A method for calculation of arterial blood gas values from measurements in the peripheral blood (v-TAC)
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Background

Arterial blood gas (ABG) sampling is an essential assessment of patient’s acid-base and blood gas status, especially in patients with chronic stable ventilatory failure; however, sample collection is complex and unpleasant. Venous blood gas (VBG), in comparison, is straight forward and is less painful for the patient. A method (named v-TAC® OBI Medical, Denmark) mathematically arterialises venous blood gas values. Our study aimed to validate this method in patients with chronic stable respiratory failure.

Peripheral venous blood differs from arterial blood by its content of oxygen and carbon dioxide. In critical ill patients in particular, the arteriovenous (A/V) difference is unpredictable, which is illustrated in Figure 1, where example A) in the pCO2 plot illustrates a large A/V difference in pCO2 of 2.5 kPa, and B) illustrates a very small A/V difference. However, arterial blood values can be calculated by removing CO2 and adding O2 in a constant ratio (RQ) that reflects the metabolism of tissue. v-TAC is a mathematical blood model implemented into software, that simulates addition of oxygen to the peripheral venous blood until simulated oxygen saturation matches what is measured non-invasively from a pulse oximeter. The amount of oxygen added in this simulation is then used to calculate the amount of CO2 removed, and as a consequence the complete arterial oxygen and acid-base status can be determined with great accuracy.

Methods

Consecutive sample pairs were collected on patients in chronic stable ventilatory failure. An arterial blood gas and a venous blood gas were measured using a Roche COBAS b221 blood gas analyser and pulse oximetry was measured for each patient. The minimal interval possible was sought between measurements and less than 5 minutes was achieved. An independent researcher performed the arterialisation of the venous blood gas values, blinded to the arterial blood gas result. Primary outcome was agreement between mathematically arterialised venous values and arterial values for pH, pCO2, and pO2.

Results

Twenty sample-pairs (from 20 patients) were studied. pH mean difference was 0.001 with 95% limits of agreement of ±0.028. r² was 0.892. pCO2 mean difference was -0.14 kPa with 95% limits of agreement of ±0.54 kPa. r² was 0.966. pO2 mean difference was -0.20 kPa and 95% limits of agreement of ±1.52 kPa. r² was 0.727.

See agreement between arterial and v-TAC (black)/venous (blue) in the Bland-Altman plots in the Figure 1 below.

Conclusion

For patients in chronic stable ventilatory failure, agreement between arterial and mathematically arterialised venous values was close. v-TAC may be a clinically useful tool in this group of patients with several potential benefits in clinical practice, compared to current practice.

Discussion

The results from this study are in line with results from previous studies, and, furthermore, the results are comparable with results from previous studies, studying the performance of capillary blood gas vs arterial, and studies studying repeatability of arterial blood gas vs arterial blood gas. Since venous blood sampling can be done easily by most nurses and other trained healthcare personnel, this raises the question if application of v-TAC potentially can enable clinical improvements and efficiency, while reducing patient pain and side effects by reducing the need for arterial punctures.

References