CHIROPRACTIC MANAGEMENT OF A PATIENT WITH ASTHMA: CASE REPORT AND FOLLOW-UP OF A 12-YEAR-OLD FEMALE

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ABSTRACT

Objective: To discuss the management of a 12-year-old female patient with previously diagnosed chronic asthma.

Clinical Features: The duration and severity of this case are noted.

Intervention and Outcome: Positive resolution of the case, primarily through a regime of chiropractic spinal care and other natural measures suggests that a drugless or reduced drug exposure may be efficacious for some patients.

Conclusion: I describe considerations and rationale for intervention based on chiropractic management. Given the amount of published empirical and more formal evidence related to the chiropractic management approach to asthma, further research is certainly justified. Such research may determine which types of asthmatic patients may provide positive outcomes. It may also determine which therapy or combination of therapies would be most efficacious for particular patients*. (Chiropr J Australia 2017;45:48-78)*

Key Indexing Terms: Asthma; Chiropractic; Vertebrae

INTRODUCTION

Asthma usually originates in childhood and sometimes has similarities with chronic obstructive pulmonary disease (COPD). It has been recognised as a condition that has a range of etiological and exacerbating factors that are not consistent across all patients. (1-4) Consequently, due to these similarities, COPD has also been alluded to in this review.

For over 100 years the chiropractic and osteopathic professions have noted positive patient response to a manipulative management in some asthmatics. (5-6) More recently, medical doctors involved in manual medicine and physiotherapist have also adopted manual therapy versions in the management of respiratory conditions such as asthma. (7-9)

Much of the evidence to date comprises clinical observations - case reports and case series. In this author's opinion, there would be sufficient positive clinical experiences, published studies, and patients' demands to warrant further formal research into this association. Recognised research evidence to the contrary appears to be primarily opinion based.

The volume of supportive reports on the chiropractic management of asthma in at least some patients should evoke serious research support. Delay in incorporating SMT in patient care may well deprive some patients of an improved quality of life

through more natural means. To deny the available evidence regardless of its source is not in the interest of patients.

In a review in 1996, Bronfort stated that asthmatic “children seem to be more responsive to chiropractic co-management than adults.” (10) Gleberzon and colleagues opined that “Studies that monitored both subjective and objective outcome measures of relevance to both patients and parents tended to report the most favourable response to SMT, especially among children with asthma.“ (11)

The manipulative component under chiropractic management may include a range of manual methods which can vary depending on the technique preferred by the practitioner, but a range of other natural, non-invasive regimens may also be employed. It can be noted that chiropractic care is not necessarily SMT alone. (12)

It is impractical to cite all the available the published papers on this topic. However, an extensive list of over 80 papers on asthma is accessible through the Index to Chiropractic Literature – which cites some 59 patients in positive case reports, and the osteopathic index list over 100 papers. (13,14) In an extensive review of paediatric respiratory conditions, Pepino and colleagues selected papers from 1147 titles. They found that under manual therapies including chiropractic, patient benefits were monitored through spirometer readings, immunological testing, cortisol levels and anxiety questionnaires. (15)

Historical Aspects

There is evidence of asthma in ancient Egyptian times. Hieroglyphic evidence on papyrus indicates that there were over 700 treatments for that condition at the time. Traditional Japanese and Chinese herbalists prescribed ephedrine-based herbs for asthmatics. In the past, asthma was once regarded as psychosomatic, but was only recognised as an inflammatory condition in the 1960s. (16,17)

In 1845, Monell noted a neurospinal factor in organic conditions. He noted that spine-related symptoms have "...been carefully noticed by a few, superficially by several, but totally neglected by the great majority of practitioners." (18) Over 170 years later this observation has barely resulted in change in conventional health care, with rare but significant exceptions, particularly in European medicine.

Medically, in 1918, Pottenger stated that asthma was ‘a part of the syndrome of increased greater vagal stimulation' with the principal symptoms being dyspnea and coughing. He affirmed this opinion further in 1931. (19,20)

Positive outcomes under manipulative care were reported in a medical paper by Murphy and Wilson in 1925. Their manipulative care of asthmatics utilised osteopathic techniques. (21)

In 1931 Marlin reported a case of asthma where his treatment was designed to "loosen up the whole of (his patient's) dorsal spine and free the ribs." He noted that the patient responded well to the first of his "six treatments". (22)

Although a different respiratory condition, in 1944, Speransky published his research on the role of neurophysiology in the pathogenesis of some infectious conditions, such as lobar pneumonia. (23)
In Russia, extensive research by Gordienko and colleagues in 1958 explored the agglutination reactions through vagus stimulation in studies involving immunological response to bacteria. (24)

In keeping with Pottenger's earlier observations, in 1966, Hahn noted parasympathetic dominance in asthmatics. He reported increased heart rates and skin temperature of these patients when compared to controls. He hypothesised that this would be contributed to by way of a "possible malfunction of autonomic negative feedback mechanisms". This finding was further supported by Miklich who monitored salivary flow between asthmatics and a control group in a 1974. The observation gained further support from Steyn and colleagues in 2013. (25-27)

In 1967 Simonsson and colleagues described the role of the autonomic nervous system (ANS) and the cough reflex in the increased responsiveness of airways in patients with obstructive airways disease. (28)

In quantum therapy research at the Ulyanovsk University in Moscow in 2012, it was reported that variable light therapies stimulated anti-inflammatory properties in asthmatics, and concluded that it was appropriate and clinically effective on a number of asthmatic symptoms in the study. (29)

The earliest mention in chiropractic for the management of asthmatics was in 1910. (5)

Review

The volume of published material on the topic of asthma is significant. The plethora of known factors, etiological theories, and management options associated with asthma compound the enigma. (30) A definitive cause or causes has yet to be established. (31) The regular flow of hypotheses and observations regarding asthma tends to reflect the equivocal status of this condition. Consequently, there is still much to discover about the condition. These multiple facets suggest that different patients appear to respond to different management approaches of suspected causes. (Table 1)

Table 1.
A Selection of The Plethora of Potential Factors Affecting or Associated with Asthmatics (and COPD)

This range of etiological or aggravating factors in asthma seems extraordinary for its variety.

- Age response better in younger patients (32)
- Air pollution - antioxidants (vitamins A,C.E & omega 3) (33)
- Analgesic – Acetominophen possibly beneficial for asthma but may increase risk of wheezing (34)

- Animal exposure (35-38)
    - Farm environment exposure – protective. (35)
    - Early life exposure to cats > increased risk of asthma (36)
    - Early life exposure to dogs > protective for asthmatics (36,37)
    - Early life exposure to farm animals > increases asthma in urban children visiting farms (36)
    - Farm animals - early exposure 37
    - Exposure to farm animals exacerbates COPD (38)
- Antibacterial agents in medication possible link (39)
- Antibiotics
    - No connection (40)
    - Overprescribed (41,42)
    - Early use risk of asthma (43)
    - Exposure increases incidence in first year of childhood (40-43)
    - Associated with asthma and allergies (44)
- Antioxidents (33)
- Apoplexy (45)
- Bacterial exposure beneficial (46,47)
- Bacterial exposure not beneficial – increases prevalence (48)
- Bed sharing – not a risk for toddlers with parents, but increases from age 6 (49)
- Bipolar disorders (50)
- CAMs – increasing patient demand for CAMs (51,52)
- Coronary syndrome (53)
- Corticosteroids – small percentage of asthmatics resistant to effects of steroids (54)
- C-sections – Childhood asthma more likely with C-section before rupture of membranes and increased frequency in adults (55,56)
- Cough in infancy possible early marker (57)
- Cured meats – tendency to exacerbate asthma over time (58)
- Damp houses – consistent association with asthma demonstrated (59)
- Diagnosis – “Overdiagnosed” (60)
- Diagnosis can be trivialised (60,61)
- Diagnosis ⅓ of ‘asthma patients do not actually have asthma (62)
- Diagnostic difficulties – may need reassessment for confirmation (62)
- Diet (63,64)
- Dust mite may or may not exacerbate (65)
- Fish (66)
- Gastroesophageal reflux – aspiration may increase severity of asthma attacks (67)
- Guidelines - deviation from and not always followed (68)
- Herpes zoster – non-medicated asthmatics have greater incidence of herpes zoster (69)
- Ibuprofen (34)
- Inhalers – overprescribed/over-diagnosed /under controlled (61)
- Mice – an etiological factor to blame (70-72)
- Microbes – intestinal – lack of exposure may lead to allergenic asthma later (46)

- Multiple factorials (15,73)
- Nephrolithiasis (epithelial dysfunction) (74)
- NSAID - Ibuprofen - may increase asthma morbidity (34)
- Nutrition - inadequate maternal and/or patient diets as risk factors (75)
- Obesity may lead to a higher risk of asthma (76)
- Omega-3 fatty acids (77)
- Paracetamol possible exacerbating factor (78)
- Peanut allergy – more common in asthmatics (79)
- Pollution demonstrable susceptibility (80)
- Pregnancy can influence onset, exacerbation or quiescence of asthma (51,81)
- Prescribing variations can vary (82)
- Prostate cancer (83)
- Response lower if patient is over 30 (32)
- Sex – similar incidence between males and females (32)
- Sleep association disturbed sleep may increase adverse outcomes (84)
- Smoke-free environment beneficial for asthmatics (85,86)
- Soda (Soft drink – sugar) (87)
- Steroids – inhaled can supress growth (88)
    - Bone loss (89)
    - No bone loss (90)
- Stress – may exacerbate adult-onset asthma (91)
- Stress - racial (92)
- Sugar (87,93,94)
- Swimming pools increases incidence, especially indoor pools (95)
- Thunderstorms – pollen laden storms produce sudden asthma even for first timers (96, 97)
- Tomatoes antioxidants protective (98)
- Tomatoes – potential asthmatic allergy (99)
- Traffic – road proximity can be exacerbating factor (80)
- Tumour necrosis factor-alpha (100)
- Vagus nerve - instrument stimulation improved FEV1 and VAS. (101)
- Vitamin D May reduce risk of exacerbations (102)
- Vitamin E (103)
- Vitamins C, D, E- can be salutary (33)
- Washing dishes by hand –fewer incidences than with machine washing (104)
- Yeast in infant stomach may increase risk (44,105)

Therapies are primarily directed at the management of the condition's symptoms rather than being able to focus on an underlying aetiology. (106,107) On that basis, and due to many reviews, reports and observations of clinically significant positive patient responses, chiropractic care can be justified as one of the optional models suitable for some asthmatics. (13,108-115) Osteopathy, (14,116-118) physiotherapy, (119) and medicine (7-9,120-122) have also reported positive clinical outcomes for asthmatic patients employing 'manual therapies'.Some of the literature reviews and clinical research trials with asthmatics under SMT may be regarded as ambivalent in that some outcomes have been designated as inconclusive, while others are quite positive. However in the main, these clinical observations, patient feedback, and

more formal studies record improved symptoms, and therefore a patient's quality of life. (10)

To that extent, patient satisfaction alone would justify exploring and exploiting the possibilities of chiropractic care. Unsubstantiated or philosophical claims that manual manipulative management of asthma does not fall under current concepts casts a dismissive shadow over the manual model. It may is then virtually overlooked as a conservative model of care, even before its potential has been independently evaluated.

In view of the reservations expressed by some as to the appropriateness for chiropractors to accept asthma patients, it would seem contradictory when it was known that chiropractic concepts have been adopted by a number of European medical doctors – but few English speaking doctors. (7-9, 120-122) In this apparent contradiction, published manual medicine reports on the manipulative management appear to be accepted and based on clinical empiricism rather than more formal evidential studies. (123)

The preponderance of these reported observations involving somatovisceral conditions constitutes a reasonable degree of clinical evidence and experience. To ignore them would tend towards negligence, especially when observation plays such an important role in scientific and clinical discovery and patient satisfaction. (124)

The Medical Use of The Chiropractic Model for Asthma

Apart from the numerous medical papers out of Europe relating to somatovisceral conditions, three prominent medical doctors have published textbooks on spinal manipulative management.

In his text on spinal manipulative management under the heading of functional disturbances, the once head of the physical medicine department of a Paris hospital lists such conditions as constipation, certain digestive pains, asthma, facial pain, Basedow's disease, mastodynia, palpitations and pseudo-ulcers, and Barré Syndrome as conditions that have responded to medical spinal manipulation. (9) Lewit's text on spinal manipulation states quite clearly that "Severe incoordination of respiratory movement may produce dyspnoea, while chronic asthma with emphysema will produce rigidity of the thorax." He states further that ..."Koberle (1975) found blockage of the segments T7-T10 associated with thorax rigidity in asthmatics. In a group of 30 asthmatics, Sachse (1975) found taut trapezius in 23 patients, a taut pectoralis in 15 and a weak lower trapezius in 15..." He also states that "The mobilisation of the ribs and of blocked segments of the thoracic spine, and training of correct breathing, will thus be the logical treatment for patients with respiratory disorders, particularly those with obstructive respiratory disease." 7 [Note: a vertebral blockage is a synonym for the chiropractic term - vertebral subluxation which as a complex includes a number of considerations such as segmental fixation, dysfunction and neural ramifications.] (7)

In addition, Mohn and Biedermann state that "Mechanical dyspnea syndrome is frequently the result of a (traumatic) blockage of one or more thoracic vertebrae and the costovertebral joints in the vicinity.... These blockages are more important in

children with internal breathing problems like asthma or obstructive bronchitis, as they tend to worsen an already precarious situation, certainly if combined with a kyphotic posture. (8)
Further medical papers relating to the chiropractic model of care in respiratory disorders provide supportive evidence of manual involvement in somato-autonomic-visceral conditions. (125-128)

CASE REPORT

A 12-year-old female Caucasian presented with a previously established diagnosis of episodic chronic asthma. The condition had been increasing in frequency, severity, and duration since the age of seven. This condition of some five years duration had been particularly persistent during the previous winter, had moderately improved during the recent summer, but was recurring again.

The patient's mother related that her daughter had undergone noticeable weight loss and had experienced two seizures attributed to hypoxia due to dyspnea. At about that time, she had reportedly been advised that she "would never ride a bike again or drive a car due to the risk of having seizures."

As an effect on her lifestyle, and due to a persistent hacking cough - particularly in winter, she had "missed a lot of school". She also reported that some people tended to eschew her due to the nature of her cough. In addition, due to her dyspnea, chest congestion and general lassitude, she had been forced to curtail physical activities. However, Ventolin PRN allowed her to participate in some mild sporting activity. Ultimately though, she had ceased all sport at the time of presentation.

In previous years the patient experienced a more severe form of asthma attacks approximately biannually. These were now becoming even more frequent and severe. Nine months earlier during the previous winter she reported 'constant' asthma for the whole winter. At that time a Ventolin nebuliser was reportedly prescribed to assist her during the more severe episodes, at which time she experienced dyspnea, wheezing, increased nocturnal coughing, and at times exhaustion. These symptoms were exacerbated in cold weather.

The patient was not aware of other possible aggravating environmental factors or allergies associated with pets, pollution, pollen, grasses, traffic fumes or particular foods. There were no smokers in her household.Temporary respite was obtained through her medications but relieving factors other than rest were also absent.
The patient's previous treatment at the time of presentation had consisted of antibiotics, expectorants, and decongestants, including Ventolin and Theo-dur 200mg. prn. She had previously undergone an extensive but unsuccessful series of physiotherapy treatments.

On examination, the patient was sitting comfortably in a chair in no respiratory distress but with notable pallor. At the time, there was no apparent use of accessory respiratory muscles, nor was a barrel chest deformity present. With the absence of a typical asthmatic thorax, the patient's posture appeared quite normal.
The patient was afebrile with vital signs being:

- Blood pressure 105/73,

- Pulse rate 94,
- Respiratory rate 28
- Vital capacity 100cc. (Using a "Spiropet"® windmill-type spirometer.)
-

Despite the chronicity, the patient's trachea was in the mid-line with no apparent tracheal tug on inspiration at the time of examination. There appeared to be reduced and forced chest expansion on inspiration with shallow expiration.
Auscultation of the thorax revealed reasonable air entry bilaterally with slightly forced chest expansion. However, there was a moderately shallow, forced expiratory wheeze with a subcrepitant breath sound. In addition, rhonchi sounds were detected indicating the presence of fluid bilaterally in the lungs. An increased respiratory drive was not apparent at the time.

Due to the prolonged nature and deteriorating pattern of the condition, the possibility of other serious respiratory conditions such as acute pleurisy and miliary TB were considered. The patient was then referred to her GP for updated chest x-rays and blood tests - including a Mantoux test - as these had not been conducted for some time. The blood tests were reported as NAD, and the radiology report together with clinical findings supported an asthmatic diagnosis. The films were not provided.
Spinal examination showed hypomobility of the patient's dorsal spine and thorax. Splinting of the paraspinal dorsal musculature involved the upper region, including the trapezius particularly. Rhomboids and levator scapulae were noted. The anterior cervical muscles were not hypertonic. Specific subluxations (fixations) were noted at L1, T2, T4 and T7, as well as in the cervical spine at C2 and C5 with general hypomobility of the lower dorsal segments in particular. These vertebral dysfunctions were addressed manually using the Diversified technique.

Management

The initial physical examination also included observations for signs contraindicating manual intervention, spinal assessment, auscultation, and spirometry. In considering the physical examination outcomes, the patient was accepted for a trial of care.
The initial treatment firstly addressed the release of the hypertonic muscles with massage and trigger point therapy. General mobilisation of the costal thorax and spine was then conducted. In order to enhance expiration, relaxation of diaphragmatic tension was carried out by using pressure points around its antero-lateral costal margin. (129,130)

Once the musculature was relaxed, preparatory thoracic spine mobilisation was carried out with the patient in the prone position Spinal palpation identified fixated vertebrae at T2, T4 and T7. The mid-dorsal vertebrae were adjusted with the patient in that prone position. The lower dorsal segments were mobilised generally using both a prone adjustive technique, T11/T12 region employing a 'high' lumbar roll technique, and L2 with a specific lumbar roll. With the patient now in a supine position, T2 was adjusted using an anterior thoracic technique. While still supine, the cervical spine was palpated and utilising a semi-rotary technique, C2 and C5 were also adjusted. Not only were these procedures employed to mobilise the structures, but also to influence autonomic respiratory innervation. (131-134)

A supine thoracic pump procedure was then carried out with care not to hyperventilate the patient. This produced the desired clearing-productive cough. The patient's mother was instructed how to continue this procedure as a home exercise, and was encouraged to perform this technique twice daily. This physical procedure is intended to enhance perfusion. It proved to be a most effective adjunct in this case. The patient was reportedly able to expel a considerable amount of mucus in the first few days through this method.

The heavy thoracic percussion technique was not employed, nor was it recommended. The firm percussion method was assessed as being too traumatic on the patient, and not as effective as the thorax pump technique. (135) This thoracic pump procedure was first proposed by Miller in 1926. (136)

The patient presented 3 days later and reported successfully implementing the thoracic pump procedure at home. Her mother estimated that in that time, her daughter had released "half a bucket" of mucus - an estimated 3.75 litres. She stated that she felt much clearer with less congestion and coughing following this regime. A further exercise recommended to the patient consisted of manually attempting to blow up balloons with forcible exhalation. This was aimed at further improving the expiratory efficiency. Her ability to do so gradually increased, and proved to be a positive self-monitoring mechanism. Since that time, this particular exercise has been subject to research in a randomised trial. (137)

Other breathing exercises such as yoga and Buteyko technique were considered but not included at this point. The family was aware of a nutritionally adequate diet. (138) Monitoring of this patient's respiratory output via spirometry conducted using a windmill type Spiropet® spirometer. (139) This test demonstrated positive response immediately post-treatment, as well as over the extended time as noted. (Table 2)

Table 2.
SUMMARY OF VITAL CAPACITY READINGS TAKEN DURING THE MANAGEMENT OF THIS CASE. (Using Windmill type spirometer - "Spiropet".)

Initial examination 1100cc. Age 12. N=2150cc*)

	PRE-ADJUSTMENT.	POST ADJUSTMENT.
Visit 28.3.1984		
Attempt 1	1300cc.	
Attempt 2	1550cc.	
Attempt 1		1720cc.
Attempt 2		1680cc.
Visit 11.4.1984		
Attempt 1	1000cc.	
Attempt 2	1100cc.	
Attempt 3	1300cc.	
Attempt 1		1300cc.
Attempt 2		1500cc.

Visit 2.5.1984
Attempt 1 1725cc. .
Attempt 2 1780cc.

Visit 10.5.1984
Attempt 1 1500cc.
Attempt 2 1700cc.
Attempt 3 1650cc.

Visit 11.7.1984
Only attempt . 3000cc.

Subsequent exacerbation of symptoms
(Age 18 years. N=2800cc*)

Visit 27.7.1989
Only attempt 600cc. (Pre)

Visit 15.8.1989
Only attempt 2300cc (Pre).

* Average standard deviation as per instrument.

Following a further 8 visits, the patient's vital capacity had increased from 1100cc to 1780cc – an increase of 61%. A further post-treatment assessment on a subsequent visit revealed a vital capacity of 3000cc. (Table 2.)

As the patient was comfortable with her positive clinical response and improved quality of life, she self-discharged to manage her condition and to present herself for occasional symptomatic care.

Recurrence

She returnedsome 5 years later due to a recurrence of the same condition. She was not aware of any triggering factor although cold days, night air, and exertion, produced coughing, and chest tightness.

At this consultation at age 17, the patient indicated that her recent high school academic year had been severely disrupted. As this was the patient's final year at secondary school, her school attendance and academic study were of vital importance to her. She had missed numerous days at school and she felt her results could be affected. Her concern was that she may not be prepared for final exams due to loss of preparation time, and thereby not complete her education. She also stated that her preferred sport of netball had been curtailed because of exacerbation of her symptoms upon exertion.

Although residing some distance away, it was not determined why she delayed presenting herself for care at that time.

Treatment of a similar nature was again instituted with similar results within 5 visits. She completed her school year and successfully graduated from high school. Her presenting vital capacity at this time was 1600cc. This increased to 2300cc within the 5 visits.

There has been no known recurrence of the particularly severe asthmatic attacks at the time of this manuscript's preparation. It was however reported that the patient experienced three comparatively minor episodes involving chest tightness and at times coughing over the years following the initial treatment. She stated that she has experienced only mild recurrences associated with an occasional "cold or chest infection". She is able to easily self-manage these and they subside relatively quickly. The patient elected not to undertake maintenance care elected for occasional symptomatic care. Since that time, the patient has married, has two children, and works full-time in a responsible managerial position which also involves intrastate and interstate travel.

The chronic nature of this patient's original condition, and the faster than anticipated initial patient response, would suggest that there may well have been a vertebrogenic factor, and that her response was more than just symptomatic.

DISCUSSION

A Rationale for Management - 4 Basic Elements

As there is no single identified cause or cure of asthma, management is primarily directed towards symptomatic care and a patient's quality of life. Some of the asthmatic symptoms can be affected by the musculoskeletal system - a Somato Autonomic Visceral Triad (SAVT). Given the variants of asthma treatments, and the reports indicating that some patients do benefit from SMT, chiropractic then becomes a viable option for some asthmatics. (140)

The hypotheses for the primary manipulative elements in the management of asthmatic cases are directed at achieving optimal functional respiratory physiology for the patient. Numerous case reports and clinical experiences indicate that some asthmatic patients do benefit from chiropractic care, and therefore an improved quality of life. Unfortunately, the evidence offered by these multiple reports does not seem to carry the weight of wider recognition. It is however, of significance to relieved patients, many of whom have chosen to seek a natural health option in preference to long-term medication.

The basis for chiropractic management of the case presented was essentially based on two primary neuromechanical components – the biomechanical and neural integrity of respiratory elements, as well as 2 secondary factors, the myological and neuroimmune elements. These 4 elements comprise some of the considerations of the vertebral subluxation complex (VSC) where the central element involves segmental dysfunction in the form of articular fixations. As a spine-influencing factor this element could be regarded as vertebrogenic, as the disruption to articular motion is thought to affect all these four physiological elements. (12,141-147)

As the VSC is essentially a physical clinical finding, the primary chiropractic objective of this neuromechanical lesion is its correction through a specific manual osseous adjustment. Chiropractic adjustments are a refined and specific form of more general manipulation, most frequently involving the spinal segments. (148-150) Together with adjunctive measures, it was the primary intervention employed in the case presented as it has for other respiratory conditions.

1. Respiratory – Biomechanical
In respiration, the physiological (functional) role of the articulations involves the segmental and global mobility of the spine and the elastic recoil provided by the costal thorax.

In asthmatics, the primary manual means of ameliorating the condition is through identifying and correcting vertebral dysfunction and costal fixations in order improve structural mobility and respiratory function. (15,151,152Hviid has shown that with asthmatics, chiropractic adjustments alone can improve vital capacity and peak flow rates as well as improve the symptoms which have been exacerbated by the physical exertion of laboured respiration. (153)

Biomechanically, the manual techniques employed are directed at improving:-

- Vital capacity of the lung, (154,155)
- Bronchial and pulmonary circulation, (12)
- The stimulation of mucus release, (12)
- Particular attention to diaphragm tone, (156)
- Optimal function of the other muscles of respiration. (12)
- Enhanced arterial oxygen (12)
- Enhanced lymphatic drainage. (12)- Optimise elastic recoil for expiration. (157,158)

2. A Neurological Component
The interaction of the spine with the autonomic nervous system (ANS) and its possible influence upon normal lung function has been postulated. The neural component of the SAV triad is considered here to be another primary element to be addressed through physical means directed at normalising vertebral influence in order to optimise that influence upon lung function. (142-148, 159-166157-162,177-184)

In 1997, Sato noted the influence of autonomic reflex responses to somatic stimulation when he stated “The analysis of neural mechanisms of these reflex responses seems to be very important for clinical application to regulate visceral function by physical treatment.” (159)

In a further paper that year, Kimura and Sato stated that “The elucidation of the neural mechanisms of somatically induced autonomic functions, usually called somato-autonomic reflexes, is essential to develop a truly scientific understanding of the mechanisms underlying most forms of physical therapy, including spinal manipulation and traditional as well as more modern forms of acupuncture and moxibustion.” (160) (Emphasis added)

There is further evidence also of an imbalance between the parasympathetic and sympathetic nervous systems being a factor in asthma – pathoneurophysiology. (125 185)

Ventilation is controlled by the dorsal and ventral respiratory group of nuclei in the medulla oblongata and pons. In SMT, it is hypothesised here, that these may be influenced through the cervical spine. (167)

Neurologically, the lungs are supplied by the parasympathetic vagus nerve, and the sympathetic supply from T1 to T5 via an intercostal path to the pulmonary plexus with both a motor and sensory function. This autonomic supply innervates the smooth muscle, bronchi glands and pulmonary vascular structures. These sympathetic post synaptic fibres innervate the vasculature of the lungs. (168,169) Bronchial asthma results in bronchoconstriction. (139) As such, it is another asthmatic component deemed to be positively influenced by SMT. (154)

The critical muscle function is controlled by the phrenic nerve (C3-C5) which provides the motor nerves, as well as receiving sensory fibres from the central region of the diaphragm. The lower thoracic segments receive sensory fibres from the periphery section of the diaphragm. (170)

An interesting study on the neurophysiological role in asthma was offered by van der Velden and Hulsmann in 1999, and also by Jarth in 2001. (171) A decade later, Goyal and colleagues stated that the immunological theory does not explain all the features of asthmatics, nor does the neurogenic theory. (169) However, they noted that higher parasympathetic tone may be an underlying cause of asthma. (172,173) Apart from an afferent influence (e.g. inflammatory or allergy), a direct efferent correlation of ANS dysfunction did not appear to be a primary consideration. This is in contrast to the statement by Kimura and Sato. (160)

A 2006 study by Mukhopadhyay et al supported the hypothesis that while posture was at times a factor in asthma, the hyperventilatory response to postural change was influenced by the autonomic supply through the parasympathetic vagus innervation. (174,175)

A paediatric study published in 2014 by Engel-Yeger and colleagues also concluded that asthmatics may suffer from a sensory processing disorder, and that the central nervous system may be involved in the pathogenesis of their response to allergens. (176)

3. An Immune Influence

Some of the earliest research on neuroimmunology was conducted in Russia by Gordienko and colleagues in 1958. This research was essentially based on the immunological response to bacteria. (177)

Research has shown an immune factor in asthma involving immunoglobulins (IgA, IgE), and cortisol. (178) It has also noted an influential association between the autonomic nervous system, immune factors and spinal manipulation. (179-183)

Given that this correlation has been demonstrated between SMT and an immune response, it is reasonable to hypothesize that chiropractic may benefit some patients where allergens are an identified factor. (165,184,185)

4. Respiratory Muscles and Their Influence in Asthma

Muscular tone is also an important consideration in the management of asthmatic patients. Hypertonicity of the primary muscles of respiration has an inhibitory affect. Respiratory muscles include the diaphragm, the three layers of intercostal muscles and at times, recruitment of the muscles of accessory respiratory muscles, as well as the abdominals. (186,187) These are primarily innervated by the cervical and thoracic spinal nerves. Sato noted that “Respiratory responses can be elicited by muscular afferent stimulation.” (158, p143-144)

Techniques to relax hypertonic muscles can be employed when indicated. (155) Release of the diaphragm is intended to increase its excursion and improve Forced Expiratory Vital Capacity (FEV_1) during a period of exacerbation.

The tone of the central diaphragmatic tendon may be influenced by the phrenic nerve (C3-C5), particularly C4, and the periphery of the diaphragm by the lower intercostal nerves.

The diaphragm has been regarded as two separate muscles – the costal and central tendon sections. The central diaphragm tendon (crus) is supplied by the phrenic nerve for sensory, tone and motor functions. The peripheral diaphragm is innervated by the lower costal nerves. (156,188,189)

The intercostal muscles are also significant respiratory muscles. Their tone is influenced by the dorsal sympathetics, and by costal and spinal flexibility. Their innervation may be influenced by costovertebral and intervertebral adjustments as well as muscle release techniques. The intercostal nerves arise from T7-11 (thoraco-abdominal nerves) innervate the thoracic and abdominal muscles, as well as providing sensory fibers to the pleura and diaphragm. (190)

Particular attention is also paid to the diaphragm attachment to T12 as a primary insertion for the peripheral diaphragm. In addition, the crus attachments to L1 and L2 may influence the diaphragm and may contribute to lower back pain at that level. Janssens and colleagues explored a firm association between the diaphragm and the lower back both structurally and in respiration. (191,192)

The variety of techniques available in manual management of asthma may indicate that certain models of manual care for the condition may be more beneficial to some asthma patients than others. (12) This also appears to be the case with other asthmatic treatments.

Recognition of a somatic effect upon the ANS and visceral function is clinically established as a somatovisceral influence. This is evidenced by the volume of chiropractic, osteopathic and medicine, manipulative management case reports. Intervention is justified as viable and warranted for some asthmatic patients at least on a trial basis – the same basis as for other models of management. (12,193,194)

General Considerations in Assessing Asthma Patients

- Mobility of the thorax – especially individual spinal segments, but also general flexibility of the costosternal and costovertebral articulations. (8,12,195)
- Hypertonicity of the diaphragm has been shown to inhibit the respiratory excursion. (196-198)
- General release of hypertonic primary and secondary respiratory muscles of respiration. (199)
- A manually assisted inspiration and expiration technique – a thoracic pump-type assisted exercise to remove phlegm. (12,135,136, 200,201)
- The exhalation respiratory exercise of inflating balloons. (150,202-207) It should be noted that there can at times be an allergic reaction to latex. (208) - Swimming and yoga breathing exercises – including the Buteyko method can also enhance exhalation in asthmatics. (138,209,210)
- Correction of postural distortions which may tend to limit respiratory function. (108,211-214)
- Advice on the avoidance of possible allergenic food and environmental substances. These may include exposure to dairy products, the presence of pets, pollen, as well as industrial and vehicular pollutants. (155,184,215-217)
- Nutritional advice. Poor nutrition has also been shown to be a possible predisposing factor in pathophysiological recovery. (155, 218,219)

- The avoidance of a smoking environment was also a recommendation. (220)

In the end, and subject to contraindications with regard to patient safety and preferences, if treatment outcomes are positive, then the care is clinically legitimate and justified, regardless of the so-called higher levels of evidence. Surely the asthmatic patient is aware when they experience fewer episodes, less severe episodes, or non-existent symptoms. There are then grounds for at least a trial of 6 to 10 treatments to assess the potential efficacy. (221)

As with all models of care and particularly with asthmatics, some conditions cannot be fully alleviated, but require occasional or possibly regular ongoing management. In addition, a patient may also prefer to manage their condition symptomatically with or without the practitioner. In any case, management needs to be personalised as the presentations and responses can vary as well as patients' preferences.

CONCLUSION

The management of this case was centred on spinal adjustments of spinal subluxations. The significance of this complex is its influence upon neurological elements – both physical and physiological. Other supportive measures were considered important but adjunctive to the management of this patient. It should be noted that chiropractic case management is not necessarily limited to manual spinal care alone.

In view of the published chiropractic, medical, and osteopathic published evidence, it would be imprudent and even unprincipled to deny that there is some evidence to support the observation of a spine-related influence in some asthmatics. Without that evidence identified in case reports, there would not be grounds for further research

on the topic or involvement in management of asthmatics. However, positive outcomes and patient demand continues to drive and justifies that involvement. As reported in Australian Doctor, 1/3rd of asthmatic patients are already seeking care outside the conventional model. This cited Canadian research study found that more than one-third of asthma patients use complementary and alternative medicines to try to control their symptoms. (222)

The case presented would indicate that a neurovertebral element may be one of the contributing factors for some asthmatics, and that a chiropractic management model may assist in some cases. As such, those asthmatics with spinal VSCs as contributing factors that are not being addressed, may therefore not achieve optimal outcomes in their case.

Continued patient demand for chiropractic care by asthmatics, as well as the published literature, suggests that spinal manipulation in conjunction with other supportive methods may positively influence respiratory function in some asthmatic patients.

As the Asthma Foundation of Victoria states: “Chiropractic medicine is expert manipulation of the spine. Some research has shown that chiropractic has a beneficial effect on airway circulation and lung capacity. As with other complementary therapies, more research is needed in this area.” (223)

Given an identifiable physical-biomechanical element associated with some asthma cases, management of that aspect of the condition is unlikely to be best provided by non-physical means. No studies were found which indicated that patients experienced an adverse outcome, although there was some equivocation at times. (12) The vast majority of papers demonstrated degrees of positive outcomes. Even in 2017, there is a plethora of theories as to the etiological and management possibilities for asthma patients. This would suggest that there is much more to be understood about this condition. It may also indicate that a combination of factors is associated with its aetiology.

Claims against a role for chiropractic with some asthmatics, (12) tends to avoid an explanation as to why there are so many patients and manual practitioners who identify positive outcomes, and appreciative asthmatic patients referring other patients regardless of what the ‘evidence’ states. (224)

As with other so-called visceral conditions under somato-autonomic influence, the outcome of chiropractic management in this case resulted in reduced severity and frequency of asthmatic symptoms, rather than a complete resolution. It is the clinical legitimacy, noted by Eastwood that essentially acknowledges clinical effectiveness of a given treatment in the absence of extensive identification of the physiological mechanisms involved. (225)

As so many positive case reports have been published, there is too much anecdotal evidence to be ignored. Further research is therefore warranted and consequently recommended to determine which types of asthma patients who would best respond to this natural manual management model. This would also advance a greater understanding of the pathophysiology of somatovisceral-related asthmatic patients. It

may also assess those cases which would best respond to this form of therapy, or to certain combinations of therapies.

Historically, incidental medical observations have contributed greatly to science and reformed facets of health care. These include the implantable pacemaker, penicillin, coronary angiography, and warfarin. These obviously were not denounced or dismissed because they were not evidence based. Similarly, the observations related to spinal manipulation need to be recognised rather than denied as an opinion-based aberration. There is just too much clinical evidence to support the manual health professions. (226)

Given the volume of positive case reports and the physiological-based evidence, there are rational grounds to justify further development, research and assessment, rather than unsubstantiated dismissal. Patient care is too crucial to be politicised and ignorance of available evidence is not a rational claim that no evidence exists! (227) “the best way to diagnose and monitor asthma in children should continue to be robustly debated." (228)

REFERENCES

1. Kim RS, Rhee YK. Overlap between asthma and COPD: where the two diseases converge. Allergy Asthma Immunol Res 2010;2(4):209-214
2. Holley AB. From asthma to COPD: what’s air got to do with it? http://www.medscape.com/viewarticle/868890. 2016
3. Causes of asthma. World Health Organisation. http://www.who.int/respiratory/asthma/causes/en/
4. Mayo Clinic Staff. Asthma causes. http://www.mayoclinic.org/diseases-conditions/asthma/basics/causes/con-20026992
5. Palmer DD. The science, art and philosophy of chiropractic. Portland Printing House Co. Portland, Oregon. 1910:424,818
6. Still AT. Osteopathy: Research and practice. Kirksville: Self Published. 1910:132-134
7. Lewit K Manipulative therapy in rehabilitation of the locomotor system. 3rd edn. Oxford. Butterworth Heinemann1999:283
8. Mohr H, Biedermann H. Manual therapy of the thoracic spine – Mechanical dyspnea syndrome. In: Biedermann H: Manual therapy in children. Edinburgh. Churchill Livingstone;2004:194-196
9. Maigne R. Functional disturbances. In: Orthopaedic medicine. A new approach to vertebral manipulations. Springfield. Charles C Thomas. 1972:164
10. Bronfort G. Asthma and chiropractic. Europ J Chiropr 1996;44:1-7
11. Gleberzon BJ, Arts J, Mei A, McMannus EL The use of spinal manipulative therapy for pediatric health conditions: a systematic review of the literature. J Can Chiropr Assoc 2012;56(2)128-142
12. Hondras MA, Linde K, Jones AP. Manual therapy for asthma. Cochrane Database of Systematic Reviews DOI: 10.1002/14651858.CD001002.pub2. April 2005
13. Index to Chiropractic Literature http://www.chiroindex.org/?advanced_search=1#results

14. Osteopathic Medical Digital Repository. http://ostemed-dr.contentdm.oclc.org/cdm/
15. Pepino VC, Ribeiro JD, Ribeiro MA, de Noronha M, Mezzacappa MA, Schivinski CI. Manual therapy for childhood respiratory disease: a systematic review. J Manipulative Physiol Ther 2013;36(1):57-65
16. Crosta P. Asthma history through the ages http://www.medicalnewstoday.com/info/asthma/asthma-history.php. 2013
17. Allergy & Allergy Medical Group & Research Center. http://www.allergyandasthma.com/home/articles/history-of-asthma. Extracted April 5,2017
18. Monell GC. Rheumatism, acute and chronic: A prize essay. New York: HG Langley;1845:20. As cited by Haldeman S. Principles and practice of chiropractic. 2nd edn. Norwalk: Appleton & Lange;1992:10
19. Pottenger FM. Asthma considered in its relationship to the vegetative nervous system. Am J Med Sci 1918 417-242
20. Pottenger FM. Important reflex relationships between the lung and other viscera. J. of Thor. Surg 1931;Oct:75-90
21. Murphy W, Wilson PT. A study of the value of osteopathic adjustment of the fourth and fifth thoracic vertebrae in a series of twenty cases of asthmatic bronchitis. Boston Med Surg 1925;192:440-442
22. Marlin T. Some common complaints amenable to spinal treatment. BMJ 1931;Oct 24:746
23. Speransky AD. Experimental and clinical lobar pneumonia. Am. Rev. of Soviet Med 1944;2:22-27
24. Zhigalina LI. The role of non-specific stimulation of the nervous system in certain immunological reactions. In: Gordienko AN. (Ed). Control of immunogenesis by the nervous system. Rostov-On-Don State Medical Institute, 1958:110-124
25. Hahn WW. Autonomic responses of asthmatic children. Psychosomatic Med 1966;28:323-332
26. Miklich DR. Salivary flow as measures of parasympathetic nervous system involvement in children's asthma. Psychosomatic Med 1974;36(3):206-214
27. Steyn E, Mohamed Z, Husselman C. Non-invasive vagus nerve stimulation for the treatment of acute asthma exacerbations – results from an initial case series. Int J Emerg Med 2013;6:7 doi:10.1186/1865-1380-6-7
28. Simonsson BG, Jacobs FM, Nadel JA. Role of the autonomic nervous system and the cough reflex in the increased responsiveness of airways in patients with obstructive airways disease. J Clin Invest 1967;46(11):1812-1819
29. Kuselman AI, Deryabina EV. Application of quantum therapy in complex treatment of bronchial asthma in children. Photodiagnosis Photodynamic Ther 2012;9 (Suppl 1):S28. http://www.pdpdt-journal.com/article/S1572-1000(12)70082-0/pdf (Abstract)
30. Causes of asthma. http://www.rightdiagnosis.com/a/asthma/causes.htm
31. Fact sheet. What causes asthma? National Asthma Council Australia. https://www.nationalasthma.org.au/living-with-asthma/resources/patients-carers/factsheets/dairy-products
32. Dunn RM, Lehman E, Chinchilli VM, et al. Impact of age and sex on response to asthma therapy. Am J Resp Crit Care Med 2015;192(5):551-558. DOI: http://dx.doi.org/10.1164/rccm.201503-0426OC

33. Romieu I, Castro-Giner F, Kunzli N, Sunyer J. Air pollution, oxidative stress and dietary supplementation: a review. Eur Resp J 2008;31:179-197
34. Kanabar D, Dale S, Rawat M. A review of ibuprofen and acetaminophen use in febrile children and the occurrence of asthma-related symptoms. Clin Ther 2007;29(12):2716-2723
35. Dimich-Ward H, Chow Y, Chung J, Trask C. Contact with livestock – a protective effect against allergies and asthma? Clin Exp Allergy 2006;36(9):1122-1129
36. Hugg TT, Jaakkola MS, Ruotsalainen R, Pushkarev V, Jaakkola JJ. Exposure to animals and the risk of allergic asthma: a population-based cross-sectional study in Finnish and Russian children. Environ Health 2008;7:28. doi: 10.1186/1476-069X-7-28
37. Fall T, Lundholm C, Ortqvist AK, et al. Early exposure to dogs and farm animals and the risk of childhood asthma. JAMA Pediatr 2015;169(11):e153219. doi:10:1001/jamapediatrics.2015.3219
38. van Dijk CE, Garcia-Aymerich J, Carsin AE, et al. Risk of exacerbations in COPD and asthma patients living in the neighbourhood of livestock farms: Observational study using longitudinal data. Int J Hyg Environ Health 2016 May;219(3):278-87. doi: 10.1016/j.ijheh.2016.01.00
39. Asmus MJ, Barros MD, Liang J, Chesrown SE, Hendeles L. Pulmonary function response to EDTA, an additive in nebulized bronchodilators. J Allergy Clin Immunol 2001;107(1):68-72
40. Su Y, Rothers J, Stern DA, Halonen M, Wright AL. Relation of early antibiotic use to childhood asthma: confounding by indication? Clin Exp Allergy 2010;40(8):1222-1229
41. Mangione-Smith R, Krogstad P. Antibiotic prescription with asthma medications: why is it so common, Pediatrics 2011;127:6:1174-1176
42. Brusselle GG, van Braeckel EV. AZALEA trial highlights antibiotic overuse in acute asthma attacks. JAMA Intern Med 2016;176(11):1637-1638 doi:10.1001/jamainternmed.2016.6046
43. Marra F, Lynd L, Coombes M, et al. Does antibiotic exposure during infancy lead to development of asthma?: a systematic review and meta-analysis. Chest 2006;129(3):610-618
44. Potera C. Asthma: a gut reaction to antibiotics. Environ Health Perspec 2005;113(6)A372. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1257633/
45. Chung WS, Lin CL, Chen YF, Ho FM, Hsu WH, Kao CH. Increased stroke risk among asthmatic patients. Eur J Clin Invest 2014 Nov;44(11):1025-33. doi: 10.1111/eci.12336
46. Arrieta MC, Finlay B. The intestinal microbiota and allergic asthma. J Infect 2014;69(Suppl 1):S53-5. doi: 10.1016/j.jinf.2014.07.015
47. Rothers J, Stern DA, Spangenberg A, et al. Influence of early day-care exposure on total IgE levels through age 3. J Allergy Clin Immunol 2007;120(5):1201-1207
48. Sun Y, Sundell J. Early daycare attendance increases the risk for respiratory infections and asthma of children. J Asthma 2011 Oct;48(8):790-6. doi: 10.3109/02770903.2011.604884
49. Luijk MPCM, Sonnenschein-van der Voort AMM, Mileve-Seitz VR, et al. Is parent-child bed-sharing a risk for wheezing and asthma in early childhood. Europ Resp J 2015;45(3):661-669. DOI: 10.1183/09031936.00041714

50. Lin TC, Lee TC, Lai TJ, et al. Association of asthma and bipolar disorder: a nationwide population-0based study in Taiwan. J Affect Disord 2014 Oct;168:30-6. doi: 10.1016/j.jad.2014.06.033
51. Worrill NA. Asthma: a descriptive case study. Br J Chiro 1998(2:1):4-5
52. Chen W, Fitsgerald JM, Rouiseau R, et al. Complementary and alternative asthma treatments and their association with asthma control: a population-based study. BMJ Open 2013;3:e003360 doi:10.1136/bmjopen-2013-003360
53. Chung WS, Shen TC, Lin CL, Chu YH, Hsu WH, Kao CH. Adult asthmatics increase the risk of acute coronary syndrome: a nationwide population-based cohort study. Eur J Intern Med 2014; 25(10):941-5. doi: 10.1016/j.ejim.2014.10.023
54. Barnes PJ. Efficacy of inhaled corticosteroids in asthma. J Allergy Clin Immunol 1998;102(4 Pt 1):531-538
55. Sevelsted A, Stokholm J, Bisgaard H. Risk of Asthma from Caesarean Delivery Depends on Membrane Rupture. J Pediatr 2016 Apr;171:38-42.e1-4. doi: 10.1016/j.jpeds.2015.12.066
56. Xu B, Pekkansen J, Hartikainen A-L, Järvelin M-R. Caesarean section and risk of asthma and allergy in adulthood. J Allergy Clin Immunol 2001;107(4):732-733
57. Oren E. Rothers J, Stern DA, Morgan WJ, Halonen M, Wright AL. Cough during infancy and subsequent childhood asthma. Clin Exp Allergy 2015;45(9):1439-1446
58. Li Z, Rava M, Bedard A, et al. Cured meat intake is associated with worsening asthma symptoms. Thorax 2016; pii: thoraxjnl-2016-208375. doi: 10.1136/thoraxjnl-2016-208375
59. Weinmayr G, Gehring U, Genuneit J et al. Dampness and moulds in relation respiratory and allergic symptoms in children: results from phase two of the international study of asthma and allergies in childhood (ISAAC Phase Two) Clin Exp Allergy 2013;43(7):762-774
60. Bush A, Fleming L. Is asthma overdiagnosed? Arch Dis Child 2O15 http://dx.doi.org/10.1136/archdischild-2015-309053
61. Woodhead M. Trivialising asthma leading to child deaths, warn doctors. Australian Doctor 2016;April 6. https://www.australiandoctor.com.au/news/latest-news/child-asthma-deaths-due-to-diagnosis-trivialised
62. Aaron SD, Vandemheen KL, Fitzgerald JM. Re-evaluation of diagnosis in adults with physician=diagnosed asthma. JAMA 2017;317(3):269-279.doi:10.1001/JAMA.2016.19627
63. Kim JL. Eifman L, Mi Y, Johansson M, Smegje G, Norback D. Current asthma and respiratory symptoms among pupils in relation to dietary factors and allergens in the school environment. Indoor Air 2005;15:170-182
64. Trask S. Diet positive management through diet. University of Newcastle's Priority Research Centre for Healthy Lungs ‘Radical’ asthma approach could change treatment. http://www.canberratimes.com.au/act-news/were-at-the-tip-of-a-new-paradigm-radical-asthma-treatment-unveiled-in-canberra-20170326-gv735a.html. March 27, 2017
65. Toelle B, Garden FL, Ng KKW, et al. Outcomes of the childhood asthma prevention study at 11.5 years. J Allergy Clin Immunol 2012 http://dx.doi.org/10.1016/j.jaci.2013.06.005

66. Nafstad P, Nystad P, Magnus P, Jaakkola JJ, Asthma and allergic rhinitis at 4 years of age to fish consumption in infancy. J Asthma 2003;40:343-348
67. Ribó P, Pacheco A, Arrieta P, Teruel C, Cobeta I. Gastroesophageal reflex as a cause of chronic cough, severe asthma, and migratory pulmonary infiltrates. Respirol Case Rep 2014;2(1):1-3
68. Bereznicki BJ, Beggs S, Duff C, Beresnicki L. Adherence to management guidelines for childhood asthma in Australia. Aust Family Physic 2015;44(12):933-938
69. Chen SJ, Huang KH, Tsai WC, Lin CL, Cheng YD, Wei CC. Asthma Status is an Independent Risk Factor for Herpes Zoster in Children: A Population-Based Cohort Study. Ann Med 2017 Mar 23:1-24. doi: 10.1080/07853890.2017.1309060
70. Ahluwalia SK, Peng RD, Breysse PN, et al. Mouse allergen is the major allergen of public health relevance in Baltimore City. J Allergy Clin Immunol 2013;132(4):830-835.e2
71. Bacharier LB. Reducing exposure to mouse allergen among children and adolescents with asthma is achievable, but is it enough? JAMA 2017 Mar 14;317(10):1023-1025. doi: 10.1001/jama.2016.21181
72. Marsui EC, Perzanowski M, Peng RD, et al. Effect of an integrated pest management intervention on asthma symptoms among mouse-sensitized children and adolescents with asthma. JAMA 2017;317(10):1027-1036. DOI: 10.1001/jama.2016.21048
73. Blum CL. Roll of chiropractic and sacro-occipital technique in asthma treatment. J Chiropr Med 2002;1(1):16-22
74. Kartha GK, Li I, Comhair S, Erzurum SC, Monga M. Co-occurrence of asthma and nephrolithiasis in children. PLoS One https://doi.org/10.1371/journal.pone.0168813
75. Jason E, Lang MD. Obesity, nutrition, and asthma in children. Pediatr Allergy Immunol Pulmonology 2012;25(2):64-75
76. Chinn S. Obesity and asthma. Paediatr Resp Rev 2006;7(3):223-228
77. Miyata J, Arita M. Role of omega-3 fatty acids and their metabolites in asthma and allergic diseases. Japanese Society Allergology 2015;64(1):27-34
78. Eyers SJ. The effect of regular paracetamol on bronchial responsiveness and asthma control in mild to moderate asthma. Thesis. University of Otago, Wellington, NZ. 2012. https://ourarchive.otago.ac.nz/bitstream/handle/10523/.../EyersSallyJ2012PhD.pdf?
79. Simpson AB, Yousef E, Hossain J. Association between peanut allergy and asthma morbidity. J Pediatr 2010;156(5):777-781
80. McConnell R, Berhane K, Yao L, et al. Traffic, susceptibility and childhood asthma. Environ Health Perspec 2006;114(5);766-772
81. Kelly W, Massoumi A, Lazarus A. Asthma in pregnancy: physiology, diagnosis, and management. Postgrad Med 2015;127(4):349-358
82. Lagerløv P, Loed M, Andrew M, Hjortdahl P. Improving doctors' prescribing behaviour through reflection on guidelines and prescription feedback: a randomised controlled trial. Qual Health Care 2000;9(3):159-165
83. Su YL, Chou CL, Rau KM, Lee CT. Asthma and risk of prostate cancer: a population-based case-cohort study in Taiwan. Med (Baltimore) 2015 Sep;94(36):e1371. doi: 10.1097/MD.0000000000001371

84. Luyster FS, Teodorescu M, Bleeker E, et al. Sleep quality and asthma control and quality of life in non-severe and severe asthma. Sleep Breath 2012;16(4):1129-1137
85. Bird Y, Staines-Orozco H. Pulmonary effects of active smoking and secondhand smoke exposure among adolescent students in Janez, Mexico. Int J Obstruct Pulmon Dis 2016;11:1459-1467
86. Moraros J, Bird Y, Chen S, et al. The impact of the 2002 Delaware smoking ordinance on heart attack and asthma. Int J Environ Res Public Health 2010;12: 4169-4178. doi: 10.3390/ijerph7124169
87. Cisneros R, Gonzales M, Brown P, Schweizer D. Soda consumption and hospital admissions among Californian adults with asthma. J Asthma 2017;54(4):371-375
88. Zhang L. Prietsch AOM, Ducharme FM. Inhaled cortisone in children with persistent asthma: effects on bone growth. Cochrane Database of Systematic Rev 2014; DOI: 10.1002/14651858.CD009471
89. Wong CA, Walsh LJ, Smith CJP, et al. Inhaled corticosteroid use and bone-mineral density in patients with asthma. The Lancet 2000;355(9213):1399-1403
90. Sosa M, Saavedra P, Valero C, et al. Inhaled steroids do not decrease bone mineral density but increase risk of fractures: data from GIUMO study group. J Clin Densitometry 2006;9(2):154-158. DOI: 10.1016/j.jocd.2005.11.005
91. Rod NH, Kristensen TS, Lange P, Prescott E, Diderichsen F. Perceived stress and risk of adult-onset asthma and other atopic disorders: a longitudinal cohort study. Allergy 2012;67:1408-1414
92. Carlson S, Borrell LN, Eng C, et al. Self-reported racial/ethnic discrimination and bronchodilator response in African youth with asthma. PLoS https://doi.org/10.1371/journal.pone.0179091
93. Bédard A, Northstone K, Henderson AJ, Shaheen SO. Maternal intake of sugar during pregnancy and childhood: respiratory and atopic outcomes. Eur Resp J 2017;50(1). pii: 1700073. doi: 10.1183/13993003.00073-2017
94. Laino C. Sugar intake linked to kids' asthma. Web MD. http://www.webmd.com/asthma/news/20080317/sugar-intake-linked-to-kids-asthma
95. Bernard A, Nickmilder M, Voisin C. Outdoor swimming pools and the risks of asthma and allergies during adolescent. Eur Rep J 2008;32(4):979-988
96. D'Amato G, Liccardi G, Frenguelli G. Thunderstorm-asthma and pollen allergy. Allergy 2007, 62(1):11-16
97. Bellomo R, Gigliotti P, Treloar A, et al. Two consecutive thunderstorm associated epidemics of asthma in the city of Melbourne. The possible role of rye grass pollen. Med J Aust 1992;156(12):834-837
98. Wood LG, Garg ML, Powell H, Gibson PG. Lycopene-rich treatments modify noneosinophilic airway inflammation in asthma: proof of concept. Free Radic Res 2008;42(1):94–102
99. Zacharisen MC, Elms NP, Kurup VP. Severe tomato allergy (Lycopersicon esculentum). Allergy Asthma Proc 2002;23(2):149-152
100. Thomas PS. Tumour necrosis factor-apha: the role of this multifunctional cytokine in asthma. Immunol Cell Biol 2001;79(2):132-140
101. Steyn E, Mohamed Z, Husselman C. Non-invasive vagus nerve stimulation for the treatment of acute asthma exacerbations – results from an initial case series. Int J Emerg Med 2013; 6:7 doi:10.1186/1865-1380-6-7

102. Martineau AR, Cates CJ, Urashima M, et al. Vitamin D to prevent asthma attacks. 2016; Cochrane Database Syst Rev 2016 Sep 5;9:CD011511
103. Stone CA. Am Acad Allergy,Asthma & Immunology 2017 Medscape Maternal Levels of Vitamin E Isoform Linked to Child Asthma American Academy of Allergy, Asthma, & Immunology (AAAAI) 2017 Annual Meeting. Abstract 263. March 4, 2017. http://www.medscape.com/viewarticle/876662?src=wnl_edit_tpal
104. Hesselmar B, Hicke-Roberts A, Wannergren G. Allergy in children in hand verses machine dishwashing. Pediatrics 2015;135(3):e1-e8
105. Finlay B, Arrieta M-C. Univ British Columbia Yeast found in babies guts increases risk of asthma. 2017. Feb 17. http://news.ubc.ca/2017/02/17/yeast-found-in-babies-guts-increases-risk-of-asthma/
106. Asthma management. National Asthma Council Australia. https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/asthma-management. Aug 2015
107. Gibbons GH. How is asthma treated and controlled? National Heart, Lung, and Blood Institute. https://www.nhlbi.nih.gov/health/health-topics/topics/asthma/treatment. October 28, 2013
108. Engel R. The effect of combining spinal manipulation with exercise on respiratory function. (Platform presentation, The Association of Chiropractic Colleges. 13th Annual Conference. Washington, March 14-16, 2006
109. Hawk C, Khorsan R, Lisi AJ, Ferrance RJ. Evans MW. Chiropractic care for non-musculoskeletal conditions: a systematic review with implications for whole system research. J Altern Complement Med 2007;13(5):491-512
110. Gatterman MI. Chiropractic management of spine related disorders. Baltimore: Williams & Wilkins. 1990;390-392
111. Dougherty PE, Engel RM, Vemulpad S, Burke J. Spinal manipulative therapy for elderly patients with chronic obstructive pulmonary disease. A case series. J Manipulative Physiol Ther 2011;34(6):413-417
112. Engel RM, Venulpad SR, Beath K. Short term effects of a course of manual therapy in people with moderate chronic obstructive pulmonary disease: a preliminary clinical trial. J Manipulative Physiol Ther 2013;36(8):4909-496
113. McElvey SE, Bull P. The chiropractic cop-management of asthma: a clinical research approach. J Chiropr Edu 2010;24(1):135
114. Redwood D, Cleveland CS. Fundamentals of chiropractic. St Louis. Mosby.2003;355,360,536-539
115. Eriksen K. Upper cervical subluxation complex. Philadelphia. Lippincott: Williams & Wilkins; 2004:405-406
116. Guiney PA, Chou R, Vianna A, Lovenheim J. Effects of osteopathic manipulative treatment on pediatric patients with asthma: a randomised controlled trial. J Am Ostop Assoc 2005;105(1):7-12. doi:10.7556/jaoa.2005.105.1.7
117. Brockenhauer SE, Julliard KN, Lo KS, Huang E. Sheth AM. Quantifiable effects ofo osteopathic manipulative techniques on patients with chronic asthma. J Am Osteop Assoc 2002;102:371-375
118. King HH, Jänig W, Patterson MM. The science and clinical application of manual therapy. Edinburgh: Churchill Livingstone;2011:94,223-225
119. Bruuns MLJ, van der Giessen LJ, Moed H. The effectiveness of physiotherapy in patients with asthma: a systematic review of the literature. Resp Med 2013;107(4):483-494

120. Bergsmann O. [The mechanical dyspnea syndrome: breath movement and thoracic disturbance.] Das mechanisch-dyspnoische Syndrom – thorakle Störung der Atembewegung. Manuelle Medizen 1974;12:79. (Cited in: Lewit K. Manipulative therapy in rehabilitation of the locomotor system. 3rd edn. Butterworth Heinemann, Oxford. 1999:283.)
121. Köberle G. [Examples of joint disturbance with chronic-obstructive airway disease.] Arthrologische Störungsmuster bei chronisch-obstruktiven Atemwegserkrankungen. In: Functional pathology of the motor system, Rehabilitacácia Suppl 10-11, p 96. Eds: Lewit K, Gutmann G. Bratislava: Obzor. 1975. (Cited in: Lewit K. Manipulative therapy in rehabilitation of the locomotor system. 3rd edn. Butterworth Heinemann, Oxford. 1999:283.)
122. Sachse T, Sachse J. [Muscle findings with chronically obstructive airway diseases.] Muskelbefunde bei chronisch obstruktiven Atemwegserkrankungen. In: Functional pathology of the motor system, Rehabilitacácia Suppl 10-11, p 98 Eds Lewit K, Gutmann G. Bratislava: Obzor. 1975. (Cited in: Lewit K. Manipulative therapy in rehabilitation of the locomotor system. 3rd edn. Butterworth Heinemann, Oxford. 1999:283.)
123. Bronfort G, Haas M, Moher D, et al. Review conclusions by Ernst and Canter regarding spinal manipulation refuted. Chiropr Man Ther 2006;14:14. doi:10.1186/1746-1340-14-14
124. Bogen J. Theory and observation in science. Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/science-theory-observation/. 2017 (Extracted May 8, 2017.)
125. Jindal SK, Kaur SJ. Relative bronchodilatory responsiveness attributable to sympathetic and parasympathetic activity in bronchial asthma. Respiration 1989;56:15-21
126. Kozlova VI. [The influence of skeletal muscle proprioception impulses on the functional state of the respiratory center.] Fiziol Zh SSSR Im I M Sechenova. 1970;56(5):759-763. (Russian) (Pubmed extract only)
127. Miner JR, Lewis LM, Mosnaim GS et al. Feasibility of percutaneous vagus nerve stimulation for the treatment of acute asthma exacerbations. Acad Emerg Med 2012.19(4):421-429
128. Steyn E, Mohamed Z, Husselman. Non-invasive vagus nerve stimulation for the treatment of acute asthma exacerbations - results from an initial case series. Internl J Emerg Med 2013, 6:7 doi:10.1186/1865-1380-6-7
129. Field T, Henteleff T, Hernandez-Reif M, Martinez E, Mavunda K, Kuhn C, Schanberg S. Children with asthma have improved pulmonary functions after massage therapy. Journal of Pediatrics 1998; 132(5): 854-858
130. Cox SF, Tornatore RA, Marquina N. The effect of adjusting on tissue oxygenation and chest expansion. J Chiro Educ 2000;14(1):30-31
131. Devi TP, Kanan W, Singh TS, Asoka W, Benjamin L. A study of the sympathetic nervous system in bronchial asthma. J Med Society 2012;26(3):159-162
132. Reed CE. Abnormal autonomic mechanisms in asthma. J Allergy Clin Immunol 1974;53:34-41
133. Shar PL, Lakhotia M, Mehta S, Jain SK, Gupta GL> Clinical dysautonomia in patients with bronchial asthma. Study with seven autonomic tests. Chest 1990;98:1408-1413
134. Kumar M, Verma NS, Tiwari S, Pandey US. Sympathetic hyperactivity in patients of bronchial asthma. Indian J Physiol Pharmacol 2005;49:89-94

135. Allen TW, Pence TK. The use of the thoracic pump in treatment of lower respiratory tract disease. J Am Osteop Assoc 1967;67(12):86-89
136. Miller CE. Osteopathic principles and thoracic pump therapeutics proved by scientific research. J Am Osteop Assoc 1926;26(7):910-914
137. Chauhan AJ, et al. Regular balloon inflation for patients with chronic bronchitis: a randomised controlled study. BMJ 1992;304:1668-9
138. Asthma Foundation Victoria Fact sheet. Asthma and Complementary therapies. https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/asthma-and-complementary-therapies?viewAsPdf=true
139. Schneider A, Gindner L, Tileman L, et al. Diagnostic accuracy of spirometry in primary care. BMC Pulm Med 2009;9:31
140. Jongeward BV, Chiropractic manipulation for childhood asthma. N Engl J Med 1999;340:391-392
141. Seaman DR, Winterstein JF. Dysafferentation: A novel term to describe the neuropathophysiological effects of joint complex dysfunction. A look at likely mechanisms of symptom generation. J Manipulative Physiol Ther 1999;22(1):45-48
142. Pickar JG. Neurophysiological effects of spinal manipulation. Spine J 2002;2(5):357-371
143. Sato A, Sato Y, Schmidt RF. The impact of somatosensory input on autonomic functions.. In: Reviews of Physiology Biochemistry and Pharmacology. Blaustein MP et al Eds. Springer-Verlag, Berlin. 1997;v130.253-256
144. Bolton PS, Budgell B. Visceral responses to spinal manipulation. J Electromyogr Kinesiol 2012;22(5):777-784
145. Henderson CN. The basis for spinal manipulation: chiropractic perspective of indications and theory. J Electromyogr Kinesiol. 2012;22(4):632-642. doi: 10.1016/j.jelekin.2012.03.008. Epub 2012 Apr 17
146. Haavik Taylor H, Holt K, Murphy B. Exploring the neuromodulatory effects of the vertebral subluxation and chiropractic care. Chiropr J Aust 2010;40(1):37-44
147. Cramer G, Budgell B, Henderson C, Khalsa P, Pickar J. Basic science research related to chiropractic spinal adjusting: the state of the art and recommendations revisited. J Manipulative Physiol Ther 2006;29(9):726-761
148. Hayek R. Chiropractic management of asthma: anatomy, evidence and best practice. World Federation of Chiropractic 8th Biennial Congress. Sydney, June 16-18, 2005:95
149. Alcantara J, Alcantara JD, Alcantara J. The chiropractic care of patients with asthma; a systematic review of the literature to inform clinical practice. Clin Chiropr 2012;15(1):23-30
150. Kaminskyj A, Frazier M, Johnstone K, Gleberzon BJ. Chiropractic care for patients with asthma: a systematic review of the literature. J Canad Chiropr Assoc 2010;54(1):24-32
151. Bronfort G, Evans PL, Kubic P, Filkin P. Chronic paediatric asthma and chiropractic manipulation. A prospective clinical series and randomised clinical pilot study. J Manipulative Physiol Ther 2001;24(6):369-377
152. Nielsen NH, Bronfort G, Bendix T, Madsen F, Weeke B. Chronic asthma and chiropractic spinal manipulation: a randomised clinical trial;. Clin Exp Allergy 1995;25(1):80-88

153. Hviid A. A comparison of the effects of chiropractic treatment on respiratory function in patinets with respiratory distress symptoms and patients without. Bull Europ Chiro Union 1978;26:17-34
154. Lines D. A wholistic approach to the treatment of bronchial asthma in a chiropractic practice. Chiro J Aust 1993;23(1):4-8
155. Lines D, McMillam A, Spehr G. Effects of soft tissue technique and Chapman's neurolymphatic reflex stimulation on respiratory function. J Australian Chiropractor's Assn March 1990;20(1):17-22
156. Rocha T, Souza H, Brandao DC, et al. The manual diaphragm release technique improves diaphragmatic mobility, inspiratory capacity and exercise capacity in people with chronic obstructive pulmonary disease: a randomised trial. J Physiotherapy 2015;61(4):182-189
157. McCulloch P. A simple mode illustrating the balancing forces of lung and chest wall recoil. Advances Physiol Educ 2004;28(3):125-127 DOI: 10.1152/advan.00011.2004
158. Bottrell J. Why does asthma cause chest pain. https://www.healthcentral.com/article/lung-anatomy-101-why-does-asthma-cause-chest-pain
159. Sato A. Neural mechanisms of autonomic responses elicited by somatic sensory stimulation. Neurosci Behav Physiol 1997 Sep-Oct;27(5):610-21
160. Kimura A, Sato A. Somatic regulation of autonomic functions in anesthetized animals – neural mechanisms of physical therapy including acupuncture. Jpn J Vet Res 1997;45(3):137-145
161. Sato A. Neural mechanisms of autonomic responses elicited by somatic stimulation. Neurosci Behav Physiol 1997;27(5):610-621
162. Sato A. Somatovisceral reflexes. J Manipulative Physiol Ther 1995;18(9):597-602.
163. Sato A. The reflex effects of spinal somatic nerve stimulation on visceral function. J Manipulative Physiol Ther 1992;15(1):57-61
164. Nelson KE, Glonek T. Somatic dysfunction in osteopathic family medicine. Philadelphia. Lippincott Williams & Wilkins. 2006
165. Leach RA. The chiropractic theories: Principles and clinical application. 3rd edn. Baltimore. Williams & Wilkins. 1994:108-115, 180-183
166. Uchida S, Budgell B. Somato-autonomic reflex. In: Binder MD, Hirokawa N, Windhorst U. Encyclopaedia of Neuroscience. 2009. 3767-3779. 10.1007/978-3-540-29678-2_5500
167. Physiology II. Cardiovascular physiology. Control of ventilation. (Citing Guyton 9th edn, Ganong, 19th edition) http://www.hodsonhome.com/mna2001/physiology/physiology2/exam3/phys2.controlofventilation.htm. (Extracted 22.7.2017)
168. Autonomics of the thorax. http://www.med.umich.edu/lrc/coursepages/m1/anatomy2010/html/modules/autonomics_thorax_module/autonomics_thorax.pdf. 2002
169. Goyal M1, Jaseja H, Verma N. Increased parasympathetic tone as the underlying cause of asthma: a hypothesis. Med Hypotheses 2010 Apr;74(4):661-4. doi: 10.1016/j.mehy.2009.11.011. Epub 2009 Dec 30
170. Muscles of respiration. http://teachinganatomy.blogspot.com.au/2013/07/respiratorymuscles.html

171. van der Velden M, Hulsmann AR. Autonomic innervation of human airways: structure, function, and pathophysiology in asthma. Neuroimmunomodulation 1999;6(3):145-159
172. Jarth T. Asthma, asthma medication and autonomic nervous system dysfunction. Clin Physiol 2001;21(2):260-269
173. Emin O, Esra G, Aysegul D, et al. Autonomic nervous system dysfunction and their relationship with disease severity in children with atopic asthma. Respir Physiol Neurolbiol 2012;183(3):206-210
174. Mukhopadhyay J, Bates R, Manney S, Ayres JG. Changes in vagal tone with posture in asthma are related to changes in ventilator pattern. Resp Med 2007;101(5):1001-1006
175. Ichinose M. [Airway autonomic nervous system dysfunction and asthma].Nihon Kokyuki Gakkai Zasshi 1999 Jan;37(1):3-9. (Abstract only) [Article in Japanese]
176. Engel-Yeger B, Almog M, Kessel A. The sensory profile of children with asthma. ACTA Paediatrica 2014; 103(11):e490-494. DOI: 10.1111/apa.12746
177. Gordienko AN. (Ed) Control of immunogenesis by the nervous system. (Translation) Washington DC, National Science Foundation Dept HEW,1960. [Original - Rostov-On-Don Medical Institute, 1958. Translated by The Israel Program for Scientific Translation.]
178. Barnes PJ. Efficacy of inhaled corticosteroids in asthma. J Allergy Clin Immunol 1998;102(4 Pt 1):531-538
179. Brennan PC, Kokjohn K, Kaltinger CJ. Enhanced phagocytic cell respiratory burst induced by spinal manipulation: potential role of substance P. J Manipulative Physiol Ther 1991;14:399-408.
180.. Hayek R. Effect of chiropractic treatments on the endocrine and immune system in asthmatic patients. Proceedings of the 2002 International Conference on Spinal Manipulation, Toronto Ontario, Canada, Oct 2002:57-58
181. Hayek R, Ali S, Holland R, et al. Somatovisceral effects of chiropractic treatment on the hypothalamo-adrenal axis and immunity of the respiratory system in asthmatics [Conference abstract] Eur J Chiropr 2002;49(1):87
182. Sears MR, Burrows B, Flannery EM, Harbison GP, Hewitt CJ, Holdaway MD. Relation between airway responsiveness and serum IgE in children with asthma and in apparently normal children. N Engl J Med 1991;325(15):1067
183. Waddell SC, Davidson JS, Befus AD, Mathison RD. Role for the cervical sympathetic trunk in regulating anaphylactic and endotoxic shock. J Manipulative Physiol Ther 1992;15(1):10-15
184. Alcantara J, van Roo L, Oman RE. Chiropractic care of a pediatric patient with asthma, allergies, chronic colds and vertebral subluxations. J Pediatr Matern Fam Health 2009;3:27-29
185. Whittle-David H, Czegus K. Chiropractic care of a pediatric patient with asthma: A case report. J Pediatr Matern Fam Health 2011;3:77-81
186. http://teachinganatomy.blogspot.com.au/2013/07/respiratorymuscles.html
187. http://www.physio-pedia.com/Muscles_of_Respiration
188. Young RL, Page AJ, Cooper NJ, Frisby CL, Blackshaw LA. Sensory and motor innervation of the crural diaphragm by the vagus nerve. Gastroenterol 2010;138(3):1091-1101.e1-5. doi: 10.1053/j.gastro.2009.08.053. Epub 2009 Sep 2
189. Crural diaphragm contribution to EGJ and neural control. Morgan & Claypool Life Sciences. https://www.ncbi.nlm.nih.gov/books/NBK54268/. 2011

190. O'Rahilly, Müller, Carpenter & Swenson. Basic Human Anatomy. https://www.dartmouth.edu/~humananatomy/part_4/chapter_20.html
191. Janssens L. Brumagne S, McConnell AK, Hermans G, Troosters T, Gayan-Ramirez G. Greater diaphragm fatigability in individuals with recurrent low back pain. Respir Physiol Neurobiol 2013;188(2):119-123
192. Beeckmans N, Vermeersch A, Lysens R. et al. The presence of respiratory disorders in individuals with low back pain: a systematic review. Man Ther 2016;26:77-86
193. Davies NJ. Chiropractic paediatrics. A clinical handbook. Edinburgh. Churchill livingstone;2000;147-152
194. Bockenhauer SE, Julliard KN, Lo KS, Huang E, Sheth AM. Quantifiable effects of osteopathic manipulative techniques on patients with chronic asthma. J Am Osteopath Assoc 2002 Jul;102(7):371-5
195. Gorini M, Iandelli I, Misuri G, et al. Chest wall hyperinflation during acute bronchoconstriction in asthma. Am J Resp Crit Care Med 1999;160(3):808-816
196. Janse J, Houser RH, Wells BF. Chiropractic principles and technic. Chicago National College of Chiropractic;1947:186-189,627-629
197. Hill AR. Respiratory muscle function in asthma. J Assoc Acad Minor Phys 1991;2(3):100-108. (Abstr)
198. Beeckmans N, Vermeersch A, Lysens R. et al. The presence of respiratory disorders in individuals with low back pain: a systematic review. Man Ther 2016;26:77-86
199. Martin JG, Shore SA, Engel LA. Mechanical load and inspiratory muscle action during induced asthma. Am Rev Resp Dis 1983;128(3):455-460
200. Dunne C. Thoracic pump. https://www.youtube.com/watch?v=2NSs5wf6lRU Feb 24, 2017
201. Noll DR, Johnson JC, Baer RW, Snider EJ. The immediate effect of individual manipulation techniques on pulmonary function measures in persons with chronic obstructive pulmonary disease. Osteop Med Prim Care 2009;3:9. doi: 10.1186/1750-4732-3-9
202. Taylor BJ, Romer LM. Effect of expiratory resistive loading on inspiratory and expiratory muscle fatigue. Respir Physiol Neurobiol 2009;166(3):164-174
203. Freitas DA, Holloway E, Bruno SS, et al. Breathing exercises for asthma. Cochrane Database of Systemic Review 1 Oct 2013 http://www.cochrane.org/CD001277/AIRWAYS_breathing-exercises-for-asthma
204. Macâdo TMF, Freitas DA, Chaves GSS, Holloway E, Mendonça KMPP. Breathing exercises for children with asthma. http://www.cochrane.org/CD011017/AIRWAYS_breathing-exercises-children-asthma
205. Bott J, Blumenthal S, Buxton M, et al. Guidelines for the physiotherapy management of the adult, medical, spontaneously breathing patient. Asthma and disordered breathing. – Exercises. http://thorax.bmj.com/content/64/Suppl_1/i1
206. Stamford B. Exercise and chronic airway obstruction. Physician Sportsmed 1991;19(3):189-190
207. Carson KV, Chandratilleke MG, Picot J, Brinn MP, Esterman AJ, Smith BJ. Physical training for asthma. Cochrane Database Syst Rev 2013 Sep 30;9:CD001116. doi: 10.1002/14651858.CD001116.pub4.

208. Bernstein D. American college of Allergy Asthma and Immunology. http://acaai.org/allergies/types/skin-allergies/latex-allergy. 2014
209. Beggs S, Foong YC, Le HC, Noor D, Wood-Baker R, Walters JA. Swimming training for asthma in children and adolescents aged 18 years and under. Cochrane Database Syst Rev 2013 Apr 30;4:CD009607. doi: 10.1002/14651858.CD009607.pub2
210. Grande AJ, Silva V, Andriolo BNG, et al. Is water-based exercise an effective and safe type of exercise for adults. Cochrane Database of Systematic Reviews https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0066237/. 2014
211. Lopes EA, Fanelli-Galvani A, Prisco CC, et al. Assessment of muscle shortening and static posture in children with persistent asthma. Europ J Pediatr 2006;166(7):715-721
212. Goldthwait JE, Brown LT, Swaim LT, Kuhns JG. The chest. In: Essentials of body mechanics in health and disease. Philadelphia: JB Lippencott Co. 1952:53-64
213. Kuznetsov NA, Luberto CM, Availone K, et al. Characteristics of postural control among young adults with asthma. J Asthma 2015;52(2):191-197
214. Chebbo A, Tfaili A, Jones SF. Hypoventilation syndromes. Med Clin North Am 2011;95(6):1189-1202
215. Kangilaski J. Chiropractic can involve more than spinal manipulation. Forum on Med 1978;Nov:33-35
216. Krogulska A, Dynowski J, Wasowska-Krolikowska K. Bronchial reactivity in schoolchildren allergic to food. Ann Allergy Asthma Immunol 2010 Jul;105(1):32-8.
217. Kaliner M, Shelhamen JH, Davis PB, Smith L J Venter JC Autonomic nervous system abnormalities and allergy. Annals of Internal Medicine 1982;96:349-357
218. Li TC. Can foods affect my asthma symptoms? 2017. Mayo Clinic. http://www.mayoclinic.org/diseases-conditions/asthma/expert-answers/asthma-diet/faq-20058105
219. Ferreira IM, Brooks D, White J, Goldstein R. Nutritional supplementation for stable chronic obstructive pulmonary disease. Cochrane Database Syst Rev 2012;Decd 12;12:CD0000998. doi: 10.1002/14651858.CD000998.pub3
220. Smoking and asthma. Australian Asthma Handbook. 2017. http://www.asthmahandbook.org.au/clinical-issues/smoking
221. Brozovich TA. The reduction of asthma symptoms and medication after chiropractic care. Chiropr J Aust 2017;45:138-143
222. Lord E. Patients with asthma turning to CAMS. Aust Doctor 6 Sept. 2013. https://www.australiandoctor.com.au/news/latest-news/patientswithasthmaturningtocams
223. Fact Sheet. Asthma and complementary therapies https://www.asthmaaustralia.org.au/ArticleDocuments/865/Asthma and Complimentary Therapies Feb2013.pdf.aspx. May 2012
224. Schneider A, Ginner L, Tilemann L, et al. Diagnostic accuracy of spirometry in primary care. BMC Pulmonary Medicine 2009, 9:31 doi:10.1186/1471-2466-9-31
225. Eastwood HL. Complementary therapies: the appeal to general practitioners. Med J Aust 2000;173:95-98
226. Dovey D. 10 Medical breakthroughs and life-saving drugs discovered by accident, from pap smears to laughing gas.

http://www.medicaldaily.com/penicillin-pap-smears-and-8-other-medical-breakthroughs-discovered-accident-396249
227. Redwood D, Cleveland CS. Fundamentals of chiropractic. St Louis. Mosby.2003;355,360,536-539
228. Walker S, Cramb S. Diagnosis and management of asthma in children. BMJ 2015;350:h996