2.1 Tissue pO\textsubscript{2} Monitoring. A New Method in the Care of the Critically Ill Patient

K. Schönleben, J.P. Hauss, U. Spiegel, H. Bünte, and M. Kessler

The measurement of tissue-pO\textsubscript{2} with multiwire surface electrodes developed by Kessler and Lübbers (1) is a well known method in the physiological research. We as clinicians see the importance of local pO\textsubscript{2}-measurement in getting a totally new parameter, which cannot be received from any usual clinical investigation. We get important hints about the situation in the microcirculation, whose quality is decisive for the survival of critically ill patients.

Method

According to experiments in animals (2, 5) we chose the skeletal muscle as test-organ (m. quadriceps femoris). Concerning clinical appliance and comparing clinical investigation see Schönleben et al. (4). We registrated the local pO\textsubscript{2} tension in form of histograms (about significance of histograms see Kessler et al. [3]).

Results

The value of local pO\textsubscript{2} measurement in typical clinical examples is demonstrated out of a series of 65 patients.

Early Recognition of Volume-Deficiency.

In case of a volume deficit at first the periphery starts to empty as a result of centralization. ABP, CVP and HR, three classical parameters of circulation, remain on the same level for a long time. As the continuous pO\textsubscript{2}-monitoring by electrodes registrates the diminishing oxygen supply of the periphery it becomes therefore an early signal of impaired circulation. In Fig. 1 is seen the registered example of a patient suffering from an acute gastro-intestinal hemorrhage. The continuous decrease of local oxygen pressure after each shift of the electrode to another measuring area, indicates the beginning of a hemorrhagic shock. At each measuring point the highest and the lowest values of the 8 electrode-wires are marked. BP, CVP and HR remained constant during the whole procedure. Only after a quick blood transfusion the worsening tendency could be stopped. Only one hour after this treatment the hemorrhage became clinically manifest by hematemesis.
Control of Inspiratory Oxygen Supply

In patients blood gas analysis shows whether artificial respiration and increased inspiratory oxygen supply is necessary or not. However a correct conclusion concerning the oxygen supply to the organs is not very often possible as shown by our investigations. A low arterial pO\textsubscript{2} can nearly always be corrected simply by increasing the inspiratory oxygen supply. The harmful effect of too high oxygen concentrations is not shown. Kessler defines two kinds of disturbances of the pO\textsubscript{2} histogram:

a) disturbances of microcirculatory pattern \textit{without} anoxia,
b) disturbances of microcirculatory pattern \textit{with} anoxia.

Both are shown in the next example (Fig. 2):

In a polytraumatized patient with shock-lung the assisted respiration with an oxygen content of 30% was insufficient (see lowest histogram and p\textsubscript{a}O\textsubscript{2}). Here we found disturbances of microcirculatory pattern \textit{with} anoxia. By bringing the oxygen up to 50%, the local oxygen supply improved significantly and the histogram returned to physiological levels. Although an elevation to 70% O\textsubscript{2} gave even a better p\textsubscript{a}O\textsubscript{2}, in the tissue the number of hypoxemic areas increased. Pure oxygen then caused pathological changes in the local oxygen supply. There are very high and very low oxygen areas, which show that the breathing of pure oxygen caused a counterregulation of microcirculation. Such a configuration of a histogram is typical for disturbances of microcirculatory pattern \textit{without} anoxia. According to the electrode measurement the inspiratory concentration of 50% O\textsubscript{2} was optimal for this patient. Similar findings were registered in 22 other patients.