The author of this highly relevant and well-designed study has compared the effects of different forms of transcutaneous electrical nerve stimulation to experimentally induced fingertip pain. In so doing, Jette pointed out that experimental pain cannot be equated with actual clinical pain. The differences between these two types of pain only were alluded to, however, and I would like to add further clarification to the issue.

No universal and fully reliable method of producing experimental pain can be correlated accurately with a patient's clinical description of pain or analgesia. In Jette's study, not only has experimental pain been compared with clinical pain, but conclusions may be drawn that encompass the differences between acute (experimental) and chronic (clinical) pain and the differences between distinctly localized (fingertip) versus diffuse (radicular) pain.

Even though Nortermans has recommended specific electrical characteristics for producing a reliable "pain-prick" sensation, most experimentally induced pain shows marked differences from natural nociceptive stimuli. In Jette's experiment, the nociceptive stimuli induced what is known as first- or superficial pain characterized by a sharp, short-lasting, and well-localized sensation in line with that of the pain- or pin-prick sensation. Chronic pain, however, is categorized as dull, achy, poorly localized, and long lasting, most often beyond that of the normal stimulus. Behavioral components cannot be simulated adequately in the experimental situation as the author states, but such factors have not hindered pain research and should limit the conclusions drawn from such experimentation.

I have raised these comments because, in my clinical experience, I find greater success with TENS techniques by varying not only the stimulation mode but also electrode placement sites relative to each patient's individual pain (acute or chronic) characteristics. Each stimulation mode, composed of different variables (pulse rate, pulse width, and intensity) regardless of the type of device (low voltage, high voltage, point stimulators, or portable TENS units), has certain characteristics, some of which may be more applicable in specific clinical situations than others. No absolute list of pain syndromes exists, however, in which a specific stimulation mode is recommended, and success often is enhanced by a different stimulation mode when the initial choice is not beneficial. My initial choice in the majority of clinical situations is to begin with the conventional stimulation mode. If this mode is unsuccessful with various electrode arrays, then I will proceed to evaluate other modes.

Electrode placement sites very often need to be altered when changing one stimulation mode to another, regardless of the pain syndrome in any patient. Tolerance to one or more stimulation modes will vary at different body regions. This was illustrated clearly by Eriksson and Sjolund, who used TENS for patients with chronic pain such as trigeminal neuralgia. For patients who did not respond to the conventional mode, a greater number obtained pain relief from TENS by the addition of either the high intensity (rhythmic muscle contraction) pulse train or the burst mode.

The acupuncture-like mode frequently is not tolerated well by the patient in the area of pain. Strong muscle contractions (rhythmic) at a painful site do not facilitate enough tolerance for pain relief to ensue. This stimulation mode, however, may be successful when applied at segmentally related myotomes remote from the area of pain.

Variations in electrode placement sites and the size and shape of electrodes were not addressed in this study. I believe the author correctly used the same electrode placements with each different stimulation mode to decrease variability; however, the area of excitation differed between the different sizes of electrodes (portable TENS, high voltage galvanic stimulation, and hyperstimulation). In keeping with the aforementioned points, the results of this study may have been distinctly different with electrode placement at areas closer to the fingertip. I would expect to obtain the most rapid and profound analgesic effect with conventional to brief-intense stimulation mode characteristics consisting of a single channel of one electrode wrapped around the volar surface of the third finger just proximal to the distal phalanx and another at the volar surface of the wrist overlaying the median nerve. Such an electrode array has been used to control hyperesthesia and phantom pain in a patient with a traumatic amputation of the distal phalanx of the middle finger. Ongoing stimulation provided by this arrangement produced enough pain control to allow the therapist to perform joint mobilization for hypomobility. Strassburg et al have performed stimulation with electrodes placed proximal to or surrounding the site of minor surgical procedures to produce adequate analgesia for the performance of muscle biopsies and median nerve decompression. A complete review of the use of TENS for the relief of various pain syndromes and the performance of specific therapeutic procedures relative to the hand is available.

The degree and duration of pain relief obtained by the various forms of stimuli after the stimulation period (aftereffect) in this particular study need to be addressed. Not every form of TENS provides a significant aftereffect. If TENS was applied simultaneously with the nociceptive stimulus and electrode placement provided as previously discussed, the outcome again would be dramatically different. Experiments using this type of paradigm have been performed.

Campbell and Taub stimulated the digital nerves in the median distribution in man percutaneously. A nociceptive stimulus was provided via a needle to the skin of the fingertip while simultaneous stimulation at different intensities was performed proximally. A 100-Hz, 1-msec current of 10 to 12V, 22V, and 50V was used. They found that the lowest voltage raised the threshold to touch but not pain; 22V raised both touch and pain thresholds; and continuous stimulation of 50V, 0.5 msec, eliminated perception of pain, except for a brief jabbing sensation when the skin was pierced.

Jancko and Trontelz also stimulated sensory fibers of the median nerve with variable frequencies and wave forms while noxious stimuli were produced by electrical stimulation of the distal phalanx of the third finger. They found that high frequency, high intensity stimulation (50-100 Hz) after a few
minutes produced a profound loss of tactile and pain sensation distal to the stimulating electrodes. No difference existed among wave forms, but the best results occurred when TENS was applied to the same finger as that receiving the noxious stimulus.

Without further literature review, a general consensus is that experimentally induced fingertip pain is relieved best by high frequency, high intensity stimulation, producing significant electrical paresthesia in the area of pain and provided just proximal to the point of pain simultaneously with the pain stimulus. Similar results have been obtained with subjects with clinical pain. This strongly supports the author’s results that hyperstimulation may be more effective than low frequency TENS in the immediate reduction of pain. The aftereffect of this type of TENS, however, is relatively short-lasting. If the discomfort persists and becomes more in line with pain of the chronic variety, therefore, stimulation must be applied periodically or another stimulation mode that may provide a long aftereffect should be implemented.

The acupuncture-like and high intensity pulse-train or burst modes have been shown to provide longer aftereffects than hyperstimulation. The aftereffect depends, however, on many factors, such as what the patient does after the stimulation ceases. A patient who can participate in an active exercise program and maintain proper body mechanics and posture will be able to obtain a longer aftereffect than one who does not. I believe that this is due to the increased production of proprioceptive (large fiber mediated) stimuli and a decreased production of nociceptive (small fiber mediated) stimuli. The best results from any form of TENS, therefore, will be achieved when it is used adjunctively as part of a comprehensive treatment program geared to restore normal function and prevent the recurrence of pain.

In conclusion, I do not believe that a trial and error approach is necessary to decide on the stimulation mode or device in each clinical situation. The clinician must consider the characteristics of the pain syndrome (quality, location, distribution, chronology, and intensity) and the environment in which it is present (clinical, home, or work) and select electrode placement sites and stimulation characteristics that may be best suited for a particular situation. A thorough knowledge of the differences of each stimulation mode is needed, as discussed by Jette. Suggestions for various pain syndromes are available based on numerous clinical and experimental applications, but, again, none are absolute.

This study represents an excellent starting point in the comparison of various types of electrical stimuli. I strongly agree with Jette that further research is needed in clinical situations, which, of course, is difficult to perform. I hope that I have added another dimension based on my clinical experience and that of others to the conclusions drawn from this study.

JEFFREY S. MANNHEIMER, MA, PT
President
Delaware Valley Physical Therapy Associates
123 Franklin Corner Rd, Suite 101
Lawrenceville, NJ 08648

REFERENCES
10. Mannheimer JS: TENS as an adjunctive technique in hand rehabilitation. APTA Hand Rehab Section Newsletter 1:3–5, 1983

Author’s Response

I appreciate Mr. Mannheimer’s thoughtful comments. I believe he correctly points out the differences in experimental and clinical settings in evaluating clinical techniques. He also makes valid points in stating that different electrode placements or measurement of pain during TENS might have given significant or different results. My study was an attempt to test only the efficacy of different forms of TENS on experimentally induced pain. It is a small step toward substantiating or refuting techniques currently in practice. It would be wrong to make strong statements based on my mostly nonsignificant results.

Although Mannheimer’s comments are based on a thorough knowledge of the literature and his clinical experience, I argue that, thus far, clinical and experimental research results do not point to the same conclusions. This discrepancy in results may be attributed to large variations in the current characteristics studied, electrode placements used, the type of pain and how it was measured, and whether valid statistical tests were applied to the data. Indeed, Mannheimer and Lampe cite equal numbers of sources that show either a short aftereffect or a prolonged aftereffect of high frequency TENS. In his commentary, Mannheimer states, “Each