

## Extracorporeal oxygenation in premature lambs

St. Schmidt, J.W. Dudenhausen, E. Saling

One main cause of premature babies' morbidity and mortality is the respiratory distress syndrome. This is so in spite of the fact that the prophylaxis and therapy of this disease have been improved in the last years. For this group of patients an ALTERNATIVE to VENTILATION should be provided even if it is more complicated from the medical and technological point of view. One ALTERNATIVE to VENTILATION may be a temporary respiratory support via an extra corporeal membrane oxygenator.

The latest results of KOLOBOW of extracorporeal membrane oxygenation in adult patients with acute respiratory failure (ARF) seem to encourage the hope of a new mode of therapy for acute lung disease. A mode of keeping the lung motionless, inflated or ventilated at only two times per minute seems to overcome the ventilation perfusion mismatching due to ventilation maldistribution in stiff non homogenous lungs, and prevents the pulmonary barotrauma and extrapulmonary derrangement caused by conventional mechanical ventilation.

In 1980 he also started the application of this method for the neonate, using newborn lambs. His model, using the conditioning of the lungs by keeping the lung inflated by constant static intrapulmonary pressure, showed that in this way they could provide a postnatal lung maturity by an extracorporeal circuit after only short periods of time. To us it was a challenge to proceed with these experiments using the umbilicus and not sacrificing other vessels in order to proceed on the way to make the method practicable and usable for the human neonate.

We studied pre-term lamb fetuses of 128 to 130 days of gestation. The gestational age was accurately known by a single day exposure of a ewe to a ram. The number of fetuses was known from realtime studies with an ADR realtime scanner in 5 sheep. An extracorporeal bypass using the arterial-venous mode, with interposition of spiral coils membrane lung and a pump was used. After caesarean section the lamb was intubated. Then the lung was inflated by a constant static interpulmonary pressure continuously.

To start the ECMO the flow was slowly accelerated in order to prevent arterial pressure fall. The blood pressure was monitored as well as the EKG. We proceeded operating with a flow rate ranging from 55 to 80 ml/min. With such low flow rates we were able to provide an oxygen tension comparable to levels in utero during gas exchange via the placenta. Satisfactory CO<sub>2</sub> removal is also possible by low flow perfusion.

Thus the pH-drop that we observed might be surprising, but might be explained with the rise of pyruvic and lactic acid noted already by other authors to be typical for the initial phase of ECMO

in premature lambs. To compensate this early metabolic acidosis the application of buffers or an increase in the initial blood flow as suggested by Kolobow may be a solution as this metabolic acidosis is known to cease after some 2 hours of ECMO. Using heparinized adult sheep blood as priming volume, more than a complete heparinizing dose was applied to the lamb at the beginning of ECMO.

The lack of bleeding in our experiment might in part be due to the lower AT III and plasminogen levels and fits with the observations of other authors. Anticoagulation with heparine blocks fibrin formation, but does not reduce the platelet activity. The loss of platelets could be hazardous and limiting during prolonged use of an artificial organ.

A drop down of the thrombocyte level is shown on the slide. As it stabilizes after one hour, at least a part of the initial drop may be caused by a hemodilution due to Ringer's lactate solution of the priming volume. A typical hematologic change in longterm perfusions is no longer the destruction of red cells. Thus, in order to calculate the influence of the ECMO to red cells, it is necessary to investigate sublethal damages by an adequate method. The tracing of the corpuscular volume distribution of red cells meets these requirements.

The biggest shift is seen in the fetal cells, that seem to be more vulnerable - the shift to the left demonstrates a swelling of these cells (due to the influx of natrium). It can be seen on the tracing after two hours that this phenomenon is reversible to some extent. This might implicate that our mode of ECMO is relatively innocuous to red cells.

While Kolobow's experiments prove that a postnatal induction of lung maturity is evaluated by apnoic oxygenation during ECMO by changing of the lung's compliance, he did not give satisfactory information about the mechanisms of the lung's conditioning.

As prenatal lung maturity is known to be induced by corticosteroids and thyroxin, we were especially interested in studying these hormones. A rising level of the stimulating hormone TSH is noted, the same being true for ACTH.

In our next series of animal experiments the following improvements are foreseen:

The ECMO is to be operated without a pump - the application of heparin is to be avoided - the period of perfusion is to be shortened.

Literature by the author.

Author's name and address: Dr. Stephan Schmidt  
Arbeitsgruppe Perinatale Medizin der  
Frauenklinik Neukölln Freien Universität Berlin  
Mariendorfer Weg 28 D-1000 Berlin 44