

Continuous measurement of pH with the glass electrode.

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Clinical Data

Continuous monitoring of the tissue pH of the fetus during labour offers valuable information of the condition of the fetus. However, in order to understand this information it is essential to be aware of the differences between the pH of the extracellular compartment (the tissue pH = tpH) and the pH of blood plasma (the blood pH).

In newborns the extracellular volume is about eight times that of blood plasma (1). Consequently, the total amount of bicarbonate in this extracellular compartment is greater than that of blood. Furthermore, the extracellular fluid is in direct contact with the cellular metabolic products.

If the blood supply of the area in which the electrode is situated is adequate and pH changes slowly - tissue pH will be very close to blood pH.

If - on the other hand - tissue perfusion is decreased, lactic acid and CO₂ may accumulate in the tissue and tpH will tend to be lower than blood pH.

Furthermore, the following situations may arise:

- 1) During acute respiratory acidosis CO₂ accumulates in the tissue and the blood. If the subcutis in which the electrode is placed is producing less CO₂ than other organs, the CO₂ in blood will be elevated before local tissue pCO₂. Consequently, the tpH decrease will develop slower and may be less pronounced.
- 2) During acute metabolic acidosis in areas other than the place of the electrode (e.g. liver and intestines) lactic acid accumulates first in the blood and later in the tissue in which the electrode is situated.
- 3) During metabolic acidosis - including the tissue in which the electrode is situated - the electrode will register the tpH-decrease before it is present in the blood.

As tissue pH reflects the situation of the compartment closest to the cells, tpH might be a better predictor of the actual state of the cells in the brain.

An indirect clue to this, is the findings of Myers (3) that se-lactate (in animals exposed to hypoxia) correlates to the seriousness of brain damage and that Hochberg et al (2) found that the tpH-arterial pH gap correlated to the base excess of arterial blood during shock (in cats).

Further, situations in which tpH was normal and umbilical artery pH was low are often seen together with vigorous newborns (4).

The present state of tpH monitoring with the glass electrode.

At present the only clinically tested glass electrode is the Roche electrode. We have used the electrode in two series:

In series I 152 fetuses were monitored but tpH did not change the management of labour.

In series II 96 fetuses were monitored with CTG and tpH as follows:

CTG normal: no intervention irrespective of the tpH value, because of possible false low tpH measurements.

CTG pathological (late decelerations, severe variable decelerations, severe bradycardia, decreased variability + tachycardia) and tpH more than 7.20 (7.15 if delivery could be expected within 15 minutes): no intervention.

CTG pathological and tpH less than 7.20 (7.15): operative delivery should be performed.

Seventy-two successful monitorings (75 per cent) in series II were matched to 72 monitorings in series I according to age and parity. A decreased number of outlet forceps/vacuum extractions was found if tpH was used in the management of labour (26 versus 9 per cent). The state of neonates did not differ (Apgar scores one and five minutes after delivery, umbilical artery and vein pH, pCO₂, base excess, standard bicarbonate, pO₂, oxygen saturation, hemoglobin).

Although theoretically there are situations in which tpH differs from blood pH, we have found a good correlation between tpH and blood pH ($r=0.78$ and 0.67 ($n=81$) when comparing tpH to umbilical artery and vein, respectively).

The disadvantages of tpH monitoring with the present electrode are:

- 1) it is difficult to use - and even after a long training period the success rate is only about 75 per cent.
- 2) The electrode is too big and the tip of the electrode is too close to the skin incision.
- 3) The price of the electrode is now more than 500 £.

Consequently, we need a smaller and cheaper electrode which is easy to handle and with electrode characteristics as accurate as the Roche electrode. If this can be accomplished the results with the Roche electrode indicates that such an electrode will be a valuable instrument in the handling of high risk deliveries and deliveries in which the CTG (or the transcutaneous CO₂/O₂) is not completely normal.

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