The Buteyko breakthrough

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Abstract

Chronic hyperventilation is a multi-pathogenic condition characterized by low carbon dioxide and bicarbonate in the body. It results from habitually breathing more air than the body needs for it to function properly. Since its discovery in all patients with Da Costa's syndrome by Sir Thomas Lewis in 1916, it has remained ignored by mainstream medicine. The profound biochemical disruptions caused by chronically low carbon dioxide in the body can result in, or contribute to, an array of apparently unrelated symptoms and disorders. Around 50 years ago, Buteyko joined the movement to have this condition placed firmly on the medical map by developing a regimen for reversing it. The success of recent clinical trials using Buteyko's therapy for asthma has given the hyperventilationists a much needed boost and has shown that even they may have underestimated the significance of chronic hyperventilation as a cause of disease.

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1. Introduction

Chronic hyperventilation (CHV) is a condition characterized by chronically low arterial carbon dioxide resulting from a physiological habituation to over breathing. Over the past century, much has been written in the medical literature about this condition. Although CHV produces profound biochemical disturbances [1], giving rise to a huge range of debilitating disorders, it remains unrecognized within medicine in the developed western nations [1-5].

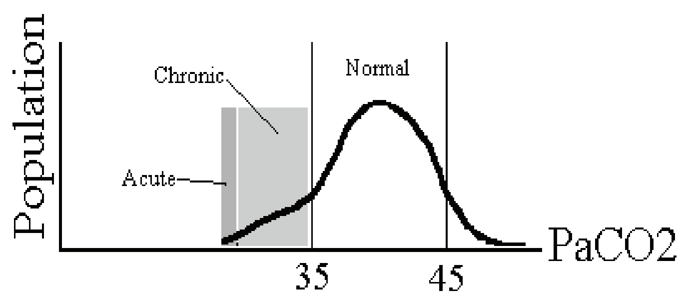
Fuel has been added to this debate over the past decade by the emergence of a simple education program aimed at reversing this condition. The therapy was developed by Dr. K. P. Buteyko in Russia over the second half of the 20th century and first appeared in the west in 1990. After the Buteyko method was subjected to at least two clinical trials in Russia, it was first tested outside Russia in 1995 in Brisbane, Australia for its effectiveness on asthma [6]. The success of this clinical trial, which demonstrated, for example, a dramatic 96% reduction in the need for bronchodilators, has led to several other studies [7-10], all producing similar results. Yet even some of the researchers conducting these trials have shown an inability, or an unwillingness, to explore chronic hyperventilation as the underlying problem in asthma [6].

Asthma is just one of over 100 disorders listed in the medical literature as having CHV as a possible cause [1,4,5,11,12]. Apart from asthma, none of these disorders has yet been treated in trials using the Buteyko method outside of Russia.

CHV is a bizarre and confusing condition that produces a profound derangement of normal biochemistry, which affects every organ, every body part, and every system [1]. The symptoms are variable and depend on the level of hyperventilation and the genetic makeup of the individual [2,3,5,13].

Both the degree of hyperventilation at which symptoms appear and the kinds of symptoms that develop vary from person to person. Hence, although Waites [13] refers to it as "Chronic Hyperventilation Syndrome" (CHVS), technically it escapes the normal definition of a syndrome. In fact Lum [1] laments that there is not even a name for this condition anywhere in the medical dictionary.

Figure 1. Population distribution representation for arterial carbon dioxide.



CHV is a condition in which excessive breathing over a long time results in accommodation to abnormally low arterial carbon dioxide [4,5,12,14]. The situation is best illustrated with a population distribution representation for arterial carbon dioxide ($PaCO_2$). As shown in Figure 1, most people fit into the normal range between 35 and 45 mmHg. Occasionally medical practitioners will come across *acute* hyperventilation, which even medical students easily recognize. Such patients present with the triad of overt over-breathing, carpopedal spasm, and paresthesia. This condition is transient. However, the *acute* form represents only 1% of all hyperventilation cases [1]. The other 99% do not present with these symptoms. They could be suffering from a variety of conditions, including headaches [1],

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migraines [4,11], asthma [1,4,5,11,12], chronic fatigue [1-5,11], digestive disorders [1-4,11,13], anxiety [1,4,5,13] and panic attacks [4,11], to name a few. Yet rarely considered is the possibility that the cause of their condition might be CHV-related [1-5]. These are what Lum calls the "hidden body of the iceberg" [1] and Buteyko calls "hidden hyperventilation."

2. Theory

The Buteyko theory holds that when life was first formed there was very much more carbon dioxide (CO_2) in the atmosphere (30-40%) and very little oxygen [15,16]. Gradually plant life depleted the CO_2 and replaced it with oxygen, a waste product. Animal life was probably formed when CO_2 had run down to around 6%. As atmospheric CO_2 reduced still further, man's respiratory system gradually adapted to maintain this level for the optimum functioning of the cells. Kazarinov [17] argues that all important metabolic and biosynthetic processes involve carbon dioxide, including the biosynthesis of several of the amino acids, nitrogenous bases, lipids, and carbohydrates [17]. Carbon dioxide is also involved in the regulation of activity of the nervous system, the hormonal system, the cardiovascular system, and the digestive system [17]. All these processes and control functions are compromised when CO_2 levels are too low.

Paradoxically, too much breathing also leads to cellular hypoxia. Low baseline arterial CO_2 inhibits the unloading of oxygen from hemoglobin in the metabolically active tissue where it is needed. There are two reasons for this. Firstly, there is a left shift in the oxy-hemoglobin dissociation curve resulting from a depressed Bohr effect [3,5,11-13]. Secondly, chronic hyperventilators often suffer from hypophosphatemia [3,5,13] which inhibits the production of 2,3 diphospho-glycerate, the other factor involved in oxy-hemoglobin dissociation [3]. There is a further reduction in oxygenation due to constriction of blood vessels in conditions of low CO_2. For example, cerebral blood flow is reduced by 2% for every drop in $PaCO_2$ by 1 mmHg [5,13]. The resulting tissue hypoxia affects the tricarboxylic acid [17] or Krebs cycle, and leads to the painful build up of acids such as lactic acid in the muscles and uric acid in the joints [1,4,11].

Low CO_2 also causes a shift in calcium from the extra-cellular fluid to inside the cells [1,4]. This causes spasm in smooth muscle of the bronchioles, arteries, ducts, glands, and digestive tract [1,4,5,11,12]. This may result in asthma [1,4,5,11,12], hypertension [4], and a multitude of digestive disorders such as spastic colon [4], irritable bowel syndrome [4], bloating [1,3], constipation [1], and diarrhea [1].

3. Causes of CHV

Any stress, good or bad, produces an increase in respiration and hence a drop in CO_2. When stresses are properly discharged and short lived the CO_2 returns to normal. However, undischarged stresses that last for a long time, result in a physiological habituation to lower CO_2 [4,5,12].

In addition, the lifestyle in the developed western nations, as exhibited by sedentary city dwellers [18,19], is a major contributing factor to over-breathing [20]. The three most significant reasons for CHV in Russian children were found to be: over-feeding, over-heating (too much clothing and too many blankets), and too little physical activity. [20].

Buteyko also found that excessive alcohol consumption and the consumption of animal proteins increases breathing [15]. In fact, anything that is a stress to the system, including viral, bacterial, and fungal infections [21], will increase breathing. It is the accumulation of such stresses over a period of time that eventually leads to hyperventilation becoming chronic with associated low baseline CO_2.

4. Habituation [14] to lower CO_2

The respiratory center is distributed over a number of nuclei in the pons and medulla. It is fundamentally a pace maker that determines the depth and frequency of breathing in response to the pH of the cerebrospinal fluid (CSF). Separating the CSF from the blood is the blood-brain barrier, which has the following relevant properties: it is:

- virtually impermeable to hydrogen ions,
- very permeable to CO_2, and
- only slightly permeable to bicarbonate.

From the Henderson-Hasselbach equation,

$$pH = 6.1 + \log\left\{\frac{[HCO_3]^-}{0.03[CO_2]}\right\}$$

it is clear that, for pH to remain constant, it is necessary to maintain the ratio of CO_2 to bicarbonate. By controlling the ventilation of the lungs, the respiratory center maintains the concentration of CO_2 in the blood and hence the CSF. The result is a tightly regulated pH between 7.36 and 7.44.

On top of this basic regulation there is a modulation of CO_2 brought about by various stress conditions. An error analysis of the Henderson-Hasselbach equation shows that a variation in $PaCO_2$ by ±4 mmHg from the base line level will maintain the pH in the normal range.

When CO_2 is low for a long time, such as the condition found during periods of chronic stress, a respiratory alkalosis develops. Kidneys compensate for this by dumping bicarbonate, but the process is relatively slow. A positive concentration gradient drives the bicarbonate from the CSF into the blood. Again, the process is very slow, typically taking place over a few days because of the low permeability of the blood-brain barrier to bicarbonate ions. When the stress is eventually lifted, the CSF contains less bicarbonate, and hence less CO_2 is required to restore the pH. The habituation process to lower CO_2 is now complete.

5. Reversing CHV with Buteyko's Therapy

Buteyko's therapy is an education program designed to inform students about the causes of CHV and how to avoid them during their recovery. It focuses on relaxation, the aim of which is to sustain a sense of slight air shortage over a long time. In this way, the habituation process that leads to CHV is reversed. Exercises often have to be tailored for individuals who cannot relax.

Buteyko also developed a simple and cheap method for patients to assess their breathing. The basis for the test is the recognition that hyperventilators, having to breathe more air to sustain a lower CO_2 level, are unable to hold their breath for as long as those with a normal level of carbon dioxide in their blood, the "normocapniacs," who require less air. This has led to the development of a carefully defined breath hold time to which the name "Control Pause" has been given. When measured correctly, it provides an estimate of arterial carbon dioxide [22].

6. CHV and asthma

While Buteyko's therapy is commonly provided for sleep apnea, anxiety and panic attacks, it has mainly become known as a "treatment" for asthma. Unlike conventional medical asthma treatment, Buteyko's therapy is based on a solid physiological model of asthma. Chronic hyperventilation is seen as the cause of all forms of asthma, rather than the result of asthma. Hence the reversal of hyperventilation is the target of the therapy.

There are three components of asthma: Bronchospasm, allergic and inflammatory hyper-responsiveness and mucus plugging.

Bronchospasm: Although bronchioles are innervated, they are known to constrict mainly in response to local conditions [23]. Teleologically, it makes sense that the role of this smooth muscle is to even out ventilation in the same way as smooth muscle in the walls of arterioles control local blood flow. When alveoli become over-ventilated, the local bronchioles that supply them with air need to constrict. Conversely, under-ventilated parts of the lungs fill up with CO_2. Since CO_2 is a well-known smooth muscle relaxant [18], it causes the bronchioles to dilate. When baseline arterial CO_2 is low and alveoli are chronically over-ventilated, it is reasonable to expect that most of the bronchioles will remain in a twitchy state, ready to close down. Hence normal transient increases in respiration could readily trigger an asthma attack in those who have bronchioles that are particularly good at performing their function such as in people with the asthma gene. Under this model, bronchospasm is not seen as a disease, but as a normal and healthy response to over ventilation.

Inflammatory hyper responsiveness: In the Buteyko model, the immune system is seen as just as vulnerable to the biochemical disturbances caused by CHV as any of the other systems referred to by Lum. [1]. The immune system is a finely tuned biological protective mechanism designed to identify and eliminate pathogenic invaders. At the same time, it has to avoid overreacting to non-pathogens as well as to the body's own cells. Disturbances to the immune system are well known following chronic stress. The general malfunctioning of the immune system in the Buteyko model does not make it necessarily over-reactive or under-reactive, just mal-reactive. This compromises its ability to respond to genuine pathogens such as flu viruses, while at the same time overreacting to the relatively harmless pollens inhaled into the lungs. It fails to pick up cancer cells and destroys the body's own cells as seen in autoimmune disorders such as arthritis and diabetes type 1. Anecdotal evidence from Buteyko clinics support Buteyko's claim that allergies are, indeed, the product of chronic hyperventilation [15], since they dissipate during therapy.

Mucus Plugging is the consequence of a natural reaction to protect the raw and inflamed airways. It is often exacerbated by breathing through the mouth, which dries out the airways and bypasses the normal protection of the filtering and sterilizing mechanism provided by the nasal passages.

7. Asthma and hypercapnia

While in a mildly obstructive asthma attack carbon dioxide is always low, typically at 24 mmHg [24], the same cannot necessarily be said for severe asthma. In cases where the disease has caused serious damage to the lungs, oxygen is low and CO_2 can be very high. These are the symptoms of suffocation which necessitate an increase in ventilation of the areas of the lungs that are still functioning reasonably well, hence, an ever increasing demand for bronchodilators. For this reason Buteyko refers to asthma as being caused by *alveolar* hyperventilation [18,24].

The etiology of the disease is easier to follow from clues left in the initial stages, when obstruction is mild, than after the ravages of the disease has taken its toll.

8. Clinical trials on Buteyko therapy for asthma

Several clinical trials have been held outside of Russia on the effectiveness of Buteyko's therapy for asthma. [6-10,25] The first of these was a double blind placebo controlled clinical trial with 39 participants who were selected and divided into a test (Buteyko) group and a control group [6]. The word "Buteyko" was never mentioned. While the test group was given Buteyko's therapy, the control group was taught standard diaphragmatic breathing and relaxation exercises by a physiotherapist. In addition, a group of healthy individuals working at the hospital was also tested for comparative purposes.

All of the outcomes support Buteyko's hyperventilation theory of asthma, with the exception of one that was equivocal. Initially, the study found that all the asthmatics had significantly higher minute volume and lower CO_2 than the healthy group. At the end of three months, the Buteyko group had reduced its bronchodilator usage by 96% and a trend was observed toward reduced steroid use by 49%, while there were no significant changes in the control group. There was also a 71% reduction in symptoms accompanying the reduction in medication in the test group [26]. In fact, the decrease in medication was linearly related to the decrease in minute volume, which was also statistically significant.

However, the increase in end tidal CO_2 level ($ETCO_2$) was found to be not statistically significant in spite of a significant reduction in minute volume. Arterial CO_2 is labile, a single deep breath can change CO_2 concentration by up to 16 mmHg [13]. Chronic hyperventilators experience particularly severe fluctuations in their levels of CO_2 [2,11]. Hence, $ETCO_2$ is probably not a reliable measure of bicarbonate in the cerebrospinal fluid, which is ultimately the "capnostat" (cf. thermostat for regulating temperature) that Buteyko's therapy aims to reset.

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There was also no change in the asthma gold standard—lung function. Failure to see changes in lung function should come as no surprise since this is what Buteyko's hyperventilation model of asthma predicts. In mainstream medical practice, asthma is quantitatively assessed on the basis of the results from two tests performed by the patient. Both the peak expiratory flow (PEF) test and the forced expiratory flow in 1-second (FEV1) test rely on the response observed after a hyperventilation manoeuvre. A single breath of the type required for these tests reduces specific airway resistance by 70% in asthmatics [27]. The fact that the parameter being measured is significantly changed by the measurement process, violates the most fundamental rule of measurement, making these tests meaningless in the Buteyko context. At best, they serve as an indicator of how well the bronchioles respond to hyperventilation

9. Buteyko and cortisone [22]

Cortisone supplementation is a point of convergence between Buteyko therapy and conventional medical treatment for asthma. However, the rationale is different. While in conventional medical asthma treatment the anti-inflammatory properties of cortisone are important, Buteyko saw the problem as being one of adrenal insufficiency. Adrenal fatigue should be anticipated because hyperventilation produces a shift from parasympathetic to sympathetic tone [1,3,5,13,28]. In the chronic state, the demands on the adrenal glands become severe.

During stress peaks, when the body's need for cortisone can no longer be met, heart rate and ventilation increase. The increase in ventilation reduces alveolar CO_2, which causes bronchospasm. Supplementing with sufficient cortisone to meet the shortfall will reduce breathing and hence bronchospasm.

This has implications for hyperventilation disorders that have no inflammatory component and for which cortisone supplementation could be helpful. This work was pioneered by MckJefferies [29,30]. While MckJefferies has not claimed any link between CHV and low adrenal reserve, his approach to providing physiological rather than pharmacological doses to meet the systemic needs of the body, matches that of Buteyko. He has found considerable success in using cortisol to treat disorders such as infertility, autoimmune disorders, hypoglycemia and chronic fatigue syndrome, all of which can also be symptoms of chronic hyperventilation [29].

10. Conclusion

Breathing too much over time can lead to a physiological habituation to over breathing, which in turn, can result in a significant disruption in normal biochemistry. The effect of this disruption depends on the individual. This condition is generally not recognized by mainstream medical practitioners in the developed western nations who see hypocapnia (low blood CO_2) as the consequence rather than the cause of disease.

The vast and varied ways in which individuals react to hyperventilation suggest that the definition of HV may need to be widened rather than specified by a single threshold value number that applies to everyone. Although the commonly accepted definition of hyperventilation is a $PaCO_2$ of less than 35 mmHg, a case could be made that this threshold is still too low for some individuals. If they get hyperventilation symptoms at higher $PaCO_2$ levels and these symptoms can be reversed by raising CO_2, then it could be argued that they have been hyperventilating.

The Buteyko model answers many age-old questions relating to asthma. For example, a current theory on the "pampered child syndrome" is that disorders such as asthma come about because of an excessively sterile environment. Buteyko's theory suggests that more likely explanations would be some combination of excessive feeding, too little exercise and overheating. (Over-heated children have to breathe more to get rid of metabolic heat). The resulting biochemical disturbances could produce immediate symptoms such as asthma, or, in some cases, other long-term disorders that may appear later in life.

Buteyko's theory also has an explanation for the placebo effect and the positive effects of various forms of faith healing. By replacing psychological stressors concerning health with belief in a therapy or religion that might be helpful, stress-related hyperventilation is reduced and, as a result, CO_2 levels rise, restoring normal biochemistry and, therefore, health.

The Buteyko model also has implications for the management of various medical procedures, such as vaccinations, which are a stress on the immune system and hence increase breathing. Children that are already stressed as a result of some combination of undesirable parenting practices such as over-heating and over-feeding, psychological stresses, or fighting infection, could well have their hyperventilation pushed over the edge by the additional burden of a vaccination. The resulting drop in carbon dioxide and bicarbonate could then lead to the development of any of the many known symptoms of hyperventilation as well as symptoms that are not yet known to be associated with hyperventilation. For example, the tenuous link between autism and vaccinations finds a ready explanation in Buteyko's hyperventilation theory, although it must be said that the etiology of autism is not yet known. For this reason, Buteyko theory would suggest that vaccination policy should take into account the condition of each child and possibly defer vaccinations when a child is not completely well. Incorporating Buteyko principles clearly also affects the decisions taken about the age at which these immunizations are given as well as the extent to which immunizations should be combined. The aim should always be to minimize total stress on the system so that hyperventilation disorders are less likely to develop.

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