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PICO question: In patients with COPD, is rib cage mobilization or incentive spirometry more effective at increasing distance walked.

First Author, Year	Sample(s)			Intervention(s)			Outcome measure(s)	Findings	Applicability (relevance to your question and clinical practice)	Comments on evidence level / study quality
	Age, Gender	Time since injury/event	(other, eg. Injury severity measure)	Experimental	Control	NA / Other				
Malaguti, 2009	N=26; all Male; age 68	COPD: FEV_1 45% predicted	No COPD exacerbations, no smoking, no O2 dependence, no comorbidities (neuro, cardiac, respiratory), no chest wall deformities or high BMI	none	Measurement of Max. Expiration & Max. Inspiration chest expansion at 3 anatomical levels ***All measurements performed on 2 separate visits over 2 days***		*Inter- and Intra-rater reliability at 3 different anatomical levels *Inspiratory Capacity per spirometry	*Good Reliability (p.001) all levels, all raters between measurements *Fair-Good INTERrater reliability (p.004) b/w visits *Fair-Good INTRArater (p.001) b/w visits *Sig. correlation with Inspiratory Cap. & Abdominal Mobility only	The results regarding inter- and intra-rater reliability regarding chest wall mobility measurements is useful to establish it as a viable means of obtaining objective measures regarding change in chest wall mobility following an intervention. Additionally, the correlation b/w mobility, though only at the abdominal level, to inspiratory capacity demonstrates beginning evidence of chest wall mobility correlating with improved respiratory function. Could be used as a base study for one which included the link to a functional outcome or QoL indicator.	**Cohort** Study, no control group **All** male, unsure of correlation with females **Additional** respiratory function tests would have been helpful such as residual volume and total lung capacity **Measurers** were blinded, appropriate statistics were performed **Unsure** of standardization of tape measurement process
Putt, 2008	N=14; 8M; age 66	COPD: FEV_1 <70% predicted	Excluded for: dypsnea >5; contraindications for hold relax technique	Hold-Relax Stretch to chest muscles	PROM in resistance-free ROM ***Interventions performed for each group x 2 days, 3 day wash out period, then each received the opposite intervention x 2 days. Base and final measurements taken directly before and after***		*Chest Expansion; *Vital Capacity; *Shld ROM; *Dypsnea; *Resp. Rate; *ACE, XCE	↑ VC in Hold-Relax (p.005); ↑ Shld ROM in Hold-Relax (p.004); Near Sig. effect ACE in Hold-Relax; No effect XCE with Hold-Relax, or in resp. rate or dypsnea	Vital Capacity improvement is correlated with overall respiratory improvement. The ability to perform an intervention as a PT which impacts the chest wall mobility only and shows improvement in vital capacity begins the evidence for the correlation between chest wall mobility and improved respiratory function. The study would have been more applicable to PT had it included a functional test such as the 6MWT	**RCT** double-blind crossover **Small** sample size **Vital** capacity measured which correlates with the restrictive issue in COPD-good -no functional tests or QoL indicators used **Appropriate** statistics **Immediate** effects only **High** risk of bias
Leelarungrayub,2009	N=1; age 60M	COPD, ventilated x 3 months	Obstruction from secretions,recurrent		CPT-standard Chest wall stretching: thoracic rotation, mid-sternum stretch, lateral thoracic,mid-thoracic spine with deep breathing ***Unclear of intensity or duration of the interventions***		*Expired tidal volume (ETV) *Dypsnea Level (BORG) *Chest Expansion (tape measure nipple level)	↑Chest Expansion (2.1cm-3.cm) ↑ETV -significantly (no p value) ↓Dypsnea (6.6-4.2)	This case-study did not provide enough information regarding the interventions, order of intervention, skill sets or training of the providers of the interventions or the intensity or schedule or duration of the interventions for the outcomes to matter to my clinical practice. Overall, it is of such poor quality, it is not useful to support my PICO despite it's reporting of favorable outcomes with their chest wall stretching activities.	**Single** subject case-study **Outcomes** reported as clinically significant but supportive data was not included **Inconsistencies** in reporting of intensity and duration of interventions **Poor** control of interventions
Zanotti, 2011	N=20; 15M, age 64	COPD: FEV_1 <30% predicted	Excluded for: Low BMI, no neuro or ortho disease limiting mobility, no COPD exacerbations in 3 months	Osteopathic Manual Therapy **(OMT)** by chiro student to neuromuscular and cranial system Standard Education, nutrition, psychological support ***1x/week for 4weeks, unclear time***	Pulmonary Rehab (**PR**) standard respiratory therapy pulmonary rehab interventions Standard Education, nutrition, psychological support ***2 x per day 40 sessions, unclear time***	PR and Soft Manipulation **$(SM)_{sham}$** UE/LE Cycling and PR Standard Education, nutrition, psychological support ***2x per day, 30 min per session 40 sessions***	*Exercise Capacity (6MWT) *Pulmonary Function Test (PFT) via incentive spirometry	6MWT improved OMT/SM sig. OMT sig. > SM in 6MWT (p.01) OMT ↓ Residual Volume (p.05) significant b/w groups (p.001) ONLY OMT ↑ in FEV_1, no b/w group difference	This study provides initial evidence to support the benefit of manual therapy in improving functional and respiratory function outcomes EVEN WITHOUT EXERCISE TRAINING and more significantly than PR alone. Were this a better quality study, it would be a valuable resources in guiding clinicians to intervention choices for COPD patients to improve their function.	**RCT** double-blind **Appropriate** statistical analysis performed **Restricted** to low BMI, unsure of carryover to others **OMT** not standardized or explained, can not be duplicated **More** severely impaired than other studies
Engel, 2012	N=15; 9M; age 56	COPD: FEV_1 <62%	Excluded for: inability to walk, more severe COPD, contraindications to spinal manipulation	Soft Tissue & Manipulation **(SM)** HVLA manipulation to thoracic, costovertebral and transverse + ST	Soft Tissue **(ST)** gentle massage mm of post chest ***ALL groups: 8 interventions 4 weeks, 2x/week***	Soft Tissue, Manipulation & Exercise **(EX)** Continuous walking x 6 min plus SM & ST	*FEV_1 *Forced Vital Capacity (FVC) *QoL- CRQ-SAS chronic resp. question. *Exercise Capacity 6MWT *Monitoring of adverse events	↑FVC in EX not ST, SM (b.001) ↑6MWT distance EX, SM not ST ↑Improved dypsnea rating SM, EX not ST No significant adverse events	The use of manual therapy appears to enhance functional outcomes, be cause there was no significant difference between groups SM and EX for FVC, 6MWT and dypsnea rating, it shows one intervention is not superior to the other, but that ST without Sm and EX does not have a positive impact on the outcome measures examined. A larger study would enhance these findings and their generalizability.	**RCT** with blinded assessors and subjects **Lack** of exercise only group as control group **Clear** descriptions of interventions **Use** of functional outcome and QoL outcome useful **Lack** clarity for inclusion/exclusion criteria for mobility or medically limited

Scherer, 2000	N=30; 19M; age 67	COPD; FEV_1<70% predicted	Excluded for: Activity limitations other than dypsnea, cardiac (could be cleared), poor compliance, drug/alcohol abuse, O2 retention, mechanical vent	Respiratory Muscle Endurance Training **(RMT)** normaocapneic hyperpnea training with new mechanical device	Incentive Spirometry breathing exercises	n/a	*Respiratory mm endurance (sustained ventilation) *Inspiratory mm endurance (sustained inspiratory threshold) *Maximal Expiratory Pressure *6MWT distance *VO_2 peak *SF-12 physical & mental component (QoL)	↑inspiratory mm endurance RMT vs. control (p.010) ↑6MWT (p.015), VO_2 peak (p.002) & SF-12 physical (p.o3) with RMT No Change SF-12 mental Both groups ↓ dypsnea, no sig. b/w groups difference ↑PE_{max} (p.001) (not Pt_{max}) in RMT (p.oo2) ↑Exercise performance both groups, larger gain in RMT, clinically relevant at 58 m increase in 6MWT ***Both groups trained 2x daily for 15 minutes each time for 5 days per week for 8 weeks.***	Training with the device for normocapneic hyperpnea improved PEmax, indicative of a training effect, and a greater gain in distance on the functional performance of a 6MWT and on QoL indicator, SF-12 physical portion. I do not have access to this type of equipment and therefore, though it is good to know that training of the endurance mm of respiration, it is not something I can replicate in my daily interventions. It therefore, does not have strong value to my PICO.	**RCT** single-blind study **Well** defined inclusion and exclusion criteria **Activities** outside of study not well controlled or identified, leading to probable high degree of bias **Control** group was a sham use of incentive spirometry, should have included group using incentive spirometry appropriately to determine if this costly device is truly better than incentive spirometry, versus nothing, as in this study
Heneghan, 2012	7 Studies N ranged 5-35 No age restriction	COPD (allowed emphysema and bronchitis) of "mild to moderate" severity *this was not defined*	Exclusion not listed	Manual Therapy (MT) to include hands on techniques including manipulation, mobilization, ROM	Control/ Sham treatments defined as routine, light touch, non-therapeutic or no intervention ***Dose, frequency and time variable from single session - may sessions over period of time to 9 month study***	n/a	Any lung parameter including: FEV_1,FVC, VC were sought out, variable measures used in each study.	**Miller,** 1975 RCT *↑FEV_1 , VC TLC & pt. reported outcomes with OMT **Howell**, 1975 pre-post study *improved O2 sat & TLC with OMT **Witt,** 1986 Crossover RCT *↑FVC, FVC% predicted ↑ in Trager method & improved self-reported QoL **Beeken,** 1998 pre-post study *↓FVC, FEV_1 no QoL: poor quality **Noll**, 2008 Double-blind RCT *↓FVC, FEV_1 TLC with OMT, +benefit QoL and breathing ease-much more severe level of COPD and older **Putt**, 2008 Double blind crossover *Post intervention ↑VC, no change dypsnea **Noll,** 2009 RCT *no sig. change after any intervention or from baseline**,** ↑pt reported QoL with most interventions	The selection of subjects, research settings, skill of persons performing the intervention, blinding only achieved in 2 of the studies al raising question regarding the quality of the evidence reported. The types of interventions and outcome measures used were so scattered they were not able to be compared to each other. There is little conclusion I can draw from this small sample of 7 included studies to look at the use of manual therapy techniques in the management of COPD.	**Systematic Review** **Small** sample sizes Poorly defined recruitment **Variety** of interventions presented made comparison impossible **Inconsistent** use of outcome measures made comparison of benefit difficult **Lack** of inclusion of functional outcome measures limits application clinically for PT
Geddes,2005	19 studies N= 12-133 Avg. Age 61-70 70%+ M	Adults with COPD: FEV_1 24-52% predicted,		Inspiratory Muscle Training (IMT): any intervention to train the inspiratory muscles	No Intervention - medical management only or Sham/low intensity Intervention which was same as experimental group, but to a lesser degree ***Dose and intensity and duration varied from 1-3x per day, 2-7 days per week and 6-24 weeks.***		*Inspiratory muscle strength *Maximum inspiratory pressure *Inspiratory muscle endurance *Exercise capacity (6MWT, BORG) *dyspnea *QoL *Lung volumes /spirometry (forced vital capacity, forced expiratory volume)	**Inspiratory Muscles Strength:** *7 of 9 studies showed IMT better than Sham or low-intensity IMT **Inspiratory Muscle Endurance:** * 3 of 4 studies favored IMT over sham or low intensity **Exercise Capacity:** *Only 2 studies, no significant effect for IMT versus sham/ low intensity **BORG scale for respiratory effort :** *Only 2 studies, no significant effect b/w groups **Dypsnea Index**: *sensitivity testing favors IMT for decreasing self-reported dypsnea ratings **Spirometry/Pulmonary Function:** *FVC improved of 3 of 4 studies **FEV_1** *2 of 4 studies showed improved performance on this measure with IMT, though not significantly greater than sham or low intensity	The methods of intervention, definitions of sham versus intervention and outcome measures varied to such a great degree, comparisons were difficult. Overall, the researchers report IMT appears to be useful in improving respiratory function. However, IMT did not show favorable outcomes in the measures I am interested in for my PICO question including exercise capacity and BORG respiratory effort scales. Interestingly, spirometry did not always improve the functional measures it is stated to be used to treat, making me question it's application in any situation.	**Large** variance in sample size (12-133) provided more weight to one study than another in terms of outcomes **Variance** in recruitment, application and type of intervention and statistics and outcome measures made comparison difficult **Predominantly** males were used, questionable transferability of information to females **Immediate effects** versus long-term outcomes **Did only** include RCT**'s** **Variance** in amount of supervision and outcome based on target or non-targeted threshold instruction
Abbreviations: ACE -axillary chest expansion; XCE- xiphisternal chest expansion; b/w- between; QoL- quality of life; sig.-significant; cap. - capacity; resp. - respiratory; CPT - chest Physical Therapy; HVLA-high velocity low amplitude; mm- muscle; post. - posterior; FVC- forced vital capacity; FEV- forced expiratory volume; VC- vital capacity; TLC- total lung capacity; pt.-patient; sat. - saturation										