

FINAL PROGRESS REPORT

Occupational Medicine
West Virginia University School of Medicine
Morgantown, WV 26506-9145

Appalachian Training Program in Occupational Health and Safety
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LIST OF ABBREVIATIONS

ABET	Accreditation Board for Engineering and Technology
ABPM	American Board of Preventive Medicine
ACGME	Accreditation Council for Graduate Medical Education
ACOEM	American College of Occupational and Environmental Medicine
ARC	Appalachian Regional Commission
ATP-OHS	Appalachian Training Program in Occupational Health and Safety
CAOHC	Council for Accreditation in Occupational Hearing Conservation
CEPH	Council for Education in Public Health
CME	Continuing Medical Education
DRDS	Division of Respiratory Disease Studies
DSR	Division of Safety Research
HSC	Health Sciences Center
IH	Industrial Hygiene
IOEH	Institute of Occupational of Environmental Health
MPH	Master of Public Health
NIOSH	National Institute for Occupational Safety and Health
NRCCE	National Research Center for Coal and Energy
OMR	Occupational Medicine Residency
OSHE	Occupational Safety and Health Engineering
PGY	Post-Graduate Year
SoPH	School of Public Health
WVU	West Virginia University

Title: Appalachian Training Program in Occupational Health & Safety

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FINAL REPORT ABSTRACT

Periodically since 1978, NIOSH has commissioned national surveys of the Occupational Safety and Health (OS&H) workforce. The most recent report was released in October 2011 “to respond to growing concern and debate over the supply and demand for occupational safety and health professionals in the United States” (National Assessment of the Occupational Safety and Health Workforce available at <http://www.cdc.gov/niosh/oshworkforce/>). One of the main conclusions of this study was that:

“The estimated number of OS&H professionals employers expect to hire in 2011 and over the next 5 years is substantially higher than the number to be produced from OS&H training programs. ... Anticipated retirement figures notwithstanding, this applies to the 4 major OS&H disciplines (safety, industrial hygiene, occupational medicine, and occupational health nursing).” The survey projected a decline in the number of OS&H students which “is troubling given employers’ hiring expectations, anticipated retirement figures, the “graying” of some of the disciplines, and the increasing quality of students enrolling in programs”.

West Virginia has a tragic legacy of occupational and environmental disasters. Historically, these include names such as Hawk’s Nest (arguably one of the largest outbreaks of fatal occupational disease in US history) and Willow Island (the highest number of fatalities in a construction-related accident). As more recent West Virginia locations of Sago, Upper Big Branch, and Elk River demonstrate, this legacy continues. It is therefore not surprising that, according to the most recent Census of Fatal Occupational Injuries from the Bureau of Labor Statistics, West Virginia exceeds national averages in all areas. For U.S. workers in 2012, the rate of fatal occupational injuries was 3.2 per 100,000 workers while in West Virginia it was more than two-fold greater at 6.9 per 100,000 workers. Nowhere in the United States is the need for trained occupational safety and health professionals greater than here.

The Appalachian Training Program in Occupational Health and Safety at West Virginia University (WVU) therefore serves a critical need to supply qualified occupational health and safety professionals for our state and region. Our specific goal is a practical one: to train professionals who understand hazardous workplaces and who are prepared to serve in a “front-line” capacity to prevent, mitigate, and manage workplace injuries and disease. We emphasize the recruitment and training of graduates who will be committed to remain within the Appalachian region. The program provides Master’s level training in Industrial Hygiene (IH), both Master’s and Doctoral-level programs in Occupational Safety and Health Engineering (OSHE), and an Occupational Medicine Residency (OMR) for physicians. The OMR has been supported by NIOSH since 1988, the IH program since 1980 and the OSHE program since 2005.

All three programs benefit not only from the resources of a large, land-grant university but a close relationship with all three Divisions of NIOSH-Morgantown, the only such facility in the country located on a university campus and adjacent to the HSC.

Occupational Medicine Residency – OMR

SECTION I

HIGHLIGHTS/SIGNIFICANT RESULTS

The program received a favorable review by the ACGME with 5-year full reaccreditation in January 2013.

Creation of a new School of Public Health, which received full CEPH accreditation in June 2015.

Dr. Martin served as a member of the Preventive Medicine Milestones Working Group for the Accreditation Council for Graduate Medical Education

Dr. Martin served as a member of the National Assessment of the Occupational Safety and Health Workforce at the request of the Director of NIOSH, Dr. John Howard

Establishment of international agreements allowing the program to train three scholars sponsored by the government of Saudi Arabia and one by Saudi Aramco

Translation of Findings

The program is stable with a national and international presence. The program continues to grow and support broader training in public health.

OUTCOMES/RELEVANCE/IMPACT

We also serve our state of region. Although we are small program graduating 1-2 physicians each year, there are 9 program graduates in practice in West Virginia (Table 1) with an additional 7 board certified OM physicians, of whom 4 are formally associated with the program. This means that more than 81% of the occupational medicine physicians in West Virginia are program graduates or connected to the program.

(See Appendix A – Table 1)

There are an additional 6 program graduates who are outside of West Virginia but within Appalachia.

(See Appendix A – Table 2)

SECTION II

TECHNICAL REPORT

Background

It is difficult to overstate the importance of these programs to Appalachia, defined by the Appalachian Regional Commission as a 205,000 square-mile area with approximately 25 million people extending from southern New York to northern Mississippi. This is the only OMR in the entire region, and there are only two other NIOSH-supported programs providing training in IH and three in OSHE. Not only do these programs serve critical regional needs for qualified occupational health and safety professionals, but this grant helps connect programs based within the Benjamin M. Statler College of Engineering and Mineral Resources (CEMR) to those of the Robert C. Byrd Health Sciences Center (HSC) and form the nucleus around which larger activities are built, such as broader educational outreach, research, clinical service, workplace evaluation and control efforts, and national/international faculty recruitment and retention.

There has been a steady decline in the number of individuals taking the certification examination in Occupational Medicine from the American Board of Preventive Medicine (ABPM) over the past 10 years.

(See Appendix B)

The number of new diplomats is below those lost to attrition. This is therefore a critical time for NIOSH to support existing OMR training programs in order to fulfill its mandate to provide an adequate supply of qualified personnel to carry out the Occupational Safety and Health Act.

The Occupational Health program was previously based in the Department of Emergency Medicine of the School of Medicine. However, the program is currently transitioning into the new School of Public Health and will be a Division within the Department of Occupational and Environmental Health Sciences.

Objectives

We perceive serious under-recognition and inadequate prevention and treatment of occupational injuries and disease, statewide and in the broader region. The need for well-trained health professionals specializing in occupational health and safety cannot be overstated. The aim of this program is therefore clear: To train skilled professionals who understand work places, recognize and manage occupational disease and injuries as members of a team, and who are prepared for and dedicated to mitigation and prevention in the Appalachian region.

Results/Discussion

The OMR is a two-year program designed to meet the requirements for board certification in Occupational Medicine by the ABPM. Consistent with new requirements from the ACGME, throughout both years (denoted as Preventive Medicine-1 and 2) trainees are actively involved in academic and practical (clinical) activities. Residents complete coursework over the first year to satisfy the requirements for a Master of Public Health (MPH) degree and participate in the Occupational Medicine clinic at WVU. During the second year, they carry out research work and engage in clinical, industrial, and administrative experiences. The program emphasizes two broad areas: clinical occupational medicine and workplace hazard evaluation and control.

1. Preventive Medicine-1 (PM-1)

PM-1 provides the core knowledge and skills which form the basis of the practice of both public health in general as well as occupational and environmental medicine specifically. The resident completes all MPH coursework, participates in additional weekly didactic activities and evaluates and manages patients in the Occupational Medicine clinic.

The MPH program has been accredited by the Council on Education for Public Health (CEPH) since 1997 and recently received a 7-year reaccreditation. All residents complete the on-campus MPH degree, Occupational and Environmental Health Sciences track.

2. Preventive Medicine-2 (PM-2)

PM-2 is designed to provide residents with the opportunity to apply the knowledge and skills gained in PM-1 in a broad range of settings. All residents complete a 6-month rotation at NIOSH Morgantown and participate in a national-level field investigation. Additional rotations are spent in a variety of industries, workers' compensation agencies and clinical settings.

PM-2 is designed to provide trainees with supervised opportunities through research, clinical, administrative, governmental, corporate and on-site worksite experiences. Flexibility is an important aspect of this year to accommodate each resident's background, career and educational goals. During PM-2, residents:

1. participate in a wide spectrum of practicum rotations
2. complete the MPH practice based experience (research activities and cumulative experience at NIOSH)
3. complete the MPH 1 hour capstone project/presentation
4. engage in clinical activities with progressive responsibility
5. attend additional residency-related didactic activities (OM Rounds, SoPH Rounds, NIOSH Spirometry and CAOHC Hearing Conservation courses)

3. Rotations

We use a combination of concurrent, blended rotations for experiences requiring more extended time periods to maximize learning opportunities (NIOSH, US Steel, Washington Hospital Occupational Medicine Center, OM and other clinical rotations) and traditional block rotations for those rotations in which a regular, onsite presence is required (John Deere, OSHA, BrickStreet Insurance, Kanawha-Charleston Health Department).

Elective experiences are specifically noted and denoted in italics, otherwise the rotation is required of all residents. Six months are based in Morgantown, during which time trainees take the following rotations concurrently:

- National Institute of Occupational Safety and Health
 - Division of Safety Research (DSR)
OR
 - Division of Respiratory Disease Studies (DRDS)
OR
 - Health Effects Laboratory Division (HELD)
- OM Clinic (four half-days per week)
- *Other clinic rotations at WVU (Dermatology, Pulmonary Medicine, Sports Medicine, etc.) as electives*

A minimum of three half-days per week are spent at NIOSH based at either DSR, DRDS, or HELD depending upon the interests of the trainee and rotation availability. The rationale behind more prolonged, concurrent rotations is to maximize learning opportunities at NIOSH. In particular, considerable advanced planning is needed not only for placement at NIOSH, but also to arrange participation in national-level field investigations, either Health Hazard Evaluations (HHE) through DSR or Fatality Assessment and Control Evaluations (FACE) through DRDS. Furthermore, a more extended NIOSH experience permits trainees to see a project through to completion from data gathering to presentation and write-up.

Additional industrial rotations are taken in a block format.

- *OSHA Office of Occupational Medicine (2 months)*. This rotation is an elective and contingent upon admission by OSHA personnel.
- *John Deere Moline, IL*

Trainees also spend approximately 2 months based in Charleston and take the following rotations concurrently.

- BrickStreet Insurance
- Kanawha-Charleston Health Department, Charleston, WV

Several additional rotations are also available to the resident. The time spent will vary for each resident, as these experiences are scheduled concurrently with other required rotations.

- US Steel, Pittsburgh, PA
- Washington Hospital Occupational Medicine Center, Washington, PA

Additional, required 1 week experiences include:

- Materion Corporation. David Deubner MD, MPH, is the Vice President of Occupational and Environmental Medicine of the only fully integrated producer of beryllium and beryllium oxide in the world located in Elmore, Ohio. This workplace offers residents a unique opportunity to understand mechanisms to deal with an occupational hazard through engineering, personal protective equipment and surveillance-based strategies. Since this company actively collaborates with NIOSH DRDS, residents frequently have long-term involvement in beryllium-related issues.
- John Deere symposium: David Deeter, MD, MPH, MHA is the Medical Director of Deere & Company in Moline, IL. Previously serving as our Residency Advisory Committee (RAC) Chair, he saw the need to introduce the residents to the roles of the occupational medicine physician in global manufacturing. For the last four years he has hosted a one-week symposium for our residents, as well as Occupational Medicine residents from several other programs. Activities in which the resident participate include: various tours (John Deere Harvester Works, Historic Site, Parts Distribution Center, Waterloo and the U.S. Army Rock Island Arsenal industrial facility), discussions with John Deere's industrial hygiene, safety and environmental directors and introduction to Deere's international travel health and travel security departments. Our residents also have the opportunity to spend a one-month rotation at John Deere, if they choose.

4. **Clinical Activities (PM-1 and PM-2)**

Clinical work occurs longitudinally throughout both years of the residency. Residents spend a minimum of two half-days in clinic each week during PM-1 to as many as four half-days during PM-2 in the Occupational Medicine clinic. In addition, based on prior clinical training, residents may be asked to engage in clinical work in other departments, such as Family Medicine during PM-1.

With an average of approximately 350 patient visits per month, the clinical practice through WVU Occupational Medicine is one of the busiest academic occupational medicine clinics nationally, and is an important resource in the region. A full spectrum of clinical care is offered.

PROGRAM FACULTY

Chris Martin, MD, MSc, began as the principle faculty member directing the program in 1999 and formally served as Program Director from 2002-2013. He will become Program Director in September 2015. He is a Professor of Medicine in the School of Medicine and of Occupational and Environmental Health Sciences of the School of Public Health. As Director of the Division of Occupational Medicine, Dr. Martin bears overall responsibility for all clinical, scholarly, and educational activities in Occupational Medicine at WVU, including the OMR and the TPG. As Program Director, Dr. Martin is responsible for all administrative, clinical and didactic elements of the OMR and ensures compliance with general and program-specific requirements of the ACGME. He regularly communicates with all rotation preceptors to ensure a cohesive, progressive experience for trainees.

Charles L. (Carl) Werntz III, DO, MPH served as the Interim Program Director of the Occupational Medicine Residency from July 2013 – September 2015. He previously served as Associate Program director from 2003 through 2013 and was Program Director of the Osteopathic-Accredited Occupational Medicine Residency Program at WVU 2008-2011.

He has almost daily contact with residents and monitors individual performance. He teaches two courses taken by OMR trainees: *Medical Toxicology* (OEHS 766) and *Introduction to Global Public Health* (PUBH 605).

Anna Allen MD, MPH, MS is an Assistant Professor in the Department of Occupational and Environmental Health Sciences of the WVU School of Public Health.

She was appointed Associate Program Director in 2014. In addition to near daily contact, Drs. Martin and Allen meet with each trainee every 3 months and provide written documentation of accomplishments, rotation planning, summative/formative feedback, and career guidance. She is the Master's of Public Health faculty advisor for all residents and chairs the new Clinical Competency Committee, which became an integral component of the Next Accreditation System for OMR's in July 1, 2014. Dr. Allen is the course director for *OEHS 620 Occupational and Environmental Hazard Assessment* in the School of Public Health (a required course for both OMR and IH trainees) and a small group leader for the *Physical Diagnosis and Clinical Integration* course taken by all first-year medical students.

Robert M. Gerbo, MD is an Associate Professor in the Department of Occupational and Environmental Health Sciences of the WVU School of Public Health. He provides multiple lectures to residents on a variety of topics in clinical preventive medicine and the commercial driver medical examination as well as serving as a preceptor in clinic.

ChuanFang Jin, MD, MPH, MS is an Associate Professor in the Department of Emergency Medicine. She provides hands-on clinical teaching to the residents and the medical students in the Occupational Medicine clinic at WVU. In addition to patient care, she performs exposure evaluation, independent medical evaluations and consultations for variety of clients. She serves as a physician in WVU's Travel Medicine Clinic and provides immigration medical examinations as a CDC-designated Civil Surgeon.

Robin Altobello A great asset of the program is the Residency Manager, Ms. Robin Altobello, who has served in this capacity since 2003. She will devote 50% of her time to the program. Conforming with all ACGME requirements requires a great deal of administrative work and extensive documentation, a role Ms. Altobello serves capably. She schedules visits and agendas for candidates to the program, is responsible for all administrative aspects associated with the hiring of new residents, assists Dr. Werntz in scheduling all trainee activities, booking accommodations for off-site rotations, coordination of RAC meetings, maintains minutes and letters, logs of duty hour and moonlighting hours, and both grant and financial management for the program. She is widely recognized as one of the most talented Residency Managers in the School of Medicine, and was selected in 2012 by senior leadership in the School of Medicine to serve 50% in the central GME Office. In that capacity, she coordinates all school-wide GME special events including GME Week, the new resident orientation, and an educational development series for both Program Directors and Managers.

Additional Faculty

Trainees benefit from an exceptionally large and diverse group of faculty from WVU, all three divisions of NIOSH Morgantown as well as a variety of external institutions.

The new School of Public Health was created in July 2012 and currently has 41 full-time faculty. Within the Department of Occupational and Environmental Health Sciences there are 10 faculty, including IOEH faculty Drs. Allen and Werntz through adjunct appointments.

Strong support from NIOSH Morgantown personnel is evident through a variety of interactions: supervision of OMR trainees on rotation at NIOSH, service on the RAC, lecturing in weekly rounds and involvement in WVU course offerings. There are a total of 21 NIOSH Morgantown personnel with adjunct appointments within

Occupational Medicine or the School of Public Health (**See Appendix C**). Program faculty is listed above. Within Occupational Medicine, trainees interact with four board-certified occupational medicine physicians.

CONCLUSION

The Occupational Medicine Residency at WVU is one of only two rural-based programs in the country and the only one within the Appalachian region. The program has a long and successful record of placing graduates within Appalachia or other rural areas. At a time when many other programs have closed, the OMR is stable, with long-serving, experienced faculty and a record of 20 continuous years of commendation for substantial compliance with the rigorous requirements of the ACGME.

The program incorporates several novel approaches as follows:

- Trainee exposure to a workplace with unique hazards upon entry to the program through a one-week experience during orientation at Materion Corporation in Elmore, OH, the only fully integrated manufacturer of beryllium products in the country.
- A structured one-week symposium at John Deere in Moline, IL, taken with trainees from the OMR programs at the University of Iowa, University of Illinois at Chicago and University of Minnesota
- Funded training programs for international physicians
- NIOSH rotations completed by all trainees, which include national-level field investigations.
- A full spectrum, high-volume academic occupational medicine clinic. Diverse services are provided including MRO work, FAA examinations, Travel Medicine, immigration examinations, federal black lung evaluations, and independent medical evaluations.
- All trainees are required to become certified in the performance of spirometry and audiograms.

Occupational Safety & Health Engineering program (OSHE)

HIGHLIGHTS/SIGNIFICANT RESULTS

During the last funding cycle, the Occupational Safety and Health Engineering (OSHE) program was successful in meeting its primary objective of educating engineering students at the master's and doctorate level in the Occupational Safety and Health related areas. On average, eight students were enrolled in the program per year. Two Ph.D. and seven M.S. students graduated from the program. Both Ph.D. students are currently working in academia in Occupational Safety and Health (OSH) fields. The M.S. students are either working or pursuing higher degrees (Ph.D.) in OSH related fields.

OUTCOMES/RELEVANCE/IMPACT

During the last funding cycle, the students and the program faculty were very active in disseminating the outcomes of their scholarly research activities. Thirty four peer-reviewed journal papers, 14 peer-reviewed conference papers, 22 abstract peer-reviewed conference papers were published, and over 40 presentations were made at local, national, and international OSH conferences or meetings. **See Appendix E**

TECHNICAL REPORT

Background and Specific objectives:

The Occupational Safety and Health Engineering (OSHE) program at West Virginia University (WVU) is designed to educate engineering students at the master's and doctorate level with the goal of developing and supporting a new generation of OSH professionals. The curriculum is designed to provide a strong foundation and help develop the analytical skills needed to identify occupational hazards, understand failure modes and effects, engineer out hazards, and implement administrative controls as stop-gap measures, and to use experimental, simulation, and engineering models to develop, test, and evaluate design interventions.

The master's degree curriculum focuses on providing training that enables our graduates to: (1) understand, recognize, and quantify occupational hazards; (2) conduct mathematical, statistical, and probabilistic analysis to engineer out occupational hazards; (3) develop and test innovative engineering and administrative controls to mitigate occupational hazards; (4) assess economic feasibility of controls to ascertain effective implementation.

The overall goal of the doctoral training program is to educate trainees to the highest level of competency in teaching and research. The program helps trainees develop skills and experience to perform independent research in the application of scientific principles to anticipate, recognize, evaluate, control, and manage occupational and environmental hazards. The research work for the doctoral dissertation must show a high degree of originality on the part of the trainee, and must constitute an original contribution to the art and science of industrial engineering and occupational safety and health.

Results and Discussion:

A new advisory committee was formed for the OSHE program in the Fall of 2011. This committee has been a valuable addition to the program. The committee meets annually to review the state of the program. The committee currently consists of the following members:

1. Dr. Hongwei Hsiao, Committee Chair, Chief of the Protective Technology Branch, Division of Safety Research (DSR), NIOSH, Morgantown, West Virginia
2. Dr. Anna M. Allen, MD, MPH, Assistant Professor, Department of Emergency Medicine-Occupational Medicine, West Virginia University School of Medicine, Morgantown, West Virginia
3. Robin A. Altobello, Program Manager, Department of Emergency Medicine-Occupational Medicine,

West Virginia University School of Medicine, Morgantown, West Virginia

4. Dr. Sheree L. Gibson, P.E., CPE, President, Ergonomics Applications, Salem, South Carolina
5. Mr. Timothy J. Pizatella, Deputy Director, Division of Safety Research, NIOSH, Morgantown, West Virginia

The program's curricula have been significantly revised in the last three years:

1. A new ergonomics course was developed (IH&S 460: Ergonomics). This course covers basic work physiology and biomechanics topics. In addition, several other important ergonomics topics such as information processing theory, signal detection theory, anthropometry, and workplace environments (noise, vibration, climate, illumination) are also covered in this course.
2. The content of IENG 564 (Industrial Ergonomics) was significantly revised by including several advanced biomechanics (3D kinematics, inverse dynamic analysis, optimization based modeling techniques, etc.) and work physiology topics (stress-strain evaluation using physiological matrices such as heart rate, oxygen consumption, metabolism, etc.).
3. Dr. Harris, a Research Safety Engineer in the Division of Safety Research at NIOSH in Morgantown and an Adjunct Assistant Professor for the OSHE program, started teaching systems safety courses (IENG 461 and IENG 662) starting in the spring of 2013. He has made significant changes in the content of these courses.
4. The content of IENG 461 (Systems Safety Engineering I) was significantly revised by incorporating various qualitative hazard identification techniques including fault tree analysis (FTA), failure modes and effects analysis (FMEA), hazard and operability analysis (HAZOP), management oversight and risk tree (MORT), and bow tie analysis.
5. The content of IENG 662 (Systems Safety Engineering II) was revised by including topics on probabilistic design with a concentration on normal, lognormal, Weibull, and Poisson distributions. This course also includes topics on standard guidance in determining control reliability for functional safety evaluations.
6. The content of IENG 660 (Human Factors System Design) was also revised by incorporating several advanced human performance modelling techniques and system safety topics (signal detection theory in inspection and quality control, sampling methods, learning models, synthetic time measurement systems, etc.)

A structured internship program was developed through a partnership with the Division of Safety Research (DSR) at NIOSH in Morgantown. Opportunities of summer internship positions in various labs within NIOSH in both the Morgantown and Pittsburgh campuses are circulated to all OSHE trainees at the beginning of every spring semester (late January or early February). Trainees complete the application process and learn about the final employment decision during the mid-spring semester (late March or early April).

The OSHE program continued to hire new core faculty to enhance its offerings. One new faculty member (Dr. Ning) joined the program in the fall of 2011 and another new faculty member (Dr. He) joined the program in the fall of 2014. **See Appendix F** for full listing of program faculty.

Several new equipment and software (~ \$100,000) were added to enhance the research capabilities of the OSHE program's Industrial Ergonomics and Industrial Hygiene labs.

Conclusion:

Over the last funding cycle, on average, eight students were enrolled in the program per year. The NIOSH TPG funding supports approximately 15-20% students enrolled in the program. Two Ph.D. and seven M.S students graduated from the program. Both Ph.D. students are currently working in academia in OSH fields: one working as an Assistant Professor in the Department of Safety and Occupational Health Applied Sciences at Keene State College in New Hampshire and other working as an Assistant Professor in the Department of Safety Sciences at Indiana University of Pennsylvania. Among the seven M.S. students who graduated during the last funding cycle, four students were supported by the NIOSH TPG. The recent master's degree graduates are employed as OSH professionals with different local organizations including the Department of Energy, WVU healthcare, Consol Energy, and the U.S. military.

Industrial Hygiene (IH)

HIGHLIGHTS/SIGNIFICANT RESULTS

During the 5-year term of this grant, 2010-2015, there were 41 students enrolled in the WVU Industrial Hygiene Master's program, an increase of 5 from the previous 5-year period. Of those 41, twenty-five graduated, 4 dropped out, and the other 12 are making progress towards graduation.

For the same period, 18 students received NIOSH funding. Of those, 8 have graduated, 3 have withdrawn, and 7 are making progress but have not been students long enough to graduate or are now part-time students who will take an indeterminate time to graduate. **See Appendix G: IH Masters Students Receiving NIOSH Funding in 2010-2015.**

Of the 25 who graduated in this period, all are employed in safety and health. Indeed, all of our students, except foreign students, are employed either part-time or full time in professional IH positions after completing their first year.

OUTCOMES/RELEVANCE/IMPACT

At WVU, all MPH students in the School of Public Health Occupational and Environmental Health Sciences program are required to complete our industrial hygiene sampling course (IENG 561). In it they learn not only how to sample airborne contaminants, but also at least the rudiments of noise measurements and ventilation design. Hence, when they enter the workforce as safety managers or occupational physicians, they have a higher than typical working knowledge of industrial hygiene. Likewise, Safety Management students (about 40/yr) now take an alternate version of our first sampling course (IENG 561). It is somewhat less technical and is more of a survey course than IENG 561.

It is difficult to produce accurate statistics on this, but we are confident that we train the great majority of industrial hygienists practicing in West Virginia and a significant fraction of those working in Appalachia.

All or nearly all of our funds were spent each year.

Research done by faculty and students in this period will likely prove important to the practice of industrial hygiene. Progress in research was also significant. The faculty in IMSE who teach and mentor IH students had a combined 44 publications and allied faculty (adjuncts and faculty in the WVU School of Public Health) had a combined 42 publications. The most important research areas during the project period were: (1) real time determination of noise reduction provided during normal work shifts, (2) effectiveness of both enclosing and capturing ventilation hoods under typical work conditions, (3) ergonomic research programs in biomechanics, (4) fall protection, safety of scissors lifts and rollover protection, and (5) respirator effectiveness research by our new faculty member, Dr. He.

Research funded by NIOSH demonstrated that noise reductions (NR) provided during normal coal mining and other work by both ear muffs and earplugs were highly variable (5 dBA), as were fit-test results (5 dBA). As a result, it is difficult to assess the effectiveness of a hearing protection without at least 5 fit-tests.

A study of the effectiveness of capturing hoods showed them to be highly effective if the cross-draft came over the worker's back. We are in the process of testing other flow orientations.

Respirator fit-testing has found that breathing frequency significantly affects effectiveness, with the strength of the association varying with type of respirator and particle size.

Ergonomic studies in the following areas have continued:

1. Quantification of the cervical spine loading among the surgeons using surgical loupes
2. Evaluation of the cervical spine loading during forceful arm exertions
3. Design and evaluation of cervical spine support mechanism for VDT users
4. Use of Iyengar yoga therapy to reduce low back pain among West Virginia residents

5. Understanding the contribution of physical and psychosocial stress on the loading of neck musculature among healthcare workers
6. Effect of dual monitor display on the electromyography of cervical musculature.
7. Biomechanical evaluation of different techniques used to lift retaining wall blocks by construction workers
8. Understanding the relationship between ingress, egress and reaching tasks volumes and influence of anthropometric dimensions on motions during such tasks
9. Evaluation of an autonomous motion analysis system to quantify biomechanical loading using full body musculoskeletal modeling techniques
10. Evaluation of loaded locomotion on uneven terrains using full body musculoskeletal modeling

TECHNICAL REPORT

Background:

The population of West Virginia is largely employed in OSHA's "high hazard" industries: mining, railroading, logging and timbering, chemical and steel production. The Appalachian region, including West Virginia, has an unacceptably high level of occupational injuries and disease. Based on the most recent US Department of Labor statistics, West Virginia has a non-fatal injury and illness rate of 5.2%, which is roughly 25% higher than the national average of 4.2%. West Virginia's rate of fatal work injuries is twice the national rate at 7.7 per 100,000 workers. Aside from the much greater losses to injured workers and their families, occupational injuries and illnesses have been extremely costly for the WV's worker compensation fund, which is over \$2 billion underfunded, yet disability outlays are more than 8.0% of total payroll costs, the highest rate in the nation. Other nearby areas, such as southwestern Pennsylvania, western Maryland, eastern Kentucky, southwestern Virginia and southern and eastern Ohio, show a similar employment profile. Clearly, there is a tremendous state and regional need for improvements in safety, health and the environment. Just as clearly, it is critical to continue training qualified safety and health professionals if we are to continue improving the occupational safety and health quality of life for workers in West Virginia, the region, and the nation.

Indeed, the training of qualified safety and health professionals is prerequisite for improving the occupational safety and health quality of life for workers in West Virginia and the nation.

Objectives

The objective of the West Virginia University Industrial Hygiene program is to educate students at the masters' level in the field of industrial hygiene, occupational ergonomics, and safety engineering. The IH program is administered through the Industrial and Management Systems Engineering Department (IMSE) in the College of Engineering and Mineral Resources.

The goal of the program is to provide applications-oriented education in the field of industrial hygiene, occupational ergonomics and safety engineering while emphasizing cost-effective and practical solutions to safety and health problems in the workplace. Graduates of the program are prepared to function in both private and public sectors.

- 1) The I.H. program is structured to meet the needs for a well-trained, broad-based safety and health professionals. The applications-oriented program provides a masters-level education in the fields of industrial hygiene, occupational ergonomics, and safety -- with additional classes in environmental science, toxicology, noise, ventilation, and epidemiology. The goal of the program is to provide applications-oriented education emphasizing cost-effective and practical solutions to safety and health problems in the workplace. Graduates of the program are prepared to function in both the private and public sectors.
- 2) Our specific goal is to train 10 new industrial hygienists per year and to place them all in professional industrial hygiene or safety positions, with as many as possible in Appalachia. We obviously have no

control over where they go when they graduate, but those who were born in this area are far more likely to work here than those who were not.

Secondary goals of the program are:

- 1) To provide introductory industrial hygiene, safety, and ergonomics education to undergraduate engineering students,
- 2) to provide similar training to doctoral and masters graduate students in engineering and other parts of the university (e.g. Wood Products, Occupational Medicine, Industrial and Labor Relations, Safety and Environmental Management), and 3) to serve the state of West Virginia by providing limited safety and health services.

Results and Discussion

As can be seen in the **Appendix H**, the total number of students in the program has fluctuated between 4 and 9. Likewise, the number graduating each year has fluctuated between 1 and 7. Note that it lists the numbers of new students each year, not the total number enrolled. All students accepted into the I.H. program must meet ABET standards.

To date, we have had far more employers eager to hire our students than we have students. Our graduates have accepted employment in industry, government, and labor. They have accepted employment as industrial hygienists, researchers, safety engineers, ergonomists, and as general health, safety, and environmental professionals utilizing their broad-based education. We currently have two students who did not immediately find a position after graduating. Both are international students and one is restrained to stay in Morgantown by her husband's career.

Trainee grant funds paid for trainee stipends and tuition, as well as for trips by the Program Coordinator and most of the trainees to the national American Industrial Hygiene Conference and Exhibition for all 5 years. In addition, it paid for one-half month of the Program Coordinator's salary, enabling the Coordinator to spend the time necessary to administer and improve the program.

Core Faculty

All core faculty are members of the Industrial and Management Systems Engineering Department.

Steve Guffey, PhD, CIH Dr. Guffey is the Co-PI for the Industrial Hygiene section of the TPG. His involvement includes: advising, teaching, mentoring and liaison with supporting departments; his areas of competence is ventilation, industrial hygiene, air sampling, noise control, ergonomics and statistics. Dr. Guffey, has worked for OSHA and has consulted widely among Fortune 500 firms and with much smaller companies, giving him great practical experience. In addition, he has a Master's degree in ergonomics/safety and an undergraduate degree in engineering mechanics. He has designed engineering controls for hundreds of companies over many years and has done extensive research on ventilation design, exposure assessment, and noise controls. Dr. Guffey serves on the JOEH Editorial Board and the ACGIH Ventilation Committee, and he is a member of the AIHA Engineering Committee and the AIHA Noise Committee. He has written ventilation design software that is sold all over the world, and is the sole author of 3 chapters of the latest version of the ACGIH Industrial Ventilation manual, including two of the most important: ventilation measurements and hood design (next edition). He was awarded the "Best Paper of the Year" by the AIHA Engineering Committee three times in 7 years. Dr. Guffey has received the "Best Paper" award from the AIHA Engineering Committee for 1994, 1995, and 2000.

Warren Myers, PhD, CIH Dr. Myers is the Associate Dean for Academic Affairs giving the program additional security, visibility within the college and university, as well as visibility with other engineering programs. His involvement includes teaching, advising, mentoring, liaison with dean's office and university; his areas of competence is industrial hygiene, air sampling, ventilation, statistics and noise control. Dr. Myers is a CIH with considerable research experience in protective equipment with NIOSH. He has been commended for his work with respiratory protection. Dr. Myers has been editor of an international occupational safety and health journal, has chaired one AIHA technical committee and was an officer on another. Dr. Myers has received the John M. White award given by the American Industrial Hygiene Association three times in the last 14 years. He is the only researcher in the US to be so honored.

Xinjian He, PhD Dr. He is an Assistant Professor. His involvement includes teaching and advising; his areas of competence is respiratory protection, ventilation design, noise control, disaster preparedness and mine explosion hazards. Dr. He has published 17 peer-reviewed research articles and has already developed a well-funded respiratory protection research program.

Dr. Xiaopeng Ning Dr. Ning is a new Assistant Professor. His involvement includes teaching and advising; his areas of competence is ergonomics and safety. Dr. Ning has 8 peer-reviewed journal articles and is well funded.

Ashish Nimbarte, PhD Dr. Nimbarte is an Associate Professor and Co-PI for the OSHE section of the TPG. His involvement includes teaching and mentoring; his areas of competence is ergonomics and safety. He is a very active publisher and researcher. His research efforts include joint mechanics and lifting. Dr. Nimbarte, has been on the faculty for 5 years and already has 15 accepted or published research articles. Dr. Nimbarte is a Certified Professional Ergonomist.

Supporting Faculty

Ann Allen, MD, MS Dr. Allen's involvement includes teaching and mentoring; areas of competence are occupational medicine and industrial hygiene. Dr. Allen is an occupational medicine physician with an MS in IH and a comprehensive practical experience in IH and safety.

Travis Knuckles, PhD Dr. Knuckles involvement includes teaching and point of contact in toxicology; areas of competence include toxicology and pharmacology.

Baqiyah Conway, PhD Dr. Conway teaches epidemiology.

Michael McCawley, PhD Dr. McCawley's involvement includes teaching and mentoring in engineering controls; his areas of competence are aerosols physics, industrial hygiene, and engineering controls for pollution control.

Brandon Takacs, MS Mr. Takacs's involvement includes teaching sampling course lab; his areas of competence are industrial hygiene practice and coal mining.

Gerry Hobbs, PhD Dr. Hobbs' teaches statistics and is well regarded in his academic community. .

Gary Winn, PhD Dr. Winn teaches safety electives and serves on the committees and is a Certified Safety Professional.

Adjunct Faculty

We are blessed with many active adjuncts who have substantial expertise. Note that adjunct faculty can serve on student research committees (AEC) as the "outside" member.

James Harris, PhD Dr. Harris is a retired NIOSH researcher who teaches both required safety courses; his areas of competence are risk assessment and engineering controls and is a certified safety professional.

Kevin Michael, PhD Dr. Michael, an audiologist with a world-wide reputation in hearing protector effectiveness research and hearing conservation, who serves on nearly all of the several student committees;

his areas of competence are noise measurements, audiometry, and research on the effectiveness of hearing protective devices.

Chris Coffey, PhD Dr. Coffey is an expert on ventilation filtration, both for ventilation and for respirators, and in sampling and evaluating volatile organic compounds. He is currently a researcher at NIOSH and guest lectures; his areas of competence include industrial hygiene, air sampling, respiratory protection, and analytical instruments.

Martin Harper, PhD, CIH Dr. Harper is a well-known expert on sampling and is currently a researcher at NIOSH and guest lectures; his area of competence includes industrial hygiene, air sampling and analytical instruments.

Hongwei Hsiao, PhD Dr. Hsiao is a highly published researcher on trips and falls from heights and many other safety issues and currently a researcher at NIOSH and guest lectures; his areas of competence is ergonomics and safety.

M. Abbas Virgi, ScD, CIH Dr. Virgi has strong research credentials in respiratory protection, nano-materials and noise measurement and control; he serves on student research committees.

Ziqing Zhuang, PhD Dr. Zhuang, an ergonomist researcher, serves on student research committees; his areas of competence is ergonomics and respirators.

Curriculum

The Industrial Hygiene (I.H.) program offers a Master's of Science degree. Graduates of the I.H. program are qualified to take the ABIH certification for industrial hygiene (C.I.H.) and the ASSE certification for safety (C.S.P). In addition, with two or three courses in ergonomics, graduates should be competent to resolve most ergonomics issues. In addition, the elective course in environmental management is invaluable in dealing with hazardous wastes and pollution control, another "hat" often worn by industrial hygiene and safety professionals. **See Appendix I.**

We believe that our students are thoroughly trained in sampling and analyses, ergonomics and human factors, noise, ventilation, and safety. In addition, they are given background training typical of IH programs nationwide in toxicology and epidemiology. Students who do not enter with substantial field experience or gain it from work experience while a student are strongly encouraged to take CMED 791A, an elective course which involves student IH inspection and recommendations to at least 3 industrial operations. However, nearly all students gain experience from a full-time, paying job in IH and safety during the summer. All students must complete a Project or Thesis (IH&S 697). Furthermore, hands-on laboratory experience is provided in courses, such as Industrial Hygiene Engineering (IENG 561), Ventilation (IH&S 528), Noise Control (IH&S 627), and Ergonomics (IENG 660 and 564). Statistical analyses are stressed in IENG 561 (industrial hygiene engineering), IH&S 725 (sampling and analyses), and IH&S 627 (noise). Report-writing is stressed in Industrial Hygiene (IENG 561, IH&S 725), Ventilation (IH&S 528), and Noise Control (IH&S 627).

Changes in the curriculum

During the 5-year period we began requiring a graduate course in statistics (STAT 511) in the first fall semester of attendance. IH&S 725 (advanced sampling) has always been strongly oriented to statistical analyses of realistic data sets. In the noise course we have increased the amount of statistical lectures and assignments for noise sampling data.

We have added a biohazard module to IENG 561 (sampling) and increased the time allotted to IAQ in the ventilation course. We have also added a module on non-ionizing radiation to the vent course.

In response to suggestions made by site visitors during the TPG site visit in Spring 2010, we made several changes to the curriculum, including:

- (1) Combining the two safety courses into a single course (IENG 662) thus removing redundancies between the two courses,

- (2) Adding a course with a strong risk assessment and management component (OEHS 601)
- (3) Continue making changes to the second ergonomics course to make it a research training course. As discussed earlier, as a course requirement, all students develop and defend a thesis proposal, do the research, and write a "thesis" and defend it before the class.
- (4) Increase the emphasis on exposure assessment in the two sampling courses by removing topics redundant with other courses and redundant between the two courses.

We also developed a new ergonomics course just for IH students (IH&S 460). In addition, we required a graduate level biology course (OEHS 630) for students without previous course in biology.

In response to our recent NIOSH Summary Statement, we are making the following additional changes:

- (1) Eliminating the remaining safety course,
- (2) Eliminating the second ergonomics course and requiring only IH&S 460.
- (3) Formalize the practical experience requirement.

We regret the loss of training in safety and ergonomics, but those changes do serve to reduce our required credits by 8, which should reduce the time to graduate by a semester in most cases. Hopefully, that will increase our retention and graduation rate.

Internships (a paid position as an IH during the summer) are arranged so that students have a directed field experience if they have not gained it from either prior experience or from working while in school. Nearly all students both work fulltime as IHs in the summer and part time as IHs during the school year. To date, there have been far more opportunities for internships than we have students. If they cannot obtain practical experience from an internship or part-time job, we require that students take OEHS 660 (Worksite Evaluation).

Our experience is that companies provide internships primarily to evaluate the student for permanent employment, but also to have special projects done. In every case, our students have been supervised by highly qualified industrial hygienists or safety professionals. All report being given challenging tasks that greatly enhanced their appreciation and understanding of IH methods.

Interdisciplinary experiences

WVU is in a particularly opportune location in Morgantown to integrate the course work of IH Masters students with students from other disciplines both within the University as well as in town. WVU and the CEMR are uniquely located next to three Divisions of the National Institute for Occupational Safety and Health, the Morgantown office of URS Federal Services which has the occupational and environmental safety and health responsibilities for the Federal Energy Technology Center in Morgantown and Pittsburgh and the Occupational Medicine Residency Program at the WVU School of Medicine. As a result, they provide many research opportunities in the areas of: Safety Research, Ergonomics Exposure, Assessment Respirator Research, Toxicology, and Industrial Hygiene.

In addition, WVU is located near the National Research Center for Coal and Energy (NRCCE), which has funding in excess of \$80M on coal and energy related research, with particular emphasis is: Acid mine drainage remediation, small watershed improvement, fossil fuel efficiency and improvement and small mine safety and health.

Training Program Evaluation

We are ABET accredited as an industrial hygiene Master's program. The assessment requirements completely overlap necessary assessments of the TPG other than financial ones.

Our meeting with the IH Advisory Group each year is the culmination of nearly constant assessments. Those assessments, which are all discussed with the Advisory Group, including:

Quality and number of applicants and enrolled students

Review of admissions requirements

Review of the program goals and objectives

Review of the curriculum and how it matches the goals and objectives

Assessments of each required course based on the goals and objectives met by that course

Surveys of alumni and alumni employers (every 6 years)

Exit interviews with graduating students

Formal and informal discussions with the Student Local AIHA Section and with individual students

Measures taken to “close the loop” (i.e., improvements) based on all of the assessments

With the Advisory Group, we also discuss recruiting strategies, measures to further improve interactions with NIOSH-Morgantown scientists, and problems encountered by students in progressing through the program.

Recruiting

Students are recruited nationally. The great majority are from West Virginia, with a substantial minority from Pennsylvania, Maryland, Ohio, and Virginia. Their undergraduate backgrounds are varied, with biology, chemistry, engineering, and environmental health and safety predominating. Many are referred to us by faculty in undergraduate safety and health programs at other institutions. WVU students know of us from two emails sent to all graduating seniors with GPAs above 3.0 in appropriate departments and from notices posted by faculty at universities in surrounding states. A significant fraction know of us from surfing the web and finding our web site or the Program Coordinator’s personal website. Others were referred to us by members of the IH Advisory Committee and alumni.

Monitoring Trainee Progress

Trainee progress in the program is monitored through a combination of individual advising sessions with Drs. Myers, He, Nimbarte, and Guffey for students taking their courses, and individual counseling and advising sessions by the Program Coordinator with each student at every opportunity. The instructors for the toxicology and epidemiology classes have been very good about contacting the Program Coordinator when IH students have difficulty in their classes, leading to counseling with the Program Coordinator.

Conclusion:

West Virginia University seeks to provide educational excellence in areas of concern to state and regional residents. The Industrial Hygiene program strongly matches with the institutional goals and objectives of the University and the College of Engineering and Mineral Resources by providing trained professionals to businesses of the state, region and nation. We will continue to provide training to doctoral and masters graduate students in engineering and other parts of the university (e.g. Wood Products, Occupational Medicine, Industrial and Labor Relations, Safety and Environmental Management), and to serve the state of West Virginia by providing safety and health services.

Appendix A

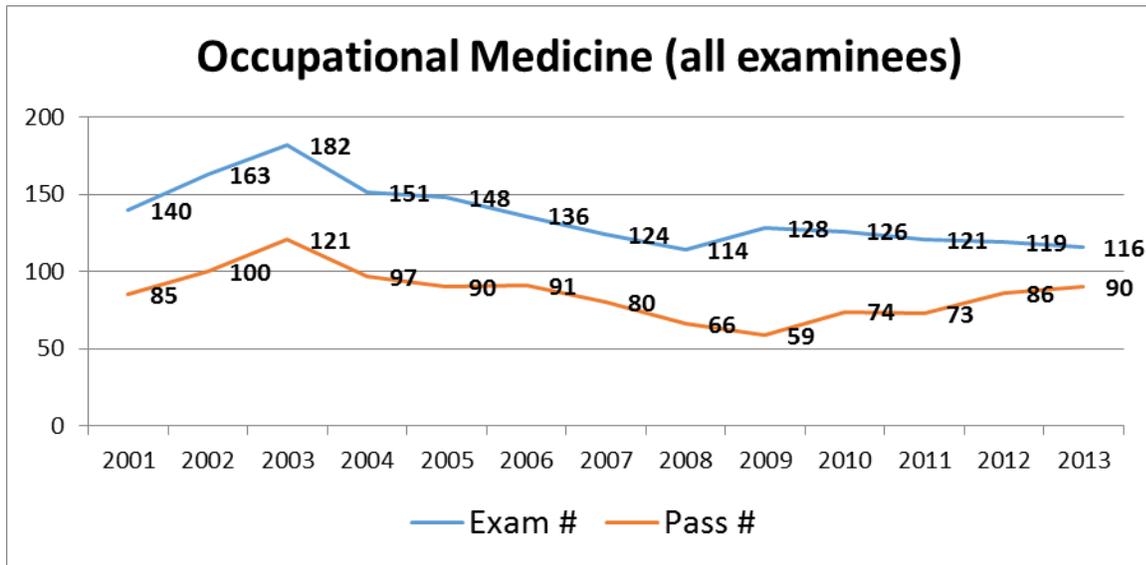
Table 1: WVU OMR graduates in West Virginia.

Mohammed Ranavaya, MD, MPH	Chapmanville, WV
Syam Stoll, MD, MPH	Huntington, WV
Ghazala Kazi (Afaq), MD, MPH	Martinsburg, WV
Charles Werntz, DO, MPH	Morgantown, WV
William Hoh, MD, MPH	Charleston, WV
Chuanfang Jin, MD, MPH	Morgantown, WV
Kristin Cummings, MD, MPH	Morgantown, WV
Anna Allen, MD, MPH	Morgantown, WV
Jean Meade, PhD, DVM, MD, MPH	Morgantown, WV

Table 2: WVU OMR graduates outside West Virginia in Appalachia.

Ibrahim Heiba, MD, MSTM&H	Kingsport, TN
Gerard DeGuzman, MD, MPH	Salem, VA
Scott Leslie, MD, MPH	Washington, PA
Sanjeev Kakkar, MD, MPH	Bristol, TN
Mohannad Kusti, MD, MPH	Pittsburgh, PA
Jennifer Lultschik, MD, MPH	Meadville, PA

Appendix B



Appendix C

OMR Adjunct Faculty

Michael Andrew, PhD	Mathematical Statistician, NIOSH
Rachel Bailey, DO	Medical Officer III, Epidemiologist, NIOSH-DRDS
Ki Bang, PHD	Professor, School of Public Health
Penelope Baughman, PhD	Associate Service Fellow, NIOSH
James Becker, MD	Professor, Marshall Health University Family Health
Dawn Castillo, MD	Director, NIOSH-DSR
Kristin Cummings, MD	Medical Officer, NIOSH-DRDS
Philip Franklin, MD	Medical Director, Sanofi-Aventis
Steven Guffey, PhD	Professor, Industrial & Management Systems Engineering, WVU
Rahul Gupta, MD	Commissioner, WV Bureau for Public Health
Paul Henneberger, PhD	Research Epidemiologist, NIOSH
Gerald Hobbs, PhD	Professor, Statistics, WVU
Margaret Kitt, MD	Deputy Director for Programs, NIOSH
Kathleen Kreiss, MD	Guest Researcher, NIOSH-DSR
Jean Meade, MD	Guest Researcher, NIOSH-HELD
Ashish Nimbarte, PhD	Associate Professor, Industrial & Management Systems Engineering, WVU
Christine Schuler, PhD	Associate Director for Science, NIOSH
Eileen Storey, MD	Supervisor, Research Medical Officer, NIOSH-DSR
David Weissman, MD	Director, NIOSH-DRDS

Appendix D

OMR – Publications

OM Residents

Hall MM, Finnoff JT, Sayed YA, Smith J. Sonographic. (2015) Evaluation of the Plantar Heel in Asymptomatic Endurance Runners. J Ultrasound Med. 2015 Oct;34(10):1861-71. PMID: 26362149

Sayed Y, Allen A, Minardi J, Kurdi H, Werntz CL 3rd, (2015) Musculoskeletal ultrasound in American Occupational Medicine Residency Programs: a survey of program directors. J Occup Environ Med. May;57(5):e55-6. PMID: 25951425

Sayed Y, Sully K, Allen A, Werntz CL 3rd. (2014) The emerging role of musculoskeletal ultrasound in occupational medicine. J Occup Environ Med. Dec;56(12):e160. PMID: 25479308.

Anderson SE, Franko J, Wells JR, Lukomska E, Meade BJ. (2013) Evaluation of the hypersensitivity potential of alternative butter flavorings. Food Chem Toxicol. Dec;62:373-81. Epub 2013 Sep 2. PMID: 24007741.

Demian C. Martin CJ. (2013) Is this man's cancer related to his occupation? J Occup Environ Med. Jan;55(1):112-4. PMID: 23291954. *MPH Project.

Anderson SE, Franko J, Jackson LG, Wells JR, Ham JE, Meade BJ. (2012) Toxicol Sci. Irritancy and allergic responses induced by exposure to the indoor air chemical 4-oxopentanal. Jun;127(2):371-81. PMID: 22403157

Anderson SE, Tapp L, Durgam S, Meade BJ, Jackson LG, Cohen DE. (2012) J Immunotoxicol. The identification of a sensitizing component used in the manufacturing of an ink ribbon. Apr-June;9(2):193-200. PMID: 22375946

Franko J, Meade BJ, Frasch HF, Barbero AM, Anderson SE. (2012) J Toxicol Environ Health A. Dermal penetration potential of perfluorooctanoic acid (PFOA) in human and mouse skin. 75(1):50-62. PMID: 22047163.

Franko J, Jackson LG, Hubbs A, Kashon M, Meade BJ, Anderson SE. (2012) Toxicol Sci. Evaluation of furfuryl alcohol sensitization potential following dermal and pulmonary exposure: enhancement of airway responsiveness. PMID: 22003193

Anderson SE, Tapp L, Durgam S, Meade BJ, Jackson LG, Cohen DE.. (2012) The identification of a sensitizing component used in the manufacturing of an ink ribbon. J Immunotoxicol. Apr-Jun;9(2):193-200. PMID: 22375946.

Anderson SE, Franko J, Lukomska E, Meade BJ. (2011) J Toxicol Environ Health A. Potential immunotoxicological health effects following exposure to COREXIT 9500A during cleanup of the Deepwater Horizon oil spill. 74(21):1419-30. PMID: 21916747

Franko J, Jackson LG, Meade BJ, Anderson SE. J Allergy (Cairo). (2011) Allergic Potential and Immunotoxicity Induced by Topical Application of 1-Chloro-4-(Trifluoromethyl) Benzene (PCBTf) in a Murine Model. May 14. PMID: 21747864.

NIOSH In-house FACE Report 2010-01, August 26, 2011. Solid Waste Compost Facility Worker Dies, Body Is Recovered In Digester Tube – Tennessee The investigation was conducted by Virginia Lutz, Safety and Occupational Health Specialist, Fatality Investigations Team, Surveillance and Field Investigations Branch,

Division of Safety Research, and Andrew Yorgason D.O., Guest Researcher, West Virginia University Occupational Medicine Residency Program, Surveillance and Field Investigations Branch, Division of Safety Research. *MPH Project.

Faculty

Sayed Y, **Allen A**, Minardi J, Kurdi H, **Werntz CL 3rd**. (2015) Musculoskeletal ultrasound in American Occupational Medicine Residency Programs: a survey of program directors. May;57(5) e55-6. PMID 25951425

Sayed Y, Sully K, **Allen A**, **Werntz CL 3rd**. (2014) The emerging role of musculoskeletal ultrasound in occupational medicine. J. Occup. Environ. Med. Dec;56(12)e160. PMID: 25479308.

Doney B, Hnizdo E, Syamlal G, Kullman G, Burchfield C, **Martin CJ**, Mujuru P. J Occup Environ Med (2014) Prevalence of chronic obstructive pulmonary disease among US working adults aged 40 to 70 years. National Health Interview Survey data 2004 to 2011. Oct; 56(10); 1088-93. PMID: 25285832

Doney B, Hnizdo E, Graziani M, Kullman G, Burchfield C, Baron S, Fujishiro K, Enright P, Hankins JL, Stukovsky KH, **Martin CJ**, Donohue KM, Barr RG. COPD (2014). Occupational risk factors for COPD phenotypes in the Multi-Ethnic Study of Atherosclerosis (MESA) Lung Study. Aug;11(4); 368-80. PMID: 24568208

Demian C, **Martin CJ**. J. Occup Environ Med. (2013) Is this man's cancer related to his occupation? Jan;55(1):112-4. PMID: 23291954

Gerbo R, Jin CF, Allen MA. (2012) J. Occup Environ Med. How should a commercial driver medical examiner approach determining fitness for duty in a commercial motor vehicle operator with a body mass index >33 kg/m²? Oct;54(10):1315-7. PMID: 23041947.

Werntz CL 3rd. (2010) J. Occup. Environ. Med. Fitness for duty evaluations; how should blood pressure be considered? Mar;52(3):355-7. PMID: 20216368

Baughman P, Marott, JL, Lange P, **Martin CJ**, Shankar A, Peterson EL Hnizdo E. Combined effect of lung function level and decline increases morbidity and mortality risks. Eur J Epidemiol 2012 Dec;27(12):933-43.

Appendix E

OSHE Publications

Trainee Publications

- 1) Nimbarte, A.D., Zreiqat, M., Ning, X., (2014) Impact of fatigue and shoulder position on the flexion-relaxation response in cervical spine, *Clinical Biomechanics*, 29(3), 277-82.
- 2) Moore, C.W., Nimbarte, A.D., Rajulu, S., (2014) Kinematic compatibility between the body and a mock spacesuit during basic upper body motions. *International Journal of Industrial Ergonomics*, (in press).
- 3) Moore, C.W., Nimbarte, A.D., Rajulu, S., Ning, X., Guffey, S., (2014) Effect of seat orientation on ingress/egress joint kinematics and reach envelope. *Occupational Ergonomics* (in press)
- 4) Ning, X., Della-Giustina, D.E., Hu, B., (In press). The assessment of musculoskeletal injury risks among steel manufacturing workers. To appear on *Iron & Steel Technology*.
- 5) Ning, X., Zhou, J., Dai, B., Jaridi, M., (In press). The assessment of material handling strategies in dealing with sudden loading: the effects of load handling position on trunk biomechanics, to appear on *Applied Ergonomics*.
- 6) Hu, B., Shan, X., Zhou, J., Ning, X., 2014. The effects of stance width and foot posture on lumbar muscle flexion-relaxation phenomenon, *Clinical Biomechanics* 29(3): 311-316.
- 7) Zhou, J., Dai, B., Ning, X., 2013. The assessment of material handling strategies in dealing with sudden loading: influences of foot placement on trunk biomechanics, *Ergonomics*. 56(10): 1569-1576.
- 8) Chowdhury, S.K., Nimbarte, A.D., Jaridi, M., Creese, R.C., (2013) Discrete wavelet transform analysis of surface electromyography for the fatigue assessment of neck and shoulder muscles. *Journal of Electromyography and Kinesiology*. 23(5), 995-1003.
- 9) Nimbarte, A.D., Sun, Y., Jaridi, M., Hsiao, H., (2013) Biomechanical loading of the shoulder complex and lumbosacral joints during dynamic cart pushing task. *Applied Ergonomics*, 44(5), 841-849
- 10) Nimbarte, A.D., Chowdhury, S.K., Cartwright, D., (2013) Empirical evaluation of neck muscle fatigue generated by healthcare related exertions. *Safety Science*, 57, 100-107.
- 11) Moore, C., Nimbarte, A.D., Sun, Y., (2013) Kinematics of cart pushing and pulling under different load weights and surface gradient conditions, *Occupational Ergonomics*, 11 (2-3), 75-84.
- 12) Hu, B., Ning, X., Nimbarte, A.D., (2013) The changes of lumbar muscle flexion-relaxation response due to laterally slanted ground surfaces. *Ergonomics*, 56 (8), 1295-1303
- 13) Nimbarte, A.D., Alabdulmohsen, R.T., Guffey, S.E., Etherton, J. (2013) The impact of dual-screen monitor use on neck muscle activity and 3D head/neck posture. *IIE Transactions on Occupational Ergonomics and Human Factors*, 1(1), 38-49.
- 14) Nimbarte, A.D., Al Hassan, M.J., Guffey, S.E., Myers, W.R. (2012) Influence of psychosocial stress and personality type on the biomechanical loading of neck and shoulder muscles. *International Journal of Industrial Ergonomics*, 42, 397-405
- 15) Sun, Y., Nimbarte, A.D., (2012) Effect of horizontal pushing and pulling exertions on neck muscle activity. *Occupational Ergonomics*, 10(4), 155-164.
- 16) Moore, C., Nimbarte, A.D., Rajulu, S., Aghazadeh, F. (2012) A study of the kinematics of ingress and egress of upright and recumbent seats. *WORK: A Journal of Prevention, Assessment, and Rehabilitation*, 41, 1316-1322
- 17) Nimbarte, A. D., Aghazadeh, F., Ikuma, L.H. Sun, Y. (2012) Evaluation of overhead pushing and pulling exertions on the loading of neck and shoulder musculature. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 22(4), 317-327.

Refereed Conference Proceedings

- 1) Zhou, J., Ning, X., Nimbarte, A.D., Dai, B., (2014) The effect of load holding height on trunk biomechanics during sudden loading. Proceedings of the Human Factors and Ergonomics Society 58th Annual Meeting, Chicago, IL, USA, October 27-31.
- 2) Cutlip, K., Nimbarte, A.D., Ning, X., Jaridi, M., (2014) A biomechanical strain index to evaluate shoulder stress. Proceedings of the Industrial Systems Engineering Research Conference, May 31-June 3, Montreal, Canada.
- 3) Hu, B., Ning, X., Nussbaum, M.A., The Influence of Hand Load on Lumbar-pelvic Coordination During Lifting Task. International Annual Meeting of the Human Factors and Ergonomics Society, Chicago, IL, USA October 27-31, 2014.
- 4) Hu, B., Ning, X., Nimbarte, A.D., (2013) Changes of lumbar muscle flexion relaxation phenomenon when standing on unilaterally elevated ground. International Annual Meeting of the Human Factors and Ergonomics Society, September 30-October 4, 2013, San Diego, CA, USA.
- 5) Nimbarte, A.D., Zreiqat, M., Moore, C., Ning, X., (2013) Flexion-relaxation response induced by neck extensor muscle fatigue. Proceedings of the Industrial Systems Engineering Research Conference, May 18-22, San Juan, Puerto Rico.
- 6) Zhou, J., Ning, X., Dai, B., Trunk Kinematics under Sudden loading Impact when Adopting Different Foot Postures International Annual Meeting of the Human Factors and Ergonomics Society, San Diego, CA, USA September 30-October 4, 2013.
- 7) Chowdhury, S.K., Nimbarte, A.D., Jaridi, M., Creese, R.C., (2012) Assessment of neck muscle fatigue using discrete wavelet transforms of electromyography. Proceedings of the Human Factors and Ergonomics Society 56th Annual Meeting, Boston, Massachusetts, USA, October 22-26.
- 8) Sun, Y., Nimbarte, A.D., Jaridi, M., Hsiao, H., (2012) Biomechanical Loading of Shoulder Joints during Dynamic Cart Pushing Tasks. Proceedings of the Industrial and Systems Engineering Research Conference, G. Lim and J.W.Herrmann, eds., Orlando, Florida, USA, May 19-23.
- 9) Nimbarte, A.D., Zreiqat, M., Chapman, M., Sivak-Callcott, J.A., (2012) Physical risk factors for neck pain among oculoplastic surgeons. Proceedings of the Industrial and Systems Engineering Research Conference, G. Lim and J.W.Herrmann, eds., Orlando, Florida, USA, May 19-23.
- 10) Sun, Y., Moore, C., Nimbarte, A.D., (2011). Musculoskeletal loading during dynamic two-wheeled cart pushing and pulling. Proceedings of the Institute of Industrial Engineers Annual Conference, May 21-25, Reno, Nevada.

Non-refereed (abstract peer-reviewed) Conference Proceedings and Presentations

- 1) Zreiqat, M., Nimbarte, A.D., (2014) Fatigue induced changes in the cervical spine reflex response. Proceedings of the XXVI Annual Occupational Ergonomics and Safety Conference El Paso, TX, USA, June 5-6, 2013
- 2) Cutlip, K., Moore, C., Kaiser, J., Nimbarte, A.D., (2014) Evaluation of concavity compression vectors to estimate shoulder stress. Proceedings of the XXVI Annual Occupational Ergonomics and Safety Conference El Paso, TX, USA, June 5-6, 2013
- 3) Moore, C., Nimbarte, A.D., Cutlip, K., (2014) Toward an understanding of work-related factors affecting shoulder stability. Proceedings of the XXVI Annual Occupational Ergonomics and Safety Conference El Paso, TX, USA, June 5-6, 2013
- 4) Cutlip, K., Nimbarte, A.D., Moore, C., (2013) Stability of the Shoulder Complex During Manual Exertions. Proceedings of the XXV Annual Occupational Ergonomics and Safety Conference Atlanta, GA, USA June 6-7, 2013
- 5) Moore, C., Stewart, B., Nimbarte, A.D., Jones, J., (2013) Development of a Model to Study Low Back Kinematics of Working Dogs. Proceedings of the XXV Annual Occupational Ergonomics and Safety Conference Atlanta, GA, USA June 6-7, 2013
- 6) Moore, C., Nimbarte, A.D., Rajulu, S., (2013) Effect of Display Position and Direction of Motion on the Ingress/Egress Kinematics. Proceedings of the XXV Annual Occupational Ergonomics and Safety Conference Atlanta, GA, USA June 6-7, 2013

- 7) Nimbarte, A.D., Chapman, M., Sivak-Callcott, J., Ning, X., Jaridi, M., (2013) Biomechanical evaluation of surgical loupes. Paper presented at the Industrial Systems Engineering Research Conference, May 18-22, San Juan, Puerto Rico.
- 8) Hu, B., Nimbarte, A.D., Ning, X., (2013) Back muscle flexion relaxation phenomenon under uneven ground conditions. Paper presented at the Industrial Systems Engineering Research Conference, May 18-22, San Juan, Puerto Rico.
- 9) Moore, C.W., Nimbarte, A.D., Rajulu, S., Guffey, S., and Ning, X., (2012) A study of kinematics during ingress and egress of vertical and horizontal seats. Proceedings of the XXIVth Annual International Occupational Ergonomics and Safety Conference Fort Lauderdale, Florida, USA June 7-8.
- 10) Nimbarte, A.D., Chowdhury, S.K., Cartwright E. D., (2012) Impact of physical and psychosocial demand on neck and shoulder muscle fatigue. Proceedings of the XXIVth Annual International Occupational Ergonomics and Safety Conference Fort Lauderdale, Florida, USA June 7-8.
- 11) Chapman, M., Nimbarte, A.D., Sivak-Callcott, J.A., Ning, X., Jaridi, M., and Cartwright, E.D., (2012) Effect of surgical loupe angles on neck muscle activity. Proceedings of the XXIVth Annual International Occupational Ergonomics and Safety Conference Fort Lauderdale, Florida, USA June 7-8.
- 12) Moore, C.W., Nimbarte, A.D., Rajulu, S., (2012) Study of suited kinematics using an optical motion analysis system. Proceedings of the XXIVth Annual International Occupational Ergonomics and Safety Conference Fort Lauderdale, Florida, USA June 7-8.
- 13) Al Hassan, M., Nimbarte, A.D., Guffey, S.E., Myers, W. R. (2011) Understanding the effect of physical and cognitive stress, and personality type on loading of neck and shoulder muscles. In proceedings of the International Occupational Ergonomics and Safety Annual Conference. June 08-10, Baltimore, Maryland, USA.
- 14) Nimbarte, A.D., Sivak-Callcott, J., Sun, Y., (2011) Working postures commonly adopted by the surgeons operating with surgical loupes In proceedings of the International Occupational Ergonomics and Safety Annual Conference. June 08-10, Baltimore, Maryland, USA.
- 15) Nimbarte, A.D., Moore, C., Sun, Y., Meador, J. (2011) Biomechanical evaluation of concrete block handling tool. Paper presented at the Institute of Industrial Engineers Annual Conference, May 21-25, Reno, Nevada.
- 16) Nimbarte, A.D., AlAbdulmohsen R., Sun, Y., Moore, C., Alhassan, A. (2011). Effect of single/dual monitor use on behavior of neck-shoulder musculature. Paper presented at the Institute of Industrial Engineers Annual Conference, May 21-25, Reno, Nevada.
- 17) Nimbarte, A.D., Sun, Y., Sivak-Callcott, J., Li, J., (2011) "Cervical load due to operating with surgical loupes. Paper presented at the 14th Annual Applied Ergonomics Conference, March 21- 24, Orlando, Florida.
- 18) Nimbarte, A. D., Sun, Y., Aghazadeh, F. (2010). Effect of overhead pushing and pulling exertions on the cervical spine loading. Paper presented at the International Occupational Ergonomics and Safety Annual Conference. June 05-07, Phoenix, Arizona, USA.

Appendix F

OSHE Faculty

Xiaopeng Ning, PhD, Assistant Professor

Occupational Biomechanics, Ergonomics, Human Factors Engineering

Steve Guffey, PhD, CIH, Professor

Ventilation Design, Exposure Assessment, Noise Controls

Majid Jaridi, PhD, Professor

Quality Control, Decision Analysis, and Human Factors

Xinjian He, PhD, Assistant Professor

Respiratory Protection, Industrial Ventilation, Noise Control, Underground Coal Mine Safety

Rashpal Ahluwalia, PhD, PE, Professor

Manufacturing Systems, Quality and Reliability Engineering, Robotics and Automation

Jack Byrd, Jr, PhD, PE, Professor

Operations Research, Workforce Development, Work Design, Integrated Product Development

Robert Crees, PhD, PE, Professor

Manufacturing Processes/Systems, Foundry Engineering, Cost Engineering

B. Gopalakrishnan, PhD, PE, Professor

Manufacturing Processes and Production Systems, Expert Systems, Industrial Energy and Waste Minimization, Productivity Improvement

Gary Winn, PhD, Professor

Construction Safety, Transportation Safety and Program Evaluation, Total Quality Management, Theory of Paradigm Shifts

Alan McKendall, Jr., PhD, Associate Professor

Operations Research, Meta-heuristics, Facilities Layout and Materials Handling, Project Scheduling, Integrated Production Systems

Feng Yang, PhD, Associate Professor

Simulation, Applied Statistics, Stochastic Processes

Thorsten Wuest, PhD, Assistant Professor

Smart Manufacturing, Item-level Product Lifecycle Management (PLM), Machine Learning, Big Data Applications

Appendix G

IH Masters Students Receiving NIOSH Funding 2010-2015

Year Funded	Student	Level	Current Employer, all FT	Grad. Date
2009-2010	700-15-0399 700-25-4542	M.S.	Depart. of Veterans Affairs Marathon Petroleum	5/10 5/11
2010-2011	□□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□	M.S.	Assistant Prof of IH NIOSH researcher IH in Saudia Arabia Campbell Transportation Company IH in Saudia Arabia	8/10 8/10 5/11 5/11 5/11
2011-2012	□□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□	M.S.	IH in Saudia Arabia Doctoral student at WVU Lost contact, was working as IH Chevron NRCCE, West Virginia U. Pepsico	5/12 5/12 5/12 5/12 5/12 5/12
2012-2013	□□□□□□□□	M.S.	C&K Industrial Services, Inc	12/12
2013-2014	□□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□	M.S.	Mylan Pharmecuticals still looking Marathon Petroleum Lost touch TRC Consol Energy NIOSH	12/13 12/13 12/13 12/13 12/13 12/13 12/13
2014-2015 (spring)	□□□□□□□□ □□□□□□□□ □□□□□□□□ □□□□□□□□	M.S.	TRC Solvay Specialty Polymers returned to India, still looking George Washington University	12/14 5/15 5/15 5/15

Appendix H

IH: Recent History of Enrollment in the Program (First Year Students)

Year	Showed Up	No Show	Rejected	Total Applicants	Graduates
<i>2009-2010</i>	6	4	0	10	2
<i>2010-2011</i>	8	0	4	12	5
<i>2011-2012</i>	5	0	4	9	6
<i>2012-2013</i>	7	0	3	10	1
<i>2013-2014</i>	12	4	6	22	7
<i>2014-2015</i>	10	0	8	18	4
<i>Total</i>	48	8	25	81	25

Appendix I

IH Curriculum

Prog.	No.	Title	Credit	Required	Instructor
IENG	662	Systems Safety Engineering II	3	yes	Dr. Harris
IENG	561	Industrial Hygiene Engineering (includes lab)	4	yes	Dr. Allen
	561 lab	IH Engineering Lab (see above)		yes	Mr. Takacs
IH&S	725	Industrial Hygiene Sampling and Analyses	4	yes	Dr. Coffey
IENG	460	Ergonomics	3	yes	Dr. Nimbarte
IENG	564 or 660	Industrial Ergonomics	3	yes	Drs. Ning or Nimbarte
IH&S	527	Industrial Hygiene Noise Assessment and Control	3	yes	Dr. Guffey
IH&S	528	Ventilation Control Technology	3	yes	Dr. Guffey
PCOL	562	Occupational Toxicology	3	yes	Dr. Knuckles
PUBH	660	Public Health Epidemiology recommended	3	yes	Dr. Conway
STAT	511	Graduate level statistics course	3	yes	Dr. Hobbs
Various		Environmental Elective	3	yes	
Various		Safety and Health Elective	3	yes	
IH&S 697		Masters thesis (6 credits) or a Problem Report (3 credits).	3 or 6	yes	Faculty

Appendix J

Publications--IH Core Faculty

1. Dennis Groce*, Steve **Guffey**, Dennis Viscusi, Stephanie Lynch, Stacey Benson, and Ziqing Zhuang. [2010]. Three-Dimensional Facial Parameters and Principal Component Scores: Association with Respirator Fit. *Journal of the International Society for Respiratory Protection*, 27(1): 1-15.
2. Al Hassan*, M., Nimbarte, A.D., **Guffey**, S.E., Myers, W. R. (2012) Influence of psychosocial stress and personality type on the biomechanical loading of neck and shoulder muscles, *International Journal of Industrial Ergonomics* 42 (2012) 397-405.
3. Ashish D. Nimbarte, Rabab T. Alabdulmohsen*, Steve E. **Guffey**, John R. **Etherton** (2012), The Impact of Use of Dual Monitor Screens on 3D Head–Neck Posture and Activity of Neck Muscles, *IIE Transactions on Occupational Ergonomics and Human Factors*
4. Hassan*, M, A. Nimbarte, S. Guffey, W. Myers. 2012. Influence of psychosocial stress and personality type on the biomechanical loading of neck and shoulder muscles. *International Journal of Industrial Ergonomics*. 42: 397-405.
5. Nimbarte, A., R. Alabdulmohsen, S. Guffey, J. Etherton. 2012. The Impact of Use of Dual Monitor Screens on 3D Head–Neck Posture and Activity of Neck Muscles. *IIE Transactions on Occupational Ergonomics and Human Factors*. 1(1) 38-49.
6. Xinjian, He*, S. Guffey. 2013. Quantitative Evaluation of the Performance of an Industrial Benchtop Enclosing Hood, *Journal of Occupational and Environmental Hygiene*. 10(8): 409-418.
7. Karaismail, E., I. Celik, S. Guffey. 2013. Flow Dynamics and Contaminant Transport in Industrial-Type Enclosing Exhaust Hoods, *Journal of Occupational and Environmental Hygiene*. 10: 1-13
8. WU, M. *, S. Guffey, B. Takacs, and K. Michael. 2013. Variability in Fit Test Result for Earplugs and the Fraction of Noise Exposure Dose of Coal Miners due to Failure to Wear. *International Journal of Occupational Hygiene*. 5: 123-131.
9. Christopher Moore*, A. Nimbarte, Rajulub*, X. Ning and S. Guffey, *Effect of seat orientation on ingress/egress joint kinematics and reach envelope*, *Occ. Ergonomics* 11 (2013) 137–151
10. **Harris JR**, Powers JR, Pan CS, Boehler B. Fall arrest characteristics of a scissor lift. *Journal of Safety Research* 2010;41:213-220.
11. Wu JZ, Powers JR, **Harris JR**, Pan CS. Estimation of the kinetic energy dissipation in fall-arrest system and manikin during fall impact. *Ergonomics* 2011;54(4):367-379.
12. **Harris JR**, Winn GL, Ayers PA, McKenzie EA. Predicting the performance of cost-effective rollover protective structure designs. *Safety Science* 2011;49:1252-1261. [**2012 Charles C. Shepard Science Award for Outstanding Scientific Paper – NIOSH nominee**]
13. **Harris JR**, Current RS. Machine safety: New and updated consensus standards...what you need to know. *Proceedings of the 2011 American Society of Safety Engineers Professional Development Conference and Exposition; 2011 June 12-15; Chicago, IL session #520. (Re-printed by invitation in ByDesign 2011;11(2):10-18 and also re-printed by invitation [with sidebar addition] in Professional Safety 2012;57(5):50-57)*
14. Dong RG, Pan CS, Hartsell JJ, Welcome DE, Lutz T, Brumfield A, **Harris JR**, Wu JZ, Wimer B, Mucino V, Means K. An investigation on the dynamic stability of scissor lift. *Open Journal of Safety Science and Technology* 2012;2;8-15.

15. Branche CM, Stout N, Castillo DN, Pratt SG, **Harris JR**, Pizatella TJ. Work-related Unintentional Injuries (Invited chapter). In Robert H. Friis (Ed.). *The Praeger Handbook of Environmental Health, Volume 4: Current Issues and Emerging Debates*. Santa Barbara, California: Praeger Publisher, 2012; 163-184.
16. Pan CS, Powers JR, Hartsell JJ, **Harris JR**, Wimer BM, Dong RG, Wu JZ. Assessment of fall arrest systems for scissor lift operators: computer modeling and manikin drop testing. *Human Factors* 2012;54(3):358-372.
17. Vo, E., Z. Zhuang, M. Horvatin, Y. Liu, **X. He**, and S. Rengasamy. "Respirator Performance against Nanoparticles under Simulated Workplace Activities". (Accepted) *Annals of Occupational Hygiene* (2015).
18. Gao, S., J. Kim, M. Yermakov, Y. Elmashae, **X. He**, T. Reponen, and S.A. Grinshpun. "Penetration of Combustion Aerosol Particles through Filters of NIOSH-Certified Filtering Facepiece Respirators (FFRs)". (Accepted). *Journal of Occupational & Environmental Hygiene*. (2015)
19. Bergman, S.M., **X. He**, M. Joseph, Z. Zhuang, B.K. Heimbuch, R.E. Shaffer, M. Choe, J.D. Wander. "Correlation of Respirator Fit between Human Subjects and a Static Advanced Headform". *Journal of Occupational & Environmental Hygiene*. 12(3):163-171, (2014)
20. Koehler, H.R., **X. He**, S.A. Grinshpun. "A Novel Face Seal Design for Filtering Facepiece Respirators: Development and Pilot Testing in a Hospital Operating Room". *Journal of the International Society for Respiratory Protection*. 31(2):116-128, (2014)
21. **He, X.**, T. Reponen, R. McKay, S.A. Grinshpun. "How does breathing frequency affect the performance of an N95 filtering facepiece respirator and a surgical mask against surrogates of viral particles?". *Journal of Occupational & Environmental Hygiene*. 11(3):178-185, (2014)
22. **He, X.**, S.A. Grinshpun, T. Reponen, R. McKay, S.M. Bergman, Z. Zhuang. "Effect of Breathing Frequency on the Total Inward Leakage of an Elastomeric Half-Mask Donned on an Advanced Manikin Headform". 58(2):182-194. *Annals of Occupational Hygiene*. (2014)
23. **He, X.**, S.A. Grinshpun, R. McKay, M. Yermakov, T. Reponen, J. Lu, P. Soroushian. "Performance Characteristics of an Elastomeric Half-mask Respirator Modified with a Polymer Micro-Patterned Adhesive". *Journal of the International Society for Respiratory Protection*. 30(2):95-104, (2013)
24. Eastlake, A., B. Knipper, **X. He**, B. Alexander, K. Davis. "Lifestyle and Safety Practices of Firefighters and Their Relation to Cardiovascular Risk Factors". *WORK: Journal of Prevention, Assessment & Rehabilitation*. (2013)
25. **He, X.**, S.A. Grinshpun, T. Reponen, R. McKay. "Effect of Particle Size on the Performance of an N95 Filtering Facepiece Respirator and a Surgical Mask at Various Breathing Conditions". *Aerosol Science & Technology*. 47(11):1180-1187, (2013)
26. **He, X.**, S.E. Guffey. "Quantitative Evaluation of the Performance of an Industrial Benchtop Enclosing Hood". *Journal of Occupational & Environmental Hygiene*. 10(8):409-418, (2013)
27. **He, X.**, S.A. Grinshpun, T. Reponen, M. Yermakov, R. McKay, H. Karuta, K. Kimura. "Laboratory Evaluation of the Particle Size Effect on the Performance of an Elastomeric Half-mask Respirator against Ultrafine Combustion Particles". *Annals of Occupational Hygiene*. 57(7):884-897, (2013)
28. **He, X.**, M. Yermakov, T. Reponen, R. McKay, K. James, S.A. Grinshpun. "Manikin-based performance evaluation of elastomeric respirators against combustion particles". *Journal of Occupational & Environmental Hygiene*, 10(4):203-212, (2013)
29. **He, X.**, S.Y. Son, K. James, M. Yermakov, T. Reponen, S.A. McKay, S.A. Grinshpun. "Exploring a Novel Ultrafine Particle Counter for Utilization in Respiratory Protection Studies". *Journal of Occupational & Environmental Hygiene*, 10(4):D52-D54, (2013)
30. Chowdhury, S. K. and Nimbarte, A. D. "Comparison of Fourier and Wavelet analysis for fatigue assessment during repetitive dynamic exertion." *Journal of Electromyography & Kinesiology*: In press
31. Nimbarte, A. D., Zreiqat, M. and Ning, X. (2014). "Impact of shoulder position and fatigue on the flexion-relaxation response in cervical spine." *Clinical Biomechanics* 29(3): 277-282.

32. Moore, C. W., Nimbarte, A. D. and Rajulu, S. (2014). "Kinematic compatibility between the body and a mock spacesuit during basic upper body motions." *International Journal of Industrial Ergonomics* 44(2014): 739-746.
33. Nimbarte, A. D. (2014). "Risk of neck musculoskeletal disorders among males and females in lifting exertions." *International Journal of Industrial Ergonomics* 44(2014): 253-259.
34. Nimbarte, A. D., Zreiqat, M. and Chowdhury, S. K. (2014). "Cervical flexion relaxation response to neck muscle fatigue in males and females." *Journal of Electromyography and Kinesiology*: In press.
35. Nimbarte, A. D., Alabdulmohsen, R. T., Guffey, S. E. and Etherton, J. (2013). "The impact of dual-screen monitor use on neck muscle activity and 3D head/neck posture." *IIE Transactions on Occupational Ergonomics and Human Factors* 1(1): 38-49.
36. Nimbarte, A. D., Chowdhury, S. K. and Cartwright, D. (2013). "Empirical evaluation of neck muscle fatigue generated by healthcare related exertions." *Safety Science* 57: 100-107.
37. Nimbarte, A. D., Sivak-Callcott, J. A., Zreiqat, M. and Chapman, M. (2013). "Neck postures and cervical spine loading among microsurgeons operating with loupes and headlamp." *IIE Transactions on Occupational Ergonomics and Human Factors* 1(4): 215-223.
38. Nimbarte, A. D., Sun, Y., Jaridi, M. and Hsiao, H. (2013). "Biomechanical loading of the shoulder complex and lumbosacral joints during dynamic cart pushing task." *Applied Ergonomics* 44(5): 841-849.
39. Nimbarte, A. D., Al Hassan, M. J., Guffey, S. E. and Myers, W. R. (2012). "Influence of psychosocial stress and personality type on the biomechanical loading of neck and shoulder muscles." *International Journal of Industrial Ergonomics* 42(5): 397-405.
40. **Ning, X.**, Huang, Y., Hu, B., Nimbarte, A., 2015. Neck Kinematics and Muscle Activity during Mobile Device Operations. *International Journal of Industrial Ergonomics* 48: 10-15.
41. Hu, B., **Ning, X.**, 2015. The changes of trunk motion rhythm and spinal loading during trunk flexion and extension motions caused by lumbar muscle fatigue. *Annals of Biomedical Engineering* DOI: 10.1007/s10439-015-1248-0.
42. Wang, D., Dai, F., **Ning, X.**, 2015. Risk assessment of work-related musculoskeletal disorders in construction: a state of the art review. *Journal of Construction Engineering and Management* DOI: 10.1061/(ASCE) CO.1943-7862.0000979.
43. Hu, B., **Ning, X.**, 2015. The influence of lumbar extensor muscle fatigue on lumbar-pelvic coordination during weight lifting. *Ergonomics* 13: 1-24.
44. Dai, B., Heinbaugh, E.M., **Ning, X.**, Zhu, Q. 2014. A resistance band increased internal hip abduction moments and gluteus medius activation during pre-landing and early-landing. *Journal of Biomechanics* 47(15): 3674-3680.

IH Allied faculty publications

45. "Diagnosis at a Glance", Scott Cook MD, MPH and **Anna Allen, MD**; *Emergency Medicine* Nov 2005, 31-32
46. **Knuckles, T.L.**, Jaskot, R., Richards, J.H., Miller, C.A., Ledbetter A., McGee, J., Linak, W.P., and K. L. Dreher. Biokinetically-Based In Vitro Cardiotoxicity of Residual Oil Fly Ash: Hazard Identification and Mechanisms of Injury. *Cardiovascular Toxicology* 13 (4):426-437, 2013 PMID: 24048980
47. Rai AT, Carpenter JS, Raghuram K, Roberts TD, Rodgers D, **Hobbs GR**, "Endovascular Therapy Yields Significantly Superior Outcomes for Large Vessel Occlusions Compared with Intravenous Thrombolysis: Is it Time to Randomize?", *J Neurointervent Surg*, V5(5) Sep 2013 pp. 430-434 2012, 28 Jul doi:10.1136/neurintsurg-2012-010429 PMID: 22842210

48. Bhardwaj R, Manavannan S, Gharib W, Warden B, **Hobbs G**, Jain A, "Acute Effects of Diets Rich in Almonds and Walnuts on Endothelial Function in Humans", Circulation, V126(21S) #14738 Nov 2012
49. Cumpston A, Craig M, Hamadani M, Abraham J, **Hobbs GR**, Sarwari AR, "Extended follow-up of an antibiotic cycling program for the management of febrile neutropenia in a hematologic malignancy and hematopoietic cell transplantation unit", Transpl Infect Dis, V15(2) Apr 2013 pp. 142-149 PMID: 23279656
50. Hossein A, Hogan TF, **Hobbs G**, Rahman R, "Survival Disparities in Bladder, Kidney and Prostate Cancer in Asian-Indian & Pakistani Immigrants to the United States as Compared to Other US Ethnic Groups: A Surveillance, Epidemiology and End Result (SEER) 2011 Public Use Database Study", Cancer and Clinical Oncology, V2(1) 2013 pp. 103-114 doi:10.5539/cco.v2n1p103
51. Jones AC, Woldemikael D, Fisher T, **Hobbs GR**, Prud'homme BJ, Bal GK, "Repeated Computed Tomographic Scans in Transferred Trauma Patients: Indications, Costs, and Radiation Exposure", J Trauma Acute Care Surg, V73(6) Dec 2012 pp. 1564-1569
52. Javins B, **Hobbs G**, Ducatman AM, Pilkerton C, Tacker D, Knox SS, "Circulating Material Perfluoroalkyl Substances During Pregnancy in the C8 Health Study", Environ Sci Technol V47(3), 5 Feb 2013 pp 1606-1613 doi: 10.1021/es3028082 PMID 23272997
53. Chi A, Ma P, Fu G, **Hobbs G**, Welsh JS, Nguyen NP, Jang SY, Dai J, Jin J, Komaki R, "Critical Structure Sparing in Stereotactic Ablative Radiotherapy for Central Lung Lesions: Helical Tomography vs. Volumetric Modulated Arc Therapy", PLoS One, V8(4) April 2013 doi:10.1371/journal.pone.0059729 Epub Apr 5 PMID: 23577071
54. Riggs JE, **Hobbs GR**, "The Dependence of Reported Homicide Rates on Reported Non-Motor Vehicle Accident Death Rates in US Young Children and Infants, 1940-2007", Adv Appl Sociol, V(3)1, Mar 2013 pp 13-19
55. Bonner D, Swisher A, Gilleland D, Abraham J, Garcia J, Hobbs G, Kurian S, Reynolds A, Watts B, Yanosik MA, Vona-Davis L, "Predicted Vs. Measured Vo(2) Peak in Obese Hormone-negative Breast Cancer Survivors", Med Sci Sports Exerc, V45(5)-S1, May 2013, Pp. 213
56. Chetlin RD, Palermo L, Hobbs G, Sherlock L, "The Effects of Combined Aquatic and Occupational Therapies in Older Adults with Osteoarthritis", Med Sci Sports Exerc, V45(5) (May 2013) pp. 644
57. Ghoreishi M, Dawood M, **Hobbs G**, Pasrija C, Riley P, Petrose L, Griffith BP, Gammie JS, "Repeat Sternotomy: No Longer a Risk Factor in Mitral Valve Surgical Procedures", Ann Thorac Surg, V96(4), (Oct) 2013, pp 1358-1366 PMID: 23924002
58. Young ST, Wells JD, **Hobbs GR**, Bishop CP, "Estimating Postmortem Interval Using RNA Degradation and Morphological Changes in Tooth Pulp", Forensic Sci Int, V229(1-3) Jun 10, 2013 DOI: 10.1016/j.forsciint.2013.03.035 PMID 23647867
59. Muzaffar S, Cummings K, **Hobbs G**, Allison P, Kreiss K, "Factors Associated with Fatal Mining Injuries Among Contractors and Operators", J Occup Environ Med, V55(11) Nov 2013, pp. 1337-1344 PMID:24164762 doi:10.1097/JOM.0b013e3182a2a5a2
60. Ross AL, Tharp JL, **Hobbs GR**, McKnight R, Cumpston A, "Evaluation of Extended Interval Dosing Aminoglycosides in the Morbidly Obese Population", Adv Pharmacol Sci, 2013;2013:194389. doi: 10.1155/2013/194389 Epub 2013 Aug 19 PMID 24023540
61. Mullett MD, Cottrell L, Lily C, Gadikota K, Dong LL, Hobbs G, Neal WA, "Association Between Birth Characteristics and Coronary Disease Risk Factors Among Fifth Graders", J Pediatr, 2013 Oct 10 doi:10.1016/j.peds.2013.08.064 PMID24120018 [Epub] V164(1) Jan 2014, pp 78-84
62. Vona-Davis L, Rose DP, Gadiyaram V, Ducatman B, Hobbs G, Hazard H, Kurian S, Abraham J, "Breast Cancer Pathology, Receptor Status, and Patterns of Metastasis in a Rural Appalachian Population", J Cancer Epidemiol, [Epub] 2014,2014:170634. Doi: 10.1155/2014/170634 Epub 2014 Jan 9 PMID 24527034 PMCID 3913201

63. Younis IR, George DJ, McManus TJ, Hurwitz H, Creel P, Armstrong AJ, Yu JJ, Bacon K, Hobbs G, Peer CJ, Petros WP, "Clinical Pharmacology of an Atrasentan and Docetaxel Regimen in Men with Hormone-Refractory Prostate Cancer", Cancer Chemother Pharmacol, V73(5) (May 2014) pp. 991-997 Epub 2014 Mar 12 doi: 10.1007/s00280-014-2432-x) PMID 24619498
64. Sze EHM, Hobbs G, "A Retrospective Comparison of Ring Pessary and Multicomponent Behavioral Therapy in Managing Overactive Bladder", Int Urogyn J, V25(11), Nov 2014, pp. 1583-1588 PMID 24803217 doi:10.1007/s00192-014-2397-7 (Epub 2014 May 07)
65. Khimani F, Perrotta PL, Hobbs GR, Hogan TF, "A High Incidence of Patients with MTHFR (Methylenetetrahydrofolate Reductase) Gene Mutations Noted in an Appalachian Population Seen for Thrombophilia at the West Virginia University Hospitals, 2006-2012", Am J Hematol, V89(6) Jun 2014, pp. E57-E57
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