NIEHS
National Institute of
Environmental Health Sciences

NIEHS
Health and Safety Guide to Laboratory Ergonomics

Health & Safety Branch

U.S. Department of Health and Human Services
National Institutes of Health
National Institute of Enviromental Health Sciences

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INTRODUCTION

Laboratory researchers are at risk for repetitive motion injuries during routine laboratory procedures such as pipetting, working at microscopes, operating microtomes, using cell counters and video display terminals. Repetitive motion injuries develop over time and occur when muscles and joints are stressed, tendons are inflamed, nerves are pinched and the flow of blood is restricted. Standing and working in awkward positions in laboratory hoods/biological safety cabinets can also present ergonomic problems.

This guide is designed to help research staff reduce repetitive motion injuries and awkward postures in the laboratory environment by incorporating some simple ergonomic principles. Early intervention is critical to helping employees avoid some preventable injuries and unnecessary pain. Protective measures listed throughout this guide should be followed to eliminate or reduce ergonomic stressors during routine laboratory procedures. Various websites for laboratory ergonomic related products to be used as examples for employees have also been listed. The Health and Safety Branch is not endorsing any specific products or companies.

The Health and Safety Branch is also available to perform Laboratory Ergonomic Evaluations. Please contact us at 1-3384 with your requests or concerns.

CHAPTER I
Ergonomic Disorders Commonly Found Among Laboratory Personnel

A. De Quervain's Tenosynovitis

De Quervain's tenosynovitis, the most common disorder with tendon sheath swelling, occurs in the abductor (moving away from the midline) and extensor tendons of the thumb. These tendons share a common sheath, and swelling can affect both. Impingement on the tendon by swollen sheath and the production of excess synovial fluid can lead to loss of tendon function.

De Quervain's tenosynovitis, which is commonly recognized as an occupational disorder, may be precipitated by forceful grasping and turning, particularly of hard objects such as vials. Symptoms include swelling, pain and tenderness at the base of the thumb. Pain is aggravated by attempts to extend the thumb. Flexion and adduction may produce a "trigger" effect or popping sensation.

B. Carpal Tunnel Syndrome

Carpal tunnel syndrome is the most common nerve entrapment disorder. Symptoms result from compression of the median nerve as it passes through the wrist within the carpal tunnel, a narrow, confined space formed by the eight carpal bones and the transverse carpal ligament. Within this limited space, swelling of any of the components can increase pressure in the tunnel. Because the median nerve provides both sensory (feeling) and motor (muscular movement) innervation to both the thumb and middle three fingers, damage can result in pain and disability.

Although it has been extensively studied, carpal tunnel syndrome still remains a subject of controversy in terms of etiology, relation to work, diagnosis and treatment. However, its association with cumulative occupational trauma is becoming more generally accepted.

Carpal tunnel syndrome can result from any process that leads to increased pressure on the contents of the tunnel. The nerve is the most vulnerable component. Nonspecific tenosynovitis (swelling of the tendon sheaths) of the flexor tendons within the tunnel may be the most common cause of increased pressure. Decreased capacity of the tunnel may result from prior fracture or discoloration of the hand or forearm, rheumatoid arthritis or congenital anomalies.

Early symptoms include numbness, painful tingling, and burning pain and weakness in the thumb and first three fingers. These symptoms are often precipitated by repetitive hand or finger actions, but nocturnal symptoms that wake the patient are common. Shaking the hand may bring relief. Sensory loss in the ring finger frequently occurs only on the lateral (away from the body) side. Numbness rarely radiates proximal to the wrist, but sometimes the forearm and shoulder aches. Typically the dominant hand is most affected, with involvement of the other hand being evident only upon electrodiagnostic studies. Weakness eventually develops in the muscles that abduct and oppose the thumb. In advanced cases, the thumb cannot move properly in opposition to the other fingers, and the worker may drop objects.

C. Tendonitis & Tenosynovitis

Two of the best documented work related disorders are tendonitis and tenosynovitis. Both are painful and disabling and play a role in nerve compression syndromes. Tendonitis-inflammation of the tendon (fibrous band connecting skeletal muscle to bone) - can effect any extremity, but in the workplace, it is most common in the wrist and fingers. Tenosynovitis is inflammation of the synovial sheath that encloses tendons running within fibro-osseous (having both connective tissue and bone) tunnels. The sheath's inner membrane secretes a viscous fluid that lubricates the joint, and this secretion increases during an inflammatory process.

Tendonitis, which is often accompanied or preceded by tenosynovitis, is common among people who perform repetitive work, especially when a tendon rubs against other structures as it passes through a fibro-osseous tunnel. Occupational risk factors include repetitive tension and motion, bending and vibration. Risk increases with age, due to tendon stiffening.

Tendonitis is diagnosed by tendon swelling found on physical examination, with localized pain on palpation or resisted movement. Common disorders are rotator cuff tendonitis, biceps tendonitis, lateral epicondylitis ("tennis elbow") and medial epicondylitis ("golfer's elbow").

D. Rotator Cuff Tendonitis

Rotator cuff tendonitis is a shoulder disorder characterized by inflammation of the supraspinatus muscle to the humerus (upper arm bone). Rotator cuff tendonitis has several causes, which may be classified as extrinsic (due to mechanical impingement from outside of the cuff) or intrinsic (due to changes within the cuff, such as aging or diminished vascular supply). In primary mechanical impingement, elevation of the arm leads to pressing of the supraspinatus tendon against the acromion. When this is repetitive or excessive, the resulting irritation and ischemia (reduction in blood supply) lead to rotator cuff tendonitis.

The primary symptoms of rotator cuff tendonitis are shoulder pain, sometimes radiating down the arm. Generally tendonitis pain is exacerbated by movement and relieved by rest, but it may occur at night also, especially if the cause is impingement. Movement may be limited by pain, stiffness or weakness. Rotator cuff injuries are common among workers who perform repetitive tasks with their elbows above mid-torso height, particularly if their arms are raised overhead.

E. Thoracic Outlet Syndrome

Thoracic outlet syndrome consists of upper extremity symptoms resulting from pressure on nerves of blood vessels between the base of the neck and the axilla (armpit). The syndrome may involve any of the several structures in the thoracic region, and symptoms make it difficult to distinguish the specific area.

Structures that are subject to compression are usually the nerves of the brachial plexus (the braid of nerve fibers formed by the anterior branches of cervical nerves C5-C8 and thoracic nerve T1; it begins in the base of the neck and extends into the axilla, where it divides into the major nerves of the arm). Less commonly (in fewer that 10 % of cases), the subclavian artery or vein is compressed.

Symptoms include neck pain, arm weakness and numbness extending along the inner forearm into the medial two fingers. Symptoms may be precipitated or aggravated by postural changes, especially arm elevation. Vascular symptoms are aching or throbbing in the arms, coldness and periodic blanching of the fingers. Diagnosis is difficult because many physical signs are nonspecific.

F. Wrist Ganglion

The wrist ganglion is considered by many to be a herniation of the joint capsule or of the synovial sheath of the tendon; other authorities believe it to be a cystic structure. It usually appears slowly after a wrist strain and contains a clear, mucous fluid. The ganglion most often appears on the back of the wrist, but can appear at any tendonous point in the wrist or hand. They are often treated surgically.

G. Trigger Finger

The trigger finger or thumb is an example of stenosing tenosynovitis, which is a condition where the tendon surface becomes irritated and rough, the sheath becomes inflamed, and the tendon sheath undergoes progressive constriction. It most commonly occurs in a flexor tendon that runs through a common sheath with other tendons. Thickening of the sheath or tendon occur, thus constricting the sliding tendon. A nodule in the synovium of the sheath adds to the difficulty of gliding. The worker complains that when the finger or thumb is flexed, there is resistance to re-extension, producing a snapping that is both palpable and audible.

This disorder is usually associated with activities involving the repetitive usage of tools that have handles with sharp edges or hard edges. Examples of laboratory activities involving work with sharp edges can include repetitive work opening vials, closing vials, pipetting and cover slip applications.

H. Back Injuries

Back injuries are categorized as ergonomic disorders when they result from chronic, or long term injury to the back rather than from one specific incident. Once back muscles or ligaments are injured from repetitive pulling and straining, additional injuries are more likely to occur because the back muscles, discs and ligaments may be scarred and weakened and can lose their ability to support the back.

One of the main causes of low back injuries in the laboratory is the awkward lifting of centrifuge rotors. Overhead lifting of materials off of shelves and frequent rearrangement of laboratory equipment due to lack of space also lead to a significant amount of back injuries.

CHAPTER II

Protective Measures to Help Eliminate or Reduce Ergonomic Stressors During Routine Laboratory Procedures

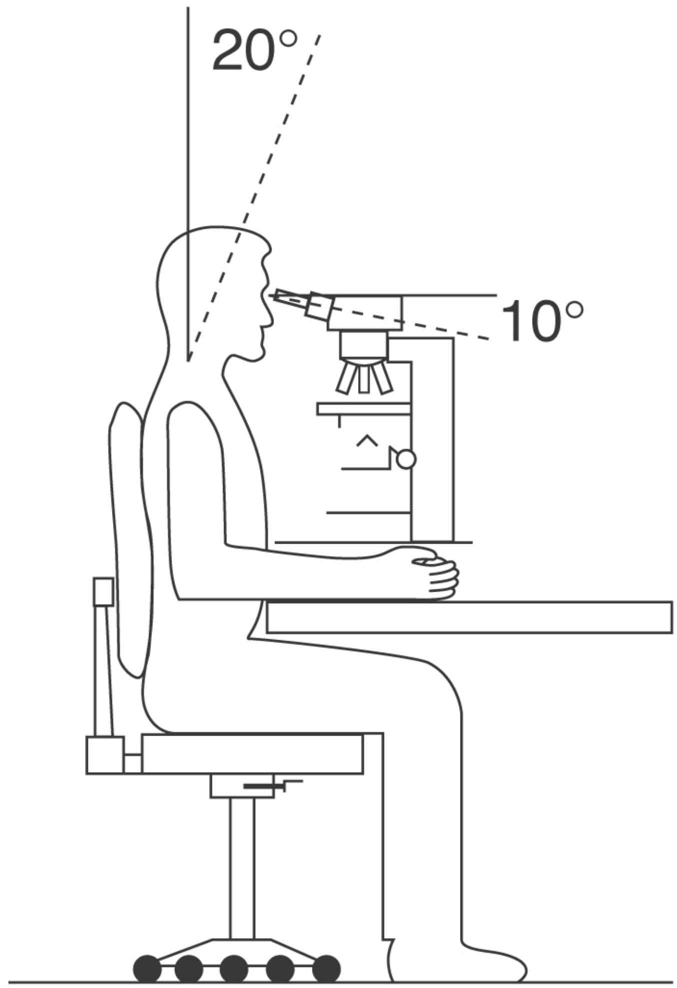
A. PIPETTING

- Purchase an electronic operated or a latch-mode pipetter to replace manual plunger-operated pipettes. Both of these units reduce the need for excessive thumb force and repetition. Electronic pipettors are strongly recommended for highly repetitive tasks.
- Use thin-walled pipette tips that are easy to eject.
- Limit periods of continuous pipetting to 20 minutes or less. Vary activities, or take frequent short breaks (e.g., 2 minutes for every 20 minutes of pipetting).
- Rotate pipetting tasks among several people.
- Work with arms close to the body to reduce strain on shoulders.
- Keep head and shoulders in a neutral position (bent forward no more than 30 degrees)
- Use adjustable chairs or ergo-task stools with built-in solid foot rest.
- Don’t elevate your arm without support for lengthy periods.
- Use low profile waste receptacles for used tips. These should be no higher than the top of the tubes being filled.

B. MICROSCOPY

- Use a fully adjustable ergo-task chair or stool with built-in solid foot rest.
- Adjust the eyepieces and angle of observation to prevent neck strain. Use adjustable microscope stands.
- Use proper sitting posture and positioning.
- Take stretch breaks (see Chapter IV. Laboratory Stretching Exercises) and rotate tasks.
- Use lifters and angled microscope arm supports to relieve fatigue and strain.
- Ensure that sufficient knee and leg space is available.
- Use television systems to eliminate the use of binocular eyepieces when appropriate.

WORKSTATION SET-UP FOR MICROSCOPY

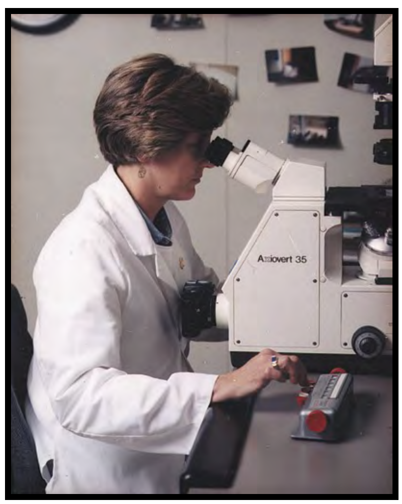


C. MICROTOME WORK

- Purchase an automatic microtome to replace manual unit.
- Reduce force when operating hand wheel.
- Adjust the feed wheel position to reduce stress.
- Use motorize cutting.
- Use an external control unit like a front pedal instead of the hand operated wheel.
- Apply padding to the work surface and the edge of the work surface to eliminate sharp edges and increase the amount of blood flow to the hands.
- Rotate tasks and take frequent short breaks.
- Use a fully adjustable ergo-task chair or stool with built-in solid foot rest.

D. CELL COUNTERS

- Purchase an electronic differential tally counter to replace manual counter. Soft keys permit accurate and fast counting with decreased hand fatigue.
- Reduce the force needed to strike the manual counter.
- Use an edge protector to reduce stress on the forearm and wrist.
- Take frequent short breaks.
- Rotate tasks among several people.
- Use an adjustable chair or ergo-task stool with built-in solid footrest.



E. LABORATORY HOODS/BIOLOGICAL SAFETY CABINETS (BSCs)

- Position materials in laboratory hoods/BSCs as close as possible to avoid extended reaching. Perform work at least 6 inches back into the laboratory hood for safety reasons.
- Use a fully adjustable ergo-task chair or stool with built-in solid footrest.
- Apply foam padding to the front edge of the hood/BSC (away from the downdraft) to reduce contact forces with the forearm and wrists.
- Use an anti-fatigue mat if you will be standing for long periods of time while working in hoods/BSCs.
- Make sure the lights in hoods/BSCs are working properly. Call 1-3311 for replacement of bulbs.
- Use proper sitting posture and positioning.
- Take short breaks to relieve forearm and wrist pressure caused by leaning on the front edge of hoods/BSCs.
- Use an ergonomically designed footrest if you will be working for long periods in a BSC.

F. LABORATORY WORKBENCHES

- Laboratory workbenches are at fixed heights and have been designed using general guidelines suggested by the National Institute of Occupational Safety and Health (NIOSH). These guidelines are as follows:

  Precision Work – Workbench height should be above elbow height.

  Light Work – Workbench height should be just below elbow height.

  Heavy Work – Workbench should be 4-6 inches below elbow height.

Preventive Measures:

- Use a fully adjustable ergo-task chair or stool with built-in solid footrest.
- Use anti-fatigue mats if you will be standing for long periods of time while working at the laboratory workbench.
- Remove drawers, supplies and other materials underneath workbenches to provide leg room
- Use an ergonomically designed footrest if your feet do not rest comfortably on the floor.

G. MICRO-MANIPULATION & FINE MOTOR SKILLS

- Use plastic vials with fewer threads to reduce twisting motions during capping and uncapping lids.
- Use small pieces of foam, similar to the type used on pencils and pens to prevent soreness on the fingertips, where fingers and forceps articulate. This will distribute the force out over a greater surface area, thus reducing the compressive forces on the soft tissue.
- Practice using forceps between the first and second digits instead of the using the thumb and the first digit. Then try alternating between the two positions to reduce the use of the thumb extensors and flexors. The thumb is used repetitively with almost every job task performed in the laboratory (See Chapter VI – Alternative Manipulation of Forceps).
- Tilt storage bins toward the worker to reduce wrist flexion while reaching for supplies.
- Take short breaks and perform hand, wrist and forearm exercises (See Chapter IV – Laboratory Stretching Exercises).

H. CENTRIFUGE ROTORS

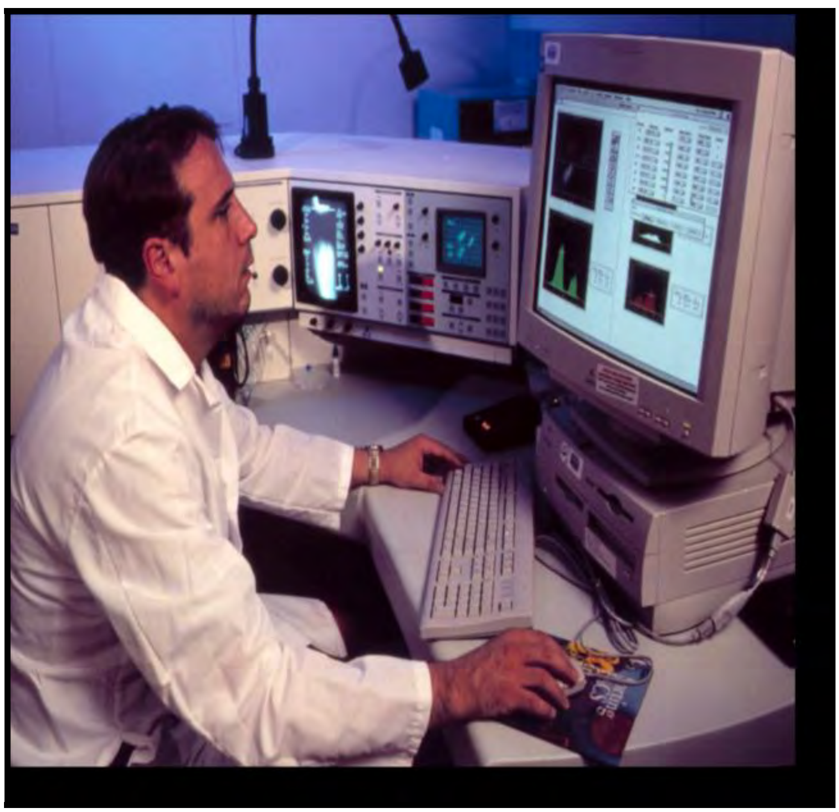
- Use a team approach to removing heavy centrifuge rotors. If the employee is small or not strong enough, use a second person to assist with the lifting task.
- Design a harness, which would wrap around the rotor and attach to straps that would come up out of the centrifuge to the laboratory worker. With a strap on each side of the rotor, two workers could pull out the rotor in the centrifuge. This will reduce low back flexion and decrease the load by one-half.
- Use a laboratory cart to transport the rotor(s).

I. OVERHEAD LIFTING

- Use a footstool or stepladder to reach objects that are stored on shelves. Avoid asymmetric lifting (twisting). The object to be lifted should be directly in front of the worker.
- Store materials that are frequently used on shelving units no higher than shoulder height.
- Store materials as close to the employee as possible or permitted. This reduces excessive reaching for objects.

J. FLOW CYTOMETERS

- Raise the flow cytometer by placing a block between the flow cytometer and the workbench.
- Purchase an electric or hydraulic adjustable table. Each laboratory technician will be able to adjust the flow cytometer to a height which is most comfortable for them.
- Use a fully adjustable ergo-task chair or stool with built-in solid footrest.
- Position the VDT display so the top of the screen is approximately at eye level.



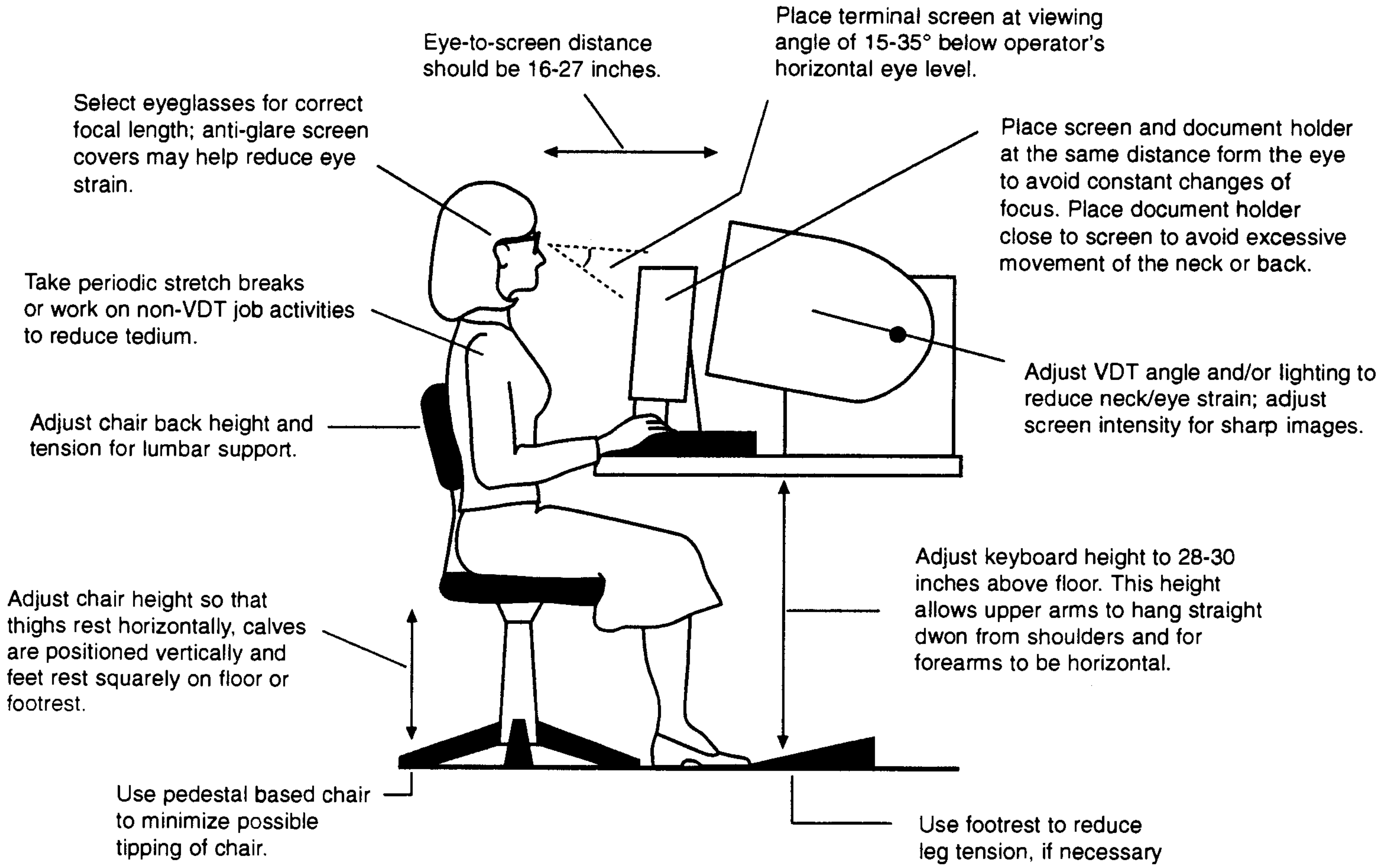
K. GLOVE BOXES

- Move all materials to be used for the experiment from the side chamber to the main chamber at one time to reduce the amount of side reaching.
- Use highly absorbent hand powder for glove comfort.
- Utilize job enlargement to avid long continuous used of glove boxes.
- Provide anti-fatigue mats for extended use of glove boxes.
- Take short breaks to perform stretching exercises (See Chapter IV – Laboratory Stretching Exercises) to relieve static loading from the shoulders. This improves blood circulation to the arms and hands.

L. CRYOSTAT WORK

- Purchase an automatic foot operated cryostat.
- Avoid placing utensils such as forceps inside of the cryostat. Forceps should be placed outside of the cryostat when not being used. This will keep the utensils at room temperature and reduce cold exposure to the hands and fingers.
- Use a fully adjustable ergo-task chair or stool with built-in footrest.
- Apply padding to the edge of the cryostat to reduce contact stresses.
- Take short stretch breaks (See Chapter IV – Laboratory Stretching Exercises).

M. VIDEO DISPLAY TERMINALS (VDTs)



VDTs and Vision

The American Academy of Opthalmology described VDTs as presenting no hazard to vision. VDT exposure does not result in cataracts or any other damage to the eye. According to the National Safety Council, any close work can cause discomfort and stress with time. Occasionally you should:

- stretch
- look away from your work
- get up
- do other tasks to alter work routines throughout the day

VDTs and Radiation

The National Institute of Occupational Safety and Health (NIOSH), the U.S. Army Environmental Hygiene Agency, and others have measured radiation emitted by VDTs. The tests show that levels for all types of radiation are below those allowed in current standards. In fact, some measurements show radiation levels so low that they cannot be distinguished from general environmental radiation (background radiation).

Currently, OSHA has no reliable information that any birth defect has ever resulted from a pregnant woman working at a video display terminal. However, the possible effects of radiation from VDTs on pregnancies continue to concern employees. Therefore, NIOSH and others are currently conducting major studies to thoroughly investigate any potential problems.

CHAPTER III

Helpful Information on How to Select An Ergonomic Chair

Helpful Information on How to Select an Ergonomic Chair

Almost every catalog featuring office and laboratory chairs stresses that their products are "ergonomically" designed. This may or may not be the case. The NIEHS Health and Safety Branch (HSB) has compiled a list of helpful links and recommended vendors below to help you make the right decision in selecting an office/laboratory chair.

The Office Chair Guide
http://www.theofficechairsguide.com/howtoselect.htm

Choosing the Right Ergonomic Chair
http://www.spine-health.com/topics/conserv/chair/chair01.html

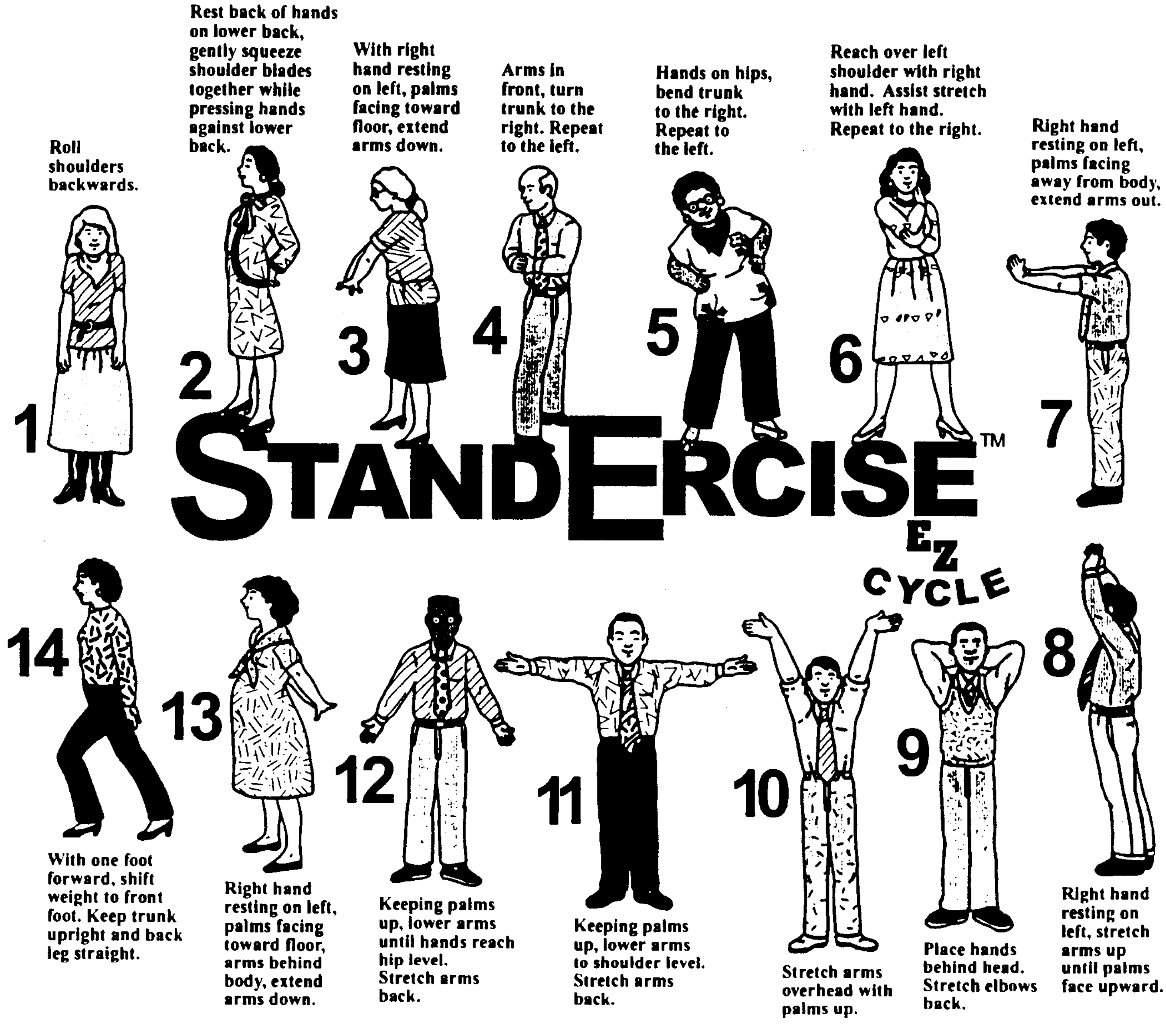
Healthy Computing – Chair Buyer's Guide
http://www.healthycomputing.com/office/buyersguides/chair_buyersguide.htm

Selecting the Correct Ergonomic Chair
http://www.ergostoreonline.com/selecting_ergonomic_chair.html

<u>CHAPTER IV</u>

Laboratory Stretching Exercises

LABORATORY STRETCHING EXERCISES



*Adapted from LivingBody Shop, Inc. in cooperation with NIH. Performing these exercises is voluntary. Studies have shown them to be beneficial when performed consistently and correctly.

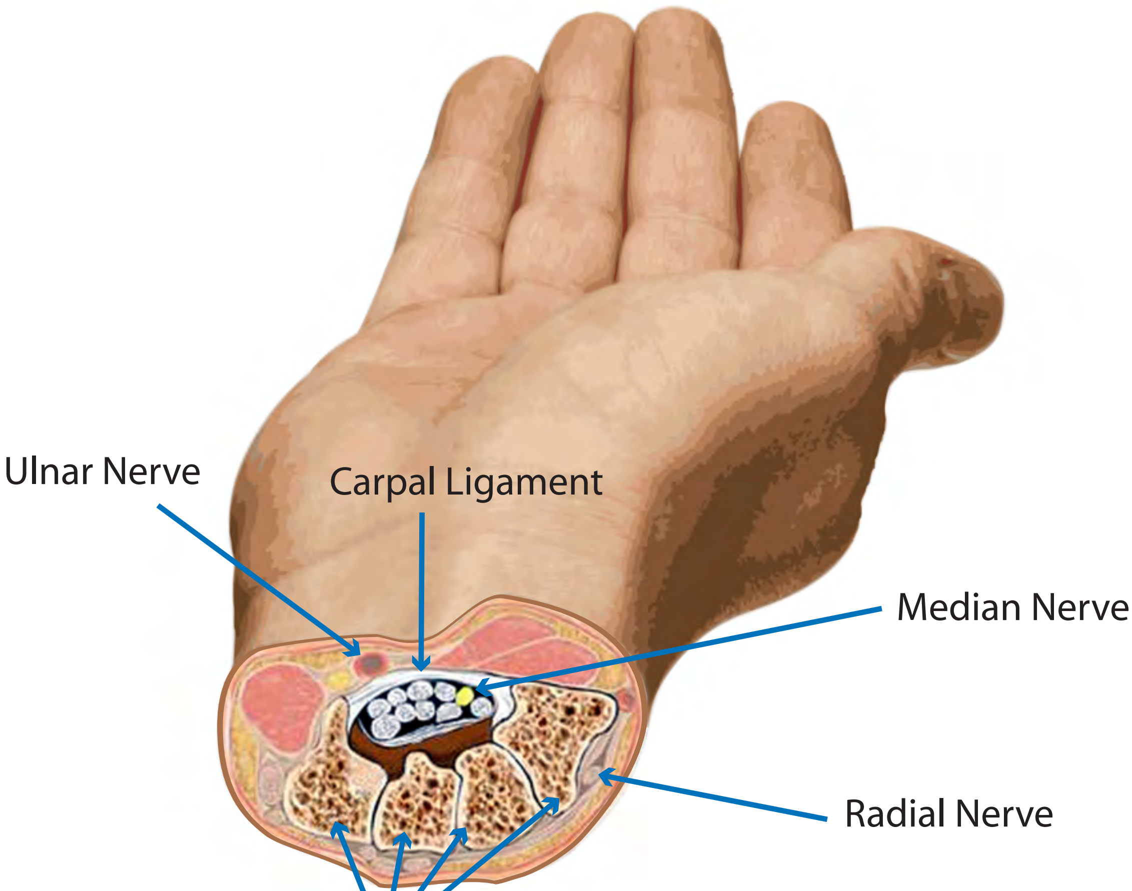
Additional Hand, Wrist and Forearm Exercises:

1) Rotate the wrists in a circular motion.
2) Squeeze the hands into a fist and then release.
3) Relax arms at your sides, internally and externally rotate the forearm.
4) Relax arms at your sides, shake hands to increase blood flow.

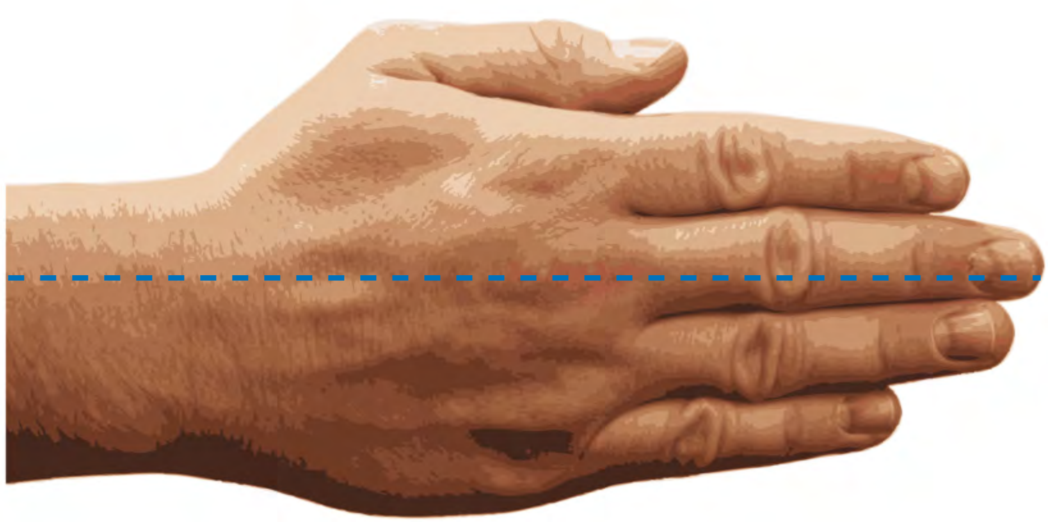
<u>CHAPTER V</u>

Anatomy and Ergonomic Fundamentals of Human Motion

Internal bones and soft tissue of the hand and wrist:

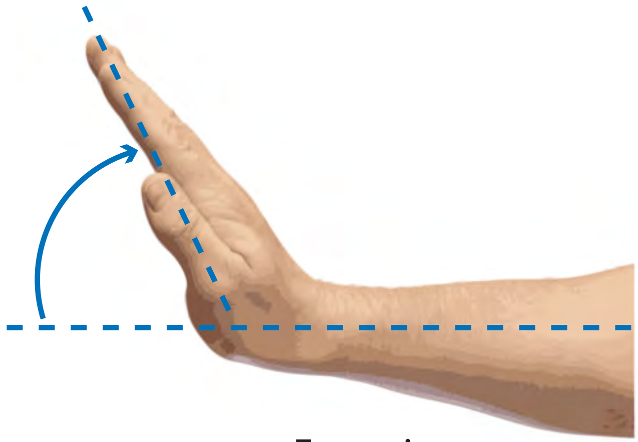


The following position is neutral and should be encouraged:

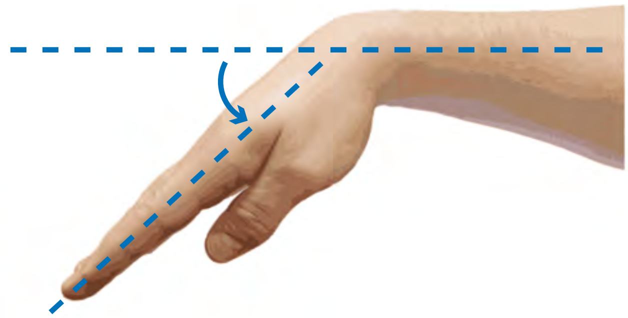


Neutral

Non-neutral positions:

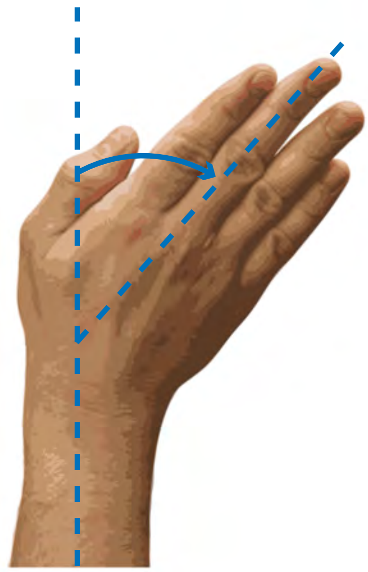


Extension



Flexion

Radial Deviation



Ulnar Deviation

Pronation

Supination

Avoid using a pinch grip:

Don’t

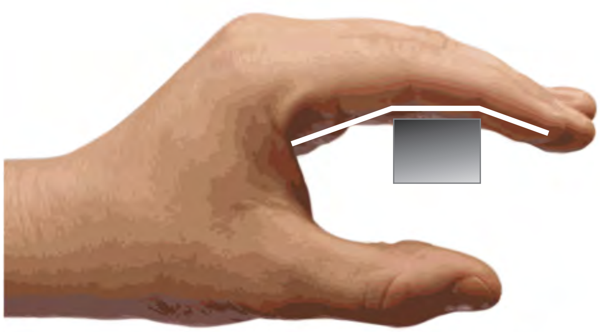
Pinch Grip

Do

Power Grip

Avoid using laboratory instruments with sharp edges:

Don’t



Do

Anatomical movements of the shoulders:
(should be minimized)

Shoulder Flexion

Shoulder Extension

Shoulder Abduction

Shoulder Adduction

Elbow Flexion

Elbow Extension

Avoid working with excessive arm abduction (>30°)

Don’t

Do

Avoid extended reaching and overhead lifting

Don’t

Do

Don’t

Do

CHAPTER VI

Alternative Manipulation of Forceps

Alternative Manipulation of Forceps

Typical method of handling forceps:

Alternative method to reduce thumb micro-trauma:

CHAPTER VII

Laboratory Self-Assessment Checklist

LABORATORY SELF-ASSESSMENT CHECKLIST

DATE: _______________

LABORATORY LOCATION:
____

COMPUTER WORKSTATIONS	Yes	No
1. Is a seat provided?	[ ]	[ ]*
2. Is the seat height adjustable within the recommendations?	[ ]	[ ]*
3. Is lumbar back support provided?	[ ]	[ ]*
4. Is a footrest provided?	[ ]	[ ]*
5. Is there ample leg room?	[ ]	[ ]*
6. Are all adjustability features easy to use?	[ ]	[ ]*
7. Is there ample room to accommodate a keyboard and a computer Mouse so the employee can rest their arms at their side and forearms parallel to the floor?	[ ]	[ ]*
8. Is there ample room to place the monitor at arm length's distance	[ ]	[ ]*
9. Is the monitor at the recommended height?	[ ]	[ ]*
10. If documents are frequently used, is there a document holder?	[ ]	[ ]*

LABORATORY BENCHES

1. If the worker stands, is anti-fatigue matting supplied	[ ]	[ ]*
2. Is the height of the bench appropriate for the work that is performed?	[ ]	[ ]*
3. Is there adequate leg room?	[ ]	[ ]*
4. Do contact stressors exist such as bench tops with sharp edges?	[ ]	[ ]*

LABORATORY CHAIRS

1. Can all laboratory chairs be adjusted to accommodate all the employees who need to use chairs?	[ ]	[ ]*

MICROSCOPES

1. Do the shoulders appear rounded and/or is the worker hunched over?	[ ]*	[ ]
2. Is there excessive neck flexion (>25 degrees)?	[ ]*	[ ]
3. Are there contact stresses between sharp edges and the forearms?	[ ]*	[ ]
4. Is the microscope pulled out to the edge of the workbench?	[ ]	[ ]*
5. Are armrests or padding provided?	[ ]	[ ]*

6. **Is the sufficient leg room? .... [ ] [ ]***
7. **Does the worker rest their feet on the lab stool?.. [ ]* [ ]**
8. **Is there a foot rest provided? .... [ ] [ ]***
9. **Has the individual been trained how to properly sit at a microscope workstation .... [ ] [ ]***
10. **Are microscope work breaks provided? .... [ ] [ ]***

PIPETTING

1. **Are manual pipettors used? .... [ ]* [ ]**
2. **Are electronic pipettors provided?.. [ ] [ ]***
3. **Are latch-mode pipettors provided? .... [ ] [ ]***
4. **Is the pipettor designed to reduce contact with sharp edges? .... [ ] [ ]***
5. **Has the individual been trained how to properly operate the pipettor (e.g., pickup tips, eject tips, program electronic pipettor, etc.) .... [ ] [ ]***
6. **Does the worker pipette more than 2 hours per day? .... [ ]* [ ]**
7. **Are frequent breaks provided?.. [ ] [ ]***
8. **Is the pipettor computer-controlled to allow for computer-activated multiple dispensing instead of finger-activated dispensing?.......................... [ ] [ ]***

FINE MOTOR SKILLS

1. **Are vials with the fewest amounts of threads allowable used?...................... [ ] [ ]***
2. **Does the worker perform dissection or micro-manipulation with forceps more than 5 hours per week? .... [ ]* [ ]**
3. **Are frequent micro breaks provided?... [ ] [ ]***
4. **Do contact stresses exist between the forearm and workbench?.................. [ ]* [ ]**

MICROTOME AND CRYOSTAT

1. **Does the worker use excessive wrist flexion and extension when operating the microtome or cryostat?.. [ ]* [ ]**
2. **Is the workstation at a height that reduces arm abduction as much as possible? .... [ ] [ ]***
3. **Does the worker have access to an automatic microtome/cryostat .... [ ] [ ]***
4. **Are frequent breaks provided?.. [ ] [ ]***
5. **Is a fully adjustable chair provided?... [ ] [ ]***

NOTE: You should follow up on all responses with a "*" beside the box.