Hearing screening using distortion product otoacoustic emission(DPOAE) in high-risk employees of an Indonesian hospital

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Abstract. Noises in hospitals cause noise-induced hearing loss in the employees. The standard diagnostic is audiometry to determine the hearing level. Distortion product otoacoustic emission (DPOAE)is a potential screening tool for cochlear problems. Noise exposure can be found not only in industrial areas but also in hospitals.This study aims to hear conservations to control the risk factors by doing noise measurement using the sound level meter. The design of this study was an analytic observational study with the cross-sectional design where measurements were made ofintensity and noise dose in 3 installations, namely medical facilities maintenance (MFM), sanitation, and nutrition. Fifty-sixsubjects underwent tympanometry to exclude conductive hearing loss, resulting in a total of 48 subjects who fit the inclusion criteria. The correlation between examination results and age, work station, and working duration were analyzed by usingthe Spearman correlation test ($p<0.05$). The correlation between noise dose, intensity, and hearing status, however, were analyzed by using Fischer test ($p<0.05$). The result showed theaverage noise intensity at MFM was 95.83dBA, at the nutrition installation was 99.07dBA, and at the sanitation installation was 105.5dBA. Meanwhile, the average noise dose at MFM was 674.25%, at nutrition was 1632.5%, and at sanitation was 8 977.75%.Abnormal audiometry was 50% and DPOAE refer 77.083%. Thus, it can be argued that there was a significant correlation between the work station and DPOAE ($p=0.0184$). There wasalso a correlation between noise intensity and hearing loss, whileno significant differenceswere discovered between DPOAE and audiometry.

Keywords: Hearing screening; distortion product otoacoustic emission; audiometry

1. Introduction

Noise is an unwanted sound that gives negative impacts onhuman health, and it can trigger noise-induced hearing loss (hereafter, NIHL). Audiogram notch at 4,000 Hz is pathognomonic for NIHL, firstly found by Fowler in 1939 [1]. WHO data reported 16% of adults to suffer from hearing impairment due to noise exposure at work, which number will rise especially indeveloping countries [2].

Noises source are not only found in industrial areas but also hospitals. A hospital is a health provider for the public that must also provide the health of its employees. There are three installationsin General HospitalDr. Soetomo in Surabaya, Indonesia, with the intensity of>85 dB, namely medical facilities maintenance (hereafter, MFM), sanitation installation, and nutrition installation. According to the Minister of Health of the Republic of Indonesia RegulationNo. 48 of 2016 on the Standards of Occupational Safety and Health in the Workplace,noise is consideredasthe potential physical danger to employees that can cause hearing loss. Thus, efforts to control risk factors, early disease cases, disease management, and health recovery for employees are needed [3].

Based on the background, therefore, this study aimsto hear conservations to control the risk factors by doing noise measurement using a sound level meter.Distortion product otoacoustic emission (hereafter, DPOAE) plays a significantrole in NIHL screening, besides being able to interpret the hair cell response in two different frequencies [4].Permissible noise dose exposure could be analyzed more precisely, especially in noise-exposed employees in more than one source in a certain period [5].

2. Material and methods

This studywas an analytic observational study with a cross-sectional design. The subjects were high-risk employees in General Hospital Dr. Soetomo Surabaya, Indonesia, who met theinclusion criteria, such as being exposed to >85 dB noise intensity at the specified threeinstallations, willing to undergo several examinations, and filling out the consent form.Meanwhile, the exclusion criteria covered the presence of any conductive or mix type of hearing loss from audiometry, common cold, allergic rhinitis, nasal polyp, and the history of using ototoxic drugs. Initially, there were 56 subjects; however, only 48 subjects fit the criteria – nine subjects from MFM installation, seven subjects from sanitation installation, and 32 subjects from nutrition installation.

Noise intensity measurement and exposure were carried out byutilizinga sound level meter performed by several students from Physical Engineering Program Studyof Sepuluh Nopember Institute of Technology, Surabaya, for twodays (April 12 – April 13, 2017). Furthermore, the data was obtained using a sound level meter digital with standing mic in front of the noise source with distance ±120 cm from the ground. The measurement was held for 24 hours with a 4-level equivalent (Leq) in the afternoon and3Leqs in the night at several spots. The data was collected for 10 minutes for every Leq with data clipping for every 5 seconds by using Realtime Analyzer software. Thus, in 10 minutes, 120 data could be obtained.Data collected twice in two days for accuracy.

The examination processes included history taking, ENT-KL physical examination, tympanometry examination, audiometry examination, and DPOAE. The results of DPOAE were in the monitor, pass for normal and refer toabnormal hearing function.The statistical analysis of the correlation between the examination results and age, working station, and working duration was completed by using the Spearman correlation test ($p < 0.05$). The analysis of the correlation between noise dose, noise intensity, and hearing level further performed by using the Fisher test ($p < 0.05$).

This study had been conducted fromApril 1 to April 30, 2017, with the ethical clearance according to the ethical committee of General Hospital Dr. Soetomo Surabaya.

3. Results

From a total of 48 participants, more than half of them were women (58.33%). The educational attainment of most respondents was high school (81.25%), and worked in the nutrition installation (68.75%) by the time this study was carried out. Moreover, the data indicated that the average age of the respondents was 42.43±10.72 in the age range of 22-58 years old, while the average working durationwas 19.54±9.56 years in the 1-36 year periods. The average noise intensities showed the numbers of105,5dBA at sanitation installation, 95.83dBA at MFM installation, and 99.07dBA at nutrition installation. Meanwhile, the average noise doses were8 977.75% at sanitation installation, 674.25% at MFM installation, and 1 632.5% at nutrition installation (Table 1).

Table 1. Noise Record from ThreeInstallations

No	Location	Machine	Leq (dB) Average	Duration (hours) Reference	Duration (hours) Real-time	Dose (%)
1.	Workshop	Gerinda	102.04	0.17	2	1 263
		"Bubut"	88.66	3.56	4	116
2.	Incinerator	Incinerator	101.33	0.19	2	1 074
		Driller	112.90	0.01		15 431

3.	Water Pump	inside	103.98	0.10	10	9 877
		outside	103.82	0.11		9 529
4.	Boiler	inside	96.45	0.59	7	1 222
		outside	85.39	7.48		96
5.	Kitchen	stove 1				
		blower 1	99.07	0.33	8.5	2 714
		blower 2				
		washer	92.15			551

From the anamnesis and physical examinations, it can be noticed thatthreesubjects from nutrition installation suffered froma common cold. From the tympanometry examination, there were fiveresults type B:onesubject from the sanitation installation, twosubjects from MFM installation, and twosubjects from nutrition installation.

Furtherresults indicated that NIHL with a peak in high frequencies of 4,000 Hz and 6,000 Hz was found in 16 subjects:two subjects from sanitation installation (12.5%), fivesubjects from MFM installation (31.25%) and ninesubjects from nutrition installation (56.25%). Audiometry with normal level (<25dB), mild level (26-40dB), and moderate level (41-55 dB)wasdiscovered in six subjects, six subjects, and four subjects, respectively. Normal audiometry was further found in 24 participants:five of sanitation installation (20.83%), oneof MFMinstallation (4.16%), and 18 of nutrition installation (75.01%). Neural sensory audiometry was found in the remaining eightsubjects, namelythree participants of MFM installation (37.5%) and five of nutrition installation (62.5%).

DPOAE results referred in one/two ears in 37 respondents(77.083%), including 9 respondents from sanitation installation (24.32%), 6 respondents from MFM installation (16.21%), and 22 respondentsfrom nutrition installation (59.47%). Furthermore, at sanitation installation, three subjects referred DPOAE in both ears, threesubjects referred in one ear, and onesubject passed both ears. At MFM installation, additionally,seven subjects referred DPOAE in both ears, twosubjects referred in one ear, and no subject passed. Seventeenparticipants at nutrition installation, moreover, referred DPOAE in both ears, whilefive participants referred in one ear, and tensubjects passed.

4. Discussion

In other words, it can be argued that there was a significant correlation between the work station and the DPOAE referred (p =0.0184), in addition to a correlation between noise intensity and hearing level (p= 0.0242). Noise exposure allowed is 85dBA in 8 hours straight. Meanwhile, all measurements showed a noise intensity of>85dB, which according to the rule,it was a high potential for causing NIHL.Several methods were found to diagnose NIHL. The standard examination, according to the hearing conservation program, however, was audiometry.

There are many studies agreedthat OAE, as a diagnostic tool, is better in assessing how middle ear function to noise exposure besides its usage as a screening tool NIHL [6,7].Moepeng in 2016 conducted a study about DPOAE applicability as a screening tool for the cochlear problem after noise exposure. The result revealed that DPOAE was sensitive in detected cochlear problems in NIHL. Moreover, DPOAE was found easy to use, cheap, and did not need an examination chamber [8]. Shupak et al., in 2007 carried out a study in naval Israel, which at the beginning of training, they performed audiometry, TEOAE, and DPOAE to obtain the initial data and twomore examinations in the following years as the evaluation. The final resultsdisclosed that DPOAE had no significant correlation with pure tone audiometry and that it could not be used as an objective tool to determine hearing level changes in early NIHL [9].However, in this study, there were some limitations, including no differentiation of the working period and the use of a hearing protector for each employee.

6. Conclusion

In this study, DPOAE was utilized as a screening tool for NIHL since it could also assess the cochlear function. More in-depth studies with a bigger sample size are still needed because there are still many high-intensity noise areas in hospitals. Besides, a regular hearing examination is necessaryto support the hearing conservation program for the employees. In conclusion, there was no significant difference between audiometry results and DPOAE results. DPOAE can also be further used as a screening tool and replace the audiometry.

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9. Conflict of Interest

This study didn't haveany conflicts of interest.

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