

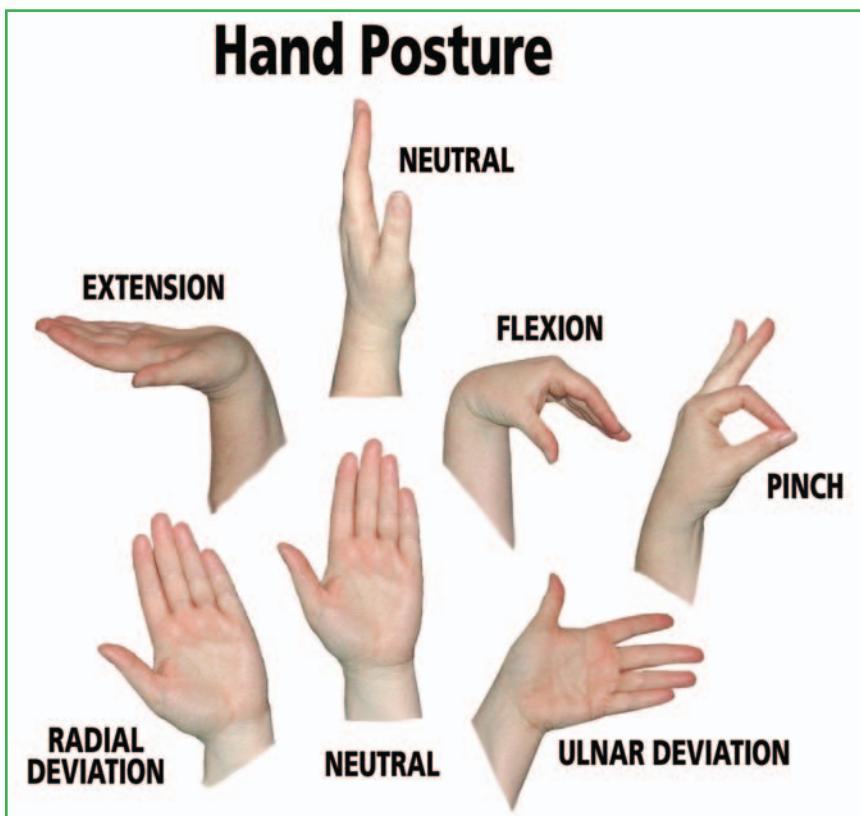
Laboratory Workers Commonly Report Work-Related Musculoskeletal Disorders from the Use of Manual Pipettes

■ Ergonomic Science May Hold the Key to Prevention

by Kevin J. Costello, Certified Ergonomist, The DuPont Company

The pipette is one of the most essential tools in clinical and research laboratories. To develop new drugs and other laboratory-based innovations, or to perform diagnostic tests, quality control, and quality assurance procedures, laboratorians expend tremendous care and effort on examining and testing chemical and biological materials. The process requires transferring precise amounts of liquid and is typically performed manually using pipettes. Researchers and laboratory personnel use pipettes several hours daily and experience fatigue and discomfort in the upper extremities. With time and repetition, muscles, tendons, ligaments, nerves, and blood vessels can be damaged, resulting in injuries known as musculoskeletal disorders or MSDs. The most common of these injuries or disorders reported among laboratory workers include carpal tunnel syndrome (CTS), tendinitis, epicondylitis (tennis elbow), tenosynovitis, trigger finger, cubital tunnel syndrome, tarsal tunnel syndrome, and tension neck syndrome.

The ergonomic risks from pipetting are primarily a result of awkward and static working postures. Lifting the upper arm in front of the body (upper arm flexion) between 45 and 90° is common throughout the pipetting task, and is coupled with frequent lifting of the elbow out to the side of the body (abduction of the arm). The hand and wrist are usually over-rotated and/or bent, considerably diminishing muscle strength. Performing tasks in a fume hood or booth exacerbates the stresses to the shoulder and neck. Additionally, repetitive twisting of the forearm 180° between palm-up and palm-down positions (pronation and supination of the forearm) is common. (See page S-14.)



While it may be complicated to calculate exactly how much is too much when evaluating exposure to ergonomic risks, the obvious contributing factors should be minimized to prevent fatigue, pain, and potential injury. Our bodies are simply stronger, more efficient, and less injury prone when we work within a range of neutral positions and at acceptable levels of repetition, force, and contact stress.

Various US governmental agencies, including NIOSH¹, NIEHS², and the CDC³ have suggested modifying certain laboratory practices as a means for reducing expo-

sure to risk factors when pipetting. Collectively, the recommendations include focus in four key areas.

Minimize Awkward Posture:

- Use shorter pipettes to reduce hand elevations.
- Position elbows as close to the body as possible, with arms and wrists extended in straight, neutral positions (handshake posture, palm slightly down).
- Keep work items within close reach to limit arm extension or twisting the neck and torso.

- Minimize situations and time that arms are in an elevated position.
- Use adjustable chairs or ergonomically designed stools with proper back, thigh, and foot support.
- Use “low-profile” equipment (waste receptacles, solution containers, etc.).

Minimize Force:

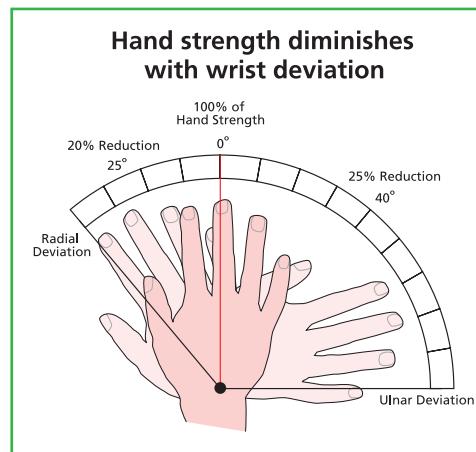
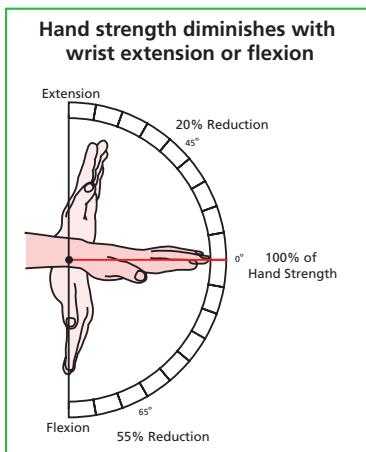
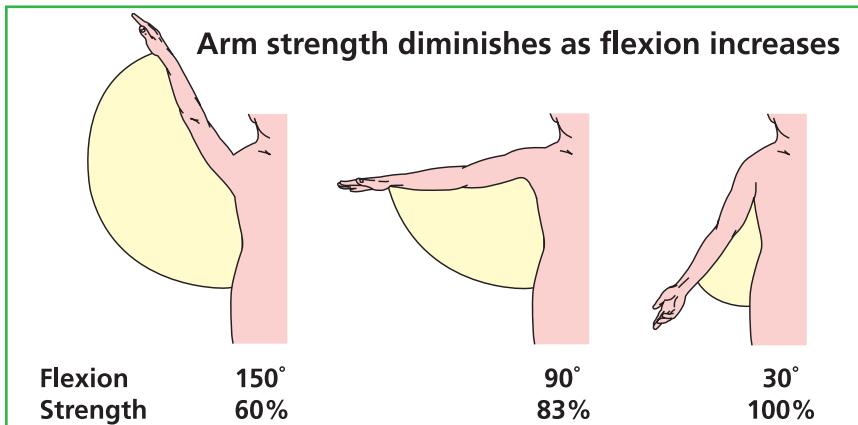
- Select/use pipettes that require less finger or thumb movement and physical effort when aspirating or dispensing fluids.
- Use only the force necessary to perform a task (avoid unnecessary exertion such as jamming on tips).
- Avoid repeated pounding with the base of the palm (common when applying tips).

Minimize Repetition Effects:

- Distribute tasks to minimize the amount of continuous pipetting.
- Share workload between right and left sides of the body.
- Vary tasks among pipettor types where activation motions are different.
- Rotate pipetting tasks among several individuals.

Minimize Contact Stress:

- Select/use pipettors that best fit the user’s hand.
- Select pipettes that use the full hand with a relaxed grip span rather than a tight grip (clenched fist).
- Avoid sharp or hard work surfaces when resting arms or elbows, providing mats or rest pads as appropriate.



Ergonomic experts have made additional recommendations based on a number of studies:

- Wrist rotation should not exceed 90° from the work surface.
- Arm/hand elevation should not exceed 12” from the work surface.
- Hand posture should remain relaxed.
- Limit load levels (muscle activity)

to 15% MVC or below (Maximum Voluntary Contraction [MVC] is the maximum force a muscle can voluntarily generate during a static contraction. For any given task, the higher the %MVC, the greater the risk of fatigue and/or injury.)

- Use pipettes that accommodate variations in user hand sizes.

Definitions

- **Repetition** - the frequency at which a motion or task is duplicated with little variation in movement. For many tasks in the laboratory, such as pipetting, it’s an unfortunate but unavoidable reality. The risk of WMSDs due to repetition is increased when combined with force, contact stress, and awkward postures.
- **Contact Stress** - results from continuous contact between a hard object and sensitive tissues. Force and repetition combine to produce mechanical friction on soft tissue and tendons that is increased when forceful exertion is used, such as a firm grip when holding a pipette. A recommended limit for maximum contact pressure during repetitive work is 26 to 57 psi for males, and 14 psi for females.
- **Force** - the physical effort needed to accomplish a motion or task. Force also refers to the stress or degree of loading placed on muscles and other tissues, such as the additional physical effort that may be needed to perform tasks in an awkward position.
- **Awkward Posture** - positions of the body that deviate significantly from the neutral position while job tasks are performed, thereby increasing muscle load and effort. Examples of awkward posture as it applies to pipetting would include over-rotation and/or bending of the wrist, a clenched hand, or suspension of the arm high over the work surface.

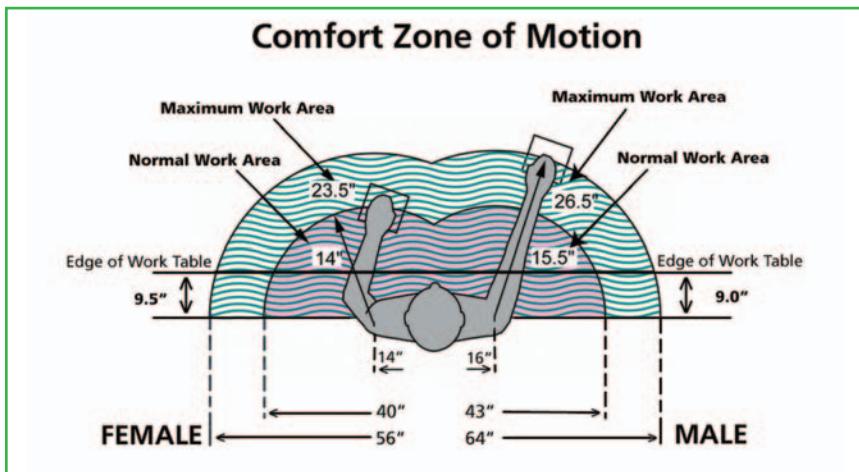
- Use pipettes with improved usability for volume adjustment, grip textures, lab bench storage, character legibility, and minimized contamination.
- Keep work items within close reach to support a comfort zone.

While specific data for laboratory-oriented environments has only been selectively collected and reported to date,

preliminary studies indicate that trends in the laboratory are consistent with industry at large in terms of injury prevalence and costs. U.S. employers are currently paying in excess of \$15 billion per year in workers' compensation costs for work-related musculoskeletal disorders and associated expenses⁴. Of larger concern is the significant cost to employers in

process inefficiency, product quality, and employee productivity. According to a recent yearlong survey of active workers in the United States, lost productive time from common pain conditions costs industry an estimated \$61.2 billion per year. Most pain-related lost productive time occurs while employees are at work, and is in the form of reduced performance⁵.

Research has also shown that for every dollar invested in an ergonomics intervention strategy, there is a return of \$17.80⁴. With education and purchase and use of the right tools for the job, employee health and safety, process efficiency, product quality, and product usability will increase, while dollars spent in lost work time due to pain, surgery, or physical therapy will decrease. To this end it is important for laboratories to develop an overall ergonomic strategy as an integral part of their operating strategy. By applying a greater understanding of how human performance issues contribute to production bottlenecks, quality control problems, injury, and turnover rates, significant ergonomic improvements can be achieved in the laboratory work environment. For those who use pipettes in the course of their work, it's possible to minimize the health and safety issues associated with the task by using products designed specifically to operate with neutral alignments of the upper arm extremities. In all likelihood this will reduce overall musculoskeletal injuries and improve job performance and satisfaction.



Example: The Ovation pipette design (VistaLab Technologies) keeps the entire upper arm in neutral positions, permitting muscles and joints to operate efficiently with minimum effort levels.



References

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2. National Institute of Environmental Health Sciences
3. Office of Health and Safety System of the Centers for Disease Control and Prevention
4. Stewart et al, JAMA 2003;290: 2443-2454
5. Buckle 1999

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