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The Importance of Noise Attenuation Levels in Neonatal Incubators

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Abstract: Background: It is known that high noise levels can be harmful to preterm infants, causing physiological and psychological disorders. It is also known that premature babies spend a lot of time in an incubator. In this sense, many studies show that incubator noise levels can range from 45 to 70 dB. However, these differences in noise levels depend, fundamentally, on the wide range of methodology that can be used. This study aims to know the levels of noise from a fan in the incubator itself and how much it can isolate the noises coming from the outside. Methods: For this purpose, the noise levels of three incubators were measured within a sound-dampened booth for free-field audiometry. For the emission of acoustic energy, a pink noise generator was used; likewise, two microphones were placed, one inside the incubator cabin and the other outside, to determine the acoustic insulation levels of the tested incubators. Results: The incubators produced equivalent continuous sound pressure levels between 53.5 and 58 dB. Acoustic insulation analysis showed that levels varied from one incubator to another, between 5.2 and 10.4 dB. Conclusions: It is necessary to improve the acoustic insulation inside the incubator cabin and to reduce the noise levels of the motor fan. On the other hand, although the incubators are meeting the noise criteria set out in the IEC60601-2-19: 2009 standard of 60 dBA, under normal use conditions, they are still far from the limit recommended by the American Academy of Pediatrics (45 dBA).

Keywords: neonates; sound pressure; incubators; noise source; NICU; risk in preterm infants

Citation: Fernández-Zacarías, F.; Puyana-Romero, V.; Hernández-Molina, R. The Importance of Noise Attenuation Levels in Neonatal Incubators. *Acoustics* **2022**, *4*, 821–833. https://doi.org/10.3390/acoustics4040049

Academic Editors: Ignacio Rodríguez-Rodríguez, Domingo Pardo-Quiles and José-Victor Rodríguez

Received: 18 August 2022
Revised: 11 September 2022
Accepted: 16 September 2022
Published: 21 September 2022

1. Introduction

Although high levels of noise are undesirable for anyone, the situation can be alarming for preterm infants, especially taking into account that they are born before their hearing system has had the opportunity to fully mature, and it could cause them sensorineural hearing loss [1]. In this sense, preterm infants have a reduced response to auditory stimulation compared with full-term infants [2].

Several investigations reveal that the stressful environment in Neonatal Intensive Care Units (NICUs) causes premature infants functional disorders [3,4]. High noise levels not only contribute to neonatal hearing loss [5–8] but also affect physiological factors: reduction in mean blood pressure [9], increased heart rate (HR) and respiratory rhythm, and decreased oxygen saturation (O-sat) [10] as well as neonates' ability to self-regulate [11]. The mid-to-long-term effects of repeated stimulation by high-intensity sounds have also been shown to influence psychological factors, and therefore, they could have significant repercussions on newborn behavior [5,12–14].

1.1. Other Effects

The mean total sleep time in 24 h of a newborn is approximately 15 h, half of which takes place during the night, and the other half takes place during the day [15]. Some studies indicate that during sleep time, the sound pressure (SP) level is within the limits recommended by the international laws, while the rest of the time, it is very far from the recommendations [16]. It has also been proven that moderate acoustic changes between 5 and 10 dBA can disrupt the sleep of very early preterm infants [17].

Other studies described the energy expenditure (EE) estimation method, which was based on a relationship between cardiorespiratory function (HR and O-sat) and measured EE. In this sense, environmental stressors, such as noise, affect the development of preterm infants, so it is necessary to reduce the stressful stimulations to conserve energy for growth [18].

1.2. Noise at NICUs

Much of the noise inside the incubator comes from sources outside the incubator. So, although the average noise level in the most modern NICUs is around 62 dBA [19], the tests performed in NICUs show that the outside noise to the incubator reach levels of 80.4 dBA vs. 79.1 dBA inside [20,21], despite the educational programs carried out for noise reduction.

At times, the incorporation of new technologies is not adequately controlled, so the noise level is increased rather than reduced (motorized paper, towel dispensers, hand dryers, etc.) [22]. On the other hand, the alarms of the various monitors and maintenance apparatuses, the crying of the newborn, and the activity of the staff are usually the principal sources of noise [23].

Sound pressure levels (SPL) in NICUs normally exceed the American Academy of Pediatrics (AAP) recommendations, although there are variations in noise levels from one hospital to another. This can be due to several reasons, such as acoustic conditioning, size of the room, or noisy sources. This would explain the variations recorded by different authors. In this sense, some researchers measured mean and maximum values within the incubator cabin of 57.0 dBA and 88.8 dBA, respectively [1,24], while others measured values of 66.8 dBA and 84.1 dBA [25]. However, in general, most of the studies revealed mean noises between 55 and 67 dBA [8,26] and impulse noise above 140 dB (banging incubator to stimulate apneic premature infants) [10]. On the other hand, the noise generated during the handling of the incubators is between 72.5 dB (placing objects on top of the incubator) and 98.4 dB (closing the cabinet) [27].

With respect to the limits specified in IEC 60601-2-19, while some authors recorded SPL lower than 60 dBA [28] other authors recorded SP levels greater than 60 dBA [29] (under switched off incubator conditions at a controlled temperature of 36 °C with a maximum humidity setting). In this sense, some authors indicate that it is also important to know the spectrum of noise levels, because low frequencies inside a modern incubator can reach levels that are probably harmful to the developing newborn [29] or that high-frequency sound levels could be the true damage by analogy with sound spectra of the gravid uterus [30]. Other studies indicate that the incubator cover seems to have some short-term effects on sleep quality in premature infants by reducing disturbing light and noise [31].

1.3. Action Program

Due to the high noise in NICUs, many researchers propose measures to tackle this problem, such as the proper design of the NICU to minimize background noise [32], implementing an educational noise reduction program [20,33,34] or earmuffs as a measure to improve sleep efficiency, thus increasing the quiet sleep time [35].

Studies of noise measurements inside the incubator show that the major sources of noise come from the water recirculation circuit of the fan, opening and closing of doors, alarms of the teams, and the conversations of professionals close to the incubator, causing the noise levels inside the incubator to be far from the recommendations of international organizations [36]. Absorption panels have been placed in the incubator to solve this problem, obtaining significant noise reductions [37].

Sound frequencies within incubators are markedly different from sound frequencies within the gravid uterus [30]. Acoustic attenuation at frequencies above 1000 Hz is desirable to simulate a sound spectra similar to that of the gravid uterus [30,38]. In this sense, the tests performed by Kellam and Bhatia within a neonatal incubator revealed that acoustic foam panels significantly reduced sound frequencies $\geq$ 500 Hz [30].

Although the AAMI/IEC standard for incubators sets the limit of the noise level within the incubators at 60 dB [39,40], this level is very far from the 45 dBA recommended by the AAP and 30 dBA recommended by the World Health Organization (WHO) [41–43].

1.4. Objective

It should be noted that there are few studies that evaluate the noise spectrum recorded inside the incubator. In this sense, it can be a key factor for the specialist doctor to know the acoustic features of the various incubator models.

A previous study showed that the attenuation of the Ohmeda Medical Giraffe incubator was 12 dBA [44], and the noise recorded in its interior was below 45 dBA. However, other incubator models recorded values between 57 and 60 dBA. So, this situation is not clear; the difference is too great [45–47]: in the latter case, it is far from 45 dBA. It was suggested that the noise should be limited to 45 dBA during the design of the incubator, more than 30 years ago [48].

Scientific publications show great variability in the methods used to measure ambient noise levels in the NICU and incubator [49,50], with inconsistencies in sample size and representativeness, configurations of measurement devices, places where the noise was measured, and evaluation of circumstances that contribute to the SPL [50].

Therefore, the purpose of this study is to know the noise level inside a neonatal incubator cabin derived from the motor-fan itself and the cabin ability to isolate noise from the outside environment. The case study extends to three incubator models: Ohmeda Giraffe Omnibed (OGO), Ohmeda OHIO Care Plus Access 3000 (OCP3000), and Ohmeda OHIO Care Plus Access 4000 (OCP4000).

2. Materials and Methods

The acoustic behavior of three models of incubators was compared: OGO, OCP3000 and OCP4000. The three incubators were chosen among the best-preserved incubators of "Puerta del Mar" Hospital in Cádiz and "Hospital Materno–Infantil" in Malaga.

Several tests were conducted to carry out the objectives. For the tests, the external generator type and the on/off status of the incubators under controlled conditions were taken into account. Thus, for each of the incubators the following variations were analyzed:

Incubator off, without any external noise sources except background noise.

Incubator on, without any external noise sources, except the noise of the incubator itself and the background noise, at a controlled temperature of 36 °C with a maximum humidity setting.

Incubator off and an external noise generator two meters away from the incubator.

Incubator on and an external noise generator two meters away from the incubator at a controlled temperature of 36 °C with a maximum humidity setting.

A Svan 958A class 1 four-channel sound and vibration analyzer of the Svantek brand was used for this study. It is capable of recording four channels simultaneously in Fast Fourier Transform (FFT) or third-octave bands. In addition to the Svan 958A, several SV 12L preamplified microphones of the Svantek brand were used, together with a Class 1 Acoustic Calibrator type 4231 and a sound source type 4224, both of the Brüel and Kjaer brand. Measurement equipment is annually calibrated by an external laboratory.

All the tests were made in a sound-dampened booth for free-field audiometry to avoid the effect of reflections and acoustic interference. The cutoff frequency of the sound-dampened booth for free-field audiometry was estimated at 100 Hz. The microphones were located at approximately the same position during the experiment. One of them was inside the incubator cabin, approximately where the infant supports the head, and mounted on a tripod at 10 cm high. The other is outside the incubator, 1.5 m away from the fan and 2 m from the external noise source. Calibrations were made for all tests, before the first measurement, and after the last measurement. The noise data were recorded in PCM digital audio, wav, 48 kHz sampling frequency, and 24-bit quantization. Although the full band spectrum was recorded, the audio band spectrum (20 Hz to 20 kHz) was ultimately analyzed. A frequency analysis of one-third octave bands with (dBA) and without (dB) an A-weighted filter was performed.

Post-processing was carried out with Matlab software ver. 2016a. Each test lasted one minute at 48 samples/s. The incubator doors were kept closed for all tests. The external noise source power was initially set, after the pretest, to evaluate the greatest possible attenuation in the incubators; after that, no modifications were made during all the tests, only turning the source on/off. Despite this, the registered values of the noise source outside the incubator oscillated between 82 and 85 dBA. However, these noise level changes affect both microphones (inside/outside) in the same way, and consequently, they do not mean any problem.

Kruskal–Wallis and Mann–Whitney tests were conducted to evaluate whether the noise levels show statistically significant differences between incubators.

3. Results

All the analyzed results are shown in two different formats: the overall noise levels are shown in tables, both in A-weighting and Z-weighting, represented by the energy mean and the standard deviation of the sample, and the results in the third-octave bands are shown in graphs.

3.1. Incubators off and Doors Closed, No External Noise Source

Table 1 shows the overall values, which were measured with the incubators switched off and the doors closed. It can be seen that the background noise level was about 40 dBA both inside and outside the incubator. The differences between the noise levels outside and inside the incubator were not higher than 0.2 dBA.

Table 1. The overall noise level inside and outside the incubators. Background noise (Incubators off).

Z-Weighted Sound Level (No Weighting)								
Model		**mean (dB)**	**sd (dB)**		**mean (dB)**	**sd (dB)**		**dB**
GIRAFFE	**Leq_Inside**	40.2	0.03	**Leq_Outside**	40.3	0.11	**Difference (Out-In)**	0.1
OCP3000		40.1	0.04		40.2	0.16		0.1
OCP4000		40.2	0.04		40.2	0.16		0.0
A-Weighted Sound Level								
Model		**mean (dBA)**	**sd (dBA)**		**mean (dBA)**	**sd (dBA)**		**dBA**
GIRAFFE	**Leq_Inside**	40.0	0.59	**Leq_Outside**	40.2	0.60	**Difference (Out-In)**	0.2
OCP3000		39.9	0.58		40.0	0.42		0.1
OCP4000		40.0	0.58		40.0	0.58		0.0

Figure 1 shows that for the three incubators at 63 Hz and 80 Hz, the differences between external and internal SPLs are negative; that is, the values inside the incubators are higher than those outside. Although a priori the reason for this phenomenon is unknown, we are going to outline some possible causes. The first one is that the power supply may emit noise when connected to the mains even when the incubator is turned off. It is also possible that the reverberation times are important at low frequencies [51,52], so it would be necessary to carry out another study that is far from the scope of the objectives of this one. In any case, these values are very low and can also be influenced by the minimum SPL that can be measured by the equipment; for values below 24 dB, the results are not reliable due to the electrical noise of the measurement equipment itself. On the other hand, the OCP3000 incubator is the one that shows the worst behavior in low frequency below 160 Hz; despite this, the overall noise recorded outside and inside of the incubator was similar. This is due to the representation in third octaves; the low-frequency bands have less energy than the high-frequency bands.

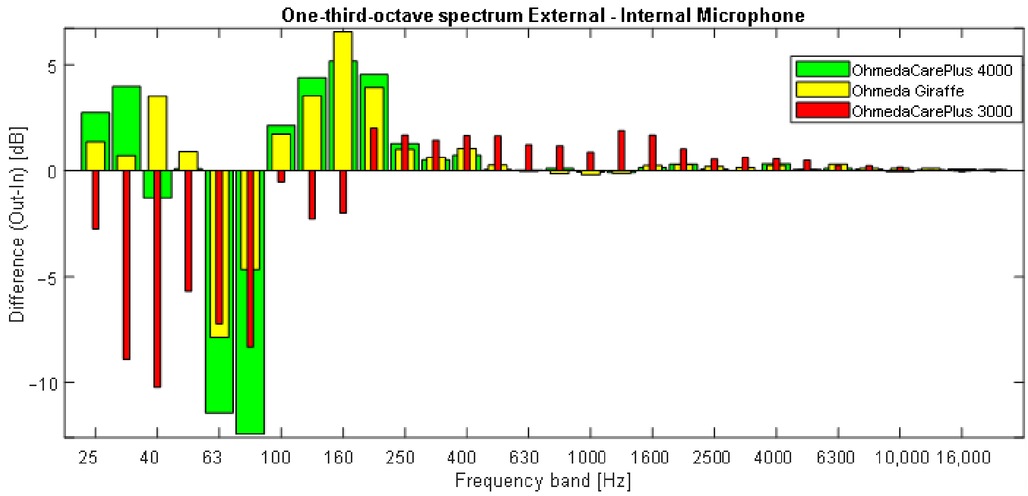

Figure 1. Background noise (Incubators off). Spectral difference between outside and inside the incubator (dB).

3.2. Incubators on and Doors Closed, No External Noise Source

When the incubator is on, the major noise source is the incubator fan; therefore, the noise recorded by the microphone inside the incubator will be precisely the fan noise. The noise level outside the incubator will depend on its insulation.

Table 2 shows that if background noise is very low, the fan noise transmitted to the outside is reduced up to 16 dB by the acoustic insulation of the incubator itself. However, to ensure this situation, a reverberation study is necessary. Therefore, during a period of lower background noise (nighttime), premature infants might be exposed to high levels of noise that cannot be perceived from the outside. On the other hand, it could be possible that this situation is an additional problem in NICUs with a large number of incubators since the noise in the room would increase. However, in most of the rooms, there is at least 1 m of separation between incubators. This is a distance sufficient to avoid noise pollution between adjoining incubators, assuming that all of them are of similar characteristics.

Table 2. The overall noise level inside and outside the incubators (Incubators on).

Z-Weighted Sound Level (No Weighting)								
Model		**mean (dB)**	**sd (dB)**		**mean (dB)**	**sd (dB)**		**dB**
GIRAFFE	**Leq_Inside**	56.7	0.17	**Leq_Outside**	40.6	0.05	**Difference (Out-In)**	−16.1
OCP3000		56.1	0.31		40.6	0.05		−15.5
OCP4000		52.1	0.17		40.6	0.05		−11.5
A-weighted sound level								
Model		**mean (dBA)**	**sd (dBA)**		**mean (dBA)**	**sd (dBA)**		**dBA**
GIRAFFE	**Leq_Inside**	56.5	0.58	**Leq_Outside**	42.3	0.35	**Difference (Out-In)**	−14.2
OCP3000		56.6	0.23		42.3	0.31		−14.3
OCP4000		51.9	0.60		40.5	0.54		−11.4

Figure 2 shows that the noise spectrum is negative, indicating that the noise level inside is higher than the outside, exceeding 25 dB in some frequency bands. Therefore, the noise inside the incubator far exceeds ambient noise. However, although background noise must be separated from incubator noise to know how much noise is from the fan, the fact that in broadband, most of the noise levels are 3 dB higher than the background noise indicates the low contribution of background noise inside the incubator.

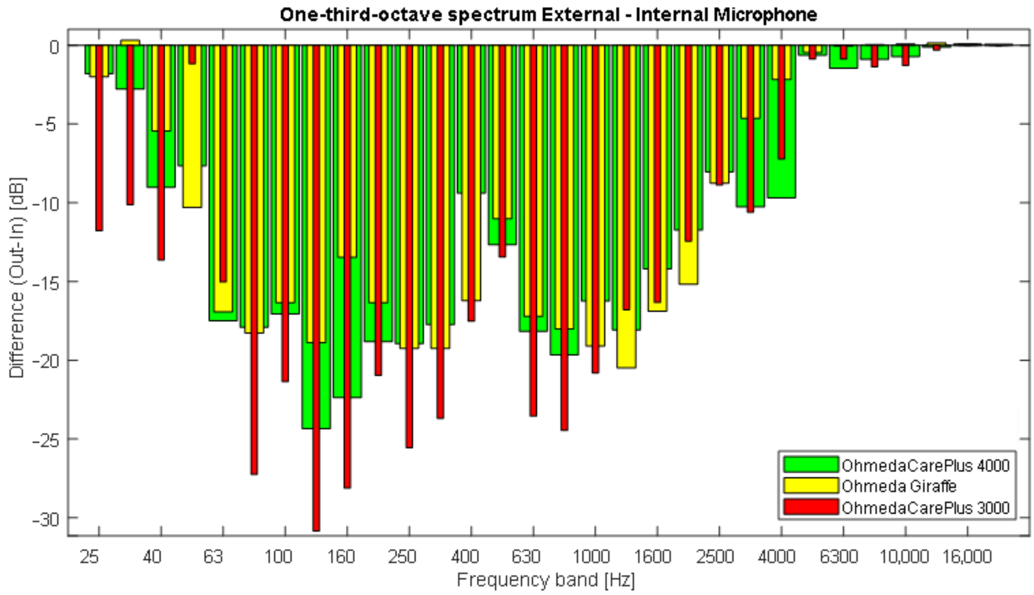

Figure 2. Incubators on: spectral difference between outside and inside the incubator (dB).

The OCP4000 incubator is the one that generates the lowest total noise in dBA with little difference. However, it is also the one that has the smallest difference between the noise inside and outside, and therefore, the lowest acoustic insulation, which was verified during the test with an external noise source.

3.3. Incubators off, Doors Closed, and External Noise Source on

When the external noise generator is activated, a pattern noise is emitted (pink noise from 100 Hz to 4 kHz, which contains equal energy per measurement band and thus has a one-third octave band level which is constant with frequency). In this case, the incubator was turned off, and therefore, the only source added was the external source of Brüel and Kjær Type 4224.

Table 3 shows the situation that occurs when the background noise is much greater than the incubator noise itself. Analyzing the noise levels recorded inside and outside the incubator, it can be deduced that the incubator insulates acoustically from the outside up to 10.8 dBA. Consequently, even with the incubator on, the external noise source is predominant.

Figure 3 shows that the acoustic insulation characteristics vary from one incubator to another. In this sense, the OCP4000 incubator has worse acoustic insulation, because it is the incubator with the lowest insulation values at high frequency (high energy band). The OCP4000 incubator loses efficacy at high frequency precisely in the frequency band where the uterine structure protects the fetus [37,38].

Table 3. The overall noise level inside and outside the incubators (Incubators off; external sound source on).

Z-Weighted Sound Level (No Weighting)								
Model		**mean (dB)**	**sd (dB)**		**mean (dB)**	**sd (dB)**		**dB**
GIRAFFE	**Leq_Inside**	74.6	0.22	**Leq_Outside**	83.8	0.27	**Difference (Out-In)**	9.3
OCP3000		74.8	0.20		85.6	0.21		10.8
OCP4000		77.6	0.14		85.6	0.21		7.8
A-Weighted Sound Level								
Model		**mean (dBA)**	**sd (dBA)**		**mean (dBA)**	**sd (dBA)**		**dBA**
GIRAFFE	**Leq_Inside**	74.4	0.54	**Leq_Outside**	83.6	0.64	**Difference (Out-In)**	9.2
OCP3000		74.6	0.57		85.4	0.58		10.8
OCP4000		77.4	0.58		82.9	0.59		5.5

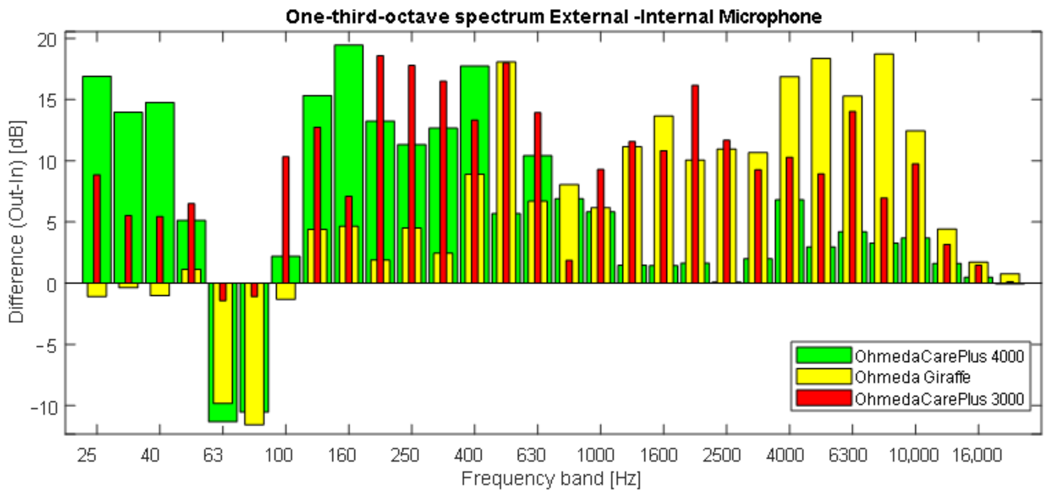

Figure 3. Incubators off and external source on: spectral difference between outside and inside the incubator (dB).

3.4. Incubators on, Doors Closed, and External Noise Source on

Two noise sources have now been added, since the external source and the incubator are turned on. The results of the measurements in these conditions are shown in Table 4. It is interesting to note that the attenuation values are similar to the results of the previous test (Incubators off and external sound source on), with values up to 9.7 dBA.

Regarding the behavior of the incubators, the overall attenuation of the Giraffe and OCP3000 models are very similar. However, the acoustic insulation at high frequency of the Giraffe incubator is better than that of the others. However, in the low-frequency bands (below 400 Hz), the OCP3000 incubator has better attenuation characteristics. In general, taking into account the general behavior of broadband noise (20 Hz to 20 kHz), the OCP3000 incubator is the best choice.

Figure 4 shows the 63 and 80 Hz tones inside the incubator, which have repeatedly appeared in all tests.

Table 4. The overall noise level inside and outside of the incubators (Incubators on; external sound source on).

Z-Weighted Sound Level (No Weighting)								
Model		**mean (dB)**	**sd (dB)**		**mean (dB)**	**sd (dB)**		**dB**
GIRAFFE	**Leq_Inside**	75.1	0.33	**Leq_Outside**	83.9	83.9	**Difference (Out-In)**	8.8
OCP3000		75.8	0.25		85.5	85.5		9.7
OCP4000		76.6	0.21		85.5	85.5		8.9
A-Weighted Sound Level								
Model		**mean (dBA)**	**sd (dBA)**		**mean (dBA)**	**sd (dBA)**		**dBA**
GIRAFFE	**Leq_Inside**	74.9	0.65	**Leq_Outside**	83.8	0.57	**Difference (Out-In)**	8.9
OCP3000		75.6	0.68		85.3	0.56		9.7
OCP4000		76.4	0.6		83.3	0.62		6.9

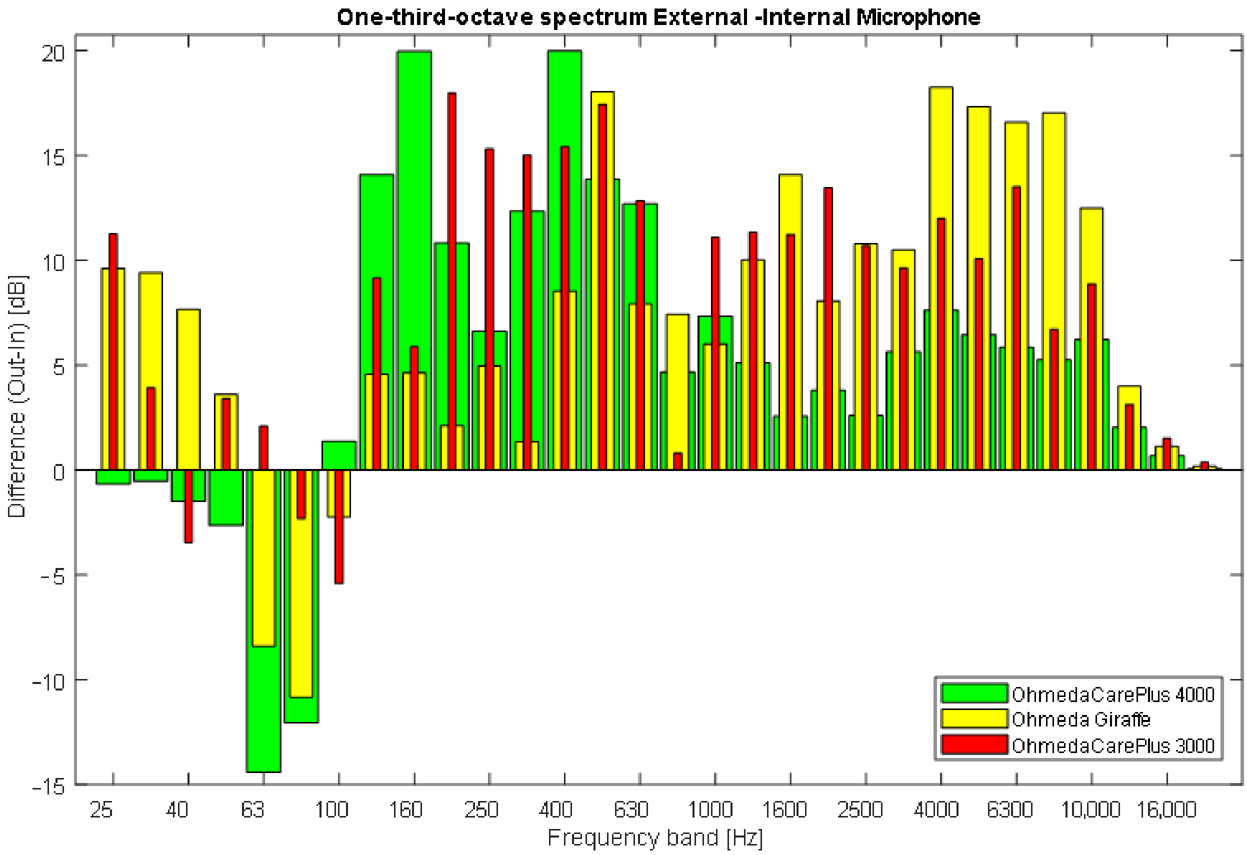

Figure 4. Incubators with an external source noise: spectral difference between outside and inside the incubator (dB).

Little difference was detected between the measured noise with open and closed doors. The most favorable difference was +2 dB (giraffe incubator), and the most unfavorable one was −1.6 dB (higher inside than outside the OCP4000 incubator).

Figure 5 shows the attenuation curves in the one-third octave of each of the tested inculcator models. In this figure, we can verify that Giraffe and OCP3000 incubators have similar attenuation profiles. However, there is a noticeable difference with the OCP4000 incubator fundamentally between 1000 and 20,000 Hz.

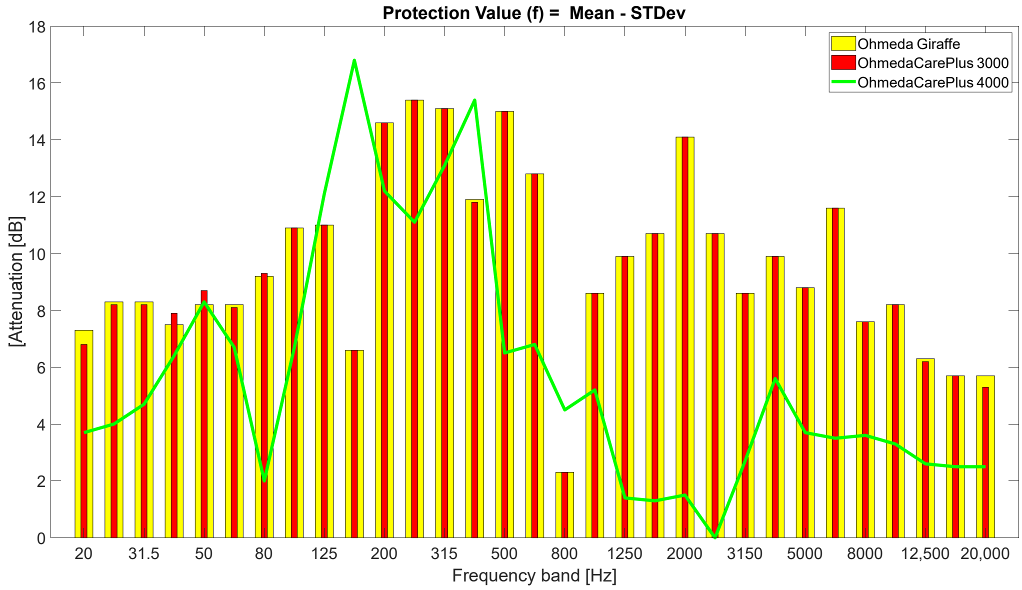

Figure 5. Frequency-dependent attenuation level for the worst situation (Mean–StdDev).

All tests performed to compare values between incubators (Kruskal–Wallis and Mann–Whitney) showed p-values < 0.05. This indicates, as is expected, that there are no significant differences between incubator models.

4. Discussion

Although more modern and less noisy incubators are recently being marketed, there are still many hospitals that have the incubator models that we tested in this study [53].

When the incubator is off, if the noise outside the incubator is less than or equal to 45 dBA (level recommended by the AAP), the noise inside the incubator cabin is approximately equal to the noise outside. However, when incubator is on, if the background noise outside of the incubator is less than the noise emitted by the incubator fan (general situation at night), the patient in the OCP3000 incubator (the one with better acoustic insulation) is exposed to high noise levels, which can be important for a newborn. If we consider the ISO 9612-2009 [54] about occupational noise exposure, for a reference period of 8 h, a worker inside the incubator cabin without any external noise source would be exposed to a noise exposure level A-weighted; noise dose can determined by the following expression:

$$Dose \geq 56 \text{ dBA} + 10 \times log\frac{T}{8} \tag{1}$$

where T is the time the newborn is in the incubator. Thus, a patient inside an incubator cabin is exposed to a minimum noise dose for 24 h equivalent to the noise level generated by the incubator fan (dBA) plus a 4.8 dBA penalty.

In the most favorable conditions, the noise level recorded in this study has always been greater than 45 dBA [42,43], which are values that exceed the recommendations of international organizations. Therefore, this situation can become a concern at night when the background noise is or should be relatively low [11,17,37,47].

Tables 3 and 4 show that there is little difference between attenuation with the incubator off and on; this is because the noise level from the external source is very high compared to the motor fan noise. Considering that a noise source is predominant if it exceeds another by 3 dB at the same recording point, this implies that if the source with the lowest power was eliminated, the overall noise level would vary very little. Applying this concept to the Giraffe incubator, Table 3 shows an acoustic insulation of 9.3 dB and Table 2 shows the motor-fan noise level of 56.7 dB, so that the external background noise will be predominant inside the incubator cabin for a higher level at 59.7 dB (56.7 + 3), but the source is outside the incubator, and its acoustic energy is attenuated 9.3 dB to pass through the incubator cabin. Therefore, the external source measured near the incubator should have a noise level of approx. 69 dB (56.7 + 9.3 + 3), which will have to be higher the farther the source is from the incubator. For the OCP3000 incubator, the noise level from a predominant external source near the incubator should be approximately 70 dB (56.1 dB {motor noise} + 10.8 dB {acoustic insulation} + 3 dB).

For the noise level from a noisy source outside the incubator to be predominant inside the incubator cabin, the noise level emitted by the source must be greater than 3 dBA plus the incubator attenuation value. In this study, the Giraffe is 68.9 dBA (56.7 + 9.2 + 3). Under this assumption, the patient would be exposed to a noise level greater than 56 dBA.

The three incubator models analyzed showed different behavior against noise [47], doubling levels from one model to another. The models of incubators with better and worse behaviors against noise were Giraffe and OCP4000, respectively, within the three models analyzed. Although the attenuation of the Giraffe model is similar to the OCP3000 model, the spectrum in the one-third octave bands of the Giraffe shows a better redistribution of levels of insulation. This is mainly due to the design of the box and the thickness of the materials.

Which incubator of those tested has obtained the best performance? The noise attenuation of the three incubator models tested is 8.5 dBA. However, this parameter is not enough; it is also necessary to know the spectrum and the noise generated by the incubator itself inside the cabin. For example, the OCP 4000 incubator has the lowest fan noise at night, but the OCP3000 one has the best acoustic insulation for noisy periods. Therefore, in this sample, there is no one recommended incubator for all situations.

In this sense, it is also necessary to regulate the noise insulation level in incubators in one-third octave bands.

International standards such as IEC must consider international recommendations (AAP and WHO) to reduce noise from incubators under normal conditions of use up to 45 dBA [55].

The noise levels measured inside the incubators comply with the IEC60601-2-19 standard, which establishes maximum of 60 dBA, under normal conditions of use. However, this requirement does not guarantee 45 dBA inside the incubator under conditions of very low background noise outside the incubator [55].

5. Conclusions

Noise from the fan–motor assembly of an incubator is not negligible; this is particularly so during the nighttime when environmental noise levels can be very low. As a result, neonates, who spend most of their time in an incubator, are invariably exposed to noise levels well above the international recommendations (e.g., 45 dBA recommended by AAP).

Having incubator manufacturers report with the acoustic attenuation characteristics of their models would facilitate selecting the most appropriate earmuffs to be used on neonates in terms of the specific sound frequency bands to be preferentially attenuated—one should bear in mind that the noise spectrum of a neonatal room can and should be known.

The three incubator models compared differ in acoustic performance, the differences arising mainly from box design, hood material and wall thickness. The large differences in acoustic attenuation between frequency bands, and also between incubator models, suggest a lack of standardization of this incubator characteristic.

Although attenuation can be as high as ca. 19 dB in some frequency bands, it varies markedly across the acoustic spectrum. A need thus exists to improve this feature, and also the acoustic insulation of fan and motor noise, by developing a standard to regulate attenuation in the one-third octave bands. In addition, norms such as the IEC standard should adhere to international recommendations (e.g., AAP's limit of 45 dBA) in order to reduce incubator noise under normal conditions of use.

Although the internal noise levels of the incubators compared here comply with IEC60601-2-19 (i.e., they do not exceed 60 dBA under normal conditions of use), the AAP-recommended limit (45 dBA) may easily be exceeded inside under conditions of very low background noise.

Author Contributions: All authors contributed to the study conception and design. Conceptualization: F.F.-Z., V.P.-R. and R.H.-M.; Funding acquisition: R.H.-M.; Methodology, analysis and conclusions: F.F.-Z.; Project administration: R.H.-M.; Resources: R.H.-M.; Supervision: F.F.-Z.; Writing—original draft preparation: F.F.-Z.; Review and editing: F.F.-Z., V.P.-R. and R.H.-M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Universidad de Cádiz, gran number PR2016-079, in the framework of its 2016–2017 program for Research and Transfer Fostering and Promotion. The APC received no external funding.

Data Availability Statement: The data obtained to carry out this work are based on original sound recordings, which were processed using specific software, specifically the 7820 Evaluator, developed by the company Brüel & Kjær. The 7820 type requires a license and associated HASP dongle to function. For this reason, it is necessary to apply certain restrictions to have these data. The data sets generated and/or analyzed during the current study are not publicly available. Still, they are available through the authors upon reasonable request and with the permission of the director of the Acoustic Engineering Laboratory of the University of Cádiz (Ricardo Hernandez Molina).

Acknowledgments: We would like to thank the NICU staff of the "Materno-Infantil" Hospital of Malaga and the NICU staff of the "Puerta del Mar" Hospital of Cádiz for their help with this project. Thanks as well to the University of Cádiz for the concession of the project within the framework of the "program for the promotion and promotion of research and transfer at the University of Cádiz 2016–2017", which has allowed the completion of this work.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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