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## NOISE AT THE NEONATAL INTENSIVE CARE UNIT AFTER THE IMPLEMENTATION OF AN EDUCATIONAL PROGRAM

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**ABSTRACT:** The present study verified the sound pressure levels inside incubators and at the Neonatal Intensive Care Unit, six months after the implementation of an educational program. Quantitative and descriptive study carried out at the Neonatal Intensive Care Unit and inside the incubators of a hospital. It was registered 151 hours and 30 minutes of sound pressure levels at the Neonatal Intensive Care Unit and inside the incubators, in January 2009 and 2010. The highest and lowest mean Leq before the educational program at the Neonatal Intensive Care Unit were 71.0 dBA and 59.0 dBA, respectively. After the intervention, it was registered at the Neonatal Intensive Care Unit the mean Leq between 80.4 and 52.6 dBA. Inside the incubators, values varied from 79.2 and 40.0 dBA to 79.1 and 45.4dBA post intervention, remaining above the recommended values. It was verified that there was no reduction of sound pressure level after the intervention. Some strategies are suggested to sensitize the staff, preparation of a guideline, architectural changes, renovation and/or preventive maintenance of equipments.

**DESCRIPTORS:** Neonatal intensive care unit. Neonatal nursing. Noise. Neonatology.

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## O RUÍDO DA UNIDADE DE TERAPIA INTENSIVA NEONATAL APÓS A IMPLEMENTAÇÃO DE PROGRAMA EDUCATIVO

**RESUMO:** O estudo verificou os níveis de pressão sonora no interior das incubadoras e na Unidade de Terapia Intensiva Neonatal, seis meses após a implementação de um programa educativo. Estudo quantitativo descritivo, realizado na Unidade de Terapia Intensiva Neonatal e no interior das incubadoras de um hospital. Foram registradas 151 horas e 30 minutos de níveis de pressão sonora da Unidade de Terapia Intensiva Neonatal e do interior da incubadora, em janeiro de 2009 e 2010. O maior e o menor Leq médios, antes do programa educativo na Unidade de Terapia Intensiva Neonatal foram 71,0 dBA e 59,0 dBA, respectivamente. Após a intervenção, registraram-se na Unidade de Terapia Intensiva Neonatal, Leq médio entre 80,4 e 52,6 dBA. Na incubadora, valores variaram de 79,2 a 40,0 dBA para 79,1 a 45,4dBA após a intervenção, permanecendo acima dos valores recomendados. Constatou-se que não houve redução do nível de pressão sonora após a intervenção. Sugerem-se estratégias para sensibilização da equipe, elaboração de guideline, mudanças arquitetônicas, e renovação e/ou manutenção preventiva de equipamentos.

**DESCRIPTORIOS:** Terapia intensiva neonatal. Enfermagem neonatal. Ruído. Neonatologia.

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## EL RUIDO DE LA UNIDAD DE CUIDADOS INTENSIVOS NEONATAL DESPUÉS DE LA IMPLEMENTACIÓN DE UN PROGRAMA EDUCATIVO

**RESUMEN:** El estudio verificó niveles de presión sonora en el interior de incubadoras en Unidad de Cuidados Intensivos Neonatal, seis meses después de la implementación de programa educativo. Estudio cuantitativo descriptivo realizado en Unidad de Cuidados Intensivos Neonatal en el interior de las incubadoras de un hospital. Fueron registradas 151 horas y 30 minutos de niveles de presión sonora en la Unidad de Cuidados Intensivos Neonatal y en el interior de incubadoras en enero de 2009 y 2010. El mayor y menor Leq medios, antes del programa educativo en unidad de cuidados intensivos neonatal fueron 71,0 y 59,0 dBA, respectivamente. Después de la intervención, se registraron en la Unidad de Cuidados Intensivos Neonatal Leq medio entre 80,4 y 52,6 dBA. Dentro de la incubadora, valores variaron de 72,9 a 40,0 dBA para 79,1 hasta 45,2 dBA después de intervención se mantuvo por encima de los valores recomendados. Se encontró que no hubo reducción del nivel de presión sonora después de la intervención. Se sugieren estrategias para la sensibilización del equipo, elaboración de guías, mudanzas arquitectónicas, renovación y/o mantenimiento preventiva de equipamientos.

**DESCRIPTORIOS:** Cuidado intensivo neonatal. Enfermería neonatal. Ruído. Neonatología.

## INTRODUCTION

The advancement of technology used in delivery rooms and the Neonatal Intensive Care Unit (NICU) brought some equipments that inevitably produce noise. This noise may impact on newborn's life quality and health, his family and health professionals. Several devices that support the life of newborns in the NICU, such as respirators, humidifiers and even incubators, when operating, become sources of noise<sup>1-2</sup> and they may also constitute potent factors of stress for neonates<sup>3-6</sup> as well as professionals.<sup>7-9</sup>

Noise is a disorganized sound in physiologically incompatible frequencies with the human ear. It can also be defined as any sound provoking unexpected effects in people, negatively affecting their health. Any sound that exceeds 80 to 85 decibels (dB) can be considered as noise.<sup>10</sup>

The study that measured Sound Pressure Level (NPS) in the delivery room of a University Hospital showed that the newborn, from birth, is already exposed to a high level of noise.

Before the exposure to excessive noise, the body of the newborn might present different answers, like: hypoxia, release of adrenocorticotrophic hormone (ACTH), adrenaline into the bloodstream, heart rate increase, systemic vasoconstriction, pupil dilation, intracranial and arterial pressure increase, oxygen consumption and caloric expenditure increase that may cause delay in weight gain and increased time of hospitalization. Noise can also provoke alterations in the baby's states of sleep and wakefulness, making him irritable, tearful and damaging his development.<sup>6</sup> Moreover, an excessively noisy environment causes alteration on his behavior, impairing his ability to interact and, thus, compromising the bond formation between the baby and his parents.<sup>5</sup>

Currently, the study on hearing loss related to long exposure to noise, in newborns hospitalized at the NICU, is pretty much explored. At high frequencies, noise can provoke hyperstimulation of the ciliated cells from the organ of Corti in neonates, causing their destruction and hence progressive hearing loss.<sup>12</sup> It is known that neonates undergoing treatments with ototoxic drugs, such as aminoglycosides and certain diuretics, are more likely to develop hearing problems when exposed to excessive noise.<sup>13</sup> The literature has also documented that one of the main risk factors for hearing loss, in newborns, is the exposure to noise inside incubators for more than seven days.<sup>14</sup>

Based on researches indicating the high sound pressure levels (SPL) to which newborns are exposed in the NICUs<sup>16</sup>, inside the incubators<sup>17</sup> and from the assumption that knowledge is one of the main guidelines of the human conduct, it is inquired whether the implementation of an educational program for professionals enlightenment and sensitization may help to reduce the NPSs from NICU environments and inside the incubators in order to minimize deleterious effects of noise, and also promote acoustic comfort to the newborn.

The choice for an educational program is justified by the possibility of immediate implementation at low cost, unlike other measures, of architectural changes and acquisition policies of neonatal equipments involving administrative decision-making and higher costs, which were impossible to be assumed by the hospital at the time.

So, it was carried out an educational program in order to increase the awareness about acoustic reality inside the NICU and incubators. Thereby, this study had the objective of comparing the (SPL) in these environments six months after the implementation of such program.

## MATERIAL AND METHOD

This is a descriptive-quantitative study conducted in a room of the NICU and inside the incubators at a University Hospital, in São Paulo. The neonatal intensive care unit has capacity for 4 beds, an area of approximately 23.80 m<sup>2</sup>, ceiling height of 3.40 m, floor made of vinyl material, masonry walls, concrete roof and glass windows.

The NICU room is next to the nursing unit. In this place, it is possible to find the phone, stock of controlled drugs and employees who perform some tasks. In extension to the nursing unit, there is a hallway, which is used by health professionals, students and faculty during clinical discussions and implementation of medical prescriptions. The NICU environment has no air conditioning. The model of all incubators used by the service is C186T S of the trademark FANEM<sup>R</sup>. At the time of data collection, these devices had an average of 15 years in use.

For this study, it was carried out the measurement of the NPS, in the NICU and inside the incubators, with the purpose of knowing the acoustic profile of the researched service. The results showed high SPLs, so, it was implemented an educational program for professionals and after

six months there was another measurement.

The educational program aimed to raise the professionals' awareness about the acoustic reality at the unit along with the objective of reducing the SPL. This intervention was performed through a lecture of around 50 minutes and conducted by the researchers. On this occasion, the professionals were informed about the results of NPSs in the NICU and inside the incubators, which were obtained in the first phase, comparing them to the SPLs recommended by the regulatory agencies inside the incubators and hospital environment. It was also discussed noise deleterious effects, both for neonates and professionals, and information about the levels recommended by regulatory agencies.

The educational program included 100 professionals, among them: physicians, nurses, technicians and nursing assistants, speech therapists, psychologists, physiotherapists, clerk and cleaning assistants who belong to the service and worked in the morning, afternoon and evening shifts. In order to involve all of the professionals, the classes were repeated several times, following a schedule elaborated according to the staff availability and based on a list of professionals from each working shift. It is noteworthy that among these professionals, teachers, students of post-graduation courses and residents of the university also participated in the educational program.

The first measurement of the SPL occurred from January 18 to 24, 2009, and the second one from January 24 to 30, 2010, six months after the implementation of the educational program.

With the objective to obtain the SPLs records, four dosimeters of the trademark Quest 400 were used. For data collection of the NPS in the NICU, three dosimeters were used and they were hung in the center of three quadrants of the NICU, at different heights: 1.65m, 1.70m and 1.90m, at least 1meter away from the walls, floor and ceiling, according to the Brazilian recommendations.<sup>18</sup> It was decided to place them at different heights, so, the three microphones would not be in a parallel plane to any of the surfaces of the room, with the objective of reducing the possibility of influencing sound waves that are stationary in the environment.

In order to get the record of the SPL inside the incubator, the dosimeter's microphone was positioned approximately at 20 cm of the baby's ear.<sup>19</sup> To decide, initially, the incubator in which the measurement would be performed, it was

identified among neonates of the unit, the one who presented the greatest value of Score for Neonatal Acute Physiology Version II (SNAPII). This criterion was adopted because such score evaluates the risk for neonatal mortality.<sup>20</sup>

The four dosimeters, with capability to record the SPL minute by minute, were configured as follows: slow response time (*slow*), measuring the sound pressure level in decibel (dB) and the reflection in frequency A dB (A).<sup>21</sup> The scale A (dBA) is the filtering method that mimics the reception characteristics of the human ear, and it is indicated to the seizure of continuous noise of equivalent sound pressure level (Leq).<sup>22</sup> All of the devices were programmed to operate at intervals of SPL between 40 and 140 dB (A). Therefore, each level of measured noise had its duration time precisely registered and stored, providing a dataset among which it stands the equivalent sound pressure level (Leq), for analysis and statistical processing. Leq is the average sound level integrated over a particular period of time. Such measurement is important because it is known that human hearing injuries are caused not only by the high level of noise, but also by its duration.

It was carried out daily battery changes in every dosimeter. Leq records and four dosimeters calibration were performed with the gauge QC10, at the end of each shift. Leq records of each working shift were obtained by disconnecting the dosimeters, at the end of the shift, and reattaching them at the beginning of another one, during every day of the week.

It was considered the possibility of behavior change from the professionals working in the NICU, due to the presence of researchers and devices. Then, it was performed the team desensitization for one week. During this time, the dosimeter's microphone remained positioned inside the incubator, and the other three dosimeters were hung from the ceiling. It was simulated the batteries exchange, records of Leq and recalibration at the end of each shift.

About data collection strategy, it was decided that the four devices remain connected simultaneously to the NICU and inside the incubator, for 24 hours, totaling 168 hours in the NICU and inside the incubator, for one week, before and after the execution of the educational program. Prior to data analysis, 30 minutes of records from the SPLs, in the beginning and in the end of each shift, were discarded in order to counteract the influence of noise on the Leq of the period, when

handling the equipments to calibrate and reinstall them. The operation to calibrate every dosimeter, which was performed in sequence, lasted on average 30 minutes. This way, 16 hours and 30 minutes of records were discarded. Thereby, the sample was composed by 151 hours and 30 minutes of records from the SPLs, in the NICU and incubator.

The records of the SPL accomplished by the dosimeter inserted inside the incubator and the other three ones installed in the NICU were transferred to the program QuestSuite for Excel, which allowed data processing. It was calculated the spatial average between Leq values obtained by the three dosimeters installed in the NICU, as well as the standard deviation among them, in different days of the week and shifts.

When analyzing the results, it was made data comparison of the measurements before and after the educational program implementation, expecting that the change of reality was caused by this intervention, since no further measure to reduce the SPL was held in that period.

The statistical analysis was performed through the mean calculation, standard deviation and Wilcoxon test. The variables considered were the SPLs in the NICU environment and inside the incubator, before and after six months of the educational program implementation, working shifts and days of the week.

Before starting data collection, it was obtained the approval from the Hospital Direction

and the Committee of Ethics on Research of the Federal University of São Paulo (process number 0391/07).

## RESULTS

The measurement results of SPL before the intervention indicate that, in the NICU, the mean Leq was 63.7 dBA, in the morning, 66.1 dBA, in the afternoon and 60.2 dBA, in the evening (Figure 1). It was found that the highest value of mean Leq was 71.0 dBA, which was recorded on Saturday morning. The lowest mean Leq was 59.0 dBA, which was recorded on Monday's night shift. In this environment, the standard deviation of  $L_{eq}$  was 3.6 dBA, in the studied week. Then, raw data of noise records, in the room, evidenced that on rare occasions the newborns are exposed to the SPLs recommended by the competent agencies.

Six months after the educational program implementation it was found that, in the NICU, the mean Leq was 62.9 dBA, in the morning, 67.0 dBA, in the afternoon and 62.1 dBA in the evening (Figure 1). The highest value of mean Leq was 80.4 dBA, on Saturday afternoon and the lowest mean  $L_{eq}$  was 52.6 dBA, on Monday's night shift, presenting a variation of 27.8 dBA between these two values. The standard deviation of Leq, after the educational program implementation in the unit, was 5.2 dBA.

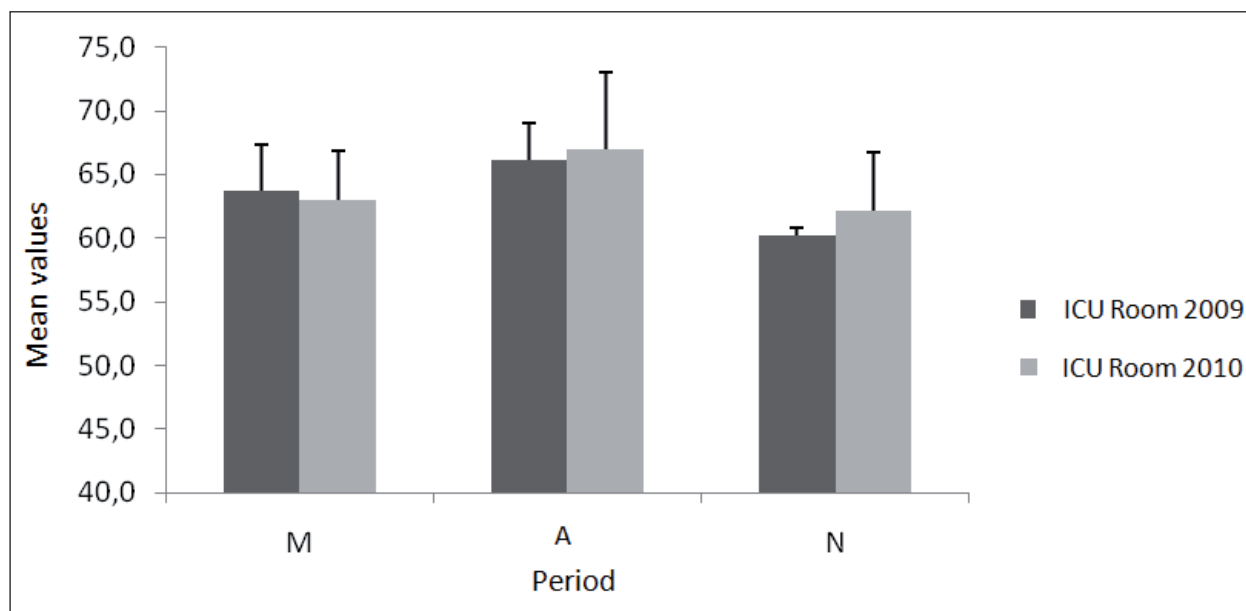
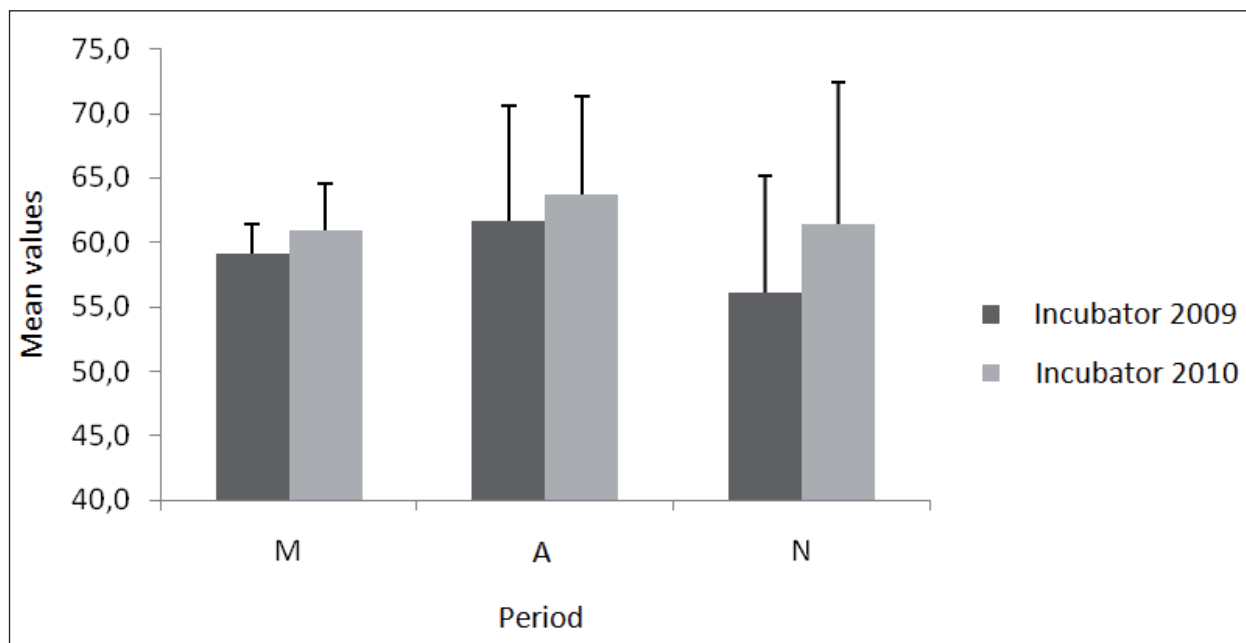


Figure 1 - Values of mean Leq inside the NICU, per shift, before and after the educational program implementation

Regarding the SPL inside the incubator, before the educational program implementation, the mean Leq was 59.1 dBA, in the morning, 61.7 dBA, in the afternoon and 56.0 dBA in the evening. (Figure 2). The biggest mean Leq recorded was 79.2 dBA, on Thursday's afternoon shift, and the lowest was 40.0 dBA, on Monday's night shift. The standard deviation of Leq inside the incubator was 7.4 dBA, in the mentioned period.

Six months after the completion of the educational program, it was found that the mean Leq was 61.0 dBA, in the morning, 63.7 dBA, in the afternoon and 61.4 dBA in the evening (Figure 1). The biggest mean Leq recorded was 79.1 dBA, on Saturday's night shift, and the lowest was 45.4 dBA on Monday's night shift. Thereby, it presented a variation between the highest and lowest mean Leq of 33.7 dBA. The standard deviation of Leq was 7.4 dBA (Figure 2).



**Figure 2 - Values of mean Leq inside the incubators, per shift, before and after the educational program implementation**

As the coefficient of variation between the two moments, before and after the educational program implementation are close, except in the NICU and during afternoon and night shifts, there was a comparison of Leq central values within the incubator and NICU, per shift, and between those two moments, through the test of Wilcoxon. However, considering  $\alpha=0.05$ , it was not possible to detect a significant difference of Leq between these two moments, obtaining P values greater than 0.176 for all of the comparisons.

## DISCUSSION

The noise in the NICU and inside the incubator exceeded the levels recommended by the official agencies, six months after the educational program implementation. The Brazilian Association of Technical Standards (ABNT) recommends values between 35 and 45 dBA for hospital envi-

ronments.<sup>18</sup> The American Academy of Pediatrics (AAP) recommends to avoid SPL above 45 dBA<sup>23</sup> and the World Health Organization proposes, in the same way, 45 dBA.<sup>24</sup> The ABNT establishes for the incubator's interior values of Leq below 60.0 dB<sup>18</sup> and the AAP establishes values below 58.0 dBA, as the maximum level allowed.<sup>25</sup>

It is emphasized that the educational program must be the first step to promote awareness in the working team on the importance of maintaining an acoustically comfortable environment to the newborn, professionals and family members, with the goal of reducing significantly the SPL, in the NICU,<sup>26</sup> to minimize noise deleterious effects not only to the newborns, but also to the professionals. A study that included nurses from one department of pediatric surgery demonstrated significant reduction of the SPL next to the cradle of the newborn, of approximately 10 dB, three months after the educational program imple-

mentation, but, no change was observed inside the incubator.

The same study concluded that the noise sources, in intensive care units, determined the SPL next to the baby's cradle, and the conversation between the team members and parents is a major factor of noise increasing. In this case, it is highlighted the importance of professionals' awareness about the behavior change. Nevertheless, the incubator produces its own noise, and it is often impossible to decrease it by controlling people's attitude.<sup>27</sup>

Data from the present study found an increase in the values of SPL, in the NICU and inside the incubator, six months after the educational program implementation, although it is not considered statistically significant. However, it is necessary to remember that in the logarithmic scale of noise measurement in decibels, an increase/decrease of 3 dB means increase/decrease of about 50% in the SPL,<sup>27</sup> therefore, any variation significantly influences the acoustic comfort of the newborn and professionals.

In order to understand these data, it is necessary to consider some aspects: time between the program implementation and second measurement of the SPL, methodology selected to the educational program and concomitant adoption of other structural and/or operational measures. Regarding the variable time, it is important to ponder that the educational program effect to reduce the SPL is not permanent. A case study conducted in a tertiary center for special care observed a reduction of 9.26 dB, in the SPL, one week after the program implementation.

Nevertheless, a new measurement performed 14 months later showed a reduction of 7.82 dB, in relation to the SPL, prior to the intervention. Although there is a reduction on the educational program effects, it is considered that it was possible to keep the decrease of the SPL, in relation to the levels prior to the intervention implementation. This happened due to the research protocol, that besides the professionals' awareness, carried out the implantation of the guideline with changes in the care activities operationalization, physical environment and continuous monitoring of the SPL, to the perception of advancement by the professionals.<sup>28</sup>

Then, these data indicate it is necessary to consider several factors that may ensure the effectiveness of the educational programs. The Theory of Reasoned Action suggests that people's

behavior is determined by the perception of immediate results of their actions, and that is also influenced by attitudes and subjective norms. So, for the professionals to adopt measures allowing the maintenance of low SPL it is needed, besides the theoretical knowledge, to have the perception about the contribution of their attitudes to the environment.<sup>29</sup> In the survey mentioned before,<sup>28</sup> nurses were able to observe, in video images, the child waking up and crying due to the sound of their voices. As for attitudes and subjective norms that influence people's behavior, it is considered the perception importance about other people's attitude and opinion, particularly from the leaders.<sup>29</sup> Thereby, it is important to remember that in the NICU, before expecting appropriate behavior of the professionals, leaders must know by themselves, that their attitudes are important references for the team.

In relation to the effectiveness of the educational program, studies show the contribution of some measures such as systematic monitoring of the SPL, so that professionals can see the progress made by the actions taken.<sup>26,30-31</sup> In addition, the maintenance of posters remembering the importance of low SPL and installation of luminous alarms turning on when the SPL reaches a certain limit should also be considered as additional measures. Thus, they might contribute to encourage the team to keep their behavior and measures that provide acoustic comfort, in the NICU.

In the present study, it was found good adhesion by the professionals to the educational program and researchers' subjective observation. There was a significant reduction of noise, in the NICU, shortly after the implementation. But, it is estimated that the educational program impact was lost over time. Other studies, which showed significant reduction of noise level in the incubator and the NICU, include architectural changes,<sup>26,30</sup> equipments replacement,<sup>31</sup> introduction of other measures such as covering the incubator, the adoption of quiet time and limitation of people entering and exiting the unit.

This aspect is especially critical in a University Hospital, because there is always a large number of professionals and students moving around this unit. On the other hand, the building of the unit studied is not considered appropriate by the direction of the service, which has already elaborated a proposal for adequacy, which could not be executed due to financial constraints. For the same reasons, the unit faces the difficulty of

equipments replacing, and the average age of the incubators is around 15 years. Therefore, the results of SPLs obtained in this study are consistent with researches performed in other units, in which there were not any operational and structural changes.<sup>26,30</sup>

## CONCLUSION

The results show that after six months of educational program implementation, there was no reduction of SPL in the NICU and inside the incubator of the researched service. While recognizing the importance of educational programs in order to promote changes in the team's attitudes, it must be recognized that the effects are not long lasting, then, it is emphasized to repeat them more often. With respect to the educational program evaluation effect, over time, it is suggested that SPL measurements need to be performed repeatedly, from time to time, to the perception of intervention evolution.

It is also suggested the execution of other strategies that include methods to promote the team's awareness in the UTIN, guideline elaboration, architectural changes, renovation and/or preventive maintenance of equipments, including parameters to the acquisition of equipments containing audible alarms. Even recognizing that the nurse occupies a key position in the context of a neonatal intensive care unit, it is quite important to note that the implementation of strategies to minimize the SPL requires the effort of the entire multidisciplinary team, along with the leaders' participation.

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