

## BIOCHEMICAL MONITORING OF INTRAPARTUM FETUS

Molly S. Chatterjee, M.D.

Associate Prof., New York Medical College, Chief, Maternal Fetal Medicine, Our Lady of Mercy Medical Center, and Chief Maternal Fetal Medicine, Catholic Medical Center of Brooklyn and Queens, Major Affiliate of New York Hospital - Cornell University.

Electronic Fetal Monitoring is being used worldwide since late 1960's. It was realized that cardiotocography needs to be complemented by biochemical monitoring to identify a fetus in stress from the fetus in distress. At the same time fetal blood sampling of intrapartum fetus for blood gas analysis was introduced by Saling. This fetal capillary blood sampling was practiced only in selected centers throughout the world and never gained popularity for the following reasons:

- 1) Intermittent serial sampling necessary.
- 2) Lack of proper training.
- 3) Lack of availability of blood gas analyser which is able to analyse a microsample (10, 1).
- 4) Potential risk of bleeding and infection.

It has been noted, since 1978, 16% of the rise in the cesarean rate was attributed to fetal distress. In 1978, only 1.1% of charts listed fetal distress as an accompanying diagnosis. Whereas, in 1984, it increased to 10.4%. This increase may be due to a change in definitions of these complications to include less severe forms. Thus, National Institute of Child Health and Human Development (NICHD) study recommends developing additional efforts to define diagnostic classes of fetal distress. There is no doubt that liberal use of fetal scalp sampling can refine the diagnosis of fetal distress as shown by Saling and his co-workers (1987). If only electronic fetal heart rate monitoring is performed, the rate of operative delivery, especially cesarean section is approximately twice as shown by the above workers. Even with combination of cardiotocography and fetal scalp blood sampling the diagnosis of fetal distress during labor remains imprecise. Combination of only these two techniques reported false positive

Dedicated to my father M. M. Ghosh, who encouraged me to pick up the field of perinatal medicine

diagnosis of fetal distress in 71 to 95% of fetuses and detected by 46-61% of distressed fetuses. Therefore, combination of more than one biochemical marker to diagnose fetal distress is necessary to improve the diagnosis of fetal distress.

Electronic heart rate monitoring has a high false positive rate which needs to be evaluated by fetal biochemical monitoring to reduce the risks of operative delivery of the mother. Labor is a stress to the fetus as shown by different workers. There could be changes in the fetal heart rate patterns due to surge of catecholamines in the normal intrapartum fetus. Development of transient respiratory acidosis or more ominous metabolic acidosis in the fetus can only be identified by biochemical monitoring of the fetus. The biochemical fetal parameters that have been and are being studied so far are:

- 1) Intermittent capillary pH.
- 2) Continuous tissue pH.
- 3) Continuous transcutaneous PCO<sub>2</sub>.
- 4) Continuous transcutaneous PO<sub>2</sub>.
- 5) Continuous base excess.
- 6) Lactate.

It is the purpose of this chapter to introduce the techniques of measurement and details of these fetal biochemical markers and the future of this high technology.

Intermittent Capillary pH - This parameter was first introduced by Saling. Introduction of Corometrics 220 pH meter at bedside has simplified the measurement process. Intermittent sampling, however, has failed to gain popularity inspite of the simplicity of the technique. Lack of adequate education and training may be partly responsible for this unpopularity. A continuous method of biochemical monitoring of the fetus was then sought for.

Continuous Tissue pH - Since late 1970 a glass electrode was introduced to study continuous fetal tissue pH. Due to extreme invasive nature of the electrode and complications associated with it, it was abandoned in a few years. Since early 1980 development of the fiber optic probe has generated renewed interest among researchers in this field. International Biomedics has developed a new monitor called fetascan 1500, which has incorporated the fiberoptic principle to monitor continuous tissue pH in the fetus by a scalp electrode. At the time of this writing,

about 500 cases have been monitored by this improved technology and the future seems to be promising because of its continuous nature and simplicity of the technique. A correlation coefficient of 0.8 has been obtained between tissue pH, capillary pH, and umbilical arterial pH monitored by this method.

Continuous Monitoring of Transcutaneous Carbon Dioxide - Recently fetal transcutaneous carbon dioxide (TcPCO<sub>2</sub>) measurements have been reported. These investigations have shown very good correlation between TcPCO<sub>2</sub> and PCO<sub>2</sub> in samples of capillary blood and umbilical arterial blood. The electrode is applied when the cervical dilatation is at least 3 cm and the membranes are ruptured. Calibration is done with 5% and 10% gas mixture at 44°C. A chemical sensor (Radiometer TCM200) fixed on fetal presenting part by a plastic suction ring by means of negative pressure of 160 mm Hg. has been used to monitor transcutaneous PCO<sub>2</sub>. Preliminary results of this electrode function are encouraging. The noninvasive nature of this technique has tremendous appeal. This method has been used in USA, Denmark, and West Germany.

Continuous Base Excess - Simultaneous continuous monitoring of acid base state by TcPCO<sub>2</sub> and tissue pH measurements would elucidate the nature of the fetal acisosis during labor. Since base excess is a mathematical manipulation of pH and PCO<sub>2</sub> this parameter has been measured by using Sigaard Anderson nomogram or computerised program. This parameter reflects the ominous type of metabolic acidosis which necessitates expedited delivery.

Continuous Transcutaneous PO<sub>2</sub> - Reports of transcutaneous PO<sub>2</sub> monitoring have come mostly from European centers. Electrodes have been developed by some centers which are capable of monitoring fetal ECG and PO<sub>2</sub> (tissue!) simultaneously. All these technical developments are still in the experimental stage. Further work is necessary to advocate measurement of these biochemical fetal markers to refine the diagnosis of fetal distress. The diagnosis of fetal distress during labor remains imprecise by combination of cardiotocography fetal scalp blood sampling and umbilical cord blood sampling (Saling, 1987).

Lactate - Lactate determinations are mostly restricted to cord blood analysis as of 1987. About 200  $\mu$ l of fetal blood is necessary for lactate determination, as a result it is impractical to attempt to study this parameter in the fetus. Future development of technology is necessary before human fetal lactate estimation can be attempted with minimal amount of fetal capillary blood in the intrapartum period.

It is proposed that future fetal blood monitoring should have 6 channels with continuous monitoring of  $PO_2$ ,  $PCO_2$ , base excess, tissue pH along with cardiotocography, before this high technology can be properly evaluated.

The fiberoptic tissue pH electrode is a major development in the field of intrapartum fetal monitoring. The continuous transcutaneous  $PCO_2$  electrode is very simple to apply by suction fixation. It has been demonstrated by the Danish group that the suction ring does not interfere with the measured value when compared with glue fixation. The latter method was used in West German by Schmidt. The suction fixation is a more popular method of application and is being used at USA in our center at the time of this writing. The continuous recording is easily documented and can be correlated with fetal heart rate patterns.

Metabolic acidosis with lactic acid formation is more ominous than respiratory acidosis. Thus, the base excess, defined as the difference in concentration of strong base between the blood and the same blood titrated with strong acid or base to pH 7.40 and  $PCO_2$  40 mm of hg at  $37^\circ C$  is the negative value of the amount of nonvolatile acid, mainly lactic acid. Knowing the  $PCO_2$  and the pH of blood, the base excess can be calculated by nomogram or Sigaard-Anderson formula.

There is no doubt that combination of continuous monitoring methods of the fetus during labor are far superior to single estimation or intermittent estimations alone. Thus, attempts are being made to continuously monitor the intrapartum fetus. Currently these monitoring methods are reserved only in research centers in Europe and USA. Further technical developments are necessary before these techniques can be applied for routine clinical use. One possibly could be optimistic and predict such routine clinical use in the near future.

## References

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