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Original Article

Monitoring of supplemental oxygen supply in neonates: challenges and potentialities*

Monitorização da oferta do oxigênio suplementar em neonatos: desafios e potências

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Objective: to evaluate the practices of the multidisciplinary team in monitoring supplemental oxygen offered to newborns. **Methods:** cross-sectional study with data from an observational instrument related to oxygen supply monitoring. Data collection occurred within one month, in the morning shift, and involved the observation of the practice of 104 professionals during a total of 22 days, and the checking of 188 monitors by the researcher. **Results:** the ratio monitors in the correct setting/monitors turned off or with altered setting resulted in a median of 0.43 and a standard deviation of 0.17. That is, 57.0% of the monitors were not properly set up. It was noteworthy that monitoring and blender were used in 100.0% of the newborns. **Conclusion:** it was found that the practices developed by the multidisciplinary team in this institution are in agreement with the Brazilian Society of Pediatrics, as monitoring and blender were used in all newborns receiving supplemental oxygen.
Descriptors: Oxygen Inhalation Therapy; Infant, Newborn; Nursing; Neonatology; Patient Care Team.

Objetivo: avaliar as práticas da equipe multidisciplinar na monitorização de oxigênio suplementar ofertado para recém-nascidos. **Métodos:** estudo transversal, com dados provenientes de um instrumento observacional relacionado à monitorização da oferta do oxigênio. A coleta de dados foi em um mês, no plantão diurno, o qual foi observado a prática de 104 profissionais resultando em 22 dias observados e 188 monitores checados pela própria pesquisadora. **Resultados:** a relação de monitores corretos, comparado a configuração está desligado e alterado o ajuste, resultou em mediana de 0,43 e desvio padrão de 0,17. Ou seja, 57,0% dos monitores não estavam no ajuste adequado. Vale destacar que 100,0% dos recém-nascidos estavam monitorizados e em uso do blender. **Conclusão:** constata-se que as práticas desenvolvidas pela equipe multidisciplinar nesta instituição estão de acordo com a Sociedade Brasileira de Pediatria diante de todos os recém-nascidos estarem monitorizados e em uso do blender na oferta do oxigênio suplementar.
Descritores: Oxigenoterapia; Recém-Nascido; Enfermagem; Neonatologia; Equipe Interdisciplinar de Saúde.

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Introduction

In recent years, the use of supplemental oxygen in preterm infants has been a reason of concern among health professionals. Supplemental oxygen therapy is one of the most widely used therapeutic interventions in Neonatal Intensive Care Units. Thus, it can be said that, just as food, heat, and water, oxygen is vital to maintaining life, but its excessive supply can cause damages[1].

Beginning in 1940, liberal use of oxygen in preterm infants resulted in increased cases of Retinopathy of Prematurity. The use of oxygen was restricted in the 1960s, reducing the incidence of Retinopathy of Prematurity but increasing hypoxia and mortality. It should be noted that both hyperoxia and hypoxia are associated with morbidities such as bronchopulmonary dysplasia, brain injury and Retinopathy of Prematurity[2-6].

One of the measures to minimize the occurrence of these morbidities is the monitoring of oxygen saturation through the use of pulse oximeter, which aims to keep oxygen levels within safe limits, allowing a more accurate control of the fraction inspired oxygen offered according to the patient's needs through the respirator[7-8].

In the scientific world, there are still uncertainties as to which is the best monitor alarm parameter, so as to determine the limit of oxygen saturation to be offered to newborns. However, there is a study that recommends setting the alarm between 89-95.0% to obtain oxygen saturation values between 90-94.0% in newborns. This reduces hypoxia, hyperoxia, volutrauma, associated morbidities, and mortality[9].

The administration of supplemental oxygen in newborns is a challenge that requires multidisciplinary action among the medical, nursing and respiratory physiotherapy staff to minimize the complications associated with hypoxia and hyperoxia, providing singular, qualified and humanized care. Thus, the objective of this study was to evaluate the practices of the multidisciplinary team in monitoring supplemental oxygen offered to newborns.

Methods

The study had a cross-sectional design and was developed in a 14-bed Neonatal Intensive Care Unit in the city of Rio de Janeiro, Brazil.

In this unit there are many newborns in serious and chronic conditions. It is also an educational institution (undergraduates, master and doctoral students, and residents) and a reference in women, children and adolescent health. In order to collect data from the largest number of professionals in the unit and avoid the disruption of the dynamics of the sector - because it is a highly busy and dynamic space - and to collect data through participant observation without the professionals' awareness so as not to interfere with the results, the group of researchers decided to collect data during one month, in the morning shift, from 7 am to 7 pm, Monday to Friday, using an observational instrument. Data collection took place in November 2016, which resulted in 22 days observed by the researcher responsible for the study.

The participants were 104 professionals, namely: 11 neonatologists (on-call staff and routine staff), 13 resident physicians (third-year and fourth-year residents), 2 on-duty physiotherapists, 2 resident physiotherapists, 20 nurses (routine and on-duty), 11 resident nurses (first-year and second-year residents), and 45 nursing technicians working in the unit. The participants were informed about the research and its method.

The evaluation of the best practices in the monitoring of supplemental oxygen supply to newborns was based on the guidelines of the Brazilian Society of Pediatrics[10-11], with observation of 100.0% of these practices, namely: use of pulse oximeter, avoiding oxygen saturation values set above 95.0% to newborns,

and using the pressure air/oxygen blender.

In the production of data about the research scenario, the following information was extracted from the observational instrument, resulting in the following variables: occupation of beds, oxygen monitoring (newborns were using a pulse oximeter), observation of professional practice as to monitor configuration (the researcher checked the monitors and the supplemental oxygen supply set to the newborns), observation of which oxygen supply methods are adopted in the unit and how the professional/newborn relationship is characterized.

It is important to highlight that newborns are not the object of research. The object is the practices developed by professionals in monitoring supplemental oxygen supply. The exclusion criteria were: monitors of newborns with heart disease, because different parameters are to be used in their case.

Data were organized with the aid of Microsoft Excel® and Microsoft Word® softwares, analyzed using descriptive statistics, through measures of central tendency and dispersion. The research protocol was approved by the Research Ethics Committee of the Fernandes Figueira Institute, with Opinion nº 1,894,151/2016.

Results

The 104 health professionals observed presented a median of 10 years elapsed after graduation, three years of experience in the unit, and six years of experience in neonatology. As to the professional profile, 37 (35.6%) had *lato sensu* specialization, 76 (73.1%) were members of the nursing staff, 54 (51.9%) were part of the permanent staff of the institution, 83 (79.8%) were on duty, the weekly workload of 75 (72.1%) participants was of 40 hours, and 57 (54.8%) did not work in any other institution (Table 1).

Table 1 – Profile of observed professionals

Variables	n (%)
Schooling	
Technical level	34 (32.7)
Higher education	16 (15.4)
Lato sensu specialization	37 (35.6)
Master	13 (12.5)
Doctorate	3 (2.9)
PhD	1 (1.0)
Title	
Nursing	76 (73.1)
Physician	24 (23.1)
Physiotherapist	4 (3.8)
Employment bond	
Permanent staff	54 (51.9)
Residence scholarship	26 (25.0)
Employment contract	23 (22.1)
Researcher - Master	1 (1.0)
Current position	
On-duty	83 (79.8)
Resident	15 (14.4)
Routine/diarist	6 (5.8)
Weekly workload (hours)	
20	1 (1.0)
30	2 (1.9)
40	75 (72.1)
≥ 60	26 (25.0)
Works at another institution	
No	57 (54.8)
Yes	47 (45.2)

The mean/median of patients per day was 15 infants, with a maximum of 18 infants (occupation of 129.0%) and a minimum of 12 (occupation of 86.0%). The standard deviation was 1.69 and the interquartile range was 14; 15; 16.

The mean number of newborns using some method of supplemental oxygen supply was 8.4; the standard deviation was 1; the median was 9; and the interquartile range was 8; 9; 9. The mean number of patients using mechanical ventilation was 4.32;

the standard deviation was 1.67; the median was 5; and the interquartile range was 2.25; 5; 6. The mean number of patients using continuous positive airway pressure was 3.5; the standard deviation was 1.18; the median was 3; and the interquartile range was 3; 3; 4. And the mean number of patients using nasal catheters was 0.5; the standard deviation was 1; the median was 0.5; and the interquartile range was 0; 0.5; 1. It is worth noting that 100.0% of the newborns were monitored and the blender was used in all cases.

The daily mean of monitors checked was 8.54; the standard deviation was 1.1; the daily median was 9; and the interquartile range was 8; 9; 9. The daily mean of disconnected monitors was 4.41; the standard deviation was 1.74; the daily median was 4; and the interquartile range was 3; 4; 5.75. The daily mean of monitors in the correct setting was 3.5; the standard deviation was 1.5; the daily median was 4; and the interquartile range was 3, 4, 4.75. And the daily mean of monitors in the altered setting was 0.64; the standard deviation was 0.73; the daily median was 0.5; and the interquartile range was 0, 0.5, 1. It is noteworthy that in the first three days of data collection the researcher found a newborn with two monitors, pre- and post-ductal, due to the severity of its condition. From the fourth day onwards, after stabilization, the newborn started to use only one monitor.

As for the ratio monitors in the correct setting/monitors turned off or with altered setting, the mean was 0.41; the standard deviation was 0.17; the median was 0.43; and the interquartile range was 0.31; 0.43; 0.54. That is, around 57.0% of the monitors were not in the proper setting. Thus the recommendation of avoiding oxygen saturation values set above 95.0% to newborns was not followed.

After observation, when the setting of the alarm collected by the researcher was turned off, or with a value different from the recommended, she would adopt an ethical posture and go to the professionals who were responsible for the care of the newborn in order to guide them, successfully getting them to configure the monitor according to the institutional parameter (monitor alarm value between 89 - 95.0%) (Table 2).

Table 2 – Monitor configuration distribution

Setting / Days	Correct	Turned off	Altered	Total
1	0	8	1	9
2	3	7	0	10
3	3	7	0	10
4	5	4	0	9
5	1	7	1	9
6	2	6	1	9
7	4	5	1	10
8	4	5	0	9
9	3	6	0	9
10	4	5	0	9
11	5	4	1	10
12	4	4	0	8
13	5	3	0	8
14	5	3	0	8
15	6	3	0	9
16	5	2	2	9
17	4	3	0	7
18	3	3	2	8
19	1	3	2	6
20	3	3	1	7
21	3	3	1	7
22	4	3	1	8

The daily size of the nursing staff had a mean/median of 2 staff nurses (standard deviation of 0.2; interquartile range of 2; 2; 2), a mean of 2.7 and median of 3 resident nurses (standard deviation of 1.13; interquartile range of 2.25; 3; 3), and the mean of 5.95 and median of 6 nursing technicians (standard deviation of 1.17; interquartile range of 5.25; 6; 7) for a mean/median of 15 occupied beds (standard deviation of 1.7; interquartile range of 14; 15; 16).

In the medical team, there was a mean of 2.27 and median of 2 neonatal physicians (standard deviation of 0.88; interquartile range of 2; 2; 3) and a mean of 6.72 and median of 7 neonatal medical residents (standard deviation of 1.72; interquartile range of 6; 7; 7.75) for a mean/median of 15 occupied beds.

In the physiotherapy team, there was a mean of 0.6 and median of 0 staff physiotherapists (standard deviation of 0.73; interquartile range of 0; 0; 1), and a mean of 0.2 and median of 0 resident physiotherapists for a mean of 8.4 and median of 9 newborns on oxygen therapy (standard deviation of 1; interquartile range of 8; 9; 9). Of the 22 days observed, there were 12 (55.0%) days without staff physiotherapist. The physiotherapy team of the sector operates from Monday to Friday, from around 8 am to 2 pm, except holidays.

It was evaluated that the multidisciplinary team developed good oxygen therapy practices for newborns, as all cases were monitored and used blender. However, the setting on the monitor was not correct for the most part. Such result may be related to work overload, because the capacity of the team was exceeded due to inadequate number of professionals. Moreover, the team may be unaware of the importance of the correct setting of monitors and its repercussions on newborn health.

Discussion

It can be said that the study is limited by the time of observation in the unit, from Monday to Friday, in the morning shift, during only one month. Another limitation was the fact that the institution was a reference service, and this can lead to difficulty in the comparison with other neonatal intensive care units.

This study made it possible to observe that all newborns were monitored, which is a good professional practice and contributes to clinical practice and society, as it generates a safety culture[12-13] for infants, bringing the impact of positive feelings on parents, as they feel much more confident about the safety of their babies.

Moreover, it was found that the demand for care was high, both for oxygen therapy and for the number of newborns in the unit. This may have contributed to the incorrect setting of monitors. Thus, as a contribution to the clinical practice and society, it is essential that these issues be discussed at the managerial level, and with the team responsible for continuing education. They are very important factors that if go on unresolved, can lead to major health problems in the future, affecting lives and implying effects on neonatal public health[14-15].

Another important factor is the use of mechanical ventilation, which aims to provide "acceptable" gas exchange levels so as to minimize circulatory problems and lung injury. In our study, there were more cases using mechanical ventilation (median of 5 cases/day). The good practices adopted by the multidisciplinary team through oxygen monitoring in this ventilatory modality minimize hypoxia and hyperoxia in newborns. The principle of mechanical ventilation is to revert the collapse of lung tissue (atelectasis) by inflating it and optimizing its volume, preventing the collapse of the alveoli with minimal use of oxygen[9].

In another study, among 43 infants who required supplemental oxygen through noninvasive respiratory support using three different target oxygen saturation ranges with a fixed midpoint of 90.0% [1 (86-94.0%); 2 (88-92.0%); and 3 (89-91.0%)], the time spent on severe hypoxemia (oxygen saturation < 80.0%) was significantly reduced during lower inspired oxygen fraction target ranges (88-92.0%, 1.9%, 89-91.0%; 1.7%) compared to the broad target value (86-94.0%; 3.4%, $p<0.001$). Furthermore, professionals end up tolerating hyperoxia to prevent bouts of hypoxia. Therefore, they recommend the desired median of ± 2.0% to reduce the time spent on hypoxemia, without increasing the risk of hyperoxemia[7].

It was found that the article brought different values in the setting of oxygen saturation. Reference values are still to be discussed and more studies on this theme are needed. Thus, in line with our work, two articles brought the optimal narrow target of oxygen saturation range of 90-94.0%[2,9] and one to the lower limit of 89.0% in the monitor setting[9,14]. Such knowledge is essential to the performance of the multidisciplinary team for the proper management of oxygen saturation. This knowledge implies clinical improvement and minimization of neonatal morbidity

and mortality related to oxygen therapy.

The setting of the monitor depends on the active action of health professionals; when they check and adjust it according to the institutional recommendation they directly contribute to the quality of care to newborns on oxygen therapy, minimizing morbidities related to excess oxygen such as retinopathy of prematurity[9,15].

A study conducted in a Neonatal Intensive Care Unit showed that the monitor was adjusted to silent mode every day of the research. This action exposes newborns to the risks of using supplemental oxygen because the monitor alarm is silenced, in which hypoxia and hyperoxia may go unnoticed and interfere with the clinical improvement of the newborns. This raises the question as to whether the professionals who work in this unit are aware of the important role of setting the alarm and whether they are aware of the necessary care measures to be implemented in the case of newborns on oxygen therapy[15].

Another vital point that needs to be seen is the excess capacity in the unit. Although the number of professionals caring for a newborn remains, the quality of the care provided may be hampered by the demand of babies who need more attention, and especially when they are in greater number than that foreseen for the team/structure[15].

The work developed in a Neonatal Intensive Care Unit found that out of every five periods observed, one presented overcrowding. Therefore, a higher demand than the capacity was observed. This may lead to the occurrence of early hospital discharge, and entail care in the Intermediate Care Unit of a higher complexity level than that recommended for this unit. This points to the need for a greater number of nursing professionals, especially nurses, to monitor babies, also in this sector[15].

Multidisciplinary work is necessary to reduce hypoxia[16] and hyperoxia[17]. That is, the medical, physiotherapy and nursing teams working together, in a complementary work, playing a key role in managing the oxygen saturation goals. Developing evidence-based guidelines and policies is also necessary to promote a safe and consistent approach to the care provided by all staff members of the Neonatal Intensive Care Unit[15,18].

Regarding staff size, the entire professional team in type III Neonatal Intensive Care Unit has a ratio of one professional to 1.33 patients in different work shifts, with a percentage distribution of 52.0% nurses and 48.0% nursing technicians. The ordinance of the Ministry of Health recommends one nurse on duty per shift for five beds, and one nursing technician per shift for two beds. As to physicians, there must be one doctor on duty for every 10 beds in each shift. And regarding physiotherapy, there must be an exclusive physiotherapist for every 10 beds in each shift[19]. Thus, these findings indicate that there was no compliance in terms of professional/patient ratio.

Researchers highlight that research on this theme is little discussed and approached, including intensive and neonatal care units[7,15]. Therefore, it is important to develop standard operating protocols and training with the entire multidisciplinary team. The team must present a quick response to alarms, adjust the setting of the monitors, and must me aware of the risks of hypoxia and hyperoxia to the life of newborns on oxygen therapy[15].

Conclusion

Throughout the study, it was found that the practices developed by the multidisciplinary team in this institution are in agreement with the Brazilian Society of Pediatrics, as monitoring and blender was used in all newborns receiving supplemental oxygen. However, the criterion of avoiding oxygen saturation values set above 95.0% to newborns was not met, as less than 50.0% of the monitors were correctly set up.

Collaborations

Cruz VOO, Lanzillotti LS, Zin A, Entringer AP and Araujo MC contributed to the conception and de-

sign, analysis and interpretation of the data, writing of the article, relevant critical review of the intellectual content and final approval of the version to be published. Silva RCL conducted the relevant critical review of the intellectual content and gave final approval of the version to be published.

References

1. Cummings JJ, Lakshminrusimha S. Oxygen saturation targeting by pulse oximetry (SpO2) in the Extremely Low Gestational Age Neonate (ELGAN): a quixotic quest. Curr Opin Pediatr. 2017; 29(2):153-8. doi: http://dx.doi.org/10.1097/MOP.0000000000000458
2. Zoban P. Optimal oxygen saturation in extremely premature neonates. Physiol Res. 2019; 68(2):171-8. doi: http://dx.doi.org/10.33549/physiolres.933987
3. Cummings JJ, Polin RA. Oxygen targeting in extremely low birth weight infants. Pediatrics. 2016; 138(2):e20161576. doi: http://dx.doi.org/10.1542/peds.2016-1576
4. Van Zanten HA, Kuypers KLAM, Stenson BJ, Bachman TE, Pauws SC, Te PAB. The effect of implementing an automated oxygen control on oxygen saturation in preterm infants. Arch Dis Child Fetal Neonatal Ed. 2017; 102(5):395-9. doi: http://dx.doi.org/10.1136/archdischild-2016-312172
5. Torres-Cuevas I, Parra-Llorca A, Sánchez-Illana A, Nuñez-Ramiro A, Kuligowski J, Cháfer-Pericás C, et al. Oxygen and oxidative stress in the perinatal period. Redox Biol. 2017; 12:674-81. doi: http://dx.doi.org/10.1016/j.redox.2017.03.011
6. Manley BJ, Kuschel CA, Elder JE, Doyle LW, Davis PG. Higher rates of retinopathy of prematurity after increasing oxygen saturation targets for very preterm infants: experience in a single center. J Pediatr. 2016; 168:242-4. doi: http://dx.doi.org/10.1016/j.jpeds.2015.10.005
7. Van den Heuvel MEN, Van Zanten HA, Bachman TE, Te PAB, Van Kaam AH, Onland W. Optimal target range of closed-loop inspired oxygen support in preterm infants: a randomized cross-over study. J Pediatr. 2018; 197:36-41. doi: http://dx.doi.org/10.1016/j.jpeds.2018.01.077
8. Dargaville PA, Sadeghi Fathabadi O, Plottier GK, Lim K, Wheeler KI, Jayakar R, et al. Development and preclinical testing of an adaptive algorithm for automated control of inspired oxygen in the preterm infant. Arch Dis Child Fetal Neonatal Ed. 2017; 102(1):31-6. doi: http://dx.doi.org/10.1136/archdischild-2016-310650
9. Sweet DG, Carnielli V, Greisen G, Hallman M, Ozek E, Plavka R, et al. European consensus guidelines on the management of respiratory distress syndrome - 2016 Update. Neonatology. 2017; 111(2):107-25. doi: http://dx.doi.org/10.1159/000448985
10. Almeida MFB, Guinsburg R. Reanimação do recém-nascido ≥ 34 semanas em sala de parto: Diretrizes 2016 da Sociedade Brasileira de Pediatria [Internet]. 2016 [citado 2019 Abr 12]. Disponível em:https://www.sbp.com.br/fileadmin/user_upload/sSBPReanimacaoRNMaior34semanas-26jan2016.pdf
11. Guinsburg R, Almeida MFB. Reanimação do recém-nascido < 34 semanas em sala de parto: Diretrizes 2016 da Sociedade Brasileira de Pediatria [Internet]. 2016 [citado 2019 Abr 12]. Disponível em:https://www.sbp.com.br/fileadmin/user_upload/nimacaoPrematuroMenor34semanas-26jan2016.pdf
12. Tomazoni A, Rocha PK, Kusahara DM, Souza AIJ, Macedo TR. Evaluation of the safety culture of the patient in neonatology units from the perspective of the multiprofessional team. Texto Contexto Enferm. 2015; 24(1):161-9. doi: http://dx.doi.org/10.1590/0104-07072015000490014
13. Panagos PG, Pearlman SA. Creating a Highly Reliable Neonatal Intensive Care Unit Through Safer Systems of Care. Clin Perinatol. 2017; 44(3):645-62. doi: dx.doi.org/10.1016/j.clp.2017.05.006
14. Manja V, Saugstad OD, Lakshminrusimha S. Oxygen saturation targets in preterm infants and outcomes at 18–24 months: a systematic review. Pediatrics. 2017; 39(1):e20161609. doi: http://dx.doi.org/10.1542/peds.2016-1609
15. Marta CB, Junior HCS, Costa DJ, Martins GM, Silva RC, Pereira LS. The nursing team before alarm triggering in the neonatal intensive care unit. Rev Pesqui Cuid Fundam Online. 2016; 8(3):4773-9. doi: http://dx.doi.org/10.9789/2175-5361.2016.v8i3.4773-4779

16. Badurdeen S, Roberts C, Blank D, Miller S, Stojanovska V, Davis P, et al. Haemodynamic instability and brain injury in neonates exposed to hypoxia–ischaemia. Brain Sci. 2019; 9(3):49. doi: http://dx.doi.org/10.3390/brainsci9030049

17. Stenson BJ. Oxygen saturation targets for extremely preterm infants after the NeOProM trials. Neonatology. 2016; 109(4):352-8. doi: http://dx.doi.org/10.1159/000444913.

18. Paul M. Oxygen administration to preterm neonates in the delivery room: Minimizing oxidative stress. Adv Neonatal Care. 2015; 15(2):94-103. doi: http://dx.doi.org/10.1097/ANC.0000000000000147

19. Luna A, Branco L, Beleza L. Nursing workload in neonatal ICU: application of the nursing activities score tool. Rev Pesqui Cuid Fundam Online. 2017; 9(1):144-51. doi: http://dx.doi.org/10.9789/2175-5361.2017.v9i1.144-151