Abstract. This work is about the problem of noise in neonatal incubators and in the environment in the neonatal intensive care units. Its main objective is to analyse the impact of noise in hospitals of Mendoza and La Rioja.

Methodology: The measures were taken in different moments in front of higher or lower severity level in the working environment. It is shown that noise produces severe damages and changes in the behaviour and the psychological status of the new born babies.

Results: The noise recorded inside the incubators and the neonatal intensive care units together have many components but the noise of motors, opening and closing of access gates have been considered the most important ones. Values above 60 db and up to 120 db in some cases were recorded, so the need to train the health staff in order to manage the new born babies, the equipment and the instruments associated with them very carefully is revealed.

Keywords: incubator, neonato, noise, premature, measurement.
these topics getting to prove in an effective way that the exposure of the new born baby to high levels of noise not only affects the hearing system but also impacts directly on the development of the central nervous system generating serious consequences in the posterior development of the baby on the way to his/her adult life and even during it. Basically, the premature new born baby’s nervous system is in a status of general immaturity. The hearing system, the visual and the central nervous ones are the latest to mature and in the premature babies, part of this maturing process, is produced in the systems that we know as neonatal incubators and in the environment of the NICU. In average terms, the hearing threshold in the 24 to 25 weeks of gestation is in the order of 40 db, diminishing then to the 13, 5 db which are characteristic of the maturing process around the 42 weeks of gestation.[2] that means an important indicator of the fetus’ capacity of perceiving intrauterine noise with a significant level of sensibility.

The new born baby’s exposure to excessive noise during this maturing process of his/her hearing system has a noticeable impact not only on the system itself but also on the different physiological parameters which become affected by it.[3] A great amount of studies and reports of the American Association of Pediatrics point out that the excessive noise in new born babies is related with the loss of the hearing capacity, appearance of chronic stress, problems of sleep, important fluctuations of arterial pressure,[4] decreasing of oxygen in blood (hypoxia) with affection of vital organs, slowing of the brain development, etc.

More recent studies show that the fetus (and so the new born babies) associate the external sounds to the mother’s voice [5] who is his/her vital source of not only physical but also emotional care. The interference of this sound with high level external noise can’t be discriminated clearly by the baby and alteration of this sound is perceived then as a severe risk or aggression by him/her, causing a strong impact in the future emotional baby’s development.

Other studies also show that the pregnant women’s exposure to high levels of noise (85 db to 95 db), affects negatively the posterior development of the fetus’colear hearing system. [6] The above mentioned takes to serious reviews of the pregnant women’s working conditions and the present lack of specific laws in Argentina.

Considering all, the American Academy of Pediatrics recommends in a ruling form that in the neonatal intensive care units and even in new born babies’ general care rooms, the limit of 45 db in daytime and 35 db at night-time won’t be exceeded ,[7] establishing that the oversight of this recommendation can affect very seriously in some cases the premature new born baby’s health.[8,9]

3. Development Of The Work

The present work took as an objective the measurement of the levels of noise in neonatal intensive care units and in general rooms in the most significant hospitals and clinics of the provinces of Mendoza and La Rioja with the purpose of achieving a standard measurement and generating a realising program related to this problem.

The measurements were categorised according to three types of noise which are: [9]

1-Stable noise:[E]Noise which presents fluctuations of the instant sound pressure level inferior or equal to 5 db, slow during a period of observation of a minute.

2-Fluctuating noise: [F] is the noise which presents fluctuations of the sound pressure level superior to 5 db slow during a period of observation of a minute.

3-Impulsive noise: [I] is the noise which presents impulses of acoustic energy lasting less than a second to intervals up to a second.

According to this categorisation the following most common sources of noise in the NICU were defined:
Table 1. Values measured in NICU of Mendoza and La Rioja.

| Sources of noise                          | Type | Level [db] | Band   |
|------------------------------------------|------|------------|--------|
| Motors of Incubators                     | E    | 67         | 54-85  |
| Daily Environmental noise                | F    | 71         | 68-77  |
| Environmental noise-Cleaning             | F    | 83         | 70-93  |
| Putting objects on the incubators        | I    | 102        | 93-107 |
| Involuntary Knocks                       | I    | 110        | 82-120 |
| Alarms and others                        | F-I  | 89         | 85-98  |
| Access gates to incubators               | I    | 103        | 8-115  |

Table 2. Values measured in NICU of Mendoza and La Rioja.

| Sources of noise                     | Type | Level [db] | Band   |
|--------------------------------------|------|------------|--------|
| Exterior background noise             | E-F  | 57         | 45-67  |
| Instrumental noise                   | F    | 71         | 68-77  |
| Environmental noise- cleaning        | F-I  | 89         | 65-98  |
| Tubing and auxiliary gates           | I    | 83         | 79-85  |

The measurements were made with decibel meters equipment with certified tracing under ISO and with a methodology of register defined in the specific protocol A415Co of the Acoustic Laboratory of the National Technological University-Regional Faculty Mendoza.(see appendix).

4. Analysis Of Data

From the above table evidence arises which take us to the following results:

1-the analysed NICU in this work mean an important show of the study (62 incubators and 5 NICU) for the provinces of La Rioja and Mendoza and the obtained data represent a significant average of the problem of noise in environments of neonatal health.

2-There is a significant asymmetry in the status of the technological field of available incubators in private health services versus state ones. A mayor updating and better general status in public health rather than in private one is registered. The causes of this situation has to do not only more frequently with the updating of the equipment by the state services but also mainly with the presence of bioengineering services and qualified maintenance in more important public hospitals, which happens in most parts of private health services which leave to third parts this type of service and lack of systematic programmes of maintenance.

3-In the analysed show, there is a 43.7% of incubators whose system of forcing air generate unacceptable levels of noise which overpass the 45 db of maximum daytime pressure and the 35db of night-time sound pressure recommended by the AAP. The bad condition of lubrication of the motors, worn out rollings, not centred turbines, etc. are some of the causes of these problems. In general, as we previously mentioned, the private area presents the most serious deficiencies in this sense.

4-The average environmental noise is in very superior levels to the recommended by the AAP ones arriving to this situation by cultural and every day customs and practices by the nursing staff who doesn’t observe and generally diminishes the effects of noise on the new born baby.

5-The alarms of devices of neonatal care and even the ones of incubators overpass highly the recommendation of 60 db maximum suggested by the standard of English fabrication for this type of
product. There isn’t the culture of adequating the sonority of the alarms to acceptable levels even when many teams of neonatal care allow this option.

6-The opening and closing of access gates to the cubicle of the incubator mean one of the most aggressive sources of impulsive noise for the newborn baby since in some cases values up to 130 db were achieved to be measured. This constitutes an unacceptable level even for an adult person. Even so the noises are impulsive ones, they cause serious reactions in the newborn babies. The average rank in this variable is one of the major weight in this work.

7-During the cleaning, feeding, and checking of rooms activities objects are put on the cubicle and they generate very important and harmful impulsive noises for the baby. In this case values of 120 db were registered. This is unacceptable in this type of working environment and neonatal care and with the change of these bad cultural-procedures practices can be easily corrected.

5. Conclusions
From the analysis made in this work, arises that in most parts of the rooms of neonatal intensive care of the show there isn’t a clear conscience of the problem of noise associated with the care of newborn babies or premature babies.

Although doctors and health staff state knowing the problems which the exposure of newborn babies to excessive noise carries, there isn’t a behaviour related in operative terms of the NICU system.

In our country there are rules of cleaning and security related to the level of exposure to noise of the workers and the consequent obligation of the employer to provide hearing protections in order to take care of the staff against these damages.

However and in spite of the scientific literature which has proved that the 45 db maximum daytime sound pressure and 35 db maximum night-time sound pressure are the values which are compatible with the fetus’ hearing, nervous, and emotional health. There is no law of national or province reach which forces to the obeying of these indicators in the neonatal intensive care units.

Finally, it is also important to point out that there is no law in respect of the pregnant woman who works in environments of high sound pollution either since her wearing of hearing protective devices (which is what the present laws of cleaning and security look for) doesn’t protect the fetus from the damage caused by that noise.

6. Appendix
The procedure used for the measurements was made according to the following protocol of work:

Identification of suitable points to do the measurements in the environment of the areas under study. In particular it was made in the inside of incubators and in the central environment of the NICU with specific and normalized lay-out schemes in all cases.

Calibration of the measure of sound level device.

Measurement and register, in the selected points, of the sound levels taking a measure every ten seconds during a lapse of 0.5 hours in the inside of an incubator and 72 hours in each NICU for daytime and night-time records.

Systematization of the obtained records.

Calculus for each point of the following indicators of noise:

Leq: is the continuous sound level equivalent, it represents the level in db (A) of a constant hypothetical noise corresponding to the same quantity of acoustic energy as the real noise considered in a determined point, and during a pre-established period of time.

L10: is the sound level, in db (A), which overpasses during the 10 % of the time of the measurement.

L50: is the medium sound level, in db (A)

L90: is the sound level, in db (A), which overpasses during the 90 % of the time of the measurement.

Fashion: is the most frequent sound level, in db (A), during the 100 % of the time of the measurement.

Lmín: is the minimal sound level, in db (A), obtained in the period of measurement.

Lmáx: is the maximum sound level, in db (A), obtained in the period of measurement.
From these indicators a categorization which allowed us to make conclusions and comparisons in the simplest and largest way was made as it is shown in the charts I and II.

Methods and techniques used to obtain the values.

Calibration of the measure of sound level device.

Using the acoustic gage the following procedure was made:

Controllers of the device for the measurement of the sound level were put in the following positions: weighting filter in “A”, response time: fast, rank: from 70 to 130 db.

A microphone of the device for the measurement of the sound level was inserted in the hole which the gage brings with that purpose.

The gage was turned on and the potenciometro “CAL” of the device for the measurement of the sound level was adjusted until the screen of the instrument displayed the level of 94 db.

Recordings.

Once the device for the measurement of the sound level was appropriately calibrated, the following procedure was made:

The instrument was put on the tripod in the chosen place.

The instrument was turned on.

The slow response time was selected.

The filter was selected in “A”.

The rank was chosen.

The instrument was put in the option “data logger” proceeding to record the sound level in intervals of ten seconds during the established period of reference.

Equipment used:

The following equipment was used to achieve the proposed objective:

Portable Device to measure the sound level. This instrument is designed according to the rule IEC651 type 2, ANSI S1.4 type 2, for field measurements, with the following characteristics:

- Ranks from 30 db to 130 db to frequencies between 20 Hz and 8 Khz.
- LCD display of four digits with a resolution of 0,1 db.
- With two filters of consideration of sound pressure levels, A and C.
- RS232 interfase to download data to a pc.
- Non-volatile storing capacity of up to 16.000 records.
- Anti-wind screen. Support for measurements in incubators.

Tripod for environmental measurements.

Acoustic gage for the device for measuring the sound level. This instrument is designed according to the rule IEC942 type 2, ANSI S1.40 – 1984, with the following characteristics:

- Ranks of calibration for 94 db and 114 db with a tone of 1 KHz.

Both equipments are certified under ISO 9001/2000 protocols.

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