Laboratory ergonomics The wake-up call:

How one company relieved stress and strain on its employees

Julia (not her real name) is a research associate at Immunex Corp. in Seattle, WA. An athletic individual in her mid-20s, Julia was running up to 25 miles a week, lifting weights, and doing aerobic workouts almost daily. Suddenly, she began to experience a constant ache in her right wrist and at the base of her thumb. Her wrist became so sore and painful she had difficulty performing daily tasks such as brushing her teeth and combing her hair. In time, her pain became so severe that she could not operate a pipettor with her right hand. To perform her work in the laboratory, Julia switched to using her left hand. In a matter of weeks, her left wrist and thumb became painful, and she realized the condition was likely related to her work.

Julia's physician diagnosed the ailment as DeQuervain's tendinitis, an inflammation of the tendons that extend the thumb. Julia had worked in laboratories for five years, the last two in an analytical chemistry and formulation laboratory. She had recently begun a new procedure that required prolonged periods of pipetting.

After Julia filed a state workers' compensation claim, a consulting occupational therapist performed an ergonomic evaluation her workstation. The assessment revealed that she was pipetting with a manual pipettor several hours a day. Furthermore, she was pipetting into flasks with a motion requiring repetitious bending of the wrist at an awkward angle. Other daily tasks included data entry into a computer located on a high shelf, which forced her to adopt an awkward position. She also opened and closed many chemical bottles during the course of the day, repeatedly screwing and unscrewing caps and lids. The therapist concluded that Julia's tendinitis was a repetitive strain injury (RSI).

This first reported case of RSI at Immunex was the impetus for a comprehensive, company-wide ergonomic program, which included an emphasis on employees working in the laboratory setting.

Ergonomics-Economics

RSIs, also known as cumulative trauma disorders (CTDs) and musculoskeletal disorders have become something of a workplace epidemic in the 1990s. OSHA has determined that RSIs are the largest single category of injury in the workplace. Workers' compensation claims from RSI represent an estimated $20 billion a year in lost-time compensation costs alone. Total costs are estimated to be $120 billion annually when lost productivity and other indirect costs are considered. As reflected in the case study just presented and other reported injuries, laboratories are not exempt from this increasing trend in RSIs.

What can be done to minimize claims and prevent injuries? First, it is helpful to understand ergonomics and how it can help. The purpose of ergonomics is to find the tools and positions that minimize stress and strain on workers while maintaining productivity. For example, when a technician uses a pipettor attached to a long serological pipette to dispense liquid, she is forced to raise her arm repeatedly above the shoulder. Both the tool and the position can cause stress on the individual.

By definition, many laboratory tasks are repetitive, therefore, good ergonomic practices are especially important in the laboratory setting. All too often, repetitive tasks are performed by researchers in awkward postures and less-than-ideal positions. The application of ergonomic principles and low-cost changes to equipment can reduce RSI injuries and the costs associated with claims.

Developing an ergonomics program at Immunex

In 1997, we decided to institute a laboratory ergonomics program at Immunex. We began with a literature search on the subject. Despite all that has been written under that heading, a limited amount of information specific to the laboratory is available. NIOSH published a report on laboratory settings that included suggestions for changes to minimize the potential for cumulative trauma disorders(1). Research by Bjorksten et al. provides information regarding the "dose" of pipetting with a manual pipettor and the potential for the development of hand and shoulder problems(2). Fredriksson's study assesses the strain that is exerted on the thumb with the use of a manual pipettor(3). Other publications contained information on stress on the thumb during certain activities and the effects of the diameter and shape of an object on the amount of force required to hold it(4,5). Although many of the research

A CASE STUDY

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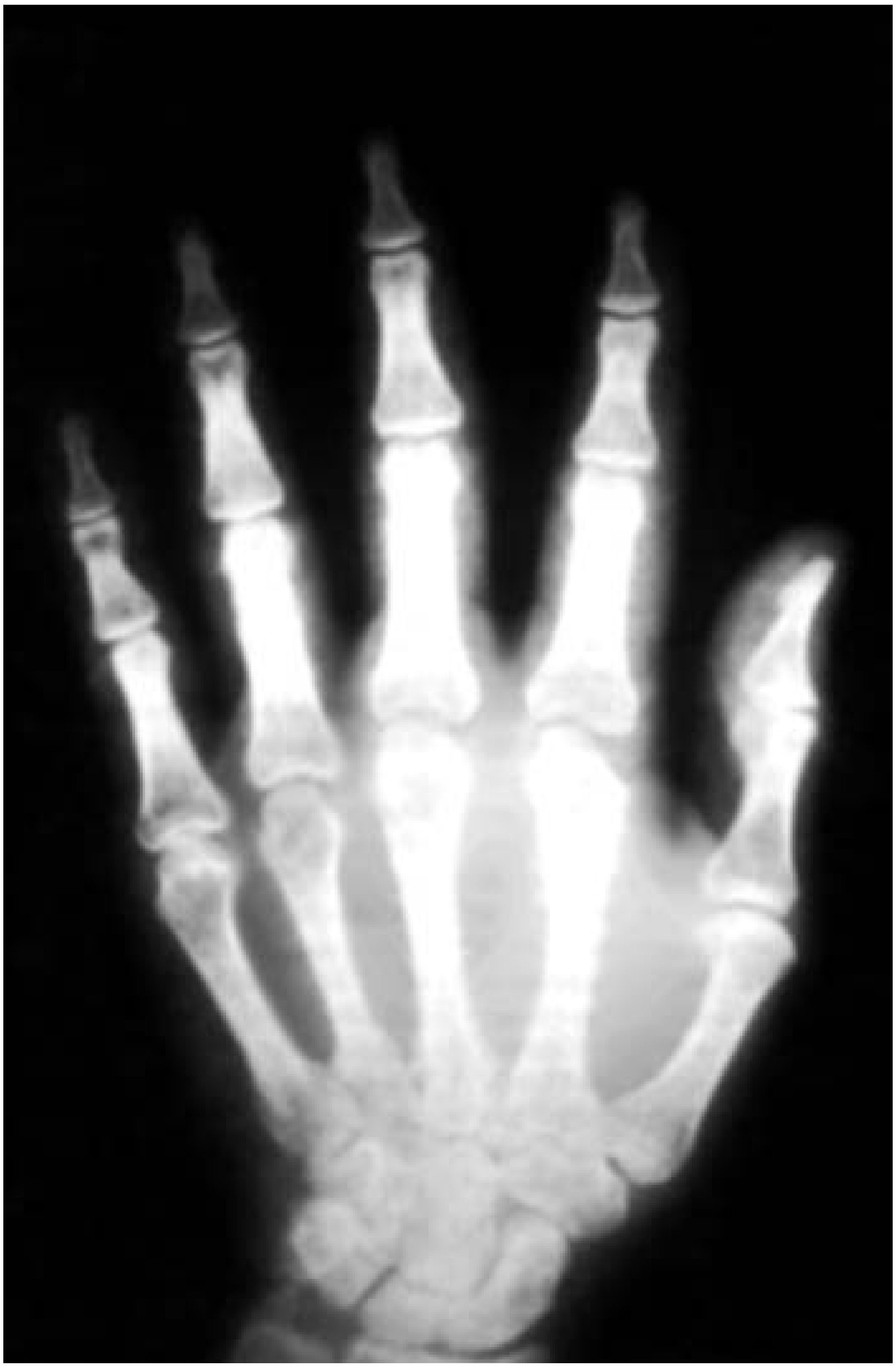


articles were helpful, the most productive source of information for the development of our program came from applying the basic concepts of ergonomics.

The basics

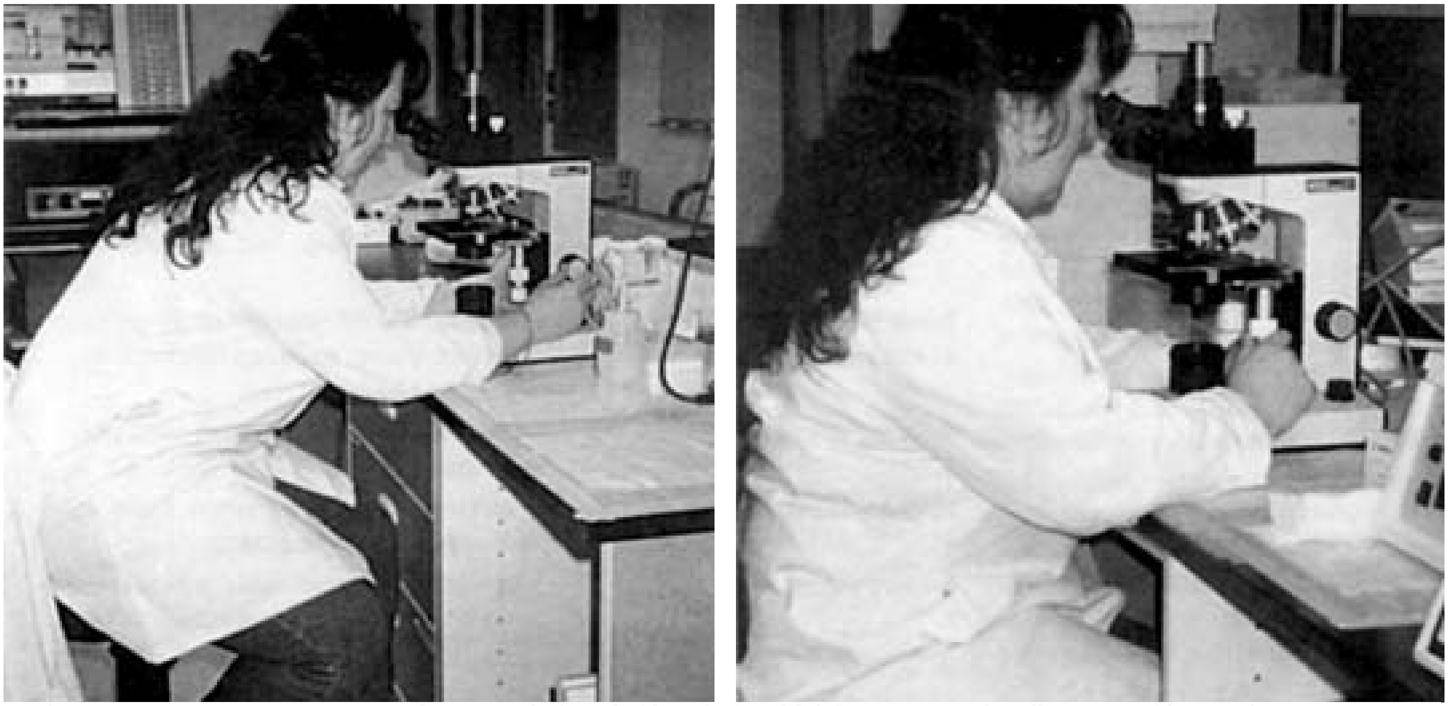
We began by evaluating workstations in the labs and identifying the risk factors associated with common laboratory activities. We spent time observing and interviewing employees who had reported repetitive strain problems and individuals without complaints. The risk factors observed in laboratories were

- contact stress,
- force,
- repetitiveness,
- static loading, and
- vibration.

Using the most common risk factors, we developed an evaluation checklist specific to the laboratory environment. The checklist is a standardized method of evaluating an employee in a variety of work settings such as at the microscope, biological safety cabinet, fume hood, computer terminal, and other instruments and pieces of equipment. The risk factors for each setting were then evaluated and addressed in a consistent manner.

Posture and positioning

The risk factor of poor posture and awkward positioning was the most evident and widespread problem seen. An almost universal observation was that many tasks, such as working at the biosafety hood or the microscope, require the head and arms to beheld in a forward position with shoulders



A lab employee at Immunex uses a microscope before (left) and after (right) an ergonomic adjustment of her work space.

rounded forward. Such a posture can compromise the vascular supply, compress nerves to the arms, and increase muscle stress and strain. This hunched-forward posture is further exaggerated when the feet are placed on the ring-style footrest common to many lab stools.

Reducing the risk factors of poor posture can be achieved by training employees in the concepts of proper posture. Proper posture is the “neutral” position, or the position that requires the least amount of muscle force and allows maximal room for blood flow. We emphasized the importance of proper posture and neutral position during each work-site evaluation. We used in-house seminars, company newsletters, and informational brochures to remind employees to check the following components of proper posture:

- ears over shoulders,
- shoulders in line with hips,
- forearms 90° or more from the upper arms, and
- wrists in a neutral position.

Other solutions to the hunched-forward position

We found that the use of an industrial-height footstool allows technicians to achieve the best possible posture and position. The footstool lets them plant their feet firmly in front of them to give a solid, three-point base of support. This position allows the employee to bend forward at the hips rather than round the neck, back, and shoulders. Most researchers noticed an immediate improvement in comfort with the addition of a footstool. Providing an adjustable lab stool with enhanced lumbar support was also an important improvement. This style of lab stool provides employees working in a forward position (such as at a biosafety cabinet) with needed support during rest periods.

Microscope work is another task that often causes awkward forward posture and positioning. To use a microscope that is positioned too low or too far away, the operator must extend the arms and bend the neck and shoulders. Microscopes are often used by various people during the day; some stand and others sit. To accommodate as many employees as possible, we moved the microscope closer to the edge of the bench for easy control-knob access, raised the microscope, and used commercially available microscope adapters. We also reminded employees to keep the kickspace areas under lab benches clear. Although some microscope or similar instruments were properly located above a kick space, the space was often full of lab supplies or spare equipment. The lack of a space to accommodate feet and legs prevents an employee from getting close to the work surface, which in turn creates awkward posture and position. With kick spaces clear, there is ample room to sit while using the microscope.

Contact stress

Contact stress is caused by frequently putting pressure on a body part that is in contact with a hard surface (e.g., leaning forward on your elbow). We explored aids that would relieve pressure on forearms and elbows resting on hard surfaces. We installed cleanable, removable foam rolls on some benches and biological safety cabinets, padded edge protectors on lab benches, and elbow pads for other applications. In addition, we are currently working with a manufacturer of laboratory stools to design chair armrests that can be placed in a forward position and used at a biological safety hood or laminar flow bench.

Pipetting equals repetition

Pipetting is one of the most common tasks performed in the research laboratory. Many RSIs can be traced to heavy use of a pipettor. In a study of women

Table 1 More ways of addressing risk factors for cumulative trauma disorders

Task	Risk factor	Solution
Labeling small test tubes and vials	Prolonged forceful pinch	Use preprinted computer-generated labels
Opening and closing flasks, jars	Force	Provide various types of jar openers, select tubes with fewer threads
Mixing tubes with a Vortexer	Vibration	Turn down speed, provide an elbow pad, use tight-fitting caps to avoid finger hold, install a Vortexer accessory holder
Cell counting	Palmar base pressure, repetitive forceful movement of fingers	Provide a small wrist rest, purchase a "light touch" manual cell counter, or an electronic cell counter
Standing in place	Prolonged static loading	Provide an antifatigue mat and a sit-stand stool where applicable
Writing lab notebooks	Prolonged forceful pinch, static loading	Provide ergonomic pens and pencils, a read-write desk, and a padded edge protector
Lifting heavy equipment and supplies (e.g., rotors, media)	Awkward posture, muscular exertion	Train in proper lifting techniques,provide an elevated stand or tool where applicable

using a manual pipettor, Bjorksten et al. found that pipetting for more than 300 hours a year increases the risk of hand and shoulder ailments(4). However, it is possible to reduce the risk factors of force, repetitiveness, and static loading associated with the task.

The choice of pipettor, which is highly individual, needs to be considered carefully. Specifically, the characteristics of the employee and the pipettor need to be analyzed, and so do the task requirements. In analyzing the employee, the most important consideration is hand size. A pipettor that is comfortably held by someone with a large hand may be hard to grasp for someone with a smaller hand. The body position needed to operate the equipment must also be considered. A technician with a long forearm may be in a better position than someone with a shorter forearm using the same pipettor.

The weight of the pipettor should be evaluated. The heavier the pipettor, the more force is required to hold it in an operating position. The location of the controls is also important. In many manual pipettors and some electronic ones, the button is located on top of the pipettor, which may require the thumb to be repeatedly extended out of the neutral thumb position. The use of multi- versus one-finger controls helps to distribute the force among several fingers rather than to any one finger. The amount of force required to operate the controls is also a major consideration. Controls with a lighter touch require less muscle and tendon force and therefore reduce the tendency for injury.

The speed of a pipettor and the ease of calibration and programming, although not directly related to ergonomics, are important to the researcher. They have a direct bearing on whether a pipettor is actually used.

Tasks such as mixing or dispensing need to be carefully analyzed. Mixing requires frequent repetitions, and so the use of an electronic pipettor with mixing functions is highly recommended. The use of a pipettor for dispensing should be avoided whenever possible owing to the repetitive nature of dispensing. Furthermore, the reagent container should be equipped with an adjustable volume dispenser to reduce the amount of hand movement required per tube. Other ergonomic applications are shown in Table 1.

Because the selection of a pipettor depends on factors that vary with the individual, we sponsored a laboratory ergonomic product show that featured various manufacturers and distributors of pipettors and accessories. A member of the health and safety department, along with an ergonomic consultant, was on hand to answer employees' questions concerning ergonomic features of the different pipettors.

Case study: A happy ending

Returning to the case of DeQuervain's tendinitis seen in Julia, let us examine the solutions we applied to her situation and the outcome. Observing her position in the lab setting, we found that while pipetting she held her upper arm at a right angle in front of her body because of the height of the workstation countertop. We suggested that she stand to pipette rather than sit or that she move to a lower bench. These solutions allowed her to pipette with her arm closer to her side, which decreased the stress to her shoulder muscles and optimized the blood supply to her arm. We also examined her posture and position while she worked at the computer, where up to three hours a day were spent at the keyboard. The placement of the keyboard caused her elbows to bend at an angle greater than 90 degrees, which can compress the nerve at the elbow. In addition her wrists were bent upward, which would tend to exacerbate the thumb tendinitis and contribute to carpal tunnel syndrome. We recommended that she adjust her stool higher and use a footrest to place her elbows and wrists in a neutral position.

We also recommended the use of a lightweight, finger-controlled electronic pipettor because of the frequent repetitions necessary to her work. A jar-opener tool was given to her to remove the stress from her thumb by allowing her to keep her wrist neutral when opening chemical bottles.

Through hand therapy and on-site training, Julia was taught the basic principles of proper posture and positioning and the importance of taking mini-breaks, rotating tasks to ease repetition, alternating hands for activities, and doing exercises specific to her injuries and work activities.

Today, Julia is symptom-free. She continues her full-time duties, runs marathons and helps her co-workers understand the importance of early prevention through ergonomics.

Ergonomics = Common sense

As we continue to search for solutions to ergonomic problems in the laboratory, we are encouraged by the ergonomic changes that are being engineered into lab equipment. From biosafety cabinets to microscopes and pipettors, manufacturers are including ergonomic principles in the design of new equipment. Purchasing based on quality, price and ergonomic factors will continue to drive manufacturers of these goods toward designing equipment with the user in mind.

Early intervention is critical in preventing RSI. More and more laboratory workers at Immunex are requesting work-site evaluations and asking for information on ergonomics. There is no longer the perception that "nothing can be done about it." Survey results collected after the first year of the ergonomic program showed a significant decrease in RSI symptoms.

OSHA does not yet have an ergonomic standard. But whether ergonomics becomes subject to regulation is not the point. As with other regulations, such as chemical hygiene, radiation safety, and fire codes, ergonomics makes good sense for employee and employer alike.

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