

# OCCUPATIONAL EXPOSURE TO NOISE BY AMBULANCE CREW

## *Exposição ao ruído ocupacional pelos tripulantes de ambulâncias*

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### ABSTRACT

**Purpose:** to describe the sound pressure levels that workers are exposed during working hours in ambulances and verify possible association between the use of sirens, traffic conditions and time of day at which the measurement was taken. **Methods:** In the first stage were measured the sound pressure level in the cabin of the ambulance during emergency trips, and the investigation of the driver's perception about traffic conditions and use of the siren. In the second stage was analyzed the noise exposure of a worker during the work. The data were analyzed statistically. **Results:** the average equivalent continuous sound level for 12 emergency trips exceeded 85 dB (A) above the value allowed by the Regulatory Standard 15, and the loud noise was associated with traffic conditions and use of the siren ( $p < 0.05$ ). The noise dose in percentage during a driver shifts varied from 17,51% to 155,68%, exceeding the recommended limit and also had an influence on traffic conditions and siren's use. **Conclusion:** the sound pressure levels to which workers are exposed during working hours in ambulances are high and beyond what is established by the Brazilian standard. Thus, it is necessary to develop preventive health actions to this professionals since the high noise levels can adversely affect their hearing health and quality of life.

**KEYWORDS:** Noise Occupational; Hearing Loss; Hearing; Working Conditions; Working Environment

### ■ INTRODUCTION

The technological evolution brings contributions for the development of the individuals in the social, cultural and biological context; however, it was also followed by innumerable issues, especially the ones that are related to labor activity, exposing the physical and emotional fragility<sup>1</sup>. In the working environment, the workers are submitted to a various physical, biological and ergonomic risks, among others, and the noise is a physical agent that potentially causes damage to the worker's health<sup>2</sup>.

The noise does not prejudice only the hearing, despite this effect is well known and typified<sup>3</sup>. According to the literature, the noise brings hearing and extra-hearing alterations, like: sleep disorders, cardiovascular events, stress, fatigue, mental stress<sup>4-6</sup>, nervousness, strain in the social relationship, dizziness, irritability, alterations of the nervous, cardiovascular, pulmonary, metabolic and endocrine system<sup>7</sup>.

It is known that the main sources of noise are the automotive vehicles in the urban centers. Nowadays, the exposure to the traffic noise is a worrying factor for hearing care of professional drivers and has been the target of many studies<sup>8-12</sup>.

The continued exposure to the traffic noise may result in a noise-induced hearing loss (NIHL), affecting professional drivers of various categories<sup>13,14</sup> and the others workers with high exposure, like ambulance crew<sup>15</sup>.

The noise-induced hearing loss is the gradual reduction of the auditory acuity, due to the continued exposure to a high levels noise<sup>16</sup>. The Regulatory

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Standard 15 (NR-15 in Portuguese)<sup>17</sup>, Ordinance n 3.214/1978, sets the limits of the exposure to the permanent or intermittent noise and of the impact noise, current in Brazil. The maximum exposure allowed for a noise of 85 dB (A) is eight hours per day.

Many studies in the literature approached the noise levels and the hearing findings in professional drivers<sup>18-20</sup>. One study realized in a city of the Fars Province, Iran, has investigated the hearing of 500 truck drivers by means of tonal threshold audiometry. The results indicated that the hearing damages of the drivers appear sooner in the frequencies of 4 and 8 kHz. Furthermore, it was also showed that the work conditions of the truck drivers may have a bilateral and symmetric injurious effect and reach all the frequencies, especially 4.000Hz<sup>19</sup>.

Research with 1.113 bus driver with average term of service of 4,6 years showed the presence of bilateral sensorial hearing loss in the frequency range from 3-6 kHz with greater change trend of auditory thresholds in the left ear in the frequency range from 0.5 to 2,0 kHz. The workers over age and with length service were the most affected<sup>18</sup>.

Another study realized with 28 ambulance drivers in the Hospital das Clínicas da Universidade de São Paulo showed that 50% of the professionals presented NIHL and 35,7% presented recruitment. It was also observed a statistically significant relationship between the variables: "Degree of hearing loss in left ear x Degree of hearing loss in right ear", "Presence of recruitment x Degree of hearing loss in left ear", "Presence of recruitment x Degree of hearing loss in right ear"<sup>15</sup>.

It is estimated that 25% of the working population exposed to noise should carry any degree of NIHL<sup>21</sup>, which enhances the necessity of reassess the working conditions of the professional that works in ambulance and check the sound pressure levels to which these individuals are exposed. The workers exposed to a high sound pressure levels shall be warned of the effects that this exposure implies, in order to improve the relation between work and health<sup>22</sup>.

Although it is the most frequency injury to the workers health, it is still limited the data about prevalence of it in Brazil. This enhances the importance of notification, which makes possible the knowledge of the reality and targeted the actions of preventions and necessary assistance<sup>21</sup>.

Thus, the aim of this study is to describe the sound pressure levels (SPL) to which workers are exposed during the working period in ambulances and check the possible association of the use of siren, traffic conditions and time of the day that the measurement was taken.

## ■ METHODS

It is a descriptive transversal study, realized in a mobile support unit of an urgency and emergency particular service in the city of Belo Horizonte, Minas Gerais. The research was analysed and approved by the Ethics Committee of the Universidade Federal de Minas Gerais under the number 12711013.5.0000.5149.

The ambulance analyzed followed the pattern used by the most of the urgency and emergency services of Belo Horizonte (MG) in terms of technical specification, physical dimensions, the cabin interior details and siren. It is an ambulance of Mercedes-Benz, Sprinter 315, CDI model, 4-door, manual and manufacturing year 2008. The model is a standard Sprinter with high ceilings.

It was used a digital sound pressure level meter with datalogger brand Instrutherm, DEC-490 model with microphone type 2 for the measure of the noise in the cab of the ambulance during the emergency trips. The measurements were realized in the frequencies of 63 to 8 kHz and the equipment was programmed to collect data in fast mode, using the weighting curve "A", as recommended by the Brazilian Norm (NBR in Portuguese) 10.151<sup>23</sup> and ISO 5128. It was used protective foam in the microphone in order to minimize the wind effects.

The equipment was positioned in the back cabin of the ambulance in the chair that is occupied by the nursing technician, nursing or physician. It was realized measurements during 20 emergency trips, which duration range from 15 to 37 min. These measurements were realized in different days, periods and shifts, and in each trip the driver reported about the traffic as "good" or "bad", and about the siren's use as "turned on" or "turned off". The average of trips differs depending on the calls, since it is an urgency and emergency company. In this particular case, the 20 trips were checked in three days of work of different professionals.

Subsequently, it was realized the analysis of the exposure of a worker to the noise during the working day. It was determinate the daily dose expressed in percentage of occupational exposure to noise during four shifts of a driver of the mobile support unit: night duty during the week, day duty during the week, night duty during the weekend and day duty during the weekend. The shifts had an average duration of 12 hours and the worker's rest periods were not considered. The dose estimation was based on the all period of shift.

It was used a dosimeter noise Simpson brand model 897, fixed on the left side of the driver throughout the data collection to determine the noise exposure dose. The equipment got stuck

on the side of the belt of the assessed individual, passing the wire inside the shirt, in order to preserve the movements required for the activity of the driver. The microphone went out in the opening of the collar and was set near to the left auditory area.

The dosimeter used in the research provides measures and stores the equivalent sound pressure level while making dosimetry. Specific measures parameters were selected as recommended by Regulatory Standard (NR in Portuguese) 15, attached I and II, as slow response time and scale compensation A, as this indicate that the measured levels are weighted by frequency according to the subjectivity of the human ear. Therefore, the results are in dB (A). Its technical features meet the specifications of standard two, ISO 1999 (1989) and ANSI SI-4-1971 for general use in field research.

The SPSS software, 16.0 version, was used for entrance, process and quantitative analysis of the data. For descriptive analysis, it was realized the frequency distribution of categorical variables of

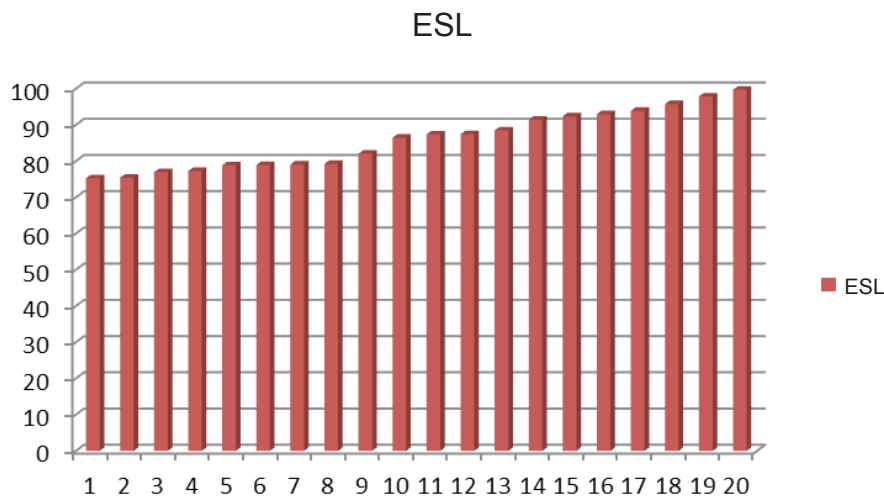
the data and analysis of the measures of central tendency and dispersion of continuous variables.

In statistical analysis, it were used the t-Student test in the quantitative continuous variables with normal distribution and Chi-Square or Fisher Exact Test in the analysis of categorical variables. To determine the distribution of quantitative variables, it was used the normality Shapiro-Wilk test. The significance level adopted was 5% ( $p < 0.05$ ).

## ■ RESULTS

The measurements of the equivalent sound levels (ESL) during the emergency trips performed by the ambulance at difference times of the day range from 75,28 dB (A) in a good traffic at night and without siren to a 99,73 dB(A) during dense traffic at daytime and with the siren use.

The average equivalent sound levels (ESL) based on the measurements performed in the 20 trips was 85,85 dB(A) ( $\pm 7,9$ ), minimum of 75,2 dB(A) and maximum of 99,7dB(A), as viewed in Figure 1.



Legend: ESL = equivalent sound level.

**Figure 1 – Equivalent Sound level in the 20 ambulances trips**

The Shapiro-Wilk normality test was used for analysis of this parameter and it was verified normal distribution of the variable noise level.

The analysis of the equivalent sound level in the trips categorized according to the siren's use,

traffic conditions and time of the day can be seen in Table 1.

Data obtained from the measurements of the noise dose of the ambulance driver during the working day in different shifts are demonstrated in Table 2.

**Table 1 - Equivalent Sound Level in the trips categorized according to the siren's use, traffic conditions and time of the day.**

ESL (dB(A))	Variable	N	Average	Median	Standard Deviation	Minimum	Maximum	T Test* or Anova	p Value
Siren	Yes	11	92,16	92,37	4,44	86,48	99,73	8,67	*0,000
	No	9	78,13	78,85	2,11	75,28	82,06		
Traffic	Bom	10	79,05	78,90	3,54	75,28	87,38	-7,63	*0,000
	Ruim	10	92,64	92,67	4,37	88,49	99,73		
Period	Morning	10	84,32	83,66	7,65	76,98	92,98	0,086	0,918
	Afternoon	5	86,37	93,07	8,72	75,48	97,86		
	Night	5	86,05	86,49	8,28	75,28	99,73		

\* Statistical Test: t- Student Test and Anova

**Table 2 – Equivalent Sound Level and noise dose in percentage during the shifts of only one driver**

ESL (dBA)	Dose %	Period	Traffic Conditions	Siren's use	Measurement Time (min)
73,38	30,10	Night duty (weekday)	Good	No	723
85,43	155,68	Day duty (weekday)	Bad	Yes	704
68,73	17,51	Night duty (weekend)	Good	No	698
79,85	72,95	Day duty (weekend)	Bad	Yes	715

## ■ DISCUSSION

In the present study, 12 of the 20 measures performed during the emergency trips presented sound pressure level greater than allowed by NR 15 (60%). The same result was observed in other studies with bus drivers in Florianópolis<sup>24</sup> and Porto Alegre<sup>10</sup>, in which the noise level found was greater than 85 dB(A) in 58,8% of the freet and 100% of the journeys, respectively. The data showed that the ambulance and bus drivers are submitted to a physical risk – noise -, which proven brings many health damage<sup>6,15</sup>.

According to the data, the noise level is associated to traffic conditions and siren's use (Table 1 and 2), which underlines the research with emergency staff that works in an ambulance and found a sound level in the cabin ranging from 96 to 102,5 dB(A) when the siren was turned on<sup>25</sup>. Then, the siren's use and traffic conditions classified as "bad" are dependents, since the bad traffic leads to the siren's use, and consequently raises the noise level. It is a common situation and unavoidable to the ambulance crew, who need to help lives in any time, factors beyond the control of the crew.

The driver's perception related to work conditions was fundamental to characterized the traffic

noise. It was observed that all the times that traffic conditions was described as "bad", the sound pressure level was higher and greater than allowed by NR 15. Despite this study does not investigate the driver's perception about traffic noise, various studies in literature described the level of discomfort of the traffic noise<sup>26,27</sup>. In interview realized in a local without noise control, 94% of the individuals reported discomfort, as in a local with noise control only 50% of the respondents complained, and it is possible to note the correlation between the higher noise level and perception<sup>26</sup>. Another research of opinion about noise perception showed that 73% of the respondents reported discomfort with the city noise, and this noise is from traffic<sup>27</sup>.

It were not found the norms that define the maximum internal noise for vehicles cabins, but the CONAMA Resolution n° 252<sup>28</sup> of 1 of February of 1999 that establishes the procedures and maximum limits for control and supervision of the noise emission by the motor vehicles. Thus, it were considered the NR 15 specifications that establishes the value of 85 dB (A) as limit of occupational noise for eight hours of exposure.

It is important to underline that the occupational noise is potentially generator of hearing and non-hearing effects<sup>29</sup>, and it is impossible to ignore the psychological reactions (as anger, stress and nervousness) and/or physical (as a rise in blood pressure), which may cause permanent damage to humans<sup>6,7</sup>. However, it is believed that the established limit by the NR 15 should be reviewed, since the value of 85 dB (A) for eight hours of exposure is high and too harmful to humans. Furthermore, the investments in working conditions of the professional by means of noise control measures in the mobile support unit and preventive actions for health preservation would also contribute to the reduction of the auditory and non-auditory effects caused by the high noise levels.

In relation to dosimetry, the lower value registered in this study happened during the night duty in the weekend in good traffic conditions and without the use of siren. The highest valor found was equal to 155% and happened during the day duty during week in bad traffic conditions and with siren use. The same was found in research performed with bus driver in which were notices noise doses greater than 100%, and this value was affected by the weekday and traffic condition<sup>24</sup>. These values exceed the daily dose allowed that is 100% according to NR 15, which, in turn, will generate negative impacts to the worker's auditory health as the development of NIHL, as well as implications for their quality of life and increased stress.

Another study performed in São Paulo with ambulance drivers showed that the occurrence of NIHL was of 50%. Since the hearing loss caused by noise is progressive and irreversible, it is necessary the use of tough control measures. These are divided into technical control measures (engineering) and control applied to man. The technical control includes the measures applied in the working environment: noise reduction at the source and reducing or preventing the spread of noise. The control applied to man includes reducing the worker noise exposure time, use of personal protective equipment (PPE) and medical control that aims to prevent the occurrence of occupational hearing loss<sup>30</sup>.

In relation to noise effects in workers hearing health, research performed in Porto Alegre with 1.113 bus drivers verified a worsening in the hearing thresholds in acute frequencies related to length of service when it was compared the results of the first and the last sequential audiometry of each worker, which shows that the exposure to the noise during the working day can be harmful to the hearing system<sup>9</sup>. The values found in this research and in the studies described above are greater than allowed by NR 15, and therefore can bring damages to workers health, underling the importance of noise control measures.

The present study allowed the knowledge of the internal noise of the ambulance cabin, as the noise dose to which the ambulance worker is exposed. However the dosimetry analysis was performed in only one driver in four shifts of 12 hours each, the results pointed to a worrying situation, since the occupation noise causes irreversible damage to the internal ear and auditory and non-auditory harmful effects to workers health when in excess of the limits established.

It is suggested the continuation of the present study with higher samples and performance of objective and subjective hearing screening, in order to quantify the damages of the occupational noise in these professionals.

## ■ CONCLUSIONS

The sound pressure levels to which the workers are exposed during the working period in ambulance are high and exceed the limits sets by the Brazilian norm. Thus, it is underlined the necessity of a Hearing Conservation Program (PCA, in portuguese) in companies of urgency and emergency where the workers are exposed to a traffic noise, alarme bells and siren, in order to minimize or even repeal their nocives effects to the workers general health.



## RESUMO

**Objetivo:** descrever os níveis de pressão sonora a que os trabalhadores estão expostos durante a jornada de trabalho em ambulâncias e verificar possível associação do uso da sirene, das condições do trânsito e do período do dia em que foi realizada a medição. **Métodos:** trata-se de estudo transversal descritivo dividido em duas etapas. Na primeira etapa foram realizadas medições do nível de pressão sonora na cabine da ambulância durante as viagens de emergência, e investigação da percepção do motorista sobre as condições do trânsito e uso da sirene. Na segunda etapa foi realizada análise da exposição de um trabalhador ao ruído durante a jornada de trabalho. Os dados foram analisados estatisticamente. **Resultados:** a média do nível sonoro contínuo equivalente durante 12 viagens de emergência foi superior a 85 dB(A), valor acima do permitido pela Norma Regulamentadora 15, sendo que o ruído elevado esteve associado às condições do trânsito e uso da sirene ( $p < 0,05$ ). A dose de ruído em porcentagem durante os plantões de um motorista variou de 17.51% a 155.68%, ultrapassando o limite preconizado e também teve influência das condições do trânsito e uso da sirene. **Conclusão:** os níveis de pressão sonora a que os trabalhadores estão expostos durante a jornada de trabalho em ambulâncias são elevados e ultrapassam o que é estabelecido pela norma Brasileira. Dessa forma, verifica-se a necessidade do desenvolvimento de ações preventivas voltadas à saúde desses profissionais já que elevados níveis de ruído podem interferir negativamente na saúde auditiva e qualidade de vida dos trabalhadores.

**DESCRITORES:** Ruído Ocupacional; Perda Auditiva; Audição; Condições de Trabalho; Ambiente de Trabalho.

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