

# **13<sup>th</sup> Annual Regional National Occupational Research Agenda (NORA) Young/New Investigators Symposium**

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and

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## **Keynote Speaker**

Sidney C. Soderholm, PhD  
NORA Coordinator, NIOSH

### **Biography**

After obtaining his PhD in Physics at the University of Rochester, Dr. Soderholm conducted research in industry, academia and the government.

His contributions have been in the fields of aerosol physics, inhalation toxicology, and the exposure of skin to chemicals.

Currently, Dr. Soderholm leads the program called the National Occupational Research Agenda (NORA) for the National Institute for Occupational Safety and Health (NIOSH) in the Centers for Disease Control and Prevention (CDC) in the United States.



## **An Ergonomics Assessment of Labeling Tasks at New Belgium Brewing Company**

Lesley Smallwood, Cameron Radtke, Kristin Schneider, Dr. John Rosecrance, PhD, CPE

Colorado State University

### **ABSTRACT**

**Introduction:** Micro and craft brewing is an industry growing in popularity in Colorado and across the nation. Beginning as small brewing operations, these breweries often expand into larger-scale production facilities to meet demand. Expansion leads to increased production, faster paced processing, and more repetitive work tasks, all of which can affect workers' risk for musculoskeletal disorders (MSDs). An ergonomic assessment was conducted at New Belgium Brewing Company located in Fort Collins, Colorado to assess process efficiency and the risk for MSDs at the labeling station of the bottling line. The objective of this assessment was to reduce the risk of MSDs and increase production efficiency.

**Methods:** The NIOSH Lifting Equation was used to assess the risk of developing low back injury and to calculate a recommended weight limit (RWL) for lifting tasks. Variables taken into consideration included weight of product, distances lifted, coupling, duration of shift, and twisting. The Hand Activity Level (HAL) was used to determine the risk for hand/wrist MSDs during labeling tasks. Variables included subjective observation of repetitive hand movements and normalized peak forces associated with the labeling tasks. Worker insight and observations were also collected.

**Results:** The RWL for the lifting tasks at the front labeling station was 9 lbs with a lifting index of 4.6 at the lift origin and 3.7 at the destination. The RWL for the lifting tasks at the back labeling station was 9.21 lbs with a lifting index of 3.15 at the origin and 1.93 at the destination. The values calculated for the HAL were below the ACGIH TLV and Action Limit.

**Conclusions:** Based on this assessment, there were several areas of potential ergonomic and process improvement including: front label station, storage and shelving of back labels, work shift duration, availability of a sit-stand workstation, and handling of glue bucket. Recommendations included reducing horizontal distance during lifting, reducing manual handling of products, and streamlining operations.



## **Characterizing the Muscle Activity of Ophthalmologists Performing Routine Patient Examinations**

Mark Schall, Nathan Fethke

University of Iowa

### **ABSTRACT**

**Introduction:** A high prevalence of work-related musculoskeletal pain, particularly of the neck and shoulder region, has been observed among ophthalmologists. Recent evidence suggests occupational exposure to physical risk factors such as sustained muscular exertions in the clinical environment may contribute to the neck and shoulder pain reported by ophthalmologists. Although a few reports are available describing ergonomics issues in the clinical environment, we are aware of no previous efforts to characterize the neck and shoulder muscle activation patterns among ophthalmologists performing routine patient examinations in a live clinic environment.

**Purpose:** The objectives of this study were to (i) characterize the frequencies and durations of common activities performed by ophthalmologists during routine patient examinations, (ii) characterize neck and shoulder muscle activation patterns during the whole clinical work day, and (iii) explore differences in neck and shoulder muscle activation patterns between common clinical activities.

**Methods:** Fifteen ophthalmologists representing a variety of ophthalmologic specialties performed routine patient examinations across two full working days in an outpatient ophthalmology clinic. For each participant and observation day, continuous surface electromyography (EMG) recordings were obtained bilaterally from the upper trapezius and anterior deltoid muscles while a research assistant recorded the time (to the nearest second) at which specific clinical activities began and ended.

**Results:** We observed 608 total patient examinations across participants and observation days. On average, participants were observed for 7.04 hours each day. Computer use was the most frequently performed clinical activity. Despite being performed less frequently and for a shorter average duration than any other clinical activity, use of the indirect ophthalmoscope was observed to require the greatest amount of mean muscular effort for all muscles among the ophthalmologists. Use of the slit lamp biomicroscope was observed to require the second greatest amount of mean muscular effort.

**Conclusions:** Results indicate that the clinical activities of using the indirect ophthalmoscope and slit lamp biomicroscope are the most appropriate for ergonomic interventions.

## Inertial Measurement Units for Wrist Posture Measurement: A Pilot Study

Howard Chen<sup>1</sup>, Mark Schall<sup>1</sup>, Nathan Fethke<sup>1</sup>, Saki Oyama<sup>2</sup>, David Douphrate<sup>3</sup>

<sup>1</sup>University of Iowa

<sup>2</sup>University of Texas San Antonio

<sup>3</sup>University of Texas School of Public Health, San Antonio

### ABSTRACT

**Introduction:** Precise and objective direct measurement methods are critical to establishing the relationship between exposure to physical risk factors (e.g., non-neutral working postures) and musculoskeletal health outcomes. Inertial measurement units (IMUs) are a promising technology for directly measuring human motion in field-based environments due their small size and low cost. The accuracy of IMUs has been evaluated for various body segments with mixed results. To date, the accuracy of IMUs has not been evaluated for measuring postures of the wrist.

**Purpose:** The purpose of this ongoing pilot study is to estimate wrist flexion/extension and ulnar/radial deviation measurement errors in comparison to a “gold-standard” optical motion capture system.

**Methods:** A simulated milking cluster attachment task common to dairy parlor work and a simulated manual material handling task was completed by one participant to evaluate the accuracy of an IMU system in a laboratory setting. The cluster attachment task required the participant to bend forward to grasp a milking cluster and then lift and secure the cluster to the teats of an artificial cow udder. The manual material handling task consisted of lifting a plastic crate from the ground to waist height. Eight trials of each task (10 repetitions per trial) were performed once every hour for eight hours. Orientations of IMUs worn on the forearm and hand were tracked using an eight-camera optical motion capture system. Wrist posture was calculated using the orientation of the IMU worn on the hand relative to the orientation of the IMU worn on the forearm.

For each task, differences in the IMU and optical motion capture estimates of wrist posture were quantified as sample-to-sample root-mean-square deviation across the 10 repetitions of each of the eight trials.

**Results:** Root-mean-square deviation [mean degrees, (SD)] observed between the IMU system and the optical motion capture system are shown in the table below.

Task	Flexion/Extension	Ulnar/Radial Deviation
Cluster Attachment	11.4 (2.2)	6.3 (1.4)
Material Handling	10.1 (1.9)	4.8 (1.9)

**Conclusions:** In general, these preliminary data suggest that IMUs may be useful for measuring wrist posture in controlled laboratory settings. Additional data collection is planned for this pilot study, and further research on the use of IMUs for assessing exposure to non-neutral postures of the wrist in field-based settings is ongoing. Important issues to address include the accuracy of IMU-based posture measure under highly dynamic motion and in the presence of localized magnetic field disturbances.

## Specific Location of Low Back Pain: Associated Factors

Skyler D. Walker, Matthew S. Thiese, PhD, MSPH, Kurt T. Hegmann, MD, MSPH, Ulrike Ott, PhD, MSPH, Atim Effiong, MSPH

RMCOEH, University of Utah

### ABSTRACT

**Background-** Nonspecific Low Back Pain (LBP) is one of the most common work related injury in the United States, sending millions of workers to the Hospital every year. An estimated 149 Million lost workdays can be attributed to Lower back pain. Nonspecific low back pain is incredibly variable from person to person. A quality of Low back pain is the surface area, or size, that the individual feels is affected by Low back Pain. This specific characteristic may provide insight to potential causal factors or treatment plans. To the best of our knowledge there are no published evaluations of size of LBP area. The goal of this project is to investigate any correlation between Job satisfaction felt by an individual and the surface area LBP. We analyzed pain diagrams in relationship to potential risk factors to explore statistical relationships.

**Methods-** The Institutional Review Boards of the University of Utah, University of Wisconsin Milwaukee and Texas A&M University approved this study. All of the Participants provided written consent before enrolling in the study. Baseline data for this cohort study was collected from 2003-2006, study participants were recruited from 27 different employers that had 30 different production facility types located in Texas, Wisconsin, Utah, Illinois, USA. Most of the participants performed manual material handling tasks.

A Health Outcome Assessment team administered electronic questionnaires, and structured interviews. Many of the different data collection instruments were developed to investigate any suspected risk factors for Nonspecific Low Back Pain. These questionnaires and structured interview questions were constructed from prior epidemiological studies. Some specific example of these contributing factors include among others: (a) demographics, (b) past medical history, and (c) psychosocial factors including a modified Zung depression index.

A LBP diagram was completed by the participants, where they were able to illustrate their location and size of pain. Individual pain locations and summed surface area were calculated for each participant and compared to both past medical history and psychosocial factors. Relationships will be statistically controlled for confounding factors including age, gender, body mass index and pain rating. Results- Of 827 participants, 418 had pain in the past month. There were statistically significant relationships between size of low back pain and both diagnosis and high blood pressure and the modified Zung depression index. Participants with a past diagnosis of high blood pressure were statistically significantly more likely to have focused (smaller size) LBP ( $p=0.008$ ). This relationship persisted even after adjustment for age, gender BMI and LBP rating. There was a trending relationship between feeling tense and focused LBP however it did not achieve statistical significance. Participants with a low or high modified Zung depression index were more likely to have diffuse (larger size) LBP ( $p=0.019$ ). This relationship was not linear, with the smallest area of pain among those participants with some depressive symptoms, as compared to those with little/none or many depressive symptoms.

**Discussion-** This is the first study to investigate relationships between detailed location and size of LBP and associated factors. These are preliminary analyses and further analyses will be performed. The largest weakness of this study is the cross sectional nature of these analyses, and thus the inability to demonstrate temporality or suggest causation.

**Conclusion-** There are factors associated with LBP size. Additional research is needed to evaluate these relationships further

## Association between Cardiovascular Risk Factors and Carpal Tunnel Syndrome

Pranjal A. Muthe, Austen J. Knudson, Ulrike Ott PhD, MSPH, Atim Effiong, MPH CHES,  
Matthew Thiese PhD, MSPH, Eric Wood MD, MPH, Kurt Hegmann, MD MPH

RMCOEH, University of Utah

### ABSTRACT

**Background-** Carpal Tunnel syndrome (CTS) is a result of median nerve entrapment or compression at the carpal tunnel of the wrist. In the U.S.A., it has an incidence of 99 per 100 000 in the general population and a prevalence between 1% and 10%. CTS plays an important role in compensation of worker's cost, lost time, lost productivity and disability.

Heart disease is the leading cause of death for both men and women. **More than half** of the deaths due to heart disease in 2009 were in men. High blood pressure, cholesterol levels, obesity, diabetes, and lack of physical activity are some of the escalating national health problems that predispose general population to CVD.

We aimed to examine the association between cardiovascular health characteristics and CTS in a large population of industrial workers.

**Methods-** This is a cross-sectional analysis of baseline measurements taken from a multi-center, prospective cohort study, the WISTAH Distal Upper Extremity (DUE) study. All participants were at least 18 years old, and employed at a participating facility. Participants for this study were enrolled from seventeen varying production facilities under fifteen different employers. Employees were involved in high, medium and low levels of physical job demands. All positions analyzed required a consistent level of physical job exposure.

The CTS diagnosis was self-reported. We defined cardiovascular health risk factors by the American College of Sports Medicine scale (ACSM). The scale for coronary artery disease risk factor thresholds included the following: smoking, hypertension, dyslipidemia, diabetes mellitus, Body Mass Index (BMI), physical activity. The ACSM score defined participants as follows: 1) low (male < 45 years, female < 55 years, with no more than one positive factor), 2) moderate (male  $\geq$  45 years, female  $\geq$  55 years, and the threshold for two or more positive risk factors), or 3) high (higher coronary artery disease risk stratification. Data were analyzed using univariate logistic regression analysis.

**Results-** A total of 1,215 industrial workers were enrolled in the study. The mean age of the workers  $42.1 \pm 1.4$  years. There were 803 females and 412 males, with a mean BMI of  $29.5 \pm 6.8$  Kg/m<sup>2</sup>. Nearly 10 percent of workers were diagnosed with CTS (n=111). Workers in the high risk ACSM category were four times more likely (OR= 4.1, 95% CI: 1.9-8.3) to have CTS than those in the low risk ACSM category. In addition, workers in the moderate risk ACSM category were twice more likely (OR=2.0, 95% CI 1.2-3.4) to have CTS than those in the low risk ACSM category.

**Conclusion** -We found strong associations between ACSM and CTS among industrial workers which warrant additional analyses.

## **Mutual Information Analysis for Identification of Major Concerns of Postural Control in a Tossing Activity**

Harshvardhan Gazula<sup>a</sup> and Simon M. Hsiang<sup>a</sup>

<sup>a</sup>*Texas Tech University*

### **ABSTRACT**

Few previous studies directly used information theory to characterize the interdependencies between various objective functions in a manual materials handling activity. We hypothesize that the relationships between different objective functions can be extracted using information theory. Human body motion for load-tossing activity was partitioned into three phases using four critical events based on the load position viz. lift-off, closest to body, peak and release. For each phase, three objective functions values, viz. mobilization, stabilization and muscular torque utilization, used to control the motion patterns, were then calculated. The kinematic data obtained with 36 treatment combinations (2 tossing distances, 2 tossing heights, 3 weights, and 3 target clearances) was used to estimate the mutual information between each pair of objective functions and construct Chow-Liu trees.

Results from this research indicate that there was no dominant concern in the first two phases of the activity; however, torque utilization and mobilization were found to be important factors in the third phase of the load tossing activity. The proposed research concept based on mutual information provides users with a useful diagnosis of the relevance of different objective functions and of the mutual dependencies in designing the task. This work is not just limited to tossing and can be extended to any manual material handling activity.

## **Influenza Outbreak in a Vaccinated Population — USS Ardent, February 2014**

Theodore L. Aquino, DO MBA<sup>a</sup>, Gary T. Brice, PhD<sup>b</sup>, Sherry Hayes, MPH<sup>c</sup>, Christopher A. Myers, PhD<sup>b</sup>, Jaqueline McDowell, MD<sup>c</sup>, Brenda White, MSPH, MPH<sup>b</sup>, Daniel Johnston<sup>d</sup>,  
Rebecca Garten, PhD<sup>e</sup>

<sup>a</sup>University of South Florida, Sunshine Education and Research Center

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<sup>c</sup>Navy Environmental and Preventive Medicine Unit Five, U.S. Navy

<sup>d</sup>USS Ardent, U.S. Navy

<sup>e</sup>World Health Organization Collaborating Center for Influenza, CDC

### **ABSTRACT**

On February 10, 2014, the USS Ardent, a U.S. Navy minesweeper, was moored in San Diego, California, while conducting training. Over the course of 3 days, 25 of 102 crew members sought medical care because of influenza-like illness (ILI). Nasal swab specimens were collected from each patient, and initial rapid influenza testing indicated 16 cases of influenza A. Ultimately, polymerase chain reaction (PCR) testing conducted by the Naval Health Research Center determined that 20 specimens were influenza A, of which 18 were subtype H3N2. Two specimens could not be subtyped. The HA gene sequence of an outbreak isolate was 99% identical to strains circulating during the 2013–14 influenza season and antigenically similar to the H3N2 component of the 2013–14 influenza vaccine. At the time of the outbreak, 99% of the crew had received influenza vaccine. Outbreak response included disseminating outbreak information to surrounding Navy units, disinfecting the ship, sending home infected crew members, identifying family members at high risk, and providing antiviral medications and guidance. No crew member had onset of symptoms >6 days after the first crew member became ill.

Since the 1950s, a policy of mandatory annual vaccination against influenza for active duty personnel has been largely successful in limiting influenza epidemics in the military (8). The current U.S. Department of Defense influenza vaccination policy mandates that all uniformed personnel receive seasonal influenza vaccination, unless medically exempt, or face punishment under the Uniform Code of Military Justice. The policy specifically directs all Navy operational units to be at least 90% vaccinated. However, despite vaccination measures, influenza outbreaks can still occur in highly vaccinated worker populations.

## Exposure Risk Assessment and Intervention in Methylene Chloride Stripping

Rebecca Foos<sup>a</sup>, Cameron Radtke<sup>a</sup>, John Rosecrance<sup>a</sup>

<sup>a</sup>Colorado State University

### **ABSTRACT**

**Introduction:** Methylene chloride is a notoriously caustic chemical stripping agent used in furniture refurbishing. Favored for extreme efficiency with all paints and stains, methylene chloride comes with a long list of OSHA requirements and monitoring standards, including supplied air and regular biological monitoring of exposed employees. In partnership with OSHA consultation, redesign of the stripping room and ventilation of a small refurbishing company targets methylene chlorides exposure as well as some of the ergonomic risks the stripping process assumes.

**Purpose:** To conduct methylene chloride monitoring and develop intervention strategies to lower exposure to permissible levels. With an initial time weighted average (8 hour TWA) of 48 ppm exceeding the STEL of 25 ppm, management hopes to eventually reduce exposure below the 50% action limit, or 12.5 ppm. The primary reason for these high levels is an ineffective ventilation system. Increasing the fan size and power is essential for lowering the exposure levels. Additionally, introducing a forward downdraft vent to the stripping table will prevent negative pressure areas when larger pieces are being stripped. The recycling process for methylene chloride reuse is also a significant source of exposure, as the system is relatively open and depends on manual pouring of the solvent back into the storage drum. Introduction of a closed, filtered recycling system will both minimize the exposure and purify the methylene chloride for higher efficiency and lower cost. Proposed ergonomic solutions include sling assists for maneuvering larger pieces on the stripping table and coupling the stripping and rinsing tables by removing the divider baffle and replacing with a weighted curtain so pieces may be moved between the two task areas more efficiently. Results will be forthcoming.

**Conclusion:** By targeting various exposure risks in design and use, furniture stripping may be optimized for employee health and process efficiency.

## Simulated Workplace Protection Factor of Facepiece Filtering Respirators and Surgical Masks against Surgical Smoke

Shuang Gao, Michael Yermakov, Sergey A. Grinshpun

Department of Environmental Health, University of Cincinnati

### ABSTRACT

**Introduction:** Use of electrocautery and other surgical equipment generates surgical smoke in operating rooms (ORs). The smoke contains a variety of substances in gaseous and especially particulate phases that are capable of causing health effects in healthcare workers. Disposable protection devices such as surgical masks and filtering facepiece respirators are commonly used by the OR healthcare personnel; however, no information is available about their effectiveness against surgical smoke. Scientifically credible data are needed to develop recommendations on the types and models of respirators that provide appropriate protection against surgical smoke particles.

**Objectives:** Determine the simulated workplace protection factors (SWPFs) of two surgical masks and two NIOSH-certified N95 filtering facepiece respirators (FFRs) currently marketed for use in ORs. Measure SWPFs on ten human subjects while they are exposed to surgical smoke generated by an electrocautery unit applied to an animal tissue in a room-size chamber.

**Methods:** Each subject wearing a surgical mask or a FFR applied an electrocautery unit to the animal tissue mimicking a conventional surgical procedure in an exposure chamber (24 m<sup>3</sup>). The aerosol sampling probes were installed inside and outside the tested respiratory protection device to measure the aerosol concentrations inside ( $C_{in}$ ) and outside ( $C_{out}$ ), respectively, using an optical particle counter (OPC) (Model 1.108, Grimm Technologies, Inc., Ainring, Germany) and an aerosol size spectrometer (Nanocheck, Model 1320, Grimm Technologies, Inc., Ainring, Germany). The SWPF were determined as  $C_{out}/C_{in}$ .

**Results:** The following SWPFs values were obtained (the number represents a geometric mean with a geometric standard deviation presented in parentheses): 1.49 (1.95) and 1.76 (1.71) for two surgical masks; 263 (2.16) and 208 (2.31) for FFRs. No significant difference was observed between the two surgical masks; similarly no significant difference was found between the two N95 FFRs. However, the SWPFs of FFRs were significantly higher than those measured for surgical masks. No notable particle size dependency of the SWPF was observed; it is partially due to high between-subject data variability.

**Conclusions:** Wearing N95 FFRs significantly reduces the exposure to surgical smoke in an OR environment. The protection offered by the tested surgical masks was very low.

**Acknowledgement:** The effort was partially funded by the National Institute for Occupational Safety and Health Pilot Research Project of the University of Cincinnati Education and Research Center grant T42-OH008432.



## A Socio-Ecological Model of Affordable Care Act Acceptance

Pratiksha Vaghela

University of South Florida

### ABSTRACT

**Background:** Since 1965, there have not been any major revisions of the healthcare laws in the United States, until the recent implementation of the Affordable Care Act (ACA). However, ACA is not well understood and is often controversial. In this study, we aim to develop a socio-ecological model of ACA acceptance to address the barriers and facilitators to implementing the new law and recommend changes to address any deficits.

**Method:** An online questionnaire was distributed anonymously to employees and employers of small businesses. The data gathered includes information on the participants' knowledge and perceptions on the law and their socio-demographic information. Bootstrapping resampling method, Kendall correlation test and GLM were employed to detect differences in the perceptions & knowledge of employees and employers.

**Results:** Based on the analysis, we found that job status significantly affects the individual perception of the law. The study showed a statistically significant negative association between the self-reported knowledge and the actual-tested knowledge of individuals.

**Conclusion:** Individual perception is a key factor in adoption of new policies. A socio-ecological model of ACA acceptance can be a powerful tool in addressing the barriers and facilitators to the successful implementation of the new law and to modify the policies to address any deficits in the law.

## Noise and Dust Hazards Associated with Production of Single-Dose Liquid Detergent Packets

Ron Tomy, Andrew Phillips, David Wu  
Course Directors: Leon Pahler, Eric Wood, Donald Blowski,

University of Utah

### ABSTRACT

**Background:** A household product manufacturer recently began production of single-dose liquid detergent packets. The manufacturer built a new room for this production process that is isolated from other areas of manufacturing. The production of these packets is automated, requiring large machinery. Each dose of detergent is sealed within a plastic shell that is covered with talc powder to prevent adhesion with other packets. The powder allows accurate packaging of the individual single-dose packets and avoids loss of usable product. Workers in the single-dose packaging room are exposed to both dust from the talc powder and noise from operation of the machinery. Talc exposure has a potential to cause respiratory illnesses including silicosis. Exposure to loud noises can cause hearing loss, as well as other health risks.

**Methods:** A dust survey was conducted in the single-dose packaging room to measure dust concentrations at each 5'x5' sampling site using a Grimm 1.109 Aerosol Spectrometer. Each dust monitoring grid site was monitored for 40 seconds with the Grimm. Both total (0.22 – 32 microns) and respirable dust fractions were measured. Noise levels were measured for 15 seconds per each 5'x5' sampling site. A Larson David SoundTrac LxT sound level meter was used to measure the Leq (dBA), Lpeak (dBC) and sound levels at the 4 KHz frequency range (dBA). Isoleths were then created for dust concentrations and noise levels using the Noise at Work 4.0 software. Noise dosimetry was excluded per the company's request because this sampling was conducted earlier.

**Results:** Air monitoring using the Grimm Aerosol Instrument showed that an average for total dust (0.22 – 32 microns) was 0.25 mg/m<sup>3</sup> and ranged from 0.03 to 1.11 mg/m<sup>3</sup>. The respirable dust average was 0.16 mg/m<sup>3</sup> and ranged from 0.02 to 0.74 mg/m<sup>3</sup>. The equivalent continuous sound level (Leq) averaged 83 dBA, with a maximum of 91 dBA, which was located around the talc generator. The average Leq was below the OSHA action level of 85 dBA. The maximum value recorded for the sound pressure peak (Lpeak) averaged 100.6 dBC, with a maximum of 110 dBC measured near the single-dose packet dispensing unit. The highest Lpeak noise level was below the OSHA limit for impulsive or impact noise of 140 dBC. Sound levels at the 4 KHz frequency, where the greatest hearing loss occurs, averaged 77.2 dBA, with a maximum of 99.5 dBA measured near the talc generator.

**Conclusion:** Overall dust concentrations were low throughout the entire single dose room as indicated by the dust isopleths. In order to obtain accurate dust concentrations for use in evaluation of controls, 8 hour personal and area dust samples should be collected using air pumps with filter cassettes. Area noise results shown by the noise isopleths suggests that sound levels in the single-dose room may be elevated and may pose a concern for workers. Engineering controls were proposed even though the cost benefit analyses demonstrated a poor return on investment. The company currently has a hearing conservation program in place and the policy throughout the facility including the single-dose room is that hearing protecting is worn to protect workers from elevated noise levels. Recommendations regarding worker exposure to dust and noise include the continued maintenance of the existing local dust exhaust ventilation system, the continuation of the existing hearing conservation program, and implementation of proposed engineering controls.

## Noise Level and Aerosol Concentration Evaluations in an Industrial Manufacturing Facility

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### ABSTRACT

**Introduction:** Noise and aerosols are common hazards in many industries. Exposure to either may result in adverse health effects. The purpose of this study was to determine sound pressure levels and aerosol concentrations in a private manufacturing setting. Noise levels was monitored in an assembly and manufacturing room. Cutting fluid aerosol concentrations were monitored in the facility's machine shop.

**Methods:** Personal and area noise monitoring were conducted to determine noise levels. Personal monitoring of three employees was conducted using 3M eg5 Edge dosimeters. Monitoring was conducted for approximately 5.5 hours and resulting dosimeter noise levels were used to estimate 8 hour time weighted average (TWA) noise levels. Dosimeter noise sampling duration was constrained because of facility scheduling. Job positions were chosen in consultation with the facility safety team and were based on highest possibility of noise exposure. Area monitoring via 15 second sampling events at 5-foot intervals was conducted using a Larson Davis LxT Sound Track Level Meter. Area noise isopleths were prepared for both the assembly and manufacturing rooms using Noise at Work 4.0 software. Particulate monitoring for metal-cutting fluid aerosols was conducted using a Grimm 1.109 portable aerosol spectrometer. Monitoring was conducted at 5-foot intervals where possible through the aisles formed by the machines, as well as at each machine's control panel or operator area. Area aerosol isopleths were prepared for the machine shop area using Noise at Work 4.0 software.

**Results:** Estimated personal 8 hour TWA noise dosimeter levels indicated that one operator's exposure may have exceeded the OSHA PEL of 90 dBA. All area noise level results exceeded the OSHA action level of 85 dBA. Average area sound level grab results did not exceed 90 dBA, although peak levels may have exceeded 90 dBA but were below the OSHA limit of 140 dBC.

A peak concentration value for respirable aerosols was recorded as 50.76  $\mu\text{g}/\text{m}^3$  and a peak concentration value for total aerosols (0.22 to 32  $\mu\text{m}$ ) was recorded as 67.76  $\mu\text{g}/\text{m}^3$ . Peak values for both particle size ranges were localized in the south end of the machine shop. The peak total particulate and peak respirable results were well below the OSHA PEL of 15  $\text{mg}/\text{m}^3$  and 5.0  $\text{mg}/\text{m}^3$  respectively.

**Conclusion:** The OSHA noise PEL was possibly exceeded by one personal noise dosimetry result, which should be resampled for the full eight hours. Proposed noise abatements for noisy machine areas should be implemented in order to reduce noise levels in the surrounding areas. The facility currently has a hearing conservation program in place to address safety and health concerns of noise exposure and should be continued. At the time of monitoring, metalworking fluid aerosol concentrations did not exceed the OSHA PEL and no abatements were recommended. However, existing engineering controls, such as local exhaust and air filtration should be continued.

## **Ergonomic Evaluation of Workplace Processes in a Bacon Processing Plant**

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### **ABSTRACT**

**Introduction:** An ergonomic evaluation of several physical tasks was requested by a local bacon processing plant. This was in response to a series of workers compensation claims (from a total of 3 shoulder injuries requiring surgery and 1 strained thumb ligament injury) resulting in a cost of \$139,057.00 to the company and 63 total days of time away from work. Other common injuries that have occurred in this working population in previous years include muscle strain/sprains of the back and upper extremities and general soreness. Analysis was requested on what the company decided were the three most hazardous tasks, which includes the following:

- I – Preparation of pork bellies
  - A – Insertion of combs into pork bellies for mounting onto a metal smoking tree
  - B – Dismounting cooked pork bellies from a smoking tree and removal of combs
- II – Trimming the ends off pre-cut bacon with scissors to fit in the appropriate packaging
- III – Manual material handling of 15 and 30 pounds boxes of bacon

**Methods:** Modes of data collection for all tasks include angle measurements of all relevant limbs, body and workspace dimensions, task and shift durations and frequencies, relevant loads and forces, and distances from said loads to the lower back and shoulder. Ergonomic analysis tools used include the Rodger's Analysis tool, RULA, Moore-Garg Strain Index, Utah Back Compressive Force worksheet, Utah Shoulder Moment worksheet, Energy/Rest Cycle evaluation worksheet, NIOSH Revised Lifting Equation (RLE), and Bernard Metabolic Load Predictive tool.

**Results:** These evaluation methods provided valuable insight to identifying key biomechanical stressors on the working population for the three tasks analyzed. Workers performing the combing/decombing tasks are subjected to extreme upper arm and trunk postures while handling large loads with poor coupling at a high frequency (via the Rodger's, RULA, and Strain Index tools). The bacon trimming task exposed workers to high degrees of trunk, neck, and wrist flexion while applying a significant amount of effort in the hands to operate scissors (via the Rodger's, RULA, and Strain Index tools). Finally, the manual material handling task was shown to subject workers to poor posture of the trunk, neck, and arms while lifting heavy loads of up to 30 lbs, which results in high back compressive forces and shoulder moments (via the RULA, Rodger's, BCF, Shoulder Moment, and NIOSH RLE). Additionally, this task was found to be metabolically stressful to most workers (via the Bernard Predictive tool).

**Conclusion:** Abatements suggested include significant but relatively simple modifications to the workspace and tasks, purchase of equipment more suited for certain tasks (e.g. replacing scissors in the bacon trimming task with a guillotine style paper cutter), purchase of equipment that eliminates stressful components of a task (e.g. a spring-loaded platform that keeps the operating zone of the manual material handling task at waist level), and administrative abatements such as shortening of work periods within the rotation schedule. Post-abatement analysis of all tasks showed a significant decrease in potential for back and upper extremity musculoskeletal disorders as well as metabolic stress.

**Future Work:** The results and proposed abatements from this analysis will be presented to the company and implementation of each abatement will be left up to their discretion.

## **Towards the Identification of Predictor Variables for Commercial Vehicle Safety**

Yao-Te Tsai, Stephen Swartz and Fadel M. Megahed

Auburn University

### **ABSTRACT**

Highway traffic safety has remained a leading public safety threat with significant economic impacts, despite the marked improvements in the rate and severity of accidents. Although the rate and total number of annual fatalities has decreased as a result of improved vehicle and infrastructure design, more work needs to be done. There are two major issues associated with highway safety. First, the majority of traffic accidents are categorized as preventable. The second, and equally alarming issue, is that the improvement rate varies per state, and the variation is consistent when the data is examined across multiple years. This suggests that public policy differences (laws and enforcement) may have an effect on safety performance. Therefore, there is an opportunity to save lives by examining the root-causes for the differences in highway safety performance between states (or regions) and identifying which policy factors are associated with improved performance. The objective of our work is to identify these factors by examining the U.S. Department of Transportation crash statistics and reports for commercial vehicles. Incident rates are compared by stratifying data based upon public policy differences. This allows us to determine the factors that lead to improved performance in certain states. We believe that this work can serve as a basis for new policies and enforcement modules that are based on the best practices identified from our proposed work.

## **Integrating Experiential Learning into the Occupational Safety and Ergonomics Curriculum**

Tom Devall, Fadel Megahed, John Evans, Richard Seseke

Auburn University

### **ABSTRACT**

Tiger Motors, Auburn University's hands-on Lego factory, uses a multi-disciplinary, experiential learning approach to integrate the entire Industrial Occupational safety and ergonomics (OSE) concerns are emphasized in all lessons. Students are presented realistic scenarios and must deal with logistical, management, and OSE issues while producing complex (250+ part) vehicles in a mixed model assembly plant. Students are actively engaged as they are immersed in a realistic factory setting. OSE principles are learned by application and experience rather than solely by lecture. This presentation highlights several examples of current OSE-related experiential activities while also indicating areas for future development.



## **Special Presentation**

### **12th Annual Paul S. Richards, MD, Endowed Distinguished Visiting Lectureship in Occupational Medicine**

Dr. Roy J. Rando, ScD, CIH

Industrial Hygiene Program in the Department of Global Environmental Health Science in the Tulane School of Public Health & Tropical Medicine, Vice Chair, Professor, and Academic Director

### ***“Flood Restoration Work, Exposure, and Respiratory Health: The Post-Hurricane Katrina Experience”***

*Dr. Roy Rando holds the B.S. degree in Chemistry from the University of New Orleans, and the M.S.P.H. and Sc.D. degrees from the Tulane University School of Public Health & Tropical Medicine. He is certified in the chemical aspects of industrial hygiene by the American Board of Industrial Hygiene. Dr. Rando has been a member of the faculty of Tulane University since 1987 and is currently Vice Chair, Professor, and Academic Director of the ABETaccredited Industrial Hygiene Program in the Department of Global Environmental Health Science in the Tulane School of Public Health & Tropical Medicine. He is also adjunct Associate Professor of Environmental Medicine in the Tulane Medical School. Dr. Rando teaches graduate courses in the topical areas of air sampling and analysis, exposure assessment, physical agents in the workplace, industrial ventilation and chemical hazard control, and occupational health. He is a member of the editorial board of the Journal of Occupational and Environmental Hygiene (JOEH). Dr. Rando’s research is focused on assessment and epidemiology of occupational respiratory disease, inhalation toxicology, occupational and environmental inhalation exposure assessment, and industrial hygiene chemistry. Dr. Rando has authored more than 75 manuscripts in the scientific literature.*





## Cardiovascular Health for the Long Haul - Analysis of Cardiovascular Risk Factors and Motor Vehicle Accidents in Truck Drivers

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University of Utah, RMCOEH

### ABSTRACT

**Introduction-**There are approximately three million Commercial Motor Vehicle (CMV) drivers in the United States (US BLS 2014). In 2012, 333,000 large trucks were involved in crashes injuring 104,000 people (US DOT 2014). CMV drivers are a high impact group due to reported poor health, lifestyle, and public health concerns. CMV drivers' cardiovascular risk factors may have a relationship with crashes.

**Objective-**The goal was to assess the relationship between the Framingham Cardiovascular Disease Risk (CVD Risk) Score and prevalence of US Department of Transportation (DOT)-reportable crash, after controlling for potential confounders.

**Methods-**Data were collected among truck drivers (N=817) in a large cross-sectional study using a computer-administered questionnaire in addition to measurements of anthropometry, blood pressure, and cholesterol. The Framingham Risk Scale (scores ranged from 0-30) was used to quantify CVD Risk for each driver. The risk factors assessed were age, gender, total cholesterol, high density lipoprotein (HDL) cholesterol, smoking, systolic blood pressure and use of blood pressure medications and drivers were categorized based on their CVD Risk Score. Scores with small numbers were collapsed with the next highest score until there were more than 100 participants to provide a stable estimate. Multivariate logistic regression analysis was used to analyze the relationship between CVD Risk and DOT-reportable crash, after controlling for alcohol consumption, cell phone use while driving within a city, drug use, depression, job satisfaction, sleep problems and sleep apnea.

**Results-**Of the 817 drivers recruited, data were analyzed for 797 drivers (97.6%). Most drivers were male, 685 (85.9%). The mean body mass index (BMI) was 32.9 kg/m<sup>2</sup> with 507 (62.1%) drivers being obese (BMI ≥30 kg/m<sup>2</sup>). 308 (38.6%) drivers reported at least one DOT-reportable crash. As compared to CMV drivers with the lowest risk score, CMV drivers in the second highest and highest CVD risk group (Framingham score of 16-20 and >20) had significantly higher Odds Ratios (OR) =2.08 [95% Confidence Interval (95% CI) =1.20-3.63] and OR =1.99 (95% CI =1.05-3.77) respectively. There was a significant trend of increasing prevalence of crashes with an increasing CVD risk score (p=0.019).

**Discussion-**This is the first study to evaluate cardiovascular risk scores and DOT-reported accidents within CMV drivers in the United States. CMV drivers with higher CVD risk scores were significantly more likely to have been involved in a crash, as compared to drivers with the lowest risk scores. While much of the crash risk among CMV drivers has been in relationship to obstructive sleep apnea, these data suggest that cardiovascular risk also appears to be related to crash risk, independent of sleep apnea diagnosis.

**Conclusion-**Truck drivers found to be at higher risk for developing cardiovascular disease according to the Framingham Risk Scale reported having been in more motor vehicle accidents than drivers who were found to be at lower risk for cardiovascular disease. Cohort studies are needed to further evaluate the relationship between CVD Risk and accidents in CMV drivers.

## Increased Prevalence of Prescription Management of Mental Illness in Truck Drivers

Jolene Mitchell, Matthew S. Thiese, Gary Moffitt, Kurt T. Hegmann

University of Utah, RMCOEH

### **ABSTRACT**

**Objectives:** Commercial motor vehicle (CMV) drivers are one of the highest risk occupations in the United States (Apostolopoulos et al., 2010). The association between commonly reported conditions such as obesity, hypertension, smoking, and early coronary artery disease with long haul truck driving and the lifestyle challenges for maintaining wellness are well reported (Apostolopoulos et al., 2010, Thiese et al., 2015). Additionally, there is also an increase in reported mental illness with commercial truck driving (Hilton et al., 2009). This study examines the prevalence of self-reported psychotropic prescription medication use among CMV drivers over time. Psychotropic prescriptions include the drug classes of antidepressants, anxiolytics, antipsychotics, dementia therapy, hypnotics, stimulants, and other psychological medication therapies.

**Methods:** A serial cross-sectional study design of 95,657 CMV drivers assessing psychotropic prescription use from their Federal Motor Carrier Safety Administration's Medical Review commercial driver medical examinations (CDMEs). The CDMEs spanned January 1, 2005 to October 31, 2012. Medications selected for review included only U.S. Federal Drug Administration approved psychotropic medications listed by trade or generic names (n=364 medication names). The psychotropic medication list was developed using the Generic Product Identifier (GPI) generated by Medi-Span Therapeutic Classification System. This is a numerical system with 14 levels that identify the prescription by drug class, medication, delivery method and dose.

**Results:** 95,598 drivers were used in this analysis. Of those, 1,431 drivers had taken psychotropic medications regularly or recently. In 2005 0.75% of the study had a prescription for psychotropic medications this increased to 2.21% by 2012. These data demonstrates a statistically significant increase in the rate of prescription psychotropic medication utilization over time, with more than a three-fold increase in prevalence among drivers from 2010, 2011, and 2012, as compared to drivers in 2005. Additional analyses are pending.

**Conclusion:** In this large database of commercial truck drivers, there has been a significant increase in the use of self-reported psychotropic medication use between the years 2005 to 2012. Increased utilization of these drugs may be a surrogate marker for measuring the increasing prevalence of mental health conditions and/or treatment of such in this population. Use of psychotropic medications may have speculative implications for increased risk of traffic crashes from adverse effects such as delayed reaction times and cognitive impairment.

**Discussion:** Recognition and appropriate medical treatment of mental health conditions in truck drivers is imperative for public safety. As an increased incidence of psychotropic medication use has been demonstrated, an equally important action will be to identify whether there has been a commensurate increase, or even a decrease in risk of crash (Apostolopoulos et al., 2010). This study is limited via the extrapolation of prescription management as an identifier for mental illness and the self-reported nature of the medications.

## **Identifying Possible Slips and Falls in Elderly Hospital Patients using Motion Capture Experiments**

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### **ABSTRACT**

The Centers for Disease and Control report that falls are the most common cause of injury in older adults. Moderate to severe fall-related injuries significantly interfere with independent living and reduce quality of life, and it is necessary to prevent these falls whenever possible. The present study seeks to identify factors within a hospital bedroom and bathroom setting that may lead to falls. A motion capture experiment was conducted in a laboratory setting on thirty subjects over the age of seventy using one bedroom and two bathroom mockups designed to match the dimensions and layout of a representative room drawn from the archives of a large healthcare design firm. Data were post processed using Cortex and Visual3D software. A potential fall was defined as a period of time during which the jerk trajectory of the upper body's center of mass remained consistently high. Preliminary results suggest that falls are more likely to occur when a patient is reaching, taking backwards steps, or turning. Future work includes locating each potential fall in a video recording to be analyzed by healthcare professionals including healthcare designers, clinicians, and a kinesiology expert. Identifying potential falls may lead to safer designs for hospital bedrooms and bathrooms and improved education for elderly adults about how to prevent falls.

## **ATV MORTALITY IN THE UNITED STATES, 2011-2013**

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### **ABSTRACT**

The purpose of this study is to examine contributing factors of ATV injuries and deaths through application of the Agent-Host-Environment epidemiological model. By analyzing the associations between contributing factors and classifying these factors based on the model, appropriate intervention strategies may be identified.

All US incident reports of ATV fatalities and injuries between 2011 and 2013 were obtained from the Consumer Product Safety Commission (CPSC). Each report was read and coded based on information available in the narrative incident report. Each coded variable was classified as relating to a section of the epidemiologic triangle: agent, host, or environment. Descriptive statistics were obtained for the coded variables and Chi-Square Automatic Interaction Detector (CHAID) analysis was performed in order to identify associations between predictor variables.

A total of 1,230 incident reports were obtained and, after data cleansing, a total 1,193 fatality reports remained. While only 12% of cases occurred on farms, the calculated mortality rate in the farming population (.62 per 100,000 population/year) is over four times higher than the overall mortality rate in the United States (.13 per 100,000 population/year). Descriptive statistics showed low helmet use (11.85% of fatal cases) and high use of alcohol and drugs (84.2% of fatal cases). The CHAID results showed significant associations between all types of variables: agent, host, and environment.

The present study provides nationwide statistics on ATV fatalities, approaching risk factor analysis with regard to the agent-host-environment epidemiological model. The three aspects of the epidemiologic triangle each contribute, and build upon each other, to create the combination of risk factors that lead to a fatal event.

By modeling and categorizing risk it is possible to develop targeted solutions to the root cause of the hazard. Through use of legislation and training, many host-related risk factors can be controlled, use of engineering controls can mitigate risk due to the agent and/or physical environment, and use of targeted marketing strategies and education may be able to limit risk due to the social environment.

## Measuring Work-Related Stress: Review and Critique of Instruments

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### ABSTRACT

**Background:** Work-related stress is traditionally measured by collecting data on the exposures and appraisals of objective and psychosocial stressors in the work environment. However, there is much confusion about the measurement of work stress, with varying emphasis on stressful events, responses, or appraisal of situations within the work environment.

**Objective:** The objective of this study was to identify the instruments used to measure work-related stress, review the instruments conceptual and measurement models, and scale reliability and validity.

**Methods:** A systematic search using electronic databases, hand searching through library shelves, academic and colleague contacts, and “snowballing” technique was carried out. For instruments meeting inclusion criteria, the underlying conceptual and measurement models were summarized and evidence of reliability and validity was assessed.

**Results:** A total of 36 instruments were identified and 25 were included. The majority of instruments used three specific theories of work stress 1) Person-Environment Fit 2) Job Demand-Control, and 3) Lazarus Transactional Model of Stress. Compared to copyrighted instruments, instruments created by governments and non-profit research institutions were more often publicly available and offered acceptable reliability and validity.

**Discussion:** The measurement of work-related stress has evolved as the work environment has changed from less manufacturing to more information technology and service sector jobs. While it is necessary to create instruments as the work environment changes, instrument revision and adaptation should be considered prior to creation of a new instrument.