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Alterations in the physiological parameters of newborns using oxygen therapy in the collection of blood gases

Alterações nos parâmetros fisiológicos dos recém-nascidos sob oxigenoterapia na coleta de gasometria

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Keywords

Newborn infants; Physiological processes; Oxygen inhalation therapy; Blood gas analysis; Neonatal nursing

Descritores

Recém-nascido; Processos fisiológicos; Oxigenoterapia; Gasometria; Enfermagem neonatal

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Abstract

Objective: To identify the changes that occur in the physiological parameters of newborns under oxygen therapy during the collection of arterial blood gases, comparing the moments immediately before, immediately after, and five minutes after the procedure.

Methods: A longitudinal study, of the before and after research design. The sample was composed of 67 newborns under oxygen therapy that had an arterial puncture for blood gas analysis.

Results: The group of newborns in an Oxyhood experienced significant alterations ($p < 0.05$) in heart rate, pulse and oxygen saturation. Newborns on mechanical ventilation had alterations in respiratory rate and pulse, while those with nasal CPAP showed no instability in physiological parameters.

Conclusion: The painful stimulus caused by the collection of blood gases in newborns showed changes in all physiological parameters, however, for such a procedure, the changes were different for each mode of oxygen therapy.

Resumo

Objetivo: Identificar as alterações que ocorrem nos parâmetros fisiológicos dos recém-nascidos sob oxigenoterapia na coleta de gasometria arterial, comparando os momentos imediatamente antes, imediatamente depois, e cinco minutos depois do procedimento.

Métodos: Estudo longitudinal, do tipo antes e depois. Amostra composta por 67 recém-nascidos sob oxigenoterapia que receberam punção arterial para gasometria.

Resultados: O grupo de recém-nascidos em Oxi-Hood sofreu alterações significativas ($p < 0,05$) na frequência cardíaca, pulso e saturação de oxigênio. Os recém-nascidos em ventilação mecânica obtiveram alterações de frequência respiratória e pulso e aqueles sob CPAP nasal não mostraram instabilidade dos parâmetros fisiológicos.

Conclusão: O estímulo doloroso causado pela coleta de gasometria nos recém-nascidos mostrou variações de todos os parâmetros fisiológicos, porém, para tal procedimento, as alterações foram diferentes em cada modalidade de oxigenoterapia.

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Introduction

One of the critical milestones in decreasing neonatal mortality was the implementation of modern Neonatal Intensive Care Units equipped with human resources and medium and high complexity technologies.

Respiratory disorders are identified as one of the primary contributors for admissions in Neonatal Intensive Care Units.⁽¹⁾ Therefore, newborns who have respiratory disorders may need some modality of oxygen therapy, requiring monitoring and indispensable procedures for an early diagnosis and, consequently, to maintain the life of these patients. Therefore, the nurse must be able to perceive these changes, as well as the reasons causing these changes, in the respiratory status of neonates.

The stay of the newborn in the Neonatal Intensive Care Unit, considered to be a high risk unit, requires a series of painful procedures and the stress caused by pain can lead to clinical instability.⁽²⁾ In the midst of so many procedures considered aggressive to these small patients, blood sampling for blood gas analysis is a common practice of nurses in high-risk units, especially when it comes to neonates with low gestational age (GA), low weight and those who are critically ill.⁽³⁾

The ability to analyze the blood gases and correlate the results with the physical evaluation of the patient is essential in nursing practice and for the identification of respiratory compromise.⁽⁴⁾

It is emphasized that, due to its being a painful procedure, collection of blood gases can lead to changes in physiological parameters of the newborns and, consequently, impair the neurological status of these smallest of patients.

The objective of this study was to identify the changes that occur in the physiological parameters of the newborns receiving oxygen therapy while performing the collection of arterial blood gases, making a comparison between the moments immediately before, immediately after, and five minutes after the procedure.

Methods

This was a longitudinal study of a before and after design, conducted in a Neonatal Intensive Care Unit in a public reference hospital, intended to provide care and the education of professionals, located in the city of Fortaleza, in the capital of Ceará, situated in the northeastern region of Brazil.

The sample (n) was composed of 67 newborns that were using oxygen therapy and who required the collection of blood for arterial blood gas analysis. A non-probabilistic convenience sample of a consecutive type was used.

Newborns were selected, regardless of gestational age, with a minimum of six hours of life who were hospitalized in a high risk bed in the Neonatal Intensive Care Units named as π and β . The newborns had to have some respiratory disorder and were being treated with some modality of oxygen therapy for, at a minimum, six hours.

The oxygen therapy modalities included in the present study were: an oxygen tent (Oxyhood), nasal Continuous Positive Airway Pressure (nasal CPAP), and mechanical ventilation (MV).

Those newborns were excluded who were extubated for less than six hours, due to hemodynamic and respiratory instability. Similarly, neonates also excluded were those with: persistent pulmonary hypertension, fever, mothers who used illicit drugs, and malformations.

The physiological parameters verified were the respiratory rate, heart rate, pulse and oxygen saturation, in three distinct moments: immediately before, immediately after, and five minutes after the procedure. These criteria were chosen with the intent of comparing the physiological parameters in the three moments of study and to examine if there were or were not changes in these parameters.

It is noted that the respiratory and heart rate were measured by counting the thoracic movements and cardiac auscultation, respectively, for one minute, with the aid of a stopwatch, while the pulse and O₂ saturation were recorded by an oximeter monitor or the multiparameter pulse of the *Dixtal*® brand.

In clinical practice, heart rate can be derived from the pulse rates, as they are parameters of the same nature.⁽⁵⁾

Before executing the data collection, a pilot test was performed with fifteen newborns regarding the evaluation of newborn physiological parameters and for evaluation of reliability; the intraclass correlation coefficient (ICC) was used for all physiological parameters, which showed excellent agreement between raters.

The data obtained were recorded on forms, contemplating the predictive or independent variable: the procedure of collecting blood gases performed by the nurse and certain outcome or dependent variables, such as the physiological parameters of cardiac and respiratory rate.

The data were presented in a table, and were analyzed using the SPSS[®] software, version 14.0, for the completion of statistical procedures. The continuous and discrete quantitative variables were initially analyzed using the Kolmogorov-Smirnov test, however it was established that there was no normal distribution of the population. Therefore, we used the Friedman test to compare the measures of central tendency (mean and median) of the physiological parameters, as well as the measures of dispersion (standard deviation and the 25th and 75th percentiles).

As for the 67 newborns submitted to the blood gas analysis procedure, only four were born at term, 63 were preterm, the neonates were considered indistinctly for the analysis of the normal ranges of the physiological parameters, in the implementation of the collection of blood gases. In this way, the means of the variables of the total number of newborns were equal to the means of the pre-term infants.

In all tests performed, the probability of a type I error (significance level) was established at 0.05 (5%), with a value of $p < 0.05$ being considered statistically significant. We chose to mark the significant values with an asterisk.

It is noteworthy that in the high-risk units where the study was conducted there was no preventive routine for the pain from painful procedures, except some intubated newborns who were

sedated, who were excluded. In the high-risk units of the present study, the arterial blood sample was collected by the nurse.

The development of the study met the requirements of national and international standards of ethics in research involving human beings.

Results

In table 1, data related to the responses of the physiological parameters of the neonates resulting from the procedure for collection of the arterial blood gas sample are provided.

When evaluating the set of physiological variables referring to the blood gas procedure, it was found that the respiratory rate was significantly lower five minutes after this practice in the newborns on MV, when compared to the moment immediately after, with no influence of this variable for the infants in an Oxyhood or nasal CPAP.

The HR decreased five minutes after the collection of blood gases in the newborns in an Oxyhood, conferring a reduction of this parameter with respect to the time immediately after the procedure. The pulse variable in the neonates in an Oxyhood obtained a reduction five minutes after the blood gases were drawn, when compared to the moment immediately after, and the newborns on MV had an elevated pulse immediately after the procedure in relationship to the reading before, but, five minutes later, it had returned to its initial value.

The SpO_2 increased directly five minutes after the collection of the blood gases of the neonates in the Oxyhood, ratifying a stabilization of this variable with respect to the time immediately after the procedure.

Given the results described for the blood gas procedure, we were able to notice that there were physiological changes of the newborns in the Oxyhood, (HR, pulse and SpO_2) and on MV (RR and pulse), but neonates with nasal CPAP showed no instability immediately before, after or five minutes after the procedure, therefore, these patients exhibited greater stability than the others, with respect to the studied parameters in the blood gas procedure.

Table 1. Comparison of the measures of central tendency and dispersion of the physiological parameters of the newborns, by oxygen therapy modality, for the blood gas procedure

Variables	Mean \pm SD	P ₂₅ -P ₅₀ -P ₇₅	p-value*
FR			
OxiHood			0.313
Before	54.0 \pm 17.0	40.7 -54.0- 60.2	
After	57.1 \pm 14.7	45.7 -56.0- 70.5	
5 min after	53.1 \pm 14.0	42.0 -52.0- 64.2	
CPAP			0.976
Before	49.1 \pm 15.8	38.0 -50.0- 61.0	
After	53.1 \pm 17.5	43.0 -53.0- 68.0	
5 min after	48.1 \pm 16.2	29.0 -48.0- 68.0	
VM			0.013*
Before	53.2 \pm 13.8	42.8 -50.0- 62.0	
After	55.8 \pm 15.6	44.5 -56.0- 67.0	
5 min after	51.0 \pm 14.6	39.5 -50.0- 61.0	
FC			
OxiHood			0.039*
Before	142.4 \pm 18.0	128.0 -142.0- 153.0	
After	149.0 \pm 20.4	132.0 -146.0- 161.0	
5 min after	141.0 \pm 20.1	132.0 -136.0- 149.0	
CPAP			0.814
Before	143.0 \pm 12.5	136.0 -140.0- 152.0	
After	143.4 \pm 15.5	128.0 -148.0- 156.0	
5 min after	145.4 \pm 17.1	126.0 -152.0- 160.0	
VM			0.227
Before	156.5 \pm 60.5	136.0 -148.0- 162.0	
After	159.0 \pm 56.1	138.0 -156.0- 164.0	
5 min after	145.0 \pm 19.2	128.0 -148.0- 160.0	
Pulse			
OxiHood			0.016*
Before	139.5 \pm 15.2	128.0 -140.0- 150.7	
After	145.3 \pm 17.7	129.0 -145.5- 158.2	
5 min after	137.9 \pm 14.7	128.0 -134.5- 145.2	
CPAP			0.076
Before	140.5 \pm 13.2	133.0 -145.0- 150.0	
After	145.8 \pm 12.3	133.0 -151.0- 153.0	
5 min after	141.0 \pm 18.0	124.0 -148.0- 154.0	
VM			0.009*
Before	145.1 \pm 20.0	131.0 -146.0- 160.0	
After	150.0 \pm 19.2	141.0 -152.0- 167.0	
5 min after	144.3 \pm 19.0	126.0 -146.0- 160.5	
SpO ₂			
OxiHood			0.049*
Before	97.4 \pm 1.3	96.0 -98.0- 98.0	
After	96.1 \pm 5.0	95.0 -97.5- 98.2	
5 min after	97.6 \pm 1.3	97.0 -98.0- 99.0	
CPAP			0.381
Before	97.1 \pm 2.5	96.0 -97.0- 100.0	
After	96.3 \pm 3.6	96.0 -97.0- 99.0	
5 min after	96.8 \pm 3.0	96.0 -97.0- 99.0	
VM			0.957
Before	96.7 \pm 2.0	96.0 -97.0- 9.0	
After	96.7 \pm 2.5	96.0 -97.0- 99.0	
5 min after	96.6 \pm 2.6	95.5 -98.0- 98.0	

n Oxyhood= 34; nCPAP= 10; n MV= 23; n= 67; P₂₅-P₅₀-P₇₅-Means; *p of Friedman; p<0.05

Discussion

Arterial gasometry is an invasive test that provides values and allows us to analyze blood gases, as well as acid-base balance. Blood gas values are ordered by the physician when the clinical condition of the critically ill newborn suggests any changes in oxygenation, ventilation or acid-base status.

The analysis of blood gas measurements guides the physician as to how the professional can intervene in treating a patient who is using some sort of long-term oxygen therapy, to try to achieve success in the oxygenation of this patient, through changes in the parameters of ventilatory support, to which the newborn is submitted.⁽⁶⁾

On his part, the nurse, knowing the blood gas measurements, may act to prevent problems that may worsen the respiratory status of the newborn, for example, malpositioning of the endotracheal tube (ETT), the ineffective functioning of the ventilator, or even a “stopper” of secretions in the ETT. Cares such as these lead to an improvement in the gas exchange of the neonatal patient, allowing him to evolve in a positive way more rapidly.

When choosing the location of the arterial puncture, one should reflect on the ease of access to the vessel and the type of periarterial tissue, since the muscles, tendons and fat are less sensitive to pain than the periosteum and nerve fibers.⁽⁷⁾ Therefore, one should consider the blood gas analysis, due to the puncture itself, as a painful practice.

Pain assessment can be made by observation of the physiological parameters (increase in HR and blood pressure and reduction of SpO₂) and behavior (crying, facial expressions, agitation, and others).⁽⁸⁾

Laboratory studies and clinical practice ensure that uncontrolled neonatal pain can cause adverse effects on health and long-term neurological development. Research conducted in a Neonatal Intensive Care Unit of São Paulo aimed to evaluate the physiological and behavioral reactivity in preterm newborns during different stages of the arterial puncture procedure. For this assessment, the Facial Action Coding System (FACS) and monitoring at the bedside was used. The results showed that in-

infants anticipated the reaction to painful stimulation of the arterial puncture, with significant changes in facial activity, HR, wakefulness and sleep, at the moment of antisepsis prior to arterial puncture.⁽⁹⁾

When evaluating the set of physiological variables related to the blood gas procedure, it was found that RR was significantly lower five minutes after this practice in the newborn on MV, when compared to the time immediately after, with no influence of this variable for the groups in an Oxyhood and nasal CPAP. It is possible that, for this painful procedure, neonates using MV were more sensitive to pain, considering that all infants who were receiving this mode of oxygen therapy were premature and were not sedated.

The heart rate decreased five minutes after the collection of blood gases in newborns in an Oxyhood, showing a reduction of this parameter in relationship to the moment immediately after the procedure. Because infants in an Oxyhood are hemodynamically more stable than the neonates on nasal CPAP and MV, it is assumed that the painful stimulus caused agitation and increased HR immediately after collection of blood gases, but according to the clinical picture of these infants, they managed a rapid decrease of HR. According to some authors, there are physiological indicators of pain, and among them are: HR, RR, SpO₂ and hormone levels.⁽¹⁰⁻¹³⁾

The variable pulse in neonates in an Oxyhood obtained a reduction five minutes after blood gas analysis, when compared to the moment immediately after, and the newborns on MV showed an increase in their pulse immediately after the procedure in relationship to before, however, five minutes later, managed to return to baseline. As mentioned previously, neonates in MV, as with all preterm infants, were more susceptible to feeling pain, so it is probable that, immediately following the procedure of the blood gas puncture, the neonate felt pain and the pulse increased, but quickly managed to return to previous values.

The SpO₂ increased slightly five minutes after collecting blood gases in the newborns in an Oxyhood, confirming the stabilization of this variable in relationship to the moment immedi-

ately after the procedure. Thus, it is possible to consider that five minutes was sufficient time for the newborns to recover from the painful stimulus caused by the sting of the needle insertion at the time of sample collection.

Given the results described for the procedure of gases, we could notice that there were physiological changes of newborns in the Oxyhood (HR, pulse and SpO₂) and MV (RR and pulse), but babies using nasal CPAP showed no instability immediately before, after or five minutes after the procedure, therefore, these subjects exhibited greater stability than the others, with respect to the studied parameters in the procedure of drawing blood gasses.

It should be noted that the collection of blood gas analysis does not require the removal of the upper airway oxygen therapy support at any time, thus it is necessary that the neonate is under continuous oxygen therapy for the results of blood gas analysis to be credible. Therefore, in this study, all infants in Oxyhood, MV and nasal CPAP were under continuous oxygenation, however, showed different responses. The physiological manifestations presented by the neonates resulted from painful stimulation caused by the collection of the blood gas samples.

Given the pain caused by the painful procedure, it is important to employ measures that reduce this condition. Some non-pharmacological measures were used for pain relief, among these: the provision of 25% oral glucose, kangaroo position, non-nutritive sucking, gauze pacifier with breast milk, as well as others.⁽¹⁴⁻¹⁶⁾

Conclusion

The results show that the changes in the physiological parameters were different for each modality of oxygen therapy during the collection of arterial blood gasses. The group of newborns in an Oxyhood suffered significant changes in cardiac rate, in the pulse and in oxygen saturation. The neonates on MV obtained significant alterations in respiratory rate and pulse.

It is possible that the change occurring in the three types of oxygen therapy studied were related

to painful stimulus caused by the arterial puncture that can be felt in a distinct manner by the neonates, in each oxygen therapy modality.

Collaborations

Barbosa AL contributed to the project design, execution of the research, drafting of the article, analysis and interpretation of the data, and approval of the final version of the article. Cardoso MVLML contributed to the project design, drafting of the article, analysis and interpretation of the data, and approval of the final version of the article.

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