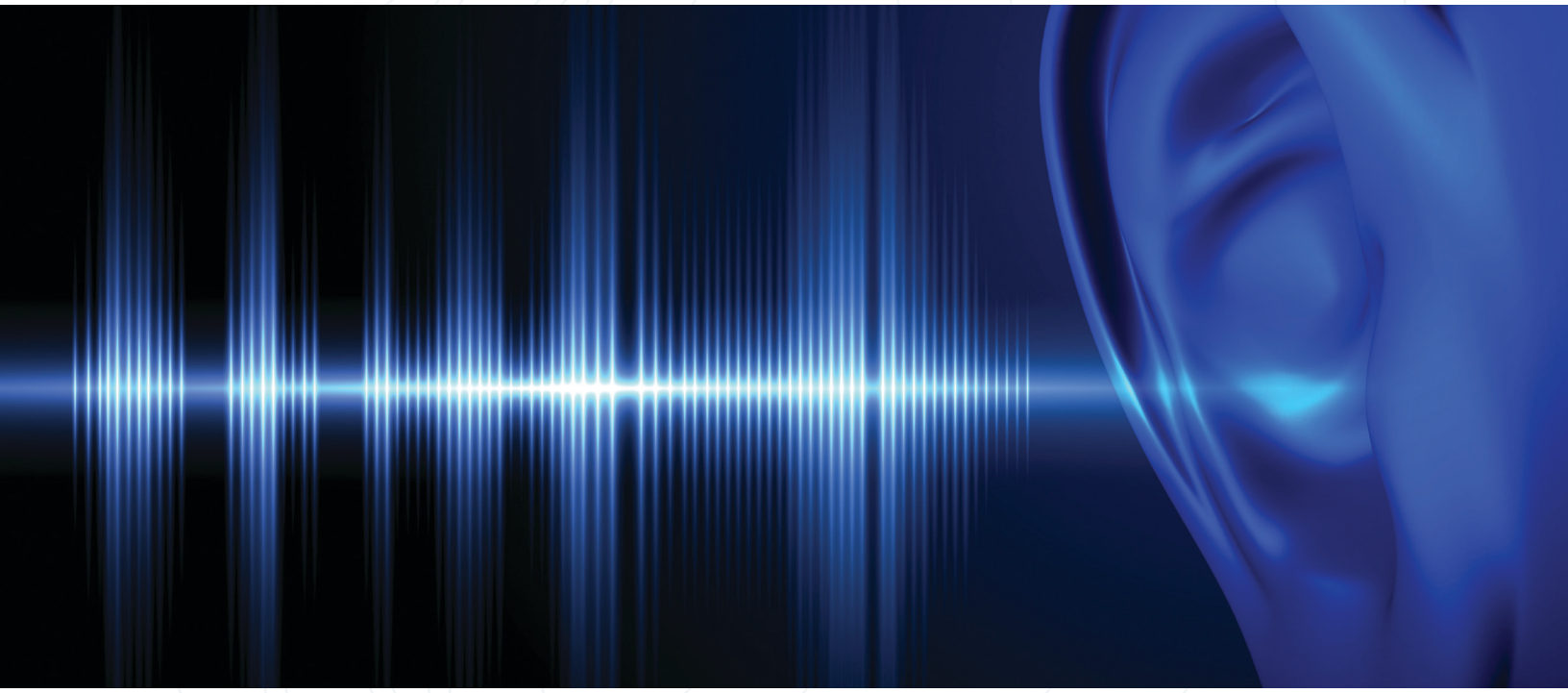
Addressing Noise-induced Hearing Loss In First Responders With Innovative Station Alerting Technologies



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Section 1: Introduction

Firefighters and paramedics face a formidable barrage of occupational noise. In-station noises include piercing alert tones and loud equipment such as compressors in the apparatus bays. Outside the station, firefighters are exposed to noise from emergency vehicles, sirens, emergency equipment, and more. **As a result, there are alarmingly high levels of hearing loss in the fire service**.

In 2025, there were approximately 1.2 million firefighters in the United States serving in more than 27,000 fire departments. **Approximately 40% of U.S. firefighters (roughly 480,000 firefighters) already have noticeable hearing loss** in the noise-sensitive frequencies of 4 to 6 kHz. *(Source: https://pmc.ncbi.nlm.nih.gov/articles/PMC6844073/)*

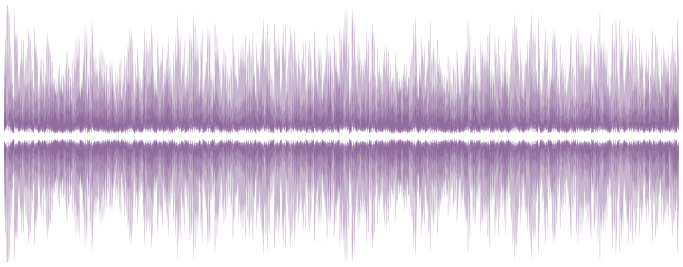
The risk of hearing loss as a worker in the fire service is further heightened by the infrequent use of hearing protection devices (HPDs). Many firefighters decline to use hearing protection because they believe that hearing protection interferes with their ability to hear alerts and impedes situational awareness.

Section 2:
The Three Types Of Occupational Noise

There are 3 types of occupational noise that can affect workers:

Continuous Noise

Ongoing noise from a specific source

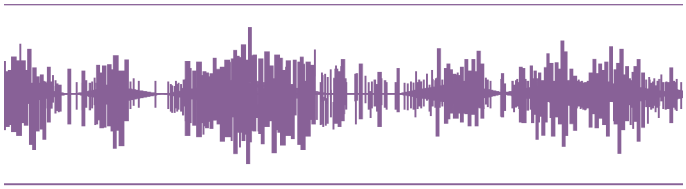


Impulse Noise

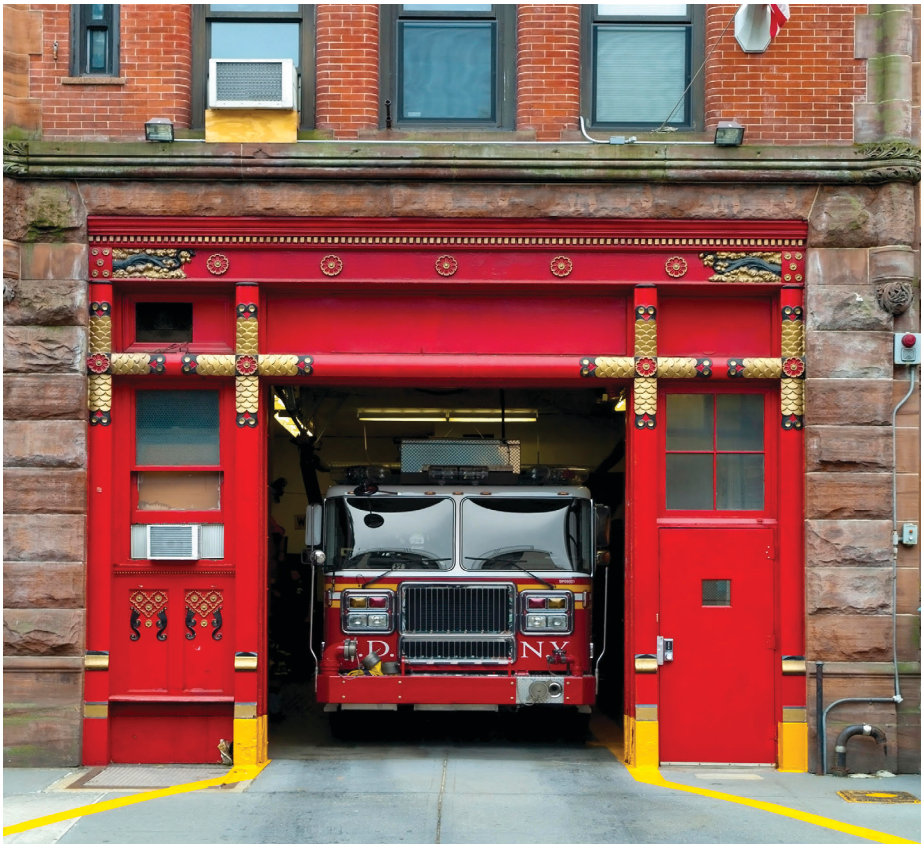
Instantaneous sharp sounds

Varying And Intermittent Noise

Noise that comes at unexpected times, in bursts or intervals



Alarms and tones that sound in fire stations to alert first responders of an incoming dispatch are considered **VARYING and INTERMITTENT NOISE**. Medical research shows that there are many negative physiological and psychological effects of varying, intermittent noise. **In fact, medical research has shown that varying and intermittent noise is more harmful than continuous noise.** The harmful effects to the health and safety of first responders are quite staggering. However, new fire station alerting technologies have been developed that can significantly reduce these threats to the health and safety of first responders, as well as their impact.



Section 3:
How Humans Hear – A Complex Process

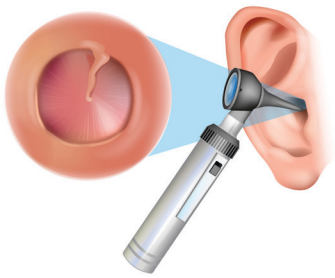
To understand how occupational noise can damage the ability to hear, the first step is to understand the physical process of how humans hear.

Step 1

Sound waves enter the outer ear and travel through a narrow passageway called the ear canal, which leads to the eardrum.

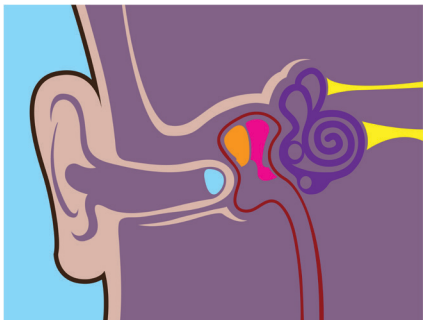
Step 2

The eardrum – also known as the tympanic membrane – vibrates from the incoming sound waves and sends these vibrations to three tiny bones in the middle ear. These bones are called the **malleus**, **incus**, and **stapes**.



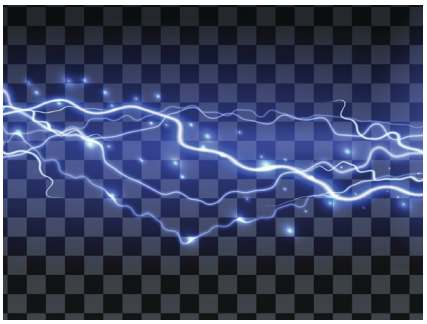
Step 3

The bones in the middle ear couple the sound vibrations from the air to fluid vibrations in the cochlea of the inner ear, which is shaped like a snail and filled with fluid. An elastic partition runs from the beginning to the end of the cochlea, splitting it into an upper and lower part. This partition is called the **basilar membrane** because it serves as the base, or ground floor, on which key hearing structures sit.



Step 4

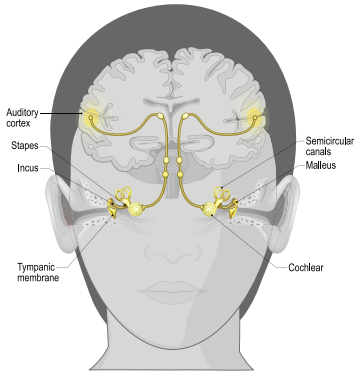
Once the vibrations cause the fluid inside the cochlea to ripple, a traveling wave forms along the basilar membrane that separates the top and bottom of the cochlea. Hair cells – sensory cells sitting on top of the basilar membrane – ride the wave.



Step 5

As the sensory hair cells move up and down riding the sound wave, microscopic, hair-like projections (known as stereocilia) that perch on top of the hair cells bump against an overlying structure and bend. Bending causes pore-like channels to open. When that happens, chemicals rush into the cells, creating an electrical signal.

Auditory system



Step 6

The auditory nerve carries this electrical signal to the brain stem and then to the auditory cortex. Located in the brain's temporal lobe, the auditory cortex analyzes the signals – which allows humans to differentiate pitch, tone, and frequency – as well as interpret the electrical signals into meaningful sounds like speech, music, or general sounds.

Section 4:

2 Ways That Noise Causes Hearing Loss

There are two ways that hearing loss can result from noise exposure.

Gradual Noise Induced Hearing Loss (NIHL) can occur over time, leading to hearing loss that is severe enough to require hearing aids to magnify the sounds.

- Exposure to chronic noise over time can steadily wear down the sensory cells in the ear. This causes gradual and permanent hearing loss over time.

Sudden Noise Induced Hearing Loss (NIHL) is caused by sudden, extremely loud bursts of sound, such as piercing alert tones at fire stations, or sirens, gun shots, or explosions on scene at an emergency.

- Sudden, loud bursts of sound cause permanent damage to structures in the anatomy of the inner ear, which results in sudden and permanent hearing loss.

3 Main Ways That Loud Bursts Of Sound Cause Hearing Loss

Loud, sharp sounds can cause permanent hearing loss by:

- Damaging the ear drum
- Damaging the bones in the inner ear
- Damaging the delicate hair cells in the cochlea (inner ear)

Healing Prognosis For Damage To Ear Infrastructure

- **Eardrum Rupture Healing Prognosis**
  A moderately ruptured ear drum can heal over the course of months. Surgery also can help repair a ruptured ear drum.
- **Inner Ear Bone Damage Healing Prognosis**
  The tiny bones in the middle ear cannot heal from damage caused by loud sounds. If bones in the middle ear are damaged, the ability to hear can sometimes be returned with surgery.
- **Cochlea Hair Cells Healing Prognosis**
  Once the hair cells in the cochlea are damaged, the damage is permanent. These hair cells that sense sound do not heal or regenerate. If the hair cells are bent or broken from loud sound bursts, hearing loss is permanent. If the hair cells are subjected to chronic noise over time, the hair cells will wear out, also causing permanent hearing loss.

3 Factors Affect The Degree Of Hearing Loss

There are 3 factors that affect the degree to which a person experiences hearing loss:

1

Decibel Level

Hearing loss can occur more rapidly when someone is exposed to higher decibel levels.

2

Duration And Frequency

The amount of time to which someone is exposed to loud, occupational noise, and the ongoing frequency of their exposure, affects the degree of hearing loss they will experience.

3

Distance

The closer a person is to the source of the sound, such as a loud piece of equipment or proximity to klaxon speakers, the higher the risk of hearing loss.

Section 5:

Where First Responder Occupational Noise Falls On The Decibel Scale

The Decibel Scale is a system of measurement of the INTENSITY of sound. Regular exposure to sound with decibel levels above the threshold level of 85 dB can cause hearing loss.

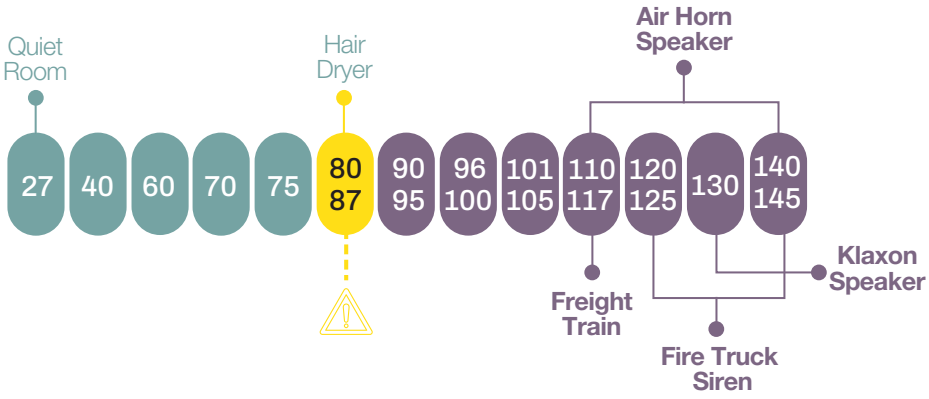
Did You Know?

Noise measurements on the decibel scale are logarithmic, not linear. This means that, for every **10 points of decibel level increase**, the sense of loudness to the human ear DOUBLES.

Decibel Level Examples:

- **Quiet room:** 27 decibels
- **Risk of hearing loss:** 85 decibels
- **Hair dryer:** 87 decibels
- **Freight train:** 117 decibels
- **Air horn speaker:** 110 to 145.8 decibels*
- **Fire truck siren:** 120-140 decibels*
- **Klaxon speaker:** 130 decibels*

*These are common noises in the daily lives of first responders.



Alert

According to the National Institute on Deafness and Other Communication Disorders, repeated exposure to sound at **85 decibels or more** can cause hearing loss.

These decibel statistics help make it clear why hearing loss is such a problem for first responders. First responders are subjected to chronic exposure to sudden, intermittent noise at very high decibel levels that are well above the threshold for the risk of hearing loss.

Section 6:

Medical Research On The Negative Effects Of Occupational Noise On First Responders

This section highlights medical research from the PubMed medical research database. PubMed is administered by the U.S. National Institutes of Health, and it currently contains approximately 40 million medical research studies.

Learning Points

- Nearly 30% of this study's participants showed mild to profound hearing loss from exposure to occupational noise from sirens, alarms, air horns and vehicles.
- **Many firefighters who participated in the study were not using hearing protection because they were afraid to miss an alert or have teamwork and situational awareness impaired.**

Prevalence Of Hearing Loss And Perceptions Of Hearing Health And Protection Among Florida Firefighters – 2023 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/36900832/Abstract

Abstract Excerpt

Firefighters are exposed to extensive hazardous noise while on the job, both during routine tasks at the station and when responding to calls.

Study Goals

- Identify sources of noise in the firefighters' work environment
- Determine hearing protection strategies for firefighters
- Discern firefighters' perceptions of occupational noise exposure and impacts to their health
- Quantify the prevalence of hearing loss among South Florida firefighters

Methodology

Researchers employed multiple methods for this study:

- An expert panel of senior-level people working in the fire service (6 participants)
- Firefighter focus groups (12 participants)
- A survey of firefighters (300 participants)
- Audiometric testing of firefighters (214 participants)

Study Results

- Most firefighters were unaware of the risk and their departments' policies and did not deploy hearing protection.
- **Many firefighters specifically avoided using hearing protection because they believed that hearing protection impeded team communication, situational awareness, and awareness of station alerts.**
- Nearly 30% of firefighters who participated in the study showed mild to profound hearing loss, a prevalence that is considerably worse than expected from normal aging alone.
- Educating firefighters about noise-induced hearing loss early in their careers may have significant health implications for their futures.

These findings provide insights for developing technologies and programs to mitigate the effects of noise exposure leading to hearing loss in the firefighting population.

Hearing Loss And Use Of Hearing Protection Among Career Firefighters In The United States – 2014 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/23887702/

Abstract Excerpt

This study was designed to quantify the amount of hearing loss in the U.S. fire service – along with assessing the use of hearing protection among career firefighters.

Study Goals

- Determine the prevalence and characteristics of noise-induced hearing loss (NIHL) in the fire service
- Assess the use of hearing protection devices (HPDs) among career firefighters

Methodology

- 425 firefighters from three states in the United States participated in this study

Researchers conducted:

- An online survey
- Standard audio testing of the firefighters' hearing

Study Results

- More than 40% of the participating firefighters showed hearing loss in the noise-sensitive frequencies (4 to 6 kHz).
- The left ear exhibited significantly poorer hearing than the right ear.
- Firefighters with more years of work in fire services demonstrated significantly worse hearing.
- Reported use of HPDs was only 34% of the time that was needed.
- Firefighters who used hearing protection less were significantly more likely to have hearing loss.

Learning Points

- **This study showed that hearing loss in the fire service is a significant problem, with more than 40% of firefighters in this survey experiencing hearing loss.**
- Despite this, researchers found very low usage rates (only about 34% of the time when appropriate) of hearing protection among firefighters.
- **Barriers to getting firefighters to use hearing protection can be mitigated with existing fire station alerting technologies that are on the market today, which subject them to much lower noise levels.**

Hearing Losses In Full-time Firefighters Occurring Early In Their Careers – 2011 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/21652572/

Abstract Excerpt

This study was designed to examine hearing loss in firefighters early in their careers.

Methodology

The researchers conducted pure-tone auditory testing on 118 male firefighters, and then again roughly 4 years later.

Study Results

- The 118 firefighters participated in initial auditory testing of both their left and right ear.
- In the second round of auditory testing, roughly 4.1 years after the first auditory testing, there was significant hearing loss in both ears.
- **The average percentage of hearing loss in the participants' right ear was 8%, over a period of 4 years.**
- **The average percentage of hearing loss in the participants' left ear was 13%, over a period of 4 years.**
- This amount of hearing loss over 4 years was statistically significant and fell into the "warning" category from the "Control of Noise at Work Regulations."

Learning Point

This study showed that significant hearing loss occurred in just 4 years of working in the fire service.

Pilot Task-based Assessment Of Noise Levels Among Firefighters – 2012 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/24443622/

Abstract Excerpt

More than one million American firefighters are routinely exposed to various occupational hazards. While efforts have been made to identify and reduce some causes of injuries and illnesses among firefighters, relatively little has been done to evaluate and understand occupational noise exposures in this group.

Study Goals

The purpose of this pilot study was to apply a task-based, noise exposure assessment methodology to firefighting operations to:

- Evaluate potential noise exposure sources causing hearing loss in the fire service
- Generate estimates of the occupational noise exposure faced by firefighters
- Evaluate firefighters' risk of noise-induced hearing loss

Methodology

- Task-based noise exposures were measured in three different fire departments:
  - A rural department in Southeast Michigan
  - Suburban and urban fire departments in Northern California

Learning Points

- Firefighters are over-exposed to occupational noise from a variety of firefighting tasks and from the use of firefighting and emergency response equipment.
- The task-based noise levels to which firefighters were exposed were found to approach or well exceed decibel thresholds that result in hearing loss.
- Task-based noise exposures in this study ranged from 82 to 109 decibels. *(Note: The National Institute of Deafness and Other Communication Disorders states that the risk of hearing loss from noise exposure starts at 85 decibels.)*
- The results of this study suggest that additional programs aimed at hearing loss prevention among firefighters are warranted.

- These noise levels were then combined with time-at-task information collected from firefighters to estimate 8-hour occupational noise exposures for the rural and suburban fire departments.
- In addition, data from 24-hour dosimetry measurements and self-reported activity categories from the urban fire department were used to develop estimates of typical 24-hour occupational noise exposures faced by firefighters.

Study Results

- **Task-based noise levels were found to range from 82 to 109 decibels.**
- The highest levels of noise exposures for firefighters came from the use of saws and pneumatic chisels.
- Some 30-minute tasks commonly performed by firefighters resulted in the entire allowable daily noise exposure.
- **The majority of 8-hour and 24-hour noise exposures exceeded recommended occupational noise exposure limits.**

Race Difference In Susceptibility To Noise-induced Hearing Loss In The Fire Service – 2023 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/3812644/

Abstract Excerpt

Researchers conducted a study on the degree of hearing loss based on race.

Study Goal

Determine if there were differences in the degree of hearing loss between white and black male firefighters.

Methodology

- Researchers conducted a study that compared the hearing of 28 white and 28 black male firefighters/EMS professionals exposed to high levels of ambulance siren noise.
- Groups were matched and compared based on:
  - » Chronological age
  - » The number of years working as a firefighter/EMS professional
  - » Non-job-related noise exposure

Learning Points

- White first responders are the most likely to experience noise-induced hearing loss.
- White individuals comprise approximately 79% to 85% of the fire service. *(Source: US Bureau of Labor Statistics)*

Study Results

- Results suggested that Caucasian people are the most susceptible to the damaging effects of high-level noise.
- In both the mid- and high-frequency regions of the audiogram, blacks showed significantly better sensitivity than whites on the poorer ear.
- On the better ear, the sensitivity difference between blacks and whites widened as employment duration and, therefore, duration of noise exposure, increased.

An Internet-based Tailored Hearing Protection Intervention For Firefighters: Development Process And Users' Feedback – 2023 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/23149759/

Abstract Excerpt

Noise-induced hearing loss is a significant occupational injury for firefighters exposed to occupational noise on the job. It is important to educate firefighters about using hearing protection devices whenever they are exposed to loud noise. Computer technology can be useful to tailor behavioral change training for firefighters.

Study Goal

The purpose of this study was to present the development process of an Internet-based tailored intervention program to promote use of hearing protection in the fire service, and to assess its efficacy.

Methodology

- Hearing protection intervention programs were implemented for 372 firefighters in three states: California, Illinois, and Indiana
- Demographics of the firefighters:
  - » Median age: 44
  - » Race: 82% Caucasian
  - » Gender: 95% male

Learning Points

- Training is needed to educate firefighters that Noise Induced Hearing Loss is preventable – and to become accustomed to assessing noise levels and use hearing protection as needed.
- This study showed that interactive, multi-media online training was welcomed by firefighters.

- The efficacy of the hearing protection promotion program was assessed from firefighters' feedback through an online survey.
- The hearing protection promotion program was a multimedia, online training program that included:
  - » Content and scripts
  - » Information delivered by print, audio, and video

Study Results

Feedback from the 372 participating firefighters was positive:

- 83% liked the online training program
- 97% said the training was easy to use
- 79% said the training program kept their interest
- 95% of participating firefighters said they would recommend this online training program to other firefighters

Subclinical Hearing Deficits In Noise-Exposed Firefighters Study – 2022 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/36078744/

Abstract Excerpt

Noise-induced Hearing Loss (NIHL) is the most prevalent occupational disease in the world. Firefighters face increased risk of NIHL due to their frequent exposure to hazardous levels of noise during service. Adverse effects of NIHL include hearing loss, acceleration of age-related hearing loss, and an increased risk of cognitive decline. A critical challenge in addressing NIHL is the delayed presentation of symptoms and lack of sensitive tools for early detection.

Methodology

The researchers collected hearing function information on 178 firefighters during their annual physical assessments.

Study Results

- Researchers found significant deficits in the firefighter's cochlear outer hair cell function
- 55% of the firefighter participants self-reported changes in hearing
- 20% of the firefighter study participants self-reported concerns about their balance

Learning Point

Firefighters display hearing loss with increasing years in the fire service. These effects were observed even when controlling for age-related hearing loss.

Predictors Of Hearing Protection Behavior Among Firefighters In The United States – 2015 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/22161219/

Abstract Excerpt

Noise-induced hearing loss (NIHL) is a major occupational health problem in the fire service that can be prevented through the use of hearing protection devices (HPDs).

Study Goal

The purpose of this study was to identify significant factors related to firefighters' use, or non-use, of hearing protection devices.

Methodology

A total of 404 firefighters from 35 fire departments in multiple states in the United States participated in an Internet-based survey.

Study Results

Analysis of firefighter survey responses showed that multiple factors affected firefighters' use or non-use of hearing protection devices, including:

- Amount of noise exposure
- Cultural/interpersonal influences
- Department support for the use of hearing protection devices
- Perceived barriers to the use of hearing protection
- Perceived susceptibility to hearing loss

Learning Point

Barriers to getting firefighters to use of hearing protection can be mitigated with existing fire station alerting technologies that are on the market today, which subject them to much lower noise levels.

Firefighters' Noise Exposure: A Literature Review – 2014 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/25991998/

Abstract Excerpt

The goal of this research study was to review the existing literature about the effects of occupational noise on the hearing ability of firefighters.

Methodology

- Researchers searched the PubMed and Scielo medical research databases for the keywords: firefighters, noise, and hearing loss.
- Initially, 24 studies were identified, but only 10 research studies met the criteria of investigating the effects of occupational noise on firefighters.

Study Results

- Two studies quantified levels of sound pressure and performed audiological tests to identify associations with noise intensity.
- Three questionnaire-based studies reported that firefighters are more susceptible to hearing loss.
- Four studies found that noise exposure damages the firefighters' hearing.

Learning Point

These compiled study results clearly indicate the hearing loss from occupational noise is a significant problem in the fire service.

Perception And Attitudes Of Firefighters On Noise Exposure And Hearing Loss – 2013 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/18213534/

Abstract Excerpt

Noise exposure of firefighters results in increased risk of hearing loss. Noise-induced hearing loss (NIHL) can be prevented by the consistent use of hearing protection devices (HPDs). However, little is known about firefighters' perceptions and attitudes on NIHL and HPD use.

Learning Points

- In many cases, firefighters forgot about taking or using hearing protection on the scene of emergencies or found that it impeded other gear they needed to wear.
- However, in-station hearing protection is an area that needs to be stressed, as well as on scene.

Study Goals

- Identify common noise sources of firefighting equipment and activities
- Discover the attitudes and beliefs of firefighters concerning the importance of their hearing, occupational noise exposure, NIHL, and use of hearing protection

Methodology

Focus groups were conducted with firefighters at two fire stations in southeast Michigan. Occupational noise faced by firefighters was identified as:

- Driving fire trucks and emergency vehicles with sirens activated
- Operating equipment such as water pumps, saws, and more
- Shouting to communicate with fellow firefighters and civilians

Study Results

Focus group results included the following insights:

- Firefighters acknowledged the significance of having good hearing in the fire service.
- However, firefighters viewed hearing loss as unavoidable on the job and viewed hearing loss as a lesser risk than other job hazards.
- There were 3 reasons why firefighters are not using hearing protection:
  - » Firefighters believed that hearing protection interfered with the ability to hear commands during emergency conditions.
  - » Use of hearing protection on the scene of emergencies interfered with wearing other safety equipment.
  - » Firefighters generally forgot to include hearing protection when suiting up.
- Firefighters recognized the importance of hearing health and welcomed a fire service hearing conservation program that would include annual training.

Learning Point

Barriers to getting firefighters to use of hearing protection can be mitigated with existing fire station alerting technologies that are on the market today, which subject them to much lower noise levels.

Accelerated Hearing Loss In Urban Emergency Medical Services Firefighters – 1985 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/3985464/

Abstract Excerpt

A group of 192 firefighters serving in a busy urban emergency medical services (EMS) system was randomly selected for hearing tests, with the intent of assessing the effects of siren noise exposure on hearing.

Methodology

- The total number of hours of siren noise exposure was calculated for each firefighter and was compared to the outcome of hearing tests.
- Hearing loss was defined by the amount of sound intensity required to hear both mid-frequency and high-frequency tones.

Study Results

- Results indicated a correlation between hearing loss and the duration of firefighter's exposure to siren noise. Their hearing loss could not be attributed to non-job-related sources.
- **The rate of hearing loss over time was 150% of that expected in age-matched, non-noise-exposed men.**

Learning Point

- Because of ongoing exposure to sirens and alarms, firefighters and EMS personnel are at risk for hearing well beyond hearing loss that stems from aging alone.

Efficacy Of An Intervention To Promote Use Of Hearing Protection Devices By Firefighters – 1990 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/2106705/

Abstract Excerpt

Numerous cases of hearing loss consistent with noise-induced damage were noted among firefighters in the city of Columbia, MO.

Study Goal

Determine the effectiveness of programs designed to increase the use of hearing protection by firefighters.

Methodology

This study featured multiple areas of action:

- Researchers conducted a **survey** of firefighters who were exposed to excessive noise levels and put at risk for noise-induced hearing loss (NIHL).
- Researchers also conducted **hearing tests** on firefighters participating in the study:
  - » The hearing tests showed that **36 percent** of the firefighters had moderate to severe hearing loss.
- Researchers then implemented an **educational program** on noise-induced hearing loss.

Learning Points

For hearing protection programs to be successful in the fire service, program components need to include:

- Education on noise-induced hearing loss
- Addressing obstacles from firefighters on the use of hearing protection
- Encouragement from management to use hearing protection

Study Results

- The educational intervention successfully increased knowledge of noise-induced hearing loss among firefighters and generated more positive attitudes toward the use of hearing protection.
- **After the hearing protection program was implemented, 85% of firefighters started using hearing protection compared to 20% before program implementation.**

Section 7:
The Top 2 Strategies For Mitigating Hearing Loss In The Fire Service

There are 2 main strategies that can be deployed to help prevent hearing loss in the fire service:

Strategy 1: Increase The Use Of Hearing Protection By Firefighters

Research shows that firefighters don't use hearing protection because they are afraid of missing an alert or compromising situational awareness. Fire departments can increase the use of hearing protection by firefighters in three key ways:

1. Implement educational programs about hearing loss prevention.
2. Strongly encourage the use of hearing protection as a department health and safety protocol.
3. Deploy fire station alerting technology that visually alerts firefighters of incoming dispatches. These station alerting devices provide an immediate visual alert of which unit is assigned to respond to a call, so firefighters are aware of alerts even when they are wearing hearing protection.

Two key visual alerting devices include:

i. **Strobes:** Flashing white lights that activate when a dispatch is arriving at the fire station.

ii. **Unit Indicator Lights (wall mount or ceiling mount):** Multi-color devices that tell a firefighter which unit is being dispatched by the color that activates on the unit indicator.

Strategy 2: Create A Quieter, In-station Environment

The evidence is clear that reducing the noise levels that firefighters face can help mitigate hearing loss in the fire service. Innovative fire station alerting technologies are available now that create a quieter environment in fire stations and reduce the risk of hearing loss for first responders. Fire station alerting technologies that reduce occupational noise in fire stations include:

- Ramped alert tones
- Heartsaver alert tone
- Near-field speaker arrays in apparatus bays
- Volume controls
- Zoned station alerting

Preventing Noise-induced Hearing Loss In Firefighters – 2013 Study

Weblink: https://pubmed.ncbi.nlm.nih.gov/23991707/

Abstract Excerpt

The National Institute of Occupational Safety and Health (NIOSH) studies consistently show firefighters face high risks of noise-induced hearing loss (NIHL) and tinnitus due to occupational noise, with significant hearing impairment often linked to years of service. Studies documented marked hearing loss in noise-sensitive frequencies, elevated noise levels during responses (up to 116 dBA), and common symptoms like muffled hearing and ringing ears, even when average 8-hour exposures seemed within limits. Key sources of occupational noise faced by first responders include:

- In-station alarms
- Sirens
- Horns
- Engine pumps
- Ventilation fans
- Pneumatic tools
- Extrication equipment

Learning Points

There are 3 key components to minimizing hearing loss for workers in the fire service:

- Education about noise-induced hearing loss
- Station alerting technology that mitigates occupational noise in fire stations
- Station alerting technology that encourages firefighters' use of hearing protection

Study Results

- **High Prevalence Of Hearing Loss:** Studies found significant percentages of firefighters with mild-to-severe hearing loss and reported tinnitus (ringing in ears).
- **Intermittent Noise Is A Major Factor:** While average noise levels might seem okay, short bursts during emergencies (in-station alarms, sirens, air horns) reach dangerous levels (99-145 decibels), causing significant damage.
- **Correlation With Experience:** Hearing loss severity often increases with the number of years served as a firefighter.
- **Beyond Hearing:** Noise exposure also impacts balance and cognitive function, potentially leading to depression and social isolation.

Study Recommendations

NIOSH recommendations to mitigate noise-induced hearing loss in first responders are:

- **Hearing Conservation Programs:** Implement fire service-specific HCPs, including training and fit-testing for hearing protection devices (HPDs).
- **Engineering Controls:** Use quieter equipment and modify vehicles with noise-absorbing materials and better mufflers.
- **Administrative Controls:** Modify work practices to reduce noise exposure.

- **Awareness and Training:** Educate firefighters about noise hazards and the importance of hearing protection.
- **Create a Quieter Work Environment:** Utilize technology and updated workplace protocols to create an overall quieter work environment for firefighters. *(Source: DHHS (NIOSH) Publication Number 2013-142: A major report detailing risks and recommendations for promoting firefighter hearing health.)*

Section 8:
Fire Station Alerting Technologies That Encourage Firefighters To Use Hearing Protection

The first strategy for reducing hearing loss in the fire service is to encourage firefighters to use hearing protection. **As a reminder, multiple research studies have shown that firefighters often do not use hearing protection in fire stations because they believe they could miss an alert.**

The deployment of **visual alerting devices** in fire stations is a practical, common sense solution that negates this concern. Visual station alerting devices can clearly alert firefighters that a dispatch is coming through and also can visually tell firefighters in the station which unit is being dispatched.

Here's a look at visual station alerting devices that can help encourage firefighters to use hearing protection in fire stations:

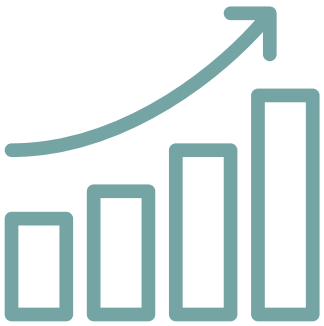
Strobes: Strobe lights are a practical way to alert firefighters that a dispatch is coming through. The white flashing light garners immediate attention, not only because of the activation of the light but because of the intermittent flashing. When a strobe light activates, firefighters using hearing protection or wearing head phones will immediately know that a dispatch is being announced. Strobes can be positioned throughout the fire station, particularly in common areas.

Unit Color Indicators: Multi-unit color indicator devices are a visual alerting tool that can visually alert firefighters which unit is being dispatched. These color indicators feature multiple colors in the device that correspond to a specific unit in the fire station. **Example:** Unit 1's color is blue. When a dispatch arrives at the fire station, the color associated with the unit designated to respond to the dispatch will activate and light up. Firefighters can immediately see which unit is assigned to handle the call based on the color that lights up on the unit color indicator. **Locution Systems' Unit Color Indicators come in 2 forms:** a wall-mount unit and a ceiling mount unit.

Section 9:

Fire Station Alerting Technologies That Mitigate Hearing Loss From In-station Noise

The second strategy to help mitigate noise-induced hearing loss in firefighters is to create a quieter environment in fire stations. To combat hearing loss from chronic exposure to sudden, loud fire station alarms and alert tones, fire station alerting technologies have been developed that help reduce firefighters' exposure to occupational noise in fire stations. These station alerting technologies include:



Ramped (or Graduated) Alert Tones

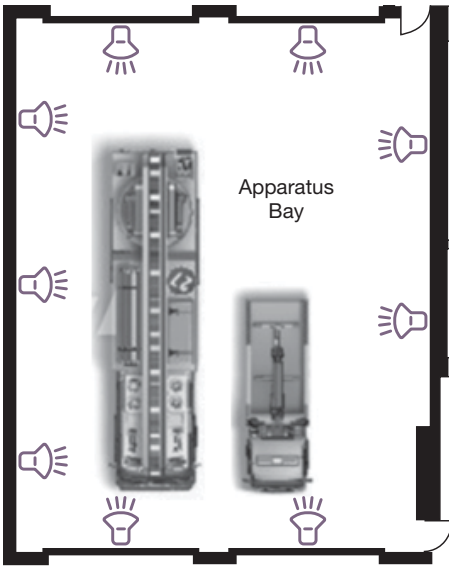
Instead of loud, piercing tones that contribute to noise-induced hearing loss, ramped fire station alert tones start quietly and ramp up to the desired volume over a specific period of time. Fire-EMS departments can configure ramped station alerting tones in a variety of ways and to their preferences.

For example, a Fire-EMS department might opt to start the volume of the ramped tone at 20% of full volume and ramp up the volume in increments of 10 percent to final desired volume of 80% of full volume.

The **PrimeAlert® Fire Station Alerting System's ramped tones** functionality is highly configurable. Fire-EMS departments can have ramped alert tones configured in a variety of volume settings and speed of ramping to partial or full volume.

HeartSaver Tone

The Locution HeartSaver fire station alerting tone is a special, gentle-sounding alert tone created to accomplish the alerting function without creating a startled, stress response in the body. The HeartSaver tone also helps mitigate noise-induced hearing loss because it is a quieter alert tone that mimics a bird call. **Note: The Locution Systems HeartSaver tone also can be ramped, i.e., start with a low volume and gradually ramp up in volume.**



Near-field Speaker Arrays

Another best practice for mitigating occupational noise and its negative effects on the health and safety of first responders is the use of near-field speaker arrays. Near-field speaker arrays are located in apparatus bays instead of having one speaker that blares alert tones and dispatches at high volume in the apparatus bay (producing a startlement response.) The multiple, near-field speakers are located at intervals along the interior walls of the apparatus bay and "wash" the entire space with sound. With this speaker configuration, much less volume is required. Responders positioned anywhere in the apparatus bay can clearly hear the tone and dispatch information from the near-field speaker that's closest to them. **As a result of using a near-field speaker array, the sound in an apparatus bay is much clearer, and the volume is much lower than using a single speaker.**

Volume Controls

Volume controls can be placed in various locations in fire stations which allows volume to be set lower in general, or to the preference of specific first responders, especially in dorm rooms.

Zoned Station Alerting

Zoned station alerting reduces noise in fire stations by precisely routing alert tones and dispatch information directly to the unit assigned to handle the call. Zoned alerts can be routed to general areas in the fire station, and also to specific bunk rooms of the members of the unit assigned to handle the call after everyone has gone to sleep. Zoned alerting mitigates noise in the fire station, as well as sleep deprivation.

Fire station alerting technologies exist that can mitigate hearing loss in the fire service by significantly reducing exposure to sudden, loud klaxon speakers and alert tones that broadcast at high volume. **Fire station alerting technologies that mitigate noise-induced hearing loss for first responders are now considered a best practice.**

Section 10:
Summary

Noise-induced Hearing Loss is the only type of hearing loss that is completely preventable.

When Fire-EMS departments deploy the new fire station alerting technologies that produce a quieter environment and encourage the use of hearing protection, noise-induced hearing loss can be significantly reduced or eliminated.

With more than 1 million U.S. firefighters already experiencing hearing loss or at risk of losing their hearing, this is an important aspect of maintaining the health and wellness of first responders.

For more information about Fire Station Alerting Technologies that help prevent noise-induced hearing loss in firefighters, please contact Locution Systems.

www.locution.com

Thank you!

Locution SYSTEMS INC.