Maximum Voluntary Effort Testing

Maximum voluntary effort testing deserves a tremendous amount of attention for it holds much promise. Maximum voluntary effort testing is a reliable method to establish an early indication of proclivity to perform at a maximum level.

In every evaluation procedure, reliability can be defined in terms of the stability or dependability of a measure, that the measure will be stable over time and without regard to the evaluee, the evaluator, or the circumstances of testing. The developers of most of the performance evaluation techniques and devices that are commercially available have demonstrated the reliability of their equipment in studies which assume that the evaluee is providing maximum voluntary effort in the evaluation tasks. This is not an acceptable assumption in a medico-legal context in which it is reasonable to doubt the evaluee's motivation to fully participate.

Performance measures are highly dependent upon the effort that is expended by the evaluee. The question, "How do we know that he tried his best?" is a challenge to the reliability of the performance that is being measured. Threats to the reliability of any performance measure that is obtained in any industrial rehabilitation setting include those that have been identified as evaluee-resident threats to reliability (Matheson, 19S6):

1. Unidentified impairment and easy fatigue-ability;
2. Fear of re-injury / pain and test anxiety;
3. Symptom Magnification Syndrome;

Most skilled rehabilitation professionals routinely consider these factors but do not directly measure their effects. Consideration of the reliability of testing usually rests principally on "equipment-resident" or procedural reliability. To be sure, the reliability of the evaluation equipment and test procedures must be carefully considered. I would argue that the reliability of the evaluee must be considered just as carefully. One of the most straightforward methods to measure maximum voluntary effort is based upon the assumption that repetitive trials within a brief span of time will be stable. The statistical measurement of stability that is frequently used is the coefficient of variation (CV), the quotient of the standard deviation of a set of scores divided by its mean. It is expressed as a percentage and is a convenient notation that can be used to compare the stability of measures on a ratio scale (with a true zero). With maximum voluntary effort based on E.R.I.C.'s serial testing protocol, we are looking at intra-task consistency.

While many performance measuring instruments are available, only a few are appropriate for the measurement of maximum voluntary effort in an industrial rehabilitation setting. The "General Guidelines for the Selection of Measures of Maximum Voluntary Effort" (Matheson, 1986) indicate that such instruments must:

1. Not require cardiovascular effort that exceeds 65% of predicted maximum heart rate.
2. Not directly involve an impaired component of the biomechanical system.
3. Be controlled by the evaluee.

4. Have low error variance.
5. Have high inherent stability relative to the range of recorded values.
6. Allow short-term (brief rest) replication.
7. Give the evaluee minimal visual or proprioceptive feedback.

The E.R.I.C. Maximum Voluntary Effort Test Battery employs a series of instruments that are currently available and that meet the above criteria. These instruments present tasks to the evaluee that require maximum strength efforts. Three serial measurements of each task are taken. Body position during the evaluation is kept consistent to control for muscle groups and joint angles used. Information regarding the measurement of effort made for each instrument is not revealed to the evaluee during testing.

Precautions and Contra indications for Maximum Voluntary Effort Testing

These test procedures have the potential to cause physical injury to the evaluee. While each procedure in the E.R.I.C. Maximum Voluntary Effort Analysis has been used for more than two years in the E.R.I.C. Work Capacity Evaluation centre in Anaheim, California and has not resulted in injury, the potential for injury is real. The clinicians who have used these procedures safely at E.R.I.C. have strictly adhered to the "Guidelines for the Selection of Measures of Maximum Voluntary Effort" presented earlier in this chapter. Those which are most important to heed in order to avoid injury are presented below:

General Guideline #1 requires that test procedures "not require cardiovascular effort that exceeds 65% of predicted maximum heart rate." Therefore, these procedures must not be used with evaluees who:

a. Have impaired cardiovascular or metabolic systems, even if such impairment is due only to extreme de-conditioning and not to a disease process.
b. Are suspected of having cardiovascular or cerebrovascular disease or any cardiorespiratory impairment who have not previously been cleared by a physician for participation in maximum strength isometric tasks. Even with this clearance, these procedures should not be used without real-time monitoring and immediately available and competent emergency assistance.
c. Display the valsalva manoeuver, in which the evaluee will close of the glottis and exert pressure on the diaphragm in order to increase intra-thorax pressure. This has tremendous and potentially dangerous cardiovascular repercussions.

General Guideline #2 requires that testing "must not directly involve an impaired component of the biomechanical system." This sort of testing is not only potentially injurious but it also is unreliable and will produce an un-interpretable result. Testing of an individual with, for example, carpal tunnel syndrome in the right upper extremity, therefore, would be limited to testing of the unimpaired left upper extremity. Similarly, testing of an individual with spinal disc impairment would avoid placing maximum loads on the spine and would concentrate on upper extremity

function.

General Guideline #3 requires that these procedures "be under the control of the evaluee." Therefore, each evaluee must participate of his or her own free-will and not under coercion. Each evaluee must also be encouraged to limit his or her performance to a level that is acceptable to the evaluee.

Special notes which present precautions or contraindications relevant to each testing device in the E.R.I.C. Maximum Voluntary Effort battery are presented below:

JAMAR Dynamometer - When the individual being tested has a diagnosis of spinal disc herniation and/or spinal neuro-radiculopathy, watch for reported localized or radiating pain occurring with the effort of maximum gripping. Caution the evaluee to avoid forceful activity with the trunk. Be especially careful when evaluee is seated, as evaluees will occasionally leverage themselves against the chair back or frame in a misbegotten attempt to generate increased force.

WEST 4 - If a symptomatic response to previous testing on the JAMAR Dynamometer has been noted, a more pronounced symptomatic response to torquing should be expected. Depending upon the level of the earlier symptomatic response, it may be inappropriate to test with the WEST 4 (or BTE Work Simulator).

BTE Work Simulator - With evaluees whose diagnoses involve the cervical, thoracic, and/or lumbar spine, a marked symptomatic response may be noted immediately, or it can build up in severity as the evaluee progresses from smaller to larger tools. The reported symptoms can range from "pulling" and "I feel the muscles are working" to reports of sharp or burning radiating pain, radiating numbness or tingling, or "I feel like my back is tearing" that persists post activity. Although on the surface it appears that the BTE Maximum Voluntary Effort procedures test upper extremity strength, in reality it challenges the evaluee's ability to stabilize the spine while applying force to tools using the upper extremities. This requires strong isometric unilateral muscle contraction of the muscles of the trunk. The forces exerted on the vertebrae may irritate existing disc or spinal nerve root problems and could potentially cause re-injury or a symptomatic response to activity that lasts for several days. The instructions regarding positioning and posture described in the BTE procedure section must be strictly adhered to. Take great care and use conservative clinical judgement with evaluees who report sharp, burning, or radiating pain, tingling, or numbness during this test. If the evaluee has a lifting restriction of “no more than 10 pounds,” do not perform testing using the #701 lever.

Procedures for Handling Symptomatic Response to Activity

Symptomatic responses to these evaluation tasks require careful handling, including notation and complete description. In addition, the symptom response may indicate the need for cessation of active testing. As the symptoms are observed and reported, the evaluator must follow the following guidelines:

1. When a symptomatic response occurs, stop the test and observe the evaluee for a period of time from 5 minutes to 30 minutes while the evaluee is performing a lighter activity or is at rest.
2. If the symptoms substantially resolve in this time, resume the test. if the symptoms do not resolve or become worse, discontinue the test and consider re testing the next day or at a later date after the evaluee has recovered Symptoms that usually have serious significance include dizziness, substantial diaphoresis, sharp, burning, or radiating pain, tingling, or numbness.
3. During resumption of testing or during re-testing, carefully analyze the evaluee's positioning to see if he or she is subtly bending or twisting while applying force. Observe posture for signs of unusual muscle recruitment. Be especially observant for signs of the valsalva manoeuver.
4. If the symptoms recur, repeat steps #1 and #2. if the symptoms do not resolve or become worse, discontinue testing and do not re-attempt.

Interpretation of Results

The interpretation of the results from maximum voluntary effort testing is based on these possible outcomes:

1. That coefficients of variation do not exceed the cutpoint for any group of trials, This is taken as a presumption that the evaluee has demonstrated maximum voluntary effort in this test.
2. That coefficients of variation exceed the cutpoint for fewer than a clinically significant number of groups of trials. This is taken as a presumption that the evaluee has demonstrated maximum voluntary effort in this test.
3. That coefficients of variation exceed the cutpoint for a clinically significant number of groups of trials. This is taken as a presumption that the evaluee has not demonstrated maximum voluntary effort in this test. Reasons for the less-than maximum voluntary effort are typically:

    a. Unidentified impairment or easy fatigue-ability;
    b. Fear of re-injury/pain or test anxiety;
    c. Symptom Magnification Syndrome;

The cutpoint for each tool has been calculated based on research conducted at the Employment and Rehabilitation Institute of California. The cutpoint reflects a value which is exceeded in only 5% of the cases in which the evaluee is preforming at maximum voluntary effort.

Evaluation	# of Trials	# of CVs	# Allowed > Cutpoint
BTE	36	12	2

BTE	60	20	3
WEST 4	12	4	1
JAMAR	30	10	2

The evaluator can be assisted in distinguishing among the three possible interpretations by looking for:

1. Unidentified Impairment

    a. The highest value is frequently obtained in the first trial in each group of trials.
    b. The lowest value is obtained in the last trial in each group of three trials.
    c. Consistently lower scores and/or greater variability are found on one side of the body with higher scores and better stability of scores on the other.
    d. Variability increases as the evaluation progresses.

2. Fear Response

    a. The lowest value is frequently obtained in the first trial in each group of three trials.
    b. The highest value is obtained in the last trial in each group of three trials.
    c. Higher variability is found early in the test with variability decreasing as the test progresses.

3. Symptom Magnification Syndrome

    a. No pattern is found within each group of trials.
    b. No progression of increased or decreased variability is found as the evaluation progresses.

Corroboration of these results is necessary. The evaluation results cannot be used to identify placement in one or another of the categories without corroboration. The simplest method of corroboration begins with an interview in which the results are presented to the evaluee and explained. This should be followed by a re-test when the evaluee has recovered from the effects of the evaluation.

Reporting Results

The results of the maximum voluntary effort evaluation are reported within the context of the evaluee's motivation. A section in E.R.I.C.'s standard report that addresses this issue reads:

Demonstrated Motivation - Mr. Smith was fully cooperative with staff, participated with enthusiasm in the evaluation process, and was generally believed to have put forth maximum effort to benefit from the evaluation.

Mr. Smith underwent a formal screening procedure on the BTE Work Simulator which is designed to identify those individuals who put forth less than full effort in evaluation tasks. The Work Simulator was utilized to present 20 different maximum isometric strength tasks to Mr. Smith, and each task repeated three times to test for consistency of response. The coefficient of variation statistic was calculated for each task.

Outcome #1 - Mr. Smith did not exceed the experimentally derived cutpoint for any of the 20 coefficients, indicating full participation in testing of this type.

Outcome #2 - Mr. Smith rarely exceeded the experimentally derived cutpoint for each coefficient, indicating full participation in testing of this type.

Outcome #3 - Mr. Smith exceeded the experimentally derived cutpoint for each coefficient on (six, nine, etc.) occasions, indicating less than full participation in testing of this type. These results are most often consistent with those obtained from individuals who have been identified as (evaluator selects one):

a. having an unidentified impairment
b. displaying a fearful response to the evaluation procedure
c. suffering from the Symptom Magnification Syndrome.

Be sure to describe and summarize inconsistent results clearly and to base your opinion on objective information.

Defending Your Results

It is important for the rehabilitation expert to distinguish between the reliability of a result and its validity. Reliability is closely tied to the testing instrument, the testing procedures, and the dependability of the evaluee. Once these issues are adequately addressed, the validity of the result may be addressed. Another way to state this is that the reliable finding must be applied. That is, now that you have a "real result," what is its meaning? Validity has to do with the application of the finding to other settings.

Validity is the meaningfulness of the result. As such, validity is an interpretation of the finding. Validity is based on the opinion of the evaluator. Validity will increase as the data that have been collected are based upon evaluation tasks which have commonality with the criterion task. That is, to the degree that the evaluation task samples critical aspects of the criterion task, it will be valid.

It is important for the evaluator to distinguish between findings and interpretation, because the validity of a test procedure is the application of findings to external criteria. Validity is an

interpretation of the findings. Unidimensional findings result in equivocal interpretations and very often can be demonstrated to have low validity. In contrast, multidimensional findings result in increased validity if the findings can be cross-referenced and if the findings corroborate each other. To the degree that multidimensional cross-referenced findings corroborate each other, the interpretation can be expected to be valid.

A mistake frequently made by rehabilitation experts is to offer an interpretation that is only supported by unidimensional results. A similar error occurs when the rehabilitation expert offers an opinion based on multidimensional results which are equivocal. In either case, the validity of the results can be successfully attacked.

It is important to distinguish between a "descriptive summary" and a “diagnostic interpretation.” The former is much more easily defended and apt to be valid than the latter. What is most interesting about this is that the former may be just as useful in a medico-legal circumstance as the latter?

To take one pertinent example, a rehabilitation expert recently was asked to review a case in which the evaluee presented inconsistent results. These results were interpreted by the evaluator to be evidence of “symptom magnification.” Maximum Voluntary Effort testing suggested that the individual was producing less-than-full effort. Inconsistencies between the individual's reports of symptoms and observed behaviours were also noted. However, the WEST Tool Sort results and results from the evaluation of lifting capacity suggested that the individual was putting forth full effort.

The evaluator made the mistake of going beyond a descriptive summary of these findings to offer a diagnostic interpretation of "symptom magnification" rather than simply describing the inconsistent results. In this way, she exposed herself to substantial attack from the plaintiff's side concerning the validity of her opinion. Unfortunately, the attack on the validity of her opinion completely over-shadowed the fact that she had reliable findings which, at the very least, indicated that the evaluee had produced less-than-full effort in certain evaluation tasks.

In most medico-legal cases, any evidence of less-than-full effort, whether or not it can be fully explained by one or another interpretation, will be seen to be important. The plaintiff will be placed in the difficult position in which he must explain the inconsistent results.

Do not make the mistake of over-interpreting findings. Diagnostic interpretations of behavioral data which appear to address issues as complex as the motivation of the evaluee must be made with extreme care. Offer an unequivocal interpretation of your results only when your results are unequivocal.