

# MCU<sup>™</sup>

## Multi-Cervical Unit



The **Multi-Cervical Unit (MCU)** from BTE Technologies has a computerized interface that records real-time cervical spine movement and isometric strength in all three planes of motion simultaneously. This eliminates the subjectivity of manual testing and optimizes treatment planning. Real-time data analysis of psychophysical performance measures are displayed on screen and in comprehensive reporting features for the health care provider, patient, and payer. In addition to evaluation, dynamic isotonic strengthening protocols for aviators and chronic neck pain sufferers have been developed by the US Navy and researchers around the world to objectively and appropriately progress a subject's cervical spine rehab or conditioning program.



Below is a summary of the peer-reviewed, published literature directly linked to the Multi-Cervical Unit. Although the MCU is most commonly linked to the treatment of chronic neck pain associated with Whiplash and Associated Disorders following a motor vehicle accident, the growing body of research appears to have captured a niche in aviation medicine market. Currently the MCU is in use with the US Navy, Australian Air Force, Israeli Air Force, and the British Royal Air Force.

Clinicians who have adopted a "multi-modal approach", the blending of technology and exercise, manual therapy, and modalities, for the treatment of cervical spine musculoskeletal disorders have documented successful clinical outcomes. Enhanced objectivity with evaluation and treatment is providing researchers and clinicians with more effective classification and outcomes prediction strategies to people back on the field, in the cockpit, or driver's seat efficiently and cost-effectively.

## **Cervical resistance training: effects on isometric and dynamic strength.**

Aviation Space Environmental Medicine. 2006 Nov;77(11):1131-5.

- **Taylor MK, Hodgdon JA, Griswold L, Miller A, Roberts DE, Escamilla RF.**

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**INTRODUCTION:** Neck injuries signify a physical fitness and human system problem with high operational significance. The prevalence of injuries in tactical aviators has been reported to be as high as 84%, although few report engaging in neck-specific strengthening exercises. It is generally believed that neck strengthening may result in fewer neck injuries. This study was designed to investigate the effects of 12 wk of cervical strength training (3 d x wk<sup>-1</sup>) on isometric strength, dynamic strength, and hypertrophy in a sample of military men. **METHODS:** Participants were tested for each of the above-mentioned variables before and after the training program as well as at 4-wk intervals, and results were compared with a control group that performed no cervical resistance training. **RESULTS:** Results indicated significant improvements in isometric strength and dynamic strength, typically occurring as early as 4 wk and improving throughout the 12-wk period. Modest increases in neck circumference were also noted. **DISCUSSION:** These findings have implications for military personnel at risk of neck injury in their occupational activities.

***BTE Commentary:** This study reinforces Burnetts study and presents a new methodology for applying a practical progressive loading strategy to increase strength of cervicothoracic musculoskeletal strength. Future studies are needed to evaluate the outcomes over larger and more diverse populations & occupations.*

## A Randomized Controlled Trial on the Efficacy of Exercise for Patients with Chronic Neck Pain.

Spine. 2005 Jan 1;30(1):E1-7.

- **Chiu TT, Lam TH, Hedley AJ.**

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**STUDY DESIGN:** A randomized controlled trial with single-blind outcome assessments. **OBJECTIVE:** To evaluate the efficacy of a neck exercise program in patients with chronic neck pain. **SUMMARY OF BACKGROUND DATA:** The effect of exercise for patients with chronic neck pain has been investigated in a number of studies. The efficacy is, however, questionable. **METHODS:** A total of 145 patients were randomly allocated into an exercise (n = 67) and a nonexercise (control) group (n = 78). Patients in the control group were given infrared irradiation and neck care advice. In addition to infrared irradiation and advice, patients in the exercise group had undergone an exercise program with activation of the deep neck muscles and dynamic strengthening of the neck muscles for 6 weeks. Subjective pain and disability and isometric neck muscle strength were measured at baseline, 6 weeks, and 6 months. Analysis was by intention-to-treat. **RESULTS:** At week 6, the exercise group had a significantly better improvement in disability score (P = 0.03), subjective report of pain (P = 0.01), and in isometric neck muscle strength (P = 0.57-0.00) in most of the directions than the control group. However, significant differences between the two groups were found only in the subjective report of pain and patient satisfaction at the 6-month follow-up. **CONCLUSIONS:** At week 6, patients with chronic neck pain can benefit from the neck exercise program with significant improvement in disability (↓28.8%), pain (↓ 34.9%), and isometric neck muscle strength (↑ 26.1 - 45.7%) in different directions. However, the effect of exercise was less favorable at 6 months.

*BTE Commentary: It is important to note that the strength training group only came for training 2x/wk and that the strength training in both the test and control groups lasted only 6 weeks. "The effect of exercise was less favorable at 6 months" refers to the differences in neck strength between the exercise and control group. However, it is important to note that pain had decreased 33.7% in the exercise group, yet there was no significant change in the control group at 6 months and the likelihood that a subject from the exercise group to have missed a day at work in the last 3 weeks due to neck pain was 3x less (3%) than someone from the control group (9%). Future studies are needed to investigate home & clinic-based strategies to enhance exercise effects at 6 months and beyond.*

## A comparison of training methods to increase neck muscle strength.

Work. 2005;25(3):205-10.

- **Burnett AF, Naumann FL, Price RS, Sanders RH.**

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**OBJECTIVE:** To compare two neck strength training modalities. **BACKGROUND:** Neck injury in pilots flying high performance aircraft is a concern in aviation medicine. Strength training may be an effective means to strengthen the neck and decrease injury risk. **METHODS:** The cohort consisted of 32 age-height-weight matched participants, divided into two experimental groups; the Multi-Cervical Unit (MCU) and Thera-Band tubing groups (THER), and a control (CTRL) group. Ten weeks of training were undertaken and pre-and post isometric strength testing for all groups was performed on the MCU. Comparisons between the three groups were made using a Kruskal-Wallis test and effect sizes between the MCU and the THER groups and the THER and CTRL groups were also calculated. **RESULTS:** The MCU group displayed the greatest increase in isometric strength (flexion 64.4%, extension 62.9%, left lateral flexion 53.3%, right lateral flexion 49.1%) and differences were only statistically significant ( $p < 0.05$ ) when compared to the CTRL group. Increases in neck strength for the THER group were lower than that shown in the MCU group (flexion 42.0%, extension 29.9%, left lateral flexion 26.7%, right lateral flexion 24.1%). Moderate to large effect sizes were found between the MCU and THER as well as the THER and CTRL groups. **CONCLUSIONS:** This study demonstrated that the MCU was the most effective training modality to increase isometric cervical muscle strength. Thera-Band tubing did however, produce moderate gains in isometric neck strength.

***BTE Commentary:** Theraband is an effective low-cost alternative to treatment on the MCU. However, strength gains with the MCU are nearly 50% greater than those achieved with Theraband. From a safety standpoint, the MCU uses fixed plane of motion, minimizing shear and accentuating the need for good craniocervical stabilization. Repetitive use and aging of Theraband may increase the likelihood for a tear or rupture of the band or tube. Additional studies to evaluate cost-benefit analysis of outcomes achieved with clinic & home based and high-tech and low-tech approaches are needed.*

## Predicting Short-Term response and Non-Response to Neck Strengthening Exercise for Chronic Neck Pain

Journal of Whiplash & Related Disorders. 2005; 4(1):43-55.

- **Keating JL, Kent P, Davidson M, Duke R, McKinnon L, DeNardis RJ**

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SUMMARY OF BACKGROUND DATA: People with chronic neck pain respond variably to exercise therapy. The likely success of exercise for chronic neck pain cannot be predicted. STUDY DESIGN: This prospective study tested the relationship between patient characteristics assessed prior to intervention and response to an exercise program for chronic neck pain. OBJECTIVES: To investigate whether responders differed from non-responders with respect to presenting characteristics. METHODS: Data were collected on 336 consecutive patients receiving physiotherapy for chronic neck pain. Subject age, sex, duration of symptoms, compensation status, Neck Disability Index (NDI) item and total scores, cervical spine range of movement, and isometric strength were assessed prior to treatment. Response to therapy was defined as a change of 14/100 or more NDI points. Subjects received a progressive, concentric/eccentric, strengthening program using computerized equipment designed for cervical spine assessment and rehabilitation. Logistic regression formulae for predicting outcome at the completion of the program were developed on one sample (n=122) data and tested on another (n=214). RESULTS: **In the first sample, NDI scores and item responses predicted response or non-response with approximately 70% accuracy.** When tested on the second sample, a prediction model using NDI item scores predicted responders (positive predictive value 56%) and non-responders (negative predictive value 74%) with considerable loss of responder prediction accuracy. Participants with low initial NDI scores (higher functional ability) appeared to benefit less from the exercise program. CONCLUSIONS: Functionally able patients may benefit less from exercise for chronic neck pain than those with greater functional limitation.

*BTE Commentary: Keating et. al. (2005) demonstrates that NDI scores and item responses can predict those who will respond and those who will not respond to strengthening on The Multi-Cervical Unit with approximately 70% accuracy. Also concludes that those patients with greater functional disability appear to benefit more from strengthening on The Multi-Cervical Unit. Analysis of the outcome data in this study indicated a 57% response rate. Future studies to improve accuracy and predictability of response rate are currently underway in Australia at the Melbourne Whiplash Centre.*

## Flight-training Effect on the Cervical Muscle Isometric Strength of Trainee Pilots.

Aviation Space Environmental Medicine. 2004 Jul;75(7):611-5.

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External stimulus/loading initiates adaptations within skeletal muscle. It has been previously found that the cervical area has the highest loading while performing flying maneuvers under +Gz. The first purpose of this study was to examine the neck muscle response to the physical environment associated with flight training, incorporating limited exposure to +Gz force, in a Pilatus PC-9 aircraft. The second purpose was to examine the short-term range of movement (ROM) response to flight training. Isometric cervical muscle strength and ROM was monitored in 9 RAAF pilots completing an 8-mo flight-training course at Pearce Airbase in Western Australia, and in 10 controls matched for gender, age, height, and weight. Isometric cervical muscle strength and ROM were measured at baseline and at 8 mo using the Multi-Cervical Rehabilitation Unit. **Results indicated that an increase in pilot neck strength was limited to flexion while in a neutral position.** No strength changes were recorded in any other site in the pilots or for the controls. These findings suggest that short-term exposure to the physical environment associated with flight training had a limited significant effect on increasing isometric cervical muscle strength. No significant changes were observed in pilot ROM, indicating that short-term exposure to flight does not effect ROM.

*BTE Commentary: Although this study did not use the MCU as a means of treatment or training, its value as a trusted, acceptable testing device to accurately measure ROM and Strength are a foundation for Burnett's 2005 study published in WORK. Additional investigations of commercial and military aviators experiencing neck pain and cervicogenic headaches resulting from musculoskeletal asymmetries and weakness are needed.*

## Evaluation of Cervical Range of Motion and Isometric Neck Muscle Strength: Reliability and Validity.

Clinical Rehabilitation. 2002 Dec;16(8):851-8.

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**OBJECTIVE:** To examine the test-retest reliability and construct validity of cervical active range of motion and isometric neck muscle strength as measured by the Multi Cervical Rehabilitation Unit. **DESIGN:** A cross-sectional study. **SETTING:** Institutional practice. **SUBJECTS:** Twenty-one patients with neck pain and 25 healthy volunteers. **METHODS:** After a trial-run session, active range of motion (AROM) was measured in the subsequent two sessions, with 2-3 days in between. During each session, three measurements were taken for each direction (flexion, extension, lateral flexions and rotations). The measurement of isometric strength was after a 15-minute break following completion of the measurement of AROM. Three measurements were made for each of the six directions (flexion, extension, lateral flexions, protraction and retraction). The software of the Multi Cervical Rehabilitation Unit automatically recorded and calculated the maximum AROM and isometric strength. **RESULTS:** There was a good to high level of reliability in the measurement of AROM for both groups of subjects, with intraclass correlation coefficients (ICCs) ranging from 0.81 to 0.96. Results also demonstrated very good to excellent reliability in isometric strength measurement (ICCs ranged from 0.92 to 0.99). Moreover, there was a significant difference in isometric neck muscle strength ( $p = 0.001$ ) and in AROM ( $p = 0.034$ ) between the two groups. **CONCLUSIONS:** The Multi Cervical Rehabilitation Unit was found to be reliable and valid for testing the cervical active range of motion and isometric neck muscle strength for both normal and patient subjects.

***BTE Commentary:** The key points of Dr Chiu's study confirm that the MCU is a reliable tool for testing both ROM and strength of both healthy and patient populations. This study serves as the foundation for Dr Chiu's subsequent outcome studies and for the biopsychosocial projects he is presently working on in Hong Kong. With the biomechanical improvements to the 2<sup>nd</sup> generation MCU, a research opportunity evaluating the potential for improvements in reliability and validity are indicated.*

## Maximal Isometric Muscle Strength of the Cervical Spine in Healthy Volunteers.

Clinical Rehabilitation. 2002 Nov;16(7):772-9.

- **Chiu TT, Lam TH, Hedley AJ.**

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**OBJECTIVE:** To describe the maximal isometric neck muscle strength in healthy Chinese volunteers, in six different directions, as measured by a Multi Cervical Rehabilitation Unit. **DESIGN:** A standardized cross-sectional observational study. **SETTING:** A university rehabilitation unit. **SUBJECTS:** Ninety-one healthy volunteers aged 20-84. **METHODS:** During the measurement the subject was instructed to do three consecutive steady contractions as hard as possible, with a 10-second rest in between each contraction and a 2-minute rest between different directions. The peak isometric strength for each of the six directions (flexion, extension, lateral flexions, protraction and retraction) was calculated. **RESULTS:** No significant difference was found in muscle strength between different age groups. Isometric muscle strength in the direction of right lateral flexion was significantly greater than that to the left in men ( $p = 0.030$ ), but no difference was found in women ( $p = 0.297$ ). Isometric strength in all directions in men was 1.2-1.7 times that in women (all  $p < 0.028$ ). Correlations between physical measurements (height and weight) and strength values were all insignificant in both genders. **CONCLUSION:** Men have approximately 20-70% greater isometric neck muscle strength than women. Both men and women can maintain high levels of cervical muscle strength in six different directions up to their seventh decade. There is no significant correlation between physical measurements and isometric neck muscle strength.

***BTE Commentary:** One question frequently asked is, "Are the reference values for isometric strength differentiated by age and by gender?" This study supports, as do others performed with other types of dynamometry that strength differences across age groups is not significant, but that gender differences are. In the MCU's software, a patient's measures are referenced based off of gender-specific reference values.*

## **In Review:**

### **The Importance of an Early Positive Change in Neck Function in Predicting Improvement Following a Tailored Cervical strengthening Program for Chronic Neck Pain.**

Manual Therapy. [in review]. 2006

- **Harding LH, Keating JL**

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**STUDY DESIGN:** This retrospective study examined the relationship between improvement in function following 3 weeks (9 treatments) of neck strengthening for people with chronic neck pain and a positive outcome at discharge. **OBJECTIVES:** To determine the potential benefits of exercise for chronic neck pain based on response following 3 weeks of exercise. **SUMMARY OF BACKGROUND DATA:** People with chronic neck pain respond variably to exercise therapy. No research exists regarding factors that signal the likely benefit of neck strengthening for chronic neck pain. **METHODS:** Linear regression analysis was used to examine the relationship between the change in Neck Disability Index (NDI, 0-50) scores at the completion of a course of neck strengthening therapy, and change in NDI scores of 7 or more points recorded 3 weeks (9 treatments) into the program. An odds ratio was derived from the regression analysis to determine whether those who are likely to benefit from sustained exercise therapy can be predicted using response after three weeks. **RESULTS:** At the final evaluation, 57.4% of people (66/115) had improved and 42.6% of people (49/115) had not improved. An overall reduction in self perceived disability could be predicted with high specificity and moderate sensitivity for people with chronic neck pain. A significant change in the NDI at the end of the first 3 weeks indicated greater odds (25.15: 95% CI 7.07-89.49) of achieving a significant change in the NDI at the completion of therapy. **CONCLUSIONS:** Those likely to benefit from therapy can be identified by early response. Positive improvement at 3 weeks on the NDI correctly classified 93.2% (95% CI 80.2%-98.2%) of participants who would display a positive response at the final evaluation. Non-response at 3 weeks correctly classified 64.8% (95% CI 52.4%-75.5%) of people who did not show a positive clinical outcome at the final evaluation. The overall classification accuracy was 75.6% (95% CI 67.1%-82.6%).

***BTE Commentary:** Significant change in NDI at 3 weeks indicates greater odds (25 times) of achieving significant change at discharge. Future studies looking at the cost-benefit relationship to an objective, high-tech, albeit higher expense, treatment among comparable classified diagnosis groups to traditional low expense treatments is warranted.*