

APPLYING ERGONOMICS FOR INJURY FREE PIPETTING

Ovation BioNatural pipettes overcome ailments associated with older axial devices

Numerous liquid handling procedures rely on the ubiquitous pipette, and pipetting has long been an indispensable laboratory skill. The awkwardness, repetitiveness, stress and tedium inherent in traditional pipetting, however, are all harbingers of cumulative trauma disorders (CTDs) - a major source of pain, discomfort, downtime and lost productivity among numerous pipette users.

CTDs - also referred to as repetitive stress injuries (RSIs) and musculoskeletal disorders (MSDs) - are prevalent in the workplace, and have been designated the leading single class of injury in the 1990s by OSHA. Lost-time and compensation costs alone average some \$20 billion annually, while total costs, which include lost productivity and indirect expenditures, amount to about \$120 billion annually. A single injury can cost more than \$25,000 in medical and indemnity claims.

Laboratory workers are hardly spared. The repetitiveness, non-optimal postures and high forces that are common in traditional pipetting cause user injuries, several far beyond the hand and thumb - contrary to popular intuition. Research organizations and government agencies have documented many risk factors^(1, 2, 3) while noting significant increases in hand and elbow injuries among pipette users.⁽¹⁾ Almost a decade ago, the National Institute of Occupational Safety and Health (NIOSH) declared that a biomechanical hazard was associated with pipetting; in a 1996 report covering laboratory operations, it outlined steps for minimizing CTD risks.⁽⁴⁾

One study on associations between pipetting and CTDs showed that in a sample of technicians, 44%, 58% and 44% reported hand, shoulder and neck problems respectively.⁽⁵⁾ Technicians who did more than 12,000 pipetting repetitions in a day felt acute soreness in their hands. A



Figure 1.

sub-analysis of women pipette users found that pipetting for more than 300 hours a year elevates the risk of hand and shoulder ailments. With laboratory workers averaging about 500 hours of pipetting a year (some 2 hours a day) the severity of the problem is clear.

What Ails Pipetting

While the long hours of repetitive motion link pipetting and CTDs, the ergonomic deficiencies of many existing pipettes contribute significantly to the problem. Traditional axial-style pipettes, a 40-year vintage, are built around a single axis of operation. These pipettes are accurate, durable and quite common, and users generally find them adequate. But their design did not to keep pace with the strides in ergonomics. As a result, they fail to shield users from cumulative injuries linked to long sessions of awkward repetitive motion.

To overcome this, VistaLab Technologies, radically updated the concept of pipetting

with the introduction of the Ovation BioNatural Pipette. Early on, the company's market research and customer feedback showed that customers were concerned about ergonomics. Users were also reporting difficulties with installing pipette tips reliably, getting them to stay on, and with removing them. Less worrisome were the actual aspirating and dispensing of fluids.

VistaLab assembled a team to examine how comfortably and for how long someone could operate one of the devices. The goal was to discover how to raise the comfort level and reduce stress for pipette users currently and mitigate injury in the long term - then turn that into an ergonomic pipette design.

In Search of Respite

VistaLab Technologies' project team started out by observing and interviewing numerous pipette users. One team member, Kevin Costello, President, US Ergonomics, and a 20-year veteran in the field, says, "Our preparatory discussions focused on the thumb and the force needed to acquire and remove tips as the problem areas. Then we went out and saw pipette users holding these long tubes in their hands with their elbows high up in the air.

"We were appalled at the positioning of the shoulder and neck and the static loading - muscles under load with a minimal amount of motion - which created high potential for fatigue in those muscles."

Based on those observations, the team designed a pipette to enable technicians to work in a neutral position - a natural ergonomic posture in which the relaxed arms, with the palms facing each other at about a 45-degree angle, are held in front of the chest area. This allows pipette users to work in a semicircular area right in front of their bodies. (Figure 1)

"The idea was to have the pipette users hold their arms closer to their sides. We looked at the angle between the elbow, shoulder and hip. It was important to keep the upper arm close to the body, minimizing



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abduction, which is the lifting of the elbow away from the body. That in turn minimizes the torque on the shoulder, the static muscle loading, and the neck and shoulder stress associated with the pipette,” says Costello.

Other key design challenges revolved around the incorporation of features that minimized the hand forces required for tip application and removal, within a light, well-balanced pipette.

Birth of the Ovation BioNatural

The team soon realized that a radical overhaul of the basic pipette design was needed.

This led to a device that had an angled design for getting tips into and out of target points. The design also stored the energy used to apply the tips in a spring for later use to remove the tip - a spring-loaded tip ejection system.

“Storing the energy from tip application for use in tip ejection eliminates the second hardest part for the hand and is really beneficial. The angle of the device and the fact that the arm can be held at the side are other major ergonomic advantages,” says Costello.

A small clicking sound lets the user know when the tip has been securely applied or removed. “The fact that the device provides some feedback when the tips are applied is valuable. This eliminates pounding and the use of additional force,” says Costello.

The Ovation uses the power grip, which increases the available hand strength by about four times compared with the pinch grip used with traditional pipettes. The power grip is loose and relaxed, making for greater endurance and enhanced productivity. Its contoured shape allows for the greatest stability and low pressure from contact with the hand. A rounded plunger and tip ejection button, both with reduced forces,

help to keep contact stresses at their lowest.

Introduced commercially in 2002 with an adjustable volume model, the ergonomic features of the Ovation BioNatural have received considerable attention. The product line has been expanded recently to include electronic multichannel and single channel models, all of which maintain the ergonomic design and other user preferred features. Of specific note is the unique tip head on the Ovation Multichannel, which significantly lowers the force needed to acquire multiple tips simultaneously and allows the use of both hands, thus reducing stress to any specific muscle group. (Figure 2)

The Ovation has been independently evaluated quite favorably and is now being used by thousands of researchers and scientists on a daily basis.

Independent Assessments of Ovation

Extensive testing by Ergonomics Technologies Corporation has shown the Ovation to be the only commercial pipette with levels of arm flexion and extension, wrist flexion and maximum muscle activity below the recommended limits.⁽⁶⁾ It is the only pipette that allows the forearm to operate in the pronated position, which generates a markedly lower level of carpal tunnel pressure.⁽⁷⁾

NIOSH Study

A 2004 NIOSH study, which was a part of the National Occupational Research Agenda (NORA), compared the Ovation and two axial pipettes. A battery of ergonomic measurements were collected and assessed.⁽⁸⁾

Finger forces were measured via 19 sensors strategically placed in special



Figure 2.

gloves. Wrist posture and forearm rotation were measured with a twin axis goniometer. Shoulder elevation was measured with video task analysis software. All the measurements were done during the major four pipetting steps: tip acquisition; aspiration; over blow and tip ejection.

Finger forces required by Ovation were some five times lower than those required for the axial pipettes. (Figure 3) This translates to greater comfort, less fatigue and lower CTD risk. In a sub-analysis of the hand forces data, significantly lower thumb force requirements were associated with Ovation versus the traditional pipettes.

The analysis also showed that wrist deviation was significantly lower with the Ovation while picking up the pipette, acquiring tips and during aspiration versus the other pipettes. (Figure 4) The values for wrist extension and flexion were lower for Ovation versus the comparators in all cases. In an analysis of the percentage of time that the shoulder is awkwardly elevated at more than 45 degrees, Ovation proved to be lowest in all cases. (Figure 5)

Comparative Analysis - United States Ergonomics

United States Ergonomics conducted comparative tests with the Ovation and other pipettes and analyzed the data for performance levels.

US Ergonomics President, Kevin Costello notes, “The Ovation device had statistically significantly lower effort levels associated with tipping and de-tipping and significantly improved posture compared with the traditional pipettes.

“For these tests, we connected electrodes to the key muscles involved in the effort - forearms, upper arms, shoulder muscles,

and the neck - we also had sensors that measured dynamic posture of the body as the device was used.

“Subjects did not know what device was being tested. We tested the Ovation pipette next to several traditional style pipettes to quantify the amount of effort needed to use them. In simple terms, the lower the effort, the lower the stress, the lower the risk of injury and inversely, the higher the productivity. Productivity is the amount of effort required to do a task.

“You won't affect repetition, that will

always be there, but you can knock down the force and improve posture. You can expect people using a device that has reduced magnitude of exposure in those areas to work longer with a lower degree of risk for any aches, pains, discomfort or injury.

“This means that there is a good chance that someone who found pipetting painful, depending on their specific injuries, will be able to use the Ovation because this device requires different muscle groups - and they will be using a lower percentage of overall effort to get the job done.

Duke University Study

The Duke University Department of Ergonomics evaluated 61 workers' pipetting experiences via an extensive questionnaire that covered work habits, location, severity and frequency of discomfort.⁽⁹⁾

Substantial discomfort was reported (Figure 6), with areas of highest frequency being: neck (56%), lower back, right shoulder (33%), right wrist (26%) and right hand (25%). The thumb, most intuitively associated with pipetting, was the sixth in discomfort frequency.

One half of the study participants were provided with Ovation pipettes, which they used in their normal lab work, as part of a six-week trial. They had no prior knowledge of the Ovation, and at the end of the six weeks they were asked to compare the pipette they used previously to the Ovation.

There was overwhelming preference for Ovation because it offered greater comfort. There was strong preference for the Ovation on questions of accuracy and general use throughout the workday.

Chris Marchand, Research Associate, Contractor, National Institutes of Health

• Acquired Ovation pipettes for technical features

"I have used the Ovation pipette almost one year now for a high throughput-screening project with 96 well plates to test thousands of compounds. We have been working with the single channel Ovation since they were launched and liked them a lot.

"So we decided to try the multichannel ones. Now we have two 8-channel and two 12-channel Ovation pipettes, which we can use by columns or by rows with the 96 well plates. We appreciate the tips because of their quality and precision.

"We were aware of the ergonomic

Figure 3.

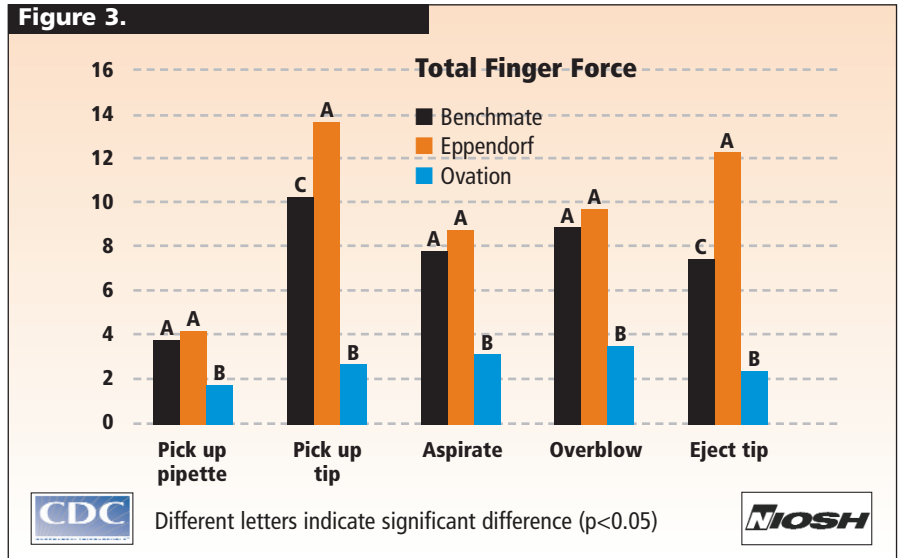
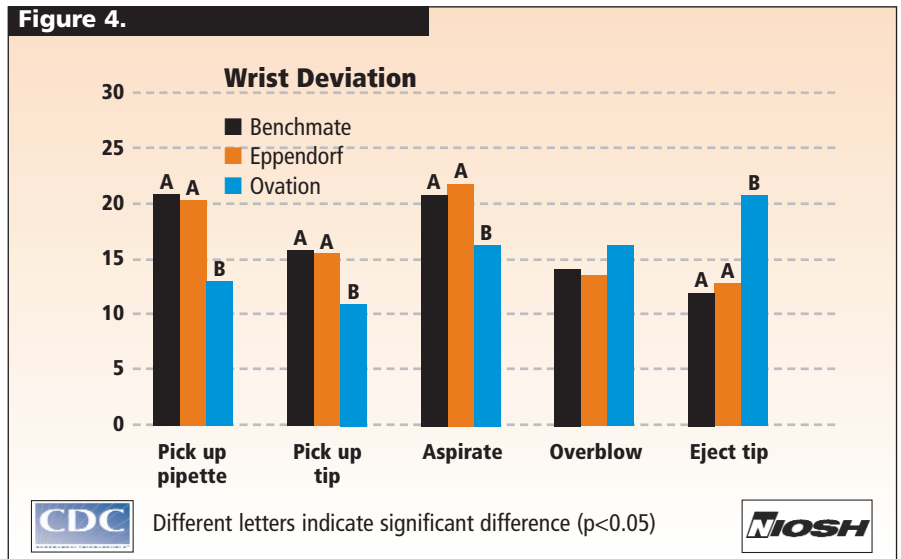


Figure 4.



improvements in the Ovation pipettes - and we believe they are much easier to use in the long run - this aspect attracted us to them but it was hardly the overriding

reason for us.

"We wanted something that was reliable, precise and easy to use, particularly the ease with which one can eject the tips.

ERGO 101

A common misconception about ergonomics is that once there is no heavy lifting, there are no ergonomic issues.

Ergonomics is concerned with several risk factor categories: posture, force, repetition levels, vibration (whole body or head and arm vibration, really not an issue with pipetting), environmental factors (temperature, lighting, noise, etc.), physical contact stress (contact between the body and an object - in the case of pipetting, how the device fits in the hand and whether there are edges digging into the skin) and personal risk factors (related to

individual awareness to control exposure; overall health; and in cases where predisposition issues arise based on the use of medications that can increase risk).

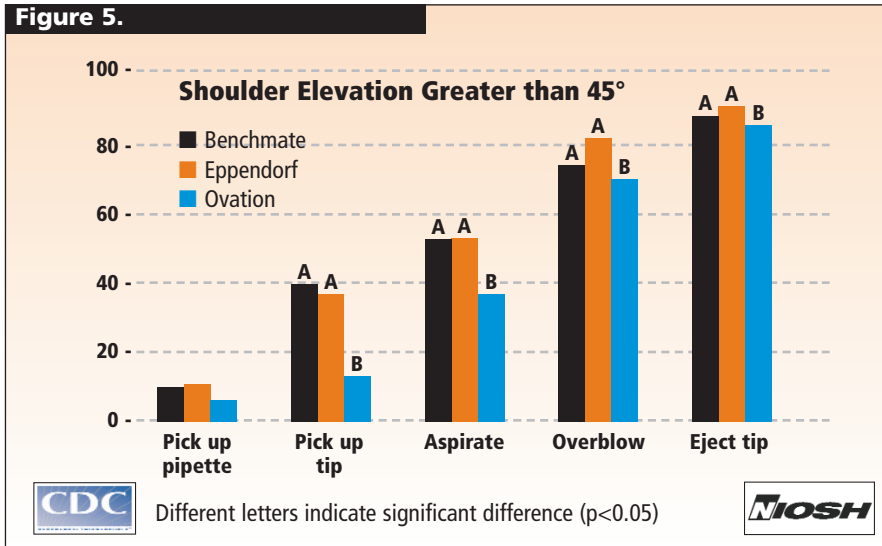
If the force level is above threshold, the likelihood of it producing an ergonomically related injury can increase significantly. But if categories are combined, such as force and repetition, the likelihood of a CTD can increase exponentially.

So even if repetition cannot be eliminated - in fact, aside from automation, repetition really cannot be eliminated from pipetting -

force, contact stress, postures, and user education can be greatly improved. This will have a major positive effect at reducing exposure and the risk.

"Ergonomic issues are cumulative. These injuries build over time. You have to minimize known risks. Pipette users who do not have pain now, who are slamming on tips and have their arms elevated might be fine now, but if they continue for any length of time, or if the work demands increase, they could see a negative effect because of the risk factors," says U.S. Ergonomics' Kevin Costello.

Figure 5.



work with the Ovation, I could last as much as four times longer than regular pipettes.

"I work through the pain and the numbness - but the Ovation definitely decreases the amount of pain I experience.

"There are a number of great features on the Ovation. It is lighter, but what I like most is the different positioning of the hand, which is what I went out looking for.

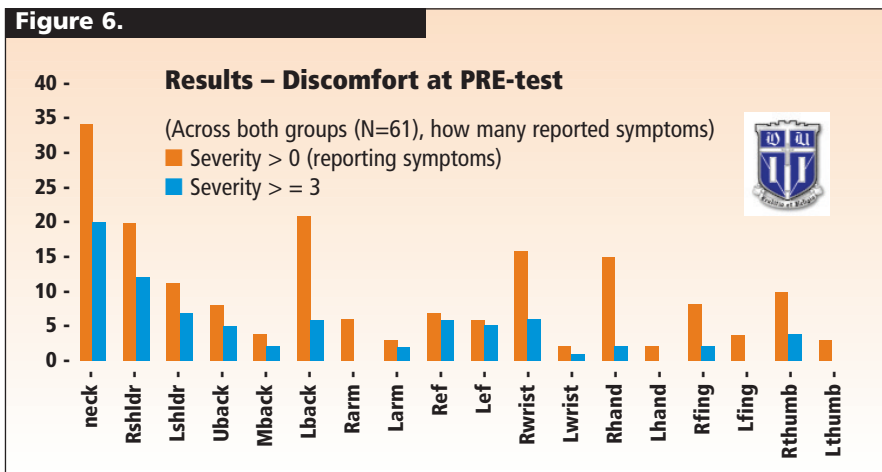
"I hold it differently but instead of using my thumb, I am using my fingers. I was looking for a pipette that will allow me to do that in a different position and this is the only one that I found. All I have been finding were pipettes with the thumbs - granted this one still requires the thumb but it is a different position of the hand.

"I literally sat for ten minutes at each of the different vendor's displays at a trade show and tried all their pipettes, and Ovation was the only one that I took home."

Author Michael Wagner writes on a wide range of topics in the life sciences.

Additional information about the Ovation BioNatural Pipette can be obtained at www.vistalab.com, or by contacting VistaLab Technologies at (888) 652-6520 or (914) 244-6226.

Figure 6.



Gabe Guzman, Post-doctoral Fellow, CIIT, North Carolina

• Driven by curiosity for ergonomics

"I have used the Ovation for a little bit over a year and can't see myself going back to using traditional pipettes anymore. Traditional pipetting feels really awkward now because of the vertical position.

"The Ovation was the first time I saw anything ergonomically designed for pipetting. Normally, you hear about ergonomics having to do with the right posture when you are in your station or sitting at your workbench. It is not often that you see it linked to dexterity, that is, to use with your hands and for repetitive action such as pipetting.

"While I have never had any trouble with my fingers, elbow etc., I could feel tiredness in my neck and shoulders whenever I had to pipette a lot in the vertical position. Because of the design of the hood, your wrist would be higher than your shoulder. With the Ovation that is not a problem anymore, my wrist is always lower than my shoulder - my

shoulders are not as tired now.

"The versatility of this pipette is its best point - softer to use, more secure, the tips don't actually fall off the sleeve of the pipette, there's no risk of actually breaking the tip, which sometimes happens because of the pushing action required with the traditional pipette when picking up a tip, especially if you push too hard.

Francis Weis-Garcia, Manager of the Monoclonal Antibody Core Facility, Memorial Sloan Kettering

• Pipette user with carpal tunnel syndrome

"I have only used Ovation for a month or so but I am going to buy them. Basically I can't pipette regularly for more than five minutes before I start getting severe symptoms of carpal tunnel syndrome - pain, numbness etc.

"With the Ovation, I could go easily for about 10 to 20 minutes. It is not a complete relief but it increases the duration I could work without experiencing the stress. When I

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- A comparison of traditional and alternative pipettes - comfort and preference - Presentation by Tamara James, MS, CPE, Ergonomics Director, Duke University and Medical Center.