A STUDY OF THE HEARING IN THE ROYAL THAI NAVY CADETS OF ROYAL THAI NAVAL ACADEMY

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Thesis

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A STUDY OF THE HEARING IN THE ROYAL THAI NAVY CADETS OF ROYAL THAI NAVAL ACADEMY.

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ABSTRACT

The purpose of this research was to study the effects of gunfire impulse noise on the hearing of 572 Royal Thai Navy Cadets of the Royal Thai Naval Academy. Audiometric measurements were conducted in 1st –5th year class cadets. The results showed 8.04% of cadets had SNHL, 91.96% had normal hearing, and neither conductive hearing loss nor mixed hearing loss were found.

Audiologic analysis in 46 SNHL cadets showed a notch at frequency of 6,000 Hz more than other frequencies. All of the SNHL cadets were R2 type by Wisuthipat's classification. Most of them had unilateral hearing loss (76.09%), and hearing loss occurred in the left ear more than the right ear.

The compound factors that related to hearing loss in this study were related to the class of cadet. This study found that being in the higher class in the 1st –3rd year class cadets had a direct relationship with hearing loss. Other factors e.g. history of ear diseases, history of noise exposure before being a cadet, knowledge of the ear and danger from noise exposure and using ear protectors had no relation with SNHL cadets. Furthermore, this study found that most of the cadets had insufficient knowledge of the ear and danger from noise exposure.

Most of the cadets always used ear protectors (89.68%). The kinds of ear protectors that they used were finger (76.9%), cotton (76.6%) and tissue (50.2%) respectively. These kinds of ear protectors were low efficiency to attenuate loud sound.

The results of this study could be used to develop guidelines for the prevention of hearing loss in The Royal Thai Navy Cadets.

KEY WORDS: NOISE-INDUCED HEARING LOSS / IMPULSE NOISE

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อศึกษาผลกระทบของเสียงดังต่อการได้ยินของนักเรียนนายเรือที่สัมผัสเสียงดังจากการฝึกวิชาทหารภาคปฏิบัติ โดยทำการตรวจการได้ยินของนักเรียนนายเรือชั้นปีที่1-5 จำนวน 572 นาย ผลการศึกษาพบอุบัติการณ์การสูญเสียการได้ยินแบบประสาทหูเสื่อมร้อยละ 8.04 มีระดับการได้ยินปกติทุกความถี่ร้อยละ 91.96 ไม่พบการได้ยินผิดปกติแบบทางนำเสียงเสื่อมและแบบผสม

การวิเคราะห์ผลการตรวจการได้ยินของนักเรียนนายเรือที่มีการสูญเสียการได้ยินแบบประสาทหูเสื่อมจำนวน 46 นาย พบว่าระดับการได้ยินเสื่อมที่ความถี่ 6,000 Hz มากกว่าความถี่อื่น ลักษณะกราฟการได้ยินเป็นแบบประสาทหูเริ่มเสื่อมชนิด R2 มากที่สุด (ตามแบบ WISUTHIPAT'S CLASSIFICATION) ซึ่งเป็นลักษณะกราฟการได้ยินแบบปกติในหูหนึ่งข้างและการได้ยินแบบประสาทหูเริ่มเสื่อมในหูอีกหนึ่งข้าง นอกจากนี้ ผลการศึกษายังพบว่ามีการสูญเสียการได้ยินในหูข้างซ้ายมากกว่าหูข้างขวา

การเกิดการสูญเสียการได้ยินแบบประสาทหูเสื่อมของนักเรียนนายเรือมีความสัมพันธ์กันโดยตรงกับชั้นปีโดยเฉพาะในนักเรียนนายเรือชั้นปีที่ 1-3 ปัจจัยที่ไม่มีความสัมพันธ์กับการเกิดการสูญเสียการได้ยินแบบประสาทหูเสื่อม ได้แก่ ประวัติโรคหู, ประวัติการสัมผัสเสียงดังก่อนเข้าเป็นนักเรียนนายเรือ, ความรู้เกี่ยวกับโรคหูและอันตรายจากการสัมผัสเสียงดัง และการใช้อุปกรณ์ป้องกันเสียงดัง นอกจากนี้ยังพบว่า นักเรียนนายเรือส่วนใหญ่ยังขาดความรู้เกี่ยวกับเรื่องหูและอันตรายจากการสัมผัสเสียงดัง

การศึกษาเรื่องการใช้อุปกรณ์ป้องกันเสียงดังพบว่า นักเรียนนายเรือส่วนใหญ่มีการใช้อุปกรณ์ป้องกันเสียงอย่างสม่ำเสมอร้อยละ 89.68 อุปกรณ์ป้องกันเสียงดังที่นักเรียนนายเรือส่วนใหญ่เลือกใช้คือ นิ้วมือ (76.9%), สำลี (76.6%) และกระดาษทิชชู (50.2%) ซึ่งเป็นอุปกรณ์ป้องกันเสียงที่มีประสิทธิภาพต่ำ

ผลการศึกษาครั้งนี้ใช้เป็นแนวทางในการป้องกันการเกิดประสาทหูเสื่อมในนักเรียนนายเรือต่อไป

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CHAPTER I
INTRODUCTION

Noise is often defined as unwanted sound (1,2). It has been reported to have many effects on people working in industry, commercial, transportation, military and daily living (3,4,5,6). The known effects of noise exposure are of two types: non-auditory effects, which influence human behavior. Auditory effects, which consist of temporary or permanent hearing loss (1).

Exposure to noise constitutes a health risk. There is sufficient scientific evidence that noise exposure can induce hearing impairment, hypertension and ischemic heart disease, annoyance, sleep disturbance, and decreased school performance. For other effects such as changes in the immune system and birth defects. Most public health impacts of noise were already identified in the 1960s and noise abatement is less of a scientific but primarily a policy problem (7).

Noise induced hearing loss is a significant occupational problem in both industrial and military working environments and has been recognized as such for many years. It can, however, be prevented by protecting the ear from excessive exposure through the use of engineering and/or administrative controls. One of the approaches that can be taken to encourage the limiting of noise exposure is to develop and enforce strict hearing damage risk criteria (2).

There are many studies in the effect of noise on hearing among pilots and military personnel who engaged in gunfire. Taylor and William (8) studied in the sport shooters of the sport-shooting club and found that the hearing loss at high frequency was 56.31%. Salmivalli (9) studied the noise exposure of persons in force who work in various units. The sensorineural hearing loss was found to be 57.20%, other ear disease was 9.6%. Bentzen (10) found that the conscript in Norway had sensorineural hearing loss at high frequency 6%. Hepler et al. (11) mentioned the examination of hearing in U.S.Armed Forces in 1975 of many services and arms who took in war for 2 years or more. He found that the loss in hearing was 20-30%. When time on active duty was 1.5-2.4 years,artillery man had hearing loss 13.0% and armoured man had hearing loss 9.0%. Infantryman had hearing loss11.5% when the period of military service ranged from 2.5 to 7.4 years; the loss of hearing was 22.5% for artilleryman, 21% for armoured man and 20% for infantryman. Walden Prosek and Worthington (12) examined the sound perception of various services and arms of conscript. They found that the hearing declination was 20-30%. Olaison Lahikainen and Salmivalli (13) studied the hearing of the conscript of Sweden and Finland and found that the declination of hearing was 10-15%. Ylikoski (14) studied the hearing of 312 the conscript in Finland. All subjects had the ear declination in time of active service. The results showed that the hearing declination was in high frequency region (more than 2000 Hz) 75% and the hearing declination in speech frequency was 25%. Charakorn (15) studied in 91 sport shooters of the sport shooting club and found that the hearing impairment was 9.34%, moderate hearing loss 1.1%, mild hearing loss 8.24%. Harnchumpol (16) studied the prevalence of sensorineural hearing loss of 115 the shooting trainer of the home guard, artillery anti-aircraft division and the 11th infantry regiments. The results showed 64.35% of subjects were hearing loss. Kasetvetin (17) studied the effect of gunfire impulse noise in 1213 Thai Army Cadets of Chulachomklao Royal Military Academy who exposed to noises from military training. The results showed that the prevalence of sensorineural hearing loss was 18.97% conductive hearing loss, mixed hearing loss and malingering hearing loss were found 0.8% each, normal hearing was 80.79%. Pruegsanusak (18) studied the effect of gunfire impulse noise in 638 cadets (1st-5th year class) The Royal Thai Air Force Cadets. The results showed 10.25% of them had noise induced hearing loss, 0.58% had conductive hearing loss, 0.15% had congenital sensorineural hearing loss, and 89.02% had normal hearing. Daungrussami (19) studied the effect of noise in 262 pilots of the Royal Thai Air Force pilots who exposed to aircraft noise during flight. The results showed 59.54% of them had normal hearing 4.26% conductive hearing loss; and 36.20% sensorineural hearing loss.

The Royal Thai Armed Force is composed of The Army, Navy, and Air Force. In Thailand, the noise induced hearing loss has been studied in Army Cadets and Air Force Cadets. Only the Navy Cadets have not been studied, and they are the Cadets who were exposed to noise during field training sessions. This research aimed to study the factors that may cause hearing loss in Royal Thai Navy Cadets and suggested possible guidelines to prevent potential noise- induced hearing loss in the cadets.

The Purpose of this research:

1. To study the percentage of type of hearing of the Royal Thai Navy Cadets.
2. To study the prevalence of sensorineural hearing loss among the Royal Thai Navy Cadets.
3. To classify the type of audiogram as recommended by Wisuthipat's classification (20).
4. To investigate the factors that may induce hearing loss among the Royal Thai Navy Cadets as following
   - The duration of noise exposure e.g. class of cadet.
   - History of ear diseases.
   - History of noise exposure before being a cadet.
   - Knowledge concerning the ear and noise exposure.
   - Using ear protectors.

The expected outcome of this research:

1. To know the hearing threshold of the Royal Thai Navy Cadets.
2. To classify the type of hearing in the Royal Thai Navy Cadets.
3. To know the factors that may relate to noise-induced hearing loss among the Royal Thai Navy Cadets.
4. To develop guidelines for the purposes of educating and preventing danger from noise exposure.

Research questions:

1. Do Royal Thai Navy Cadets who study in higher class have more chance to has noise- induced hearing loss ?
2. Do Royal Thai Navy Cadets with noise-induced hearing loss have hearing loss at frequency 6,000 Hz more than other frequencies ?
3. Do Royal Thai Navy Cadets with less knowledge concerning the ear and noise exposure have more noise-induced hearing loss ?

4. Do Royal Thai Navy Cadets who don't use ear protectors have noise-induced hearing loss more than those who always use ear protectors ?

Definitions in this research:

Royal Thai Naval Academy (RTNA): The one of institute for the Royal Thai Armed Force which to produce commission officers to the Royal Thai Navy.

Royal Thai Navy Cadet (RTNC): The male cadets who study in RTNA and they learn curriculums through classroom and field training on land and sea operations throughout their five years time in the Academy.

Class of cadets: The level of a classroom which cadets are study in each academic year.

Hearing level: A measured threshold of hearing at a specified frequency, expressed in decibels relative to a specified standard of normal hearing. The deviation in decibels of an individual threshold from the zero reference of the audiometer (1).

Audiogram: A graph or table of hearing level as a function of frequency that is obtained from an audiometric examination (2).

Tympanometry: Measurement of the resistance to the flow of acoustical energy at the tympanic membrane during various pressure change; one of three measurement utilized in acoustic impedance (21).

Air conduction (AC): Transmission of sound to the inner ear through the external auditory canal and the structures of the middle ear (21).

Bone conduction (BC): Transmission of the sound to the inner ear vibration applied to the bones of the skull; allows determination of the cochlea's hearing sensitivity while by passing any outer or middle ear abnormalities (21).

Air bone gap: The difference in decibels between the hearing levels for sound as a particular frequency as determined by air conduction and bone conduction-threshold measurements (1).

Masking: The amount or process by which the threshold of audibility of a sound is raised by the presence of another (masking) sound. The unit customarily used is the decibel (1).

Normal hearing (NH): Air conduction hearing threshold of all tested frequencies should be less than or equal to 25 dB.

Conductive hearing loss (CHL): Air conduction hearing thresholds of all frequencies or some frequencies are more than 25dB and bone conduction hearing thresholds are less than or equal to 25dB. (Bone conduction better than air conduction)

Sensorineural hearing loss (SNHL): Both air conduction thresholds and bone conduction thresholds are equal but some frequency or all frequencies are more than 25 dB.

.**Mixed hearing loss (MHL):** Air conduction hearing threshold of all frequencies or at some frequencies are more than 25 dB and bone conduction hearing threshold are more than 25 dB but the threshold of bone conduction are still better than air conduction.

.**Noise- induced hearing loss (NIHL):** It is one type of SNHL in high frequency. Air conduction at frequencies 500, 1,000, 2,000 Hz has less or equal to 25 dB and at high frequencies has more than 25 dB.

Registered hearing loss (RHL): This type of hearing loss was classified by Wisuthipat (20). It was divided into 5 types e.g. R1, R2, R3, R4, and R5. (See in chapter II)

CHAPTER II
LITERATURE REVIEW

This chapter focused on topics as follows : anatomy and physiology of the human ear, classification of hearing loss, effects of noise on human, histo-pathology of noise-induced hearing loss, ear affected, pattern of audiogram, prevalence of hearing loss, compound factors of noise-induced hearing loss, and hearing protection.

1. Anatomy and Physiology of the Human Ear

The organ of hearing consists of three distinct compartments or regions, These regions are termed the outer ear, the middle ear, and the inner ear (1).

The outer ear includes the external cartilaginous part of the ear (the auricle or pinna) and the ear canal (meatus acusticus). The outer portion of the ear canal usually has one or two bends. The cross section is generally oval and its area typically 1 cm^2. The ear canal is closed at one end by the eardrum (tympanic membrane). The wall of the ear canal contains glands which secrete ear wax (cerumen) (22).

The outer ear is the channel by which sounds from the environment are first introduced to the hearing mechanism (23). It boots or amplifies high frequency sounds. The resonant frequency is approximately 2,500 Hz, while that of the concha is roughly 5,000Hz. The resonance of these cavities is such that each structure increases the sound pressure at its resonant frequency about 10-12dB (24).

The middle ear is normally filled with air. Neutral air pressure in the middle ear is maintained by the eustachian tube, which connects the middle ear to the throat (pharynx). In the middle ear cavity there are three small bones called the ossicles ; these are the malleus , the incus , and the stapes. This chain of bones forms a lever mechanism, which conducts the vibrations of the air in the ear canal to the fluids of the inner ear. Two small muscles, the stapedius and the tensor tympani, are attached to the bones. A reflex activates these muscles when loud sounds reach the ear. When activated, they will impede the transmission of sound through the middle ear bones and there by protect the inner ear. The activity of the middle ear muscles is controlled by the acoustic reflex and can be monitored by impedance audiometry (22).

The middle ear's function is to increase energy through the use of leverage, the step-down size ratio provided by the ossicular chain, and the areal ratio between the tympanic membrane and the oval window (24). The contraction of the tensor tympani muscle and the stapedius muscle increased the stiffness and the damping of the ossicular chain.The response latency of this muscle reflex varies from 25 to over 100 milliseconds;consequently, it operated too slowly to provide protection against brief, impulsive sounds shorter than about 20 milliseconds (25).

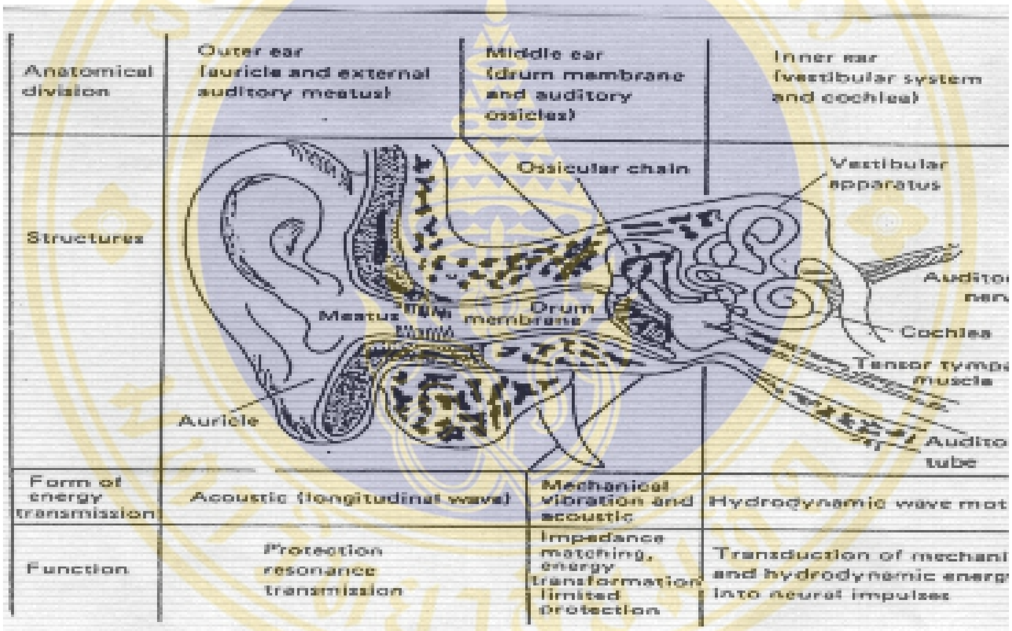


Figure 1 The anatomical divisions of the hearing mechanism and their functional roles (26)

The inner ear (cochlea) is shaped like a snail shell with two and a half turns. It is connected to the organ of balance, which consists of the sacule, the utricle and the semi-circular canals. In the lower turn of cochlea have two windows, the oval and the round windows. The oval window has a stapes footplate, which acts like a piston moving the fluid of the inner ear. All the way from the bottom to the top of the cochlea is the basilar membrane (approx. 30 mm. long) on which the hair cells are located. The hair cells are the central part of the hearing organ called "the organ of Corti". Along the basilar membrane there are four rows of hair cells, one row called the inner hair cell and three rows called the outer hair cells (21,22). The structures of the cochlear duct were showed in Figure 2.

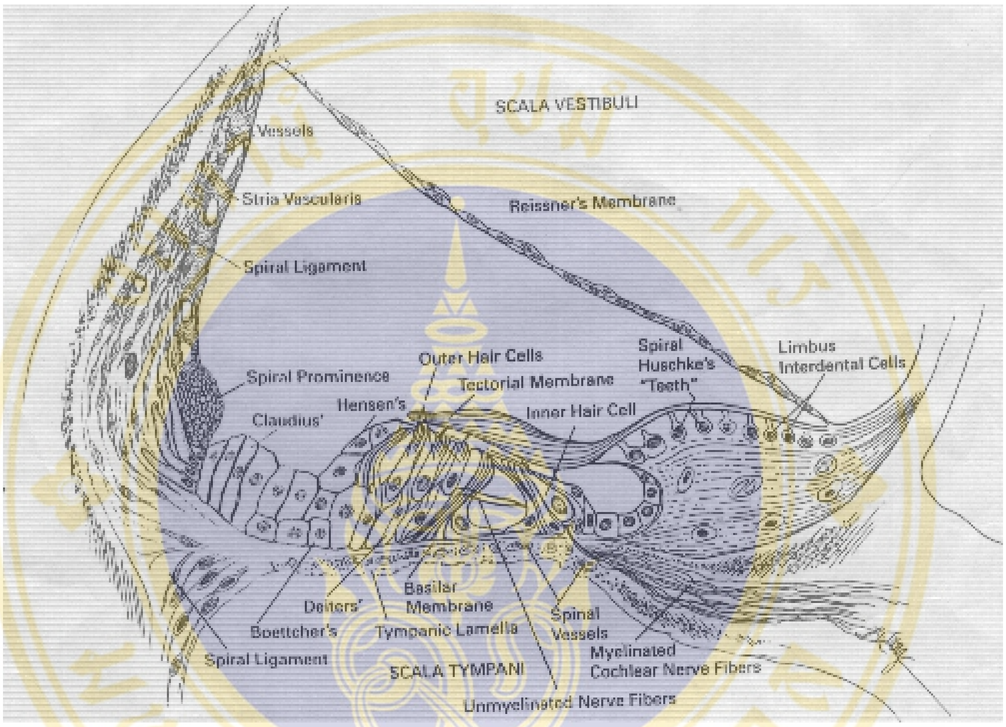


Figure 2 Structures of the cochlear duct (27)

The inner ear is a fluid-filled space interfaced between the middle ear and the auditory nerve. It acts as a device to convert sound into a form of electrochemical energy that transmits information to the brain about sound waves in terms of their frequency, intensity, and phase (23). When the oval window is moved in by the stapes, the annular ligament around the footplate stretches and displaces the perilymph at the basal end of the cochlea, propagating a wave toward the apex of the cochlea. Because the fluid of the inner ear is noncompressible, when they are displaced inward the round window membrane must yield, into the middle ear. Therefore, that the two windows are out of phase: One moves in when the other moves out. It is obvious that if they were in phase, a great deal of concellation of sound waves would take place within the cochlea, just the opposite of the desired effect.

Sound vibrations that are introduced to the scala vestibuli are conducted into the cochlear duct by the yielding of Reissner's membrane. The endolymp is thereby disturbed, and so the vibrations continue and the basilar membrane is similarly displaced, resulting in the release of the round window membrane. Therefore, sound introduced to the inner ear cause a wavelike motion, which always moves from the base of the cochlea to the apex. This is true of either air -or bone- conducted sounds. Given areas along the basilar membrane show greater displacement for some frequencies than for others. Tones of low frequency with longer wavelengths show maximum displacement near the apical end, whereas tones of high frequency with shorter wavelengths show maximum displacement near the basal end.

The basilar membrane reacts more to vibrations of the inner ear than do most of the other structures. Because the organ of corti resides upon this membrane, the vibrations are readily transmitted to it. When the basilar membrane moves up and down in response to fluid displacement caused by the in and out movement of the stapes, the hair cells are sheared (twisted) in a complex manner

The disturbances of the organ of Corti are very complex; resulting from motion of the basilar membrane in directions up and down, side to side, and lengthwise, The size of electrical response of the cochlea is directly related to the extent to which the hair cells, or the ciliary projections at their tops, are sheared. The source the electrical charge is derived from within the hair cell. When the hair cell cilia are sheared is released at the base of the hair cell (24).

2. Classification of Hearing Loss

The types of hearing loss are named according to the area of the ear that is affected. There are five types as following :conductive hearing loss, sensorineural hearing loss, mixed hearing loss, central auditory processing disorder, and functional hearing loss (23,28)

Conductive hearing loss (CHL) occurs when the outer and/ or middle ear fail to work properly. Sounds become "blocked" and are not carried all the way to the inner ear. Conductive hearing losses are often treatable with either medicine or surgery.

Common causes of conductive hearing loss are fluid build up in the middle ear or a blockage of wax in the ear canal. Children are more likely to have a conductive hearing loss than a sensorineural hearing loss (28).

Sensorineural hearing loss (SNHL) occurs when the inner ear or the actual hearing nerve itself become damaged. Sensorineural is often referred to as "nerve deafness". Nerve deafness is not a good description because the damage usually occurs within the inner ear and not the hearing nerve. SNHL may be caused by drug, toxicity, disease, aging, excessive noise, head and ear trauma, blasts, explosions and other factors (1). This type of hearing loss is usually not medically or surgically treatable (29).

Mixed hearing loss (MHL) is simple combinations of the above two types of hearing loss. It can occur when a person has a permanent sensorineural hearing loss and then also develops a temporary conductive hearing loss (29).

Central hearing loss caused by a lesion that affects primarily the central nervous system from the auditory nuclei to the cortex. Some general diseases that affected central auditory system such as encephalitis, vascular accident, brain tumors and infection etc (28).

Functional hearing loss (FHL) is the type of condition in which the patient seen to hear or to respond to any acoustic stimuli. The handicap may not be caused by any organic pathology in the peripheral or central auditory pathways. The hearing difficulty may have and entirely emotional or psychological etiology (28).

3. Effect of Noise on Human

The effect of noise on human ear can be divided into psychological and physiological response (4). Psychological response is influenced by man's perceptions, judgments, attitudes and opinions, which may be either related or unrelated to the noise itself. Physiological response, both auditory and non-auditory, involves changes in physiologic mechanisms or function attributed to the noise. Effects on auditory system of hearing function. Acoustic energy exposure can also effect the vestibular system, the autonomic nervous system, sleep and startle and induced fatigue (29,30).

Effect of noise on hearing may be divided generally into two categories: acoustic trauma and noise-induced hearing loss (NIHL). The term "acoustic trauma" is restricted to the effects of single exposure or relatively few exposures to very high level of sound (1,31). When being exposed the noise level greater than 80 dB SPL, the stapedius muscle in the middle ear starts a protective action (32,33). An extremely intense noise reaching the structures in the inner ear exceeds the mechanical limits of those structures, frequently producing complete breakdown and disruption the organ of Corti. Very intense noise exposure may also have ruptured eardrum and damage ossicles (3,33).

The term "noise-induced hearing loss" is generally referred to hearing impairment from long term repeated exposure to noise. NIHL may be either temporary or permanent. Temporary threshold shift (TTS) is a loss of sensitivity that return to normal or pre-exposure hearing levels within a few minutes to several weeks (3). With continued exposure to noise, the threshold shift become permanent. The development of permanent threshold shift (PTS) is usually gradual. (31,32,34).

4.Histo-Pathology of Noise-Induced Hearing Loss

After being exposed to moderately intense acoustic stimuli, structure changes have not been fully established but may include subtle intracellular changes in the sensory cells and swelling of the nerve ending. Others potentially reversible effects include vascular changes, metabolic exhaustion by a decrease in oxygen and energy supply to cochlea, and chemical changes within hair cells (28,35,36).

Repeated exposure to sounds that cause TTS may gradually cause permanent hearing loss. In this injury, cochlear blood flow may be impaired and a few scattered hair cells will be damaged with each exposure. With continue exposure, the number of damaged hair cells increased. Although most structures in the inner ear can be harmed by excessive sound exposure, the sensory cells are the most vulnerable. Once destroyed, the sensory cells are not replaced. Further, once a sufficient number of hair cells are lost, the nerve fibers in that region also degenerate (3,31,33).

Histological studies of human ear damaged by noise reveal diffuse degeneration of hair cells confined to the basal turns of the cochlea which maximum hair cell loss in the 10 to 12 mm region (36). Similar findings by Johnson and Hawkin (37) demonstrated the area of maximum hair cell loss, which was more severe in the 9-13 mm region of the cochlear duct. There was a greater loss of outer hair cells than inner hair cells (32,38). The region of the cochlea showing maximum damaged from noise is usually the basal turn, which is area sensitive to 3,000-6,000Hz (31,39).

4. Ear affected

Noise-induced hearing loss is generally characterized as bilaterally symmetrical. It may be asymmetrical if there is "handedness" in the source of the sound (38).

Simpson et al. (40) studied factors affecting laterality of standard threshold shift .The results showed 80% of audiometric shifts meeting Occupational Safety and Health Administration (OSHA) criteria were unilateral in a large industry. The primary factor related to unilateral OSHA shifts is asymmetric baseline hearing level; left ear is more likely to demonstrate OSHA shifts. Also, the study of aircraft noise affected on hearing in Israeli military aircrews showed the hearing threshold of left ear were poorer than right ear (41).

Kasetvetin (17) studied the effect of gunfire impulse noise on hearing of 230 Royal Thai Army cadets. Pruegsanusak (18) studied the effects of gunfire impulse noise on hearing of 70 Royal Thai Air Force cadets. Both studies showed unilateral hearing loss more than bilateral hearing loss. Hearing loss in the left ear was more common than in the right ear.

Ribak et al. (41) studied the effect of aircraft noise on hearing in Israeli military aircrews. The results indicated the hearing threshold of left ears were poorer than right ears.

Garcia and Garcia (42) studied audiometric value of 806 workers exposed to different levels of occupational noise. The results showed an increase in hearing loss with noise exposure in all frequencies, the highest loss was at frequency 4000Hz. Hearing loss in the left ear was higher than in the right ear.

Chung et al. (43) studied the lateral difference in susceptibility to noise damage from 1461 audiometric records of claims to noise-induced hearing loss. They found 4.7%(69 cases) had a well-defined pattern of hearing loss at 2,000Hz was asymmetrical and 82.6% had worse hearing thresholds in the left ear at 2,000Hz. It was believed that the asymmetry at 2,000Hz is a manifestation of a lateral difference in susceptibility to noise damage, and that the left ear is the more susceptible one in the majority of cases.

6.Pattern of Audiogram

The hearing impairment from noise exposure is sensorineural of primary cochlear origin, and the audiometric configuration characteristically reveals a notch between 3,000-6,000 Hz (28,31). In most cases, this loss initially affects hearing between 4,000 and 6,000 Hz and then spread to other frequencies (28,31,44).

Sensorineural hearing loss can be divided into 2 categories; noise induced hearing loss and registered hearing loss by Wisuthipat's classification (20). She divided into 5 patterns as following:

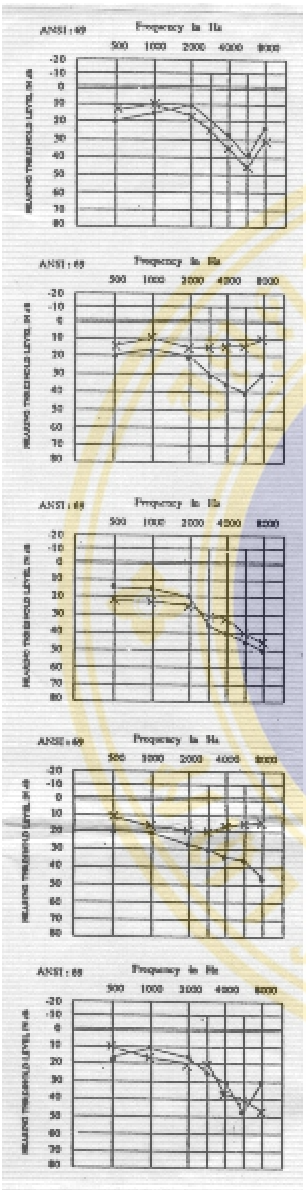
Type R1 is bilateral noise- induced hearing loss.

Type R2 is unilateral noise- induced hearing loss.

Type R3 is bilateral high frequency hearing loss.

Type R4 is unilateral high frequency hearing loss.

Type R5 is unilateral noise- induced hearing loss and unilateral high frequency hearing loss.



Type R1 is bilateral noise- induced hearing loss.

Type R2 is unilateral noise- induced hearing loss.

Type R3 is bilateral high frequency hearing loss.

Type R4 is unilateral high frequency hearing loss.

Type R5 is unilateral noise- induced hearing loss and unilateral high frequency hearing loss.

Figure 3 Registered hearing loss by Wisuthipat's classification (20)

Jasinski (45) analyzed 100 audiograms of 45 pilots and 55 non-pilots at the FAA Honolulu Aviation Medical Division. The result showed a slightly decrease in high frequency hearing at 4,000 Hz and 6,000 Hz after an accumulation of approximately 8,500 hours of flying time. The increased occurrence of hearing loss was 40 to 80 dB ranges in 4,000 and 6,000 Hz.

Fitzpatrick (46) studied noise-induced hearing loss in US Army helicopter pilots. The results showed substantial hearing loss at the high frequency (4,000-6,000 Hz).

Wu et al.(47) studied audiograms of 20 young men who were exposed to Fighter –6 ground running-up noise. They found that aircraft noise induced temporary threshold shift more than 13 dB and showed a notch or threshold shift at 6,000 Hz, not 4,000 Hz.

Kasetvetin (17) studied the audiogram of 230 RTA cadets who had sensorineural hearing loss. The average hearing threshold of them at 6,000 Hz was statistically significant more than other frequencies.

Pruegsanusak (18) studied the audiograms of 70 RTAF cadets with noise induced hearing loss. The average of hearing loss at 6,000 Hz was statistically significant more than other frequencies.

Pelausa et al (48) studied the noise-induced hearing loss in 134 Canadian military. The subjects were employed in infantry, artillery and armour that associated with high noise level. The findings showed that at 6,000 Hz notch characterized audiograms of the 3 years recall, although mean threshold values were within normal.

Daungrussami (19) studied the effects of aircraft noise on the hearing of 262 Royal Thai Air Force pilots who operated helicopters, jets and transport aircraft. The results showed that hearing loss occurred in the range of 3,000-8,000 Hz and the hearing loss revealed a notch at 6,000 Hz.

Boonpram (49) studied the effect of noise in164 army workers in the small arm ammunition factory, ordnance department. The results showed 49.16% of them had a notch of hearing loss at 6,000 Hz.

7. Prevalence of Hearing Loss

Sorasuchat et al. (44) studied the prevalence of hearing loss in 107 mechanics of aircraft at Wing 41 (Chiang Mai). They found 45.79% of them had sensorineural hearing loss.

Filzpatrick (46) studied noise-induced hearing loss in 178 US Army helicopters pilot as recommended by USAF standard. He found 8.4% of population suffered from hearing loss, and 29.7% of the subject demonstrated a loss of hearing at high frequency when classified by significant threshold shift.

William (8) studied in the shooting sporter of the shooting club and found that the hearing loss at high frequency was 56.31%

Salmivalli (9) studied the noise exposure of persons in force who worked in various units. The sensorineural hearing loss was found to be 57.20% and 9.6% were other ear disease.

Bentzen (10) found that 6% of the conscript in Norway had sensorineural hearing loss at high frequency.

Hepler et al. (11) mentioned the examination of hearing in U.S. Armed Forces in 1975 of many services and arms, who took in war for 2 years or more, he found that hearing loss was 20-30%. When time on active duty was 1.5-2.4 years, artilleryman had hearing loss 13.0%, armoured man 9.0% and infantryman 11.5%. When the period of military service ranged from 2.5-7.4 years, artilleryman, armoured man and infantryman had hearing loss 22.5%, 21% and 20% respectively.

Olaison and Salmivalli (13) studied the hearing of the conscript of Sweden and Finland and found that declination of hearing was 10-15%.

Ylikoski (14) studied the hearing of the conscript in Finland who's in the time of active service. The results showed that the hearing declination in high frequency region (more than 2,000 Hz) was 75% and the hearing declination in speech frequency was 25%.

Charakorn (15) studied in 91 sportshooters of the sportshooting club. The results showed that the hearing declination was 9.34%, 1.1% had moderate hearing loss and 8.27% had mild hearing loss.

Harnchumpol (16) studied the prevalence of hearing loss in 115 shooting trainer of the home guard, artillery anti-aircraft division and the 11th infantry regiment. The results showed 64.35% of subjects had abnormal hearing.

Kasetvetin (17) studied the effect of gunfire impulse noise in 1213 Royal Thai Army Cadets of Chulachomklao Royal Military Academy whom exposed to noise from military training. The results showed that the prevalence of sensorineural hearing loss was 18.97%, each group of conductive hearing loss, mixed hearing loss and malingering hearing loss were 0.8% and 80.79% had normal hearing.

Pruegsanusak (18) studied the effect of gunfire impulse noise in 638 The Royal Thai Air Force Cadet. The results showed 10.25% of them had noise induced hearing loss, 0.58% had conductive hearing loss, 0.15% had congenital sensorineural hearing loss, and 89.02% had normal hearing.

Daungrussami (19) studied the effect of noise in the Royal Thai Air Force pilots whom exposed to aircraft noise during flight. The amounts of samples were 262 pilots (from the branch of Royal Thai Air Force's office a province of Thailand). The results showed 59.54% of them had normal hearing, 4.26% had conductive hearing loss and 36.20% had sensorineural hearing loss.

Boonpram (49) studied the prevalence of sensorineural hearing loss among army workers in the small arm ammunition factory, ordnance department. The results showed 15% of the army workers had normal hearing, whereas 5% had conductive hearing loss and 80% had sensorineural hearing loss.

8. Compound Factor of Noise-Induced Hearing Loss

8.1 Characteristics of Noise

8.1.1 Intensity

The World Health Organization (WHO) recommended hazardous noise : an eight hours equivalent continuous A-weighted sound level equal to or greater than 85 dB, or intermittent noise above 115 dB, and impulse or impact noise above 140 dB peak SPL. Exposure to hazardous levels of noise exposure can result in hearing impairment. More intense noise exposure can cause more severe hearing loss (3,35).

Various kinds of gunfire produced difference in level of sound. Guild (50) measured peak sound level at the left ear was 140 dB and the right ear was 120 dB (while had shooting rifle by the right hand).

Kryter and Garinther (51) measured sound level that used in Army they found peak sound level was 159-172.5 dB and M.16 gun was 146-159 dB.

Taylor and William (8) found that peak sound level of pistol was 150-155 dB. Odess (52) measured peak sound level of pistol was 153.3-172.5 dB and peak sound level of rifle was 143.5-158.2 dB.

Charakorn (15) studied various kind of gun sound which sportshooters and found all 22 kind of gun was 88-129 dB.

Harnchumpol (53) studied kind of gun sound level in vary department he found that the sound level of M.16 gun was 115-126 dBA, H.K.33 gun was 124 dBA and rifle was over 130 dBA.

8.1.2 Type of noise

Loud noise that is hazard to hearing can be divided into 4 types as following:

1. Continuous noise or steady state noise. It could be described as continuous daily exposure in which the overall levels do not vary more than ±5 dB (54).

2. Impulse noise/ Impact noise / Non-steady. It referred as impulsive or impact noise or as blast overpressure such as that produced by weapon fire, punch presses and drop hammers. Impulse noise is characterized by a rapid rise time of not more than 35 milliseconds to a peak pressure. The total duration of a single impulse is not more than 500-millisecond (55).

3. Fluctuating noise. It referred continuous noise with rising and falling time (3).

4. Intermittent noise. It referred one or more short, transient, acoustical event that less than 0.5 seconds (3).

Jahrsdoerfer mentioned continuous noise damaged only cochlea its affected not to ear drum perforation or ossicle disruption but impulse noise (from weapons and explosives) had more high energy. Therefore impulse noise at 180 dB could damage to ear drum perforation and always occurred at Pars Tensa.

8.1.3 Duration of exposure

Prolong exposure to high intensity noise can cause hearing loss, the level of hearing loss is associated with duration of exposure (3,28,31).

Salmivalli (9) studied audiograms of 422 persons in force who worked in various units. The results showed significant relationship of the number of years to hearing loss. When worked for 0-5 years was found that 33.3% had hearing loss, 6-10 years The hearing loss was 49.1%, 11-15 year the hearing loss was 63.8%, 16-20 years. The hearing loss was 69.4% and work time over 20 year, the hearing loss was 75.3%.

Keim (56) studied audiograms of 14 military personnel before and after exposure to gunfire shooting for 10 weeks. The audiograms after gunfire shooting showed hearing loss at high frequency.

Cooper and Owen (57) mentioned prolong exposure to noise caused the level of hearing loss for 10-15 years then hearing level was less declination.

Harnchumpol (16) studied audiograms of 115 the shooting trainer. The results showed significant relationship of the number of years to hearing loss at high frequency.

Kasetvetin (17) studied the effect of impulse noise on the hearing of RTA cadets. Pruegsanusak (18) studied the effect of impulse noise on hearing of RTAF cadets. Their results showed the incidence of noise-induced hearing loss was significant with the number of years that cadets spent in academy.

8.2 Individual's Susceptibility to Noise

8.2.1 Gender

Although controversy continues over many aspects of noise-induced hearing loss, certain facts are generally agree upon. Men appear to have a higher incidence of hearing loss from noise than do women (Ewertson 1973, Surjan, Devald, and Palfavi 1973), perhaps because as a group they have greater noise exposure, base on the job and during leisure activities. Post-mortem electron microscope studied have shown loss of hair cells and their supporting structures in the basal end of the cochlea, and nerve degeneration in the osseous lamina (Johnson and Hawkins 1976). The hearing loss may be due to biological changes in the sensory cells, physical dislodging of hair cells during hyper acoustic stimulation, changes in the cochlear blood supply with consequent alterations in the function of the stria vascularis, loss of the three rows of outer hair cells, rupture of Reissnuer's membrane, detachment of the organ of Corti from the basillar membrane, or to a variety of other causes (58).

Szanto CS, Ionescu M (59) studied the influence of sex on hearing threshold levels in workers exposed to different intensity levels of occupational noise. The results showed that hearing loss occurred in males than females.

Pearson et al. (60) studied gender differences in a longitudinal study of age associated hearing loss. The results showed that hearing sensitivity decline in males than females.

Kei et al. (61) studied the effects of gender, ear asymmetry and activity status of 568 infants on various measure of transient evoked otoacoustic emissions (TEOAEs). The results indicated significant difference in a higher mean Signal to Noise Ratio. The right ear was found more the left ear. The causes of ear asymmetry were not well known and more research on the physiologic processes involves TEOAEs generation was required.

Aidon et al. (62) studied the characteristics of TEOAEs in 582 neonates without any risk of hearing impairment. The result of TEOAEs magnitude for the right ear of a neonate was statically different from those recorded in the left ear .The mean TEOAEs magnitude male ears was statically different from those recorded in female ears.

Newmark et al. (63) studied inter-aural and genders differences in 120 health newborns by TEOAEs. The results showed that the TEOAEs of the females were significant larger than those of the males. For the overall response, the emissions of were larger in the right ear both males and females. These inter-aural differences were more pronounced in male subjects than in female subjects. These findings may reflect the accumulating evidence that differences exist in efferent cochlear inhibition.

Boonpram (49) studied the effect of machinary noise in the small arm ammunition factory, ordnance department of 164 army workers. The results showed that hearing threshold in male army workers were poorer than females at some frequencies.

8.2.2 Age

Aging results in anatomic and physiologic degeneration at all levels of the auditory system. Presbycusis refers to hearing impairment associated with ages. The hearing impairment associated with presbycusis is usually bilateral and sensorineural of cochlear origin. The hearing impairment is usually a slowly progressive, affecting first the high frequencies and then the low frequencies (31).

Thawil (64) studied the prevalence of hearing loss in Thai with various age groups. Nineteen percent of subjects with hearing loss were in the 50-59 years age group, and 36% were in 60-69 years age group. The results showed a tendency for hearing loss increasing with age.

Ribak et al. (41) studied 777 audiograms of personnel in the Israel Airforce. The results showed a strong relationship between age and hearing threshold shift while flying time and aircraft type were poorly related.

8.2.3 Diseases of the Ear

The outer ear.

Some congenital malformation of the external ear do not result in hearing loss such as: auricle microtia, anotia, external ear trauma or burns. In case of atresia of the ear canal, the hearing loss is directly related to the involved area.

External Otitis is an infection that occur in the skin of the external auditory canal. They are often called fungus infections. The condition is often called swimmer 's ear because it frequently develops in persons who have swimming and have had water trapped in their ears.

Earwax in the external auditory canal, as in the case of external otitis, the amount of hearing loss produced by impacted earwax is directly related to the amount of ear canal occlusions.

Perforation of the tympanic membrane, the amount of hearing loss produced by a perforated tympanic membrane depends on several variables. It may become perforated in several ways. Excessive pressure buildup during a middle ear disorder may cause rupturing of the membrane. Sometimes in response to infection, usually in the middle ear, the membrane may become necroses and perforated.

The middle ear

Abnormalities of the structure or function of the middle ear result in conductive hearing loss, wherein the air conduction thresholds are depressed in direct relationship with the amount of pathology. Bone conduction thresholds are only slightly deviated from normal in conductive hearing loss, not because of abnormality of the sensorineural mechanism, but because of alterations in the middle ear's normal (inertial) contribution to bone conduction hearing.

Otitis media is any infection of the mucous membrane lining of the middle ear cleft. Generally, the amount of hearing loss is directly related to the accumulation of material in the middle ear.

Cholesteatoma is a pseudotumor in the middle ear cleft. Cholesteatomas form as a sac with onionlike concentric rings made up of keratin (a very insoluble protein) mixed with squamous (scaly) epithelium and with fats such as cholesterol. In patients with perforated tympanic membranes, the skin may enter the middle ear through the perforations.This invasion produces a secondary acquired cholesteatoma.

Otosclerosis is a new growth of spongy bone, usually over the stapedial footplate of one or both ears. When is happens, the footplate becomes partially fixed in the oval window, limiting the amplitudes of vibrations transmitted to the inner ear. The condition originates in the bony labyrinth of the inner ear is recognized clinically when it affects the middle ear, causing conductive hearing loss.

Eustachian tube dysfunction causes from edema of the eustachian tube secondary to infection or to allergy, or blockage of the orifice of the eustachian tube by hypertrophied (over grown) adenoids. Any condition that interferes with the eustachian tube's function of equating air pressure between the middle ear and outer ear may cause the air trapped within the middle ear to become absorbed by the tissues that line it, resulting in a drop in air pressure. When this absorption occurs, the greater pressure in the external auditory canal causes the tympanic membrane to be retracted. The retraction interferes with the normal vibration of the tympanic membrane and it may produce a slight conductive hearing loss.

A variety of middle ear abnormalities occur in isolation or in association with other congenital anomalies some cases of stapedial fixation appear purely on a genetic basis. Other ossicular abnormalities have been associated with syndromes involving the cheek, jaw, and face.

Skull fractures have been known to result coincidentally in fractures or interruptions of the ossicular chain, An ossicle may also be damaged by a foreign object during traumatic perforation of the tympanic membrane, as with a cotton swab or bobby pin.

The inner ear

Alteration in the structure and function of the cochlea produces more hearing loss than abnormalities in other areas of the sensorineural auditory system. Hearing loss may result from either endogenous or exogenous causes. For purely arbitrary reasons.

Prenatal cause

Cases of hereditory hearing loss have been documented in patients with no associated abnormalities , as well as in association with abnormalities of the external ear or skin, and with eye disease, nervous system disease, skeletal disease and a number of other physical anomalies.

Cerebral palsy has long been associated with hearing loss. Until fairly recently it was assumed that because cerebral palsy is the result of brain damage, the hearing loss is also produced by damage within the central auditory nervous system.

Probably the most dreaded viral infection is rubella, or german measles. Common results of maternal rubella are brain damage, blindness, heart defects, mental retardation, and sensorineural hearing loss. Of all the congenital abnormalities produced by maternal rubella in the first trimester of pregnancy, hearing loss is the most common (Karmody 1969). It is highly likely that virus enters the inner ear through the stria vascularis, which would explain why the cochlea rather than the vestibular apparatus is usually affected. Alford (1968) has suggested that the rubella virus remains in the tissues of the cochlea even after birth. If destruction of cochlear tissue continues, the child may experience from of progressive hearing loss.

Perinatal cause

Perinatal causes of hearing loss are those that occur during the process of birth itself. Such causes frequently multiple handicaps. A common cause of damage both to the cochlea and to the central nervous system is anoxia, deprivation of oxygen to important cell , which alters their metabolism are results in damage or destruction.

Postnatal cause

Postnatal causes of cochlear hearing loss are any factors occurring after birth.

An often named cause of cochlear hearing loss is otitis media. If the enzyme produced by the infectious process enter the cochlea by diffusion through the round window, a hearing loss may surely result. Often, patients with primarily conductive hearing loss produced by otitis media begin to show additional cochlear degeneration, resulting mixed hearing loss.

Some viral infections have definitely been identified as the causative factors in cochlear hearing loss. These infections include measles, mumps, chicken pox, influenza, and viral pneumonia, among others. The two most common hearing loss caused by virus are measles and mumps.

Toxic causes. The side effects of streptomycin, kanamycin and quinine caused annoying tinnitus and hearing loss. Other drugs that have been associated with hearing loss are aspirin, nicotin, and alcohol. It is usually expected these drugs will affect hearing unless they are taken in large amount and over prolonged periods of time.

Otosclerosis. as mentioned in prior part. If the otosclerosis is limited to the cochlea, SNHL results and may be either bilateral or unilateral.

Noise induced hearing loss. Its caused from intense noise exposure may be associated with brief exposure to high level sounds, with subsequent partial or complete hearing recovery, or with repeated exposure to high level sounds, with permanent impairment.

Meniere' s disease is cause of sudden unilateral hearing loss. The seat of the difficulty lies within the labyrinth and is characterized by sudden attacks of vertigo, tinnitus, vomiting, and unilateral hearing loss. Bilateral Meniere' s disease has been observed in 5% to 10% of the cases of aural vertigo studied. The onset of symptoms is described by many patients in the same way. The difficulty may begin with a sensation of fullness in one ear, followed by a low frequency roaring tinnitus, hearing loss with great difficulty in speech discrimination, the sensation of violent turning or whirling in space, and vomiting.

Head trauma. In cases in which a hearing loss may be directly related to injury to the head, the audiogram is frequently similar to that for acoustic trauma. Proctor (1956) has shown that, in addition to damage to the tympanic membrane and middle ear machanism, the structures of the inner ear may be torn, stretched, or deteriorated form the loss of oxygen following hemorrhage (65).

9.Hearing Protection

The most effective forms of protection from noise are isolation from noise source (66).

An effective ear protector serves as a barrier between the noise and the inner ear, where the noise-induced damage occurs. Ear protectors usually take one of two forms : the earmuff, which is worn over the external ear and provides an acoustic seal against the head ; or earplugs, which seal the entrance to the external ear canal (66).

Sound energy can reaches the inner ears of persons wearing protectors by three different paths : 1. By passing directly to the cochlea through vibration of the bones and tissues of the skull ; 2. By the vibration of the hearing protector itself, which generates sound in the canal; 3. By passing through leak in the hearing protector, or around the protector because of a poor fitting (3).

Ogden (67) studied the audiogram of shooting trainers who had shooted gunfire for 1-14 months. The subjects were divided into 2 groups. The first group didn't wear ear protectors and another group worn ear protectors. The results showed the groups who didn't wear ear protector had hearing loss at frequency 2,000-11,000 Hz (post training for 6 weeks) and the hearing threshold of group who worn ear protector had not change statistically significant.

Keim (56) mentioned that nobody who shoots gunfire had occurred hearing loss by without wearing ear protector.

Thapkaset and Thawil (68) studied the efficiency of various ear protectors. The subjects with normal hearing that were administrated hearing test at frequency range 250-8,000 Hz after wearing many kind of ear protectors (e.g. tissue, cotton, patty patch, wing earplug, non wing earplug and used bullet). The results showed that tissue could attenuate 32 dB, 43.15dB at frequency 500-2,000 Hz and 2,000-8,000 Hz respectively. Cotton could attenuate 29.44 dB, 39.54 dB at frequency 500-2,000 Hz and 2,000-8,000 Hz respectively. Patty patch could attenuate 35.97 dB, 40.89dB at frequency 500-2,000 Hz and 2,000-8,000 Hz respectively. Wing earplug could attenuate 36.6 dB, 46 dB at frequency 500-2,000 Hz and 2,000-8,000 Hz respectively. Non wing earplug could attenuate 37.64 dB, 49 dB at frequency 500-2,000 Hz and 2,000-8,000 Hz respectively. Used bullet could attenuate 60 dB, 59.17 dB at frequency 500-2,000 Hz and 2,000-8,000 Hz respectively.

Guild (50) found that earplug could attenuate 20-40 dB. He recommended to had using combination of earplug and earmuff while expose to loud sound.

Taylor and Williams (8) found that insert ear protector type could attenuate 15 dB, 21 dB at frequency 1,000 Hz, 4,000 Hz respectively.

Chykittiporn and Monthewan (69) studied the efficiency of insert ear protector type. They found that dry cotton with compress could attenuate loud sound 6-8 dB. Wax cotton could attenuate 20 dB, plastic ear protector type could attenuate 18-25 dB and earmuff type could attenuate 30-40 dB.

Pfander (70) found that earmuff could attenuate impulse noise 15-45 dB.

Cianci et al. (71) studied the efficiency of ear protector in many types at frequency 250-4,000 Hz. They found that normal cotton could attenuate 3.14 dB. Wax cotton could attenuate 10-32 dB. Plastic earplug could attenuate 11-30 dB and earmuff could attenuate 28-47 dB.

Harnchumpol (53) studied the efficiency of 6 ear protector types both import types and hand-made types by testing with 100 normal ears at frequency 125-8,000 Hz. The results showed that ear protector with five-wing type, which made from silicone material could attenuate 33.17-48.17 dB. (Especially frequency over 2,000 Hz).

Melnick (72) studied the efficiency of many ear protector types. He found that dry cotton could attenuate poorly and using combination of earmuff with earplug were more effective than one else (see in Figure 4).

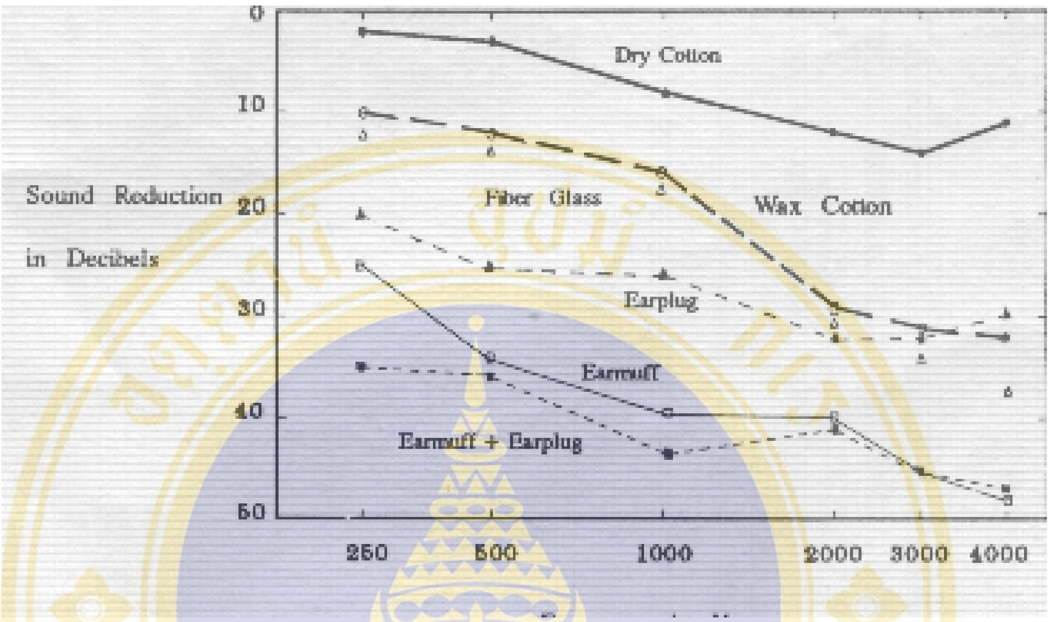


Figure 4 The effective in sound reduction of ear protectors (72)

CHAPTER III
MATERIALS AND METHODS

Subjects

The subjects served in this study were The Royal Thai Navy Cadets who were studying in academic year 2000 at The Royal Thai Naval Academy, Samuthprakan province. They were 572 male cadets whose ages ranged from 17-25 years. The hearing test was conducted from August , 2000 to December, 2000 in a quiet room at Naval hospital affiliated with The Royal Thai Naval Academy.

Instruments

1. Test room (Ambient noise 30-40 dBSPL)
2. Audiometer: Madsen Electronics model Midimate 602
3. Acoustic immittance: Amplaid model 775 calibrating to ISO 389 type 2 – IEC ANSI S3.39
4. An otoscope
5. Sound level meter: QUEST ELECTRONICS calibrating to ANSI standard 1.4 -1983 type I)
6. Questionnaires

   The questionnaires included questions regarding personnel history of hearing loss, knowledge about noise exposure and routine use of ear protectors on the field training.

Procedure

1. All RTNC had passed practical in field training session since 5 month ago (The schedule of the cadet's training sessions was showed in Appendix B).
2. The hearing test was conducted in a room that met acceptable background noise level for audiometric testing tabulated .

Table 1. The maximum allowable octave-band sound pressure levels for audiometric test rooms(73)

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure level (dB)	40	40	47	57	62

3. Each RTNC was asked to completely fill out the questionnaires.
4. Each RTNC was performed an otoscopic examination by the researcher to confirm unoccluded ear canal, no earwax and no tympanic membrane perforation.
5. Each RTNC was administered with pure tone audiometry in a quiet room. The hearing test consisted of air and bone conduction test. Weber and Rinne test was performed. The hearing threshold was determined by descending technique. The orders of test frequency were as follow: 1000, 2000, 3,000, 4000, 6000, 8000 and 500 Hz. The hearing threshold was retested at 1000Hz for test reliability. Narrow band noise masking was used when there was a difference 40 dB or more in hearing acuity between the two ears by air conduction. Pure tone bone conduction testing was performed at frequencies 500, 1,000, 2,000 and 4,000 Hz. The masked bone conduction threshold for the test ear was obtained whenever the air bone gap in the test ear exceeded 10 dB.
6.Acoustic-immittance measurement included tympanometry and the measurement of the acoustic reflex threshold was performed at frequency 500, 1000, 2000 Hz in ipsilateral ear and 500, 1000, 2000, 4000 Hz in contralateral ear.

Data analysis

In this study, the statistical package SPSS for windows was used to analyze the obtained data:

1. Percentage mean and standard deviation was used to study the prevalence of hearing loss, history of ear diseases and using ear protectors.
2. Mean and standard deviation were used to study the hearing level.
3. Chi-square test was used to study the relation between various variable.

CHAPTER IV
RESULTS

The purpose of this study was to investigate the prevalence of hearing loss of the Royal Thai Navy Cadets. The results of the study were described as follows;

1.General information

The subjects consisted of 572 cadets who passed their field training sessions. The cadets were divided in to five classes. The age's ranges were 17.8-25.1 years. The mean age was 21.4 years. (S.D.=1.59). The most of cadets were in the 3rd year class cadets (23.6%). The 4th year class cadets and the 1st year class cadets were 21.7%, 21.5% respectively. The 2nd year class cadets and the 5th year class cadets were 16.6% each. These informations were showed in Table 2.

Table 2. The number and percentage of five class cadets

Class	N	Percentage
1st year	123	21.5
2nd year	95	16.6
3rd year	135	23.6
4th year	124	21.7
5th year	95	16.6
total	572	100.0

2. Prevalence of hearing loss

Five hundred and seventy two RTNC were administered with pure tone audiometry and tympanometry. The results indicated that 91.96% of the total cadets had normal hearing (n=526) and 8.04% had sensorineural hearing loss (n=46). Neither mixed hearing loss nor conductive hearing loss was observed in this study. The prevalence of hearing loss was showed in Table 3.

Table 3. The number and percentage of the cadets hearing classification

Type of hearing	n (cases)	Percentage
Normal hearing (NH)	526	91.96
Conductive hearing loss (CHL)	-	-
Mixed hearing loss (MHL)	-	-
Sensorineural hearing loss (SNHL)	46	8.04
Total	572	100.00

From 46 SNHL cadets, it was found that most hearing loss (32.61%) occurred in the 2nd year class cadets, 30.44% occurred in the 4th year class cadets, 28.26% occurred in the 5th year class cadets, 6.52% occurred in the 3rd year cadets and only 2.17% occurred in the 1st year class cadets. These results were showed in Table 4.

Table 4. The number and percentage of the cadets with sensorineural hearing loss distributed by class

Class	SNHL (n= cases)	Percentage
1st year	1	2.17
2nd year	15	32.61
3rd year	3	6.52
4th year	14	30.44
5th year	13	28.26
Total	46	100.00

3.Audiogram analysis

3.1 Ear affected

Forty-six SNHL cadets were divided into unilateral and bilateral hearing loss. Table 5 showed the number and percentage of cadets with unilateral and bilateral hearing loss. There were 76.09% (n= 35) of unilateral hearing loss and 23.91% (n=11) of bilateral hearing loss.

Table 5. The number and percentage of the cadets with unilateral and bilateral hearing loss

Ear affected	n (cases)	percentage
Unilateral	35	76.09
Bilateral	11	23.91
Total	46	100.00

For cadets who had unilateral hearing loss 54.29% (n=19) exhibited left ear hearing loss, and 45.71% (n=16) exhibited right ear hearing loss as shown in Table 6.

Table 6. The number and percentage of the cadets with left or right ear affected

Ear affected	n(ears)	Percentage
Left ear	19	54.29
Right ear	16	45.71
Total	35	100.00

In the bilateral hearing loss (11 ears), the hearing threshold levels at 500-8,000 Hz of the left and the right ear were compared in each cadet. The results showed 81.82%(n= 9) of bilateral hearing loss cadets had symmetrical hearing loss and 18.18% (n=2) had asymmetrical hearing loss as shown in Table 7.

Table 7. The number and percentage of the cadets with symmetrical and asymmetrical hearing loss

Ear affected	n (cases)	Percentage
Symmetrical	9	81.82
Asymmetrical	2	18.18
Total	11	100.00

3.2 Frequency of hearing affected by noise.

The hearing loss occurred at the frequency of 3,000-8,000 Hz as shown in Table 8. The results showed that 47.37% (n= 27) had hearing loss at 6,000 Hz, 29.83% (n= 17) had hearing loss at 4,000Hz, 21.05% (n=12) had hearing loss at 8,000 Hz and 1.75% (n=1) had hearing loss at 3,000 Hz.

Table 8. The number and percentage of ear affected distributed by frequency

Frequency (Hz)	n (ears)	Percentage
3000	1	1.75
4000	17	29.83
6000	27	47.37
8000	12	21.05
Total	57	100.00

The group of hearing loss cadets was divided as following Wisuthipat' s classification, it was found that 65.22% of hearing loss cadets was R2 type, 15.21% of hearing loss cadets was R1 type, 10.87% of hearing loss cadets was R4 type, R3 type and R5 type were 4.35% as shown in Table 9.

Table 9. The number and percentage of SNHL cadets as follow Wisuthipat's classification

Type of Registered hearing loss	n(cases)	Percentage
R1	7	15.21
R2	30	65.22
R3	2	4.35
R4	5	10.87
R5	2	4.35
Total	46	100.00

3.3 Level of hearing loss

The mean and standard deviation (S.D.) of hearing threshold in each frequency from 500 to 8,000Hz of 46 cadets (57 ears) were analyzed as showed in Table 10. The results showed the mean level of hearing loss occurred at 6,000 Hz, 4,000Hz, 8,000 Hz and 3,000 Hz were 50.98 dB, 39.46 dB, 37.28 dB and 33.91 dB respectively. The least mean hearing threshold was 20.11dB and it occurred at 500 Hz, 1,000 Hz.

Table 10. The mean and standard deviation of hearing threshold distributed by frequency

Frequency (Hz)	500	1000	2000	3000	4000	6000	8000
Mean (dB)	20.11	20.11	22.61	33.91	39.46	50.98	37.28
S.D.	3.41	2.23	2.53	6.91	11.94	9.58	14.18

4. The relation of factors affected on hearing

4.1 Class of cadets

The mean and standard deviation of hearing threshold of 46 SNHL cadets were distributed by class of cadet were showed in Table 11. It was found that 46 SNHL cadets showed the normal hearing thresholds at frequency 500-2,000 Hz and showed mild to moderately SNHL at frequency 3,000-8,000 Hz only the 1st year class cadets were showed normal hearing threshold at frequency 8,000 Hz.

Table 11. The mean and standard deviation of hearing threshold distributed by class

Frequency (Hz) / Class (n=46)	500 mean (S.D.)	1,000 mean (S.D.)	2,000 mean (S.D.)	3,000 mean (S.D.)	4,000 mean (S.D.)	6,000 mean (S.D.)	8,000 mean (S.D.)
1st year class	20 (0)	20 (0)	20 (0)	30 (0)	45 (0)	50 (0)	25 (0)
2nd year class	19.33 (3.72)	20.00 (2.67)	22.33 (2.58)	33.00 (2.54)	39.33 (12.66)	53.00 (10.66)	35.67 (14.86)
3rd year lass	18.33 (2.89)	20.00 (0)	23.33 (2.89)	31.67 (2.89)	50.00 (17.32)	58.33 (7.64)	46.67 (15.28)
4th year lass	20.00 (3.40)	20.36 (1.34)	22.86 (2.57)	32.50 (6.12)	35.36 (11.00)	48.93 (8.59)	35.36 (15.50)
5th year class	21.54 (3.15)	20.00 (2.89)	22.69 (2.59)	37.31 (10.53)	41.15 (10.64)	49.23 (9.76)	40.00 (12.08)
Total	20.11 (3.41)	20.11 (2.23)	22.61 (2.53)	33.91 (6.91)	39.46 (11.94)	50.98 (9.58)	37.28 (14.18)

The audiogram of 46 SNHL cadets showed high frequency hearing loss above 2,000 Hz and most a notch at frequency 6,000 Hz (see in Figure 5). It was found that mean hearing threshold of the 3rd year class cadets had most hearing loss. The mean hearing thresholds were 48.93-58.33 dB.

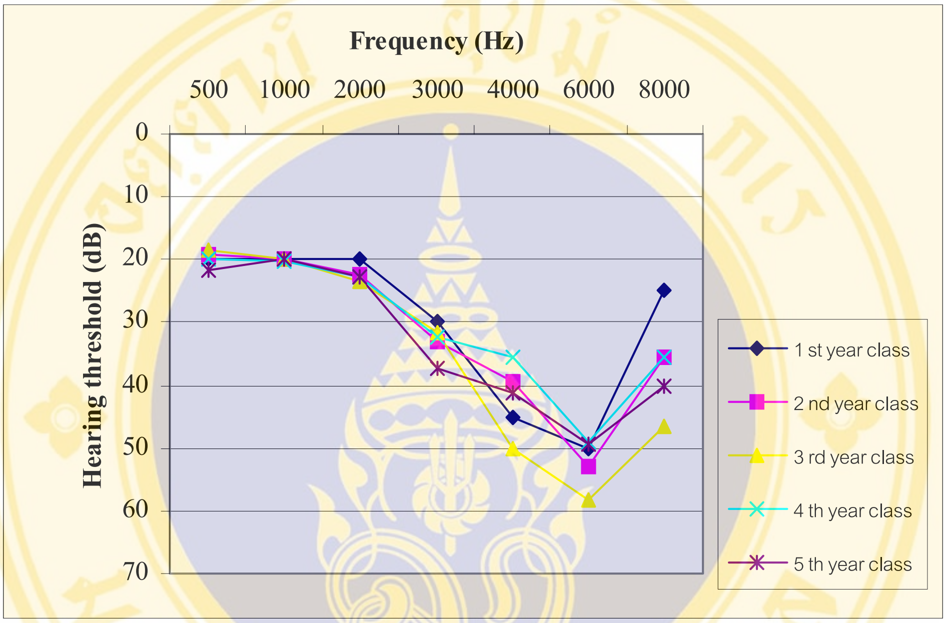


Figure 5. Composite audiogram by means hearing threshold of SNHL cadets

4.2 History of ear diseases

The correlations between history of ear diseases and type of hearing were studied by using Chi square test as shown in Table 12. The results showed that there were no correlations between them.

Table 12.The correlations between history of ear diseases and SNHL cadets

Ear disease(N=572)		Type of hearing		χ^2	df	p-value
		NH n (%)	SNHL n (%)			
Hereditary	yes	37(7.03)	3(6.52)	0.017	1	.896
	no	489(92.96)	43(93.48)			
Earache	yes	203(38.59)	10(21.74)	0.141	1	.123
	no	323(61.41)	36(78.26)			
Otorrhea	yes	38(7.22)	7(15.22)	3.729	1	.053
	no	488(92.78)	39(84.78)			
URI	yes	233(44.30)	20(43.48)	0.011	1	.915
	no	293(55.70)	26(56.52)			
Accident	yes	138(26.24)	13(28.26)	0.089	1	.769
	no	388(73.76)	33(71.74)			
Ear operated	yes	3(0.57)	-	0.264	1	.608
	no	523(99.43)	46(100.00)			
Measles	yes	90(17.11)	11(23.91)	1.346	1	.246
	no	436(82.89)	35(76.09)			
Chicken pox	yes	356(67.68)	31(67.39)	0.002	1	.968
	no	170(32.32)	15(32.61)			
Mumps	yes	147(27.95)	15(32.61)	0.453	1	.501
	no	379(72.05)	31(67.39)			
German measles	yes	20(3.80)	3(6.52)	0.811	1	.368
	no	506(91.20)	43(993.48)			
D.M.	yes	-	-	-	-	-
	no	526(100.00)	46(100.00)			
Ototoxic	yes	7(1.33)	-	0.620	1	.431
	no	519(98.67)	46(100.00)			
Vertigo	yes	146(27.76)	16(34.78)	1.029	1	.310
	no	380(72.24)	30(65.22)			

4.3 History of noise exposure before being a cadet

The correlations between history of noise exposure before being cadet and SNHL cadets were studied by Chi square test as shown in Table 13. The results showed that there were no correlations between them.

Table 13. The correlations between history of noise exposure before being a cadet and SNHL cadets

History of noise exposure before being a cadet	Type of hearing NH n (%)	SNHL n (%)	Total n (%)	χ^2	df	p-value
Yes	212(40.30)	17(36.96)	229(40.03)	.657	1	.197
No	314 (59.70)	29(63.04)	343(59.96)			
Total	526(100.00)	46(100.00)	572(100.00)			

4.4 Knowledge of the ear and danger from noise exposure

In this study, it was found that 19.40% of cadets had good knowledge of the ear and danger from noise exposure, 20.80% of cadets had moderate knowledge and 59.80% of cadets had less knowledge. The results were showed in Table 14.

Table14. The number and percentage of knowledge of the ear and danger from noise exposure in cadets

Knowledge of the ear and danger from noise exposure	N	Percentage
Good	111	19.40
Moderate	119	20.80
Less	342	59.80
Total	572	100.00

The correlations between the knowledge of the ear and danger from noise exposure with hearing loss in cadets were studied by using Chi square test as shown in Table 15. The results showed that 56.52% of SNHL cadets had less knowledge, 28.26% of SNHL cadets had good knowledge. In addition, 60.08% of normal hearing cadets had less knowledge and 18.63% of normal hearing cadets had good knowledge. It indicated that there were no correlations between them.

Table 15. The correlations between knowledge of the ear and danger from noise exposure and SNHL cadets

Knowledge of the ear and danger from noise exposure	**Type of hearing**		**Total**	χ^2	**df**	**p-value**
	NH n(%)	**SNHL n((%)**	**n (%)**			
Good	98(18.63)	13(28.26)	111(19.40)	2.861	2	.239
Moderate	112(21.29)	7(15.22)	119(20.80)			
Less	316(60.08)	26(56.52)	342(59.80)			
Total	526(100.00)	46(100.00)	572(100.00)			

4.4 Using ear protectors

The other factor that may relate to hearing loss in cadets was using ear protectors. In this study, it was found that most cadets (89.68%) always used ear protectors and cadets who didn't use ear protectors during expose to noise were only 10.32%. These results were showed in Table 16.

Table 16. The number and percentage of the cadet's using ear protectors

Using ear protectors	**n**	**Percentage**
Yes	513	89.68
No	59	10.32
Total	572	100.00

The correlations between using ear protectors with type of hearing were studied by using Chi square test as shown in Table 17. It was found that 86.96% of SNHL cadets had using ear protectors (n=40), 13.04% of SNHL cadets didn't use ear protectors (n=6). Nevertheless 89.92 % of normal hearing cadets used ear protectors (n=473), 10.08 % of normal hearing cadets didn't use ear protectors (n=53). It indicated that there were no correlations between them.

Table 17. The correlations between using ear protectors with SNHL cadets

Using ear protectors	**Type of hearing**		**Total**	χ^2	**df**	**p-value**
	NH n(%)	**SNHL n(%)**	**n (%)**			
Yes	473(89.92)	40(86.96)	513(89.69)	0.403	1	.526
No	53(10.08)	6(13.04)	59(10.31)			
Total	526(100.00)	46(100.00)	572(100.00)			

Furthermore, the results showed the kind of ear protectors which the cadets frequently used were finger 76.9% (n=440), cotton 76.6% (n=438), tissue 50.2% (n=287), sponge plug 45.3%(n=259) and earmuff 39.5%(n=226) respectively as shown in Table 18.

Table 18. The number and percentage of ear protectors which cadets used

Kind of ear protectors		**N**	**Percentage**
Finger	Yes	440	76.9
	No	132	23.1
Tissue	Yes	287	50.2
	No	285	49.8
Cotton	Yes	438	76.6
	No	134	23.4
Patty patch	Yes	99	17.3
	No	437	82.7
Used bullet	Yes	193	33.7
	No	379	66.3
Sponge plug	Yes	259	45.3
	No	313	54.7
Wing plug	Yes	153	26.3
	No	419	73.3
Ear muff	Yes	226	39.5
	No	346	60.5
Others (Wet cotton)	Yes	3	17.2
	No	569	82.8

Note: Each cadet could choose the kind of ear protector more than one type.

CHAPTER V
DISCUSSION AND CONCLUSION

This study was conducted to investigate the prevalence of hearing loss in 572 RTNC. The prevalence of hearing loss was focused on audiogram analysis and the relation factors affected on hearing loss. They were described as follows

1.Prevalence of hearing loss

In this study, audiometric measurements were administrated with 1st-5th year class cadets of the Royal Thai Naval Academy in order to investigate the prevalence of hearing loss. The results of this study were found that 8.04% of RTNC had SNHL as shown in Table 4. These findings were in an agreement with the studies of Olaison and Salmivalli (13), Charakorn (15), Pruegsanusak (18) and Fitzpatrick (46). Olaison and Salmivalli (13) found 10.15% of subjects in conscript of Sweden and Finland had SNHL, Charakorn (15) 9.34% of subjects in the sportshooters of the sportshooting club had hearing loss. Pruegsanusak (18) found that 10.25% of cadets (n=638) who study in Royal Thai Air Force Academy had SNHL. Fitzpatrick (46) found 8.4% of pilots in 178 US Army helicopter pilots as recommended by USAF standard had SNHL.

These results were difference from those studies e.g. William (8), Salmivalli (9), Ylikoski (14), Duangrussami (19) and Boonpram (49). William (8) found 56.31% of subjects in the sportshooters of sportshooting club had SNHL. Salmivalli (9) found 57.2% of subjects who worked in various units in force had SNHL. Ylikoski (14) found 75% in conscript on the time of active service in Finland had hearing loss. Duangrussami (19) found 36.20% of them in Royal Thai Air Force pilots had SNHL and Boonpram (49) found 80% in army workers in the small arm ammunition factory,ordnance department had SNHL. This may cause by those persons habitually exposed to gunfire impulse noise and blast. Therefore, exposure level and duration is sufficient to specify the hazard they had more chance to occur the hearing loss. On the other hand, the cadets had less duration of time to expose noise. They also spent the time in field training session only once a year (about 30 days). Therefore, it could possible that the prevalence of hearing loss in RTNC had less than those studies. In additions, this result indicated that the number of years to expose noise were related to the hearing loss which were in an agreement with the report in the studies of Salmivalli (9), Keim (56) and Cooper and Owen (57).

2.Audiogram analysis

2.1 Frequency affected

Type of noise which the cadets usually expose were impulse noise e.g. weapon fire, blast. Therefore more intense noise exposure the number of damaged hair cells increases (28,35). In general SNHL caused by noise exposure usually declinated in high frequency region (3,000-6,000 Hz). According to the reported by Sataloff et al. (28) after being exposed to loud noise, the hair cells in the cochlea were damaged. The region of the cochlea showing the maximum damaged from noise was usual the basal turn, which was the area at frequency of 3,000-6,000, Hz. Bess and Humes said the outer ear boosts or amplified high frequency sound about 10-12 dB. This study was found that the SNHL cadets had loss of hearing at the frequency 3,000-8,000 Hz and most of them (47.45%) had a notch at frequency of 6,000 Hz (see in Table 8). These findings were in an agreement with the studies of Kasetvetin (17), Pruesanusak (18), Duangrussami(19), Jasinski (45), Fitzpatrick(46), Wu et al (47), Boonpram (49) and Keim (56).

2.2 Ear affected

The results in Table 6 showed that 76.05% of RTNC were unilateral hearing loss. It occurred at the left ear (54.28%) more than the right ear (45.71%). In the group of bilateral hearing loss (23.90%) there were 81.82% of them had symmetrical hearing loss and 18.18% of them had asymmetrical hearing loss (see in Table 7). These findings were in an agreement with the study of Kasetvetin (17) who studied in 1213 Thai Army Cadets of Chulachomklao Royal Military Academy. Pruegsanusak (18) who studied in 638 Royal Thai Air Force Cadets. They found the use of shoulder weapon (rifle) caused the more hearing loss in the left ear than in the right ear. Furthermore, the lateral difference may be depending on susceptibility to noise damage. Chung et al (43) suggested that the left ear could be the weaker ear in most cases. Their finding demonstrated that a certain percentage of noise exposure population actually exhibited more hearing loss in one ear than the other did. In most cases the left ear was the worse one.

2.3 Pattern of Audiogram

From this study was found 91.96% of RTNC had normal hearing and 8.04% of them had SNHL. All cases of SNHL were registered hearing loss (Wisuthipat's classifications). It was found that the most pattern of audiogram were R2 type (65.22%), R1 type (15.21%), R4 type (10.87%), R3 type and R5 type were 4.35%. The R2 type is unilateral hearing loss (one hearing loss ear and another normal hearing ear). These results were in an agreement with those studies of Kasetvetin (17), Pruegsanusak (18). These findings implied that it might because of the duration of time that RTNC had less expose to noise and had not consistency. In additions, the characteristics of noise e.g. intensity, types of noise had difference in each groups. Therefore, the hearing loss in the most cadets was primary declination.

3. The relation of factors affected on hearing

3.1 Class of cadets

In this study, the differences of class were the number of the duration of time that spent in the field training session. The cadets who studied in higher class had longer expose to noise. Therefore, the cadets who studied in higher class had more chance to have hearing loss. This study found that only the 1st-3rd year class cadets related to the hearing loss. Moreover, there was no difference of hearing loss level between the 4th – 5thyear class cadets (see in Table 11). These results could imply that the hearing threshold level of the 4th –5th year class cadets were not related to the 1st-3rd year class cadets due to there was no addition of the exposure to noise in the field training sessions (see in Appendix B).

These findings were in an agreement with those studies of Kasetvetin (17) and Pruegsanusak (18) for only the 1st-3rd year class cadets. They reported that the cadets in higher class had more hearing loss caused by the number of the years were related to the hearing loss, especially in the high frequency range.

3.2 History of ear disease

This study found that the most of ear diseases, which occurred in RTNC were chicken pox (67.7%), upper respiratory infection (44.2%), earache (37.2%), mump and vertigo (28.3%). There was no relation between history of ear diseases and hearing loss. These findings could discuss that the ear diseases, which occurred in RTNC, may be only the symptoms which RTNC had ever been and did not showed more affects on overall hearing threshold of them during the researcher was collecting the data. Moreover, the other symptoms and diseases that were found less e.g. otorrhea (7.9%), hereditary (7.0%), german measles (4.0%) and ototoxic (1.2%). Therefore, this study may be reported that the history of ear diseases had no affect on these SNHL cadets.

3.3 History of noise exposure before being a cadet

This study found that history of noise expose before being a cadet were no related to hearing loss in RTNC. These results could discuss that before being a cadet, they habitually expose to noise such as music, machinery and gunfire. In addition, the effects of noise depend on differences of individual susceptibility. Therefore, it might be unlikely that the effects of that noise could affect to SNHL cadets. These results were in an agreement with the study of Kasetvetin (17).

3.4 Knowledge of the ear and danger from noise exposure

This study found that most of RTNC had less knowledge (59.8%), moderate knowledge (20.8%). There were no relation between knowledge of the ear and danger from noise exposure with hearing loss in cadets. It was implied that having more knowledge of the ear could not make the cadets to concern preventing loud noise. On the other hand, having less knowledge of the cadets would not make them hearing loss anyway. These results were in an agreement with the study of Pruegsanusak (18) that 58.5% of the Royal Air Force Cadets had less knowledge; only 2.0% of cadets had good knowledge. In additions, these results were nearly to the study of Kasetvetin (17) that Royal Thai Army Cadets of Chulachomklao Royal Military Academy had less knowledge (45.12%). It was shown in the comparison of percentage regarding the good knowledge of cadets individually that the results of Pruegsanusak and Kasetvetin were closely (2.0%, 1.57% respectively). In the meantime, it was also found in this study that 19.4% of the cadets had good knowledge.

3.5 Using ear protectors

The results of this study were found that 89.68% of RTNC had used ear protectors. It also was found that there were no relations between using ear protectors and hearing loss in cadets These results were in an agreement with the study of Kasetvetin (17) who found that 94.27% of Royal Thai Army cadets had used ear protectors. From the results of this study, it indicated that using ear protectors could not prevent them from hearing loss. It might because of the efficiency of kind of ear protectors, frequently and consistency in use. In this study found that the most of RTNC always used were finger (76.9%), cotton (76.6%) and tissue (50.2%) respectively.

These kinds of ear protectors had low efficiency to attenuate sound. According the studies of Chykittiporn and Monthewan (69), Cianci et al.(71) and Melnick (72) they reported that dry cotton with compress could attenuate loud sound 6-8 dB, wax cotton could attenuate 20dB and normal cotton could attenuate only 3.14 dB. In additions, the study of Thapkaset and Thawil (68) reported dry cotton could attenuate 29.44 dB (at frequencies 500-2000 Hz), 39.54 dB (at frequencies 2,000-8,000 Hz). Whereas, another kind of ear protectors which have more efficiency e.g. earmuff, earplug as reported by Guild (50), Pfander (69) and Melnick (72). Their findings were that earmuff type could attenuate 30-40 dB, earplug 20-40 dB. In this study found that the cadets who used sponge plug, earmuff and wing plug had only 45.3%, 39.5% and 26.3% respectively. Furthermore, in the reported of Thapkaset and Thawil (68) showed that tissue could attenuate 32 dB, 43.65 dB at frequency 500-2,000Hz and 2,000-8,000Hz respectively.

Conclusions

1.Audiometric measurement of 572 RTNC in this study was found that the prevalence of SNHL was 8.04%. Therefore, it seem to be the most of RTNC had good hearing condition.

2. Audiogram analysis

2.1 The 46 SNHL cadets had high frequency hearing loss at frequencies 3,000-8,000 Hz and occurred a notch at 6,000 Hz more than other frequencies.

2.2 The 46 SNHL cadets were asymmetrical hearing loss more symmetrical hearing loss. Furthermore, it was in the left ear more than the right ear.

3. The factors affected on hearing

3.1 The findings of this study was class of cadets had related to the SNHL cadets only the 1st-3rd year class cadets and the 4th-5th year class cadets had not difference from the 3rd year class cadets. In additions to others factors e.g. history of ear disease, history of noise exposure before being a cadet, knowledge of the ear and danger from noise exposure and using ear protectors had no related to hearing loss cadets.

3.2 The most of cadets had less knowledge of the ear and danger from noise exposure.

3.3 Using ear protectors of cadets in this study were found that 89.68% of cadets always used. The kinds of ear protectors always used were finger, cotton and tissue; they were less efficiency ear protectors.

Recommendations

From this study could advise some information as follows;

1. The cadets should have more knowledge about the danger from noise exposure. Furthermore, there should be the study of the protection from gunfire shooting. The concerning of choosing efficiency ear protectors and developing the habit of wearing ear protectors during their field training or exposed to noise.

2. Hearing conservation program should be conducted to the Academy. Superior may provided many efficiency ear protectors for supporting this program.

3. In the future study; noise- induced hearing loss should be studied in several groups of naval department.

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APPENDIX A

QUESTIONNAIRES

แบบสอบถาม

เรื่อง ปัจจัยที่มีผลกระทบต่อการได้ยินของนักเรียนทหาร

ตอนที่ 1 ข้อมูลส่วนบุคคล สำหรับผู้วิจัย

ชื่อ..................นามสกุล..............

อายุ….. ......ปี...เดือน

ชั้นเรียนปัจจุบัน(เป็นนักเรียนนายเรือชั้นปีที่)...

1.1 ข้อมูลประวัติการเจ็บป่วยเกี่ยวกับหู

1. ท่านมีญาติที่เป็นโรคหูหนวกหูตึงหรือไม่

☐ มี

☐ ไม่มี

2.ท่านเคยมีอาการปวดหูหรือไม่

☐ เคย ☐ หูซ้าย ☐ หูขวา ☐ ทั้งสองหู

☐ ไม่เคย

3.ท่านเคยมีของเหลวหรือหนองไหลออกจากหูหรือไม่

☐ เคย

☐ ไม่เคย

4. ขณะนี้ท่านมีอาการหวัด และ/หรือ อาการเจ็บคอหรือไม่

☐ เคย

☐ ไม่เคย

5. ท่านเคยเล่นกีฬา,ประสบอุบัติเหตุ ศรีษะกระแทกจนหูอื้อ

☐ เคย

☐ ไม่เคย

6. ท่านเคยได้รับการผ่าตัดหู/โรคเกี่ยวกับหูหรือไม่

☐ เคย ☐ หูซ้าย ☐ หูขวา ☐ ทั้งสองหู

☐ ไม่เคย

7. ท่านเคยเป็นโรคหรือมีประวัติเกี่ยวกับอาการต่อไปนี้หรือไม่

1) หัด ☐ เคย ☐ ไม่เคย ☐ ไม่ทราบ ☐

2.)อีสุกอีใส ☐ เคย ☐ ไม่เคย ☐ ไม่ทราบ ☐

3) คางทูม ☐ เคย ☐ ไม่เคย ☐ ไม่ทราบ ☐

4)หัดเยอมัน ☐ เคย ☐ ไม่เคย ☐ ไม่ทราบ ☐

5) เบาหวาน ☐ เคย ☐ ไม่เคย ☐ ไม่ทราบ ☐

6) กินยาหรือฉีดยาจนหูอื้อหูตึง ☐ เคย ☐ ไม่เคย ☐ ไม่ทราบ ☐

7) เวียนหัวจนรู้สึกบ้านหมุน ☐ เคย ☐ ไม่เคย ☐ ไม่ทราบ ☐

1.2. ข้อมูลประวัติเกี่ยวกับการได้ยินและสัมผัสเสียงดัง

ก่อนเป็นนักเรียนทหารเคยสัมผัสเสียงดังจนหูอื้อ หรือไม่ ☐

☐ เคย โปรดระบุชนิดของเสียง...........

☐ ไม่เคย

ตอนที่ 2 ความรู้เรื่องหูและอันตรายจากการสัมผัสเสียงดัง

1. ท่านทราบหรือไม่ว่า หูคนเราแบ่งออกเป็นกี่ชั้น ☐

☐ ทราบ ☐ 2 ชั้น ☐ 3 ชั้น

☐ ไม่ทราบ

2. ท่านทราบหรือไม่ว่า เสียงที่เป็นอันตรายต่อหู มักเกิดขึ้นที่หูชั้นใด ☐

☐ ทราบ ☐ หูชั้นนอก ☐ หูชั้นกลาง ☐ หูชั้นใน

☐ ไม่ทราบ

3. ท่านทราบหรือไม่ว่า ประสาทหูที่พิการจากเสียงดังจะรับฟังเสียงชนิดใดได้ไม่ดี ☐

☐ ทราบ ☐ เสียงต่ำ ☐ เสียงสูง

☐ ไม่ทราบ

4. ท่านทราบหรือไม่ว่า ความดังเสียงระดับใดที่กฎหมายไทยกำหนดเป็นจุดอันตราย ☐

☐ ทราบ ☐ 50 dBA ☐ 70 dBA ☐ 90 dBA

☐ ไม่ทราบ

5. ท่านทราบหรือไม่ว่า อันตรายจากการสัมผัสเสียงดังในระยะแรกประสาทหูอาจพิการแบบชั่วคราว ☐

☐ ทราบ

☐ ไม่ทราบ

6. ท่านทราบหรือไม่ว่า อาการเสียงดังในหู(คล้ายเสียงจั๊กจั่น) หลังจากยิงปืนเป็นอาการเริ่มแรกของประสาทหูพิการ ☐

☐ ทราบ

☐ ไม่ทราบ

7. ท่านทราบหรือไม่ว่า การได้ยินเสียงดังซ้ำหลายครั้ง อาจทำให้ประสาทหูพิการแบบถาวรและรักษาไม่ได้ ☐

☐ ทราบ

☐ ไม่ทราบ

8. ท่านทราบหรือไม่ว่า การใช้อุปกรณ์ป้องกันเสียงดังในเบื้องต้นอย่างสม่ำเสมอ สามารถลดความพิการของประสาทหูได้ ☐

☐ ทราบ

☐ ไม่ทราบ

ตอนที่ 3 ข้อมูลเกี่ยวกับการใช้อุปกรณ์ป้องกันเสียงดัง

คำชี้แจง บ่อยครั้ง หมายถึง ปฏิบัติ 50% ขึ้นไป

บางครั้ง หมายถึง ปฏิบัติน้อยกว่า 50%

1. ท่านเคยใช้อุปกรณ์ป้องกันเสียง ขณะได้ยินเสียงดังจากการฝึกยิงอาวุธปืนและวัตถุระเบิดหรือไม่ ☐

☐ เคย (ถ้าเคยให้ตอบคำถามข้อต่อไป)

☐ ไม่เคย

2. ท่านเลือกใช้อุปกรณ์ป้องกันเสียงแบบใดต่อไปนี้ (เลือกตอบได้มากกว่า 1 ข้อ)

☐ นิ้วมือ

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

☐ กระดาษทิชชู

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

☐ สำลีธรรมดา

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

☐ ดินน้ำมัน

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

☐ ปลอกกระสุนปืน

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

☐ ยางอุดหูชนิดฟองน้ำ

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

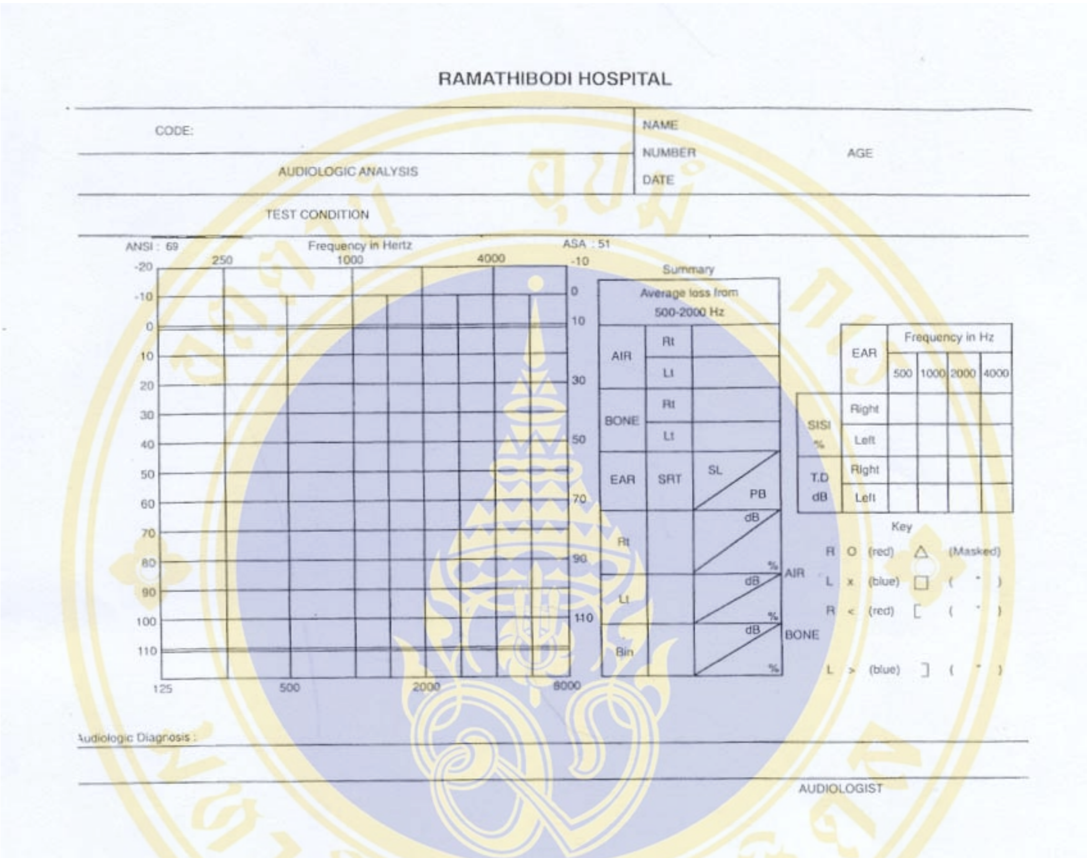
☐ ยางอุดหูชนิดมีปีก

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

☐ ที่ครอบหู (Earmuff)

ลักษณะการใช้ ☐ ทุกครั้ง ☐ บ่อยครั้ง ☐ บางครั้ง

☐ อื่นๆระบุ...



RAMATHIBODI HOSPITAL

CODE:
NAME
NUMBER
AGE
AUDIOLOGIC ANALYSIS
DATE
TEST CONDITION

ANSI : 69
Frequency in Hertz
ASA : 51
250 1000 4000
-20 -10 0 10 20 30 40 50 60 70 80 90 100 110
-10 0 10 30 50 70 90 110
125 500 2000 8000

Summary
Average loss from 500-2000 Hz

AIR	Rt	
	Lt	
BONE	Rt	
	Lt	
EAR	SRT	SL / PB
Rt		dB / %
Lt		dB / %
Bin		dB / %

AIR
BONE

	EAR	Frequency in Hz			
		500	1000	2000	4000
SISI %	Right				
	Left				
T.D dB	Right				
	Left				

Key
R O (red) △ (Masked)
L x (blue) □ (")
R < (red) [(")
L > (blue)] (")

Audiologic Diagnosis :

AUDIOLOGIST

Figure 6 Audiological record form

APPENDIX B

SCHEDULE OF CADETS' FIELD TRAINING SESSIONS

ตารางฝึกภาคปฏิบัติของนักเรียนนายเรือ

	ชนิดการฝึก / ประเภทการยิง	ชนิดอาวุธ	นัด / คน
นนร. ชั้นปีที่ 1	- อาวุธประจำกาย	ปืนเล็กยาว M16	25
	- ยิงสอน (ครูยิงให้ดู)	ปืนเล็กยาว	
	- เป้าปืนใหญ่ขั้นต้น	ปืนกล 40 เป้านิ่ง	10
	- ยิงสอบศูนย์ (ครูยิงให้ดู)	ปืนกล 40	-
	- เป้าปืนใหญ่ขั้นต้น	ปืนกล 40 (เป้าเคลื่อนที่)	10
นนร. ชั้นปีที่ 2	- เป้าปืนใหญ่ขั้นต้น	ปืนกล 40	10
	- ยิงสอบศูนย์	ปืนกล 40	
นนร. ชั้นปีที่ 3	- อาวุธพก	ปืนกลอัตโนมัติ 20 ม.ม.	45
	- ยิงทดสอบปืน	ปืนกลอัตโนมัติ 20 ม.ม.	-
นนร. ชั้นปีที่ 4	-	-	-
นนร. ชั้นปีที่ 5	-	-	-

ที่มา : กองวิชาการอาวุธ โรงเรียนนายเรือ จ. สมุทรปราการ

APPENDIX C

MATERIAL AND EAR PROTECTORS

Figure 7 Sound level meter

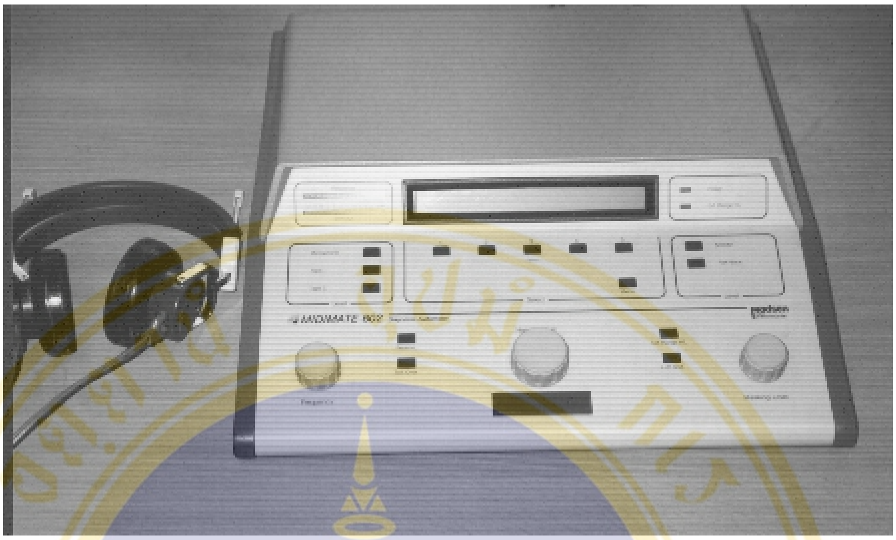


Figure 8 Audiometer

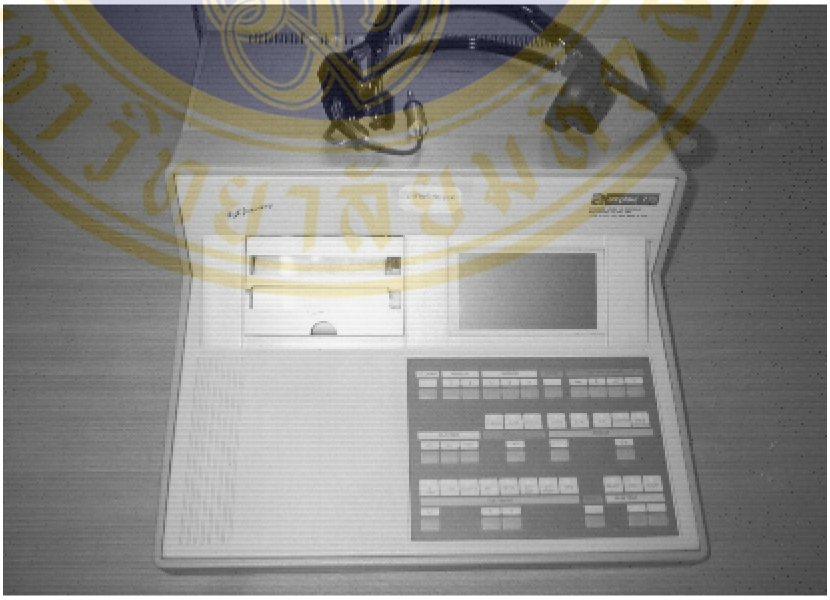


Figure 9 Acoustic Immittance

Figure 10 Earmuff

BIOGRAPHY

NAME Lt. JG. Wandee Boonhai WRTN.

DATE OF BIRTH November 13,1966

PLACE OF BIRTH Rayong, Thailand

INSTITUTIONS ATTENDED Naval Nursing College 1985-1987:
Certificate of nursing
Ramkhamhaeng University,
1987-1991:
Bachelor of Education
Sukhothaithammathiraj
University, 1992-1996:
Bachelor of nursing science
Mahidol University, 1998-2003:
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POSITION &OFFICE 1987- present, Pediatric Division,
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