Occupational Exposures
Practical Considerations

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Declaration

• I do not have any affiliation (financial or otherwise) with a commercial organization that may have a direct or indirect connection to the content of this presentation.
Learning Objectives

• By the end of the session on exposures the participant will have a basic (entry level) understanding of the major categories of occupational hazards including,
  – their source in the workplace,
  – chronic and acute effects on workers,
  – approaches to recognizing and preventing exposure

• The exposure categories include:
  – Chemical exposures (including particulates);
  – Physical exposures (noise, temperature, pressure, vibration, radiation)
  – Biological exposures
  – Ergonomic exposures
  – Psychological exposures (including harassment)
Todays Focus

• Address the section learning objectives
• Focus on approach to organizing the data
• Interaction: some clinical cases – communication from the treating physician
3 Year Course Outline

• Year 1
  – Communication and Confidentiality
  – Return to Work
  – Mental Issues

• Year 2
  – Organ Based Disease
  – Exposures
  – Industrial Hygiene

• Year 3
  – Organization of Occupational Medical Practice
  – Epidemiology and Biostatistics
  – Risk Assessment and Management
Monographs

• LaDou. Current Occupational & Environmental Medicine, Fourth Edition.
• Rom. Environmental and Occupational Medicine, Fourth Edition.
• Greenberg. Occupational, Industrial and Environmental Toxicology.
Clinical Focus

• Organ based
  – Patient presents with symptoms, signs, investigations ultimately leading to diagnosis
  – Diagnosis evokes the question:
    • Where might the causative exposure be found
  – Generates a long list of industries, jobs tasks where substance “x” may be a potential exposure
Population Based

• Considers exposures for a working cohort
• Evokes the question of what exposures may potentially occur
• Prevention focused
  – Primary
    • Engineering controls
  – Secondary
    • Medical surveillance
  – Tertiary
    • Illness – individual focus
Getting Organized

• Need to develop knowledge base considering:
  – exposures and list of possible sources
  – work places and list of possible exposures

• Additionally for exposures, consider:
  – Occ and non-occ sources
  – Routes of transmission
  – Symptoms and signs
  – Mechanisms of injury
  – Biomarkers
  – Treatment and return to work planning

• Additionally for workplaces consider
  – Hazard identification, risk assessment, controls
Evaluating Hazards for Risk

Hazard

Path

Receiver

10/4/2010
Hazard versus Risk

• A hazard is something that can cause harm if not controlled.

• Controls can be put in place to ensure that workers are unlikely to inhale, ingest or absorb making the risk negligible

• Controls
  – Substitution, engineering, administrative, PPE
Hazard versus Risk

• Examples of hazards, but low risk:
  – Asbestos behind walls
  – Non-volatile (undetectable) isocynates in adhesives
• Hazardous substances ≠ (necessarily) significant risk
• Risk = P(what might go wrong)*severity
Hazard Control Program

• What is a hazard control program?
• A control program consists of all steps necessary to
  – protect workers from exposure to a substance or system,  
  – and the procedures required to monitor worker exposure and their health to hazards such as chemicals, materials or substance, or other types such as noise and vibration.

• Source: The Canadian Centre for Occupational Health and Safety http://www.ccohs.ca/oshanswers/hsprograms/hazard_control.html
Susceptible Workers

• A worker becoming ill from a hazard exposure due to their underlying state of health.
• Controversial
• Issues of medical pre-placement limiting work vs employee assumption of risk
• Examples of purported susceptibility
  – Nerve conduction at wrist “pre-CTS” and CTS
  – Eczema and contact dermatitis
Chemical Exposures
Route of Transmission

- Respiratory
- Skin
  - Direct transmission and from contaminated surfaces
- Ingestion
  - Directly
  - Contaminated food
Ingestion

• Classic example – lead dust
• Break down of control program
  – Primary – lead in system, poor cleaning, education
• Often associated with cafeteria
Chemical Exposures

• Air transmission
  – Gas – describes a state of matter at ambient condition
  – Vapours – the gaseous phase of component which can be in liquid or solid state at ambient conditions
  – Aerosol – dispersion of solid or liquid particles
  – Fumes – aerosol of solid particles created by condensation of vapourized material
  – Smoke – aerosol of particles created by incomplete combustion
  – Dust – temporary suspension of solid particles in air
Particle Size

• Large particles >10-20 µm are airborne, they can be inhaled, called large droplets
  – Usually impact in pharynx due to high mass inertia
• Most particles between 5-10 µm diameter are deposited on the tracheobronchial surface.
• Deposition at the alveolar level occurs mainly for particles between 0.5-5 µm
• Approximately 50% of 0.5 µm particles are retained in the alveoli, the remainder are exhaled.
Effects of Respiratory Exposure

• Acute effects
  – Asphyxiation - nitrogen gas
  – Intoxication – solvent exposure
  – Irritation – tobacco smoke

• Long term
  – Sensitization - isocyanates
  – Lung disease
    • Obstructive – airways e.g. asthma, COPD
    • restrictive – interstitial disease – sarcoidosis
  – Cancer – parenchymal, pleura
Lead (Pb)

• Heavy metal
  – Others mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl)

• Occupational sources – consider life cycle
  – Extraction
    • lead miners and smelters
    • zinc and copper smelting
    • Processing of ore
  – Production
    • glass manufacturers, radiation shields, circuit boards, jet engines, and ceramic glazes, production of paints and pigments
  – Use
    • Plumbers, auto mechanics, ammunition
    • construction and demolition workers
    • battery manufacturers
    • firing range instructors
    • welding
  – Disposition
    • Battery and circuit board recyclers
    • Combustion of solid wastes
Lead (Pb)

- Non-occupational sources
  - Home plumbing
  - Ammunition hobby
  - Lead paint (pica)
  - Contaminated soil
Lead (Pb)

• Routes of transmission
  – Dust via air and surface contact
  – Ingestion

• Symptoms and signs - acute
  – Constitutional: headaches, weakness, depression, fatigue, irritability
  – Gastrointestinal: complaints, increased liver enzymes,
  – Renal: renal proximal tube dysfunction
  – Nervous: Central nervous system (mood changes, lethargy), peripheral nervous system (wrist drop), papilledema
  – Hematological: microcytic anemia
  – MSK: arthralgias, myalgias
Lead (Pb)

• Symptoms and signs - Chronic
  – Constitutional: headaches, weakness, depression
  – GI: complaints, gingival lead line (Burton’s line)
  – Renal: interstitial fibrosis, hypertension
  – Endocrine: decreased thyroid and adrenal function, gout
  – Reproductive: decreased & abnormal sperm count, spontaneous abortions, decreased libido, impotence
Lead (Pb)

• Mechanism of injury
  – bind to and interact with many of the same enzymes as calcium, iron and zinc but, due to its differing chemistry, does not properly function as a cofactor, thus interfering with the enzyme's ability to catalyze its normal reaction or reactions.
  – Blood synthesis – mimics iron and interferes with haemoglobin synthesis causing microcytic anemia
  – Interferes with interferes with the activity of an essential enzyme delta-aminolevulinic acid dehydratase (ALAD)
Lead (Pb)

• Biomarkers
  – Blood lead - increased
  – zinc protoporphyrin – increased

• Action limits
  – Medical surveillance
  – Monitor blood lead of at risk worker group

• Treatment – remove from exposure and possible chelation

• Determine what failed in workplace controls
Doctor’s Note 1

“Move employee out of paint shop as the fumes are making him ill”
Physical Exposures
Ionizing Radiation

• Ionizing particles are energetic alpha particles, beta particles, and neutrons.
• High frequency ultraviolet, x-rays, and gamma rays
• Naturally occurring: cosmic radiation, solar radiation, and radon.
• Occupational: medical diagnostic workers, nuclear power plant workers
2007 Canadian Occupational Dose by Facility Type

milliSireverts – measurement of radiation exposure corrected for type and body location
Ionizing Radiation

• Acute effects:
  – Radiation illness affecting central nervous system, gastrointestinal system, hematopoietic system

• Cancer:
  – Thyroid, skin, bone marrow, thyroid, multiple myeloma, breast cancer, stomach cancer
Non-ionizing Radiation

• Near ultraviolet, visible light, infrared, microwave, radio waves
  – Health effects:
    • Laser exposure – thermal burns, cataracts
    • Ultraviolet – skin pigmentation, cataracts, ultraviolet keratitis (welder’s arc eye, snow blindness)
    • Microwaves
      – heating tissue
      – Cell phone use – brain tumors - controversial
Physical Exposures

• Temperature
  – Ambient: hot-heat stroke; cold - hypothermia
  – Contact: fire; ice

• Electrical, factors to consider
  – Type of current (AC versus DC)
  – Quantity (amps)
  – Voltage
  – Resistance of body
  – Pathway (internal versus arching)
  – Duration of contact
Physical Exposures

• Electrical injury health effects:
  – Cardiac: ventricular fibrillation
  – Respiratory: asphyxia due to tetanic respiratory muscle contractures
  – Neurological: central respiratory arrest; deficits (spinal cord most likely site at C4-C8)
  – Musculoskeletal: reflex sympathetic dystrophy;
  – rhabdomyolysis
  – Renal: acute renal failure secondary to rhabdomyolysis
  – Skin: burns
Physical Exposures

- **Vibration**
  - Whole body - fatigue, headaches, back problems
  - Segmental - HAVS

- **Noise**
  - Hearing loss
  - Stress
  - Myocardial infarction

- **Pressure**
  - Decompression illness - a reduction in ambient pressure which results in the formation of bubbles of inert gases within tissues of the body.
  - High altitude sickness - acute exposure to low partial pressure of oxygen at high altitude.

- **Mechanical**
  - Moving equipment
  - Sharp instruments

- **Heights**
  - Falls
  - Things falling
“My patient [RN in Iodine- therapy room] is trying to have a baby and should not be exposed to Iodine-131”
Biological Exposures
Biological

• Infectious
• Immunological
  – Asthma – working with animals – lab workers
  – Hypersensitivity pneumonitis – inhaled organic dusts
• Endotoxin
  – Organic dust toxic syndrome – grain, hay
  – Mold – water damaged buildings
Infectious

• Handled materials
  – Animals
    • Zoonotic diseases – any occupation that works with or is exposed to animals
    • University of Wisconsin - School of Veterinary Medicine
      – http://svmweb.vetmed.wisc.edu/pbs/zoonoses/
  – Patients
    • Bloodbourne & airborne pathogens
    • HIV, Hep A, Hep B

• People
  – Medical responders
    • Bloodbourne pathogens
  – Airborne pathogens
    • Influenza, SARS, Tuberculous
Doctor’s Note 3

“My patient [a nurse] has a weakened immune system and cannot be exposed to ill infectious patients”.

10/4/2010

Dr. Michael Schweigert
Susceptible Workers - Infectious Exposures

• Non-vaccinated
  – Hospital workers and health care workers
  – Ontario Hospital Association
    • www.oha.ca
  – Canada Immunization Guide, 2006
    • http://198.103.98.78/publicat/cig-gci/pdf/cig-gci-2006_e.pdf
Ergonomic Exposures
Ergonomic

• Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

http://iea.cc/01_what/What%20is%20Ergonomics.html
NIOSH Review of Literature

• Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back

DHHS (NIOSH) Publication No. 97-141 (1997)

http://www.cdc.gov/niosh/docs/97-141/
## NIOSH Review Summary

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### Risk factor evidence

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### Carpal tunnel syndrome

- Repetition: ++
- Force: ++
- Posture: ++ (+/0)
- Vibration: ++
- Combination: +++
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<td>Heavy physical work</td>
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<td>Static work posture</td>
<td>+/0</td>
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Doctor’s Note 4

“Employee can only lift 10 lbs.”
Ergonomic Tables

• NIOSH Lifting Equation

\[ \text{RWL} = \text{LC} \times \text{HM} \times \text{VM} \times \text{DM} \times \text{AM} \times \text{CM} \times \text{FM} \]

where:
- RWL = Recommended Weight Limit
- LC = 51 lb
- HM = horizontal multiplier \((10/H)\)
- VM = vertical multiplier \((1-0.0075[V-30])\)
- DM = distance multiplier \((0.83+1.8/D)\)
- AS = asymmetric multiplier \((1-0.0032xA)\)
- CM = coupling multiplier (from table)
- FM = frequency multiplier (from table)

Evaluation of the Revised NIOSH Lifting Equation: A Cross-Sectional Epidemiologic Study
Ergonomic Tables

• NIOSH Guide for Evaluation of Ergonomic Job Risk Factors

Psychosocial Exposures
Psychosocial

Subjective perspective:

– **Stress** is a perceived imbalance between occupational demands and the ability to perform with consequences for failure.

– Stress is a growing and often the predominant reason for disability across all industries

– Associated with effects which are:
  
  • psychological (job satisfaction)
  • physiological (blood pressure, coronary artery disease)
  • behavioral (substance abuse)
  • Total disability
Stress - Environmental Perspective

Environmental perspective

• organizational
  – Organizational change
  – decrease communication
  – interpersonal conflict - peer and supervisor
  – conflicting with organizational goals

• career development
  – lack of promotional opportunity
  – new responsibilities beyond training
  – Unemployment or (threatened unemployment)
Stress - Environmental Perspective

• Role
  – conflict
  – Ambiguity
  – inadequate resources/authority to accomplish job

• Task
  – quantitative/qualitative overload
  – low decision making latitude
  – responsibility for others' well being
Stress – Environmental Perspective

- Karasek model
  - low decision/control + high demand leads to stress
  - Results in increased reported stress as well as coronary artery disease

![Psychological demand/decision latitude model](image)
Stress - Environmental Perspective

• work environment
  – poor aesthetics
  – physical exposures
    • heat/cold/light extremes/vibration
    • Noise
    • Odours
    • safety hazards,
    • computers[ergonomics, tasks]

• shift work (15-20% of workforce)
“My patient is being harassed at work. Please remove from toxic work environment”
Canadian Medical Protective Association

• Policy regarding third party notes.

“If physicians rely on information which they cannot substantiate independently, such as employment history or previous medical history, physicians should note in the report the source of the information and the fact that it has not been independently confirmed.”

Closing Remarks

• Spend time getting organized
• Develop a standard approach to thinking about:
  – Where’s the exposure is found
  – What is exposures are found at a given worksite
• Consider your role as an educator for the employee, employer and community physicians

10/4/2010