



# Evaluation of Employee Noise Exposures and Ergonomic Risks During Dental Procedures at a Veterinary Hospital

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# Introduction

## Request

Employees of a veterinary hospital requested a health hazard evaluation concerning noise exposures and ergonomic risks during dental cleanings and other dental procedures.

## Workplace

Dental cleanings involved the following steps:

- Administering a sedative to calm the animal.
- Placing a breathing tube down the animal's throat (intubating).
- Putting the animal to sleep (anesthetizing).
- Cleaning the animal's teeth with an ultrasonic scaler.
- Polishing the animal's teeth with a tooth polisher.
- Taking dental X-rays.

After X-rays were taken, the veterinarian determined if more dental procedures (e.g., tooth extraction) were needed. If so, the veterinarian performed these tasks with the veterinary technician's assistance.

**To learn more about the workplace, go to [Section A in the Supporting Technical Information](#)**

## Our Approach

We spent two days in the veterinary hospital in November 2018. We completed the following activities during our evaluation:

- Observed work processes, practices, and conditions.
- Measured employee exposures to noise during dental procedures.
- Observed ergonomic-related risk factors during dental procedures.
- Conducted confidential interviews about employee health.

**To learn more about our methods, go to [Section B in the Supporting Technical Information](#)**

## Our Key Findings

### Employee noise exposures during veterinary dental procedures were under the lowest occupational exposure limits

- Some employees used hearing protection that reduced noise at the ear more than needed.
- Employees who performed dental procedures were more likely to report ringing, roaring, or buzzing in their ears than employees who did not perform dental procedures.
- Few employees reported concerns of workplace noise and hearing loss.
- Some employees reported being concerned about loud noise in the kennel area.

### Equipment design or placement required employees to use awkward postures during dental procedures

- Dental procedure tables were not height adjustable. Employees used awkward postures that could cause pain and discomfort in the neck, arms, and back.
- One procedure table's design limited employees' leg placement and movement when seated.
- Employees were using awkward postures when accessing the laptop because of the laptop's position on a cart. This could cause pain and discomfort in the neck, wrists, and back.
- Sharp table edges caused contact stress when employees leaned their arms against the edges.
- Employees did not use surgical loupes (i.e., eyeglasses with magnification) when performing dental procedures.

### Some employees reported back pain, neck pain, hand or wrist discomfort, and upper extremity discomfort

- The proportion of employees reporting hand or wrist symptoms who performed dental procedures was 1.5 times greater than employees who did not perform dental procedures.
- Thirteen employees reported back pain. Of these, six (46%) said it was related to an activity at work. The most common activities associated with causing or contributing to back pain were repeated bending and repeated lifting of animals or equipment.
- Six employees reported neck pain. Of these, three (50%) stated that an activity at work contributed to the pain. All the employees who reported their neck pain being related to work performed dentistry, stating that repeatedly bending their necks contributed to their pain.

To learn more about our results, go to [Section B in the Supporting Technical Information](#)

## Our Recommendations

The Occupational Safety and Health Act requires employers to provide a safe workplace.

### Potential Benefits of Improving Workplace Health and Safety:

- |  |  |
|--|--|
| ↑ Improved worker health and well-being    | ↑ Enhanced image and reputation              |
| ↑ Better workplace morale                  | ↑ Superior products, processes, and services |
| ↑ Easier employee recruiting and retention | ↑ May increase overall cost savings          |

The recommendations below are based on the findings of our evaluation. For each recommendation, we list a series of actions you can take to address the issue at your workplace. The actions at the beginning of each list are preferable to the ones listed later. The list order is based on a well-accepted approach called the “hierarchy of controls.” The hierarchy of controls groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or practical, administrative measures and personal protective equipment might be needed. Read more about the hierarchy of controls at <https://www.cdc.gov/niosh/topics/hierarchy/>.



We encourage the company to use a health and safety committee to discuss our recommendations and develop an action plan. Both employee representatives and management representatives should be included on the committee. Helpful guidance can be found in *Recommended Practices for Safety and Health Programs* at <https://www.osha.gov/shpguidelines/index.html>.

### Recommendation 1: Provide hearing protection appropriate for the noise levels in the workplace

Why? Properly worn hearing protection reduces employees’ noise exposure and risk of hearing loss. Over-protection occurs when employees use hearing protection that reduces noise at the ears more than is needed. When over-protected, employees may not be able to communicate effectively or hear warning signals and sounds (such as equipment noises) important to their work. One common sign that an employee is over-protected is removal of their hearing protection when communicating. Over-protection can also lead to less use or improper use of hearing protection.

**How? At your workplace, we recommend these specific actions:**



**If providing earplugs for use during dental procedures, provide earplugs with a lower noise reduction rating.**

- For employees conducting dental procedures in the procedure area, hearing protectors do not need to attenuate (reduce) noise levels by more than 15 decibels.



### **Train employees on proper use of hearing protection.**

- More information on the proper use of soft foam earplugs may be found at <https://www.cdc.gov/niosh/mining/content/earplug.html>.



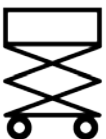
### **Measure employees' noise exposures in the kennel area to determine what hearing protection is required.**

- Previous Health Hazard Evaluations have measured kennel employee noise exposures above occupational exposure limits and hearing loss among kennel employees: <https://www.cdc.gov/niosh/hhe/reports/pdfs/2006-0212-3035.pdf> and <https://www.cdc.gov/niosh/hhe/reports/pdfs/2006-0196-3036.pdf>.

## **Recommendation 2: Provide equipment and workstations that are ergonomically designed to minimize musculoskeletal disorders in employees performing dental procedures**

Why? Musculoskeletal disorders are conditions that involve the nerves, tendons, muscles, and supporting structures of the body. They can be characterized by chronic pain and limited mobility. A substantial body of data provides strong evidence of an association between musculoskeletal disorders and certain work-related factors (physical, work organizational, and psychosocial). The preferred method for preventing and controlling work-related musculoskeletal disorders is to design tasks, workstations, and tools and other equipment to match the physiological, anatomical, and psychological characteristics and capabilities of the employee.

### ***How? At your workplace, we recommend these specific actions:***



#### **Provide procedure tables where the height can be adjusted.**

- If fully adjustable tables are not feasible, set procedure tables at different heights for various sizes of employees or animals.
- Seated workstations are recommended if the job is visually demanding.
- Seated hand-working heights should be adjustable 27"–36" or fixed at 36".
- Seated workstation clearance should be greater than 18" for knee depth and greater than 30" for knee width.
- Reaching distance for tools (from standing or sitting positions) should be less than 16".
- Height-adjustable chairs with back support should be provided. Include a footrest, if needed.
- Rounded table edges are preferred to reduce contact stress with sharp table edges.





### **Provide mobile, adjustable medical computer carts.**

- The top of the screen (display viewing height) when seated should be adjustable 35"–46" or fixed at 46".
- The top of the screen (display viewing height) when standing should be adjustable 58"–71" or fixed at 66".
- The viewing distance (distance from screen) should be adjustable 18"–30" or fixed at 23".
- The standing hand-working heights should be adjustable 38"–47" or fixed at 42".



### **Provide surgical loupes to reduce neck flexion/forward tilt.**

- Employees should be able to adjust the vertical angle of the loupes to reduce neck flexion.



### **Provide antifatigue mats near procedure tables.**

- Mats should cover the entire area that employees move while performing their work task.
- Mats should be greater than 0.5" thick and have an optimal compressibility of 3%–4%.
- Mats should have beveled edges to minimize trip hazards. Place them at least 8" under a workstation to prevent uneven standing surfaces.
- Mats should be replaced when they appear worn out or are damaged.



### **Educate employees on musculoskeletal disorders and ergonomics.**

- Include information about specific tasks that may cause or are likely to cause musculoskeletal disorders.
- Teach employees how they can avoid musculoskeletal disorders (e.g., wrists should be kept in neutral postures, without straining, as much as possible to reduce the risk of musculoskeletal disorders).

### Recommendation 3: Address other health and safety issues we identified during our evaluation

Why? A workplace can have multiple health hazards that cause worker illness or injury. These hazards can potentially cause serious health symptoms, lower morale and quality of life for your employees, and increase costs to your business. Although not the primary focus of our evaluation, we saw the following potential hazards:

- Work practices that are not in compliance with bloodborne pathogen exposure prevention
- X-rays taken in a shared space
- Trip hazards in the procedure area
- Placement of autoclave and vending machine
- Improper chemotherapy drug storage
- Latex gloves

**How? At your workplace, we recommend these specific actions:**



#### **Follow the Occupational Safety and Health Administration's bloodborne pathogens standard.**

- Provide initial and annual bloodborne pathogens training to employees who encounter animal body fluids.
- Use gloves and other appropriate personal protective equipment when body fluids are present.
- Do not recap used needles.
- To best protect employees, the American Veterinary Medical Association recommends voluntary compliance with this standard. More information on the bloodborne pathogens standard may be found at <https://www.osha.gov/SLTC/bloodbornepathogens/> and <https://www.cdc.gov/niosh/topics/bbp/genres.html>.



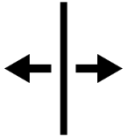
#### **Avoid taking X-rays outside of a radiology or imaging room.**

- Ensure all other employees leave the room every time an X-ray is taken if outside of a radiology or imaging room.
- Do not take more than the minimum number of X-rays necessary for diagnosis.
- Conduct baseline radiation monitoring to determine if additional radiation monitoring is required. More information on personal radiation monitoring can be found at <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1096>.
- Educate employees annually on radiation safety.



**Remove any slip, trip, and fall hazards from the floor.**

- Unplug and put away equipment and power cords that are not in use.
- Install overhead electrical outlets or retractable cords.
- Find more information on slip, trip, and fall hazards in healthcare settings in the National Institute for Occupational Safety and Health (NIOSH) publication [Slip, Trip and Fall Prevention for Healthcare Workers](#).



**Move the vending machine away from the autoclave to reduce the potential for contamination.**



**Properly label chemotherapy drugs and store them in a room that is not used for storing other items or doing other work.**

- More information on occupational hazards associated with these drugs can be found in the [NIOSH Alert: Preventing Occupational Exposures to Antineoplastic and Other Hazardous Drugs in Health Care Settings](#).



**Do not use latex gloves in the veterinary hospital to prevent possible allergic reactions.**

- Remove latex gloves from the facility.
- Continue providing powder-free nitrile gloves to employees.
- More information on occupational hazards associated with latex exposure can be found in the [NIOSH Alert: Preventing Allergic Reactions to Natural Rubber Latex in the Workplace](#).

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# Supporting Technical Information

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Evaluation of Employee Noise Exposures and  
Ergonomic Risks During Dental Procedures at a  
Veterinary Hospital

HHE Report No. 2018-0165-3374

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## Section A: Workplace Information

### Employee Information

- Total employees: 67
- Number of employees working at time of evaluation: 36
- Length of shift: approximately 8 hours
- Median age: 29 years (range: 21–63 years)
- Median job tenure: 2.6 years (range: < 1–30 years)
- Median time in veterinary duties: 5 years (range: < 1–38 years)
- Sex: 83% female
- Job titles: veterinarians (10), veterinary technicians (21), and assistants (5)
  - Because of the similarity in tasks, in this report, “veterinary technicians” refers to the job titles of veterinary nurses, veterinary technicians, and certified veterinary technicians.

### Employees Performing Dental Procedures

- Number of employees performing dental procedures: 19 (53%)
- Median tenure conducting dental procedures: 6 years (range: < 1–38 years)
- Median time per week conducting dental procedures: 4 hours (range: 1–16 hours)

Veterinarians primarily used electric dental drills, nonpowered hand tools, and pressurized water during dental procedures, while veterinary technicians used ultrasonic scalers, polishers, and nonpowered hand tools. Dental procedures typically lasted 30 to 90 minutes, with up to five procedures completed per day.

### History of Issue at Workplace

Employees reported concerns to us about possible hearing loss from using noise-generating dental equipment including electric dental drills and ultrasonic scalers. Employees reported a recent increase in the use of dental radiographs (X-rays) to identify dental disease in small animal veterinary medicine. This led to concerns over an increased amount of dental procedures with the increased amount of associated noise exposure. The employee requestors also expressed concerns about ergonomic stressors while performing dental procedures when we spoke to them prior to the evaluation.

## **Process Description**

### **Dental Cleaning**

Veterinary technicians sedated and intubated the animal on a procedure table. The animal was then anesthetized. A veterinary technician cleaned the animal's teeth on one side using a hand scaler and an ultrasonic scaler and inspected teeth for potential problems. After the teeth were cleaned, the veterinary technician polished the teeth with an electric tooth polisher. An air-water syringe (sprayer) was also used throughout the cleaning to wash out the animal's mouth. With the help of another veterinary technician, the animal was turned to the other side, and the cleaning and polishing process was repeated for the second side.

### **Radiography**

Following the dental cleaning, the veterinary technicians took dental radiographs of noted problem areas to determine if the animal's teeth required further treatment by the veterinarian.

### **Additional Dental Procedures**

When needed, the veterinarian extracted teeth. The veterinarian injected a local anesthetic and used an electric dental drill to loosen or break teeth to aid in tooth extraction. The length of drilling depended on the number of teeth requiring extraction and the size, location, and difficulty of the tooth extraction(s).

## Section B: Methods, Results, and Discussion

Our evaluation had the following objectives:

- Assess employee noise exposures.
- Evaluate noise levels and noise frequency characteristics of dental instruments (e.g., ultrasonic scaler, polisher, drill).
- Determine the prevalence of employee symptoms related to work-related noise exposures.
- Determine the potential for musculoskeletal disorders among employees.
- Determine the prevalence of employee symptoms related to work-related ergonomic stressors.

### Methods: Noise Exposure and Hearing Health

We evaluated employees' noise exposures through (1) full-shift noise dosimetry measurements, (2) measuring area sound levels during dental procedures, and (3) observations.

We collected full-shift time-weighted average (TWA) personal noise samples:

- We collected samples from 10 employees over two days.
- We took the samples in the dental procedure area.
- We used Larson Davis Spark™ 706 RC integrating noise dosimeters.
- We placed the dosimeter microphone on the top of the employee's shoulder at the midpoint between the neck and edge of the shoulder. For veterinary technicians and veterinarians, we placed one dosimeter microphone on each side of the employee's shoulder to compare right and left ear noise exposures.
- We took noise dosimetry measurements using three different settings to compare with the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL), the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL), and the OSHA action level (AL).

We also collected instantaneous area sound levels:

- We took the samples in the dental procedure area.
- We used a Larson Davis Model 824 integrating sound level meter.
- We measured one-third octave band noise frequency levels (i.e., measurement of noise levels across 30 different frequencies).
- We positioned the instrument at a height of approximately 5 feet above the floor and within 3–6 feet of the employees or the primary noise source in the area.



## Hearing Health

We interviewed employees and asked about workplace noise, hearing protection, and hearing health. We asked them questions about hearing loss derived from the Philadelphia Hearing Scale Study [Schein et al. 1970]. We also asked employees if they had tinnitus by inquiring if they had ringing, roaring, or buzzing in their ears for five minutes or more. If employees responded yes, they were asked the frequency (every day, every week, every month, or less than one time per month) and if this started after initiating work at the facility.

We asked employees if they wore hearing protection while at work. If employees reported using hearing protection, we asked during which tasks they wore hearing protection and when hearing protection use was initiated (month and year).

## Results: Noise Exposure and Hearing Health

### Personal Noise Exposures

A summary of personal noise dosimetry results collected on 10 employees over two work shifts is in Table C1. We compared employees' noise monitoring results with the noise exposure limits set by NIOSH and OSHA. These occupational noise exposure limits are meant to be the amount of noise that most employees can be exposed to without substantial risk of hearing loss. OSHA and NIOSH measure and calculate noise exposures in different ways, as described in Section D. For an 8-hour work shift, the NIOSH REL is 85 decibels, A-weighted (dBA). The OSHA AL is 85 dBA, and the OSHA PEL is 90 dBA. Employers are required to keep noise exposures below the OSHA PEL; however, the NIOSH REL is more protective.

Results showed that employees in all job titles we monitored had full-shift TWA noise exposures below the NIOSH REL. We found minimal differences between the measurement results taken near an employee's right and left ears. All employees we observed performing dental procedures were right-handed.

We observed five dental cleanings on Day 1 and three dental cleanings on Day 2. All dental cleanings were performed on dogs. Following dental cleanings and X-rays, a drill was used for tooth extraction(s) on one dog on Day 1 and on three dogs on Day 2. Dental cleanings and procedures sometimes occurred at the same time on tables located approximately 5 feet from one another. The veterinary technicians and veterinarians performing cleanings and procedures were different on both days.

### Noise from Dental Instruments

During dental cleanings, veterinary technicians typically held dental instruments 2 feet or less from their ears. The maximum instantaneous area sound levels we collected while employees used the ultrasonic scaler was 78 dBA; while they used the tooth polisher, it was 73 dBA.

Employees expressed concerns about the high frequency nature of the noise generated by the ultrasonic scaler. We used one-third octave band sound level measurements to identify the dominant frequencies of the noise generated during the use of dental instruments. One-third octave band sound level measurements taken during ultrasonic scaler use revealed that the highest sound levels were generally at frequencies above 3,150 Hertz (Hz), with dominant frequencies of 4,000 Hz; 8,000 Hz; and 16,000 Hz

(Figure B1). There was a peak in the lower frequencies of 16 Hz and 20 Hz identified for the 66.4 dBA measurement; this peak is likely not associated with the ultrasonic scaler.

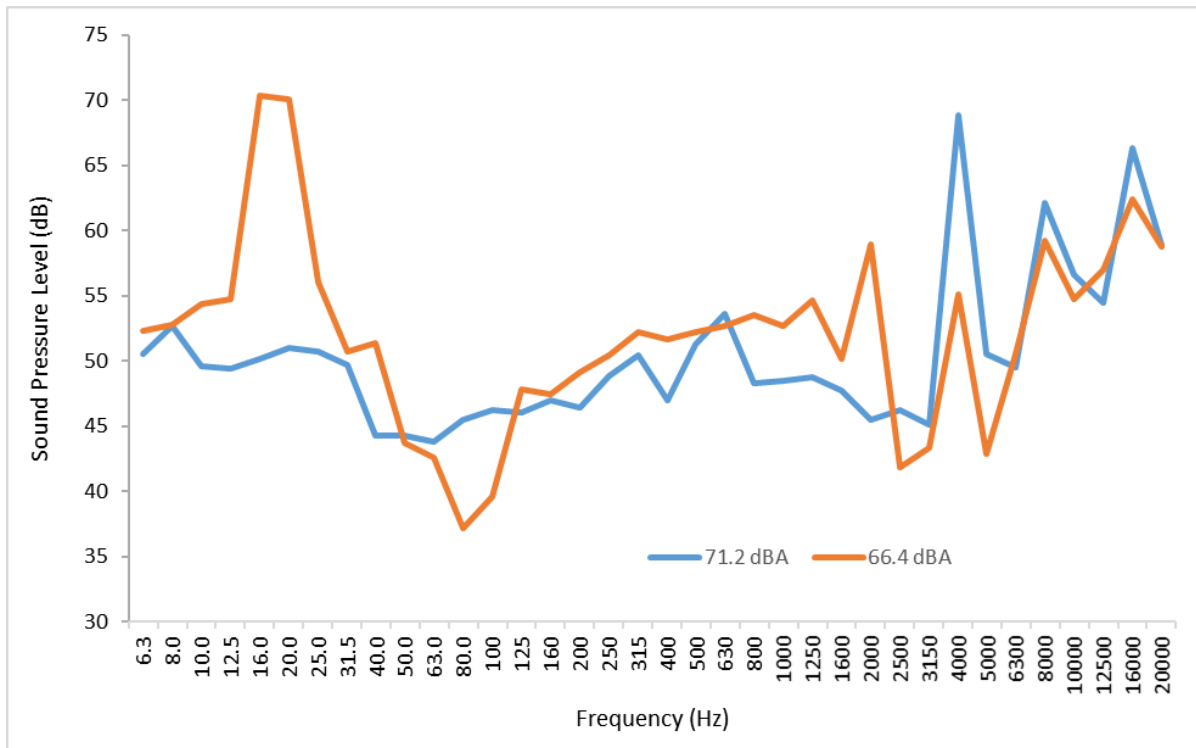


Figure B1. One-third octave band frequencies for the ultrasonic scaler. The dominant frequencies for both measurements were 4,000 Hz; 8,000 Hz; and 16,000 Hz. The 66.4 dBA measurement also had a dominant frequency at 16 Hz and 20 Hz. The sources of the noise at these frequencies is unknown and could be from other instruments or equipment in the vet hospital.

During tooth extractions, veterinarians typically held the drill about 2 feet or less from their ears. Drill use was typically intermittent and shorter in duration than dental cleaning instrument use. The maximum instantaneous area sound level during drill use was 80 dBA. Employees also expressed concerns about the high frequency nature of the noise generated by the drill. One-third octave band sound level measurements taken during drill use revealed that the highest sound levels were generally at frequencies above 5,000 Hz (Figure B2).

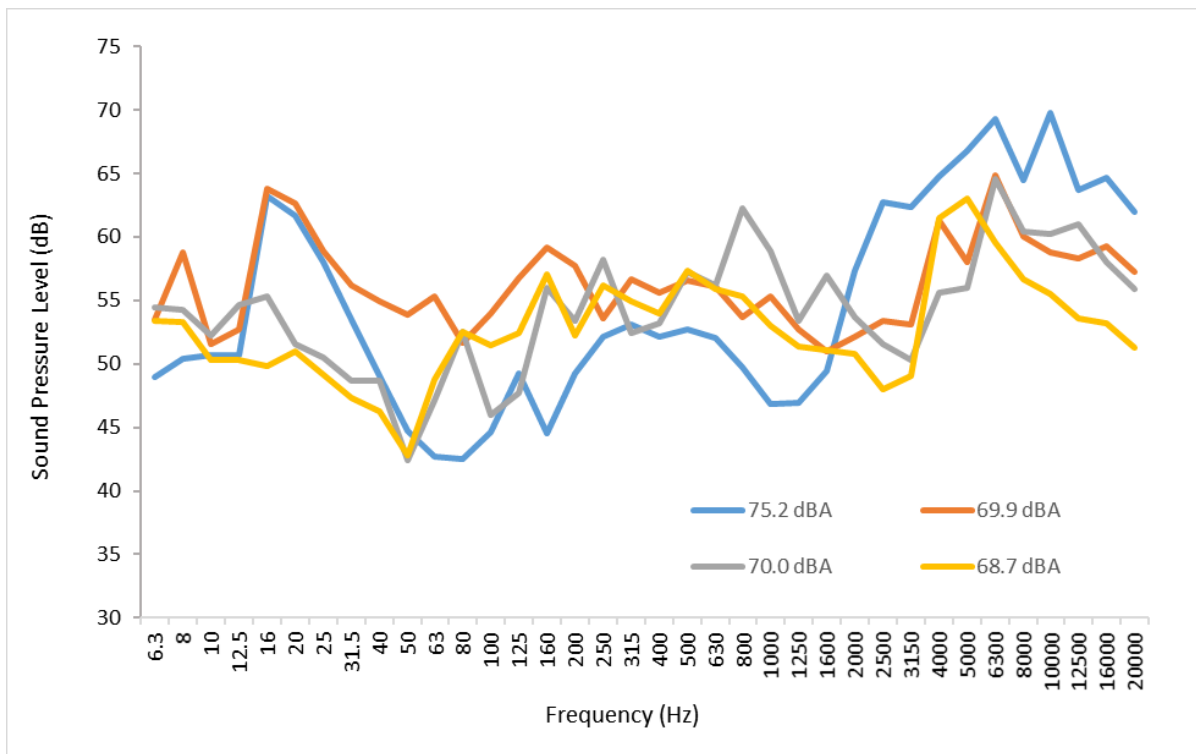


Figure B2. One-third octave band frequencies during drill use. The dominant frequencies for drill use were above 5,000 Hz.

### Hearing Health

Out of 36 employees, 32 (89%) reported good hearing in at least one ear, 30 (83%) reported good hearing in both ears, and 6 (17%) reported they had a little or a lot of trouble hearing in one or both ears.

Out of 36 employees, 8 (22%) reported they had ringing, roaring, or buzzing (tinnitus) in their ears that lasted 5 minutes or more. All eight employees performed dental procedures. Four of these employees noted that this occurred every day, while the other four employees reported that it occurred one time per month or less. Employees who performed dental procedures self-reported tinnitus in higher proportion than those employees who did not perform dental procedures (prevalence ratio 1.73; confidence interval 1.18–2.53). However, of these eight employees, only three (38%) mentioned that the ringing, roaring, or buzzing started after working at this facility. We did not ask about nonoccupational sources that could cause tinnitus, or if employees perceived their tinnitus to have worsened since starting work at this facility.

### Personal Protective Equipment Use

The veterinary hospital provided foam insert ear plugs (labeled noise reduction rating of 32 decibels [dB]) to their employees. We observed most employees wore hearing protection while conducting dental procedures. We observed that the ear plugs were not fully inserted when used.

Out of 36 employees, 19 (53%) reported wearing hearing protection while at work. The most common task during which employees reported wearing hearing protection was performing kennel work (12 of

19 employees; 63%). These employees reported infrequently entering the kennel but reported wearing ear plugs when they did.

Of the 19 employees that reported wearing hearing protection while at work, 10 (53%) employees did so while conducting dental procedures. Three or fewer employees wore ear plugs when operating the compressor or performing other tasks. One veterinary technician noted difficulty hearing monitoring instruments when wearing hearing protection.

## Methods: Ergonomic Assessment and Musculoskeletal Health

We observed workplace conditions and work practices to identify ergonomic risk factors. We measured workstation heights and tool dimensions and noted the availability of antifatigue mats and other personal protective equipment (PPE). We asked employees if they had hand or wrist, arm or shoulder, or neck or back issues over the past 12 months that could be caused by ergonomic stressors. If employees reported that they had these symptoms, we asked if their symptoms were related to an activity at work. If employees reported that it was related to an activity, we asked about specific work tasks performed during veterinary dental procedures and offered an open-ended response. If employees related symptoms to an accident, we asked them to provide an open-ended response of the nature of the accident. For employees who reported back pain, we asked them to specify if it was upper back pain, lower back pain, or both.

## Results: Ergonomic Assessment and Musculoskeletal Health

### Ergonomic Assessment

We evaluated two tables where dental procedures were performed. Neither table could be adjusted and were at fixed heights of 38" and 39". One table had a curved front that allowed leg access when seated (Figure B3). However, taller employees did not have much leg access under the curved table. This limited their ability to place their legs under the table and led to farther reach distances. The other table had a sink basin and legs that restricted the employee's leg placement when seated (Figure B4). When we observed employees using this table, we saw them working from the corner, standing to the side and bending at the back, or straddling this table to use it. Because of the way the procedure tables were designed, we observed that employees were not able to sit all the way back in the chair or use the back rest on the chair. Additionally, the tables had edges that could cause contact stress when forearms or wrists were resting on the table.



Figure B3. Fixed-height table for dental procedures with curved front allowing leg access while employees are seated. Photo by NIOSH.



Figure B4. Fixed-height table with sink basin under the top of the table. The table design does not allow employees to place legs under this table while performing dental procedures. Photo by NIOSH.

We also observed employees performing dental procedures bending at the neck when seated or bending at the back when standing to optimize their visual fields during procedures. The lack of adjustability of the tables contributed to employees having to bend at the neck or back. We did not observe employees performing dental procedures using magnification devices, such as surgical loupes.

Employees used various precision tools for dental procedures. The tools were approximately 3"–4" long and 0.25"–1" in diameter. Some tools were spring-loaded to return to an open position. For sterilization purposes, all the tools were metal. Most were contoured and had etched surfaces for improved grip.

The employees accessed information on a laptop placed on a rolling cart. The cart height was not adjustable, so when standing, the employee had to bend at the back to see the screen or to type. The floor was ceramic tile. No antifatigue mats were available for use on the floor around the dental procedure tables.

## Musculoskeletal Health

### Some employees reported work contributed to back pain

Of the 36 employees working during our evaluation, 13 (36%) reported back pain that lasted for one week or more in the past 12 months. Of these, 5 (38%) were veterinarians and 8 (62%) were veterinary technicians. Of these 13 employees reporting back pain, 6 (46%) performed dental procedures, and 6 (46%) said their back pain was related to an activity at work. The most common work activities these employees reported were repeated bending (4 of 6, 67%) and repeated lifting of animals or equipment (4 of 6, 67%). Two or fewer employees reported that their back pain was related to repeated twisting or sitting for extended periods of time, awkward postures when handling animals, pushing or pulling of animals or equipment, or an accident at work. We did not note any difference in back pain reporting in employees performing dental procedures compared to employees who did not perform dental procedures.

### Some employees reported work contributed to neck pain

Of the 36 employees working during our evaluation, 6 (17%) reported neck pain, with 3 (50%) of those 6 reporting that an activity at work contributed to the pain. Three employees reporting neck pain were veterinarians and three were veterinary technicians. All employees who reported that neck pain was associated with their work performed dental procedures and engaged in repeated bending of the neck, which contributed to this pain. We did not note any difference in neck pain reporting in employees performing dental procedures compared to employees who did not perform dental procedures.

### **Some employees reported that work contributed to upper extremity symptoms**

We asked employees about hand and wrist symptoms that may be associated with ergonomic stressors. Of the 36 employees evaluated, 8 (22%) reported experiencing one or more symptoms in the past 12 months. Of these 8 employees, 7 (88%) performing dental procedures reported hand and wrist symptoms. Employees performing dental procedures reported hand and wrist symptoms more commonly than employees who did not perform dental procedures (prevalence ratio 1.5; confidence interval 1.03–2.41). However, only half (50%) of the employees reporting hand and wrist symptoms noted that work made their symptoms worse. We did not ask about preexisting medical conditions or nonoccupational sources that could cause hand or wrist discomfort.

Of the 36 employees working during our evaluation, 7 (19%) reported shoulder or arm pain every day for a week or more in the past 12 months. We did not note any difference in shoulder or arm pain reporting in employees performing dental procedures compared to employees who did not perform dental procedures. Two or fewer employees reported that their pain was related to an activity or accident at work.

### **Methods: Other Health and Safety Issues**

We collected information about other health and safety issues at the veterinary hospital through (1) observations of workplace conditions and practices and (2) review of the OSHA 300 Log of Work-Related Injuries and Illnesses for January 1, 2015, through December 31, 2017.

### **Results: Other Health and Safety Issues**

We observed dental X-rays taken outside of a radiation room and in the dental procedure area. The dental procedure area was a crowded open area where employees worked while the X-rays were taken. Verbal warnings were given a few seconds prior to the taking of the X-ray. We observed that sometimes X-rays of the same area of the animal's mouth were taken multiple times. We observed that some employees wore radiation dosimeters.

We observed multiple trip hazards, including monitor carts and power cords for equipment and electronics not in use, laying across the floor in the dental procedure area. These trip hazards were worsened by and contributed to the crowded conditions in the area.

We observed several nonideal placements and positionings of equipment, likely the result of limited space within the veterinary hospital. The vending machine and the autoclave machine sat side-by-side in the same room (Figure B5). Chemotherapy drugs were stored in a small labeled refrigerator in a room that also served as a storage area for other items (Figure B6).



Figure B6. Vending machine and autoclave machine next to each other in the same room. Photo by NIOSH.



Figure B5. Chemotherapy drug refrigerator in a room used to store other items. Photo by NIOSH.

We observed that employees were not following standard bloodborne pathogen protocols, which are required in human medicine facilities. Specifically, we observed employees recapping used needles, handling bloody materials without gloves, and using glasses without splash protection (i.e., splash shields). Bloodborne pathogens training was not provided to employees; this training is not required by OSHA in animal care facilities.

The veterinary hospital had a box of latex gloves for use by employees; we did not observe any employees using latex gloves.

The OSHA 300 Log contained five injuries in 2015, four injuries in 2016, and one injury in 2017. All injuries were dog or cat bites.

## Discussion

Dental radiographs are routinely recommended, even for dental prophylaxis procedures [Hale 2013; Holmstrom et al. 2004]. The American Animal Hospital Association guidelines recommend performing a complete examination in all dogs and cats that have been anesthetized, which includes radiographic examination [Holmstrom et al. 2004]. Radiography can identify early dental disease, which can subsequently result in more frequent scheduling of dental procedures and surgeries for veterinarians and veterinary technicians [Holmstrom et al. 2004]. During these procedures, high-speed dental equipment is routinely used and may result in more frequent exposure to noise and more frequent use of dental equipment [Koch 2018].

Hearing loss and tinnitus are common conditions in the United States [Masterson et al. 2016]. Research has shown that dental professionals may have higher levels of noise-induced hearing loss (NIHL) and tinnitus than other job series [Burk and Neitzel 2016; Gonçalves et al. 2015; Messano and Petti 2012; Myers et al. 2016; Willershausen et al. 2014]. However, exposure assessments of noise in dental environments have shown variable results, with some studies finding levels of noise above occupational

exposure limits (OELs), while others have measured levels below applicable OELs [Burk and Neitzel 2016; Choosong et al. 2011; Jadid et al. 2011; Setcos and Mahyuddin 1998]. Although there are studies evaluating noise exposures and health effects in the human dental environment, little has been published regarding noise exposures and health effects in the animal dental environment.

We found that noise from the ultrasonic scaler and drill were higher in frequency in nature, but these dental tools produced a relatively low level of noise. Our evaluation found that veterinarians and veterinary technicians at this facility did not have noise exposures above OELs. Our noise measurement results were consistent with our assessment of hearing loss outcomes, which revealed that employees infrequently reported hearing loss. Employees who performed dental work were more likely to report tinnitus compared to those who did not perform dental work. However, we did not ask about nonoccupational exposures or use of medications that could cause or contribute to tinnitus, or if the tinnitus worsened since initiating work at this facility. We did not measure noise exposures or noise sources during dental procedures or in the procedure room that would be likely to lead to hearing loss. However, several employees were concerned about noise levels in the kennel area, and previous research has shown high noise levels in kennels that could contribute to noise exposures and the potential for effects on hearing.

While veterinarians and veterinary technicians did not experience noise exposures above OELs, employees reported concerns about noise levels in the kennel area and when retrieving dogs in the boarding rooms. Previous research has shown that noise levels in kennels may reach levels that exceed the OSHA PEL of 90 dBA or the NIOSH REL of 85 dBA [NIOSH 2007a,b,c,d]. Although not included within the scope of this evaluation, it would be prudent to perform a noise exposure assessment of the kennel space to determine the extent of noise levels and if preventive measures should be undertaken to reduce the risk of negative hearing health outcomes.

Despite low levels of noise, some employees used high-attenuation (high-reduction) hearing protection (labeled noise reduction rating of 32 dB) during dental procedures. This high level of attenuation (reduction) could result in overprotection, or more attenuation of noise than is needed based on the measured noise levels. Overprotection may interrupt communication among staff and prevent employees from hearing monitoring equipment (e.g., heart rate monitors) or their surroundings. One of the veterinary technicians noted difficulty hearing monitoring instruments when wearing hearing protection. We observed employees not fully inserting hearing protection into the ear canal. This could be a result of incomplete training on the use of hearing protection or a sign of too much hearing protection. If employees have too much hearing protection, provide them with hearing protectors that only attenuate noise levels to below hazardous levels at the ear. For employees conducting dental procedures in the procedure area, this would mean that hearing protectors should not attenuate noise levels by more than 15 dB. Flat attenuation earplugs, which reduce sound equally across all frequencies and maintain the clarity of music and speech, may be a good choice for these employees. Higher attenuation would be needed in the kennel area.

We observed employees working in awkward postures, using forceful exertions, and performing repetitive motions during dental procedures. These activities can lead to musculoskeletal disorders, which can be characterized by chronic pain and limited mobility. Evidence shows that job tasks



requiring a combination of risk factors (highly repetitive, forceful hand or wrist exertions) increase risk for hand or wrist tendonitis [NIOSH 1997a]. Additionally, low back disorders are associated with work-related lifting, forceful movements, and awkward postures such as bending and twisting [NIOSH 1997a]. Although personal factors such as age, sex, smoking, physical activity, strength, and body measurements may affect an individual's susceptibility to overexertion injuries/disorders, studies conducted in high-risk industries show that the risk associated with these personal factors is smaller than the risk associated with their occupational exposures [NIOSH 1997a]. Many of our recommendations are adapted from principles outlined in *The Handbook of Ergonomic Design Guidelines* [Humantech 2009].

Numerous studies have shown that dental professionals (in human dentistry) may be exposed to ergonomic stressors and may experience neck pain, upper extremity disorders, and back pain [Aminian et al. 2012; De Sio et al. 2018; Gupta et al. 2013; Occhionero et al. 2014; Sakzewski and Naser-ud-Din 2014]. A review paper authored by De Sio et al. [2018] identified that extreme forward head tilt was the most frequently observed incorrect posture in dental professionals. Additional research has shown that veterinary practitioners have ergonomic stressors associated with musculoskeletal pain [Randall et al. 2012; White 2012].

Research on stressors and outcomes related specifically to veterinary dentistry is limited. One study by Kozak et al. [2014] concluded that veterinarians who frequently perform dental work had greater odds of developing musculoskeletal disorders in the neck than veterinarians who did not perform dental work. This association was noted for veterinarians who performed 600 or more dental procedures per year [Kozak et al. 2014]. Another study by Scuffham et al. [2010] found a significant difference in musculoskeletal discomfort for veterinarians performing over 600 dental procedures per year than veterinarians performing fewer than 600 dental procedures. We observed employees using forceful exertions and repetitive motions of the hands during veterinary dental procedures. The tools being used met the recommended guidelines. Specifically, they were oval or circular with the appropriate handle length, diameter, and nonslip surface. However, due to the procedure table design and chair use, the employees used awkward wrist postures to complete the dental tasks. Furthermore, employees performing dental procedures had a higher prevalence of self-reported hand and wrist symptoms than employees who did not perform dental procedures.

We observed that employees had static and repeated forward flexion (bending) of the neck during dental procedures. This may be because of the small visual window during procedures, requiring veterinarians and veterinary technicians to get a "closer look" during dental procedures or surgery. None of the employees we observed performing dental procedures used surgical loupes. Properly selected and positioned magnification systems, such as surgical loupes, can help reduce forward neck flexion; loupes that are vertically adjustable allow for employees to adjust the declination angle to reduce their need to bend at the neck or back. Employees may use magnification over safety glasses to reduce the frequency of forward flexion of the neck, and the development of neck pain [Holmstrom et al. 2004].

The American Veterinary Medical Association recommends voluntarily complying with the OSHA Bloodborne Pathogen standard [29 CFR 1910.1030] with regards to medical waste, or any waste that

contains potentially infectious material [National Association of State Public Health Veterinarians 2010]. The OSHA Bloodborne Pathogen standard generally applies only to occupational exposures to human blood (or animal blood used in research that is known to be infected with human immunodeficiency virus or hepatitis B virus) [29 CFR 1910.1030]. In human medicine, controlling bloodborne pathogen risks is crucial to preventing the spread of infectious disease. In veterinary medicine, these risks are not as widely recognized or controlled.

A survey using questionnaires conducted in 2005 revealed that most veterinarians in the United States did not engage in the proper work practices or use appropriate PPE to help reduce zoonotic disease transmission [Wright et al. 2008]. However, the risk of emerging zoonotic diseases increases the need for effective infection control practices and policies. These infection control practices may include disposing of used sharps in appropriately labeled sharps containers and wearing gloves and other appropriate PPE (e.g., apron, respiratory protection, eye protection) during procedures and when handling materials contaminated by animal body fluid. Limited space in the animal hospital resulted in the problematic placement of the autoclave next to a vending machine. This is not ideal because instruments entering the autoclave may be contaminated with animal body fluids, which could result in potential contamination of the vending machine or its contents once dispensed.

We observed X-rays being taken in the treatment room while multiple staff continued with animal care duties. In most cases, it is best if the veterinary diagnostic X-ray machine is installed in a separate room or isolated area where employees are protected from potential radiation exposure, and where operations of the practice will not be disrupted [Seibert 2003]. Having the machine installed in an open environment may be acceptable, if the room can adequately be cleared of all staff prior to taking X-rays [Seibert 2003].

Because of limited space, the chemotherapy drugs were stored in a small refrigerator in an openly accessible room also used for storage. Chemotherapy and other hazardous drug exposure may result in adverse health effects including skin rashes, infertility, miscarriage, birth defects, and possibly cancer, and workers may be exposed throughout the life cycle of these drugs from manufacture to disposal [NIOSH 2004]. Chemotherapy drugs should be stored separately from other drugs or equipment in an area with sufficient general exhaust ventilation, ideally at negative pressure, and near where they will be used or compounded [NIOSH 2004; USP 2019]. Access to this storage area should be limited to authorized personnel.

Crowding in the animal hospital also led to the placement of equipment and loose cords and cables on the floor in the dental procedures area that could potentially lead to a slip, trip, or fall. Equipment and cords can become caught on an employee's foot and lead to a fall incident. Information on slip, trip, and fall hazards common in healthcare settings and ways to prevent them can be found in the NIOSH publication [Slip, Trip, and Fall Prevention for Healthcare Workers](#) [NIOSH 2010].

The veterinary hospital provided latex gloves, along with nitrile gloves, for employees to use. Latex glove use may cause skin irritation or skin allergy in some employees. Information on the occupational hazards associated with latex exposure can be found in the [NIOSH Alert: Preventing Allergic Reactions to Natural Rubber Latex in the Workplace](#) [NIOSH 1997b].

## Limitations

Limitations of our evaluation include the cross-sectional design of the evaluation. Cross-sectional studies collect information on exposures and health outcomes at the same time, so causality cannot be proven. Industrial hygiene sampling can only document exposures on the days of sampling in the locations sampled. For hearing health, we did not ask about nonoccupational exposures that could contribute to outcomes.

## Conclusions

Although few employees complained of noise exposure during dental procedures, some were concerned with noise in the kennel. Employee noise exposures measured during this evaluation were under the lowest occupational exposure limits. We observed employees using awkward positions during dental procedures, along with several other potential workplace hazards that were not part of our initial evaluation. We recommended employees wear hearing protection appropriate for the workplace that will not interfere with communication or job tasks. We also recommended ergonomic workstations and solutions for other observed workplace hazards.

## Section C: Tables

Table C1. TWA personal noise exposure results (dBA)

Day	Job title	Side	Result using NIOSH REL criteria	Result using OSHA AL criteria	Result using OSHA PEL criteria
1	Veterinarian 1	Right*	77.8	71.9	59.3
		Left	77.5	71.5	58.4
	Certified veterinary technician	Right*	76.4	69.1	57.6
		Left	77.1	70.9	57.9
	Veterinary nurse 1	Right*	76.4	69.9	53.4
		Left	70.5	60.4	42.7
	Veterinary technician	Right*	70.9	60.9	43.9
		Left	63.1	46.3	38.0
	Technician assistant 1	Right	69.7	57.2	49.3
	Technician assistant 2	Right	67.7	54.2	44.1
	2	Veterinarian 2	Right*	81.5	76.4
Left			77.6	71.0	60.3
Veterinary nurse 2		Right*	73.4	64.9	51.6
		Left	76.6	68.2	57.2
Technician assistant 3		Right	74.7	66.5	54.7
Veterinary nurse 3		Right*	65.3	53.1	26.3
		Left	61.9	46.9	26.9
Noise exposure limits (8-hour work shift)			85	85	90

\*Dominant hand

## Section D: Occupational Exposure Limits

NIOSH investigators refer to mandatory (legally enforceable) and recommended OELs for chemical, physical, and biological agents when evaluating workplace hazards. OELs have been developed by federal agencies and safety and health organizations to prevent adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure that most employees may be exposed to for up to 10 hours per day, 40 hours per week, for a working lifetime, without experiencing adverse health effects.

However, not all employees will be protected if their exposures are maintained below these levels. Some may have adverse health effects because of individual susceptibility, a preexisting medical condition, or a hypersensitivity (allergy). In addition, some hazardous substances act in combination with other exposures, with the general environment, or with medications or personal habits of the employee to produce adverse health effects. Most OELs address airborne exposures, but some substances can be absorbed directly through the skin and mucous membranes.

Most OELs are expressed as a TWA exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limits (STEL) or ceiling values. Unless otherwise noted, the STEL is a 15-minute TWA exposure. It should not be exceeded at any time during a workday. The ceiling limit should not be exceeded at any time.

In the United States, OELs have been established by federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits; others are recommendations.

- OSHA, an agency of the U.S. Department of Labor, publishes permissible exposure limits [29 CFR 1910 for general industry; 29 CFR 1926 for construction industry; and 29 CFR 1917 for maritime industry] called PELs. These legal limits are enforceable in workplaces covered under the Occupational Safety and Health Act of 1970.
- NIOSH RELs are recommendations based on a critical review of the scientific and technical information and the adequacy of methods to identify and control the hazard. NIOSH RELs are published in the *NIOSH Pocket Guide to Chemical Hazards* [NIOSH 2007e]. NIOSH also recommends risk management practices (e.g., engineering controls, safe work practices, employee education/training, PPE, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects.
- Another set of OELs commonly used and cited in the United States includes the threshold limit values or TLVs, which are recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH TLVs are developed by committee members of this professional organization from a review of the published, peer-reviewed literature. TLVs are not consensus standards. They are considered voluntary exposure guidelines for use by industrial hygienists and others trained in this discipline “to assist in the control of health hazards” [ACGIH 2020].

Outside the United States, OELs have been established by various agencies and organizations and include legal and recommended limits. The Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (Institute for Occupational Safety and Health of the German Social Accident Insurance) maintains a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the United States. The database, available at <https://www.dguv.de/ifa/gestis/gestis-stoffdatenbank/index-2.jsp>, contains international limits for more than 2,000 hazardous substances and is updated periodically.

OSHA (Public Law 91-596) requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm. This is true in the absence of a specific OEL. It also is important to keep in mind that OELs may not reflect current health-based information.

When multiple OELs exist for a substance or agent, NIOSH investigators generally encourage employers to use the lowest OEL when making risk assessment and risk management decisions.

## Noise

NIHL is an irreversible condition that progresses with noise exposure. It is caused by damage to the nerve cells of the inner ear and, unlike some other types of hearing disorders, cannot be treated medically [Berger et al. 2003]. More than 22 million U.S. workers are estimated to be exposed to workplace noise levels above 85 dBA [Tak et al. 2009]. NIOSH estimates that workers exposed to an average daily noise level of 85 dBA over a 40-year working lifetime have an 8% excess risk of material hearing impairment. This excess risk increases to 25% for an average daily noise exposure of 90 dBA [NIOSH 1998]. NIOSH defines material hearing impairment as an average of the hearing threshold levels for both ears that exceeds 25 dB at frequencies of 1,000 Hz; 2,000 Hz; 3,000 Hz; and 4,000 Hz.

Although hearing ability commonly declines with age, exposure to excessive noise can increase the rate of hearing loss. In most cases, NIHL develops slowly from repeated exposure to noise over time, but the progression of hearing loss is typically the greatest during the first several years of noise exposure. NIHL can also result from short-duration exposures to high noise levels or even from a single exposure to an impulse noise or a continuous noise, depending on the intensity of the noise and the individual's susceptibility to NIHL [Berger et al. 2003]. Noise-exposed workers can develop substantial NIHL before it is clearly recognized. Even mild hearing losses can impair a person's ability to understand speech and hear many important sounds. In addition, some people with NIHL also develop tinnitus. Tinnitus is a condition in which a person perceives sound in one or both ears, but no external sound is present. Persons with tinnitus often describe hearing ringing, hissing, buzzing, whistling, clicking, or chirping like crickets. Tinnitus can be intermittent or continuous and the perceived volume can range from soft to loud. Currently, there is no cure for tinnitus.

The preferred unit for reporting noise measurements is dBA. A-weighting is used because it approximates the "equal loudness perception characteristics of human hearing for pure tones relative to a reference of 40 dB at a frequency of 1,000 Hz" and is considered to provide a better estimation of hearing loss risk than using unweighted or other weighting measurements [Berger et al. 2003]. The

OSHA noise standard specifies a PEL of 90 dBA and an AL of 85 dBA, both as 8-hour TWAs. Exposure to impulsive noise should never exceed 140 dBA.

For noise exposure measurements, NIOSH uses an 80-dBA threshold and a 3-dB exchange rate. Noise below the threshold level is not integrated by the noise dosimeter during measurements. The exchange rate expresses how much the sound level could increase or decrease while keeping the risk of hearing loss the same, if the exposure duration was simultaneously decreased or increased. For example, a 3-dB exchange rate requires that noise exposure time be halved for each 3-dB increase in noise levels. NIOSH considers the REL and noise measured using the 3-dB exchange rate to more accurately relate noise exposures to hearing loss risk [NIOSH 1998]. Using this criterion, an employee can be exposed to 88 dBA for no more than 4 hours, 91 dBA for 2 hours, 94 dBA for 1 hour, 97 dBA for 0.5 hours, etc. For extended work shifts NIOSH adjusts the REL to 84.5 dBA for a 9-hour shift, 84.0 dBA for a 10-hour shift, 83.6 dBA for an 11-hour shift, and 83.2 dBA for a 12-hour work shift. When noise exposures exceed the REL, NIOSH recommends the use of hearing protection and implementation of a hearing loss prevention program [NIOSH 1998].

OSHA uses a 90-dBA threshold and a 5-dB exchange rate for the PEL measurements and an 80-dBA threshold and 5-dB exchange rate for the AL measurements. Using the OSHA criterion, an employee may be exposed to noise levels of 95 dBA for no more than 4 hours, 100 dBA for 2 hours, 105 dBA for 1 hour, 110 dBA for 0.5 hours, etc. OSHA does not adjust the PEL for extended work shifts. However, the AL is adjusted to 84.1 dBA for a 9-hour shift, 83.4 dBA for a 10-hour shift, 82.7 dBA for an 11-hour shift, and 82.1 dBA for a 12-hour work shift. OSHA requires implementation of a hearing conservation program when noise exposures exceed the AL [29 CFR 1910.95].

Employees exposed to noise should have baseline and yearly hearing tests to evaluate their hearing thresholds and determine whether their hearing has changed over time. Hearing testing should be done in a quiet location, such as an audiometric test booth where background noise does not interfere with accurate measurement of hearing thresholds. In workplace hearing conservation programs, hearing thresholds must be measured at 500 Hz; 1,000 Hz; 2,000 Hz; 3,000 Hz; 4,000 Hz; and 6,000 Hz. Additionally, NIOSH recommends testing at 8,000 Hz [NIOSH 1998]. The OSHA hearing conservation standard requires analysis of changes from baseline hearing thresholds to determine if the changes are substantial enough to meet OSHA criteria for a standard threshold shift. OSHA defines a standard threshold shift as a change in hearing threshold (relative to the baseline hearing test) of an average of 10 dB or more at 2,000 Hz; 3,000 Hz; and 4,000 Hz in either ear [29 CFR 1910.95]. If a standard threshold shift occurs, the company must determine if the hearing loss also meets the requirements to be recorded on the OSHA Form 300 Log of Work-Related Injuries and Illnesses [29 CFR 1904.1]. In contrast to OSHA, NIOSH defines a significant threshold shift as a change in the hearing threshold level of 15 dB or more (relative to the baseline hearing test) at any test frequency in either ear measured twice in succession [NIOSH 1998].

## Section E: References

### Health Effects of Ergonomic Stressors

Aminian O, Banafsheh Alemohammad Z, Sadeghniaat-Haghighi K [2012]. Musculoskeletal disorders in female dentists and pharmacists: a cross-sectional study. *Acta Med Iran* 50(9):635–640, <http://acta.tums.ac.ir/index.php/acta/article/view/3964>.

De Sio S, Traversini V, Rinaldo F, Colasanti V, Buomprisco G, Perri R, Mormone F, La Torre G, Guerra F [2018]. Ergonomic risk and preventive measures of musculoskeletal disorders in the dentistry environment: an umbrella review. *PeerJ* 6:e4154, <http://dx.doi.org/10.7717/peerj.4154>.

Gupta A, Ankola AV, Hebbal M [2013]. Dental ergonomics to combat musculoskeletal disorders: a review. *Int J Occup Saf Ergon* 19(4):561–571, <http://dx.doi.org/10.1080/10803548.2013.11077005>.

Kozak A, Schedlbauer G, Peters C, Neinhaus A [2014]. Self-reported musculoskeletal disorders of the distal upper extremities and the neck in German veterinarians: a cross-sectional study. *PLoS One* 9(2):e89362, <http://dx.doi.org/10.1371/journal.pone.0089362>.

Holmstrom SE, Frost PF, Eisner ER [2004]. *Veterinary dental techniques for the small animal practitioner*. 3rd ed. Chapter 13. Philadelphia, PA: Elsevier.

Humantech [2009]. *The handbook of ergonomic design guidelines*. Version 2.0. Ann Arbor, MI: Humantech, Inc.

NIOSH [1997a]. *Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 97-141, <http://www.cdc.gov/niosh/docs/97-141/>.

Occhionero V, Korpinen L, Gobba F [2014]. Upper limb musculoskeletal disorders in healthcare personnel. *Ergonomics* 57(8):1166–1191, <http://dx.doi.org/10.1080/00140139.2014.917205>.

Randall E, Hansen C, Gilkey D, Patil A, Bachand A, Rosecrance J, Douphrate D [2012]. Evaluation of ergonomic risk factors among veterinary ultrasonographers. *Vet Radiol Ultrasound* 53(4):459–454, <http://dx.doi.org/10.1111/j.1740-8261.2012.01942.x>.

Sakzewski L, Naser-ud-Din S [2014]. Work-related musculoskeletal disorders in dentists and orthodontists: a review of the literature. *Work* 48(1):37–45, <http://dx.doi.org/10.3233/WOR-131712>.

Scuffham AM, Legg SL, Firth EC, Stevenson MA [2010]. Prevalence and risk factors associated with musculoskeletal discomfort in New Zealand veterinarians. *Appl Ergon* 41(3):444–453, <http://dx.doi.org/10.1016/j.apergo.2009.09.009>.

White SW [2012]. Prevalence and risk factors associated with musculoskeletal discomfort in spay and neuter veterinarians. *Animals* 3(1):85–108, <http://dx.doi.org/10.3390/ani3010085>.



## Health Effects of Noise

Berger EH, Royster LH, Royster JD, Driscoll DP, Layne M, eds. [2003]. The noise manual. 5th rev. ed. Fairfax, VA: American Industrial Hygiene Association.

Burk A, Neitzel RL [2016]. An exploratory study of noise exposures in educational and private dental clinics. *J Occup Environ Hyg* 13(10):741–749, <https://dx.doi.org/10.1080/15459624.2016.1177646>.

Choosong T, Kaimook W, Tantisarasart R, Sooksamear P, Chayaphum S, Kongkamol C, Srisintorn W, Phakthongsuk P [2011]. Noise exposure assessment in a dental school. *Saf Health Work* 2(4):348–354, <http://dx.doi.org/10.5491/SHAW.2011.2.4.348>.

Gonçalves CG, Santos L, Lobato D, Ribas A, Lacerda AB, Marques J [2015]. Characterization of hearing thresholds from 500 to 16,000 Hz in dentists: a comparative study. *Int Arch Otorhinolaryngol* 19(2):156–160, <http://dx.doi.org/10.1055/s-0034-1390138>.

Jadid K, Klein U, Meinke D [2011]. Assessment of noise exposures in a pediatric dentistry residency clinic. *Pediatr Dent* 33(4):343–348, <https://www.ncbi.nlm.nih.gov/pubmed/21903003>.

Koch R [2018]. Hearing health and veterinary dentistry. Letter to the editor. *J Am Vet Med Assoc* 252(12):1462.

Masterson EA, Themann CL, Luckhaupt SE, Li J, Calvert GM [2016]. Hearing difficulty and tinnitus among U.S. workers and non-workers in 2007. *Am J Ind Med* 59(4):290–300, <http://dx.doi.org/10.1002/ajim.22565>.

Messano GA, Petti S [2012]. General dental practitioners and hearing impairment. *J Dent* 40(10):821–828, <http://dx.doi.org/10.1016/j.jdent.2012.06.006>.

NIOSH [2007a]. Kenton County Animal Shelter, Covington, Kentucky. By Achutan C, Tubbs RL. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Health Hazard Evaluation Report 2006-0212-3035, <https://www.cdc.gov/niosh/hhe/reports/pdfs/2006-0212-3035.pdf>.

NIOSH [2007b]. Liberty Veterinary Hospital, Liberty Township, Ohio. By Achutan C, Tubbs RL. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Health Hazard Evaluation Report 2006-0196-3036, <https://www.cdc.gov/niosh/hhe/reports/pdfs/2006-0196-3036.pdf>.

NIOSH [2007c]. Noise exposures and hearing loss assessments among animal shelter workers. By Achutan C. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Health Hazard Evaluation Report 2007-0068-3042, <https://www.cdc.gov/niosh/hhe/reports/pdfs/2007-0068-3042.pdf>.

NIOSH [2007d]. Society for the Prevention of Cruelty to Animals, Cincinnati, Ohio. By Achutan C, Tubbs RL. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Health Hazard

Evaluation Report 2006-0222-3037, <https://www.cdc.gov/niosh/hhe/reports/pdfs/2006-0222-3037.pdf>.

Myers J, John AB, Kimball S, Fruits T [2016]. Prevalence of tinnitus and noise-induced hearing loss in dentists. *Noise Health* 18(85):347–354, <https://www.ncbi.nlm.nih.gov/pubmed/27991466>.

Schein JD, Gentile A, Haase KW [1970]. Development and evaluation of an expanded hearing loss scale questionnaire. *Vital Health Stat* 2(37):1–42, <https://www.ncbi.nlm.nih.gov/pubmed/5310200>.

Setcos JC, Mahyuddin A [1998]. Noise levels encountered in dental clinics and laboratory practice. *Int J Prosthodont* 11(2):150–157, <https://www.ncbi.nlm.nih.gov/pubmed/9709605>.

Tak S, Davis RR, Calvert GM [2009]. Exposure to hazardous workplace noise and use of hearing protection devices among U.S. workers—NHANES, 1999–2004. *Am J Ind Med* 52(5):358–371, <http://dx.doi.org/10.1002/ajim.20690>.

Willershausen B, Callaway A, Wolf TG, Ehlers V, Scholz L, Wolf D, Letzel S [2014]. Hearing assessment in dental practitioners and other academic professionals from an urban setting. *Head Face Med* 10:1, <http://dx.doi.org/10.1186/1746-160X-10-1>.

## Occupational Exposure Limits

ACGIH [2020]. 2020 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

CFR [2020]. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register, <https://www.ecfr.gov/cgi-bin/ECFR?page=browse>.

NIOSH [1998]. Criteria for a recommended standard: occupational noise exposure (revised criteria 1998). Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98-126, <http://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf>.

NIOSH [2007e]. NIOSH pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-149, <http://www.cdc.gov/niosh/npg/>.

Tak S, Davis RR, Calvert GM [2009]. Exposure to hazardous workplace noise and use of hearing protection devices among US workers—NHANES, 1999–2004. *Am J Ind Med* 52(5):358–371, <http://dx.doi.org/10.1002/ajim.20690>.

## Other

National Association of State Public Health Veterinarians [2010]. Compendium of veterinary standard precautions for zoonotic disease prevention in veterinary personnel: National Association of State Public Health Veterinarians Veterinary Infection Control Committee 2010. *J Am Vet Med Assoc* 237(2):1403–1422, <http://dx.doi.org/10.2460/javma.237.12.1403>.

NIOSH [1997b]. Preventing allergic reactions to natural rubber latex in the workplace. By Biagini RE, Deitchman S, Esswein EJ, Fedan J, Flesch JP, Hodgins PK, Hodous TK, Hull RD, Jarvis WR, Lewis DM, Lipscomb JA, Lushniak BD, Pearson ML, Petsonk EL, Pinkerton L, Siegal PD, Wippel WG, Worthington KA. Cincinnati OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 97-135, <https://www.cdc.gov/niosh/docs/97-135/pdfs/97-135.pdf>.

NIOSH [2004]. Preventing occupational exposures to antineoplastic and other hazardous drugs in health care settings. By Burroughs GE, Connor TH, McDiarmid MA, Mead KR, Power LA, Reed LD. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) 2004-165, <https://www.cdc.gov/niosh/docs/2004-165/pdfs/2004-165.pdf>.

NIOSH [2010]. Slip, trip, and fall prevention for healthcare workers. By Bell J, Collins JW, Dalsey E, Sublet V. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2011-123, <https://www.cdc.gov/niosh/docs/2011-123/pdfs/2011-123.pdf>.

Seibert PJ [2003]. The complete veterinary practice regulatory compliance manual. Calhoun: TN, [www.safetyvet.com](http://www.safetyvet.com).

USP [2019]. USP general chapter <800> hazardous drugs—handling in healthcare settings. Rockville, MD: U.S. Pharmacopeia, <https://www.usp.org/compounding/general-chapter-hazardous-drugs-handling-healthcare>.

Wright JG, Jung S, Holman RC, Marano NN, McQuiston JH [2008]. Infection control practices and zoonotic disease risks among veterinarians in the United States. *J Am Vet Med Assoc* 232(12):1863–1872, <http://dx.doi.org/10.2460/javma.232.12.1863>.

## **Veterinary Dentistry**

American Animal Hospital Association [2019]. 2019 AAHA dental care guidelines for dogs and cats. By Bellows J, Berg ML, Dennis S, Harvey R, Lobprise HB, Snyder CJ, Stone AES, Van de Wetering AG. *J Am Anim Hosp Assoc* 55(2):49–69, <http://dx.doi.org/10.5326/JAAHA-MS-6933>.

Hale F [2013]. Why should you do whole-mouth intra-oral dental radiographs? *Can Vet J* 54(9):889–890, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3743578/>.

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