

Managing Ergonomic Hazards in Biotechnology Laboratories

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Introduction

- Since 1989 Mt. Auburn Occupational Health Service has been providing on-site occupational health to a growing biotech company in Cambridge
- During that period many employees have presented with various RSI's resulting from ergonomic problems specific to the biotech industry
- In the course of treating these injuries we learned that effective injury management requires
 - Accurate diagnosis (not all RSI's are CTS)
 - Aggressive medical treatment
 - Identification and correction of causative factors

Landau-Ergo talk
12/01/2006

Outline

- Repetitive strain injuries (RSI) in the Biotech Industry
 - Identifying the risk factors
 - Common injuries seen
 - Medical treatment
- Ergonomic solutions to high risk work
 - Neutral positioning
 - Workstation and equipment recommendations
- Developing a comprehensive ergonomics program
 - Program elements
 - Human Factors
 - Fitness for prevention

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Ergonomic Risk Factors

Ergonomic Risk Factors for developing Repetitive Strain Injury are the same, whether laboratory work or computer use:

- Awkward Posture
- Static Body Position
- Repetition
- Grip Force
- Finger Pressure/ Pinch Grip
- Pacing
- Poor Cardiovascular and Muscular Conditioning

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Laboratory Work Associated with RSI

- Laboratory Bench
- Pipette
- Biological Safety Cabinet
- Microscope
- Microtome
- Animal Research
 - Surgical Procedures/ Tissue Harvest
 - Injection
 - Oral Dosing

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Ergonomic Risk: Laboratory Bench

- Awkward body position
 - Prolonged standing
 - Space for leg clearance
 - Height inappropriate for work or employee
 - Elbows at 180 degrees
- Computer work in lab



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Pipette

- Laboratory instrument used to transport measured volume of liquid.
- Works by creating a vacuum above the liquid-holding chamber, and selectively releasing this vacuum to draw up and dispense liquid.
- Used extensively in:
 - Chemistry
 - Molecular Biology
 - Medical testing



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12/02/2005

Ergonomic Risk: Pipetting

- Awkward posture/ Static position
 - Elevated upper arm
 - Neck bent forward/side or "jutting" chin
 - Over-reaching
 - Standing for long periods of time
 - Elbows either "winged" or 180 degrees



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Ergonomic Risk: Pipetting

- Pinch grip when handling pipette tips or opening vials.
- Force on thumb: Tip ejection
- Repetition
 - Hands
 - Forearms
 - Thumb
 - Fingers
- Awkward hand position
 - Radially abducted thumb
 - Bending and twisting of wrist



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Injuries: Pipetting

- Trapezius Strain/ Spasm
- DeQuervain's Syndrome
- Cervical Strain
- Forearm Tendonitis
- Epicondylitis

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Biological Safety Cabinet

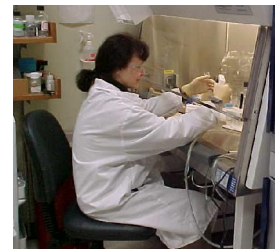
- Laminar flow biological safety cabinets are designed for:
 - Personnel protection: from harmful microbial agents inside the cabinet.
 - Product protection: to avoid contamination of the work, experiment or process.
 - Environmental protection: from contaminants contained within the cabinet.
- Used for:
 - Cell Culture
 - Tissue Culture



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Ergonomic Risk: Biological Safety Cabinets

- Awkward/ Static Body Position
 - Neck, Torso, Arms, Wrists
 - Constrained
 - Over-reaching
 - Elbows "winged"
 - Constrained knee /leg space
- Repetition
 - Hands, wrists, forearms
 - Pipetting
- Contact Pressure
 - Forearms, wrists, knees, legs



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Injuries: Biological Safety Cabinets

- Trapezius Spasm
- Cervical Strain
- Tendonitis
 - Forearm
 - Wrist
- Epicondylitis
- Lower Back Strain

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Microscope

Two types of microscopes are common in Biotechnology Laboratories:

- Optical Microscopes
- Electron Microscopes
 - Spectroscopy
 - Crystallography



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Ergonomic Risk: Microscope

- Awkward/ Static Body Position
 - Lower Back
 - Neck and Head
 - Elbows "winged"
 - Legs
 - Wrist and Hand
- Repetition
- Eye strain and fatigue
- Pinch grip
 - Adjusting eyepiece



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Injuries: Microscope

- Cervical Strain
- Lower Back Strain
- Shoulder Tendonitis
- Forearm Tendonitis
- Epicondylitis

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Microtome

- Mechanical instrument used to cut biological specimens into very thin segments for microscopic examination.
- Used in:
 - Histology
 - Cryosection
 - Electron Microscopy



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Ergonomic Risk: Microtome

- Repetition
 - 40-50 cassettes/ day (1,000 turns of the crank/ wheel on a manual model).
- Awkward Body Position
 - Lower back pain from leaning over machine.
 - Muscular strain from swivel motion/ turning the crank.
- Force
 - Turning the wheel



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Injuries: Microtome

- Tendonitis
 - Shoulder
 - Hand/ Wrist
- Trapezius Strain/ Spasm
- Cervical Strain
- Epicondylitis

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Small Animal Research

- Tissue Harvest, Micro-Surgery, Necropsy
 - Surgical removal of animal organs or tissues for the purpose of studying the pathophysiology of disease.
- Injection, Oral Dosing
 - Administration of research drugs/ compounds for the purpose of studying physiological effects.
- Small Animal Care / Husbandry



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Ergonomic Risk: Small Animal Research

	Small Animal Handling	Surgery/ Micro-Surgery Tissue Harvest	Injection Oral Gavage
"Hunched" Neck and Shoulders	+	+	+
Pinch Grip: *Animal Tail *Surgical Instruments	+	+	+
Lifting/ Pushing Cages	+		+
Rotation: *Elbow or Forearm	+	+	+
Elevation of Arm/ Shoulder	+	+	+
Force on Thumb			+
Biological Safety Cabinet	+	+	+
Microscope		+	
Repetition: *High Volume *>4 hrs/ day, 7 days/ wk	+	+	+

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Injuries: Small Animal Research

- Cervical Strain
- Trapezius Spasm
- Forearm Tendonitis
- DeQuervain's Syndrome
- Nerve Impingement Syndromes
 - Carpal Tunnel Syndrome
 - Radial/ Ulnar Nerve Impingement
 - Thoracic Outlet Syndrome
- Eye Strain

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Summary of Prevalent Injuries

	Pipetting	Safety Cabinet	Microscope	Microtome	Small animal handling
Trapezius Strain/ Spasm	+	+		+	+
DeQuervain's Syndrome	+	+		+	+
Cervical Strain	+	+		+	+
Tendonitis					
Shoulder			+	+	
Forearm	+		+		+
Hand/Wrist				+	
Epicondylitis	+		+	+	
Lower Back Strain		+	+		
Nerve Impingement Syndromes					+

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Medical Treatment

- Accurate diagnosis by an Occupational Health MD
 - *Not all RS's are Carpal Tunnel Syndrome*
- Identification of affected muscles/tendons/nerves
- Use of splinting
- Ice and/or heat
- Use of anti-inflammatory meds and muscle relaxants
- Physical Therapy/Occupational Therapy/Therapeutic Massage
- Determination of specific job function causing strain
- Appropriate work/rest recommendations to supervisor
- Recommendations for ergonomic changes
- Address additional factors
 - Co-existing medical conditions
 - Anxiety
 - Outside activities
 - Sleep issues
- Periodic follow-up

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Outline

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Neutral Positioning of the Neck

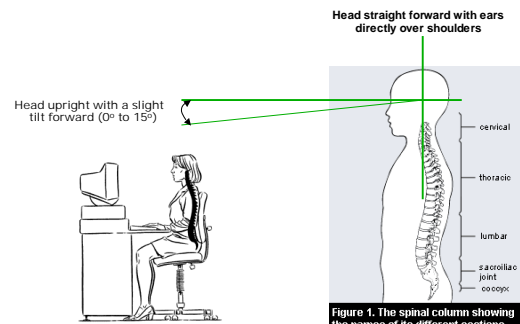


Figure 1. The spinal column showing the names of its different sections

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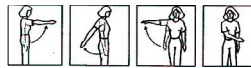
Positioning the Shoulder

Neutral



- Shoulder relaxed, not raised
- Upper arm close to body
- Forearm not rotated

Stressed



- Shoulder muscles / tendons work to reach forward or out to side
- The higher and further the arm is held, the greater its relative weight—and shoulder's work
- The longer the arm is held in static posture, the greater the shoulder stress

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Positioning the Elbow and Forearm

Neutral



- Elbow open at angle of 90 degrees or greater
- Forearm not twisted (natural thumb position is forward)
- Held close to upper body

Stressed

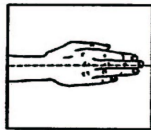


- Elbow held tightly bent (less than 90 degree angle)
- Forceful gripping
- Turning the palm upward or downward
- Direct pressure on a hard surface

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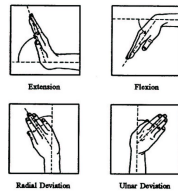
Positioning the Wrist and Hand

Neutral



- Wrist and hand in straight to slightly flexed position
- No radial deviation
- No pronation or supination
- Fingers relaxed and slightly flexed

Stressed



- Bent forward more than 15 degrees
- Bent back as with traditional keyboard position
- Palm turned upward or downward as with traditional mouse usage
- Forceful or prolonged static grip
- Pinch grip as with animal handling
- Excessive thumb work as with pipetting
- Cold, vibration, direct pressure

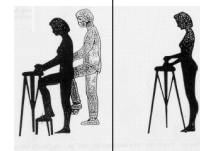
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Lower Back

Neutral



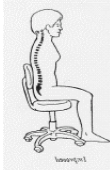
Stressed



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Seated Positions

Neutral



- Head straight
- S-curve maintained
- Lumbar supported
- Proper seat depth
- Feet supported

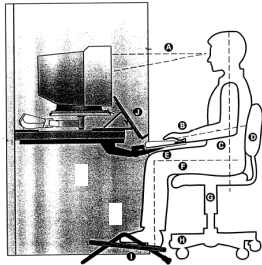
Stressed



- With slouching the head drops lower than must be pulled up to see forward
- High VDT Screens exacerbate this by requiring even more upward pulling of the head
- Documents on the desk cause craning and twisting to see them
- Leaning forward to do close work can cause further extension

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Ergonomically Correct Seating




- Eyes level Head straight
- with top 1/3 of screen
- Shoulders relaxed
- Arms and elbows close to torso
- Elbows open 90° or more
- Lumbar curve supported
- Angle between lower back and legs 90° or more
- Thighs supported by seat pan
- Foot supported by foot rest


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Working at a Bench

Stressed




Neutral




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Working in a Bio-Safety Cabinet (Hood)

Stressed



Neutral



Note armrest

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Working at a Microscope

Stressed



Neutral



Arm supported

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Seating for Forward Leaning Work

Stressed

Neutral

Note Footrest

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Stresses Associated with Traditional Manual Pipetting

Hand grips tightly while thumb is over extended and applying excessive pressure

Additional problem with laterally deviated wrist

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Improved Manual Pipettes

Biohit M-Line

Transferpette

- Thumb reach decreased
- Reduced activation pressure
- Larger grip and hook allows relaxed hand

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Some Ergonomically Designed Electronic Pipettes

Matrix

Biohit

Finn Biocontrol

Electronic pipettes greatly reduce required manual force

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The Ovation Pipette

Wrist posture in a neutral range of motion

Arm elevation less than 12°

A low hand/arm elevation and neutral wrist angle also allows better visibility and greater control for acquiring tips, and guiding tips into small vessels such as microtubes.

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Developing an Effective Ergonomics Program

Correct awkward postures and excessive force

- Work station adjustments as early as possible
- Teach proper positioning
- Make furniture and equipment recommendations

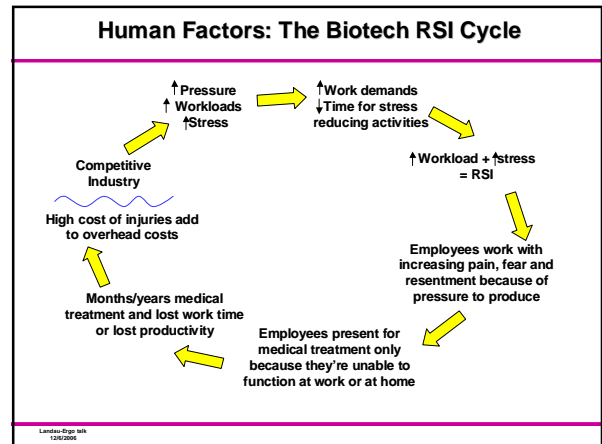
Correct repetitions over time

- Breakup work sessions
- Vary work functions
- Take frequent short breaks
- Recognize early signs of muscle fatigue
- Stretch effectively

Early intervention is key

- Stresses are cumulative over time
- Severity of injury increases over time
- Intervention is more effective before serious damage is done
- Longer duration of symptoms increases recovery time

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Human Factors: Obstacles to Preventative Measures

- Supervisors are under increasing pressure to produce and communicate this to employees
 - Employees push themselves harder in an effort to prove themselves useful contributors
- Company concerns about cost containment cause employees to resist spending on new equipment
- Work habits that increase efficiency also increase risk of injury
 - Batching work instead of varying functions
 - Speeding instead of pacing

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Effective Ways to Break the Cycle

- Early education
 - Alert to the risk of injury
 - Make aware that there are options for corrective measures
- Frequent reminders
- Corporate and Supervisor support
- Make tools easily available

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Fitness Program Development

- Problem
 - Repetitive work involves almost continuous use of small muscles that are weak because they are not generally exercised
 - Weak muscles are tight and therefore more prone to spasm and injury
- Solutions
 - Increase awareness of muscle fatigue symptoms
 - Use frequent brief rest periods to promote adequate circulation
 - Stretch tight muscles periodically
 - Vary work tasks
- To develop a fitness program
 - Observe high risk work to determine muscle stressors
 - Use observations to develop a stretching and strengthening program for affected muscle groups

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Sample Fitness Plan

RSI Prevention for Pipetting

Employee Name: _____ Ext: _____ Loc: _____ Date: _____
 Supervisor: _____ Dept: _____

Stressor	Description	Ergo Solution	Exercise/Strengthening	Exercise/Stretching
Neck/Cervical	Bent forward to watch work	Adjust height of bench top, chair, and/or standing height to minimize forward neck flexion.	N/A	1. Turn head to the right/hold for 15 seconds (same for the left) 2. Tilt head to the right, left, front, and back/hold each stretch for 15 seconds.
Cervical/Shoulder	Forward reaching with arms while holding up weight of pipette for extended time	Seating close to work with upper arms relaxed & arms supported Standing height to minimize reaching up (platforms)	Shoulder press Front raise Side raise Shrugs	Pull one arm across the chest and hold for 15 seconds, then change arms
Arms (Upper)	Above stresses to upper arms holding weight of pipette for long periods	Ergo pipettes are lighter weight.	N/A	N/A
Arms (Elbows/ forearms)	Muscles of forearm used to grip pipette, maneuver pipette, and compress controls using thumb for manual pipette, whole hand and fingers for Serologic pipettes	Ergo pipettes allow: Loose grip Neutral positioning of wrist & hand Soft touch to trigger controls No sustained pressing of controls	Hammer curl	Wrist forward stretch Wrist down stretch Arms stretched out to the side

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Sample Fitness Form (2)

Hands	Gripping pipette Compressing with thumb	Ergo pipettes and correct hand positioning		Wrist Circles
Mid back	Leaning over bench top to pipette with arms extended	Chair adjusted for back support Leg room cleared and chair as close to work Arms rest on bench for support of arms & trunk when forward lean needed	Lateral Pull-down Shrugs Reverse Fly Upright Row	Pull both arms forward and stretch for 15 seconds
Low back	Leaning as above Prolonged standing	Chair back adjustment Foot rest adjusted Chair height adjusted Alternating footrests while standing	Superman/superwoman (lay on your stomach, squeeze your glutes lifting your arms and legs off the floor)	1. Lay on your back and hug your knees into the chest and hold for 15 seconds 2. Hamstring stretch (lay on your back bend the left knee and keep it on the floor, pull the right leg straight toward your chest and hold for 15 seconds. Switch sides.

Ergo Evaluation By: ____ Fitness Evaluation by: ____

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Program Effectiveness

1996 2000 2003 2004 2005 2006

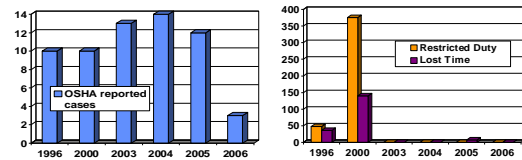
Awareness
Education
Risk alerts
Quarterly reminders
WS Evals for Sx

Preventive WS evals for high risk work
Computer
Pipette
Hoods

Increase NP hours dedicated to ergo evals
Collaborate with biosources management to reduce risk factors

Fitness Program

Full implementation all elements



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Summary

- Biotech workers are vulnerable to a range of repetitive strain injuries.
- Solutions are available through a combination of interventions including:
 - Ergonomic and postural adjustments
 - Use of ergonomically designed equipment
 - Changes in work techniques and habits
 - Fitness, stretching and exercise
- Aggressive education program is needed to increase awareness of dangers and available options
- An effective ergonomic program requires buy-in from management, health and safety personnel and workers.
- Experience has shown that preventative programs have a high payoff.

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