ADVanced Organ Support (ADVOS) based on albumin dialysis: A new method for CO_2 removal and pH stabilization

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ADVITOS Bridging Life

Introduction:

Our group has recently developed the ADVanced Organ Support (ADVOS) system based on albumin dialysis to provide intensive care treatment for patients suffering multiple organ failure including liver, kidney and lung impairments. The system has already shown improved survival in two different animal models as well as safety and efficacy to eliminate water and protein-bound toxins in humans with liver failure [1, 2]. In the present work, the ability of the ADVOS procedure to eliminate CO_2 and stabilize blood pH together with the reduction of bilirubin and urea levels has been determined. Results were compared to a conventional renal dialysis machine (NIKKISO DBB-03).

Methods:

For this purpose an ex vivo model for respiratory acidosis was developed continuously infusing 110 ml/min CO_2 (4,6 mmol/min) into 5 liters swine blood (**Fig. 1**). In addition, liver and kidney detoxification were simulated supplementing blood with bilirubin (275 mg/dl) and urea (30 mg/dl), respectively. Blood was subjected to hemodialysis in the ADVOS system for 4 hours through two dialyzers (2 x 1.9 m²) using a blood flow (BF) of 400 ml/min and a dialysate pH of 10. The NIKKISO machine was run through a dialyzer (2.5 m²) with a BF of 350 ml/min and a dialysate pH of 8. CO2, pH, bilirubin and urea levels were analyzed pre- and post-dialyzer. Blood was checked for hemolysis at the beginning and the end of the experiments.

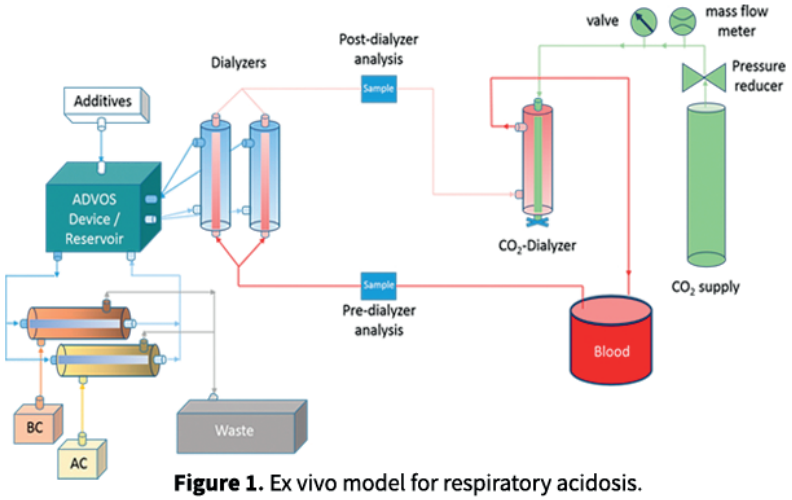

Figure 1. Ex vivo model for respiratory acidosis.

Results:

The ADVOS system was able to maintain pH stable between 7.35 and 7.45 during the experiments, while with the NIKKISO machine pH decreased to 6.60 after one hour of treatment (**Fig. 2**), being thereafter continuously out of the measuring range (hence no further calculations were possible). During the whole hemodialysis time using the ADVOS procedure, an average total CO_2 removal of 4,5 ± 0.4 mmol/l (108 ± 4 ml/min) was achieved (**Fig. 3**). The main fraction was excreted as HCO_3^- (85%), while 15% was eliminated as dissolved CO_2. In addition, post-dialyzer blood pH remained in both systems below 8. Urea was efficiently cleared with both machines (97% removal) (**Fig. 4**). Moreover, the ADVOS system reduced bilirubin levels about 3 times as much as conventional hemodialysis (59% vs. 21%) (**Fig. 5**). No signs for hemolysis were observed.

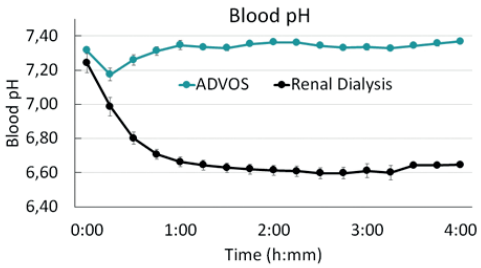

Figure 2. The ADVOS system was able to maintain pH stable.

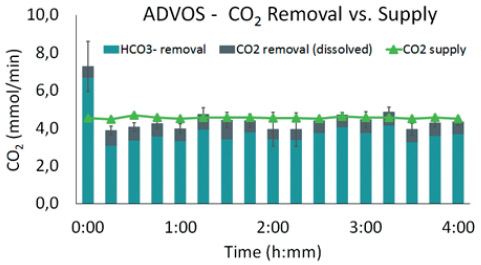

Figure 3. The ADVOS system removed 4.5 mmol/min CO_2.

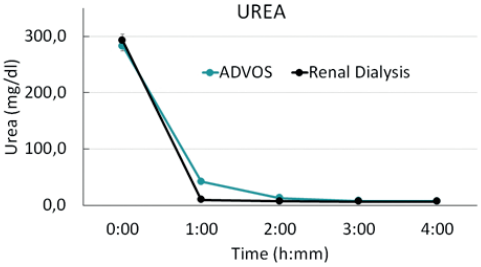

Figure 4. 97% of the urea was cleared by both devices.

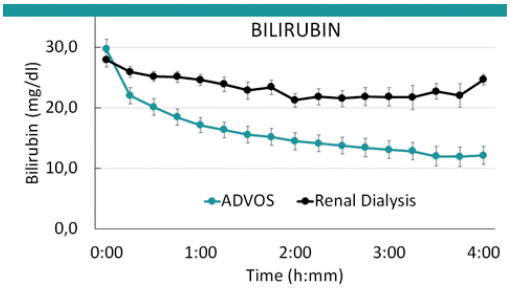

Figure 5. The ADVOS system removed 3 times more bilirubin.

KOMMENTAR

Dieses in-vitro Modell zeigt die vielfältigen Einsatzmöglichkeiten des ADVOS-Verfahrens:

1. ADVOS eliminierte bis zu 110 ml CO_2 pro Minute.
2. ADVOS stabilisierte den pH dauerhaft.
3. Darüber hinaus entfernte ADVOS auch noch Bilirubin und Harnstoff.

Fazit: Aufgrund seiner großen therapeutischen Bandbreite könnte ADVOS künftig einen wichtigen Platz in der Behandlung des Multiorganversagens einnehmen.

Conclusion:

The ADVOS system, in contrast to normal hemodialysis, was able to efficiently remove CO_2, bilirubin and urea while maintaining pH in physiological levels in an ex vivo model for respiratory acidosis simulating additional kidney and liver failure.

References:

1. Al-Chalabi A et al. BMC Gastroenterol 13: 83, 2013.
2. Henschel B et al. Crit Care 19 (Suppl 1):P383, 2015.