Quantitative Functional Capacity Evaluation: The Missing Link To Outcomes Assessment

Purpose: Both subjective and objective approaches to outcomes assessment are reviewed and discussed. Five criteria for the development of an instrument are offered, and a comparison of high- versus low-tech functional testing is made. Utilization parameters with risk factors for chronicity are also discussed. **Methods:** A qualitative literature review was performed searching for functional tests which have been found valid and reliable. Tests which included a normative database were selected. After collection of the tests, the most user friendly and valid/reliable were grouped together. **Results:** A functional capacity evaluation approach utilizing low-tech, low-cost tests were collectively grouped together and called the quantitative functional capacity evaluation (QFCE). Each test is listed and includes the procedure, the normative data and the various references reviewed. **Discussion:** The utility, the goals, and the clinical application of the QFCE are discussed. The use of the normative data and pre-/posttest result comparisons are discussed for reasons of documentation, insurance communication, and steering the rehabilitation goals and patient education. **Key words:** *disability evaluation, outcome assessment; range of motion (articular); rehabilitation; work capacity evaluation.*

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Practice aids and algorithms appear in Appendix A.

OUTCOMES ASSESSMENT (OA) is a health care buzzword for the 1990's. Quality assurance in health services delivery requires that certain guidelines be followed and that measurable outcomes be used to document the appropriateness of care. Most methods of OA have been "high-tech", requiring substantial expenses of time and money. Due to the cost and the failure to demonstrate validity, a shift in emphasis to "low-tech" approaches has occurred. Modern methods of OA must be time efficient, economical, reliable and valid.

Modern reporting on spinal pain patients requires a consensus-based classification approach, relevant historical data gathering, and reliable and valid OA of both subjective and functional parameters. Such an approach has great potential for future data collection and analysis and may even allow multiple high-quality care facilities to provide invaluable information for research purposes.

Physicians, insurance companies, medico-legal reviewers and managed care organizations are becoming increasingly interested in OA and functional testing, because of the demand to objectify patient status and document patient progress during the course of treatment[1]. OA represents a method used to measure a change in a patient's health status as a result of some type of treatment approach[2]. OA instruments are also utilized as a tool for measuring treatment effectiveness regardless of methods utilized[3]. Moreover, OA plays an important role in steering quality care and cost containment.

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THE STATE OF THE ART IN OUTCOMES ASSESSMENT

OAs are primarily concerned with showing patient progress over time and objectifying patient status. There are a number of different types of OA instruments that can be performed at critical junctures of patient care. For example, in the acute stage (initial patient evaluation), baseline data can be collected by the subjective OA questionnaires concerning pain level, disability, general health, depression, work dissatisfaction, and others. In the subacute stage, functional outcomes become necessary. A quantifiable functional capacity evaluation utilizing reliable and valid tests that can be compared to a normative data base is essential before the patient has completed 4 to 6 weeks of care. This evaluation enables the patient, doctor and third-party payer to have baseline levels of the patients' impairment or dysfunction and allows for comparison over time. A final type of OA, the work capacity evaluation (WCE), aims to establish return to work (RTW) goals. This evaluation is especially important in medico-legal situations and in instances where disability is involved.

The information gained about the acute patient through the use of subjective OA is critical for documenting, in a quantitative manner, the subjective information concerning how the injury or condition is affecting the patient. Most important, these instruments can be repeated at a future reexamination date and by comparing the baseline or initial information gathered to that at follow-up, confident clinical decision making can occur which can lead to one of the following:

- continued care (if improvement is noted without reaching maximum therapeutic benefit);
- change in treatment approach, strategy or goals (if no clinical improvement or change is noted and case resolution has not occurred);
- initation of rehabilitation and reduction of passive treatment frequency (improvement without resolve and deconditioning is complicating further improvement); or
- referral to another health care provider if therapeutic benefit can be obtained or, simply, a discharge with or without permanent residual sequelae, disability, or impairment.

The ability of the treating health care provider to make the "next" case management decision in the unresolved case has been at the core of the problem regarding overutilization of passive care, doctor dependency, chronic pain behavior, and insurance company "nightmares".

Table 1 lists some of the more common and studied OA instruments[4–40] the health care provider can choose from to

Table 1. Assessment options*

Assessment goals	Instruments
1. General health	COOP charts,[4,5] HSQ,[††] SF-36,[6] SIP[7,8]
2. Pain perception	NPS,[9] VAS,[11–13] McGill[14–16]
3. Condition specific	
• Low back pain[20]	• Oswestry,[17,18] Roland-Morris,[19] Dallas,[21] lower back TyPEs[22]
• Neck	• NDI,[23] headache questionnaire[24]
• TyPE (from Health Outcomes Institute)[††]	• Asthma, CTS, COPD, depression, low back pain, hypertension/lipid disorders, osteoarthritis of the knee, rheumatoid arthritis, allergic rhinitis, smoking cessation, and others[††]
4. Psychometrics	HSQ (questions 37–39)[†,††] SF-36,[†,6] Waddell's signs,[‡25] SARS,[‡26] modified Zung,[27] modified somatic perception questionnaire,[28] SCL-90R,[29] Beck's depression scale,[30] DRAM,[31] FABQ[32]
5. Patient satisfaction	Chiropractic satisfaction questionnaire,[33] visit-specific questionnaire[34–37]
6. Job dissatisfaction	APGAR[38]
7. Disability	Vermont questionnaire,[39] FASQ[40]

COOP = Dartmouth COOP Health Charts; HSQ = Health Status Questionnaire; SIP = sickness index profile; NPS = numerical pain scale; VAS = visual analogue scale; NDI = neck disability index; CTS = carpal tunnel syndrome; COPD = chronic obstructive pulmonary disease; SARS = somatic amplification rating scale; DRAM = distress and risk assessment method; FABQ = fear-avoidance beliefs questionnaire; FASQ = functional assessment screening questionnaire; TyPE = technology of patient experience.

*Once an OA instrument is chosen, do not change to a different OA instrument at follow-up. Otherwise the baseline information cannot be compared to follow-up information.

†Only parts of the questionnaire relate to the categories.

‡These are physical examinations, not questionnaire tests.

§Cannot be scored (not quantitative, only qualitative).

††Available: Health Outcomes Institute, 2001 Killebrew Drive, Ste 122, Bloomington, MN 55425.

help gain the leverage needed to make intelligent clinical decisions. It is necessary to utilize the same OA instrument at follow-up in order to compare results at follow-up reexaminations. Note that there are many different OA instruments from which to choose and the list in Table 1 is not all-inclusive.

The method by which the subjective OA information is documented and reported is important so that the information derived from the OA can be reviewed easily. Ease of review serves the needs of the health care provider (to render appropriate care), the patient (for orientation and referencing his or her response to treatment in a report of findings), and the insurance company (to justify payment of a claim) as well as the attorney (in a medico-legal arena such as a malpractice suit). The form in Appendix A summarizes the various tools one may use. By summarizing the results of the various OA tools on one page, the information can be reviewed quickly and clinical decisions can be driven in a prompt and efficient manner.

The common thread that ties the historical and subjective data to the objective quantitative functiona capacity evaluation (QFCE) is the various OA instruments. Once the patient is subacute, it is essential to establish objective functional baselines. Safety in applying the functional tests must be determined before proceeding with functional testing. It should be noted that functional capacity testing is contraindicated in the acute stage of an injury when pain is more of a "chemical" nature than a "mechanical". Mooney and Matheson recommend that a physical capacity evaluation (PCE) be considered at two weeks' post-injury in order to determine the "weak functional link"[41] and at 4 weeks to perform their California Functional Capacity Protocol (Cal-FCP)[42]. Triano (personal communication, May 1994) has reported that 4 weeks' post-injury is and appropriate time to initiate testing. Hart and associates[43] report indications for functional testing include the following:

- plateau in treatment progress,
- discrepancy between subjective and objective findings,
- difficulty in returning the patient to gainful employment, and
- vocational planning, or medical-legal case settlement.

As soon as the patient leaves the acute guarded stage, the QFCE not only provides ideal outcomes assessment information, but also identifies key functional pathologies that can be addressed with various treatment approaches such as manipulation, exercise, and patient education. Mooney reports that the functional capacity evaluation should be mandatory for any patient still suffering pain after 6 to 7 weeks.[41]

Functional testing serves as an objective OA method, thus complementing the subjective outcomes assessment instruments or questionnaires completed by the patient at various intervals of time during care. The objective functional tests measure factors such as flexibility, strength, coordination, endurance, aerobic capacity, posture and balance. Functional tests, whether provocative or functional in nature, must follow certain criteria in order to be useful and reliable. Five issues which must be addressed in the selection and use of any functional test in a patient population have been described.[42] 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 the evaluators, patients, and the date or time of administration;
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. 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 payer.

High-tech instrumentation and dynametric assessment of the low back have been considered the "gold standard" of lumbar spine functional assessment. This view is largely due to their reliability and reproducibility. However, the validity of some of the high-tech testing approaches has recently become an issue of controversy. Grabiner and colleagues[44] have demonstrated, for example, that normal strength measurements from a high-tech approach does not necessarily correlate with normal human function (47). In this study, electromyography (EMG) was used during isometric trunk extension. The results revealed decoupling, or asymetric lumbar paraspinal muscle activity was present in low back pain subjects who were considered normal on high-tech dynametric testing. This decoupling phenomenon also differentiated between pain and non-pain subjects. This study suggests that musculoskeletal function involves not only strength, but also coordination during the performance of a specified task. Because spinal movement and coordination use complex neuromuscular functions, simple strength assessment by high-tech dynamometer does not necessarily correlate with assessment of spinal function. The EMG results illustrate the limitations of high-tech dynamometric testing of muscle strength and endurance, and they also suggest that the often harsh criticism of low-tech evaluation approaches regarding strength and coordination may be inappropriate and unjustified.

Newton and Waddell[45] reported that no convincing evidence supports that isokinetic or any other type of iso-measure has greater utility in assessing the patient with low back pain

than a clinical evaluation of physical impairment, isometric strength, a simple isoinertial lift or psychophysical testing. Because of the inability to demonstrate high quality of spinal function assessment by high tech methodologies, there has been insufficient evidence to suggest abandonment of lower tech quantifiable tests. Many low-tech approaches to identify functional pathology have been reported[46-73]. Valid and reliable information, often with normative database, has been reported; hence, serves as excellent low-tech functional OA tools. Careful observation of the quality of movement during the test can give valuable insight to treatment prescription addressing functional pathologies such as muscle imbalance, joint stiffness, poor movement and coordination, and postural dysfunction.

Reliability has been reported in several low-tech tests that do not provide numerical quantification results. For example, the *National Institute for Occupational Safety and Health* (NIOSH) *Low Back Atlas* identified 19 tests with significant reliability (<0.74 Cohen's Kappa and >0.79 coefficient for interclass correlation, coefficient [ICC]).[63, 69]. Moffroid[70] studied the ability of the 53 NIOSH tests to discriminate between low back pain and non-painful subjects. It was found that 23 of the 53 tests could not discriminate adequately between the two groups and when the 7 strongest tests were grouped together, a sensitivity of 87% and specificity of 93% were obtained. Interestingly, the most important measurements were those which assessed passive mobility, dynamic mobility, strength, and symmetry. Reports[71] have recently been published that also suggest that non-dynametric tests correlate better with pain and disability than those that deal with isokinetic testing. The authors were careful to point out that non-dynamometric tests are still useful in the clinical setting in spite of the development of more sophisticated and accurate methods of testing muscle strength.[69] Harding and Williams[72] reported a group of low-tech tests were determined safe, reliable and valid for assessment of physical dysfunction in chronic pain subjects. A normative data base segregated by age, gender and vocation (blue collar vs white collar) were studied and found reliable when tests on over 500 individuals were carried out.[73] Hence, because validity and reliability have been established, as well as a normative database regarding several low-tech functional tests, it would appear natural to adopt these particular tests as representatives in a low-tech functional capacity evaluation setting.

THE QFCE

Achieving a low-cost, time-efficient, valid, and reliable method of evaluating functional capacity of a patient was the goal in developing the QFCE instrument. This test is intended to allow the doctor to identify functional baselines for active rehabilitation in order to improve deconditioning and restore function. The QFCE introduces an OA instrument that can be used both as an objective barometer for measuring change in function over time ("descriptive"), as well as an aid in driving specific rehabilitation protocols ("prescriptive"). When coupled with the subjective OA instrument(s), the QFCE enables the provider to document changes in symptoms and function over time. It also provides a method for the health care provider to use in making a clinical decision (change treatment approach, refer, discharge with or without permanent residuals, and so forth), depending in part on the QFCE results. The QFCE is not designed to replace but rather, complement, other qualitative, less "objective" tests such as trigger point and end-feel palpation, postural and gait analysis, and observation of altered movement patterns.

The second goal is to incorporate the QFCE into a computerized format in preparation for establishing a large database for clinical as well as research objectives. Regardless of whether it is used in a computerized or non-computerized format, the data derived from the QFCE can be used to generate reports for documentation reasons which can enhance communication with the patient when reporting findings, with insurance companies when supporting the need for rehabilitative care and with the treating physician/therapist when facilitating the process of establishing maximum therapeutic benefit or maximum medical improvement (MMI) and thus, support case closure or referral.

Each test of the QFCE is fully explained and referenced. When the original reference was unclear, the principle author who described the specific test was contacted and the clarifying information was incorporated into the text. Because low-tech functional testing is gaining interest in the research community, it is probable that the QFCE will be updated from time to time in order to stay current as well as to incorporate new valid and reliable approaches that measure function.

When performing the QFCE, it is important to perform each test as precisely as possible as they are described. Such adherence is important for improving reliability. Ekstrand and coworkers[47] observed an improvement in the coefficient of variation (CV) from 7.5 ± 2.9 to 1.9 ± 0.7 after using the tests for two months and refining their technique. In particular they paid attention to the details regarding:

- standardizing inclinometer placement and allowing the pendulum of the gravity type to swing freely,
- stiffening up the examination table (plywood with straps),
- identifying bony anatomic landmarks (mark on skin), and
- standardizing examination bench height for each visit.

The following text describes each of the 21 tests that comprise the QFCE (in the order they are performed). Data summary and examinations forms are located in Appendix A.

Initial and final test

1. Visual analogue scale

The Visual Analogue Scale (VAS)[10–14] evaluates the patient's perception of his or her pain level on a 0 to 10 pain scale. It is completed at the beginning and conclusion of the QFCE. Pain is most commonly measured by intensity, frequency, and duration. The VAS is a 10-cm line with two pain descriptors at each end ("No Pain" or "0" and "Unbearable Pain" or "10"). For the purpose of the QFCE, the pain being rated is pain that is being perceived at the time the QFCE is administered. Scoring is completed by laying a transparent 10-cm ruler over the line and reading the centimeter and millimeter markings. More specifically, a 0 to 10 scale is used where 1 cm = 1/10 pain; 5.5 cm = 5.5/10 pain; and so forth.

Standing tests

2. Repetitive squat

The repetitive squat[71, 73] evaluates the strength and endurance of those muscles required to perform a squat. The patient stands with his or her feet 15 cm apart and squats until the thighs are horizontal; the patient then returns to the upright position (Fig 1). Each repetition lasts 2 to 3 seconds in duration, and each test is repeated until a maximum number of repetitions is achieved or 50 repetitions are done, whichever occurs first. Observation of the quality of movement as well as the number of repetitions is important as information derived about the quality of movement gives rise to treatment and exercise prescriptions. Therefore, the quantitative information assesses outcomes while the qualitative data drive treatment goals. The normative data are age, gender, and occupational specific, as depicted in Table 2.[73]

3. Range of motion: Lumbar

The range of motion (ROM): lumbar test evaluates the mobility of the lumbar spine[57,74-80] An inclinometer is placed at T-12 and S-2. Sagittal plane movements (flexion/extension) are assessed by placing the inclinometer vertically perpendicular to the spine on the midline. Frontal plane motion (lateral flexion) is assessed by placing the base of the inclinometer horizontal so that the needle hangs freely. The end points of movement are recorded at both the T-12 and S-2 and the difference is calculated using the equation: T-12 – S-2. If the average of three consecutive readings falls within 5° or 10% of the average, the highest of the three readings is recorded. This procedure may be repeated a maximum of six times in attempt to achieve this result.[57] Table 3 presents the normative data for the lumbar spine.[80]

4. Pain/tenderness (Waddell Non-organic low back pain test 1

The Waddell nonorganic low back pain (LBP) signs evaluate for abnormal psychosocial issues.[25] More specifically, this test is performed by applying a light touch in a manner that should normally not provoke pain. A nonorganic pain response is reported when the patient describes or portrays pain. There are five categories (see Table 4) of the Waddell

a

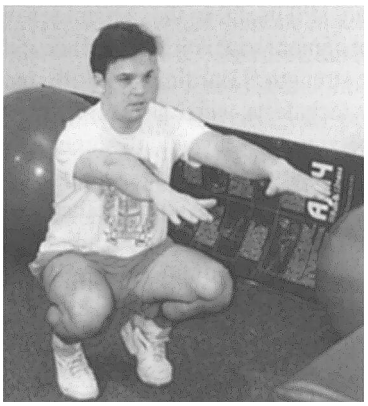

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Fig 1. Repetitive squat test.

Table 2. Normative data for repetitive squatting test*

	Males (n = 242)						Females (n = 233)					
	Blue collar		White collar		All		Blue collar		White collar		All	
Age	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
35–39	39	13	46	8	42	12	24	11	27	12	26	12
40–44	34	14	45	9	38	13	22	13	18	8	20	12
45–49	30	12	40	11	33	13	19	12	26	13	22	13
50–54	28	14	41	11	33	14	13	10	18	14	14	11
35–54	33	14	43	10	37	13	20	12	23	12	21	12

$\bar{X}$ = mean; SD = standard deviation.
*A maximum of 50 repetitions is allowed.
Source: Alaranta H, Hurri H, Heliovaara M, et al. Non-dynamometric trunk performance tests: reliability and normative data. *Scand J Rehab Med.* 1994;26:211–215.

nonorganic LBP test (QFCE tests 4, 5, 8, 9, 10, 13), which are nonprovocative tests (ie, do not try to provoke a pain response such as when performing standard orthopaedic provocative tests). If a pain response occurs, this finding constitutes a positive (+) response. The practitioner should determine if there is a physiological explanation and repeat the tests as many times as needed in order to assure evaluator objectivity. These tests are reported as positive or negative in terms of presence of nonorganic LBP rather than in terms of a number. The final score is documented as the total number of positive signs out of the five (eg, two out of five). When three or more of the five signs are positive, nonorganic LBP must be considered and the psychosocial issues must be therapeutically addressed.

Table 3. Normal ranges of lumbar motion in railroad workers

Motion	Mean ± SD*	Normal range	Percent of normal
True flexion	58 ± 9.6	65°	89.2
True extension	22 ± 9.7	30°	72.7
Pelvic flexion	60 ± 13.8	55°	109.1
Straight leg raise			
Right	77 ± 12.5	75°	102.9
Left	77 ± 12.0	75°	102.9
Right lateral flexion	24 ± 7.4	25°	96.9
Left lateral flexion	25 ± 8.2	25°	100.6

*Sample includes 160 male railroad workers; average age = 35 years ± 8 years; height = 70 in ± 3 in; weight = 187 ± 29 lbs.[8]
Sources: Mayer T, Tencer A, Kristoferson S, Mooney V. Use of noninvasive techniques for quantification of spinal range-of-motion in normal subjects and chronic low-back dysfunction patients. *Spine.* 1984;9:588–595. Mayer T, Gatchel RJ, Keeley J, Mayer H, Richling D. A male incumbent worker industrial database. *Spine.* 1994;19:762–764.

Test 1 is performed by standing or sitting behind the patient and a light touch or pinch is applied to the skin over the lumbar area. A deep type of palpation over a nonanatomic, wide area of pain not localized to one structure is also performed. Observation focuses on looking for a disproportionate or exaggerated response ("jump sign," verbal response, and so on).

5. Simulation (Waddell nonorganic low back pain test 2)

Axial Compression

This test[25] is performed by standing behind the patient and placing a light pressure downward on the occiput, similar to a cervical compression test. However, it is performed in a manner that should not normally provoke pain. Nonorganic LBP is suggested if a pain response is obtained. Neck pain may occur with axial loading; hence, this approach may be contraindicated. If it occurs, downward pressure on the shoulders will simulate a similar test.

Trunk Rotation

This test[25] is performed by standing behind the weight-bearing patient. The pelvis is manually rotated at the hips in a manner that should not normally provoke a pain response. The patient is instructed not to rotate the shoulders beyond the movement being actively assisted by the evaluator at the pelvis. Nonorganic LBP is suggested if a pain response is obtained. (*Note:* if lumbar root pain is present, a false-positive response may be obtained. Therefore, it should be correlated with a straight leg raise and neurologic examination findings.)

The following two functional tests are included in this evaluation due to the importance of the ankle joint in maintaining balance and coordination and its important relationship to the "kinetic chain." In addition, the stability of the subtalar joint is highly dependent on the flexibility of the ankle

Table 4. Waddell nonorganic low back pain signs

Test	Assessment method	Reporting
Pain (superficial)	Light pressure to skin	+ or –
Simulation		
Axial compression	Light downward pressure on calvarium	+ or –
Trunk rotation	Minimal twisting of the pelvis without excess shoulder rotation	+ or –
Distraction	Sitting (distracted) SLR is nonpainful versus the nondistracted supine SLR	+ or –
Regional neurology	Nonanatomic findings during routine neurologic examination	+ or –
Exaggeration	Noted at any time during the physical examination	+ or –

SLR = straight leg raise.
Source: Waddell G, McCulloch JA, Kummel E, Venner RM. Nonorganic physical signs in low-back pain. *Spine.* 1980;5:117–125.

and must be intact for proper proprioceptive function. Determination of the ROM at the ankle can also yield valuable information when correlated to the Dictionary of Occupational Titles (DOT) when assessment of work capacities is requested.

6. Gastrocnemius/ankle dorsiflexion test (knee straight)

In this test,[46,47] the patients stands upright, feet parallel and knees straight. The inclinometer is positioned above the lateral malleolus and "zeroed" in the upright standing position. The patient leans forward, placing the hands on a wall to a point of maximum ankle dorsiflexion (DF), while keeping the heel down; the angle is then measured. The normative data reveals 22.5° ± 0.7°, intra-assay CV is 2.2%, and inter-assay CV is 2.5%[47].

7. Soleus/ankle dorsiflexion test (knee flexed)

The patient position in this test[46,47] is standing with one leg on floor and the foot being tested is placed on a bench. The knee is flexed and the ankle is dorsiflexed to a maximum angle maintaining heel-to-bench contact. The normative data reveal 24.9° ± 0.8, intra-assay CV is 2.2%, and inter-assay CV 2.6%.[47]

Sitting tests

8. Sitting vs supine straight leg raise/distraction (Waddell nonorganic low back pain test 3)

This test[25] evaluates for abnormal psychosocial issues. The patient is seated and the doctor performs a sitting straight leg raise (SLr) test while distracting the patient by the performance of a plantar superficial reflex while rapidly extending the knee. A positive test occurs when there is little to no pain noted in the distracted sitting SLR position and a disproportionately high level of pain observed during the nondistracted supine SLR test (positive "flip" sign). Note that if a sciatic nerve tension sign exist, this test may be invalid. Also, the evaluator should be cautious regarding the speed at which the sitting SLR is performed if nerve tension is suspected. As with the other Waddell nonorganic LBP signs, this test is reported as positive or negative as it relates to nonorganic LBP rather than a number (Table 4).

9. Regional Neurology (Waddell nonorganic low back pain test 4)

This test[25] evaluates for abnormal psychosocial issues. The health care provider performs a standard neurological physical examination (deep tendon reflexes, muscle strength, sensory perception). A positive test is present when the neurologic examination reveals findings that do not follow an expected anatomic pattern or are highly inconsistent (or both). These findings may include altered motor functions where many muscle groups are weak. If the quality of weakness is of a "breakaway" variety, where the patient suddenly discontinues the strength test, one must differentiate between pain-induced weakness (physiologic) and a poor voluntary effort (nonorganic). Sensory changes may be of a nondermatomal variety often with hyperpathia mixed with dysesthesia. Another differential diagnosis to consider is sclerotomal pain which may arise from the posterior disc or joint structure usually described in the history as a deep, nonspecific, rather global distribution, that does not follow any obvious anatomic pathway. In general, the evaluator should look for multiple signs of nonorganic LBP before feeling secure about this assessment. This test is reported as positive or negative as it relates to nonorganic LBP rather than a number (Table 4).

10. Exaggeration/overreaction (Waddell nonorganic low back pain test 5)

This test[25] evaluates for aabnormal psychosocial issues. It is not a specific test but rather inconsistent examination findings with overreaction noted at any time during the consultation or examination. Observation focuses on looking for disproportionate responses, such as tremor, crying out, and collapse. This test is reported as positive or negative as it relates to nonorganic LBP rather than a number (Table 4).

11. ROM: Cervical

This test[57,78,80] evaluates the mobility of the cervical spine. An inclinometer is placed at the occiput and T-1. Sagittal plane movements (flexion/extension) are assessed by placing the

inclinometer vertically perpendicular to the spine in the midline. Frontal plane motion (lateral flexion) is assessed by placing the base of the inclinometer horizontal so that the needle hangs freely. The endpoints of movement are recorded at both the occiput and T-1 and the difference is then calculated using the equation: occiput – T1. If the average of three consecutive readings fall within 5° or 10% of the average, the highest of the three readings is recorded (Table 5). This procedure may be repeated a maximum of six times to try to achieve this result.

Supine tests

12. Modified Thomas test/hip extension test

Five steps are involved with this test.[47, 81–83] The steps are as follows:

1. With the inclinometer placed 5 cm above the patella on the lateral thigh, the patient is first positioned supine with the knees straight on the bench to obtain an initial inclinometer reading, reset at zero.
2. The patient is next positioned at the end of bench in a manner where the ischial tuberosities are supported by the end of the table's edge in a partially standing and sitting posititon.
3. The contralateral knee and hip are flexed to the chest to eliminate lumbar lordosis and the patient is lowered to a supine position.
4. The testing hip is then passively flexed to a 90° angle, the inclinometer is reset to zero and the leg is allowed to hang freely towards the floor fully relaxed.
5. The evaluator records the angle when the tested leg is fully relaxed, hip extended, and the lumbar lordosis is removed.

Table 5. Cervical ranges of motion

Motion	Mean ± SD*	Normal range	Percent of normal
Flexion	53 ± 12.1	50°	105.6
Extension	71 ± 14.1	63°	112.6
Right lateral flexion	49 ± 7.2	45°	109.6
Left lateral flexion	50 ± 7.8	45°	112.0
Right rotation	88 ± 10.6	85°	103.3
Left rotation	90 ± 9.6	85°	105.5

*Sample includes 160 male railroad workers; average age = 35 years ± 7.5 years; height = 64.9 in ± 2.6 in; weight = 187 ± 28.6 lbs.

SD = standard deviation.

Sources: Mayer T, Tencer A, Kristoferson S, Mooney V. Use of noninvasive techniques for quantification of spinal range-of-motion in normal subjects and chronic low-back dysfunction patients. *Spine.* 1984;9:588–595. Mayer T, Gatchel RJ, Keeley J, Mayer H, Richling D. A male incumbent worker industrial database. *Spine.* 1994;19:762–764.

The normative data are 83.5° ± 1.1°, intra-assay CV is 0.7%, and interaassay CV is 1.2%.

13a. Supine vs sitting SLR/distraction (Waddell nonorganic low back pain tests 2)

The reader is referred to the discussion under "8. Sitting vs Supine Straight Leg Raise/Distraction."

13b. SLR (hamstring flexibility) test

A SLR (Hamstring flexibility)[46,47,61,79] test is performed with the doctor supporting the lower extremity (with crook of elbow) while holding the zeroed inclinometer mid-tibia or having it strapped to the lateral thigh (5 cm above patella), the doctor's indifferent hand stabilizes the pelvis. The leg is raised to a point of first of knee flexion (of the leg being tested) and/or the pelvis begins to rock and opposite knee flexes. The evaluator records the hip flexion angle. Normative data range from 70° to 90°.[47]

14. Repetitive Sit-up

In this test,[71–73] the patient is positioned supine with the knees flexed 90° with the ankles fixed. The patient is instructed to sit up until the thenar pad of the hand touches the patella; the patient then curls back down fully to the supine position. The number of repetitions are counted to a maximum of 50. The normative data are age, gender, and occupational specific, as depicted in Table 6.[73].

Prone tests

15. Knee flexion test/nachlas

In this test,[46,47,83,84] the doctor's position is to the side of patient. The patient is placed in the prone position. The inclinometer is placed on the lower leg with the knee fully extended (the feet may hang over the edge to ensure full extension). With the pelvis strapped down, the knee is passively flexed (the heel is brought towards the buttocks). The angle is recorded at the moment hip flexion or hiking occurs. The normal angle equals 147.9° ± 1.6, intra-assay CV is 0.5%, and inter-assay CV is 1.1%.[47]

16. Repetitive arch-up test

When performing the repetitive arch-up test,[71,73] the patient is placed prone with the anterior superior iliac spine (ASIS) just on the table, trunk extended off, arms at sides, and the ankles and thighs are fixed to the table by strapping. The patient raises upwards to the horizontal position and then down to a 45° angle. The number of repetitions are counted (maximum of 50). The normative data are age, gender and occupational specific, as depicted in Table 7.[73]

Table 6. Repetitive sit-up test*

	Males (n = 242)						Females (n = 233)					
	Blue collar		White collar		All		Blue collar		White collar		All	
Age	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
35–39	29	13	35	13	32	13	24	12	30	16	27	14
40–44	22	11	34	12	27	13	18	12	19	13	19	12
45–49	19	11	33	15	24	14	17	14	22	15	19	14
50–54	17	13	36	16	23	16	9	10	20	13	11	11
35–54	23	13	35	13	27	14	17	13	24	15	19	14

$\bar{X}$ = mean; SD = standard deviation.
*A maximum of 50 repetitions is allowed.
Source: Alaranta H, Hurri H, Heliovaara M, et al. Non-dynamometric trunk performance tests: reliability and normative data. *Scand J Rehab Med.* 1994;26:211–215.

17. Hip ROM (internal and external rotation)

To test hip ROM,[59,85] the patient is prone with the inclinometer fixed to the anterior distal third of lower leg; with the knee flexed 90°. A stabilizing strap is placed across the pelvis and internal rotation (IR) and external rotation (ER) of the hip are performed to a point of firm end feel or hip hiking. The evaluator records the angle at maximum IR and ER of the hip. The normative data established by Chesworth are 41° to 45° for internal rotation and 41° to 43° for external rotation.[85]

18. Static back endurance test

In this test,[49,71,73,82] the set up is the same as in test 16, (ie patient is prone with the ASISs just on the end of the table, arms at the sides, and ankles fixed). Rather than performing repetitions, the patients holds the horizontal position for as long as possible or for 240 seconds, whichever occurs first. The normative data are age, gender, and ocupational specific, as depicted in Table 8.[73]

19. Grip strength dynamometry

In this test,[57,86] the patient may sit or stand. A Jamar hand dynamometer, usually in the secord or third position (depending on size of hand), is used to take three readings. the three readings are averaged. The three tests, which are taken at different times during the examination, are considered reliable if there is less than 20% variation among them (this screening effort is a screen for full effort; the 20% variation "screen" can be used to evaluate for poor effort, barring pain-induced weakness is not the cause of weakness.)[86] The evaluator compares normal to abnormal; no significant difference in

Table 7. Repetitive arch-up test*

	Males (n = 242)						Females (n = 233)					
	Blue collar		White collar		All		Blue collar		White collar		All	
Age	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
35–39	26	11	34	14	29	13	28	13	27	11	27	12
40–44	23	12	36	14	28	14	25	14	20	11	23	13
45–49	24	13	34	16	28	15	25	15	31	16	27	15
50–54	21	11	35	17	26	15	18	14	26	14	19	14
35–54	24	12	35	15	28	14	24	14	26	13	24	14

$\bar{X}$ = mean; SD = standard deviation.
*A maximum of 50 repetitions is allowed.
Source: Alaranta H, Hurri H, Heliovaara M, et al. Non-dynamometric trunk performance tests: reliability and normative data. *Scand J Rehab Med.* 1994;26:211–215.

Table 8. Static back endurance test*

	Males (n = 242)						Females (n = 233)					
	Blue collar		White collar		All		Blue collar		White collar		All	
Age	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
35–39	87	38	113	47	97	43	91	61	95	48	93	55
40–44	83	51	129	57	101	57	89	57	67	51	80	55
45–49	81	45	131	64	99	58	90	55	122	73	102	64
50–54	73	47	121	56	89	55	62	55	99	78	69	60
35–54	82	45	123	55	97	53	82	58	94	62	87	59

$\bar{X}$ = mean; SD = standard deviation.
*The maximum amount of time allowed is 240 s.
Source: Alaranta H, Hurri H, Heliovaara M, et al. Non-dynamometric trunk performance tests: reliability and normative data. *Scand J Rehab Med.* 1994;26:211–215.

dominant side strength is considered. If bilateral, normative data can be found in a variety of texts.[57,86]

20. Subjective outcome assessment instrumentation

Several self-administered, subjective OA instruments[4,17–24,27,40] are included in the QFCE for obvious reasons. First, they provide valuable information which has been found to be reliable regarding patient perception of condition-specific problems, general health issues and psychometrics (eg, depression). Second, they serve as valuable and sensitive ways to assess outcomes, which is a primary goal of the QFCE. Third, much has been published regarding their utility and practicality and they complement the functional assessment the same way the history complements the physical examination. Because there are many condition-specific and general health questionnaires, it is important to stay with the same instrument used initially to collect the baseline information throughout the case management process. Information regarding these various instruments has been published elsewhere and will not be specifically discussed at this time.[4–40] See Appendix A for summary page.

21. Post-VAS

The reader is referred to "1. Visual Analogue Scale."

Test completion

The average time for the authors to cmplete the QFCE is 35 minutes (excluding data analysis). No significant problems or exacerbations were experienced in performing the QFCE, and similar success with many of the same tests has been reported elsewhere.[73]

CONCLUSION

With the discrepancy between the inflation rate of healthcare (17%) and the inflation rate (3% to 5%), the need to monitor the effectiveness of treatment becomes obvious.[3] With the objective of cost containment, there is a need for functional tests which are valid, reliable, practical, safe, and useful. The QFCE appears to fulfill these criteria as well as to facilitate the need for objective data that, when coupled with subjective OA instruments, can provide the practitioner with the necessary information to make informed and wise clinical decisions based on OA. The issue of practicality goes further as the various tests which comprise the QFCE are movements of normal daily living. As a result, the manner in which the injured person moves as well as the end point measurement result in both prescriptive and descriptive validity, respectively. The combination of low cost, movements used in activities of daily living, relatively short examination time (35 minutes), and practicality, favors the use of low-tech functional capacity over high-tech instrumentation in these authors' opinion.

Because the QFCE and associated protocol require that care be taken to perform the tests exactly the same as described, a national database is being established for the purpose of determining the reliability and validity of this instrument. A call thus goes out to those who are using the QFCE to forward their results to the principal author. The protocol is available on computer disk which will provide the summary reports, important for documentation reasons and a valuable asset for third-party payers, managed care companies as well as for easy submission of the results for the national database. Appreciation is extended in advance to those who decide to contribute. (Please forward results to the principal author at the correspondence address onthe opening page of the article.)

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