

Fetal pulse oximetry: the European experience and threshold values

Bruno Carbonne - Saint Antoine Hospital, Paris, France

Pulse oximetry is a technique of fetal monitoring during labour based on non-invasive measurement of fetal arterial oxygen saturation. It has been shown in animal studies that metabolic acidosis occurred for a fetal arterial oxygen saturation below 30%. One of the main debates during initial experience in humans, was focused on the adequate cut-off for intervention (or non-intervention), and the duration of time below this threshold. Most of the data feeding this debate came from Europe where it was generally felt that determining an adequate cut-off was a prerequisite to the design of randomised trials.

One of the German groups involved in pulse oximetry aimed to substantiate the *a priori* accepted 30% threshold in 46 patients with simultaneous scalp pH samples and fetal pulse oximetry (Kühnert et al. 1998). They found a good separation between fetuses with an oxygen saturation $> 30\%$ or $\leq 30\%$ for at least 10 minutes, especially in predicting a fetal scalp pH > 7.20 or ≤ 7.20 respectively. This approach, however, would require to accept fetal scalp pH as an indisputable tool for fetal monitoring. Moreover, most of these data were obtained from selected oxygen saturation measurements without signal loss.

They further observed that neonates with a pH < 7.15 or base excess > 12 mmol/L in the umbilical artery differed from others in the duration of fetal arterial oxygen saturation $\leq 30\%$ but not in the duration of medium (30-60%) and high ($> 60\%$) fetal arterial oxygen saturation (Seelbach-Gobel et al. 1999).

The French experience was mainly represented by a prospective multicenter observational study comparing the predictive value of fetal pulse oximetry to that of fetal scalp blood pH for an abnormal neonatal outcome in case of abnormal fetal heart rate (Carbonne et al. 1997). Simultaneous readings of fetal oxygen saturation and fetal scalp pH samples obtained before birth were compared to the neonatal status. Abnormal neonatal outcome was defined as a combined variable including: 5 min. Apgar score ≤ 7 , umbilical arterial pH ≤ 7.15 , secondary respiratory distress, transfer in a neonatal care unit, or neonatal death.

At a 7.20 threshold for fetal scalp pH, and 30% for fetal oxygen saturation (i.e. the tenth centile in the study population), the predictive value of fetal pulse oximetry was similar to that of fetal blood analysis (positive predictive value 56% vs 55%, negative predictive value 81% vs 82%, sensitivity 29% vs 35%, and specificity 93% vs 91% respectively).

Although the performances of both techniques seem quite similar, one may note that the sensitivity is rather poor at such cut-offs. Receiver operating curve showed that the performance of fetal pulse oximetry became superior at higher thresholds. At a 40% threshold, the sensitivity of pulse oximetry reached 76% and the NPV was 89%.

Further published experience on routine clinical use of pulse oximetry has shown that neonatal depression could occur despite intrapartum fetal oxygen saturation above 30% (Luttkus et al. 1997; Schmidt et al. 1998).

Altogether, these data suggest that a 30% cut-off may be too low when used for reassurance in case of abnormal fetal heart rate. On the other hand a fetal arterial oxygen saturation below 30% for 10 minutes may indicate the need for prompt delivery. Despite these limitations, pulse oximetry may improve the identification of depressed fetuses when compared to FHR alone as suggested by a recent American randomised controlled trial. The future of fetal pulse oximetry in Europe probably depends on the results of an European randomised study.

- Carbonne B, Langer B, Goffinet F, Audibert F, Tardif D, Le Goueff F, Laville M, Maillard F. Multicenter study on the clinical value of fetal pulse oximetry. II. Compared predictive values of pulse oximetry and fetal blood analysis. *Am J Obstet Gynecol* 1997;177:593-8
- Kühnert M, Seelbach-Gobel B, Butterwegge M. Predictive agreement between the fetal arterial oxygen saturation and fetal scalp pH: results of the German multicenter study. *Am J Obstet Gynecol* 1998;178:330-5
- Luttkus AK, Dudenhausen JW. Fetal pulse oximetry. *Curr Opin Obstet Gynecol* 1998;10:481-6
- Schmidt S, Koslowski S, Sierra F, Meyer-Wittkopf M, Heller G. Clinical usefulness of pulse oximetry in the fetus with non-reassuring heart rate pattern? *J Perinat Med* 2000;28:298-305
- Seelbach-Gobel B, Heupel M, Kühnert M, Butterwegge M. The prediction of fetal acidosis by means of intrapartum fetal pulse oximetry. *Am J Obstet Gynecol* 1999;180:73-81