The New Jersey Section of the American Industrial Hygiene Association

Quantitative Ergonomics Assessment Techniques

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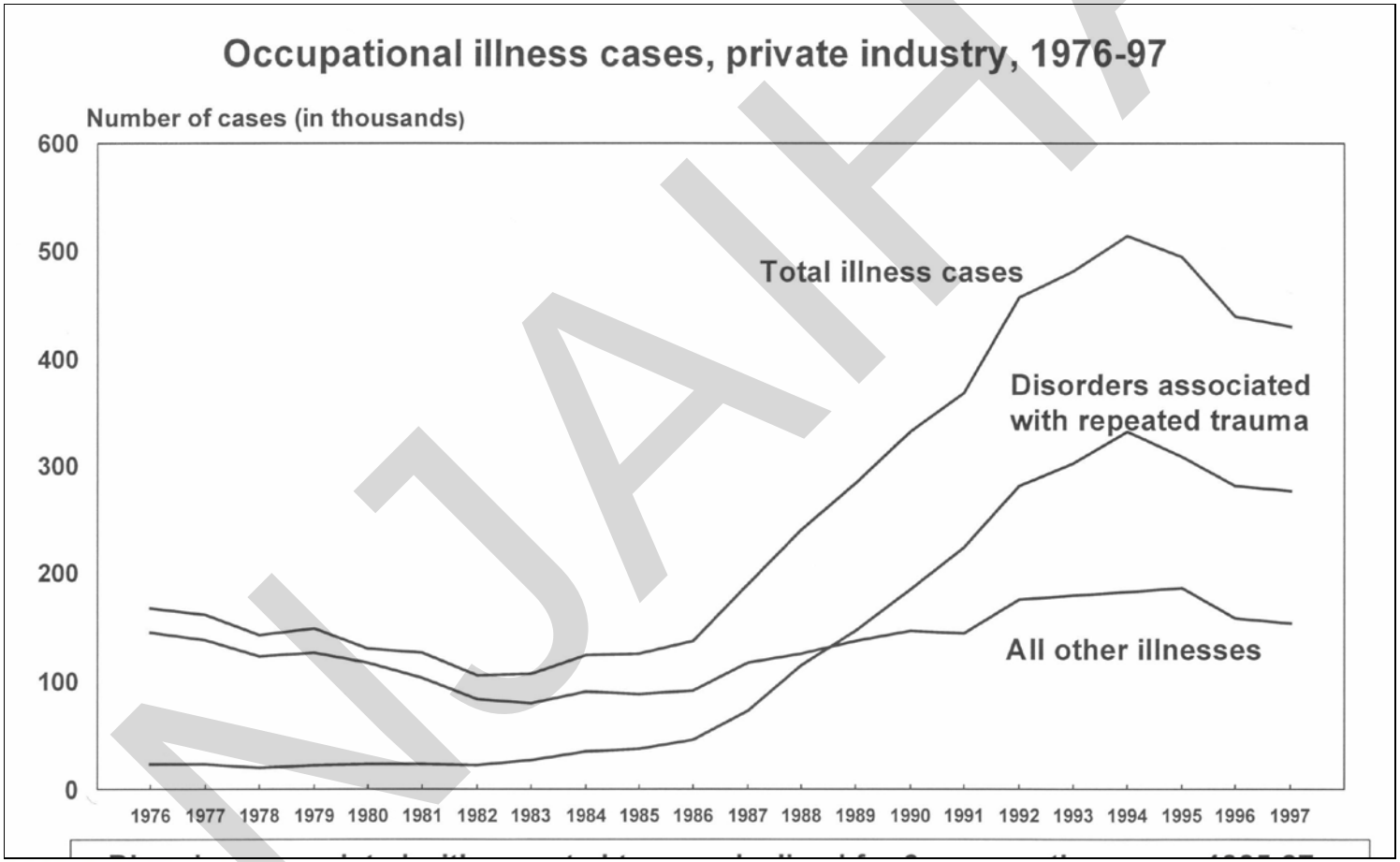
About the Presenter: Richard M. Lynch, Ph.D., CIH

- Certified Industrial Hygienist
- Doctorate in occupational health
- Ergonomics consultant
  - ergonomics assessments, training
  - ergonomics programs
  - litigation support
- NIOSH ergonomics and safety management training course director
- Authored ergo studies from electronics, retail, health care, telecommunications

Overview

- Incidence and costs of ergonomic disorders
- Occupational risk ractors
- Overview of OSHA-proposed ergo standard
- Quantitative assessment techniques
- Impact on interventions
- What good is ergo training?
- For assistance

Repeated Trauma and Total Occupational Illnesses



Incidence / Costs of Ergonomic Disorders

- **Cumulative Trauma Disorders**
  - 62.5% Illnesses in 2006
  - 63% Illnesses in 1993 – 38.3/10,000
  - 64% in 1997 = 32/10,000
  - Estimated $2.1 Billion in direct and indirect
  - $3,500 – $30,000/case
  - Approx. 33% WC $

Industry	Disorders from repeated trauma	Total cases	% Rep. Trauma
Eating and Drinking Places	4.6	16.0	28.80
Hospitals	20.7	81.0	25.50
Nursing and Personal Care Facilities	3.1	29.6	2.70
Grocery Stores	25.1	30.8	81.50
Motor vehicles and equipment	435.8	533.2	81.70
Department Stores	11.0	25.2	46.80
Trucking and courier services, except air	3.0	13.3	26.00
Air transportation, scheduled	34.5	65.6	52.70
Hotels and motels	9.1	30.4	29.90
Meat products	686.0	773.5	88.70
Incidence rate per 10,000 full-time workers for all of private industry, 1997	32.0	49.8	64.25

Incidence/Costs of Ergonomic Disorders

- **Back Injuries**
  - 26% of 1.8 million LT injuries to Back
  - $50-$100 Billion/year (estimated in 1990)
  - Avg. $8,300/case
  - 35-40% WC
  - 30% American Workers at Risk

2006 BLS Injury / Illness Types

- By Body Part

Ergonomic Risk Factors

- High force
  - 10-30% MVC, 770lbs @ L5S1 disk
- Repetition
  - > 2 cycles/min, static exertion
- Awkward posture
  - > 30-50% range of motion
- Contact stress
  - direct trauma, hard surfaces, tool handles
- Vibration
  - hand-arm vibration >125 cycles min
- Cold, poorly-fitting gloves
- Present throughout U.S. industry

OSHA Ergonomics History

- **November 1999:** OSHA Publishes Proposed Ergonomics Standard in Federal Register – Comment Period Open till March 2000 – Hearings Throughout Summer 2000
- **February 19, 1999:** OSHA begins small business review of its draft ergonomics rule, makes draft regulatory text available to stakeholders
- **January 8-9, 1997:** OSHA/NIOSH conference on successful ergonomic programs held in Chicago.
- **October 1996:** Appropriations rider prohibiting expenditure of funds for ergonomics standard/guidelines publication expires.
- **June 1995:** Congress prohibits use of OSHA funds to issue proposed or final ergonomics standard or guidelines.
- **March 1995:** OSHA begins meetings w/ stakeholders to discuss outline of draft ergo standard.

OSHA Ergonomics Standard

- Proposed Rule 11/99 - 1910.900
- Manufacturing, manual handling, WMSD
- Basic obligation
  - ergo program
  - management leadership, employee participation
  - hazard analysis, control
  - training, medical management
  - program evaluation

Management Leadership
Employee Participation

- Assign and communicate responsibilities.
- Provide authority and resources.
- Encourage early reporting.
- Take action.
- Prompt responses to employees.
- Access to information.
- Regular communication.

Hazard Information and Reporting

- System for reporting WMSD.
- Review records.
- Provide information on signs / symptoms.
- Reasonably likely hazards.
- System for reporting signs and symptoms.
- System for making recommendations.

Hazard Analysis and Control

- Representative sample of jobs.
- Inquire about symptoms, difficulties, and associated problem tasks.
- Observe job factors to determine which reasonably likely to cause or contribute to problem.
- Identify, evaluate, implement control measures.
- Track progress on WMSDs and communicate.

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Hazard Analysis and Control

(continued)

- Identify hazards when changing equipment or process.
- Engineering / administrative controls and PPE.
- Materially reduce hazards.
- Incremental abatement process or “quick fix.”

Worksite Analysis Techniques

- Information gathering:
  - injury / illness rates, production
- Determine duty exposure:
  - summary of major job functions
- Quantitative exposure assessment:
  - backs, extremities
- Compare predicted to manifest risk.

Evaluating Back Injury Risks

- Occupational Risk Factors:
  - high force
  - high repetition
  - awkward posture
  - direct trauma
  - single overexertion
  - repeated trauma
  - prolonged sitting

Ideal VDT Workstation Posture

HEAD Directly over shoulders, without straining forward or backward, about an arm's length from screen.

NECK Elongated and relaxed.

SHOULDERS Kept down with the chest open and wide.

BACK Upright or inclined slightly forward from the hips. Maintain the slight natural curve of the lower back.

ELBOWS Relaxed, at about a right angle.

WRISTS Relaxed and in a neutral position, without flexing up or down.

KNEES Slightly lower than the hips.

CHAIR Sloped slightly forward to facilitate proper knee position.

SCREEN At eye level or slightly lower.

FINGERS Gently curved.

KEYBOARD Best when kept flat or at slight negative tilt (for proper wrist positioning) and at or just below elbow level. Computer keys that are far away should be reached by moving the entire arm, starting from the shoulders, rather than by twisting the wrists or straining the fingers. Take frequent rest breaks.

FEET Firmly planted on the floor. Shorter people may need a footrest.

Efficacy of Interventions

- Awareness approach
- PPE approach (back belts)
- Training approach
- Ergonomics approach
  - adjustable 5 – 95%
  - proper design of workstations and tools
- Ergonomics Program approach
  - management leadership, employee participation, worksite analysis and control

Quantitative Back Injury Risk

- 1991 NIOSH Lifting Equation:
  - compression of L5 / S1 intervertebral disk
  - repetition also incorporated
- RWL=51(10/H)(1-(0.0075[V-30]))(.82+(1.8/D))(1-(.0032A))(FM)(CM)
- Utilizes distance from body, height of lift, angle twisted, frequency and coupling.
- Compute at origin and destination of lift.

Lifting Index

- 30 lb. boxes to pallet.
- Lifting Index > 2.2 – 2.3.
- Ideal body mechanics reduce to 1.6.
- Engineering controls needed.

Lifting Index

- 40 lb. trays to pans.
- Lifting index 4.3 – 4.5.
- Ideal body mechanics 2.9.
- No readily available engineering controls.
- Need additional assistance.

Back Injury Risk (continued)

- Physiological Fatigue:
  - as fatigue increases, strength reduces with posture
- Mean Aerobic Capacity = 9.5 kcal / min
  - < 1 hr/day = 50% MAC
  - 1-2 hr/day = 40% MAC
  - 2-8 hr/day = 33% MAC

Physiological Fatigue

- 52 lb. hay bails
- Lifted / thrown to barn door
- Pulse > 120
- 2.5 hours / day
- Poor footing / posture
- High risk for back injury

Back Injury Risk (continued)

- Psychophysical Factor:
  - perception of safety during lifting
- Manual Handling Tasks Acceptable to 75% Females and 90% Males
- Tables by Snook and Ciriello:
  - acceptable weights of lift, lower, push, pull, carry for males and females.

Psychophysical Perception

- 60 - 52 lb. bails / hour
- Origin below waist
- < 75% Males
- < 25% Females
- High risk of back injury

Evaluating CTD Risks

- Occupational risk factors:
  - force
  - repetition
  - awkward posture
  - direct nerve compression
  - vibration
  - cold
  - poorly fitting gloves

Quantitative CTD Risk

- Force - 50% MVC:
  - adequate rest / recovery intervals
- Repetition - cycle time < 30 sec.
- Watch for downward spiral effect.
- Contact Stress - tool handles or hard surfaces.

ACGIH Hand Activity Level TLV

- Consider hand activity level (scale 0-10) and normalized peak force (scale 0-10) to determine Action Level and TLV.
- NPF can be via actual measurements or subjective Borg Scale.
- Ratio = NPF / (10-HAL)
- TLV=0.78 AL=0.56

Select Pilot Solutions

- Each quantitative model address unique aspect of work / worker interface.
- Choose potential solutions based upon computed priorities and manifest problems.
- Consider impacts on:
  - ergonomic risk – increase, no effect, decrease
  - costs – increase, no effect, decrease
- Incorporate employee input / feedback
- Re-assess ergonomic risk on pilot solution.

Ergonomics Training: Who Needs It?

- Required for:
  - affected employees
  - supervisors and managers
  - in-house health care providers
  - external medical providers

What Should Ergonomics Training Contain?

- Risk factors for CTDs and back injuries.
- Early signs and symptoms.
- Job tasks presenting risk factors.
- Steps employees can take to reduce risks.
- How to report symptoms, and to whom
- Employer's ergonomics program elements.

Ergonomics Training Content

- Risk factors from hand tools.
- Proper methods for using hand tools.
- Methods for reporting or replacing defective tools.
- Results of ergonomic analysis and tool redesign.

Ergonomics Controls Training

- Engineering controls implemented or under study by the employers.
- Administrative controls which employees can take on their own by request.
- Active or passive surveillance systems in use.
- Personal Protective Equipment – use and availability.

Supervisor / Manager Training

- Signs and symptoms of CTDs and back injuries.
- Risk factors present in common job tasks.
- What to do when employees complain.
- Contact safety and medical departments for follow-up.
- Potential light-duty positions for injured employees.

Ergo Evaluation Training for Employees / Supervisors

- Management / employee cooperation in identifying potentially problem jobs.
- Fosters:
  - effective innovation
  - feasible solutions
  - planning and forecasting $$$
  - Improved cooperation and trust
  - reduced lost-time injuries and costs, litigation
  - locker room credibility

Benefits of Training Following Ergonomics Assessment

- Provides objective measure of risk.
- Provides objective means of comparison:
  - between different jobs
  - between individuals
  - before and after intervention
  - before and after training
- Supports data-based decision making and continuous improvement processes.
- Focuses training on employee-controllable behaviors!

Back Injury Prevention in Health Care
(Lynch, Freund - AIHA J. 61: March / April 2000)

TABLE IV
Back Injury Statistics
1993 - 1996

Back Injury Category	1993	1994	1995	1996
#Injuries Resulting in Lost Time (days away or restricted)	29	47	18	22
Percent of Lost Time Injuries in Nursing Dept.	50%	53%	56%	64%
Work Days Lost to Moving Patients/Stretchers (All Departments)	393	1,593	469	138
Total Work Days Lost	959	2,198	666	227
Average Work Days Lost per Lost Time Back Injury	33	47	37	10.5

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