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THE ROLE OF ECHOCARDIOGRAPHY PERFORMED BY A NEONATOLOGIST IN THE ASSESSMENT AND TREATMENT OF SHOCK IN NEWBORNS

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Abstract:

One of the main problems during neonatal intensive care is the early detection and correction of hemodynamic disorders. Standard clinical assessment of neonatal hemodynamic status is subjective and imprecise, highlighting the need for objective monitoring methods. Below is a review of data on the use of echocardiography performed by a neonatologist to identify hemodynamic disorders and select tactics for normalizing hemodynamics.

Keywords: pathological physiology, premature babies, respiratory diseases, consequences, therapy

INTRODUCTION

Diagnosis and treatment of shock in a newborn presents a number of difficulties for neonatologists. Determination of overall circulatory status is still largely subjective, and there are currently no validated clinical scoring systems. Mean arterial pressure, despite many limitations, remains the most commonly used marker of hemodynamic disorders. However, assessing the state of the circulatory system only on the basis of mean arterial pressure is an overly simplified approach to a much more complex problem. Normal blood pressure does not mean normal blood flow in target organs

MATERIALS AND METHODS

Shock is defined as a state of impaired cellular energy (ATP) synthesis when the supply of oxygen to tissues becomes insufficient to meet their oxygen demand [1]. In the first phase of shock, perfusion and oxygen supply to the so-called vital organs (heart, brain and adrenal glands) are maintained, which is carried out due to selective local vasodilation in combination with vasoconstriction in relation to less important tissues (muscles, skin, kidneys) , abdominal organs). This phase of shock compensation is due to the action of neuroendocrine mechanisms. Blood pressure, determined by cardiac output (which decreases) and systemic vascular resistance (which increases), remains in the normal range during the shock compensation phase.

RESULTS AND DISCUSSION

Echocardiography is one of the diagnostic methods that can be used to assess cardiac output in critically ill neonates, mainly because clinical assessment of cardiac output is quite imprecise [4]. In addition, echocardiography performed by a neonatologist (EN) can help the clinician understand the possible pathophysiological mechanisms of circulatory disorders and be used to evaluate the effectiveness of therapeutic interventions.

Assessing the hemodynamic status of the newborn using echocardiography can improve the quality of neonatal intensive care [1]. This review discusses the physiology of cardiac output and tissue oxygen delivery, methodology and validation of several methods for measuring central blood flow [left and right ventricular ejection (LVO, RVE), superior vena cava flow (SVC), and descending aortic flow (HAo)], reference values of indicators and recommendations for an individualized approach to the normalization of hemodynamics under the control of EVN.

One of the most important functions of the circulatory system is the delivery of oxygen and nutrients to tissues, as well as the delivery of carbon dioxide and metabolic products to the excretory organs. Normally, the level of oxygen intake exceeds the level of its consumption.

The level of oxygen delivered is determined by the hemoglobin concentration in the blood serum, arterial oxygen saturation, cardiac output and is calculated by multiplying the arterial oxygen concentration (CaO2) by cardiac output (CO). CaO2 is calculated as follows: [SaO2 (as a gradient) × Hb (mmol/l) × 0.98) + (PaO2 (kPa) × 0.0004]. As can be seen from this formula, the contribution of dissolved oxygen to the total the oxygen content in arterial blood can be neglected.Oxygen consumption is affected by metabolic rate (sedation, pain, agitation), thermogenesis (chills, fever, catecholamine production) and the external work of the body (respiratory work, sepsis, trauma, catabolism) [2].

To create sufficient preload on the myocardium, it is necessary to have an appropriate intravascular volume of fluid. Intravascular fluid expansion is often used as

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first-line therapy for hemodynamic compromise in newborns [2]. In cases of true hypovolemia, fluid support plays an important role; however, excessive fluid administration is associated with increased mortality and complications [3]. Possible mechanisms for these undesirable effects are volume overload leading to tissue edema. In addition, there is evidence that the increased release of natriuretic peptides in response to increased pressure when filling the heart chambers is associated with damage to the endothelial glycocalyx, which leads to an increase in endothelial permeability [4]. It would be useful if the response to volume expansion and the need for volume expansion could be predicted. The intravascular volume response is defined as an increase in stroke volume (5–10%) with fluid bolus administration [2]. However, restoration of hemodynamics in response to infusion therapy does not automatically imply the presence of a hypovolemic state requiring an increase in intravascular volume. Clinical (static) hemodynamic parameters, such as heart rate and blood pressure, are not reliable enough to predict response to fluid administration in newborns [3]. Dynamic measures of fluid response, such as changes in blood pressure and stroke volume due to heart-lung interactions, have been studied in adults and older children under certain circumstances and have shown promising prognostic results. However, these methods are not applicable in daily clinical practice in intensive care units [4].

Monitoring cardiac output is just one key aspect in the effort to improve outcomes in critically ill newborns. "Normal" SC values do not automatically mean that perfusion in all tissues is sufficient. Assessment of cardiac output provides information only about central, but not peripheral blood flow (in individual organs). The near-infrared spectroscopy (NIRS) method has been introduced into clinical practice to monitor cerebral hemodynamics and oxygenation; the method can also be used to assess perfusion of the kidneys and abdominal organs [2]. Increased regional absorption of oxygen by tissues may reflect the phenomena of its redistribution aimed at maintaining the perfusion of vital organs. In addition, simultaneous assessment and coherence analysis of blood pressure and regional cerebral tissue oxygen saturation (rScO2) provides information about the brain's ability to self-regulate [3]. It should be remembered, however, that rScO2 reflects cerebral blood flow only when the intensity of cerebral oxygen consumption, arterial oxygen saturation, hemoglobin concentration and partial pressure of carbon dioxide in arterial blood are stable, and there are no measurement artifacts. Assessment of regional perfusion will complement the results of hemodynamic assessment, on the basis of which individualized patient management tactics can be developed.

Comprehensive monitoring of hemodynamic parameters followed by competent interpretation of the results obtained, together with an individualized targeted approach to the patient, plays a crucial role in reducing mortality and the incidence of complications. Elsayed et al. [4] published the results of a retrospective study in which newborns with hemodynamic instability experienced faster clinical recovery after the introduction of comprehensive hemodynamic monitoring, including the use of echocardiography performed by a neonatologist.

CONCLUSION

Assessing hemodynamic parameters in newborns is complex and must include more than just monitoring of heart rate, blood pressure, and other imprecise clinical variables. EVI can potentially play a key role in the timely detection of cardiovascular failure, the selection of individualized treatment tactics and monitoring the effects of therapeutic interventions.

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