their own developments for the hemolysis detection in order to ensure patient safety.

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