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Original Article

Endotracheal and upper airways suctioning: changes in newborns' physiological parameters

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This study investigated which physiological parameters change when endotracheal and upper airway suctioning is performed immediately before, immediately after and five minutes after this procedure is performed in newborns hospitalized in a Neonatal Intensive Care Unit (NICU). This is a quantitative and longitudinal study, before and after type, performed in the NICU of a public institution in the city of Fortaleza, CE, Brazil. The sample was composed of 104 newborns using oxigenotherapy and who needed endotracheal and upper airway suctioning. The results showed significant alterations in respiratory and heart rates ($p<0.05$) in neonates using Oxyhood and nasal CPAP while the pulse significantly changed ($p<0.05$) in newborns placed in oxyhood, using nasal CPAP and Mechanical Ventilation; oxygen saturation was the only parameter that did not alter significantly. We propose that nurses develop non-pharmacological interventions to reduce potential alterations caused in newborns' physiological parameters due to this procedure.

Descriptors: Newborn Infants; Physiological Processes; Oxygen Inhalation Therapy; Respiratory Aspiration; Neonatal Nursing.

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Aspiração do tubo orotraqueal e de vias aéreas superiores: alterações nos parâmetros fisiológicos em recém-nascidos

Objetivou-se investigar quais são os parâmetros fisiológicos que se alteram na execução da aspiração do tubo orotraqueal (TOT) e das vias aéreas superiores (VAS), comparando-os imediatamente antes, imediatamente depois e cinco minutos após a realização do referido procedimento. Trata-se de estudo quantitativo, longitudinal, do tipo antes e depois, realizado em Unidade de Terapia Intensiva Neonatal (Utin) de uma instituição pública em Fortaleza, CE, Brasil. A amostra constou de 104 recém-nascidos em uso de oxigenoterapia, e que necessitaram de aspiração do tubo orotraqueal e das vias aéreas superiores. Os resultados mostraram alterações significativas ($p<0,05$) nas frequências respiratória (FR) e cardíaca (FC) dos recém-nascidos, em uso de tenda de oxigênio (Oxi-Hood) e pressão contínua das vias aéreas (CPAP nasal), e também de pulso ($p<0,05$) para os recém-nascidos em Oxi-Hood, CPAP nasal e ventilação mecânica (VM), sendo a saturação de oxigênio (SpO_2) o único parâmetro que não foi estatisticamente significante. Propõe-se aos profissionais enfermeiros o desenvolvimento de intervenções não farmacológicas para reduzir possíveis alterações dos parâmetros fisiológicos dos recém-nascidos, decorrentes desse procedimento.

Descritores: Recém-Nascido; Processos Fisiológicos; Oxigenoterapia; Aspiração Respiratória; Enfermagem Neonatal.

Aspiración del tubo endotraqueal y de las vías aéreas superiores: alteraciones en los parámetros fisiológicos en recién nacidos

Se objetivó investigar cuales son los parámetros fisiológicos que se alteran en la ejecución de la aspiración del tubo endotraqueal (TOT) y de las vías aéreas superiores (VAS), comparándolos inmediatamente antes, inmediatamente después y cinco minutos después de la realización del referido procedimiento. Se trata de un estudio cuantitativo, longitudinal, del tipo antes y después, realizado en una Unidad de Terapia Intensiva Neonatal (UTIN) de una institución pública en Fortaleza, CE, Brasil. La muestra constó de 104 recién nacidos que usaban oxigenoterapia, y que necesitaron de aspiración del tubo endotraqueal y de las vías aéreas superiores. Los resultados mostraron, alteraciones significativas ($p<0,05$) en las frecuencias respiratorias (FR) y cardíaca (FC) de los recién nacidos en uso de Oxi-Hood y CPAP nasal, y también del pulso ($p<0,05$) para los recién nacidos en Oxi-Hood, CPAP nasal y Ventilación Mecánica (VM), siendo la saturación de oxígeno (SpO_2), el único parámetro que no fue estadísticamente significativo. Se propone a los enfermeros desarrollar intervenciones no farmacológicas para reducir posibles alteraciones de los parámetros fisiológicos de los recién nacidos provenientes de este procedimiento.

Descriptores: Recién Nacidos; Procesos Fisiológicos; Oxigenoterapia; Aspiración Respiratoria; Enfermería Neonatal.

Introduction

Birth conditions are determinant factors in the adaptation and evolution of postnatal life. According to evaluations immediately after birth of newborns' risk of complications, when newborns are severely ill, with unstable vital functions or hemodynamically unstable, they require intensive care in a Neonatal Intensive Care Unit (NICU) regardless of the diagnosis, where clinical surveillance, continuous monitoring and invasive procedures are the priority[1].

Among the care procedures performed by nurses in NICU we highlight the Endotracheal Tube (ETT) suction to clear airway secretions in newborns undergoing Mechanical Ventilation (MV) and suction in the Upper Respiratory Track (URT) in infants undergoing other types of oxygen therapy, such as Continuous Positive Airway Pressure (nasal CPAP) and Oxygen Hoods.

The presence of an ETT increases the production of secretion because it impedes the patient from performing the normal mechanism of cleaning the URT through coughing. The need to clear secretions is mainly determined by visual observation of accumulated secretion and pulmonary auscultation, which reveals the presence of secretion or obstruction in URT[2]. Suctioning URT may aggravate the situation of newborns, thus it requires professionals to master the technical procedure in addition to having knowledge concerning the physiopathology of the patient's respiratory tract[3].

Standardized schedules are usually established in ICUs to perform technical procedures such as suctioning. Such schedules do not take into account the real needs and potential harmful effects on patients' oxygenation when no care is provided before, during and after such a procedure. The American Association for Respiratory Care (AARC) recommends this procedure be performed according to clinical signs and symptoms such as: worsened respiratory discomfort, presence of secretion within the tube, agitation and decline in oxygen saturation[4].

A cohort study conducted in Switzerland described the type and frequency of procedures performed in an ICU and endotracheal and nasopharyngeal suctioning were considered the second and third most frequent procedures, perceived as being painful and very painful, respectively, on a pain scale[5].

It is believed that care performed in ICUs should attempt to reduce excessive handling that may put the wellbeing of newborns at risk, such as from causing stress, pain, physiological and behavioral alterations[6].

There are many agents causing respiratory alterations in newborns when they are hospitalized in an ICU. Therefore, nurses should be apt to perceive such alterations as well as the reasons causing these changes in the respiratory condition of newborns.

We believe in the relevance of this topic and for this reason we decided to investigate what physiological parameters that suffer changes due to the performance of ETT and URT suctioning comparing them before, immediately after, and five minutes after the procedure is performed.

Method

This before and after longitudinal and quantitative study was conducted in an ICU of a public referral facility that provides care and educates professionals located in Fortaleza, capital of the state of Ceará, Brazil. The study was carried out only in the high-risk units that we gave the fictitious names π and β.

The sample (n) was composed of newborns under oxygen therapy and needed endotracheal or upper airway suctioning between December 2008 and June 2009. A non-probabilistic consecutive sampling was performed. Preterm and term newborns were selected regardless of their gestational age (GA), with at least six hours of life and hospitalized in high-risk beds of NICUs referred to as π and β. Another requirement was that newborns should have some respiratory disorder and undergo some type of oxygen therapy (Oxyhood, CPAP nasal or MV) for at least six hours.

The infants were included in the study as the need to perform ETT or upper airway suctioning was observed; each infant participated in the study only once. Therefore, the number of newborns coincided with the number of procedures. Those with less than six hours of extubation were excluded from the study given their potential hemodynamic and respiratory instability. Consequently, newborns with Persistent Pulmonary Hypertension (PPH) were excluded from the study, as well as those with fever, and children of drug addicted mothers, given the deleterious effects that drugs can cause on newborns such as alterations in brain functioning that result in hypoxemia and, malformed children.

Based on the inclusion and exclusion criteria, the sample size was established at 104 newborns undergoing ETT and upper airway suctioning; 97 of these were preterm and only seven were term infants. The sample was computed according to the formula for before and after studies.

The physiological parameters to be observed included: respiratory rate (RR), heart rate (HR) in the apical region, pulse rate (P) and oxygen saturation (SpO_2). These parameters were measured at three distinct points in time: immediately before, immediately after and five minutes after suctioning was performed. Such criteria were chosen to compare physiological parameters at the three points in time and verify whether they changed as well as return to baseline values five minutes after the procedure was performed by nurses.

We note that RR and RR were measured from the count of chest movements and auscultation in the apical

region during one minute with the aid of a chronometer; pulse and SpO_2 recorded by a monitor or a *Dixtal*® multiparameter pulse oxymeter. The first parameter measured was the RR so that the newborns were not touched, avoiding causing this parameter to alter. HR was then measured and, finally, the parameters related to pulse and SpO_2 were measured through oxymetry.

We note that, considering that the HR measured in the apical region and pulse rate measured through oxymetry are parameters of the same nature, they were independently measured since a difference between the two values is observed in the literature[7].

We highlight that before effectively collecting data, a pilot test was conducted on the assessment of the newborns' physiological parameters. The researcher and one graduate nursing student performed this test. A sample of 15 newborns, with criteria similar to those used in this study, had their RR, HR, pulse and SpO_2 assessed. Interclass Correlation Coefficient (ICC) was used to compare the evaluators' results. The ICCs related to RR, HR, pulse and SpO_2 were respectively 0.900, 0.933, 0.948 and 0.909. An excellent level of agreement is achieved when ICC is above 0.800; a good level of agreement when ICC is between 0.600 and 0.800, and a low level of agreement when it is below 0.600[8], we note that the ICCs for all the parameters were considered excellent, with a high level of agreement between the evaluators.

Collected data were recorded on a previously developed form with the predictor or independent variable (ETT or upper airway suctioning performed by nurses) and dependent or outcomes variables: RR, HR physiological parameters along with those monitored during the procedure (pulse and SpO_2).

Data were presented in a table and statistical procedures were processed in SPSS® version 14.0. The quantitative, continuous and discrete variables were initially analyzed using the Kolmogorov-Smirnov test to verify whether the population distribution was normal and it revealed non-normality. Consequently, the central tendency measures (average and median) of the physiological parameters before, immediately after and five minutes after the procedure, as well as the dispersion measures (standard deviation and 25^{th} and 75^{th} percentiles) were compared through the Friedman test.

The newborns were indistinctly considered whether they were preterm or term in analyzing the normal ranges of physiological parameters during ETT and upper airway suctioning since, according to the Capurro scale, only seven out of 104 newborns were term. Hence, the averages of the variables of all the newborns were equal to the averages of the preterm infants. We adopted the Capurro scale to evaluate GA because the medical files of most of the investigated newborns contained only the Capurro computation instead of the GA computed through an ultrasound.

The alpha probability of a type I error (level of significance) was fixed at 0.05 (5%) for all the tests performed; $p<0.05$ was considered statistically significant. An asterisk marks all the significant values.

Ethical aspects followed Resolution 196/96, Brazilian National Council of Health, Ministry of Health that guides research performed with human subjects. Hence, confidentiality of the participants' identities was ensured and the study's nature, purpose and objectives were clarified and the project was submitted to and approved by the Ethics Research Committee (Protocol CEP.88/08) at the institution where the study was conducted. The newborns' legal guardians signed free and informed consent forms that ensured accessibility to data, identity confidentiality, and the freedom to withdraw from the study if desired. The nurses participating in the study also signed consent forms and were conferred the same rights as those conferred to the infants' legal guardians.

Results

Table 1 presents data related to the physiological responses of newborns under going ETT or upper airway suctioning organized among 31 newborns in oxyhood, 23 in nasal CPAP and 50 newborns in MV. Closed ETT suction was used for newborns using MV.

Table 1 – Comparison of central tendency and dispersion measures of the newborns' physiological parameters by type of oxygen therapy for the ETT and upper airway suction procedure, Fortaleza, CE, Brazil, 2009

	Average ± SD	P_{25}-P_{50}-P_{75}	P*
	RR		
Oxyhood (n=31)			0.002†
Before	57.4±17.9	44.0-52.0-70.0	
Immediately after	50.8±19.5	38.0-44.0-61.0	
5 min after	50.8±19.1	39.0-47.0-59.0	
CPAP (n=23)			0.009†
Before	48.6±20.6	29.5-51.0-60.7	
Immediately after	50.0±21.9	33.5-49.0-61.5	
5 min after	44.0±20.0	32.2-39.0-51.5	

(continue...)

Table 1 – (continuation)

	Average ± SD	P_{25}-P_{50}-P_{75}	P*
VM (n=50)			0.168
Before	56.7±17.9	44.0-54.0-66.0	
Immediately after	53.5±18.0	39.5-49.0-66.5	
5 min after	55.8±14.1	46.5-56.0-65.0	
HR			
Oxyhood			0.006†
Before	137.3±17.9	128.0-138.0-144.0	
Immediately after	144.1±13.6	136.0-144.0-154.0	
5 min after	140.0±12.4	132.0-140.0-148.0	
CPAP (n=23)			0.017†
Before	140.8±15.0	132.0-140.0-152.0	
Immediately after	148.8±16.4	133.0-154.0-160.0	
5 min after	144.6±17.3	133.0-144.0-159.5	
VM (n=50)			0.268
Before	145.8±19.2	136.0-144.0-160.0	
Immediately after	153.8±19.6	136.0-148.0-160.0	
5 min after	148.0±18.5	134.0-144.0-160.0	
Pulse			
Oxyhood (n=31)			<0.0001†
Before	134.6±15.3	126.0-136.0-144.0	
Immediately after	142.2±12.5	134.0-141.0-152.0	
5 min after	136.0±12.3	129.0-136.0-147.0	
CPAP (n=23)			0.04†
Before	139.0±15.7	129.0-141.0-147.0	
Immediately after	145.0±15.7	126.2-143.0-153.0	
5 min after	142.0±17.8	125.2-143.0-156.0	
VM (n=50)			0.002†
Before	143.3±19.0	129.0-142.0-155.0	
Immediately after	148.0±20.0	131.5-147.0-156.0	
5 min after	146.0±19.1	125.5-144.0-156.7	
SpO_2			
Oxyhood (n=31)			0.325
Before	97.7±1.6	97.0-98.0-99.0	
Immediately after	97.6±2.0	97.0-98.0-99.0	
5 min after	97.7±1.7	97.0-98.0-99.0	
CPAP (n=23)			0.066
Before	97.4±1.3	97.0-97.5-98.0	
Immediately after	97.0±3.3	96.2-98.0-99.0	
5 min after	97.8±1.4	97.0-98.0-99.0	
VM (n=50)			0.307
Before	95.6±4.0	94.5-97.0-98.0	
Immediately after	96.2±2.7	96.0-97.0-98.0	
5 min after	96.3±3.2	95.5-97.0-98.0	

n=104
*p Friedman
†p<0.05

Decreased RR was observed during, immediately and five minutes after the ETT and upper airway suction was performed, when compared to the time before the procedure was performed in newborns using an oxyhood. Newborns on a nasal CPAP also presented decreased RR five minutes after the procedure when compared to the time immediately after the procedure, but no significant alteration was observed among those in MV.

HR increased immediately after the procedure among newborns placed in an oxyhood; those using nasal CPAP and decreased five minutes after the procedure only among those with oxyhood. Hence, the increase in HR showed that this parameter was strongly influenced immediately after suctioning was applied in newborns placed in an oxyhood and using nasal CPAP. Newborns in MV also did not present significant change in HR in any of the studied times.

Pulse rose immediately after the procedure when compared to the time before in newborns undergoing the three types of oxygen therapy. Newborns placed in oxyhood were the only ones whose pulse decreased five minutes after the procedure when compared to the time immediately after the procedure.

SpO_2 did not present statistically significant alteration according to the Friedman test in any of the groups of newborns (oxyhood, nasal CPAP or MV).

Discussion

ETT and upper airway suction performed on newborns hospitalized in NICUs undergoing oxygen therapy is a procedure routinely performed to maintain permeability of airways threatened by the risk of becoming obstructed by secretion plugs.

One prospective study conducted with 151 newborns during the first 14 days of hospitalization in an NICU in Rotterdam, The Netherlands, revealed that the greatest exposure to painful procedures occurred during the first day of hospitalization, and most of the procedures (63.6%) consisted of suctioning, including nasal and endotracheal suctioning[9]. The ETT and upper airway suction, considered stressful and painful, may also cause other alterations that deserve attention and harmfully affect the newborn, depending on his/her clinical condition and how the health worker performs this practice.

The parameters to be monitored before, during and after the procedure are the following: respiratory pattern, RR, pulse oxymetry, pulmonary auscultation, cough effort, ventilator parameters, hemodynamic parameters (HR, BP and peripheral perfusion) and intracranial pressure[10].

Based on the discussed results, the averages showed that despite all the alterations presented in RR, HR and pulse, these remained within the range recommended in the literature. Even though the alterations of physiological parameters were kept within normal levels at the three points in time, we cannot affirm the newborns were not at clinical risk since the stress caused by the procedure can lead newborns to have health problems in the future.

According to the comparison among the three types of oxygen therapy in this study, the newborns placed in oxyhood were those who suffered the greatest changes in their respiratory function due to the procedure, which was manifested through their difficulty in returning RR to values prior to the suctioning procedure. Another important fact is in regard to the newborns in nasal CPAP: their RR was stabilized five minutes after the procedure. Newborns in MV did not respond with any significant alteration in their RR due to the ETT and upper airway suctioning.

In relation to the variations in physiological parameters, we verified that newborns in an oxyhood clinically require a smaller fraction of inspired O_2 (FiO_2) to keep the respiratory system stable immediately after the suctioning procedure; newborns had difficulties keeping RR within the normal range and this phenomenon continued at five minutes after the procedure. Bradypnea probably occurred immediately after upper airway suctioning and continued five minutes after it. This may have happened either because there was no need to implement such an intervention given the absence of or little secretion in the upper airways or due to the negative pressure of the suctioning system when introducing the probe into the upper airways.

Given the intensity of respiratory disorders and the need for a type of oxygen therapy with greater respiratory support, newborns using nasal CPAP would probably experience some adverse effect in respiratory function immediately after upper airways suctioning, which in fact happened.

For newborns in MV, the absence of a significant response relating RR to the procedure may be explained by the use of ventilator support, a respirator, which being in the Intermittent Mandatory Ventilation (IMV) mode permits setting mandatory cycles that are triggered by the machine according to the patient's inspiratory effort in addition to the patient's spontaneous cycles. Hence, any greater effort caused by the procedure on the newborn using MV may be improved by IMV. The raised pulse in these patients is probably due to agitation in response to discomfort caused by the procedure.

One study carried out in Ireland investigated the physiological and neurobehavioral responses of 15 preterm infants while undergoing endotracheal suction, a procedure considered one of the most distressing practices performed in NICUs. The studied parameters included reactions of body movements (distal, proximal limb, trunk), HR and SpO_2. The newborns' movements were recorded with a video camera while HR and SpO_2 were monitored. Observations took place before (for two minutes), during and after (two minutes) the endotracheal suctioning. The results showed significant alterations in HR, SpO_2 and behavioral variations with the presence of movements of adduction and abduction of the limbs in addition to trunk movements[11].

One prospective study conducted in the maternity ward of the *Hospital das Clinicas*, University of São Paulo, Medical School, evaluated physiological (RR, HR and SpO_2) and behavioral (according to the Neonatal Infant Pain Scale – NIPS) parameters of 50 newborns with GA below than 34 weeks, weight below 1,500 kg and using MV during the endotracheal and upper airway suction. Pulse oxymetry was used to evaluate the physiological parameters. Preterm newborns not under the effect of analgesics or sedated were included in the study and data were collected on the third day of life. Three points in time were investigated: before, immediately after and five minutes after the procedure. The results showed no statistically significant alterations in RR and HR in any of the times, though an important difference was observed in SpO_2 among the three times. In relation to the application of NIPS, a higher score was observed immediately after the procedure[12].

This study corroborates the results of the study previously mentioned since there were no alterations in the physiological parameters of RR and HR in newborns using MV before, immediately after and five minutes after the ETT and upper airway suctioning. There is,] however, a disagreement concerning SpO_2, because this parameter was not altered due to the procedure.

It is worth noting that in assessing newborns hospitalized in NICUs, SpO_2 is an important parameter during any procedure, including ETT and upper airway suctioning, since this parameter shows the oxygenation of newborns, whose recovery has to be monitored to observe a potential decrease in SpO_2 in order to avoid hypoxemia.

Newborns on nasal CPAP experienced an increase in their HR and pulse immediately after suctioning. It

may have occurred because during this practice nurses have to take the O_2 system off for a few seconds in order to introduce the tracheal probe, which may cause some pain in newborns who may become agitated; hence pain may raise the HR.

It is also suggested that newborns in nasal CPAP destabilized more easily because when the probe is introduced into the upper airway, they go a few seconds without oxygenation and since they require positive pressure for the alveoli not collapse, this absence of oxygen therapy for a few seconds may cause important alterations in the physiological parameters of these patients. Pulse significantly rose immediately after the procedure in the three oxygen therapy modalities.

Even though the suctioning procedure is performed to maintain upper airway permeability, it requires rigorous care due to undesirable effects that can potentially occur such as diverse cardiovascular alterations caused by hypoxemia and alterations in the autonomous nervous system[13].

One observational, prospective and cross-sectional study conducted in a neonatal and pediatric ICU at the Samuel Libânio *Hospital das Clinicas* in Pouso Alegre, MG, Brazil evaluated the physiological parameters RR, HR, BP and SpO_2 five minutes before and five minutes after tracheal suctioning. The sample was composed of ten preterm or term newborns in MV with indication of tracheal suctioning. The results did not indicate alteration of RR and SpO_2 but a discrete increase in HR and BP[14]. These data corroborate those in this study in relation to RR and SpO_2, because no alterations were observed in these two parameters from before and after the procedure's implementation for newborns using MV.

Endotracheal suctioning is an aggressive practice for patients; it causes pain and discomfort, in addition to other complications[15]. As shown by diverse studies, we know that because the ETT and upper airway suctioning is a painful practice, it may cause some changes in newborns' physiological parameters.

Even though behavioral observation was not the focus of this study, we observe that among the ways used to communicate in neonatology, gestures express more significant messages than verbalizations. Therefore, we can state that during the studied suctioning procedures observed in this study, newborns presented agitation with extension and retraction of limbs in addition to movements of head and trunk, signaling discomfort during such practices.

Conclusion

Most of the population of newborns hospitalized in an NICU is composed of infants who present respiratory disorders and require some type of oxygen therapy to stabilize their pulmonary function. Hence, this study was concerned with these patients in relation to repercussions caused to the physiological parameters during the implementation of ETT and upper airway suctioning performed by nurses.

When evaluating the set of physiological parameters during the procedure of ETT or upper airway suctioning performed by nurses we perceived important alterations in RR, HR and pulse, while SpO_2 was the most stable parameter. Newborns placed in an oxyhood and using nasal CPAP were the most unstable in such parameters in response to the procedure, while infants using MV were the most stable. We also identified that, despite variations in the newborns' physiological parameters, these professionals carefully respected SpO_2 during the procedure, not allowing newborns to undergo long periods of hypoxia.

Given the acknowledgement that endotracheal and upper airway suctioning is a stressful and painful practice for newborns, nurses should intervene using non-pharmacological techniques to reduce potential changes in RR, HR, pulse and SpO_2 while performing this procedure.

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