Dear ladies and gentlemen, dear ADVOS users and interested parties,
we are pleased to present you another issue of our ADVOS Literature Service. We regularly select one or more papers from international journals which might be of interest to you in connection with our ADVOS procedure. This month we have selected the following:

RESPIRATORY AND METABOLIC ACIDOSIS CORRECTION WITH THE ADVANCED ORGAN SUPPORT SYSTEM.

Perez et al.

Key message

The regulation of acid-base balance is a complex process where the lungs, the kidney and the liver are involved. A multiple organ approach is therefore needed. The ADVOS therapy can correct acidosis thanks to the albumin containing dialysate. The pH of the dialysate can be adjusted to meet the needs of each patient. The correction of acidosis is achieved through the direct elimination of acid from blood. CO_2 is eliminated through a concentration gradient of HCO_3^- between blood and dialysate and direct acid elimination. The most determinant settings for acidosis correction and CO_2 removal are blood flow, dialysate pH and dialysate's bicarbonate level.

Background

Especially in critical ill patients, acidosis is associated with increased mortality rates. The three main detoxification organs (liver, lung and kidney) regulate the acid-base balance. A novel therapeutic approach in case of acidosis is the direct fluid-based removal of acid. This, together with the removal of CO_2 can be achieved by the ADVOS therapy. In this publication, the proof of concept for acidosis correction and the mechanism for CO_2 removal through ADVOS therapy is described.

Methods

An ex vivo model of either hypercapnic (continuous CO_2 supply) or lactic acidosis (lactic acid infusion) using porcine blood was employed for all experiments. Different parameters, including blood and dialysate flows, various dialysate pH settings, and acid and base concentrate combinations with different concentrations of carbonate were examined. A comparison with standard continuous veno-venous hemofiltration (CVVH) using high bicarbonate substitution fluid and continuous veno-venous hemodialysis (CVVHD) were conducted additionally.

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Results

Applying the ADVOS multi, 61 ml/min (2.7 mmol/min) of CO_2 was removed using a blood flow of 400 ml/min and a dialysate pH of 10 without altering blood pCO_2 (36 mmHg) and HCO_3^- (20 mmol/l). If elevated pCO_2 (117 mmHg) and HCO_3^- (63 mmol/l) were allowed, up to 142 ml/min (6.3 mmol/min) of CO_2 were removed. An acid load of up to 3 mmol/min was compensated during continuous lactic acid infusion. ADVOS multi normalized the pH and the bicarbonate levels within 1 hour when acidosis was triggered (Figure 1). Neither CVVH nor CVVHD were able to do this.

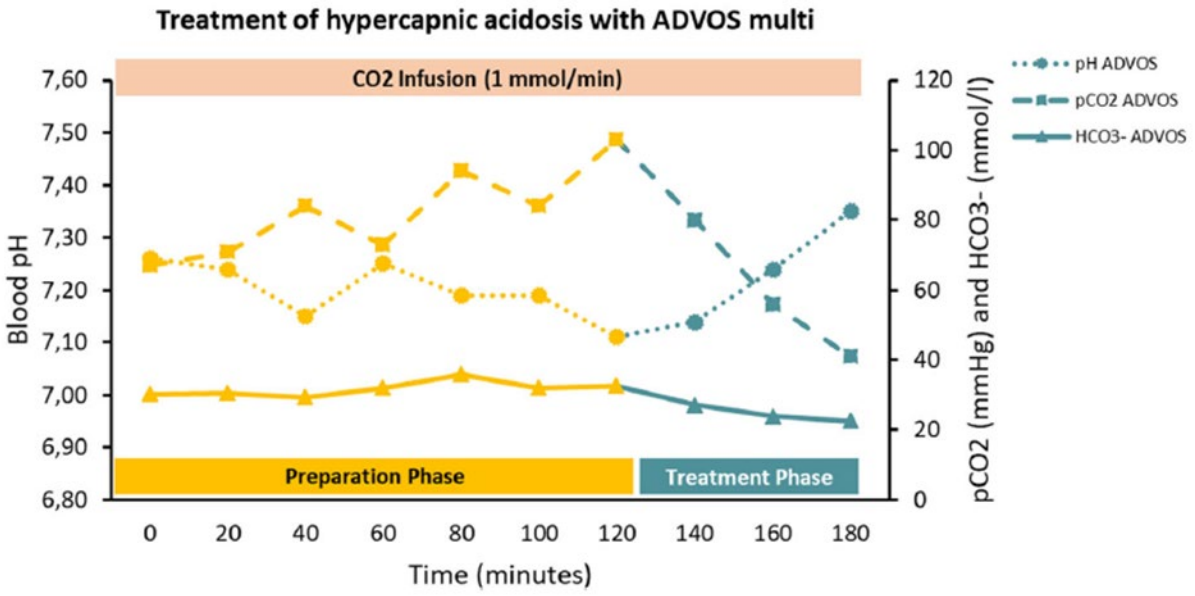

Figure 1: Course of pH, pCO_2, and HCO_3^- in blood during ADVOS multi treatment with a continuous supply of 27 ml/min of CO_2. During the preparation phase (yellow), a respiratory acidosis was triggered while this was corrected during the treatment phase (green).

The authors conclude:

ADVOS multi was able to eliminate more than 50% of the quantity of CO_2 normally generated by an adult. The blood pH was kept steady within the physiological range of 7.35-7.45. Blood flow, dialysate composition and the initial acid-base status are the most important determinants to correct the blood pH through the ADVOS therapy.

1. A higher blood flow may account for a higher HCO_3^- concentration gradient between blood and dialysate (i.e., 400 ml/min).
2. A higher dialysate pH (with a higher SID) allows a higher decrease in H^+ concentration (i.e., dialysate pH 10).
3. Lower (or none) dialysate carbonate levels permit a more effective convective elimination of bicarbonate (i.e. detoxification). Finally, this convective transport will be faster insofar a higher concentrate flow is set (i.e., 320 ml/min).

The lungs and kidneys are typically outlined to be responsible for acid-base control. The liver plays also an important role (i.e., metabolism of organic acid anions like citrate, lactate and certain amino acids) thereby producing bicarbonate. All these three organs can be supported by ADVOS multi. Drolz and colleagues demonstrated in a study with 178 critically ill patients suffering from liver cirrhosis and acute on chronic liver

failure that acidemia and metabolic acidosis are closely associated with a poor outcome in cirrhosis patients. Considering this, attention should not only be paid to one single organ (1). The majority of patients have a mixture of metabolic and respiratory acidosis. A multiple organ approach seems to be needed while facing acidosis, where the variety of adjustable parameters of the ADVOS multi might play an important role. In fact, this study demonstrates the ability of the ADVOS therapy to support:

- the lungs: through CO_2 removal;
- the kidneys: by a renal compensatory mechanism for acidosis through direct acid removal and HCO_3^- resorption; and
- the liver: through lactate elimination and bicarbonate production, as it is done in the Cori-cycle.

References

(1) Drolz A, Horvatits T, Roedl K, Rutter K, Brunner R, Zauner C et al (2018) Acid-base status and its clinical implications in critically ill patients with cirrhosis, acute-on-chronic liver failure and without liver disease. Ann Intensive Care. 8:48. https://doi.org/10.1186/s13613-018-0391-9

If you have further questions or suggestions - please contact us at marketing@advitos.com.

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