STANDARDIZED EVALUATION OF WORK CAPACITY

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Abstract

A standardized method of evaluation of the work capacity of persons who are impaired by soft-tissue injuries is described. A demonstration project which involved testing 64 impaired subjects is described. The Cal-FCP test battery can be administered independently by a properly trained professional or by a technician under a physician’s supervision and requires two hours or less to complete. This study demonstrated that the results of the test battery are unbiased in terms of both gender and age and can be applied to a standardized disability rating system.

Key Words: work capacity, impairment, functional limitation, occupational disability, performance test, disability rating, disability determination.
1. **Introduction**

The construct of “work capacity” describes an individual’s ability to perform work tasks on a safe and dependable basis. It is a complex construct that encapsulates many different abilities [1] as they apply to work tasks. These abilities are measured and compared to task demands in order to determine the likelihood that the individual will be able to perform the tasks with reasonable safety and dependability [2,3]. Work capacity is difficult to measure [4,5]. Therefore, a work capacity evaluation must be operationally defined within the context of the application to which it will be put. For the purposes of this paper, work capacity evaluation will be defined as the objective quantification of occupational disability which can be used for three purposes: To provide compensation; to measure the progress of a treatment program; and to compare the effect of different types of treatment.

2. **Occupational Disability**

Disability is the summation of the role consequences of functional limitations [6-9]. Occupational disability can be defined as the individual’s uncompensated shortfalls in responding to work demands [10]. Figure One represents this definition in graphic terms.

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The occupational disability that a person experiences after an injury is a consequence of the severity of the pathology and resultant impairment and functional limitations that are work-related, compared to the individual’s pre-injury work capacity.

In practical terms, the current work capacity of the individual must be measured in a manner that allows comparison to the work capacity of that person if the pathology had not occurred. The

net loss of work capacity can be used to “rate” the disability that is attributed to the injury. This presents a difficult problem in that, prior to an injury, an individual’s work capacity usually is not known. Thus, an estimation must be made. Further, because the effects of age are confounded with work capacity, this estimate must take age into account.

Age-linked changes in work capacity have been studied extensively. The relationship of aerobic capacity to age was studied in the 1930’s by Robinson [11], who found that pulmonary capacity steadily declined after 25 years of age in men. It appears that although heart-rate declines progressively with age, aerobic capacity need not, depending on the exercise regime of the individual. Studies of healthy athletes [12,13] have found that maximum heart rate declined approximately one beat per minute per year and that the decline occurred even in well-trained individuals. The primary difference in aerobic capacity was found between individuals who were maintaining a competitive training regimen and those who were not. In a classic work, Fisher and Birren [14] found that peak values for maximum strength are achieved during the 20’s and 30’s and decline with age. Muscles of the lower body exhibit greater declines with age than do muscles of the upper body. Age-related declines in muscular endurance are less than losses seen in muscular strength. With regard to lifting, Matheson [15] studied 531 healthy subjects and found that age made a significant contribution to lift capacity which continued to be significant even when resting heart rate and body mass were considered, suggesting that age-linked decrements in aerobic capacity and musculoskeletal strength may have a potentiating effect on decrements in lift capacity.

The most broadly-based physical work demands center around the strength of the worker [16-18]. Strength has been defined as the maximum voluntary force a worker is willing to exert in a single attempt [19]. Within the context of strength, the worker’s demonstrated lifting capacity
and grasping capacity are two frequently encountered issues [3, 4, 20, 21]. Lifting is an important component of many jobs [22]. Additionally, lifting is an important variable to assess because lifting tasks appear to be related to industrial injuries [23-30]. Numerous researchers [19, 29, 31-33] point to the importance of properly matching the worker’s lift capacity to the job’s demands.

Perhaps the most useful method for quantifying the occupational consequences of a particular injury has been provided by the California Division of Industrial Accidents [34]. In this system, the diagnosis (considering pathology and impairment together), work capacity, occupation, and age of the worker are considered jointly. For example, a 49 year-old construction carpenter who has suffered a low back injury which restricts him from performing heavy lifting would receive a disability rating of 30%, based on the following procedure:

1. Determine age;

2. Determine diagnosis;

3. Determine occupational category;

4. Determine work capacity based on prophylactic work restrictions;

5. Use work capacity to determine the standard rating;

6. Use occupational category and diagnosis to determine the disability-occupation variable;


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7. Use **disability-occupation variable** in combination with the **standard rating** to derive the **occupational disability rating**;

8. Adjust the **occupational disability rating** based on the **age** of the worker.

Because the occupational disability rating is based on the occupational impact of the standard disability rating, it takes into account variations that are likely to be found as workers with different types of impairments perform a particular occupation. For example, if the above example were changed to reflect the a diagnosis of amputation of the middle and ring fingers at the distal joints on the non-dominant hand, the final occupational disability rating would be 5.5%. Conversely, as workers with the same type of impairment perform different jobs, the disability rating reflects the differential impact of the diagnosis on the ability to perform that job. If, in the original example, the occupation of the worker were changed to accountant, the final occupational disability rating would be 17%.

The primary advantage of such an approach over the ratings of impairment provided by the Guides to the Evaluation of Permanent Impairment [35] is that the extent of disability is recognized as a consequence of the interaction between the individual’s work capacity and the job’s demands. However, the severity of the disability is based on the work capacity of the individual compared with an unknown pre-injury standard, as in Table One. Because this is not known, the accuracy of the rating is cast into doubt.

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3. **A New Method**


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The difficulty experienced by physicians in evaluating work capacity has been described [36]. In recognition of this difficulty and with joint concerns about the inaccuracy of physician estimation of pre-injury work capacity and the natural age decrement in work capacity, the authors developed the California Functional Capacity Protocol (Cal FCP). This is a standardized method [37] to measure the work consequences of soft tissue musculoskeletal injury. The Cal FCP allows measurement of the patient’s work capacity by the treating physician so that the information can be used within the California disability determination model. This was submitted to the California Industrial Medical Council in response to a request to investigate the feasibility of using objective medical findings to evaluate soft tissue injuries [38].

The Cal-FCP test battery was designed to be used by the treating physician to address these criteria 30 days after the injury if the individual either has not returned to work or continues in active treatment. This is based on the assumption that, if information was collected by the treating physician that was pertinent to the rating process, additional medical evaluations by physician specialists would be unnecessary. Additional evaluations are extremely expensive, often costing as much as all of the expenditures on medical treatment. In addition, early use of the Cal-FCP addressed a concern that every physician who evaluates the patient increases the probability that the primary care physician’s case control would be diminished or lost. Finally, the use of the treating physician to interpret the results of the Cal-FCP is based on the observation that the treating physician is the best professional to consider the test results in light of issues such as the patient’s motivation, fears and goals and to integrate other medical findings.

4. Description of System

The first step in the development of the Cal-FCP was to develop a flow chart that parsimoniously defined the steps in the decision-making process. This flow chart is presented in Figure 2.
This flow chart is used by the Cal-FCP evaluator to identify the most reasonable disability category. This information is presented to the treating physician as a recommendation, along with all of the data collected during the examination. The treating physician uses these data to prepare a written report that is pertinent to the occupational disability rating model. This should usually be done after 30 days of treatment if the patient has not returned to work and at least once again at the conclusion of treatment if there are permanent functional limitations.

5. Development of Test Criteria

The second step in the process was to set criteria for the test battery that were reasonable within the context of the workers’ compensation system and the limitations of readily available technology. The standards which have been published by the American Psychological Association [39] and the American Physical Therapy Association [40] for evaluation of human performance were used as guides. In these models, there are five issues which must be addressed in the selection and use of any functional test in a patient population. These issues, presented in hierarchical order, are:

1. Safety - Given the known characteristics of the patient, the procedure should not be expected to lead to injury;

2. Reliability - The test score should be dependable across evaluators, patients, and the date or time of test administration;

--- Insert Figure 2 Here ---


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3. Validity - The interpretation of the test score should be able to predict or reflect the patient's performance in a target work setting;

4. Practicality - The cost of the test procedure should be reasonable and customary. Cost is measured in terms of the direct expense of the test procedure plus the amount of time required of the patient, plus the delay in providing the information derived from the procedure to the referral source;

5. Utility - The usefulness of the procedure is the degree to which it meets the needs of the patient, referrer, and payor.

This hierarchy requires that each of the factors be addressed so that the factors which are presented earlier are maintained. For example, it is not permissible to sacrifice safety for the sake of practicality. In addition, the first four factors must be adequately addressed in order for utility to be achieved. Of course, without utility, the test is of no value. Using this approach, the following design criteria were established:

1. Safety - Because the patient may not be medically stable, the test battery must be able to be safely administered under specified circumstances. These are:

   a. Appropriate diagnostic procedures must have been completed to confirm that the test procedures can be administered safely and/or appropriate guidelines for safe test administration can be specified.
b. The test battery must be administered by an appropriately trained physician or by appropriately trained personnel under the supervision of a physician.

2. Reliability - Because the test battery will be administered by personnel with many different types of professional preparation in many different settings to many different types of patients, special efforts must be made to insure reliability. These include:

a. The components of the test battery must be standardized and invariant without regard to the patient.

b. Each instrument in the test battery must have a standardized administration protocol which can be modified to meet the needs of the particular patient.

c. The formal reliability of each test protocol must have been demonstrated experimentally.

d. The instruments in the test battery must require no calibration or must be able to be easily calibrated.

e. The formal reliability of each test instrument must have been demonstrated experimentally.
f. The oral and written instructions must be able to be presented in an understandable manner to the patient, making allowance for the language and level of sophistication of the patient.

g. There must be checks that are built into the test battery to measure degree of effort and to gage the likelihood that the results of the tests are based on full-effort performance.

h. The evaluator must be formally trained and tested. The reliability of the evaluator’s test administration must be demonstrated in comparison to a clear professional standard and on an intra-rater basis within his or her own clinical site. The evaluator must demonstrate ability to administer the test battery in a formal test-retest setting.

i. The reliability of the physician’s interpretation of the test results must be able to be demonstrated on both an intra-rater basis in his or her own clinical setting and on inter-rater basis across physician’s specialties and across clinical sites.

3. Validity - Common and widely agreed-upon performance targets must be used to provide a measure of general work capacity which focuses on the most salient vocational consequences of soft tissue injury. This requires:

   a. The focus of the test battery must be on primary physical job demands.

b. The test battery must use a common and widely agreed-upon work demands taxonomy.

c. Performance references to allow comparison to the work demands taxonomy must be available for each test.

4. Practicality - The cost of the test battery must be reasonable so that the test can be widely available.

   a. The test battery must be able to be administered by a trained technician with proper supervision.

   b. The test battery must use inexpensive equipment that is widely available.

   c. The test battery must require two hours or less for administration.

5. Utility - The test results must help the treating physician to determine:

   a. The injured worker’s ability to return to his or her usual and customary employment.
b. When a functional plateau has occurred during treatment.

c. The functional level at which the patient is likely to return to work.

6. Selection of Tests

After the test selection criteria were specified, the following evaluation tasks were selected, presented in order of administration in the Cal-FCP test battery:

**Structured Interview** - Basic information concerning the patient’s demographics and current status is collected through the use of a structured interview. This segment of the Cal-FCP test battery requires the use of a standard evaluation record. Questions are posed about current functional abilities compared with his or her ability prior to the injury. For example, the evaluator asks:

**How would you rate your ability to sit in an office chair now as compared with prior to the injury?**

or ...

**How would you rate your ability to lift an object from waist to shoulder height with your right hand now as compared with prior to the injury?**

Based on the evaluee’s response, the evaluator rates current ability on a one to five ordinal scale, from “Able” to “Unable” compared with the evaluee’s pre-injury ability using the criteria that are presented in Table 2.
Health Questionnaire - The most physically demanding aspect of the Cal-FCP is the lift capacity test. Because evaluatees must be screened for cardiovascular risk factors prior to undertaking such a test, a health questionnaire is administered and resting blood pressure and heart rate are recorded. After these items are completed, the health questionnaire is reviewed by the evaluator. Items that indicate medical instability or excess cardiovascular risk are noted and explored fully and a determination is made whether or not the lift capacity test battery can be administered.

Perceived Physical Capacity - Perceived functional capacity is an important indicator of the effect of injury. In order to standardize collection of information concerning perceived functional capacity of people with spinal impairment, the Spinal Function Sort [41] is used. The patient is provided instructions and allowed to work on a self-paced basis. The evaluator is available for questions.

Pain & Sensation Drawing - Symptoms are an important indicator of injury, although the contribution of symptoms to the severity of an injury is not straightforward. In order to standardize collection of information concerning symptoms a pain drawing form has been developed. The pain and sensation drawing is completed by the patient with the assistance of the evaluator. The pain drawing allows a record to be made of pain in terms of these factors:

a. Location - The patient uses a red pen or pencil to draw on the figure the location of the pain.

b. Type - The patient draws on the figure the type of pain at each location. Adjectives which are commonly used to describe symptoms are provided with a reference key.

c. Intensity of Worst Pain - The patient draws an “X” on the 10 cm analog scale at the bottom of each drawing with the red pen or pencil at the bottom of each figure to describe “your highest level of pain ... over the past week”. The patient draws a line from the analog scale to each pain location. The pain is rated according to the following scale:

--- Insert Table 3 Here ---

d. Frequency of Worst Pain - After the patient has completed the intensity rating of each symptom area, the evaluator asks the patient about the frequency of this (these) symptom (s) and records the frequency of the drawing according to the following rating scale:

--- Insert Table 4 Here ---

e. Intensity of Usual Pain - The patient draws an “O” on the analog scale with the red pen or pencil to describe “your usual level of pain ... over the past week” and a line from the analog scale to each pain location.
f. Frequency of Usual Pain - The evaluator asks the patient about the frequency of this (these) symptom(s) and records the frequency of the drawing according to the above rating scale.

**Job Demands Questionnaire** - A short questionnaire [42] that structures input from the evaluatee in terms of his or her job demands is completed as the last step in the seated segment of the Cal-FCP. The purpose of this exercise is to provide information about the evaluatee’s perception of the job demands against which the performance test measures can be compared. In addition, this activity extends seated task duration. This information is not included in the disability rating but will be useful to the treating doctor. Accordingly, it is included as an attachment to the Cal-FCP standard report form that is provided to the doctor at the conclusion of treatment.

**Lateral Pinch Test** - Lateral pinch (also known as “key pinch”) strength is measured through the use of the B & L Pinch Gauge following the protocol endorsed by the American Society of Hand Therapists [43] because this has been shown to be reliable [43,44] and normative data are based on this protocol [45].

**Power Grip Test** - Grip strength is evaluated in a seated position through the use of the JAMAR Hand Dynamometer following the protocol endorsed by the American Society of Hand Therapists. Position #2 on the dynamometer handle is utilized because normative data are based on testing with this span [46]. The practice and test protocols are similar to those used for measurement of pinch strength.

**Standing Range of Motion** - The standing range of motion test measures anthropometric range of motion, that is, using the evaluatee’s own stature as a frame of reference. The evaluator begins
each test session by explaining the purpose of the test to the evaluatee. The evaluatee stands in front of a solid wall, at a distance with arms outstretched hands can be comfortably placed on the wall. Feet are shoulder width apart. The evaluatee is instructed to move from a standing position to each posture and to return to a standing position according to the heights listed in Table 4.

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Up to a one-minute standing rest is allowed between postures. The evaluator counts down 15 seconds for the evaluatee to hold each of the five postures.

**Lift Capacity Test** - An isoinertial measure of progressive lift capacity, the EPIC Lift Capacity test (ELC) is used in the Cal-FCP because of the availability of age-based normative data [15,36]. In addition, the ELC has been demonstrated to be safe and reliable, with low reactivity in use with persons who have medical impairments [46,47]. In the Cal-FCP, the first three segments of the ELC are administered, following the standard procedures.

**Carrying Test** - The evaluatee’s ability to carry the loads that he or she was able to lift in ELC Test #3 is assessed through the use of a structured task simulation. The evaluatee is instructed to carry the ELC crate with each of the loads that were used for each stage of ELC Test #3 while walking on a 100-foot course over a flat and unobstructed surface at 3 miles per hour. The evaluatee begins with the starting load for ELC Test #3 and completes one cycle. After a 20-second standing rest, the load is incremented by 10 pounds and the evaluatee completes another cycle. The test progresses in this manner until the maximum acceptable weight achieved in ELC Test #3 is reached. After the evaluatee completes the carrying task, the evaluator rates the evaluatee’s performance according to the criteria in Table 2.

**Climbing Test** - The evaluatee’s ability to climb while carrying the maximum load that he or she was able to lift in ELC Test #3 is assessed through the use of a structured task simulation. This task simulates climbing up and down one ten-foot flight of stairs in an office building. The evaluatee is instructed to carry the ELC crate with the maximum acceptable weight achieved in ELC Test #3 while stepping up and down an eight-inch high step for 15 cycles with a cadence of one-step per second. Cadence is counted by the evaluator. Alternately, a metronome can be used. The evaluatee will require 60 seconds to complete this task. The evaluatee’s ability to complete this task is rated by the evaluator according to the five-point ability scale, from able to unable. After the evaluatee completes the climbing task, the evaluator rates the evaluatee’s performance according to the criteria in Table 2.

7. **Effort Rating**

Because the results of the Cal-FCP had important financial consequences for each evaluatee, it was important to screen for less than full effort performance. Four of the tests (SFS, Pinch, Grip and ELC) have built-in indicators of effort. In addition, an evaluator’s rating of effort was made on each case. The evaluator’s rating of effort previously has been shown to be a reliable and useful indicator of full effort [48] and has been shown to be useful in both assessment and treatment of persons who are disabled due to spinal injury [49,50]. Unlike the ten-point test performance scale used by Hazard and his colleagues [48] or the four-point global scale used by Mayer and his colleagues [49,50], the present study devised a three-level rating scale which focused on effort during the ELC lift test. The scale ranged from “reliable effort” to “questionable effort” to “unreliable effort”. Examples of each were developed and provided to evaluators during the training process.

8. **Test Order**

The evaluation tasks are grouped and each is presented to the evaluatee in an invariant order to allow optimal observation of prolonged sitting. Thus, the lengthy paper and pencil tasks combine to become a functional activity so that sitting tolerance can be assessed. The order which each test is presented to the evaluatee is described in Table 6.

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The duration of each task will vary from patient to patient but has been shown in practice to conform to these general parameters.

9. **Demonstration Project**

Once the Cal-FCP test protocol was developed, training of experienced health care clinicians was undertaken at five centers in various parts of California. A demonstration project was designed to evaluate the implementation of the protocol. The duration of the Cal-FCP protocol in hands other than its developers, the internal consistency of the protocol, and its utility in measurement of work capacity were issues to be addressed in this project.

10. **Methods**

**Subjects** - Sixty-four subjects (32 females and 32 males) were studied. Subjects in this study included adults who were under treatment for work-related soft tissue musculoskeletal injuries as part of the California workers’ compensation program. Lumbar spine patients predominated (n=46), with knee (n=5) and cervical patients (n=4) also represented. The remaining subjects had a variety of soft tissue injuries. Subjects reported onset of symptoms 1 month to 10 years prior to program entry, with a mean (SD) of 1.82 (2.1) years. Only 2 of the subjects were tested.
within 30 days of injury onset, while an additional 23 subjects were tested within one year of injury. Subject characteristics are presented in Table 7.

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**Procedures** - Upon referral to the treatment program, all subjects were provided with an informed consent document and a brief description of the research project. After consent was obtained, subjects underwent Cal FCP testing, following the protocol described above. The test battery was administered by exercise physiologists, a registered nurse, physical therapists and occupational therapists who had participated in a special two-day training program which included a knowledge test and required demonstration of reliability on the lift capacity test with five test-retests of healthy subjects. No new injuries or exacerbations of current impairment were reported.

11. Results

**Subject Characteristics** - A series of unpaired t-tests demonstrated that there were no significant differences between genders in terms of age ($t_{62} = -.124, p = .90$) or time since injury ($t_{62} = 1.42, p = .16$). Expected differences were found for both height ($t_{62} = -6.60, p < .0001$) and weight ($t_{61} = -3.99, p = .0002$), with males being taller and heavier.

**Duration of Test Administration** - One of the most important questions for the demonstration project was how long the Cal FCP test battery would take to administer. The mean (SD) duration was found to be 84 (17) minutes. There were no significant differences between males and females on test battery duration ($t_{26} = .87, p = .39$). No new injuries or exacerbations of current impairment were reported.

**Measurement of Lost Work Capacity** - Another important question for the demonstration project had to do with the measurement of loss of work capacity and the extent to which subjects would be found to be disabled, given use of information from the Cal FCP in the California workers’ compensation system. The Decision Tree depicted in Figure 2 begins with loss of lift capacity. Mean (SD) lift capacity for this sample, expressed as a percent of body weight was 21.1% (12%). As expected, there was a significant difference between males and females on lift capacity ($t_{55} = -3.86, p = .0003$). This sample demonstrated a mean (SD) loss of lift capacity of 40.9% (27.9%). There was no significant difference between men and women in terms of loss of lift capacity ($t_{54} = 1.28, p = .21$), as is described in Table 7. Seven (7) of the subjects (four men and three women) had no loss of lift capacity. An additional 11 subjects (six men and five women) had a loss of lift capacity that was less than 25%, which is interpreted by the California model into no residual disability.

**Disability Rating** - The disability rating that is based on Cal-FCP data was able to be ascertained for 57 of the 64 subjects (89%). The degree to which gender affected disability rating was studied by Chi-Square analysis which demonstrated a non-significant finding ($\chi^2_{7} = 3.81, p = .80$). A similar analysis of the effect of age on disability rating was performed after re-coding age by splitting subjects into two groups, using 40 years as the cut-point. This cut-point corresponds to United States federal age discrimination laws. This analysis also demonstrated a non-significant finding ($\chi^2_{7} = 3.03, p = .88$). The distribution of subjects by disability categories is described in Table 8.

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Measurement of Effort - Twelve of the 64 subjects had effort ratings by the evaluator that were less than full effort. Interestingly, none of the subjects was rated as “not reliable”. All were found to have “questionable” ratings, which were equally divided between males and females. The rating of effort was studied by comparing those subjects who had less than full effort ratings in terms of several performance variables in serial analyses of variance. There were no significant differences between groups based on age, time since injury, duration of testing, pinch or grip. Significant differences were found for Spinal Function Sort score ($F_{1,60} = 11.07, p = .0015$) and loss of lift capacity ($F_{1,54} = 8.04, p = .0064$). The values are presented in Table 9.

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Internal Consistency - The final set of questions for the demonstration project had to do with the consistency of tests within the Cal-FCP battery. In order to address this issue, a series of regression equations were developed between variables that were expected to be related. The regression for pinch strength on grip strength was $R=.63$ on the right ($F_{1,60} = 38.9, p < .0001$) and $R=.67$ on the left ($F_{1,60} = 49.3, p < .0001$). The relationship between the Spinal Function Sort score and both lift capacity and lost work capacity was studied. SFS score predicts lift capacity on ELC test #3 ($F_{1,53} = 26.2, p < .0001$, $R=.58$) and capacity considered as a percent of body weight on ELC test #3 ($F_{1,53} = 28.9, p < .0001$, $R=.59$). SFS score predicts lost work capacity as calculated based on the Decision Tree in Figure 2 ($F_{1,45} = 37.5, p < .0001$, $R=.67$).

12. Summary

This paper describes the development of the Cal-FCP test battery, which is a method to measure the work capacity of people with soft tissue musculoskeletal injuries in a standardized manner. The purpose and goals of the development project were to improve the reliability and validity of

the disability determination system. The established system requires the physician to compare the patient’s current lift capacity with his or her pre-injury lift capacity so that the loss of lift capacity can be used as the basis of disability determination. This is widely acknowledged to be an “educated guess” which is inherently unreliable. A more reliable estimate of lost work capacity can be made by using a procedure for which there are normative data which can be used to guide the physician and other decision-makers. In order to not discriminate unfairly based on gender, normative data must be gender-specific. If such a system is fair, although there will be differences between men and women in terms of test performance, the derived disability rating will not be biased.

The current paper describes the application of the Cal-FCP battery in a clinical setting with injured workers who were evaluated while in the California workers’ compensation program. All had suffered soft tissue musculoskeletal injuries. On average, these patients had been injured almost two years prior to evaluation. More than 70% of the subjects had suffered lumbar spine soft tissue injuries.

The Cal-FCP test battery was designed to provide information to the treating physician 30 days after the injury if the individual either has not returned to work or continues in active treatment. In this demonstration project, referrals for evaluation were accepted without regard to duration of impairment. Surprisingly, the battery more often was used by physicians other than the treating physician for patients who were more than 30 days post-injury. In fact, all but two of the patients were referred after 30 days, with many referred for testing more than one year after injury.

The duration of the test battery was designed to require 120 minutes to complete. On average, the Cal-FCP required less 1.5 hours. If time for test scoring and report preparation is included, more than 90% of the subject’s cases were completed within 2 hours.

The expected gender differences and age differences in current lift capacity were found in this study. However, there were no gender-based or age-based differences in lost lift capacity as measured by the EPIC Lift Capacity test. This is likely to be due to the normative comparison on which the test is based, which is structured by both age and gender. In addition, there were no gender-based or age-based differences in disability rating.

The finding of no apparent bias is disability rating using this system may have important public policy implications. Title VII of the Civil Rights Act of 1964 prohibits discrimination based on race, color, gender, religion and national origin. It was amended in 1972 and 1978. In 1967, the Age Discrimination in Employment Act was passed. This prohibits employment discrimination against individuals over the age of 40. This has been amended frequently in subsequent years. There has been no prior demonstration that the disability rating system employed by the State of California (or by other states or governmental agencies) is gender-fair or absent of age bias. The current system [34] employs an adjustment for age which uses 39 years of age as a reference above and below which the disability rating is adjusted. For example, a disability rating of 50% for a 39-year-old person is modified to be 43% for a 21-year-old and 57% for a 56-year-old. Prior research indicates that a perfectly linear age gradient beginning at 21 years of age is probably inappropriate. It is more likely to begin later, certainly not before 25 years of age. The normative references that are used in the Cal-FCP resulted in no adverse impact against (or advantage for) older persons in terms of derived disability ratings. These data demonstrate a slight age decrement in lift capacity up to and including 39 years, with a pronounced decrement.
after that age. Thus, the California system may over-correct for age, discriminating unfairly against young workers.

In the current project, although men and women differed in lift capacity, the use of lift capacity normative data that were gender-based resulted in no adverse impact against females with regards to either loss of lift capacity or the disability rating. In the United States, this is a legal requirement for performance tests which may affect employment. The California system makes no provision for gender, presuming that the physician’s judgment will allow for gender differences. The apparent inconsistency between excluding an adjustment for gender and including the adjustment for age points to the difficulties that are encountered if normative data are not used to guide such procedures. The use of gender-based norms is certainly preferable to reliance on the physician to fairly estimate loss of work capacity without a gender bias. This has been recognized by the American Medical Association and is included in the grip strength and pinch strength sections of the Guides to the Evaluation of Permanent Impairment [35]. In contrast, for spinal soft tissue injuries, the Guides uses two approaches, one reliant on diagnosis and the other on range of motion measurement. It may be time to consider extending the strength measurement approach used with hand injuries to a measure of work performance such as lift capacity for the spine.

The current study did not make a comparison between the individual’s impairment and the disability rating. Thus, it is not possible to determine their correspondence. However, the World Health Organization [8], the National Center for Medical Rehabilitation Research [6] and the American Medical Association [35] have emphasized the distinction between impairment and disability. In general, disability is due to, but not the same as, impairment. Disability is based on the individual’s task-relevant functional limitations. Thus, it seems reasonable that

measurement of work task-relevant functional limitations would provide a more valid estimate of disability than would a measure of impairment. This will be addressed by future research.

The present study has relevance for other systems of disability determination beyond that employed in California. For example, recent efforts by the United States Social Security Administration to “re-engineer” the federal disability determination system [51] by including functional performance test results should consider inclusion of norms-based references such as were used in the present study. This would serve to facilitate standardization of disability determination so that the age and gender effects on disability determination are appropriately managed.

This research project provides the first example of how functional performance information can be collected and used to complement diagnosis and impairment information to address the extent of the individual’s disability. There is no doubt that additional methods will be developed to further the continuing trend of moving from diagnosis-based disability determination to a functional basis. This is likely to have an important effect on rehabilitation in that it will tend to shift the emphasis on intervention away from palliative treatment to more aggressive functional restoration, using serial functional test performance as a key indicator of treatment effect.

The current research suggests that estimation of the evaluatee’s effort by the evaluator may be worthy of further exploration. It appears that the evaluatee’s effort is reflected in performance on lift capacity tests and on the test of self-perceived physical capacity. These findings support providing the Cal-FCP findings to the physician for interpretation so that the effort rating can be factored into the disability rating, rather than simply using these test results without such interpretation. Further research on the use of the physician’s interpretation may not support this.
strategy, although it seems reasonable to factor in a reliability control such as this in order to improve the likelihood that the test results are valid.

In conclusion, this study demonstrated that the Cal-FCP test battery is a safe, reliable and useful method to objectively evaluate the work capacity of individuals who are impaired with musculoskeletal soft tissue injuries. It can be administered in a physician’s office independently by a specially-trained and qualified professional or by a trained technician under the supervision of a physician in two hours or less. Results of the test battery can be used to rate occupational disability after a serious injury in a manner that is fair and unbiased, taking into account the evaluatee’s gender and the effects of the natural aging process on work capacity. Finally, because this method relies on a statistical estimate of loss of lift capacity, it is likely to be more accurate and reliable than the present system that requires the physician to estimate both the patient’s pre-injury and current work capacity.
References


42. Evanoff B. 1993. Physical demands questionnaire. Washington University School of Medicine, St. Louis.


<table>
<thead>
<tr>
<th>Disability Category</th>
<th>Performance Description</th>
<th>Standard Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Very Heavy Lifting</td>
<td>Loss of approximately one-quarter of pre-injury capacity for lifting.</td>
<td>10%</td>
</tr>
<tr>
<td>b. Very Heavy Work</td>
<td>Loss of approximately one-quarter of pre-injury capacity for performing such activities as bending, stooping, lifting, pushing, pulling and climbing or other activities involving comparable physical effort.</td>
<td>15%</td>
</tr>
<tr>
<td>c. Heavy Lifting</td>
<td>Loss of approximately one-half of pre-injury capacity for lifting.</td>
<td>20%</td>
</tr>
<tr>
<td>d. Heavy Lifting, Repeated Bending and Stooping</td>
<td>Loss of approximately one-quarter of pre-injury capacity for lifting, bending and stooping.</td>
<td>25%</td>
</tr>
<tr>
<td>e. Heavy Work</td>
<td>Loss of approximately one-half of pre-injury capacity for performing such activities as bending, stooping, lifting, pushing, pulling and climbing or other activities involving comparable physical effort.</td>
<td>30%</td>
</tr>
<tr>
<td>f. Light Work</td>
<td>Able to work in a standing or walking position, with a minimum of demands for physical effort.</td>
<td>50%</td>
</tr>
<tr>
<td>g. Semi-Sedentary Work</td>
<td>Able to work approximately one-half the time in a sitting position and approximately one-half the time in a standing or walking position, with a minimum of demands for physical effort.</td>
<td>60%</td>
</tr>
<tr>
<td>h. Sedentary Work</td>
<td>Able to work predominantly in a sitting position, with a minimum of demands for physical effort and with some degree of walking or walking being permitted.</td>
<td>70%</td>
</tr>
</tbody>
</table>


Table 2. Criteria for rating current functional ability.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Carry Task</th>
<th>Climb Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “Able”</td>
<td>Able with MAW&lt;sup&gt;a&lt;/sup&gt; for 100 feet without slowing.</td>
<td>15 cycles/60 seconds</td>
</tr>
<tr>
<td>2. “Slightly Restricted”</td>
<td>Able with MAW for 100 feet slower than usual.</td>
<td>15 cycles/75 seconds</td>
</tr>
<tr>
<td>3. “Moderately Restricted”</td>
<td>Able with MAW for 100 feet with 1 rest break.</td>
<td>15 cycles/90 seconds</td>
</tr>
<tr>
<td>4. “Very Restricted”</td>
<td>Unable with MAW for 100 feet with rest break. Able for 50 feet or able with 10 pounds for 100 feet.</td>
<td>15 cycles/120 seconds</td>
</tr>
<tr>
<td>5. “Unable”</td>
<td>Unable with 10 pounds for 100 feet with rest break.</td>
<td>Unable to complete.</td>
</tr>
</tbody>
</table>

<sup>a</sup> “MAW” indicates maximum acceptable weight from ELC Test #3.
Table 3. Pain intensity rating criteria based on the 10 cm visual analog scale.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe</td>
<td>&gt; 7.6 cm</td>
</tr>
<tr>
<td>Moderate</td>
<td>5.1 cm to 7.5 cm</td>
</tr>
<tr>
<td>Slight</td>
<td>2.6 cm to 5.0 cm</td>
</tr>
<tr>
<td>Minimal</td>
<td>&lt; 2.5 cm</td>
</tr>
</tbody>
</table>
**Table 4.** Pain frequency rating criteria.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Most of the waking and sleeping hours.</td>
</tr>
<tr>
<td>Frequent</td>
<td>Most of the waking hours.</td>
</tr>
<tr>
<td>Intermittent</td>
<td>Several times during the waking hours.</td>
</tr>
<tr>
<td>Occasional</td>
<td>A few times during the waking hours.</td>
</tr>
</tbody>
</table>

Table 5. Standing range of motion performance criteria.

<table>
<thead>
<tr>
<th>Height</th>
<th>Posture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder Level</td>
<td>Stand</td>
</tr>
<tr>
<td>Eye Level</td>
<td>Stand</td>
</tr>
<tr>
<td>Knee Level Stand</td>
<td>Stoop</td>
</tr>
<tr>
<td>Knee Level Crouch</td>
<td></td>
</tr>
<tr>
<td>Knee Level Kneel</td>
<td></td>
</tr>
</tbody>
</table>
**Table 6.** Order and duration (minutes) of testing, Cal-FCP battery.

<table>
<thead>
<tr>
<th>Order</th>
<th>Task</th>
<th>Posture</th>
<th>Duration</th>
<th>Cum Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Structured Interview</td>
<td>Sit</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Health Questionnaire</td>
<td>Sit</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Perceived Physical Capacity</td>
<td>Sit</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>Pain &amp; Sensation Drawing</td>
<td>Sit</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>Job Demands Questionnaire</td>
<td>Sit</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>B &amp; L Lateral Pinch Test</td>
<td>Sit</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td>7</td>
<td>JAMAR Power Grip Test</td>
<td>Sit</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>Standing ROM</td>
<td>Stand</td>
<td>10</td>
<td>70</td>
</tr>
<tr>
<td>9</td>
<td>EPIC Lift Capacity Test</td>
<td>Stand</td>
<td>35</td>
<td>105</td>
</tr>
<tr>
<td>10</td>
<td>Carrying Test</td>
<td>Stand</td>
<td>5</td>
<td>110</td>
</tr>
<tr>
<td>11</td>
<td>Climbing Test</td>
<td>Stand</td>
<td>5</td>
<td>115</td>
</tr>
<tr>
<td>12</td>
<td>Cool-Down</td>
<td>Stand</td>
<td>5</td>
<td>120</td>
</tr>
</tbody>
</table>
**Table 7.** Demographic description of subjects.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 32)</td>
<td>(n = 32)</td>
</tr>
<tr>
<td>Age$^a$ (SD)</td>
<td>38.38 (8.9)</td>
<td>38.06 (11.2)</td>
</tr>
<tr>
<td>Height$^b$ (SD)</td>
<td>69.19 (2.9)</td>
<td>64.15 (3.2)</td>
</tr>
<tr>
<td>Weight$^c$ (SD)</td>
<td>188.69 (37.5)</td>
<td>149.77 (39.9)</td>
</tr>
<tr>
<td>R.A.W.$^d$</td>
<td>26.5% ( 8%)</td>
<td>15.5% (13%) *</td>
</tr>
<tr>
<td>Lost Lift Capacity$^e$</td>
<td>36.2% ( 28%)</td>
<td>45.7% (28%)</td>
</tr>
</tbody>
</table>

$^a$ Mean (SD) years.

$^b$ Mean (SD) inches.

$^c$ Mean (SD) pounds.

$^d$ Maximum acceptable weight on ELC test #3 divided by body weight (SD).

$^e$ Mean (SD).
Table 8. Disability categories based on gender and age.

<table>
<thead>
<tr>
<th>Category</th>
<th>Male</th>
<th>Female</th>
<th>&lt;= 39 years</th>
<th>40 + years</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>d</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>e</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>f</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>g</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>h</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>no disability</td>
<td>12</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>28</td>
<td>31</td>
<td>26</td>
</tr>
</tbody>
</table>
Table 9. Differences related to evaluator’s effort rating.

<table>
<thead>
<tr>
<th></th>
<th>Full Effort (n = 52)</th>
<th>Questionable (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age$^a$ (SD)</td>
<td>38.40 (10.5)</td>
<td>37.42 (7.9)</td>
</tr>
<tr>
<td>Time Since Injury$^b$ (SD)</td>
<td>1.59 (1.8)</td>
<td>2.7 (3.1)</td>
</tr>
<tr>
<td>Duration$^c$ (SD)</td>
<td>83.01 (15.9)</td>
<td>89.33 (16.7)</td>
</tr>
<tr>
<td>SFS Score (SD)</td>
<td>136.18 (44.1)</td>
<td>89.9 (39.4) *</td>
</tr>
<tr>
<td>Pinch Right$^d$ (SD)</td>
<td>18.96 (8.6)</td>
<td>18.18 (5.5)</td>
</tr>
<tr>
<td>Pinch Left$^d$ (SD)</td>
<td>18.65 (8.1)</td>
<td>17.73 (4.5)</td>
</tr>
<tr>
<td>Grip Right$^d$ (SD)</td>
<td>81.4 (33.7)</td>
<td>75.58 (28.9)</td>
</tr>
<tr>
<td>Grip Left$^d$ (SD)</td>
<td>79.04 (31.3)</td>
<td>71.42 (27.8)</td>
</tr>
<tr>
<td>Lost Lift Capacity$^e$ (SD)</td>
<td>36% (28%)</td>
<td>61% (18%) **</td>
</tr>
</tbody>
</table>

$^a$ Mean (SD) years.
$^b$ Mean (SD) years.
$^c$ Mean (SD) minutes.
$^d$ Mean (SD) pounds.

* $p = .0015$
** $p = .0064$
Figure 1. Disability lies at the interface between functional limitations and role demands.
Figure 2. Decision tree for disability rating: California Division of Workers’ Compensation system.

Evaluate Loss of Lift Capacity

- < 25% loss
  - Able
  - Limited

- 25% loss
  - Able to bend, stoop, climb and carry?
  - Limited

- 50% loss
  - Able to bend, stoop, climb and carry?
    - Limited
    - Able to grip and pinch?
      - Limited
      - Able

- > 50% loss
  - Able to stand without limitation?
    - Limited
    - Able to stand with limitation?
      - Limited
      - Able

Disability Category

- Category A = 10%
  - No very heavy lifting.

- Category B = 15%
  - No very heavy work.

- Category C = 20%
  - No heavy lifting.

- Category D = 25%
  - No heavy lifting, repeated bending & stooping.

- Category E = 30%
  - No heavy work.

- Category F = 50%
  - Light work.

- Category G = 60%
  - Semi-sedentary work.

- Category H = 70%
  - Sedentary work.

California Schedule for Rating Permanent Disabilities

Work Capacity Decision Tree

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Page 45
Evaluate Loss of Lift Capacity

< 25% loss

Able to bend, stoop, climb and carry?

Able

Limited

25% loss

Able
to bend, stoop, climb and carry?

Able

Limited

50% loss

Able
to bend, stoop, climb and carry?

Able

Limited

Able to grip and pinch?

Able

Limited

> 50% loss

Able
to stand without limitation?

Able

Limited

Able to stand with limitation?

Limited

California Schedule for Rating Permanent Disabilities
Work Capacity Decision Tree