

Acid–base parameters of umbilical cord blood as evidence in a criminal trials

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INTRODUCTION

Criminal trials assessing the correctness of obstetric procedures to establish a causal link between intrapartum hypoxic events and the neurological outcome are among the most demanding of all cases concerning so-called medical errors. The degree of their complexity results not only from the presence of two carriers of legal rights (mother and child) and the need to evaluate the criminal-legal consequences for each of them but above all from the abundance of evidence necessary for the assessment. It is currently recognized that many potential causes can lead to neonatal encephalopathy and therefore a comprehensive, multidimensional evaluation of the newborn's condition is needed (including fetal heart rate), as well as an evaluation of all the factors possibly influencing the negative outcome of the newborn such as maternal medical history, obstetric backgrounds, intrapartum factors, and placental pathology. A precise description of the items to be assessed appeared in the second edition of the Task Force Report on Neonatal Encephalopathy and Neurologic Outcome [1], including fetal umbilical artery acidemia as one of the crucial elements of clinical description. Fetal umbilical artery pH less than 7.0, base deficit greater than or equal to 12 mmol/L, or both, increase the probability of neonatal encephalopathy [1]. However, such evidence can only be utilized if included in the case files in the form of blood test results, so-called blood gases, and acid-base balance, measured in the sample of umbilical cord blood. In the reality of the ongoing proceedings, these key laboratory tests are not available.

MATERIAL AND METHODS

The study covered 68 criminal cases conducted to establish a causal link between intrapartum hypoxic events and grievous bodily harm or the death of a child. The analyzed cases were selected from among 143 criminal cases evaluating the correctness of proceedings in various obstetric situations. In each of them, in the years 2011–2015, the Medical University of Silesia was appointed by the Prosecutor's Office or the Court to issue a medico-legal opinion. It should be noted that the proceedings from 2016 and above have not yet been legally completed, which prevented the analysis of documents from that period.

In each of the 68 cases the factors assessed were the availability of the results of acid-base parameters of umbilical cord blood determined in a newborn, the time elapsed from birth to the analysis and the site of collection (umbilical cord, capillary blood). The obtained results were juxtaposed with the criminal-legal effect grievous bodily harm in accordance with Art. 156 of the Criminal Code [2] and/or the death of a child.

RESULTS

In the analyzed group of 68 procedures, in 10 of them intrauterine stillbirth was diagnosed, therefore no umbilical cord blood collection was required. From the remaining 58 procedures, umbilical cord blood samples were not taken in 19 cases (33%), in 8 cases there was no information on this subject in the patient's history files (14%), and in the remaining 31 cases, blood samples were collected (53%).

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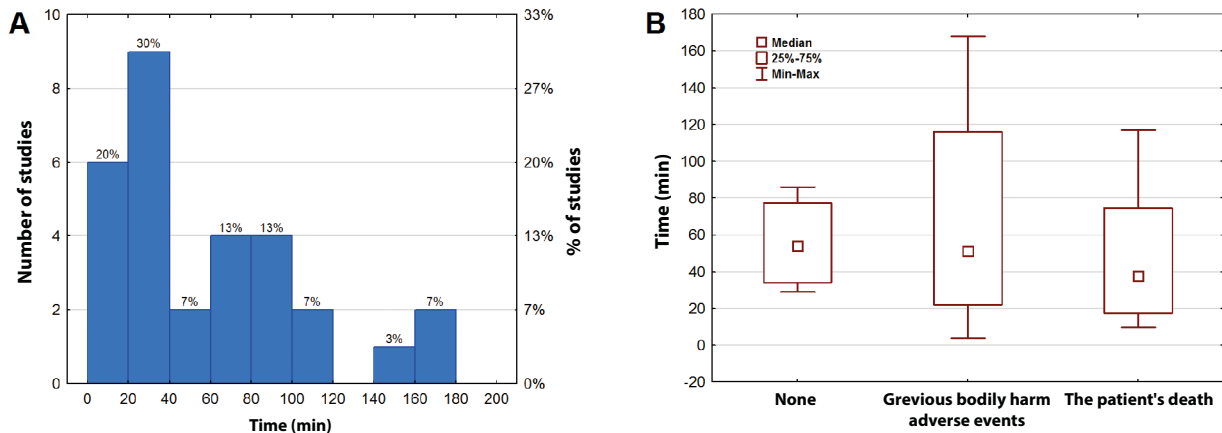


Figure 1. A. The histogram shows the percentage of acid-base balance tests carried out and the time of sampling in minutes from the birth of the child ($n = 30$) and **B.** the time (minutes) from birth to the measurement of acid-base balance tests, taking into account the category of criminal-legal effect

The time of analysis measured from birth ranged from 4 to 582 minutes. After removing the upper outlier, the time measurement range was 4 to 168 minutes, mean value (mean \pm standard deviation): 59 ± 47 minutes and median (lower-upper quartile): 41 (22–89) minutes. The time presented on Figure 1A is given by the right-skewed distribution (skewness factor: $As = 0.87$). Half of all the measurements took place in less than 41 minutes, with 20% (6 cases) were done within 20 minutes and 30% (9 cases) within 40 minutes. For 10% of the procedures, blood gases analysis took place 2 hours after birth.

Out of 31 blood collections, only in 9 cases (29%) it was possible to identify the site of collection. In 4 cases it was umbilical cord blood — without indication of its arterial or venous origin, in 4 cases it was capillary blood, in 1 case the test was marked as fetal capillary scalp blood.

Out of 58 analyzed cases in which the result of the fetal acid-base balance was an important element in the proving process, in 15 cases the child was delivered with no signs of life, and despite the undertaken resuscitation, the child was pronounced dead (26%). In 32 cases, there was grievous bodily harm of the child (55%), of which 21 newborns survived and 11 died. In total, 26 newborns (45%) died.

Considering the type of adverse reaction, there were no statistically significant differences with the time of neonatal blood sampling ($p = 0.734$, Kruskal-Wallis one-way analysis of variance test) – (Fig. 1B).

DISCUSSION

The result of the umbilical cord blood gas and acid-base analysis is used not only in clinical evaluation or prognosis [3] but also constitutes evidence in criminal trials. Rightly argues Jassem-Bobowicz et al. [4] referring to the works of Młodawska et al. [5, 6], indicating the need to secure umbilical cord arterial blood. However, the conducted study

shows that in every second criminal trial either blood for testing was not sampled or there is no information on this subject, and in the remaining ones — only in every third case the patient's history contained information about the place of blood collection. In no case was it stated whether the blood was of venous or arterial origin. Such a result is even more surprising as in every second case the child developed grievous bodily harm, and in every fourth case, despite the perinatal care, the newborn was delivered without signs of life, and the undertaken life support maneuvers were fruitless. In such situations, a routine assessment of umbilical cord blood gases and acid-base balance should take place, including optimally arterial and venous blood gases (two samples allow to state whether the right blood has been collected; arteriovenous difference in $pH > 0.02$, and $pCO_2 > 0.5$ kPa/3.75 mmHg) [7–9]. The key stage is also the time of sampling [10, 11]. Such data did not result from the available case files. Delayed blood sampling may alter acid-base parameters resulting in incorrect conclusions [10, 11]. The preferred method of sampling is to collect blood from a still pulsating vessel within 1 minute of delivery and to determine the acid-base balance within 30 minutes of collection. In half of the examined cases, this time was higher.

CONCLUSION

Incorrect blood sampling for acid-base parameters or lack of blood sample collection can make it difficult, and in some cases impossible, to assess fetal clinical status in the course of labor based on umbilical artery acidemia in the trial regarding correctness of obstetric proceedings.

In all cases of suspected intrapartum hypoxic events, umbilical cord arterial and venous blood should be routinely sampled and measured for acid-base parameters' assessment.

Conflict of interest

All authors declare no conflict of interest.

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