

## Evidence in Action

### Your Patient Has Wrist/hand Pain and Paresthesias – Does She Have Carpal Tunnel Syndrome?

By Robert M. Rowell, DC, MS

*A 52-year-old woman seeks care for pain and paresthesias in her right hand.*

#### The Condition History

Your patient, a healthy, fit 52-year-old woman, has recently started training with her friends for an upcoming long-distance cycling trip through Holland, scheduled for three months in the future. One month ago, she significantly increased her weekly cycling distance.

Pain, numbness, and tingling in her right thumb, forefinger, and middle finger have been noticeable for almost a month. Her concern about her hand numbness has increased in the past week after she noticed that unless she is careful, she drops items held in her right hand.

#### The Physical Examination

Examination of your patient includes a cervical and upper-extremity evaluation. The cervical examination is negative. The upper-extremity examination reveals loss of sensation to painful stimuli along the palmar surface of her right index finger compared to the palmar surface of the ipsilateral fifth digit, as well as weak right thumb abduction. Phalen's and Tinel's signs were both negative.

Because of the mixed signs and symptoms, your differential diagnosis list includes carpal tunnel syndrome (CTS), but you don't feel you have enough information to definitively confirm that diagnosis. You could order electrodiagnostic studies, but you decide to review the literature about carpal tunnel syndrome. You need information quickly because your patient is waiting in the exam room. Rather than start by searching thousands of primary research articles in Medline or Pubmed, you begin your search in a database called Dynamed,<sup>1</sup> which contains

summaries of current information on thousands of conditions. In the Dynamed summary of CTS, you find the information divided into sections that include history and physical, treatment, and prognosis. You are most interested in the physical exam findings to aid in making an accurate diagnosis, so you read that section first.

In the summary, you learn that electrodiagnostic studies are considered the gold standard and that both Phalen's and Tinel's signs are often not helpful for making the diagnosis of CTS. Instead, the best predictive value comes from a cluster of signs and symptoms.

1. Hypalgesia
  - o Decreased sensation to painful stimuli along the palmar surface of the index finger in comparison to the palmar surface of the ipsilateral 5<sup>th</sup> digit
2. Classic or probable distribution of hand symptoms
  - o Median nerve distribution of the 1<sup>st</sup> through lateral ½ of the 4<sup>th</sup> digits
3. Weak thumb abduction
4. Closed fist sign
  - o Paresthesias in the median nerve distribution with active flexion of the fingers into a closed fist for 60 seconds.
5. Flick sign
  - o Improvement in symptoms when the patient flicks the wrist and hands quickly, as in shaking down a thermometer.
6. Square wrist sign
  - o The wrist is measured at the distal wrist crease in the anterior to posterior dimension (AP) and the lateral dimension. Calculate the

ratio of the AP measurement to the lateral measurement. Positive square wrist sign is a ratio greater than 0.7.

These signs and symptoms all have good positive predictive value for making the diagnosis of CTS. The Dynamed summary goes on to describe the likelihood ratios associated with each diagnostic criterion. So far, you have spent only a few minutes reading. But before reading further, you return to your patient to complete your examination. First, you perform the closed fist sign, which is positive in 45 seconds for median nerve paresthesia. Next, you use your x-ray caliper to measure your patient's wrist and calculate the square wrist sign. Her ratio is 0.8. Finally, you ask your patient what she does to improve her symptoms, and she demonstrates the flick sign to you. You now have enough information to be fairly certain that your patient suffers from CTS. You still want to read more about likelihood ratios and positive predictive values, so you tell your patient that you will do some research and see her again in two days.

#### Predictive Value and Likelihood Ratios

Positive predictive value (PPV) is the probability that a patient with a positive test result really does have the disease. This is a good indicator of the quality of a test. The higher the predictive value, the better the test is at identifying those patients with the disease. On the other hand, negative predictive value (NPV) is the probability that a patient with a negative test result really doesn't have the disease. Again, the higher the value, the better the test is at identifying patients without the disease.

When a new diagnostic test is developed, research is conducted to compare the new test to the existing gold standard test. Unfortunately, all diagnostic tests give both true results and false results. The true results are true positive tests (TP), which are positive results in those with the disease and true negative tests (TN), which are negative results in those without the disease. The false results can be false positive tests (FP) in which the patient doesn't have the disease but the

test is positive, or false negative (FN) in which the patient really does have the disease but the test is negative. Since PPV is the probability that a patient with a positive test result really has the disease, the formula is simply the number of patients with the disease divided by all positive tests: true or false.  $PPV = TP / (TP+FP)$ . NPV is also a simple division problem. The probability that a patient with a negative test really doesn't have the disease can be expressed as  $NPV = TN / (TN+FN)$ . When a new diagnostic test is studied, the researchers will report the number of FP, FN, TP, and TN tests in the results section of their paper. If the researchers don't report the PPV and NPV of a test (and they often don't), a clinician can easily calculate it.

While PPV and NPV are good indicators of the value of a diagnostic test, from the clinician's perspective, likelihood ratios (LRs) are even more valuable. LRs help a clinician calculate the probability that a patient has a disease. All clinicians routinely estimate that probability. After performing a diagnostic test, the clinician can then use the LR for the test to calculate the new probability of the patient's having the disease, taking into account the test that was performed. This could involve performing calculations, or the clinician can use a simple device known as a nomogram. The nomogram is a combination of three scales. The first scale is the clinician's estimate of the probability that the patient has the disease (pre-test probability). The middle scale is the LR for the diagnostic test. The third scale will show the probability of the patient's having the disease after the diagnostic test is performed (post-test probability).

Likelihood ratios are the likelihood of a test result's occurring in a patient with the suspected disease compared to the likelihood that the same test result will occur in a patient without the suspected disease. Likelihood ratios are a ratio of likelihoods. Since a ratio is just a division problem, a likelihood ratio is a division problem. In fact, it's one ratio divided by another ratio (ratio of ratios). The  $LR_+$  is the ratio of the ratio of positive tests in those with disease to the ratio of positive tests in those without disease. Another

way to describe this is that the LR<sub>+</sub> is the ratio of positive tests in those with disease divided by the ratio of positive tests in those without disease. The formula is:

$$LR_+ = \frac{TP / (TP + FN)}{FP / (TN + FP)}$$

Those who are familiar with the study of diagnostic tests may recognize that the LR<sub>+</sub> can easily be calculated from the sensitivity and specificity of the test. This can be handy since researchers often (unfortunately) report only sensitivity and specificity. That formula is:

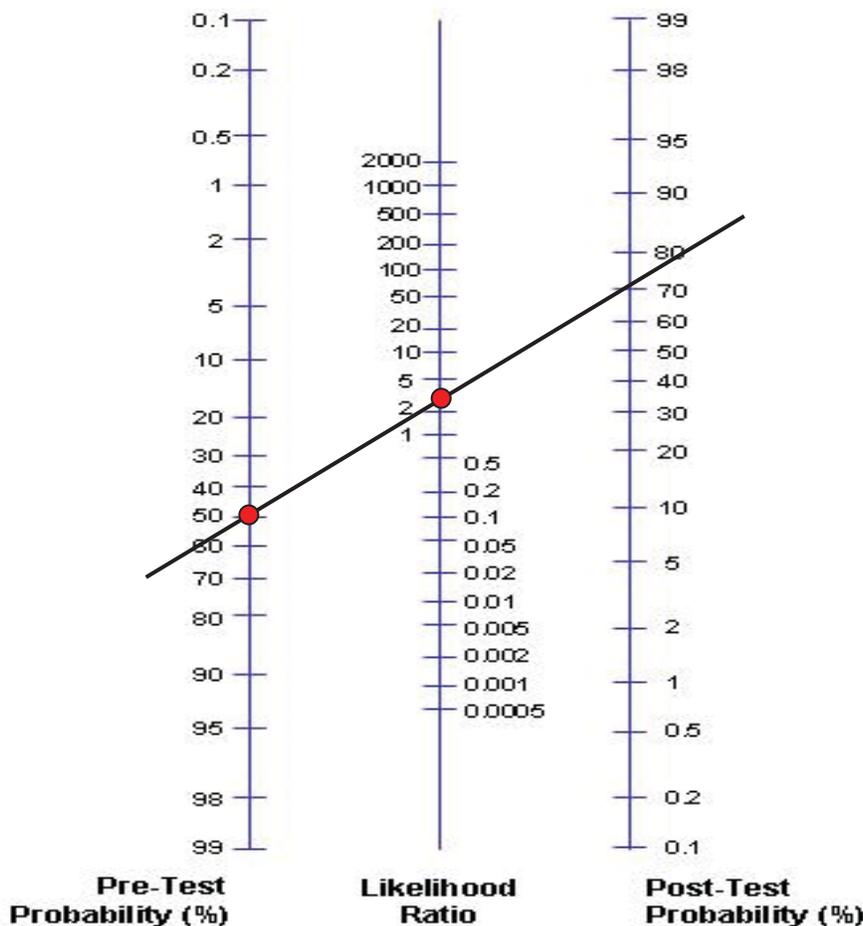
$$LR_+ = \frac{\text{Sensitivity}}{1 - \text{Specificity}}$$

It is not as important for a clinician to understand how to calculate LRs as it is to know how to

interpret them. The formulas are readily available on the Internet.

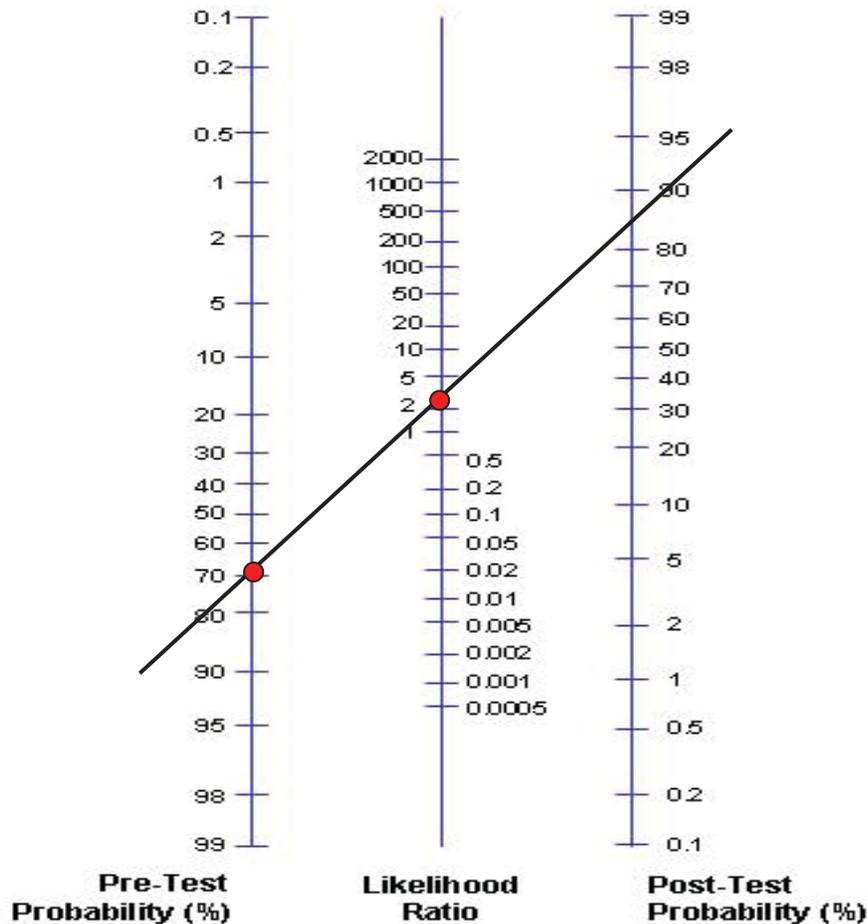
### Applying LR<sub>+</sub> to Your Patient With Suspected CTS

After your initial evaluation of your patient with suspected CTS, you feel the probability of CTS is 50% because the history made sense for that diagnosis, but Phalen's and Tinel's signs were negative. Next, you checked for hypalgesia, which was positive. The positive likelihood ratio (LR<sub>+</sub>) for hypalgesia is 3.1. Using the nomogram, a ruler is placed at 50% (your estimate of pre-test probability of CTS). Next a line is drawn through 3.1 (the LR<sub>+</sub> for hypalgesia). The line is extended through the third scale, and the number indicated is the post-test probability of the patient's having CTS (70%). Performing that one test raised our diagnostic certainty from 50% to 70%.



The next positive test to consider is classic or probable distribution of hand symptoms. The (LR<sub>+</sub>) for this test is 2.4. If we use the post-test probability of 70% as our pre-test probability for the next test, we can calculate a new post-test

probability. In this case, the post-test probability is 85%. You must be careful, however, because you can over-estimate the post-test probability by using multiple tests. Some authors suggest just using the LR<sub>+</sub> for the test with the highest LR<sub>+</sub>.



### Treatment

Having arrived at a diagnosis with which you feel comfortable, you now must determine the most effective treatment plan for this patient.

### PICO Question

Your next step is to turn to the literature. In order to conduct a focused search and find the most specific answer possible, you first formulate a PICO question. PICO is an acronym for Patient, Intervention, Comparison, and Outcome. These are the components of a searchable and specific health care question. Your question is: In middle-aged women with CTS, is tendon gliding exercise

more effective than standard conservative care for relief of paresthesias and pain and improving function? You search PubMed with the search terms: carpal tunnel syndrome AND treatment and limit the search to clinical queries. You find a very recent article<sup>2</sup> that addresses the use of tendon gliding exercise, nerve gliding exercise, paraffin, and bracing for CTS:

Horng YS, Hsieh SF, Tu YK, Lin MC, Horng YS, Wang JD. The comparative effectiveness of tendon and nerve gliding exercises in patients with carpal tunnel

syndrome: a randomized trial. *Am J Phys Med Rehabil.* 2011 Jun;90(6):435-42.

*What does the Horng et al. article mean to you?*

In this study, patients with CTS were randomly assigned to one of three groups. Group 1 received paraffin bath therapy, a wrist brace to wear at night, and instructions to perform “tendon gliding exercises.” Group 2 received paraffin bath therapy, a nighttime wrist brace, and “nerve gliding exercises.” Group 3 received only paraffin bath therapy and a brace. Patients were instructed to wear the brace every night, throughout the night, for at least eight weeks. In addition to the brace, all patients were treated with paraffin bath therapy twice a week. Paraffin treatments consisted of dipping the hand and wrist in paraffin nine times, then wrapping it in plastic and towels to keep the warmth in. All of the groups showed improvement that was consistent with other studies of CTS. However, the patients performing tendon gliding exercises showed significantly more improvement than the other two groups. The authors concluded that paraffin, nighttime bracing, and tendon gliding exercises was a better treatment for CTS than paraffin and bracing alone or paraffin, bracing, and nerve gliding exercises. The authors gave a

good description of the tendon gliding exercises as well as a reference. With this information in hand, you can begin therapy for your patient with CTS.

#### Important Terms

- Positive predictive value (PPV) – the probability that a patient with a positive test result really does have the disease.
- Negative predictive value (NPV) – the probability that a patient with a negative test result really doesn’t have the disease.
- Likelihood ratio (LR) – the likelihood of a test result’s occurring in a patient with the suspected disease compared to the likelihood of the tests result’s occurring in a patient without the suspected disease.
- Pre-test probability – the clinician’s estimate of the probability that the patient has the suspected disease.
- Post-test probability – the probability of the patient’s having the suspected disease after the diagnostic test is performed.

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#### **References**

1. *DynaMed* [Internet]. Ipswich (MA): EBSCO Publishing. 1995. – Record No. 113671, Carpal Tunnel Syndrome; [updated 2012 Feb 22; cited 2012 Feb 23]; Available from <http://search.ebscohost.com.proxy.palmer.edu/login.aspx?direct=true&site=DynaMed&id=113862>. Registration and login required.
2. Horng YS, Hsieh SF, Tu YK, Lin MC, Horng YS, Wang JD. The comparative effectiveness of tendon and nerve gliding exercises in patients with carpal tunnel syndrome: a randomized trial. *Am J Phys Med Rehabil.* 2011 Jun;90(6):435-42.

#### **Recommended Reading**

Simel DL, Bedlack R. Make the diagnosis: carpal tunnel syndrome. In: Simel DL, Rennie D, eds. *The Rational Clinical Examination: Evidence-Based Clinical Diagnosis*. NY, NY: McGraw-Hill; 2009.