Ergonomics in the Biosciences

***Melanie Alexandre, OTR, CPE
Ergonomist
Lawrence Berkeley National Laboratory***

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Topics to be discussed

- Common laboratory risk factors
- JGI program
- Risks and solutions identification
- Case studies/examples
- My lessons learned
- Research & guidelines

Common risk factors

Ergonomics Risk Factors

Many lab activities involve repetitive, forceful pinching in awkward postures

High precision demand

Static postures → Fatigue → Contact stress

Common laboratory tasks

- Pipetting
- Microscopy
- Micromanipulation
- Biosafety cabinets, fume hoods, and glove boxes
- Material handling
- Standing
- Sitting
- Computer use

Pipetting

- Risks
  - Repetitive
  - Forceful exertions
  - Awkward positions
  - Extended reach
  - Monotonous
- Controls
  - Determine best tool for job
    - Consider volume, weight, balance, length, plunger force, blowout force, tip eject force, grip comfort, display, and volume adjustment
  - Optimal work station set up
  - 'Switch hit'
  - Create time limits/ restrictions
  - Self care techniques

David & Buckle, Applied Ergonomics, 28:4, 1997

Manual Pipetting – Epidemiology

- Frequent use (>300 hrs/yr) associated with high risk of hand & shoulder problems: pipetting > 1-1.5 hours per day
  - Hand problems (5.0 x control group)
  - Shoulder problems (2.4 x control group)

(David & Buckle, 1997)

(Bjorksten, 1994)¹¹

Microscopy

- Risks
  - High visual demands
  - Monotonous
  - Extended reach
  - Repetitive motion
  - Static/ awkward postures
  - Contact pressure
- Controls
  - Optimize equipment and set-up
    - Consider adjustable
  - Use external monitors
  - Self care techniques

Microscopy

85% of cytotechnologists had some musculoskeletal symptom(s): headache, neck pain/stiffness, back pain, upper-extremity discomfort.

Numbness, tingling, & pain in fingers:

>1/2 Right hand

>1/3 Left hand

Micromanipulation

- Risks
  - Repetitive
  - Forceful use of small muscles
  - High visual demands
  - Awkward/ static postures
  - Monotonous
  - Contact pressure
- Controls
  - Optimize workstation set-up
  - Turn 'pinch' into 'grip'
  - Self care techniques

Biosafety cabinets & fume hoods

- Risks
  - Glare
  - Extended reach
  - Awkward/static postures
- Controls
  - Optimal workstation set-up
  - Shorter handled tools
  - Self care techniques

What are some design guidelines for height and reach?

Gloveboxes

- Risks

- Excessive reaching forward and sideways
- Prolonged standing
- Forceful grasping, reaching and lifting
- Reduced strength due to poor fitting gloves and working out of comfort zone
  - Thicker gloves and ambidextrous gloves make the hands work harder
- Forearm pressure from rim of glove ports
- Glare

- Controls

- Optimize height
- Use properly fitted gloves
- Avoid manual handling of objects greater than 15 pounds
- Increasing length of levers, dials, and tools
- Establish ways to avoid elbow and forearm pressure
- Eliminate sources of glare
- Place items within a comfortable reach
- Self care techniques

“Ideal” glovebox worker

Material handling

- Risks
  - Forceful exertions
  - Awkward postures
- Controls
  - Eliminate manual handling
  - Optimize placement (between chest and thigh level)
  - Self care techniques
  - Note: use team lifts sparingly

Standing

- Risks
  - Static posture
  - Can be coupled with awkward postures
- Controls
  - Optimize work station set-up
  - Provide alternatives
    - Sitting
    - Elevating a foot
    - Vary stance
  - Anti-fatigue products
  - Self care techniques

Sitting

- Risks
  - Static posture
  - Can be coupled with awkward postures
  - Inadequate leg clearance
- Controls
  - Optimize work station set-up
  - Provide alternatives
  - Self care techniques

Resting Muscles

Dynamic Work

Static Work

Computer use

- Risks
  - May not follow the same guidelines that are applied in the office set-up
- Controls
  - Apply the same guidelines for office set-up

JGI Program

Current DOE Mission Relevance

Carbon Cycling

Office & Manufacturing Work Environments

60% staff in computer-
intensive office settings

40% staff in hand-intensive
production tasks
(2 shifts)

Root Causes of Ergonomic Injuries

- Equipment/instruments designed for small batches used for high throughput operation
- Culture:
  - Understanding Efficiency vs. Speed
- High force hand-intensive tasks

We are striving to determine
how much is too much

History of Ergonomics at JGI (Dec 2005-Current)

Engineering designs and solutions

Early intervention

Targets employees
with discomfort
Includes bi-weekly
review meeting

Proactive Efforts

Labs and offices
Monitoring
Walk-about
Comfort surveys

Safety Culture Working Group

Promotion
Awareness
Communication

Training/education

Risk targeted classes
Stretch break programs
Potty training
Website resources

Relaxation/Rejuvenation Room

Ergonomics Demo Room

Work tool and practices

Ergo Points
Required Practices

Organizational issues and ongoing efforts

- Organizational issues:
  - Responsibility
  - Accountability
  - Follow up
  - Communication
  - Trust
- Ongoing efforts:
  - Conduct evaluations and monitoring of individuals
    - Keep close watch on high risk folks
  - Conduct risk assessments prior to implementation of emerging technologies
    - Establish acceptable ergo risk threshold prior to implementation

Top 3 High Risk Factor Tasks (Pre-2007)

Thermal Cycler Loading

Peeling Seals

Freezer Rack Lifting

Top 3 High Risk Factor Tasks (Now-2010)

Pipetting

Capping/uncapping

Vortexing

Employee Driven Designs

454 & Illumina Pipetting

Viaflo

Eppendorf Xstream

Vistalab Ovation

Best Practices= Do's and Don'ts

What is Ergo Points?

- Supervisors want to know....
“HOW MUCH IS TOO MUCH?”
- Guidelines for schedulers
  - What tasks can be scheduled together
  - How many tasks can be conducted in one day
- No ergonomics risk tool exist for low force high repetition tasks like at JGI Production

GOAL: Reduce ergonomic risk caused by the combination of tasks assigned

Weight Watchers

Food	Weight Watchers Points
Medium Fries	10
Cheeseburger	7
Big Mac	14
Corn on Cob	3

Weight Watchers

Task	Ergo Points
Handling bio-assay trays	20
Loading/Unloading Stackers (Top Loading)	16
Loading/Unloading Stackers (Front Loading)	5
Unsealing Heat Seals	18

JGI Wins the Ergo Cup Again!

**FOR...the Ergonomic Program Improvement Initiatives category:
“Empowering Employees in Ergonomics,”** which focuses on employee-driven elements of the DOE JGI program that help promote awareness of ergonomics and safety while encouraging employee involvement in both safety & ergonomics.

Risk and Solution Identification

What risks do you see?

What could be done?

Picture 1

Picture 2

What risks do you see?

What could be done?

Picture 1

Picture 2

Picture 3

What risks do you see?

What could be done?

Picture 1

Picture 2

Picture 3

What risks do you see?

What could be done?

Picture 1

Picture 2

Picture 3

Ways to control risk factors

1. Work with elbows close to body
  - Avoid excessive forward and sideways reaching
2. Avoid overhead and below knee tasks
3. Alternate tasks
  - To avoid repetition
  - Sitting ↔ Standing
4. Optimize work environment/equipment
5. Use grip versus pinch
6. Utilize arm/forearm support
7. Take breaks
8. Perform stretches
9. Alternate hands
10. Use both hands

Ways to control risk factors: Alternate tasks & take breaks

Elevate a foot

Use a cueing device

Take a seat

Use anti-fatigue mats or
personal shoe covers/inserts⁴³

Ways to control risk factors

Optimize equipment & utilize support

Microscope arm pads

Edge padding

Reverse action padded tweezers

Case studies/ Examples

***Where should
things go?***

***Where should
things go?***

Height adjustability adapts to changes in equipment and technology over time

Bench top DNA Hood before ergo modification

Early mock-ups for 454 group input & collaboration w/ Ergo Team (June 07)

Final lab bench redesign

www.jha-techspace.com

Bench top DNA Hood re-design

1. Recessed area & tilted receptacles reduce awkward wrist postures
2. Padding protects elbows & forearms
3. Programmable pipette (Eppendorf Xstream) improves hand position, reduces force & repetitive movement

Case Study

- Animal care facility
  - Significant risk factors
    - Prolonged standing
    - Repetitive hand and arm activities
    - Overhead and below knee reaching, bending, and stooping
    - Forceful lifting, carrying, bending, reaching, pushing, and pulling

Before

Before

After

After

Case Study

What would you do?

My lessons learned

Lessons Learned

- Be the 'wind beneath the wings'
  - Do not have to be a know-it-all
  - Have an “employee knows best” attitude
- Speak several languages
  - Management= \$, productivity, ROI, savings
  - Employees= apply info specifically to them

Lessons Learned

- Think out of the box
- K-I-S-S

Lessons Learned

- Small successes can pave the way for bigger ones
- Create ergonomics 'eyes and ears' everywhere

What research shows...

- Microscopy
  - Thompson, S.K. & Mason, E. (December 2004)
    - Established work load limits should consider accuracy, productivity, and ergonomics
    - Found 85% of survey respondents perform only 56% of maximum work limit, but have Musculoskeletal Disorder Symptoms (MSDs)
  - James, T., Lamar, S., Marker, T. & Frederick, L. (2000)
    - Key features of ergonomically designed microscope include tilting and telescopic head, optional riser tubes, one-hand focus control, and in-line focusing
    - Results included increased comfort, especially in the neck and shoulders area when using an ergonomic microscope versus traditional microscope
  - Kofler, M., Kreczy, A., & Gschwendtner, A. (February 19, 2002)
    - EMG activity was reduced for all muscles that were studied when using the ergonomic workstation versus a standard workstation
    - Ergonomic workstation included adjustable table, microscope, and horizontal forearm supports
  - Sillanpaa, J, Nyberg, M. & Laippala, P. (July 10, 2003)
    - Key features of ergonomically designed microscope include adjustable ocular angle and height, adjustment knobs positioned low, forehead support
    - Key features of ergonomically designed microscope table include adjustable height, adequate space and leg room, cut-away section at front of table, tilt able ocular angle, forearm and forehead support,
- Standing work
  - Whistance, R.S., Adams, L.P., VanGeems, B.A., & Birdger, R.S. (December 1995)
    - Postural adaptations for work that is too far away include trunk and hip flexion
    - Postural adaptations for work that is too close include neck flexion and thoracic kyphosis

What research shows...

- Pipetting
  - Fredriksson, K. (May 2005)
    - The symptoms increase with:
      - Amount of time spent pipetting
      - Age
      - Weak thumb muscular structures
    - Suggestions include:
      - Consider automation as amount of time increases
      - Design with minimal button resistance
      - Handles that fit different hand sizes
- Biosafety cabinets
  - Jones, R.L. & Eagleson, D (May 2001)
    - Reach= shortest anthropometrics 8-14 inches
    - Use footrests and armrests
    - 10 degree angled view screen slope
    - Place equipment/ supplies at edge of work surface
- Lab design
  - Garikes, R.W. (July 2004)
    - Six Sigma can improve quality, eliminate waste, reduce lead time and costs while also improving ergonomics and work flow
      - Flexibility is the most important design element
        - » Create abilities to expand, modify, and completely change
- Standing work
  - Whistance, R.S., Adams, L.P., VanGeems, B.A., & Birdger, R.S. (December 1995)
    - Postural adaptations for work that is too far away include trunk and hip flexion
    - Postural adaptations for work that is too close include neck flexion and thoracic kyphosis

Laboratory Guidelines

Target	Recommendation	Reference
Physical Environment	•Minimal per person space requirement > 10 m² / 107 ft² •Passageways (1 person: 2 feet 2 persons: 3 feet)	NF X35-102
Furniture	•Use adjustable tables and seats •Hoods with easy access and comfortable seating •Place frequently used items in logical locations	NF X35-104 NF X35-105 ISO 9241-5 Ref.9
Pipettes	•Choose pipette that fits the task •Use manufacturers recommended tips •Use multi-channel for 96+ well plate applications •Use motorized pipettes for repetitive and mixing tasks	ISO 8655
Work Organization	•Do not exceed more than 30 gestures/minute •Take frequent, short breaks •Take a mandatory pause after each sequence of repetitive tasks •Vary tasks (work with different muscles)	NF EN 1005-5
Work Conditions	•Noise <55dBA •Comfortable ambient temperature •Lighting 300-600 lux •Eliminate glare and reflections	ISO 9241-6 ISO 7730 NF X35-103

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