Combined removal of 4.5 mol/day of protons and protein bound and water soluble substances in an ex vivo model for metabolic acidosis using an ADVanced Organ Support (ADVOS) system based on albumin dialysis

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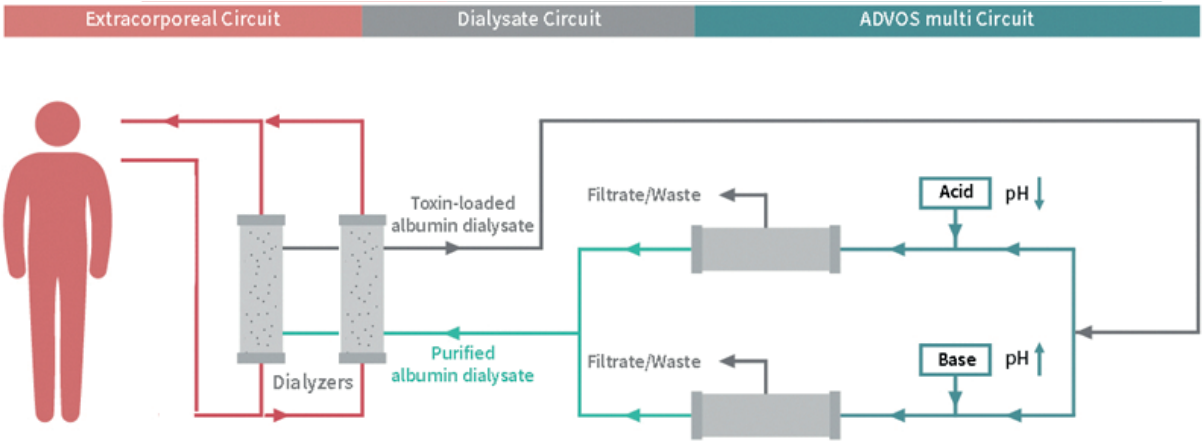
ADVITOS Bridging Life

Introduction:

Metabolic acidosis is a common event among patients with multiple organ failure. When it is caused by an impaired carbohydrate metabolism due to hypoxia, lactic acidosis may occur increasing blood lactate and reducing pH. Our group has integrated the treatment of acidosis, without increasing bicarbonate in dialysate, into an ADVanced Organ Support (ADVOS) system based on albumin dialysis. It consists of 3 circuits that allow elimination of water and protein bound toxins, regeneration of the albumin used in the process and stabilization of pH [1]. The aim of this work is to show these features of the ADVOS system by means of lactate elimination, pH stabilization and bilirubin clearance in an ex vivo model for metabolic acidosis and comparing them with a normal renal dialysis machine (NIKKISO DBB-03).

Methods:

An ex vivo model for metabolic acidosis with liver involvement was designed setting a continuous infusion of lactic acid into 5 liters porcine blood, which was spiked with bilirubin (275 mg/dl) before. Blood was dialyzed through the ADVOS system for 2 hours at 200 and 400 ml/min blood flow (BF). A dialysate pH of 9 was set. To determine the maximum lactate addition and removal, lactic acid infusion was progressively increased until blood pH was out of physiological ranges. Once the maximum addition was determined, tests were repeated with the NIKKISO machine using a BF of 400 ml/min. Lactate, pH and bilirubin levels were analyzed pre- and post-dialyzer every 15 minutes. Blood was checked for hemolysis at the beginning and the end of the experiments.



Results:

The ADVOS system was able to stabilize the blood pH in a physiological range till a maximum lactic acid addition of 3.1 mmol/min (BF 400 ml/min). Moreover, with a BF of 200 ml/min up to 1.9 mmol/min (75%) of lactate was eliminated, which would result into a proton elimination of 4,464 mmol/day. Additionally, the ADVOS system removed significantly more bilirubin from blood as the NIKKISO DBB-03 machine (66% vs. 21%). Although the NIKKISO DBB-03 machine achieved a higher lactate elimination rate of 80%, blood pH decreased to 6.90.

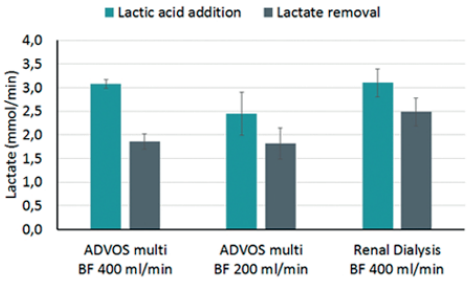


Figure 2. Lactate removal with ADVOS system and renal dialysis.

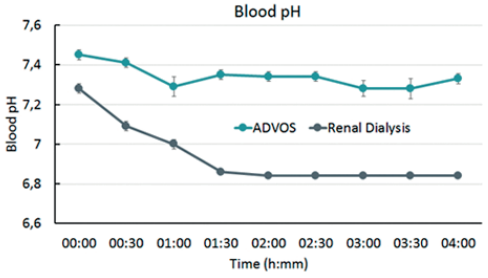


Figure 3. Comparison of blood pH during renal dialysis and ADVOS.

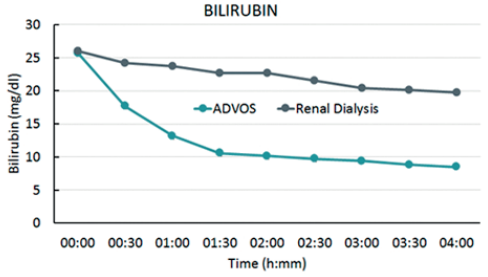


Figure 4. ADVOS removes 66% of bilirubin, while renal dialysis 21%.

COMMENTARY

This in-vitro model of metabolic acidosis describes another use for the ADVOS method:

1. ADVOS eliminated both, lactic acid as well as protons.
2. ADVOS stabilized the pH via a goal-directed manipulation of the dialysate pH - yet without adding bicarbonate.

Conclusion: As opposed to conventional dialysis, ADVOS is capable of correcting the pH rapidly and of maintaining it within the physiological range.

Conclusion:

During a continuous infusion of up to 3.1 mmol/min of lactic acid in an ex vivo model for metabolic acidosis, blood pH decreased to 6.90 under conventional hemodialysis. With the ADVOS system, blood pH remained stable between 7.35 and 7.45and additionally an efficient elimination of bilirubin was achieved. Hence, ADVOS has a potential advantage for the treatment of critically ill patients with multiple organ failure.

References:

1. Henschel B et al. Crit Care 19 (Suppl 1):P383, 2015.