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## THE CORRELATION BETWEEN TNF- $\alpha$ VALUE WITH HEARING THRESHOLD AT 4000 HERTZ AFTER EXPOSURE TO GUNFIRE OF NATIONAL POLICE ACADEMY IN EAST JAVA

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### ABSTRACT

The incidence of acoustic trauma after gunshot exposure in students of the Sekolah Polisi Negara (SPN) is quite high. Prevention has been done by using the earplugs, but it was not effective so that other methods are needed to prevent the occurrence of acoustic trauma. Tumor Necrotic Factor  $\alpha$  (TNF  $\alpha$ ) is chemotaxis factor with function to pull monocytes to inflammation area and make inflammation cell accumulation, the relationship between the levels of TNF  $\alpha$  and the hearing threshold frequency hearing threshold post gunshot exposure in SPN East Java students. This study is observational analytic with a retrospective cross sectional approach using secondary data of medical records of students of the SPN East Java batch 2017/2018. The samples were selected by simple random sampling. Out of the 50 students, the youngest was 18 years old and the oldest was 21 years with an average of 19.62 years. All research samples are male. Decreasing the hearing threshold frequency at 4000 Hz indicated as acoustic trauma was found in 28 students (56%), the minimum hearing threshold frequency at 4000 Hz 5 dB and maximum of 65 dB with an average of 31.52 dB. The minimum value of TNF  $\alpha$  was 11,91 ng/ml and maximum was 407,87 ng/ml with an average of 164,74 ng/ml. Hearing loss complaints were found in student (2%). Complaints of tinnitus and vertigo were not found. Statistical tests with Pearson correlation between TNF  $\alpha$  levels in serum with a hearing threshold value at 4000 Hz frequency showed that the SD 116,60 and  $p=0.17(p>0.05)$ . There is not a strong relationship between TNF  $\alpha$  levels and the hearing threshold at 4000 Hz frequency after gunshot exposure in SPN East Java students.

**KEY WORDS :** Acoustic Trauma, TNF  $\alpha$ , Hearing Threshold Level At Frequency 4000 Hz

### INTRODUCTION

Sensory neural hearing loss (SNHL) is a hearing impairment occurred in an individual who exposed by gunshot and causing acoustic trauma for the shooters. Pure tone audiometry test in acoustic trauma will reveal a SNHL, accompanied by notch or elevated hearing threshold at 4000 Hz frequency (Dobie, 2014; Sasongko, 2015; Purnami *et al*, 2017). Shooting training is one of study curriculum in Sekolah Polisi Negara (SPN). Acoustic trauma post

gunshot exposure incidence quite high in SPN students, a study conducted in 100 SPN East Java student shows 15 % incidence of acoustic trauma (Purnami *et al*, 2017). Another study conducted in 100 SPN Bali shows 11% incidence of trauma acoustic (Mahardana, 2008) Prevention of acoustic trauma in SPN done by using ear plug, however the practice remain not routinely used. Ear plug also ineffective to reduce the exposure intensity, because it only reduced 8 to 25 dB intensity, so they require another method to prevent the development of

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acoustic trauma post gunshot exposure (Mahardana *et al.*, 2008; Krug *et al.*, 2015).

Cochlear damage caused by noise exposure with high frequency and intensity focused at 4000 Hz frequency. Approximately 10 mm from foramen oval located an area with a fragile anatomy structure and the receptor of 4000 Hz, it's the hair cell with the greatest amplitude who also received the greatest force from noise exposure. This area was the locus minoris in the organ of corti. High intensity of noise exposure at higher frequency will induce damage on basal part of the hair cell, whereas lower frequency will induce damage on apical part of hair cell (Dobie, 2014). Tonotopic difference of basal to apical cochlear including outer hair cell (OHC) viability, vascularization, intrinsic vulnerability of basal hair cell towards free radical which causing basal receptor sensitive to damaged. Antioxidant level in the basal part also lower compared to the apical, thus, damage caused by high frequency will be easier to occur in the basal part (Vonllberg, 2011).

Gunshot noise would damaging organ of corti, stereocillia, and hair cell of the cochlea so may inhibit the sound transduction process. Noise may result in cellular stress which will trigger *chaperon* activity and activating the inflammation signaling pathway (Wang, Hirose, Liberman, 2002).

Noise exposure inducing cellular stress and activating inflammation pathway, TNF  $\alpha$  molecule as a chemotic factor act which recruiting monocyte into inflammation area, so inflammation cell will accumulated. Experimental study using rat model demonstrate an increased TNF  $\alpha$  expression in response to increased noise exposure (Purnami, 2009).

Relation between TNF  $\alpha$  level with hearing threshold at 4000 Hz become a reason to give anti-inflammatory drugs to prevent acoustic trauma. Until this day, relation between TNF  $\alpha$  level and hearing threshold at 4000 Hz frequency after gunshot exposure SPN East Java remain unknown.

Administration of anti-inflammatory drug becoming a trend, because SNHL may present at all age, and may become a global problem that need an attention (Haryuna, 2013).

## MATERIALS AND METHODS

This study was analytic observational with retrospective cross sectional approach using secondary data from medical record of student from

SPN East Java 2017/ 2018 generation. This study conducted in Sekolah Polisi Negara East Java, the data collected from SPN East Java students' medical record including history, physical examination, pure tone audiometry test, and TNF  $\alpha$  level. This study starts from Augusts 2018 until November 2018. The study population was the students from SPN East Java from 2017/ 2018 generation. The study sample was the study population who meets the inclusion and exclusion criteria, this study using simple random sampling. Inclusion criteria including a complete medical record, which consist of history, physical examination, audiogram, TNF  $\alpha$  level results. The exclusion criteria including tympanic membrane perforation/ ruptured tympanic membrane, TNF  $\alpha$  result cannot be assessed. Total sample calculation based on equation from Madiyono, *et al* (Madiyono *et al*, 2014).

The sample used in this set was 50 sample. Sampling method using simple random sampling from total population based on the minimal amount of sample. Tools in this study including medical record data, data collection paper, stationary, calculator, and computer. Independent variable of this study is TNF  $\alpha$  level. Dependent variable of study is hearing threshold at 4000 Hz frequency.

The Sample is student medical record data of SPN East Java 2017/ 2018 generation who undergo shooting training for 5 month. Every student performing 40 times shootings in 1 month. In total for 5 month, each student performing 200 time shootings, 100 times using long gun and 100 times using pistol. Shooting training performed in group with each shooters distances is short and held for 1 hour long, one group consist of 20 students. Ear plug not routinely used. The test including history taking, physical examination, pure tone audiometry, and TNF  $\alpha$  level measurement which is conducted in 2 weeks after the last shooting training session.

Hearing threshold level defined as the minimal pure tone sounds intensity that can be heard at certain frequency. Gunshot exposure may cause SNHL hearing impairment accompanied with notch at 4000 Hz frequency. Pure tone audiometry test performed 2 weeks after the last session of gunshot exposure. Pure tone audiometry used in this study are the result from the worst ear sides. The test performed in a quiet room which available in SPN, sound level meter result of the room was 40 to 45 dB. Audiometer used in this study was Interacoustic type AD226 which calibrated. Sound level meter and pure sound audiometry test done by expert

from RSUD Dr. Soetomo Surabaya.

TNF  $\alpha$  is a substance that demonstrate cellular stress which activating inflammation pathway in cell and can be used as biomarker of inflammation process. The higher the TNF  $\alpha$  level presenting a greater inflammation process. TNF  $\alpha$  level measured is TNF  $\alpha$  serum using Enzyme Linked Immunosorbent Assay (ELISA) method with human TNF  $\alpha$  ELISA kit reagent from Elabscience with catalog number No E-EL-H0109. Blood regiment taken 2 weeks after the last gunshot exposure and TNF  $\alpha$  level measured in Pathology installation of RSUD Dr. Soetomo Surabaya. Measurement result interpreted by senior clinical pathologist (consultant). The result of TNF  $\alpha$  level measurement presented in pg/ml unit.

All collected data in data collection paper listed in a table and then analyzed using descriptive and analytic method. Processing and analyzing data using software in computer. Descriptive data presented in frequency table including patients' age, gender and symptoms.

Statistical test to analyzing the relationship between TNF  $\alpha$  level and hearing threshold at 4000 Hz frequency using Pearson correlation test. Significance in this study determined by ( $\alpha$ ) value 0.05.

**RESULTS**

Basic data collected in this study including age, gender and symptom. All student in this study are male. Age distribution in this study presented in Table 1 below.

**Table 1.** Age distribution of SPN East Java students

Age (years)	Frequency (n)	Percentage (%)
18	4	8%
19	18	36%
20	21	42%
21	7	14%
Total	50	100

Youngest student is 18 years old while the oldest is 21 years old with mean 19,62 years old and standard deviation 0,83. The most frequent student is 20 years old , with 21 student (42%) and the least is 18 years old with 4 students (8%).

Student symptom distribution in this study presented in Table 2 below.

Most student didn't feel any symptom, except students who experiencing hearing loss (2%), and

**Table 2.** Symptom distribution of SPN East Java student

Symptom	Frequency (n)	Percentage (%)
Hearing Loss	1	2%
Tinnitus	0	0%
Vertigo No symptom	0	0%
Total	49	98%
	50	100

neither in this study experiencing tinnitus and vertigo.

TNF  $\alpha$  result and hearing threshold at 4000 Hz frequency, presented in Table 3.

**Table 3.** Distribution of TNF  $\alpha$  level and hearing treshold at 4000 Hz frequency in SPN East Java students.

	TNF $\alpha$ ng/mL	NAD Freq 4000 Hz dB	
N	50	50	
Mean	164.74	31.5	
Median	124.6	30	p=0.17
SD	116.60	13.4	
Minimum Value	11.91	5	
Maximum Value	407.87	65	

\*\* Correlation is not significant at the 0.17

The minimum level of TNF  $\alpha$  is 11.91 ng/ml and the maximum is 407.87 ng/ml, with mean 164.74 ng/ml, SD 116.60 ng/ml. The hearing threshold at 4000 Hz frequency result in this study reveals the minimum level is 5 dB and maximum level is 65 dB with mean 31.52 dB and standard deviation 13.47.

Correlation analysis between TNF  $\alpha$  level with hearing threshold at 4000 Hz frequency after gunshot exposure in SPN East Java students using Pearson correlation test in consequence to distribution test result with normal distribution .Statistical test result using Pearson correlation test reveals a not significance relation between TNF  $\alpha$  level and hearing threshold at 4000 Hz frequency (p = 0.17).

**DISCUSSIONS**

The data collected in this study including age, gender, and symptom. The youngest student in this study is 18 years old and the oldest is 21 years old. The most frequent age is 20 years old with 21 students (42%) and mean 19.62 with standard deviation 0,83 (Table 1). Studies conducted by Sasongko (Sasongko, 2015). Mentioning the youngest population in his study is 19 years old and



the oldest is 22 years old with mean 20.8 years old and standard deviation 0.90. Hidayati<sup>12</sup> mentioning id SPN is a student which graduated from senior high school student / equal who aged 17 to 22 years old. Sample in this study was SPN student who graduated from senior high school / equal with age ranging between 18 to 21 years old. The mean age in this study almost similar with prior studies, because the freshmen from SPN and TNI trooper are the same, which is 17 to 22 years old.

In the gender, all study samples are male (100%). Another previous studies, by Mahardana, *et al.* (2008), all samples are male, and Sasongko, *et al.*, (Sasongko, 2015) his study and the previous sample studies are male, this happened because all SPN East Java students are male.

In this study, hearing loss experienced by 1 student (2%), and no student experiencing tinnitus nor vertigo (Table 2). Moon, *et al* (Moon, 2011) state the most common symptom experienced after gunshot exposure was tinnitus, with 63 sample (94.2%). Ghasemi, *et al.*, (Ghasemi, 2012) evaluated 40 military soldier after exposure and 1 week after exposure resulting 53% experiencing tinnitus, 32% experiencing vertigo, and 20% experiencing hearing loss. Re-evaluation in 1 week after exposure resulting in an improvement of the symptom with only 7,5% experiencing tinnitus, 7,5% experiencing hearing loss, and no vertigo symptom. Rezaee *et al.*, (Rezaee, 2012) in his study conclude that most of the patient complaining tinnitus rather than hearing loss and vertigo.

Noise exposure inducing cellular stress and activating inflammation pathway, TNF  $\alpha$  molecule has a role as chemotic factor which recruiting monocyte to the inflammation area, causing accumulation of inflammatory cell. Symptom presented in this study differ from previous studies, this differences possibly caused by sampling time. This studies sampling conducted 2 weeks after gunshot exposure resulting in TTS on most of the student, regeneration of stereo cilia already occurred whereas support the resolution of tinnitus, hearing loss, and vertigo symptom. Permanent threshold shift (PTS) found 1 student (2%).

The minimal level of hearing threshold at 4000 Hz frequency in this study is 5 dB while the maximum level is 65 dB with mean (SD) 31.52 dB (13.47) (Table 3). Studies conducted in Turkey reporting mean (SD) of SNHL accompanied by notch at 4000 Hz frequency in intensity lower than 20 dB is 37.5 dB (17.5) (Cetin, 2008). Damage in basal

hair cell may be caused by high intensity noise exposure at high frequency, while damage of apical hair cell may be caused by high intensity noise exposure at low frequency.

Difference between basal and apical hair cell damage may be caused by tonotopic difference in basal and apex area of cochlea including outer hair cell viability, vascularization, intrinsic vulnerability of basal hair cell to free radical which causing basal receptor become more sensitive to damage. Antioxidant level in the basal part also lower compared to the apex, in consequence, damage from higher frequency occurred easily in the basal (Vonllberg, 2011). The mean result of hearing threshold level in this study are increased, similar with previous studies. This study and previous studies demonstrate an increased hearing threshold level at the high frequency, especially at 4000 Hz frequency.

This study results demonstrate a decreased hearing threshold at 4000 Hz frequency which indicating acoustic trauma in 28 students (56%). Studies conducted by Mahardana *et al.*, (Mahardana *et al.*, 2008) among 100 SPN Singaraja student showing 11% of acoustic trauma incidences. In 2001, studies conducted in among Brimob trooper, SPN student and Poltabes troops demonstrate 16.67% incidences of acoustic trauma (Budiyanto, 2003). Previous study among 100 SPN Mojokerto Surabaya student show 15% rate of acoustic trauma (Sasongko, 2015). Acoustic trauma incidences in this study much higher than in the previous studies, this possibly caused by the number of exposure. Studies conducted in Bali, performing examination after 1 shooting training session, previous studies in SPN east java reported if the test carried out ater 12 shooting training session. This studies carried out the test after 20 shooting training session.

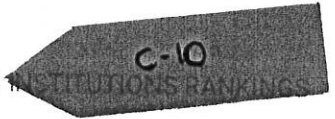
Correlation analysis between TNF  $\alpha$  level with hearing threshold level in this study using Pearson correlation test because the data used in this study are in ratio scale. Normality test using scatter plot diagram resulting in normally distributed data. Statistical result from Pearson correlation test in this study shows no significance correlation between TNF  $\alpha$  level and hearing threshold level ( $p = 0.17$ ). This result in contrast with Purnami N (Purnami, 2009) studies which result in an increased TNF  $\alpha$  expression after noise exposure. This may result as bias, the last exposure time and sampling time has a long distance, in consequence, the inflammation process marked with TNF  $\alpha$  expression may

undergone resolution, ultimately the TNF  $\alpha$  level becoming normal again.

In conclusion, there's no relationship between TNF  $\alpha$  and hearing threshold at 4000 Hz frequency post gunshot exposure in SPN East Java students.

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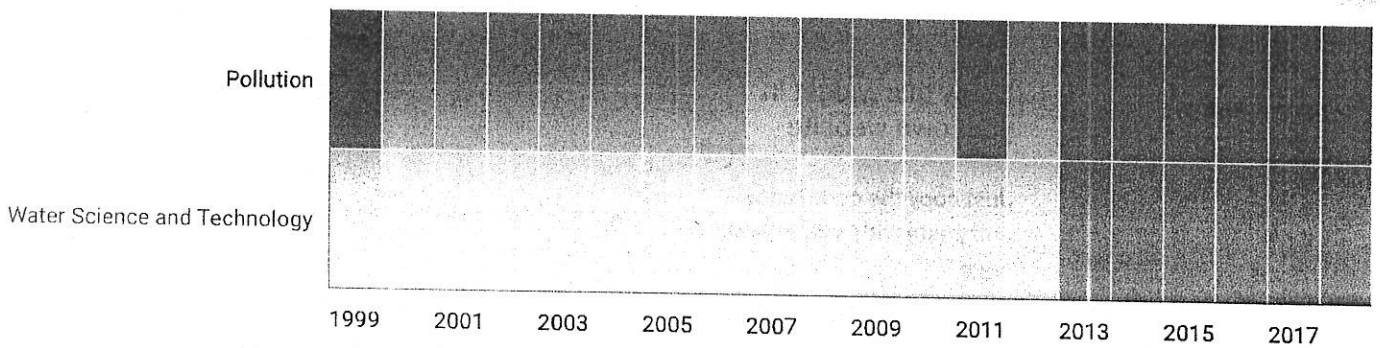
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