Title
Ergonomics in the Biosciences

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Author
Alexandre, Melanie

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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
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)
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

Thompson, 2003
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
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
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
DOE Joint Genome Institute
Production Genomics Facility

The Human Genome 2003

Current DOE Mission Relevance

Bioenergy

Biogeochemistry

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)

- **Dec’05**: JGI Ergo Program Established
- **Dec’06**
- **Mar’07**: JGI Ergo Points In-House Risk Assessment Tool
- **Aug’07**: Required Practices Established to control risk
- **Nov’07**: Early Intervention Program Established
- **Dec’07**: JGI Wins 2007 Ergo Cup Award at Applied Ergonomics Conference
- **Dec’08**: December Stand Down of Production Line
- **Feb’08**: Daily Monitoring in Production Areas
- **Apr ’10**: JGI Wins 2010 Ergo Cup!
Engineering designs and solutions

Early intervention
- Targets employees with discomfort
- Includes bi-weekly review meeting

Proactive Efforts
- Labs and offices
- Monitoring
- Walk-abouts
- 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

Vistalab Ovation

Eppendorf Xstream
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

<table>
<thead>
<tr>
<th>Food</th>
<th>Weight Watchers Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium Fries</td>
<td>10</td>
</tr>
<tr>
<td>Cheeseburger</td>
<td>7</td>
</tr>
<tr>
<td>Big Mac</td>
<td>14</td>
</tr>
<tr>
<td>Corn on Cob</td>
<td>3</td>
</tr>
</tbody>
</table>
# Weight Watchers

<table>
<thead>
<tr>
<th>Task</th>
<th>Ergo Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handling bio-assay trays</td>
<td>20</td>
</tr>
<tr>
<td>Loading/Unloading Stackers (Top Loading)</td>
<td>16</td>
</tr>
<tr>
<td>Loading/Unloading Stackers (Front Loading)</td>
<td>5</td>
</tr>
<tr>
<td>Unsealing Heat Seals</td>
<td>18</td>
</tr>
</tbody>
</table>
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?
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

- Use a cueing device
- Elevate a foot
- Take a seat
- Use anti-fatigue mats or personal shoe covers/inserts
Ways to control risk factors
Optimize equipment & utilize support

Edge padding

Microscope arm pads

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
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
    - 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**
    - 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
    • 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
    • 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

<table>
<thead>
<tr>
<th>Target</th>
<th>Recommendation</th>
<th>Reference</th>
</tr>
</thead>
</table>
| 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                                                | NF X35-104            |
|                            | • Hoods with easy access and comfortable seating                                 | NF X35-105            |
|                            | • Place frequently used items in logical locations                                | ISO 9241-5 Ref.9      |
| Pipettes                   | • Choose pipette that fits the task                                              | ISO 8655              |
|                            | • Use manufacturers recommended tips                                            |                       |
|                            | • Use multi-channel for 96+ well plate applications                              |                       |
|                            | • Use motorized pipettes for repetitive and mixing tasks                         |                       |
| Work Organization          | • Do not exceed more than 30 gestures/minute                                     | NF EN 1005-5          |
|                            | • Take frequent, short breaks                                                   |                       |
|                            | • Take a mandatory pause after each sequence of repetitive tasks                 |                       |
|                            | • Vary tasks (work with different muscles)                                      |                       |
| Work Conditions            | • Noise <55dBA                                                                   | ISO 9241-6 ISO 7730   |
|                            | • Comfortable ambient temperature                                               | NF X35-103            |
|                            | • Lighting 300-600 lux                                                          |                       |
|                            | • Eliminate glare and reflections                                               |                       |

Adapted from Gilson Laboratory Ergonomics: Things you should know… things you should do http://www.gilson.com/Downloads/mlhAppNote1.pdf
References and resources

- Center for Disease Control, Laboratory Ergonomics website [http://www.cdc.gov/od/ohs/Ergonomics/labergo.htm](http://www.cdc.gov/od/ohs/Ergonomics/labergo.htm)

Include JGI intranet if available