November 2025

Using CO_2 Rebreathing to Mitigate Sleep Disordered Breathing

Preamble: Although most references describe the US prevalence of sleep apnea in men to be 14% of the population[1] (and women to be 5%), the largest distributor of Sleep Apnea gear (ResMed) states that "Nearly 1 Billion People Worldwide Have Sleep Disordered Breathing (SDB)" as defined by Obstructive (OSA)[2], Central Sleep Apnea (CSA)[3] and Cheyne-Stokes Respiration.[2,4] Subgroups could also include Upper Airway Resistance Syndrome[5,6] and Sudden Infant Death Syndrome. "The economic burden of OSA-related automobile collisions alone is enormous.[7] Patients with sleep apnea have a three- to sevenfold increased risk of motor vehicle crashes."[8,9] Tens of billions of dollars are lost to Sleep Disordered Breathing annually, the cost to society in pain and suffering is immeasurable.[10]

Contemporary treatments for SDB are tenuous at best (compliance rates for OSA are only 20-40%)[11,12,13] and presently no treatment exists at all for CSA. The two major treatments of OSA include Continuous Positive Airway Pressure (CPAP) and Mandibular Advancement Devices (MAD)[14] and costly (>$30,000) surgical treatments include a Uvulo-Palato Pharyngoplasty (UPPP) and Inspire™. Poor compliance rates are also anticipated due to the incredible prevalence of complications and frustrations with these treatments. CPAP concerns include, but are not limited to: Aerophagia-swallowing air, discomfort, claustrophobia, mask leak, dry, stuffy nose or nosebleeds, skin irritations, dry, mouth, infections, headaches, lung discomfort, dizziness and shortness of breath[15]. Whereas the MADs cause jaw pain (and fatigue), teeth sensitivity, dental damage and near 100% need for realignment orthodontia.[16] There is an obvious need for a novel treatment that provides efficacy and compliance and reduces complications.

Treating SDB with CO_2 is *not new*. The use of CO_2 to stabilize periodic breathing has been investigated since the early 1980s.[17] Studies dating back to 1995 can be found with rather dramatic claims of near eradication of apneas and hypopneas (partial breathing). In fact, CO_2 helps reduce apneas and improves sleep quality (compared to CPAP).[18,19] Studies have already been done on added dead space to treat CSA.[20] Further, Patz and Hacket et. al. found that using a dead space rebreather mask at altitude, completely eliminated CSA. [21] Of late, the physiology mechanistic look into CSA and OSA have looked to the concept of Loop gain and Plant gain and direct benefits to modulating CO_2 levels in subjects; we direct the reader to the excellent REVIEW article by advisor to DeltaChase, Jerome Dempsey PhD.[22,23]

"CO_2 is the most important regulator of respiration and blood ph." [24] In sleep dynamics, CO_2 helps reduce apneas and improves sleep quality, 2% added CO_2 led to an *increase in total sleep duration* (while 6% reduced it). [25] 3% CO_2 has been shown to eradicate Cheyne-Stokes breathing in congestive heart failure (a form of CSA).[26]

Nasal Breathing:

This REVIEW article on The Nose and Sleep Disordered breathing concludes that the switch to oral nasal breathing in chronic nasal congestion is the final common pathway in sleep disordered breathing. [27] The Buteyko method of breathing[28] has touted the benefits of breathing through one's mouth for decades. Although one would find it difficult to argue the reams of articles cited to reflect this benefit, we believe the Buteyko advocates have overlooked a simple but critical physiological imperative. The mere switching from nasal to oral breathing drops end-tidal CO_2 ($ETCO_2$) by ~3.5 mmHg. Oral breathing in children, leads to a higher prevalence of learning disabilities, attention deficit-hyperactive disorder, deficits in working memory, reading comprehension and arithmetic skills. Interaction between nasal and oral breathing also occur that may have implications for the pathophysiology of OSA. [29]

David Smith MD (DrDave™)
Chief Science Officer
Delta Chase LLC

References

[1] **Apnea, Obstructive Sleep Apnea** Jennifer M. Slowik; Jacob F. Collen, NCBI Bookshelf. A service of the National Library of Medicine, National Institutes of Health. Stat Pearls [Internet]. Treasure Island (FL): Stat Pearls Publishing; 2018 Jan-.

[2] Hein et al, Respiratory Research, Prevalence of Moderate to Severe Obstructive Sleep Apnea in Insomnia Sufferers (2017) 18: 135 DOI 10.1186/s12931-017-0616-8

[3] Lucas M. Donovan, MD, Vishesh K. Kapur, MD, MPH, Prevalence and Characteristics of Central Compared to Obstructive Sleep Apnea: Analyses from the Sleep Heart Health Study Cohort, *Sleep*, Volume 39, Issue 7, July 2016, Pages 1353–1359, https://doi.org/10.5665/sleep.5962

[4] https://investors.resmed.com/investor-relations/events-and-presentations/press-releases/press-release-details/2018/Nearly-1-Billion-People-Worldwide-Have-Sleep-Apnea-International-Sleep-Experts-Estimate/default.aspx

[5] Jonathan Cheetham, Amanda Jones, and Manuel Martin-Flores, Effect of inhaled carbon dioxide on laryngeal abduction, J *Appl Physiol* 118: 489–494, 2015.

[6] M.F. Fitzpatrick, H. McLean, A.M. Urton, A. Tan, D. O9Donnell, H.S. Driver, Effect of nasal or oral breathing route on upper airway resistance during sleep, Eur Respir J 2003; 22: 827–832

[7] Nayef AlGhanim, Vikram R. Comondor, John Fleetham, Carlo A. Marra, Najib T. Ayas, The Economic Impact of Obstructive Sleep Apnea, Lung (2008) 186:7–12 DOI 10.1007/s00408-007-9055-5

[8] George CF (2001) Reduction in motor vehicle collisions following treatment of sleep apnea with nasal CPAP. Thorax 56:508–512

[9] Teran-Santos J, Jimenez-Gomez A, Cordero-Guevara J (1999) The association between sleep apnea and the risk of traffic accidents. Cooperative Group Burgos-Santander. N Engl J Med 340(11):847–851

[10] REVIEW ARTICLE Clinical consequences and economic costs of untreated obstructive sleep apnea syndrome, Melissa Knauert, Sreelatha Naik, M. Boyd Gillespie, Meir Kryger, World Journal of Otorhinolaryngology-Head and Neck Surgery (2015) 1, 17e27

[11] Rotenberg et al. Trends in CPAP adherence over twenty years of data collection: a flattened curve, Journal of Otolaryngology - Head and Neck Surgery (2016) 45:43 DOI 10.1186/s40463-016-0156-0

[12] N Wolkove, M Baltzan, H Kamel, R Dabrusin, M Palayew. Long-term compliance with continuous positive airway pressure in patients with obstructive sleep apnea. Can Respir J 2008;15(7):365-369.

[13] Influencing factors on CPAP adherence and anatomic characteristics of upper airway in OSA subjects, Park et al. Medicine (2017) 96:51

[14] An update on mandibular advancement devices for the treatment of obstructive sleep apnea hypopnea syndrome, Shadi Basyuni, Michal Barabas, Tim Quinnell, *J Thorac Dis* 2018;10(Suppl 1):S48-S56

[15] https://www.sleepassociation.org/sleep-apnea/cpap-treatment/cpap-side-effects/

[16] https://dentalsleeppractice.com/medical-insights/mandibular-advancement-devices/

[17] Bersessenbrugge A. Dempsey J., Iber C., Skatrud J., Wilson P, 1983, Mechanisms of hypoxia-induced periodic Breathing during sleep in Humans, *J Physiol* 343, 507-24

[18] A review of preventing central sleep apnea by inspired CO_2, Mulchrone *et al* 2016 *Physiol. Meas.* **37** R36

[19] Thomas RJ. Carbon dioxide in sleep medicine: the next frontier for measurement, manipulation, and research. *J Clin Sleep Med* 2014;10(5):523-526.

[20] Effects of Inhaled CO_2 and added Dead Space on idiopathic Central Sleep Apnea, Xie et. al. journals.physiology.org/journal/jappl (072.049.175.167

[21] Dead Space Mask Eliminates Central Apnea at Altitude, David S. Patz, M.D., Michael D. Patz, M.D., and Peter H. Hackett, M.D., HIGH ALTITUDE MEDICINE & BIOLOGY Volume 14, Number 2, 2013

[22] REVIEW Central sleep apnea: misunderstood and mistreated! peer review: 2 approved], Jerome A. Dempsey, F1000Research 2019, 8(F1000 Faculty Rev):981 Last updated: 28 JUN 2019

[23] Physiology in Medicine: Obstructive sleep apnea pathogenesis and treatment—considerations beyond airway anatomy, Jerome A. Dempsey, Ailiang Xie, David S. Patz, and David Wang, J Appl Physiol (1985). 2014 Jan 1; 116(1): 3–12.

[24] Carbon Dioxide in Sleep Medicine: The Next Frontier for Measurement, Manipulation, and Research, Commentary on Wang et al. Hypercapnia is a key correlate of EEG activation and daytime sleepiness in hypercapnic sleep disordered breathing patients. J Clin Sleep Med 2014; 10:517-522, Robert Joseph Thomas, M.D., *Journal of Clinical Sleep Medicine, Vol. 10, No. 5, 2014*

[25] The Effects of Carbon Dioxide on Breathing and Sleep, Jimmy Fraigne, Witali Dunnen-Barkowski, John Orem, Sleep 2008 Jul;31(7):1025-33

[26] Effect of Inhaled 3% CO_2 on Cheyne-Stokes Respiration in Congestive Heart Failure, Rodney D. Steens, Thomas W. Millar, Su Xiaoling, Darren Biberdorf, Patricia Buckle, Mansoor Ahmed and Meir H. Kryger, *Sleep, 17(1):61-68*

[27] REVIEW: The Nose and Sleep Disordered breathing, what we Know and what we do Not Know, Rappia et. al., CHEST 2003, 124 2309-2323

[28] The Buteyko Breathing Technique for Asthma, A REVIEW, Bruton, Lewith, Complimentary therapies in medicine, (2005) 13 41-46

[29] The Nose and OSA; Variable Nasal Obstruction may be more important in Pathophysiology than Fixed Obstruction, McNicholas, Eur Respir J, 2008 32: 3-8