MedX Rehabilitation

Establish specific treatment goals prior to starting a rehabilitation program. This allows the clinician to monitor the patient's progress, and helps determine when maximal medical improvement (MMI) has been reached. Treatment goals should be based upon the assessment of initial MedX testing sessions, and all other objective information available.

Primary Treatment Goals

1. Increase isometric strength through the ROM
   a) reduce the flexion:extension strength ratio (flatten curve)
   b) remove abnormalities in the strength curve related to functional weakness

2. Increase dynamic strength and endurance
   a) absolute workload
   b) time-under-load (using a weightload equivalent to an initial training session)

3. Increase ROM

4. Decrease subjective rating of pain – this should be documented using a validated inventory such as the West Haven Yale Multidimensional Pain Inventory (WHYMPI) or an analog system.

5. Improve functional activities of daily living (ADL) – document by using a proven inventory such as the WHYMPI, SIP, Oswestry, Pain Drawing, etc.

6. Improve psychosocial function – How the patient views him/herself, and how he/she interacts with others. Document by using a proven psychological inventory, such as WHYMPI.

Secondary Treatment Goals

1. Increase overall upper- and lower-body strength

2. Increase aerobic capacity

3. Improve body composition
   a) increase lean tissue
   b) decrease fat tissue

4. Improve posture/body mechanics

5. Improve work-related performance skills

Exercise Prescription Principles

I. Anatomy – Basic Ultrastructure

A. Skeletal Muscle Structural Hierarchy
   1. Myofilaments (actin, myosin; comprise sarcomeres)
   2. Myofibrils (series of sarcomeres)
   3. Muscle fibers (series of myofibrils in parallel)
   4. Fascicles (group of muscle fibers bound by fascia)
   5. Whole muscles

B. Sliding filament theory of muscle contraction

C. Length -Tension relationship

D. Force – Velocity relationship

E. Fiber type characterization

II. Exercise Prescription

A. General Adaptation Syndrome (overload principle)

B. Progressive Resistance Exercise
   1. CES Research
   2. 1-set versus 3-set training

C. Factors involved in designing a training program
   1. Volume
   2. Intensity
   3. Specificity
   4. Recovery

III. Strength Training Adaptations

A. Neural (primary changes in first 4-6 weeks)
   1. Motor unit recruitment
   2. Motor unit synchronization

B. Structural
   1. Biochemical
      a) anaerobic/glycolytic enzyme levels increase
      b) mitochondria levels maintained

   2. Histochemical
      a) hypertrophy (increased CSA)
      b) number of capillaries increased (density drops then is maintained)
      c) number of muscle substrates increase

   3. Bone density increases

Strength Testing, Anatomy & Function

I. Importance of Measuring Muscular Strength

A. Important component of physical fitness

B. Assessment and maintenance of rehabilitation programs

C. Indicator of soft-tissue abnormalities

D. Indicator of performance attributes

II. Types of Muscular Contractions

A. Concentric – shortening of a muscle (e.g., raising a weight)

B. Eccentric – lengthening of a muscle (e.g., lowering a weight)

C. Static (isometric) – no muscular movement (e.g., pushing against a wall)

III. Types of External Resistance of Testing Strength

A. Dynamic
   1. isotonic (IT) = “same tension” (e.g., 1 RM)
      a) variable resistance (e.g., Nautilus, Hammer)
      b) constant resistance (e.g., Universal Gym)
   2. isokinetic (IK) = “same speed” (e.g., Biodex)

B. Isometric (IM) = “same length” (e.g., MedX)

IV. Underlying Objective:

1. to safely and accurately determine the maximal amount of tension (torque) a muscle (or muscle group) can develop at any given point throughout a ROM.

V. Strength Testing Limitations

A. Dynamic testing limitations
   1. strength test is submaximal (e.g., 1RM) and is limited to the weakest joint angle due to biomechanical changes throughout ROM (**IT**).
   2. time for motor unit recruitment is insufficient for a maximal measurement (IT, IK).
   3. acceleration beyond joint’s most biomechanically advantageous position (IK).
   4. safety a key factor: functional capacity can exceed structural capacity (IT, IK).
   5. acceleration/deceleration (as much as 20-30º of ROM (IK)
   6. torque overshoot – large amount of artifact (IK)
   7. impact forces – dangerous and inaccurate (IK)
   8. dampening – causes a shift of curve (IK)
   9. “bell shaped” curve not characteristic of all muscles (IK)
   10. validity and variability are suspect (IK)

Strength Testing, Anatomy & Function (cont.)

B. Isometric Testing Limitations
   1. variations in angle of pull with cable tensiometers
   2. difficulty of reproducing joint angle, and testing at multiple joint angles

C. Common Testing Limitations (IT, IK, IM)
   1. poor body stabilization
   2. poor testing standardization
   3. poor muscle isolation
   4. no compensation for effect of gravity on measurement

VI. Review of Previous Spinal Strength Testing Research & Apparatus

VII. Muscular and Functional Anatomy of the Spine (L5-S1 to T10)

A. Extensor muscles of the lumbar spine
   1. erector spinae group
      a) illiocostalis lumborum
      b) longissimus thoracis (dorsi)
      c) spinalis thoracis (dorsi)
   2. multifidus (deep to erector spinae)
   3. sempispinalis thoracis (dorsi)

B. Lumbar spine kinematics
   1. lumbar extensors act in tandem with hip extensors (hamstrings and gluteals) to produce compound trunk extension
      a) hip extension (femurs rotating around pelvis) account for ~ 110º of trunk extension
      b) lumbar extension accounts for ~72º of trunk extension
   2. with pelvis secure, lumbar extensors function bilaterally to extend lumbar spine
   3. as lumbar spine extends, axis of rotation shits posteriorly and sown to articulating facets on adjacent vertebrae
   4. change in axis of rotation causes lumbar spine to elongate in extension

C. Extensor muscles (deep) of the cervical spine (C1 to T2)
   1. Sub-occipital muscle group
      a) rectus capitis posterior major and minor (2)
      b) obliquus capitis superior and inferior (2)
   2. semispinalis cervicis (primary)
   3. semispinalis capitis (primary)
   4. longissimus cervicis
   5. splenius cervicis
   6. splenius capitis

D. Cerfical spine kinematics
   1. Capitis and cervicis muscles acting bilaterally form a compound movement (occipital and cervical extension) through a 126º ROM.

Human Muscle Fiber Type Characteristics and Classifications*

Type I — slow oxidative — red — slow twitch

Type IIa — fast oxidative glycolytic — white — fast twitch

Type IIb — fast glycolytic

1. Activity	marathon	mid distance (800 m)	sprint! power
2. Fatigue Resistance	hih	moderate	very low
a. aerobic capacity	hi~h	moderate	low
b. anaerobic capacity	low	moderate	high
c. ca pillary density	high (4/fiber)	high (4/fiber)	low (3/fiber)
d. gly'co~en content	low	moderate	high
e. rrutoc ondria density	high	high	low
f. primary A TP source	ox. phos.	ox. phos.	glycolysis
3. Fiber Size	small	medium	large
4. Strength of Contraction	low (IOg/mu)	moderate (20g/mu)	high (50g/ mu)
5. Time to Peak Tension (msec)	80	40	30
6. Fibers per Motor Unit	540	440	750
7. Reference Man	50%	35%	15%
8. Erector Spinae (deep)	55%	45% (Type IIa,b combined)	

- adapted from:

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Recommended Clinical Rehabilitation Protocols

	Weeks 1 through 4		Weeks 5 and Beyond	
	Lumbar	Cervical	Lumbar	Cervical
Sessions/week	2	2	1	2
Reps/session	15-20	15-20	10-15	10-15
Special Conditions			Geriatric patients using lighter resistance, severely limited patients who have progressed slowly, and those unable to achieve volitional fatigue should continue 2/wk sessions	Rep range can remain at 15-20

For the Lumbar

Based upon its research the University of Florida's spinal certification program recommended specific rehabilitative exercise for the spine at a frequency of two (2) times per week on non-consecutive days for the first four (4) weeks using 15-20 repetitions at each exercise session. Following a satisfactory static test at week 4, clinicians are advised to reduce training frequency to 1 time per week for most patients, and reduce the target rep range to between 10 and 15.

After 4 weeks of treatment, many patients have gained strength that now requires more recovery time between application of the stimulus. Researchers (Graves et al., Spine: 15, 1990) found that exercising with the MedX Lumbar Extension Machine to volitional fatigue more frequently than 1 time per week did not result in additional improvement. Risch et al. (Spine: 18, 1993) found that chronic low back pain patients who perform lumbar extension exercise to volitional fatigue 1 time per week demonstrate significant improvements in strength and psychosocial function, with a corresponding reduction in pain.

Volitional fatigue is key to frequency. If a patient is unable or unwilling to carry the exercise to momentary muscular failure, clinicians may choose to continue treatment 2/wk beyond the initial 4 weeks. Exercising twice per week is also common for geriatric patients and those limited in some way that restricts reaching volitional fatigue.

For the Cervical

In order to be extra cautious with resistance load, the cervical can be treated twice per week beyond the first 4 weeks, and reps can remain at 15-20.

Supplemental Exercise

Upper- and lower-body strength and/or aerobic re-conditioning exercise should be implemented if the patient would benefit from such activities. These reconditioning exercises are generally prescribed for patients who are de-conditioned from a lack of regular exercise.

Clinical rehabilitation generally concludes within 8-12 weeks. However, additional treatment may be warranted. For example, patients who are treated at a conservative level due to their low tolerance for exercise may start to receive treatment benefits at 12 weeks. Healthy individuals continue to increase lumbar extensor strength by continued training up to 20 weeks (Carpenter et al, Physical Therapy: 71, 1992).

Clinical justification for continuing a patient's training should be based upon strength and range-of-motion improvements and symptomology documented at 8 and/or 12 weeks. Particular trends such as the patient showing marked improvement from 8 to 12 weeks, should be considered in this decision. If the decision is made to continue treatment beyond 12 weeks, the 4-week cycle should be repeated until the patient has made satisfactory progress.

Standard Lumbar Extension Treatment Plan

ADL	Activities of Daily Living
PRE	Progressive Resistance Exercise
ROM	Range of Motion
IM	Isometric Test
rep	Repetitions
PAE	Progressive Aerobic Exercise

Visit:	
	Week 1
1	* ADL and pain inventories * Light exercise: approximately 2-3 minutes; WT = 45lb - female; 60 lb - male * 3-angle IM practice test at midpoint, fully flexed and fully extended positions approximately 50% effort (submaximal), followed by 5-minute rest * Baseline IM test at standardized test points through full ROM
2	* PRE Wt= 50% peak torque from baseline IM test; 15-20 rep. (Note: an optional IM re-test may be administered if patient reliability is questionable.)
	Week 2
3-4	* PRE 15-20 rep * General PRE and PAE
	Week 3
5-6	* PRE 15-20 rep * General PRE and PAE
	Week 4
7	* PRE 15-20 rep * General PRE and PAE
8	* 4-week IM test * Dynamic Endurance Test, WT=50% peak torque from 4-wk IM test * General PRE and PAE
	Weeks 5-7
9-11	* PRE 10-15 rep * General PRE and PAE

Lumbar Treatment Plan (Cont.)

12	Week 8 * 8-week IM test * Dynamic Endurance Test, same absolute WT as Visit 8 * General PRE and PAE
13-15	Weeks 9-11 * PRE 10-15 rep * General PRE and PAE
16	Week 12 * 12-week IM test * Dynamic Endurance Test, same absolute WT as Visit 8 * General PRE and PAE

Standard Cervical Extension Treatment Plan

ADL	Activities of Daily Living
PRE	Progressive Resistance Exercise
ROM	Range of Motion
IM	Isometric Test
rep	Repetitions
PAE	Progressive Aerobic Exercise

Visit:	Week 1
1	* ADL and pain inventories Light exercise: approximately 2-3 minutes; WT = 60 lb - female; 90 lb - male * 3-angle IM practice test at midpoint, fully flexed and fully extended positions approximately 50% effort (submaximal), followed by 5-minute rest Baseline IM test at standardized test points through full ROM
2	* PRE WT = 80% peak torque from baseline IM test; 15-20 rep. (Note: an optional IM re-test may be administered if patient reliability is questionable.)
	Week 2
3-4	* PRE 15-20 rep * General PRE
	Week 3
5-6	* PRE 15-20 rep * General PRE and PAE
	Week 4
7	* PRE 15-20 rep * General PRE and PAE
8	* 4-week IM test * Dynamic Endurance Test, WT= 80% peak torque from 4-wk IM test * General PRE and PAE

Cervical Treatment Plan (Cont.)

9-14	Weeks 5-7 * PRE 10-15 rep * General PRE and PAE
15	Week 8 * 8-week IM test * Dynamic Endurance Test, same absolute WT as Visit 8 * General PRE and PAE
16	* PRE 10-15 rep * General PRE and PAE
17-22	Weeks 9-11 * PRE 10-15 rep * General PRE and PAE
23	Week 12 * 12-week IM test * Dynamic Endurance Test, same absolute WT as Visit 8 * General PRE and PAE