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PREVENTION OF PULMONARY COMPLICATIONS DURING NEONATAL RESUSCITATION

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The pulmonary functions were measured during resuscitation of eight critically ill newborns by the "Pulmonary Evaluation and Diagnostic System" (PEDS UNIT-M.A.S.Inc.) The asphyxiated infants (Apgar score 0-3;PH 6,9) required more agressive ventilator support than "traditional" cases. The danger of the pulmonary injuries was larger in this period. In spite of this, there were no signs of air leaks syndrome and the oxygenation was improved in every case. Worsening or improving the pulmonary mechanics it is possible to change the ventilator settings immediately. This method seems to be advisable to introduce in the everyday routin to prevent iatrogenic pulmonary complications in such critical situation - the reanimation.

INTRODUCTION

The aim of neonatal resuscitation is to insure the vital functions in the case of extreme hypoxia and acidosis. "Since asphyxia in fetus and newborn, whether chronic or acute, is a progressive process that can lead the infant's demise, it is imperative that a rational and agressive approach be undertaken to reverse this potentially lethal process" /1/.

Using agressive ventilator settings in this situation the risk of the complications /barotrauma, air leaks, hypo - or hyperventilation/ are significant. It has not been able to optimize the level of the supportive therapy without controlling the permanent changes in these cases before, but we can do it now with controlling the pulmonary function and mechanics. We used this method first time when there was only one chance - the agressive therapy - to keep the patient alive.

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MATERIALS AND METHODS

Eight critically ill infants - ranging in weight from 1400 g to 3800 g;gest. age from 31 to 42 weeks and in age from zero to 96 hours - were monitorized during the complex reanimation by the Pulmonary Evaluation and Diagnostic System (PEDS Unit). This equipment - made by Medical Associated Service Inc. (Hatfield-PA) - consists of a pneumotachometer, differential pressure transducers and an IBM personal computer /2,3,4/. We used it in "monitor function", which made possible to follow the changes of the "pressure-flow-volume curves", the "volume-pressure loop" and the "flow-volume curve" continuously. Recognizing the signs of the insufficient ventilator-support, the respirator settings were changed.

Every patient was ventilated by Bourns BP 200 type respirator. Chestwall impedance, heart rate and heart rate variability were measured by CAMAC system.

$TcpO_2$ was controlled by Kontron-Roche monitor. Blood gas analysis was carried out by Radiometer ABL 330. Blood pressure was measured by Nippon-Colin neonatal sphyngomanometer. In every case arterial or vena umbilical catheters were used for central fluid therapy.

In any case of underinflation and the insufficient oxygenation we increased the mean airway pressure (MAP). We found that the ventilator settings could be enhanced to a more agressive level than the traditional one. (It is shown on the Table I). It seemed to be necessary in an extreme hypoxic and acidemic situation.

TABLE I

Respirator settings

	Traditional settings	Controlled by PEDS
PIP (cmH_2O)	14 - 30	15 - 42
PEEP (cmH_2O)	1 - 3	3 - 5
MAP (cmH_2O)	9 - 15	9 - 25
BPM	50	40 - 70
I:E rate	1:2	3:1-1:3
Flow (lit/sec)	10	10
FiO_2	1.00	1.00

PIP: positive inspiratory pressure; PEEP: positive end expiratory pressure; MAP: mean airway pressure; BPM: breath per minute; I:E rate: inspiratory-expiratory ratios

Following this procedure we reached improvement of oxygenation and blood gas status permanently or transitorically depending on the original diseases (Table II). The Table III shows the starting and the optimal values of the blood gases.

In spite of the more agressive ventilation, the signs of overdistension developed only in one case. No signs of the "air leaks" have developed. The chestwall distorsion could be well-documented in time, when the spontaneous breathing restarted.

TABLE II

Distribution of the resuscitated babies according to the diagnosis

Diagnosis	Number of cases
Postasphyxiated syndrome	3
Sepsis (B group Streptocc)	1
Meconium aspiration sy.	1
Hernia diaphragmatica	1
Hypovolaemic shock (rupture of umb.chord)	1
Hypoplastic left ventricular sy.	1

TABLE III

Acid - base values at the beginning and the best values

	starting	best
pH	6.46 - 6.98	6.93 - 7.51
PCO_2 mmHg	10 - 118	21 - 54
pO_2 mmHg	10 - 321	14 - 324
HCO_3 mmol/l	1.6 - 14.5	6.3 - 25.5
BE mmol/l	(-) 30 - (-) 18	(-) 22 - (+) 2.7

DISCUSSION

Critically ill infants, who are suffering from serious asphyxia, require agressive ventilator settings /5,6/. Improving the baby's condition lower respirator settings are satisfactory. The most of the iatrogenic complications developed in that "blind period" when the agressive therapy was continued in spite of the improving condition. Previously, we could only recognize indirectly the improved pulmonary mechanics. The traditional diagnostic methods - the blood gase analysis and the X ray - reflected only a static state, and there was a "technical limit" to repeat it too frequently. The transcutaneous pO_2, pCO_2 monitors gave more information about the dynamical processes but these findings were resulted by the common respiratory and circulatory effects. There was no possibility to test the bed side on line way. The PEDS Unit enables us to follow the dynamic changes in the airway.

There are a lot of experiences using it during mechanical ventilation /7,8,9,10,11,12/ but we did not find any report on resuscitation. We analysed the "pressure-volume loop" and the "flow-volume curve" simultaneously. The signs of the underinflation or overdistension and the flow-interruption were easily recognized. The optimal value of the peak inspiratory (PIP) and the positive end expiratory pressure (PEEP) could be estimated and the efficiency of the arteficial ventilation during the reanimation was well controlled. On the basis of these data, we could change the respiratory settings according to the requirements, and follow those "blind diagnostic periode", when most of the iatrogenic complications can develop.

Connected with described method the two following questions can arise: 1. Is the time sufficient during resuscitation for using the PEDS? 2. Which is the optimal step to use in the procedure of reanimation?

The answer for the first question is "Yes". It takes 1-2 minutes to put it in operation, after this, it is functioning well.

Connected with the second question, we recommend the following: after suctioning, intubation and the beginning of the mechanical ventilation, when there is no need for external cardiac massage, it is high time to use the PEDS.

The presence of this equipment does not disturb the other diagnostic and therapeutical procedures, for example insertion of the arterial or vena canules, X ray, pictures, blood gas analysis, ECG and transcutaneous pO_2, pCO_2 monitor. However it is advisable to start these examinations only after fitting of PEDS.

This procedure was found very effective in particular in that 5 cases (Apgar score was between 0-2 at the admission) which were transported to our department.

We suggest that our preliminary results are convincing that this non invasive, bed side evaluation of pulmonary functions and mechanics together with the traditional diagnostic methods can give new possibilities to prevent the iatrogenic complications, first of all lung injuries, during such a critical period as the resuscitation of the newborn.

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