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Undetected discrepancies between pO_2 and sO_2 values in arterial blood gases

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Recently, a staff member of our clinical laboratory received a call from the ICU-staff with the remark that frequently discrepancies were found between pO_2 and related sO_2 levels, the latter being too high for the related pO_2. Since we had not noticed this problem, we started a comparison between our two ABL800flex blood gas analyzers (ABL1 and ABL2, Radiometer, Denmark).

Method

We compared 14 arterial blood gases with a $pO_2 \leq 70$ mmHg and a pH 7.35 – 7.45 on both analyzers, with a maximum time between the 2 measurements of 10 minutes. Six out of 14 samples were first measured on ABL1 and the other 8 on ABL2. Samples with a $pO_2 \leq 70$ mmHg were used because we wanted to focus on the steep part of the oxygen-hemoglobin-dissociation curve, since discrepancies between pO_2 and related sO_2 levels are more easily seen in this range.

Results

The results from ABL1 and ABL2 were compared with corresponding values of the oxygen-hemoglobin dissociation curve (pH 7.4), based on the article by Severinghaus (1). Mean pH (ABL1 7.4 (0.1) vs. ABL2 7.4 (0.1), mean (SD)) and mean pO_2 (ABL1 64 (9.3) vs. ABL2 63 (8.0) mmHg) were not significantly different on both analyzers. However, we found that ABL2 consistently reported higher sO_2 values in comparison to ABL1 (ABL1 92 (6.2) vs. ABL2 95 (4.3) %, paired t-test: $P<0.01$), and, as a consequence, sO_2 values produced by ABL2 differ significantly from those produced by ABL1 in comparison to calculated oxygen saturation values of the oxygen-hemoglobin-dissociation curve (ABL1: 1.2 (1.1) vs ABL2: 4.2 (1.3) %, paired t-test: $P<0.001$), thereby confirming the observation of the ICU-staff (figure 1). This finding prompted us to review our quality control data from the last months, using our scores in the Radiometer Worldwide Data Check (WDC), which showed no abnormalities. In our laboratory, aberrant blood gas values are also detected by VALAB, our laboratory data validation system, to be authorized by the clinical chemist. Unfortunately, the pO_2/sO_2 discrepancy was not noted in this final authorization step, probably due to a combination of VALAB settings and unawareness of this possible problem by the clinical chemist, since the QC summaries (WDC) were normal.

Radiometer was contacted and during examination and calibration of the ABL2 a problem with the cuvette was noted, where after the hemolyzer unit in ABL2 was replaced. A new comparison between ABL1 and ABL2 revealed no significant differences in pH (ABL1 7.4 (0.1) vs. ABL2 7.4 (0.1)), pO_2 (ABL1 62 (6.6) vs. ABL2 62 (6.9) mmHg), and sO_2 (ABL1 92 (3.0) vs. ABL2 92 (3.6) %, mean (SD)). More importantly, both ABL analyzers reported an sO_2 comparable with the oxygen-dissociation curve values at pH 7.4 (difference in sO_2: ABL1 0.9 (2.1) vs. ABL2 0.9 (1.9) %).

Discussion and conclusion

Although the problem was solved, we were not satisfied because there was still no guarantee for timely detection of similar problems in the future. In addition to the replacement of our hemolyzer unit, Radiometer also performed a thorough investigation on this unknown problem. Indeed, a defect was found in the cuvette of the hemolyzer unit, which may have lead to

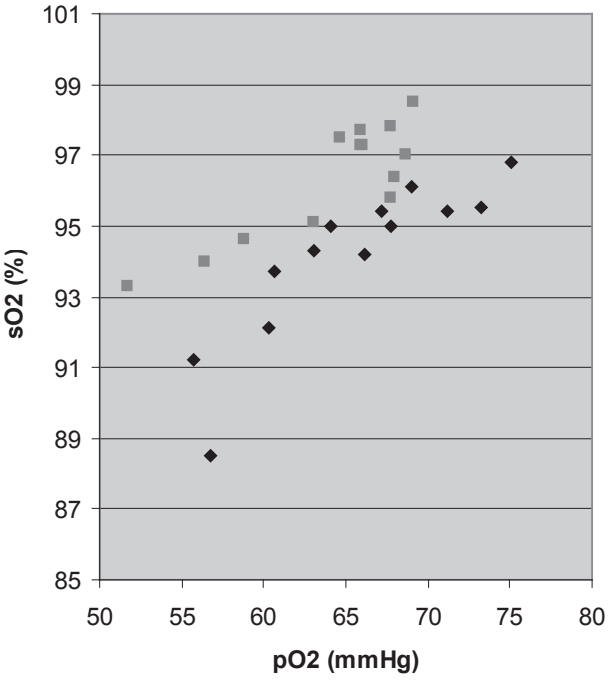

Figure 1. Reported sO_2 values from our two ABL800flex blood gas analyzers, showing that ABL2 consistently reported higher oxygen saturation values. ◆ ABL 1; ■ ABL 2

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defective flow-through of the washing solution. Subsequently, the remaining washing solution in the cuvette may increase oxygen levels in blood containing low levels of oxygen due to tonometry and thereby alter the absorption pattern of oxygenated hemoglobin, eventually leading to increased oxygen saturation measurements. Also, Radiometer performed an analysis on our individual QC results. We use 4 different pO_2-levels in our daily QC-routine, one level representing a pO_2 of 68,5 mmHg. No significant changes or trends were noted during examination of the WDC reports between ABL1 and ABL2, since the QC material used for oxygen saturation measurements is not susceptible to tonometry and in this aspect differs from patient samples Interestingly, the QC of ABL2 showed 5 outliers for oxygen saturation and hemoglobin in the last 70 data points before the hemolyzer unit was replaced. Outliers are a known problem in the daily QC practice of the clinical laboratory, and most outliers are inexplicable. In this case, the outliers were noted by our laboratory personnel, and QC was repeated on ABL2, which produced normal results. Since no cause for the outliers was found, daily laboratory practice continued unchanged, and falsely elevated oxygen saturation data were reported to our clinicians, until the remark from our ICU. The degree of falsely elevated results is minor in the normal range of arterial samples as these, with their high pO_2 values, are placed on the flat part of the oxygen-hemoglobin-dissociation curve. In conclusion, this problem in the cuvette of the hemolyzer unit was displayed in two different ways; by outliers in QC results and by increased oxygen saturation in patient material, probably due to the different nature of both materials.

To prevent this problem in the future, we changed our VALAB settings and informed our personnel on the importance of individual outliers in the QC of the ABL blood gas analyzer, as recommended by Radiometer.

This report indicates that the presence of sporadic, randomly occurring outliers in Radiometer QC material already may indicate a problem with the blood gas analyzer, although the majority of the QC results are within the normal range. Therefore, thorough analysis of individual QC results is necessary to control the functioning of the blood gas analyzer, and preferable over the WDC summary.

References

1. Severinghaus JW. Simple, accurate equation for human blood O_2 dissociation computations. J Appl Physiol. 1979; 46(3): 599-602.

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Verbetering van de logistiek rondom het bloedafnameproces

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Veranderingen in het zorgstelsel initiëren concurrentie tussen de ziekenhuizen onderling en ook bij de ziekenhuis- en huisartslaboratoria. Patiënten (cliënten) kunnen een ziekenhuis kiezen. Daarbij wordt o.a. gelet op korte wachttijden, snelle service, aandacht voor de klant, optimale (na-)zorg en eventuele extraatjes, zoals een kopje koffie, gratis krant etc.

Per dag bezoeken ca. 250 cliënten het afnamelaboratorium van het Medisch Centrum Alkmaar. Inzicht in de tevredenheid en (veranderende) wensen van cliënten van het afnamelaboratorium is derhalve belangrijk. Ondanks een hoge overall score voor tevredenheid (gemiddeld 8,2), en een vrij acceptabele beleving van de wachttijd, kwamen er relatief gezien toch veel opmerkingen over lange wachttijden in het afnamelaboratorium.

Op grond van de resultaten van de patiënttevredenheidsonderzoeken en het belang van een efficiënte bedrijfsvoering is er met de medewerkers van het afnamelaboratorium in 2010 een project gestart om de logistiek rondom het bloedafnameproces in het afnamelaboratorium door te lichten en te verbeteren.

Binnen het afnamelaboratorium worden meerdere patiëntenstromen onderscheiden, namelijk patiënten voor routine-bloedafname, cito-bloedafname, afgifte materialen en overig (o.a. ophalen materialen). Een goede procesbeheersing van deze patiëntenstromen draagt bij aan een hoge zorgverlening. Efficiëntie en effectiviteit worden bereikt wanneer er een goede informatievoorziening plaatsvindt naar de medewerkers van het afnamelaboratorium.

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Methode

Q-Matic Patiëntbegeleidingssysteem

Voor logistieke procesbeheersing van de verschillende patiëntenstromen op het afnamelaboratorium is in juni 2011 het Q-Matic Patiënt Begeleidingssysteem