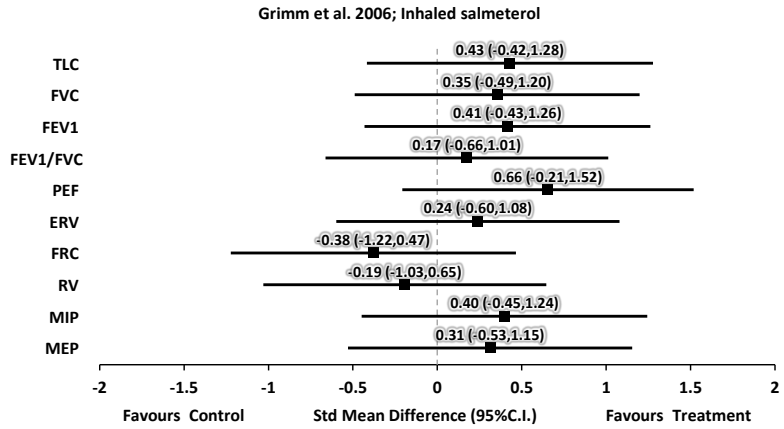
Author Year Country Research Design Score Sample Size	Methods	Outcome
[Grimm et al. 2006](#) USA RCT (crossover) PEDro = 6 Level 1b N initial = 13 N final = 11	**Population:** 13 males; mean (SD) age: 40 (8) yrs; DOI 18(10) yrs; complete and incomplete, C4-C7. **Treatment:** Salmeterol inhalation (50 µg) **Outcome Measures:** Spirometric and lung volume parameters, MIP, and MEP.	1. Regardless of administration order with placebo, salmeterol was associated with a significant increase in FVC, FEV_1, PEFR, MIP and MEP compared with placebo and baseline. 2. ERV increased significantly during salmeterol administration compared to baseline.
	Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention data. 	
[Schilero et al. 2004](#) USA Pre-post Level 4 N = 10	**Population:** 5 tetraplegia (C4-C7), 2 complete, 3 incomplete, mean(SD) age:45(16) yrs, 17(8) yrs post-injury; 5 paraplegia (below T5), 2 complete, 3 incomplete, age:40(9) yrs, 19(10) yrs post-injury. **Treatment:** Inhalation of 0.3 mL of 5% solution of metaproterenol sulfate via nebulizer. **Outcome Measures:** Spirometry and specific airway conductance as measured by body	1. In people with tetraplegia, inhaled metaproterenol resulted in significant increase in specific airway conductance and significant increases in FEV_1 and forced expiratory flow 25-75%. 2. In people with paraplegia, inhaled metaproterenol resulted in significant increase in specific airway conductance although the increase was considerably less than that seen in

	plethysmography pre- and post-bronchodilator.	tetraplegia. There was no significant change in FVC, FEV_1 and forced expiratory flow 25-75%.
Grimm et al. 1999 USA Pre-post Level 4 N = 15	**Population:** 9 tetraplegia (C4-C7) and 6 paraplegia (T9-L1), 4 complete & 11 incomplete, all male, age:25-61yrs, 4-32yrs post-injury **Treatment:** Increasing duration of exposure time to ultrasonically nebulized distilled water (UNDW). 5 participants responding to UNDW returned on a separate day for UNDW challenge following the inhalation of aerosolized ipratropium bromide. **Outcome Measures:** Spirometry, PD_{20}	1. 8/9 tetraplegic participants (known histamine response positive) had a significant bronchoconstrictor response to UNDW (PD_{20} 7.76 +/- 7.67 mL). 2. 0/6 paraplegic participants (known histamine response negative) demonstrated a response to UNDW (PD_{20} 24 mL). 3. 5/5 tetraplegic responders to UNDW no longer responded after pretreatment with ipratropium bromide.
Singas et al. 1999 USA Prospective controlled trial Level 2 N = 25	**Population:** 25 tetraplegia (C4-C7): 10 complete & 15 incomplete, all males, age range:23-63yrs, 1-40yrs post-injury, 12 maintained on oral oxybutynin & 13 age-matched controls. **Treatment:** 6/12 oxybutynin participants were challenged with methacholine, & 6/12 with histamine; 7/13 control participants were challenged with methacholine & 6/13 with histamine. Increasing concentrations of aerosolized histamine or methacholine were administered. **Outcome Measures:** Spirometry, $PC_{20.}$	1. All 13 control participants (methacholine and histamine) and all 6 oxybutynin-histamine participants had a significant bronchoconstrictor response (PC_{20}<8 mg/mL). 2. The oxybutynin-methacholine participants had a normal response to methacholine. (PC_{20}>=25 mg/mL).
Fein et al. 1998 USA Pre-post Level 4 N = 15	**Population:** 15 tetraplegia (C4-C7): 5 complete and 10 incomplete, all male, age range: 24-64yrs, DOI range: 3-31 yrs **Treatment:** Increasing inhaled concentrations of aerosolized histamine diphosphate. Responders to histamine were	1. 12/15 participants had a significant bronchoconstrictor response to aerosolized histamine (geometric mean PC_{20} 1.27 mg/mL). 2. There were no significant differences in FVC and FEV_1

	retested on a separate day after pre-treatment with ipratropium bromide 72 mcg. **Outcome Measures:** Spirometry, PC_{20}.	values between responders and non-responders. 3. All 12 participants initially responsive to histamine were again hyperresponsive at the time of rechallenge following ipratropium (geometric mean PC_{20} 1.50 mg/mL).
Grimm et al. 1997 USA Prospective controlled trial Level 2 N = 24	**Population:** tetraplegia (C4-C7), all male, age range: 23-65, time since injury range: 2-29 yrs, 14 on chronic oral baclofen and 10 age-matched controls **Treatment:** Administration of histamine by inhaler in 14 baclofen participants and 10 controls. Administration of methacholine in 4 baclofen participants and 5 controls. **Outcome Measures:** Spirometry, PC_{20}.	1. 11/14 participants on baclofen and 8/10 control participants had significant bronchoconstrictor response to histamine. 2. There was no significant difference in mean PC_{20} between the baclofen and control groups (mean(SD) PC_{20}= 2.91(2.3) and PC_{20} =2.18(1.9), respectively). 3. The methacholine and histamine PC_{20} were almost identical in controls. ¾ baclofen participants had significantly different responses to methacholine and histamine.
Almenoff et al. 1995 USA Pre-post Level 4 N=25	**Population:** 25 tetraplegia: 6 complete,19 incomplete, all male, mean (SD) age: 43(3) yrs, 11(2) yrs post-injury. **Treatment:** Administration of 72 mcg ipratropium bromide by inhaler with spacer. **Outcome Measures:** Spirometry pre- and post-bronchodilator (improvement in FVC or FEV_1>=12%).	1. 48% of participants had a positive bronchodilator response (6/10 smokers and 6/15 non-smokers). 2. There were no significant correlations between the response to ipratropium and dyspnea at rest, smoking history, or sensory completeness of cord lesion.
Dicpinigaitis et al. 1994b USA Prospective controlled trial Level 2 N = 14	**Population:** tetraplegia (C4-C7); all male, age range 23-57 years, 6 on chronic oral baclofen and 8 controls **Treatment:** Administration of increasing concentrations of nebulized methacholine. **Outcome Measures:** Spirometry, PC_{20}.	1. 8 out of 8 control participants showed significant bronchoconstrictor response to methacholine (mean(SD) PC_{20}= 1.42(1.6)). 2. 2 out of 6 baclofen participants had borderline to mild bronchoconstrictor response to methacholine.

		4/6 baclofen participants did not respond to methacholine (mean(SD) PC_{20}= 15.0(9.1) for baclofen group). There was no correlation between PC_{20} and dosage or duration of baclofen.
Spungen et al. 1993 USA Pre-post Level 4 N = 34	**Population:** tetraplegia: 34 males, all motor complete, non-smokers' mean(SD) age:40(5) yrs, smokers' age: 48(3) yrs, 11.8(1.6) yrs since injury. **Treatment:** Inhalation of 2.5 ml metaproterenol sulfate inhalation solution. **Outcome Measures:** Spirometry pre- and post-bronchodilator (improvement in FEV_1>=12%).	1. 41% of participants demonstrated a significant response in FEV_1 to inhaled metaproterenol (5/12 non-smokers and 9/22 smokers). 2. In the non-smokers, the correlation of FVC and FEV_1 with level of lesion was positive and significant prior to administration of bronchodilator and became more significant post-bronchodilator. 3. In the smokers, FVC and FEV_1 failed to significantly correlate with level of lesion.