UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW HAMPSHIRE

Kathleen Muzerall

v. Civil No. 97-C-102-B

International Business Machines Corp.;
Memorex-Telex;
and Honeywell, Inc.,

MEMORANDUM AND ORDER

Kathleen Muzerall claims that she suffered serious hand, wrist, and arm injuries after using computer keyboards manufactured by International Business Machines Corporation, Memorex-Telex, and Honeywell, Inc. She has sued all three companies claiming that they defectively designed their keyboards and failed to adequately warn of the hazards associated with keyboard use.

Muzerall intends to rely on expert testimony provided by Dr. Laura Punnett, an epidemiologist and ergonomist, to prove that uninterrupted keyboard use for prolonged periods and improper posture while keyboarding can cause the types of injuries from which she suffers. Defendants have moved to exclude her testimony on the ground that it is not sufficiently reliable to satisfy the requirements of Fed. R. Evid. 702. Anticipating success on their motion in limine, defendants have also moved for summary judgment, arguing that Muzerall cannot prove that her

injuries were caused by keyboard use. Because I am unpersuaded by defendants' arguments, I deny their motions.

I.

A. Muzerall's Work and Medical History

Muzerall worked as an accounts payable clerk/administrator for Polymer Technology from March 1988 until August 1992. At some point after she started the job at Polymer, the company purchased an IBM AS/400 mainframe computer and IBM terminals. Muzerall was responsible for entering data into the new system, sometimes spending each day typing in batches of 20 invoices every half-hour.

Muzerall began working at Fireye Technology in August 1993, again as an accounts payable clerk/administrator. At Fireye, Muzerall used a Memorex-Telex keyboard manufactured by Honeywell to access an IBM AS/400 mainframe computer. She spent her entire day, except for a one-hour lunch break, entering invoice data into the computer through that keyboard.

In March 1994, Muzerall began experiencing pain, tingling, and numbness in her hands and wrists. Her physician initially diagnosed tendinitis.[1] After conservative treatment failed to

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[1] Tendinitis is the inflammation of a tendon, which is a "fibrous cord or band that connects a muscle with its bony attachment or other structure." Stedman's Medical Dictionary

alleviate her pain, Muzerall went to an orthopaedic surgeon, Dr. Steven Brown, who diagnosed both tendinitis and early medial epicondylitis.[2]

Dr. Brown performed surgery on Muzerall's left wrist in August 1994. He performed a second operation on the same wrist the following October, scraping the ulna bone to prevent its impact with the lunate bone. Muzerall returned to work part-time, but was eventually counseled by her doctors to leave her job altogether.

In April 1995, Dr. Brown performed an arthroscopy and total synovectomy[3] to Muzerall's right wrist. A test of Muzerall's blood at that time ruled out rheumatoid arthritis as a source of her pain. Because pain and swelling continued after the procedures, Muzerall sought the advice of another doctor in May 1995. Dr. Craig Stirrat recommended another ulna-shortening procedure for the right wrist. Dr. Mark Belsky performed an

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1769 (26th ed. 1995).

[2] Epicondylitis is the inflamation of an epicondyle, which is a projection from a long bone near the extremity joint. See Stedman's Medical Dictionary 582.

[3] A synovectomy is the excision of the synovial membrane of a joint. See Stedman's Medical Dictionary 1746. The synovial membrane is the connective tissue that lines the joint and produces synovial fluid, a lubricant in a joint or tendon sheath. See id. at 665, 1085-86.

osteotomy[4] of the left wrist in February 1996 and a fifth surgery in August to remove hardware left from the previous operation. Subsequently, Dr. Belsky recommended yet another surgery to Muzerall's right wrist. At that point, Muzerall sought a second opinion from Dr. Kenneth O'Neil, who concurred and performed a tenosynovectomy[5] and reconstruction of the tendon sheath in the right wrist in July 1997.

Muzerall claims that her injuries[6] were caused by the defendants' failure to warn her about the importance of proper posture while keyboarding, taking frequent breaks, and the dangers of repetitive computer work.

B. Muzerall's Expert Witness

To succeed with her claim that her injuries were caused by defendants' failure to warn her of the hazards associated with keyboard use, Muzerall must first prove "general" causation.

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[4] An osteotomy is the cutting of bone. See Stedman's Medical Dictionary 1271.

[5] A tenosynovectomy is the excision of a tendon sheath. See Stedman's Medical Dictionary 1771.

[6] Muzerall suffers from synovitis, tenosynovitis and tendinitis, chondromalacia, ulnar impaction syndrome, and injury to the triangular fibrocartilage complex ("TFCC"). See Tr. at I:5.13-16; I:5.25; I:7.8-10. Synovitis is the inflammation of a synovial membrane, especially of a joint. See Stedman's Medical Dictionary 1746. Tenosynovitis is the inflamation of a tendon and its enveloping sheath. See id. at 1771.

That is, she must prove that defendants' allegedly wrongful conduct is capable of causing the types of injuries she claims she sustained.[7] Muzerall relies on expert testimony provided by Dr. Laura Punnett to satisfy her burden of proof on this issue.

Dr. Punnett is an epidemiologist and ergonomist who has studied computer-related musculoskeletal disorders. She received both a master's degree and a doctorate from the Harvard School of Public Health. She conducted post-doctoral research at the Center for Ergonomics at the University of Michigan and has provided epidemiological consulting services to a number of corporations and organizations. She has previously testified in other trials dealing with claimed injuries similar to those suffered by Muzerall. See Schneck v. IBM, 1996 WL 885789, *16 (D.N.J.) ("the studies relied upon by Dr. Punnett are of the type reasonably relied on by experts in the field to render a conclusion with respect to general causation"); Vice v. Northern Telecom, Inc., 1996 WL 200281, *9 (E.D. La.) ("the proposed testimony of Dr. Punnett is sufficiently reliable to be admissible . . . the shortcomings complained of by NTI go to the

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[7] Muzerall also plans to rely on testimony from Dr. Punnett and several other experts to prove specific causation - that her injuries were, in fact, caused by defendants' wrongful conduct. This order addresses only Dr. Punnett's testimony on the issue of general causation.

weight to which the testimony is entitled"). If she is permitted to testify at trial, Dr. Punnett will claim that prolonged, uninterrupted keyboard use is causally associated with several conditions of the hand and wrist including tendinitis, synovitis, tenosynovitis, chondromalacia, ulnar impaction syndrome, and injury to the triangular fibrocartilage complex ("TFCC"). She will also assert that the risk of injury is significantly enhanced if proper posture is not maintained during keyboard use.

Dr. Punnett bases her general causation opinion primarily on a 1997 peer-reviewed article which she co-authored with Dr. Ulf Bergquist.[8] In the article's executive summary, Punnett and Bergquist conclude that

> Some general conclusions regarding VDU work and musculoskeletal disorders emerge from this review. These conclusions are supported both by studies of questionnaire-reported symptoms and studies utilizing objective findings from physical examinations or diagnoses. For disorders of the hand and wrist, we found evidence that the use of the VDU [video display unit] or the keyboard was a direct causative agent, mediated primarily through repetitive finger motion and sustained muscle loading across the forearm

[8] Dr. Punnett initially formed her opinion that keyboard use can cause injuries of the types claimed by Muzerall after preparing a literature review of approximately 20 epidemiological studies in 1993 for an attorney representing another plaintiff with similar claims. The 1997 article is an outgrowth of the 1993 literature review.

> and wrist. The odds for such disorders among VDU users with at least 4 hours of keyboard work per day appear to be about twice that of those with little or no keyboard work.
> . . .
> Although not all specific factors have been adequately studied, either singly or in combination with each other, there is convincing evidence regarding some. Strong evidence exists for elevated risks of upper extremity disorders with data entry, and similar intensive keying tasks, and for hand and wrist disorders, at least, with hours of keying per day. High work demand and postural stress resulting from poor work-station design and layout also increase the risk of upper extremity disorders. Thus, there is - in our opinion - a scientific basis that justifies ergonomic and work organization interventions to improve work situations characterized by these conditions.

Laura Punnett & Ulf Bergquist, Visual Display Unit Work and Upper Musculoskeletal Disorders, (National Institute for Working Life - Ergonomic Expert Committee Document No. 1, 1997:16) (hereinafter "Punnett & Bergquist").

Although Dr. Punnett relied on more than 50 epidemiological studies in the 1997 article, she focused on three studies in particular when testifying in this case. She first cited a 1989 National Institute for Occupational Health and Safety ("NIOSH") study of employees who regularly used video display terminals ("VDTs") while working at the Los Angeles Times. The study's

first phase was a cross-sectional[9] analysis using the results of self-administered questionnaires. A person was classified as suffering from a musculoskeletal disorder of the hand or wrist ("hand/wrist MSD") in this phase of the study if she reported that

> symptoms (pain, numbness, tingling, itching, stiffness, or burning) in the affected period occurred within the preceding year and all of the following apply: 1) No previous accident or sudden injury that was not work-related (such as dislocation, sports injury, fracture, or tendon tear); 2) symptoms began after starting the current job; (3) symptoms lasted for more than one week or occurred at least once a month within the past year; 4) symptoms were reported as "moderate" (the midpoint) or worse on a five-point scale intensity scale [sic]. All those participants who were not excluded because of previous injury and not fulfilling the case definition were considered non-cases for the analysis of Phase I.

Defs.' Ex. S5, NIOSH Health Hazard Evaluation Report, Los Angeles Times at 11 (hereinafter "Los Angeles Times Study"). In Phase II, the investigators attempted to validate the case definition of hand/wrist MSD used in Phase I by subjecting a randomly

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[9] A cross-sectional study is

> A study that examines the relationship between the diseases (or other health-related characteristics) and other variables of interest as they exist in a defined population at one particular time.

A Dictionary of Epidemiology 40 (3rd ed. 1995).

selected subset of the Phase I cases to physical examination and nerve conduction testing. This group of cases was then compared with a control group of uninjured workers in a case-control[10] study.

The prevalence rate of hand/wrist MSD identified in the Phase I study was 22 percent. Other potentially relevant Phase I results to the present case include the fact that "the odds of having hand/wrist [MSD] symptoms were increased for those reporting: (1) more time spent typing on computer keyboards; (2) a greater number of hours on deadline; and (3) less support from their immediate supervisor." Los Angeles Times Study at 22. Using the more restricted definition of hand/wrist MSD employed in the Phase II study, the study's authors reported that "the ratio of cases defined by positive physical exam finding to those defined by symptoms alone (about 50%) is similar to that found in other [MSD] studies conducted in a variety of industries, using comparable methods." Id. at 2. They also concluded that

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[10] A case-control study is an observational epidemiologic study of persons with the disease (or other outcome variable) of interest and a suitable control (comparison, reference) group of persons without the disease. A Dictionary of Epidemiology 23.

> The risk factors associated with the more restrictive hand/wrist case definition were 1) female gender, and 2) percent of time spent typing on the computer keyboard, categorized by 20% increments. Similar variables were also important in the Phase I analysis (gender and number of hours spent typing on the computer keyboard). The other two important variables identified in Phase I (the number of hours spent on deadline and lack of support from an immediate supervisor) were not important risk factors using the more restrictive case definition . . . . This investigation (both Phases I and II) provides additional evidence that increasing time spent typing on computer keyboards is related to the occurrence of [MSDs], particularly for symptoms and physical findings in the hand/wrist area, which confirms findings of a previous NIOSH study at another large newspaper facility.

Id. at 2-3.

The second study cited by Dr. Punnett examined the effect of VDT use on workers employed by U.S. West Communications (the "U.S. West Study"). Like the first phase of the Los Angeles Times Study, the U.S. West Study was cross-sectional in nature. A person was classified as suffering from a hand/wrist MSD in this study if she reported symptoms of injury on a self-administered questionnaire and injury was confirmed through a positive physical examination.

The prevalence rate for hand/wrist MSD identified in the U.S. West Study was 12 percent. The only other pertinent

variables tested in the study that yielded statistically significant associations were a small negative association with the number of hours spent at a VDT workstation per day,[11] and a positive association with high information processing demands. In her 1997 article, Dr. Punnett compared the prevalence rate for hand/wrist MSD identified in the U.S. West Study with other prevalence data for hand/wrist MSD for individuals who did not regularly use VDTs or engage in work that involved highly repetitive manual tasks. According to Dr. Punnett, this comparison demonstrated a strong positive association between keyboard use and hand/wrist MSD.[12]

The third study discussed by Dr. Punnett during her testimony examined associations between keyboard use and musculoskeletal injuries among keyboard operators employed by a large Australian company. See Pl.'s Ex. 3C, Maurice Oxenburgh, Musculosketal Injuries Occurring in Word Processor Operators, Readings in RSI (Michael Stevenson ed., New South Wales Univ.

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[11] See discussion of this result in infra p.30.

[12] Dr. Punnett obtained similar results when she used prevalence data for hand/wrist MSD drawn from the Los Angeles Times Study and other studies of VDT use. See Punnett & Bergquist at 49, Table 5. As defendants did not challenge the reliability of Dr. Punnett's analysis on this point, I need not further discuss this aspect of her analysis.

Press 1987) (hereinafter "Oxenburgh Study"). The Oxenburgh Study was a case-control study. The case group included 46 keyboard operators who were identified as suffering from aching and fatigue of various degrees in the fingers, hand, wrist, or elbow. The control group consisted of keyboard users who did not report the relevant symptoms. The study's central findings were that

> [k]eyboard workload was the major causative factor of injury. There was a significant difference between the injured and the non-injured groups of the total time spent per day at a keyboard. From these findings the majority of the injured group (51%) spent more than 6 hours/day at the keyboard, compared to the non-injured group where only 8 per cent [sic] spent this amount of time at the keyboard.
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> Sudden increases in workload can also precipitate injury. Forty-three per cent [sic] of the injured group had their workload on the average almost doubled to 5.6 hours keyboard work/day prior to the injury and, of these cases, 55 per cent [sic] had this workload increase within one week prior to the injury.

Oxenburgh Study at 95. Dr. Punnett testified that she subjected the data obtained by the Oxenburgh Study to a "Mantel's Trend Test."[13] She claimed that this test demonstrated a highly statistically significant association between the number of hours

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[13] A Mantel's Trend Test is "a regression test of the odds ratio against a numerical variable representing ordered categories of exposure." A Dictionary of Epidemiology 100.

per day spent at the keyboard and the risk of being diagnosed with the injuries under study. See Transcript of Motion Hearing Before the Hon. Paul J. Barbadoro at I.120 (hereinafter "Transcript").

Dr. Punnett did not testify concerning the basis for her opinion that improper posture during keyboard use is causally associated with hand/wrist MSD. However, she cites several studies in the 1997 article that she claims support her opinion on this subject. See Punnett & Bergquist at 50-58.

Defendants challenge Dr. Punnett's proposed testimony pursuant to Fed. R. Evid. 702,[14] arguing both that the underlying studies and her method of analysis were faulty, rendering her opinions unreliable. Anticipating that Dr. Punnett will be barred from testifying, defendants also seek summary judgment, alleging that the remaining evidence cannot satisfy Muzerall's burden of proof on the issue of causation.

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[14] Fed. R. Evid. 702 states that "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise."

II.

Separate standards of review govern defendants' motions in limine and their motion for summary judgment.

A. The Motion in Limine

When the admissibility of expert testimony is challenged through a motion in limine, Fed. R. Evid. 104(a) requires the court to make a preliminary finding on admissibility. See Fed. R. Evid. 104(a). The party offering the expert testimony bears the burden of proving by a preponderance of the evidence that the proposed testimony meets the requirements of Rule 702. See Ruiz-Trouche v. Pepsi Cola of Puerto Rico Bottling Co., 161 F.3d 77, 85 (1st Cir. 1998).

B. The Motion for Summary Judgment

Summary judgment is appropriate "if the pleadings, depositions, answers to interrogatories, and admissions on file, together with affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to judgment as a matter of law." Fed. R. Civ. P. 56(c). A "genuine" issue is one "that properly can be resolved only by a finder of fact because [it] may reasonably be resolved in favor of either party." Anderson v. Liberty Lobby, Inc., 477 U.S. 242,

250 (1986); accord Garside v. Osco Drug, Inc., 895 F.2d 46, 48 (1st Cir. 1990). A "material issue" is one that "affects the outcome of the suit . . . ." Anderson, 477 U.S. at 248. The burden is upon the moving party to aver the lack of a genuine, material factual issue, see Finn v. Consolidated Rail Corp., 782 F.2d 13, 15 (1st Cir. 1986), and the court must view the record in the light most favorable to the non-movant, according the non-movant all beneficial inferences discernable from the evidence. See Oliver v. Digital Equip. Corp., 846 F.2d 103, 105 (1st Cir. 1988). If a motion for summary judgment is properly supported, the burden shifts to the non-movant to show that a genuine issue exists. See Donovan v. Agnew, 712 F.2d 1509, 1516 (1st Cir. 1983).

When a motion for summary judgment is premised upon a claim that the plaintiff's expert testimony is inadmissible, summary judgment should be granted if the proffered testimony fails to meet the threshold for admissibility and the remaining evidence in the record is insufficient to prove plaintiff's claim for relief. See Cortes-Irizarry v. Corporacion Insular De Seguros, 111 F.3d 184, 188 (1st Cir. 1997).

III.

A. Rule 702 and Reliability Standards for Epidemiological Evidence

To satisfy the admissibility threshold of Fed. R. Evid. 702, expert testimony must meet three requirements. See United States v. Shay, 57 F.3d 126, 132 (1st Cir. 1995); Grimes v. Hoffmann-LaRoche, Inc., 907 F. Supp. 33, 34 (D.N.H. 1995); see also Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 589-91 (1993). The expert must be qualified, the expert's testimony must be reliable, and the testimony must fit the facts of the case. See Shay, 57 F.3d at 132; Grimes, 907 F. Supp. at 34. When scientific testimony is in dispute, Rule 702's reliability requirement demands that the expert's opinions must be grounded on the "'methods and procedures of science' rather than on subjective belief or 'unsupported speculation.'" In re Paoli RR Yard PCB Litigation, 35 F.3d 717, 742 (3d Cir. 1994) (quoting Daubert, 509 U.S. at 591). The Supreme Court has identified several criteria that may be relevant in evaluating the reliability of scientific testimony. These include:

> (1) whether the opinion can be or has been tested; (2) whether the theory or technique on which the opinion is based has been subjected to peer review and publication; (3) the technique's known or potential error rate; (4) the existence and maintenance of standards controlling the technique's operations; and (5) general acceptance.

Grimes, 907 F. Supp. at 35 (citing Daubert, 509 U.S. at 591-95). In its most recent opinion addressing the issue, the Court emphasized that these criteria are to be applied flexibly and that other factors may also be relevant depending upon the nature of the witness's claimed expertise. See Kumho v. Carmichael, 1999 WL 152455 *9, ___ S. Ct. ___ (1999).

Dr. Punnett's testimony in this case is based primarily on her expertise in the field of epidemiology. An epidemiologist develops opinions about the causes of disease through a two-step process. First, she examines population groups to determine whether an association exists between a suspected cause of the disease and known patterns of disease distribution. See generally B. McMahon & D. Trichopoulos, Epidemiology Principles and Methods (2d ed. 1996); Reference Guide on Epidemiology, (Federal Judicial Center 1994) at 125-26 (hereinafter "Reference Guide"). Several questions should be considered when evaluating the trustworthiness of an epidemiologist's conclusion that an association exists between disease and a suspected causal agent. These questions include:

> (1) Was the research design appropriate for answering the research question?;
> (2) Were the study populations well defined and samples adequately selected so as to allow for meaningful comparisons (between study groups or between time periods)?;

> (3) Was exposure to the putative agent measured using a standardized and reliable methodology?; and
> (4) Were the health effects (i.e., disease, disability) clearly defined and reliably measured?

Reference Guide at 131.

Once an association has been identified, an epidemiologist will review the relevant evidence in light of certain generally recognized criteria to determine whether an inference of causation is warranted. See McMahon & Trichopoulos at 22-23. One such set of criteria, known as "Koch's postulates," lists the following factors as relevant to the analysis:

> (1) strength of the association; (2) temporal relationship; (3) consistency of the association; (4) biologic plausibility; (5) consideration of alternative explanations; (6) specificity of the association; and (7) dose-response relationship.

Reference Guide at 161.[15]

I evaluate the reliability of Dr. Punnett's testimony on general causation in light of the factors identified by the Supreme Court in Daubert as well as the above-identified criteria

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[15] Although Koch's postulates were intended to be used in identifying causes of infectious diseases, see Reference Guide at 163 n.119, and the use of certain of the criteria in other contexts may not be appropriate, see McMahon & Trichopoulos at 23-24, most of the criteria are applicable in this case and are helpful in evaluating the trustworthiness of Dr. Punnett's testimony.

that bear specifically on the reliability of epidemiological evidence.

B. Application

Muzerall argues that Dr. Punnett's testimony satisfies the requirements of Fed. R. Evid. 702 because her opinion on general causation has been vetted in a peer-reviewed article, it is based on several reliable epidemiological studies, and, applying accepted criteria used by epidemiologists, the evidence of an association between keyboard use and injury demonstrated by these studies is sufficiently compelling to warrant an inference of causation. Defendants challenge this argument for several reasons. Most significantly, they claim that: (1) the studies that Dr. Punnett relies on to support her conclusion contain serious methodological flaws; (2) any evidence of an association between keyboard use and injury suggested by the studies she cites is not sufficiently compelling to justify an inference that keyboard use causes injury; and (3) the evidence she relies on will not reasonably support a conclusion that the specific conditions from which Muzerall suffers can be caused by defendants' alleged failure to properly warn of the hazards associated with keyboard use. I address each of these arguments in turn.

1. Methodological Criticisms

Defendants have mounted a multifaceted challenge to the three studies Dr. Punnett most prominently relies on in concluding that an association exists between prolonged, uninterrupted keyboard use and hand/wrist MSD. They argue that: (1) the studies are subject to "selection bias"[16] because they focus on workplaces with a perceived problem of injuries among keyboard users; (2) the studies are subject to "recall bias"[17] because they depend upon historical information concerning exposures obtained from participants; (3) the studies use an overly broad and largely subjective definition of injury; (4) injury is defined in some of the studies through self-report of symptoms rather than objective evidence of injury; (5) the studies measured the prevalence[18] rather than the incidence[19] of

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[16] Selection bias is "[e]rror due to systematic differences in characteristics between those who are selected for study and those who are not." A Dictionary of Epidemiology 153.

[17] Recall bias is "[s]ystematic error due to differences in accuracy or completeness of recall to memory of past events or experiences." A Dictionary of Epidemiology 141.

[18] Prevalence is "[t]he number of events, e.g., instances of a given disease or other condition in a given population at a designated time . . . ." A Dictionary of Epidemiology 129.

[19] Incidence is "[t]he number of instances of illness commencing, or of persons falling ill, during a given period of time in a specified population." A Dictionary of Epidemiology

injury and (6) because the studies examined so many variables, there is a substantial risk that any positive associations reported in the studies for a select few variables was due to chance.

The short answer to defendants' methodological critique is that while the concerns they raise are legitimate, they represent the kinds of criticisms that affect the weight that should be given to Dr. Punnett's testimony by the jury rather than its admissibility. It is undisputed that the studies at issue were carefully constructed and conducted by qualified experts. Many of the studies note and attempt to account for the limitations cited by the defendants. Moreover, Dr. Punnett has offered reasonable, if not necessarily dispositive, answers to each of defendants' contentions. Generally speaking, when the debate involves a reasonable disagreement among qualified experts with the way in which accepted methodologies were used in a particular case, the choice among competing views is best left to the jury. Such is the case here.

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82. When studying causal factors of disease, epidemiologists generally agree that incidence measured as soon as practicable after onset is the most useful measure of disease frequency. See MacMahon & Trichopoulos at 62.

2. Causation

Defendants also argue that the evidence of an association between keyboard use and injury identified in the studies Dr. Punnett cites does not support her conclusion that hand/wrist MSD can be caused by prolonged, uninterrupted keyboard use and improper posture during keyboard use. Applying accepted criteria used by epidemiologists when investigating the issue of causation, defendants argue that an inference of causation cannot be drawn here because: (1) the studies Dr. Punnett relies on cannot be used to establish an appropriate temporal relationship between exposure and injury; (2) Dr. Punnett has failed to sufficiently establish that prolonged keyboard use is a biologically plausible cause of the types of injuries from which Muzerall suffers; and (3) any association between keyboard use and injury demonstrated in the studies is not sufficiently strong and consistently identified to support an inference of causation.

a. Temporal Relationship

An exposure to something such as keyboard use logically cannot be a cause of a particular injury unless the exposure precedes the injury. Accordingly, it is important to attempt to demonstrate an appropriate temporal relationship between exposure and injury when drawing an inference of causation. See Reference

Guide at 162 n.113. If the correct temporal sequence cannot be proved, it is vital that "there must be at least the possibility that such a sequence exists." MacMahon & Trichopoulos at 23.

Phase I of both the Los Angeles Times Study and the U.S. West Study were cross-sectional studies. Because such studies examine exposure and injury among study participants at the same point in time, they are of limited value in inferring a temporal relationship between the exposure and the injury. See id. at 81-82. Further, because Phase II of the Los Angeles Times Study and the Oxenburgh Study were case-control studies, they necessarily were dependant upon historical information concerning the relationship between exposure and injury, a limitation which also restricts their usefulness in reliably identifying a temporal relationship between keyboard use and injury. See id. at 79-80. Defendants invoke these limitations in challenging Dr. Punnett's testimony.

Dr. Punnett readily acknowledges that the studies she relied on cannot conclusively demonstrate the appropriate temporal relationship between keyboard use and injury. Nevertheless, she defends her conclusion with two arguments. First, she notes that two of the three studies at issue - the Los Angeles Times Study and U.S. West Study - eliminated persons who reported the onset

of symptoms before they became employed. She then stated that this fact makes it unlikely that anyone in the groups being studied developed hand/wrist MSD before they began to regularly use keyboards. Second, she argues that it is unlikely that many of the keyboard users who suffered from hand/wrist MSD had the condition before they began to regularly use keyboards because it is reasonable to presume that persons with hand/wrist MSD are unlikely to move in large numbers to jobs that require extensive keyboard use. While other experts reasonably could be left unpersuaded by these arguments, they are not the type of manifestly meritless assertions that must be rejected before they can even be presented to the trier of fact.

b. Biological Plausibility

Defendants next argue that Dr. Punnett has failed to demonstrate that it is biologically reasonable to infer that prolonged, uninterrupted keyboard use or poor posture can cause the types of injuries from which Muzerall suffers. To support their assertion, defendants argue that the studies cited by Dr. Punnett on this issue all involved much greater levels of force than occurs during keyboard use. Defendants have also have produced expert testimony suggesting various reasons why it is biologically implausible to infer that such a causal relationship

exists. Muzerall responds by citing testimony from Dr. Punnett, who claims that there is "a large body of evidence" to support the biologic plausibility of her opinion on general causation. See Tr. at II.5.23-6.16. In particular, she testified:

> Well, there's a paper by Armstrong and Chaffin, for example, which shows that the - I'm sorry, yes-- which shows that the speed with which the fingers move, the length of the work period before resting, and the length of the rest period relative to the work period all predict the loading on the tendons. That is, the actual mechanical stretching of the tendon tissues as a function of being pulled on by the contracting muscle. Other work by Armstrong with a Dr. Steven Goldstein has gone further into this examining the cumulative tendon strain, the cell damage and loss of normal function of the tendon.
> THE COURT: So prolonged loading of the tendon has been demonstrated to produce injury to the tendon, and the sheath consistent with tendinitis, tenosynovitis and synovitis. Is that what you're saying the study showed?
> THE WITNESS: Yes, your Honor. I would say repetitive motion and prolonged periods of repetitive motion, yes.
> THE COURT: So loading the tendon in the same way repeatedly over a significant period of time is what has biologically been show[n] to produce the kind of injury that we're talking about.
> THE WITNESS: Correct. There's at least one other paper that I can think of right now which shows further that if the fingers are moving with the wrist bent, either flexed or extended, because of the biomechanical disadvantage of this posture the load on the tendons is even greater and the probability

> of these kinds of tissue damages is even greater.[20]

Tr. at II.17.18-19.1. This testimony is sufficiently persuasive to support Dr. Punnett's testimony that a biologically reasonable explanation exists for the inference of a causal relationship between prolonged, uninterrupted keyboard use or poor posture and hand/wrist MSD.

c. Strength and Consistency of Association

Defendants also contend that any association between exposure and keyboard use demonstrated by the studies Dr. Punnett relies on is not sufficiently strong and consistently demonstrated to support an inference of causation. In making this argument, defendants they rely heavily on the negative association between the number of hours spent at a VDT workstation per day and hand/wrist MSD reported by the U.S. West Study.

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[20] Dr. Punnett did not identify the specific works she was referring to in her testimony. However, in supporting similar assertions in the 1997 article she cites to a number of papers. See Punnett & Bergquist at 6-7 (citing Armstrong, Buckle & Fine, et al., A Conceptual Model for Work-Related Neck and Upper Limb Musculoskeletal Disorders, Scand. J. Work Environ. Health 1993, 19:73-84; Armstrong, Fine & Goldstein, et al., Ergonomic Considerations in Hand and Wrist Tendinitis, J. Hand Surg. 1987, 12A:830-837; Chaffin & Andersson, Occupational Biomechanics (2d ed.) New York, NY: Wiley & Sons (1991); and Goldstein, Armstrong & Chaffin, et al., Analysis of Cumulative Strain in Tendons and Tendon Sheaths, J. Biomech. 1987, 20:1-6).

It is undisputed that the three studies Dr. Punnett most prominently relies on have sufficient power[21] to reliably identify the existence of an association between prolonged, uninterrupted keyboard use and hand/wrist MSD. Dr. Punnett has also offered a plausible argument that the association between keyboard use and injury demonstrated by these studies is likely to be understated because of a phenomenon known as the "healthy worker effect."[22] Further, rather than relying on only one study to support her opinion, Dr. Punnett identifies numerous other studies that also report statistically significant associations between keyboard use and injury. Finally, she plausibly explains the negative association identified in the U.S. West Study by stating that since the subjects included in the study all spent at least six hours per day typing, the only conclusion that the negative association supports is that typing more than six hours

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[21] Power is "the ability of a study to determine an association if one exists." A Dictionary of Epidemiology 128.

[22] The "healthy worker effect" is a phenomenon in which workers may exhibit lower overall rates of injury than the general population "because the severely ill and chronically disabled are ordinarily excluded from employment." A Dictionary of Epidemiology 75. In the context of this case, Dr. Punnett theorizes that the healthy worker effect will cause the association between keyboard use and injury in studies of active workers to be understated because some of the injured workers will remove themselves from the work force and hence will not be identified.

per day does not increase the risk of injury. Accordingly, she argues that this finding is not necessarily inconsistent with the positive associations reported in other studies. Her testimony on this issue sufficiently supports her claim of a strong and consistent association between keyboard use and injury to overcome defendants' objections on this point.

In summary, while the existence of a causal relationship between prolonged, uninterrupted keyboard use or poor posture and hand/wrist MSD remains controversial, Dr. Punnett's opinion on general causation is reasonably based on the methods and procedures generally employed by practitioners in the field of epidemiology. Accordingly, her disagreements with defendants' expert represent the type of conflict that ordinarily should be resolved by a jury.

3. Definition of Hand/Wrist MSD and its Relationship to Muzerall's Medical Conditions

Perhaps defendants' most troubling argument is their claim that even if prolonged, uninterrupted keyboard use and poor posture are causally associated with the cluster of medical conditions that Dr. Punnett calls hand/wrist MSDs, the evidence will not support her more specific conclusion that such keyboard use is causally associated with the specific conditions from

which Muzerall suffers. In essence, defendants' argument is that because the studies relied on by Dr. Punnett defined the term "hand/wrist MSD" broadly to include a large group of symptoms, syndromes, and specific medical conditions from which Muzerall does not suffer, it is impossible to tell whether any demonstrated association between keyboard use and the entire group of problems defined as hand/wrist MSD also reflects a comparably strong association between keyboard use and the specific medical conditions at issue in this case.

Dr. Punnett acknowledges this problem, but minimizes its significance. She testified that tendinitis, the primary condition from which Muzerall suffers, represents a large subset of the medical conditions collectively comprising hand/wrist MSD. She also claims that "the pattern of tendinitis tracks the patterns for [the] other disorders" included within the definition of hand/wrist MSD. See Tr. at II.162-63. Accordingly, she concludes that it is unlikely that the possible association demonstrated between keyboard use and hand/wrist MSD does not also accurately describe the association between keyboard use and the kind of tendinitis from which Muzerall suffers. Once again, I find this argument sufficiently

persuasive to allow Muzerall to present Dr. Punnett's testimony on this point to a jury.

IV. CONCLUSION

Dr. Punnett's opinions on the causal relationship between keyboard use and the disorders from which Muzerall suffers remain controversial. While reasonable experts could disagree with her conclusions and challenge the rigor with which they have been supported, I am satisfied that Dr. Punnett has based her opinions on methods that are sufficiently reliable to permit her to express those opinions to a jury. Her central conclusions that prolonged, uninterrupted keyboard use and improper posture while using a keyboard are causally associated with hand/wrist MSD have been subjected to peer review and publication. The studies she relies on to support her opinions are methodologically sound and the criteria she used in forming those opinions are generally accepted as appropriate by epidemiologists. Accordingly, I conclude that Muzerall has satisfied Rule 702's reliability requirement.

Defendants have also argued that Dr. Punnett's opinion on general causation is barred by Rule 702 because it does not "fit" the facts of the case. "The concept of fit requires that a valid

connection exist between the expert's testimony and a disputed issue." Shay, 57 F.3d at 133. Defendants argue that Dr. Punnett's testimony does not fit the facts of the case because Muzerall has not demonstrated that her history of keyboard use involved the type of prolonged, uninterrupted use and poor posture that Dr. Punnett claims is causally associated with injury. They also contend that Dr. Punnett's general causation opinion does not address certain specific conditions that Muzerall suffers from such as the TFCC. The current record is not sufficiently developed to permit me to rule on these arguments now. Accordingly, I deny defendants' motion in limine without prejudice as to these issues and will resolve them later if they are raised again at trial.[23]

Defendants' motion in limine and for summary judgment (document no. 36) is denied.

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[23] Defendants also invoked Fed. R. Evid. 403 but presented no specific argument based on this rule. Since they did not develop their argument, I have not attempted to address it in this order. Further, although defendants have challenged the admissibility of Muzerall's expert testimony on the issue of specific causation, the record is not sufficiently developed to permit me to rule on their contentions. Accordingly, I also deny their motion without prejudice as to these arguments.

SO ORDERED.

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Paul Barbadoro
Chief Judge

March 31, 1999

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