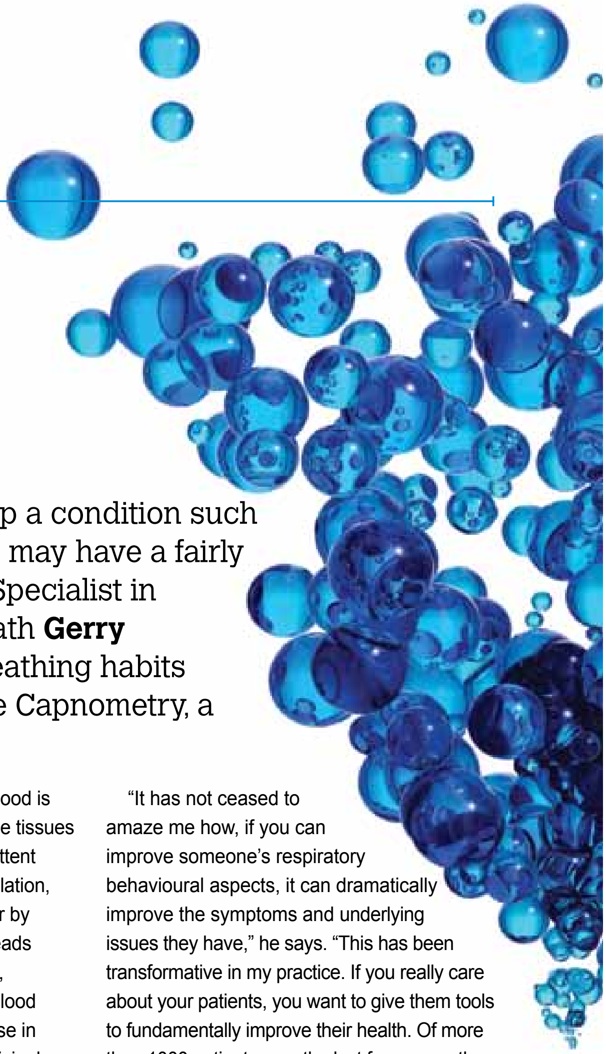


Our life breath and our health

We rarely pay attention to our breath unless we develop a condition such as asthma or a cold. On top of that, as practitioners, we may have a fairly primitive grasp of what really goes on with breathing. Specialist in stress and trauma **Dr Robert Kissner**, PhD, and osteopath **Gerry Gajadharsingh**, DO, explain the links between poor breathing habits and conditions such as chronic fatigue – and introduce Capnometry, a scientific way to evaluate breathing behavior.

For each of us, our first breath marked the beginning of life. And that special connection to breathing and breath that each of us felt at the start of life returns at the end of life, when we witness a person's last breath.

However our accommodation to the routine of our breathing means we seldom pay attention to our breath unless we develop a condition, such as asthma, a cold or flu, which calls the routine into question. If we paid closer attention to our breathing we would find that most of us, as adults, breathe within a range of 12-20 breaths a minute or 15,000-30,000 litres of air a day. As we will illustrate shortly, getting such a frequent event right or wrong has a huge impact on health and is at the centre of our emotions.

CO_2 as the energy or releasing source for O_2

If you were to ask your average patient what he or she believes about breathing the likely answer would be: "Breathing is easy. You breathe in oxygen and you breathe out carbon dioxide. Oxygen is the good guy and carbon dioxide is the bad guy." Most people accept as "common wisdom" the notion that bigger breaths of air and deeper breathing is what we need to relax and to be healthy, when nothing could be farther from the truth.

As counter-intuitive as it may seem, what a lot of people do not know is that the adequate delivery of oxygen to be released on a cellular level in our bodies is very much dependent on the amount of carbon dioxide (CO_2) we retain within our system. Thus, those critical functions that we assign exclusively to oxygen – brain function, muscle function, heart and liver function, all depend on a balance between oxygen and carbon dioxide.

This phenomenon, first described in 1904 by a Danish physiologist named Christian Bohr and subsequently named the Bohr Effect, shows that oxygen (02) carried in the blood is released in higher concentration in those tissues that have a higher level of CO_2. Intermittent or chronic over-breathing, or hyperventilation, often caused by breathing too quickly or by gulping in too much air in one breath, leads to hypocapnia, or low CO_2 blood levels, reduced CO_2 in the lungs and arterial blood and, consequently, hampered O_2 release in our bodies on a cellular level. Not surprisingly, hypocapnia is a common component of many illnesses. The obvious example is acute asthma, and a less obvious example is Chronic Fatigue Syndrome. Research suggests that hypocapnia is a biological marker for orthostatic intolerance (symptoms worsen when they stand up), among a significant number of patients with CFS.

The link with pH

Equally important to our understanding is a formula common to first year physiology courses, the Henderson-Hasselbalch equation, which states that CO_2 levels interacting with your kidneys determines your body's pH. For good reason, Arthur Guyton, an American physiologist who became famous for demonstrating that cardiac output was not controlled by the heart itself but by the need of body tissues for oxygen, observed that "All chronic pain, suffering and diseases are caused by a lack of oxygen at a cellular level." (1)

For these reasons, it is critical for physiological function that a clinician measure the CO_2 levels of patients at risk and that, subsequently, these patients should be taught how to optimize their CO_2 and therefore increase the delivery of oxygen on a cellular level. Gerry Gajadharsingh estimates that on an average week he explores the breathing physiology of at least 50% of his patients and that at least 70% of these patients do not breathe properly.

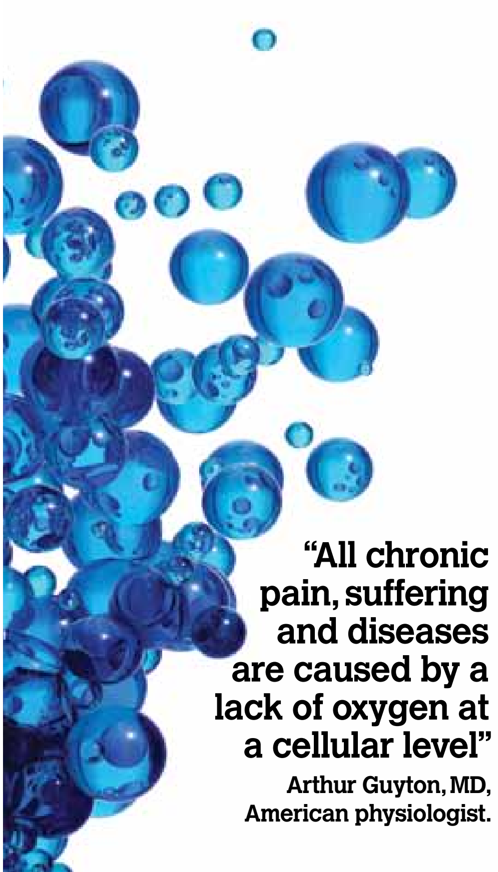
"It has not ceased to amaze me how, if you can improve someone's respiratory behavioural aspects, it can dramatically improve the symptoms and underlying issues they have," he says. "This has been transformative in my practice. If you really care about your patients, you want to give them tools to fundamentally improve their health. Of more than 1000 patients over the last four years, there are only two patients, interestingly both with chronic long term anxiety/depression, that I have not been successful with."

Headaches, upper neck and back pain

Few people are aware of the relationship of breathing to neck and back pain.

Many people who have dysregulated breathing tend to breathe from their upper chest while neck and shoulder muscles are relied on for breathing. However over-recruitment of these muscles can lead to decreased CO_2 and shortened neck and shoulder muscles. These shortened muscles can cause temple headaches, neck and shoulder as well as back pain. Karel Lewit, MD, the father of manual medicine, commented that: "If breathing is not normalized no other movement pattern can be." (2)

The nerve supply of the diaphragm, the main muscle of breathing, receives its main nerve supply from the phrenic nerve, innervated from C3, 4 and 5, from the cervical spine. Incidentally, the nerve supply to the shoulders is from C4 and 5. Hence many patients with neck, shoulder and upper back pain should be explored for proper breathing behaviour. As we will describe later, increased muscle tension can often be caused by sympathetic (stress) nervous system over-activation, as part of the stress cascade. Many patients presenting with musculoskeletal pain will have increased



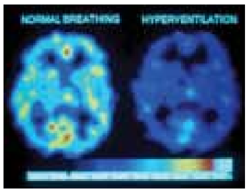
> "All chronic pain, suffering and diseases are caused by a lack of oxygen at a cellular level"
> **Arthur Guyton, MD, American physiologist.**

muscle tension leading to muscle ischaemia and a build up of the products of muscle metabolism, often causing pain. Strategies for clinicians and patients to recognise this and offer patients ways to help down-regulate sympathetic over-activation and therefore promote relaxation can be very helpful.

In a recent paper in the Journal of Orthopaedic and Sports Physical Therapy, Kolar reports that patients with chronic lower back pain appear to have both an abnormal position and an abnormal slope to their diaphragm. (3) Likewise, because of the attachment of the diaphragm and its fascial connection through the iliopsoas muscle that inserts onto the hips, the hips can also be affected. The iliopsoas are primary hip flexors and primary trunk flexors. As a consequence they are often activated as a protective response in acute lower back pain. For many patients, fear is a dominant emotion that seems to activate the iliopsoas muscles. Clear diagnosis and sound treatment strategy can go along way to alleviating the fear that an acute low back pain episode invokes. Conversely, fear responses driven by other factors in the patient's life can actually provoke an acute low back pain episode in the absence of obvious mechanical/medical reasons for the pain.

Functional digestive issues

If we consider gut problems, we need also to look at the influence of diaphragmatic breathing. As a person breathes in, the diaphragm descends, the heart rate speeds up and the abdomen protrudes. The opposite happens when a person exhales. The heart speeding up as a consequence of inhalation (sympathetic response) has an inhibitory effect on the digestive system while exhalation increases it (parasympathetic response); this is because digestive activity is primarily a parasympathetic (relaxation) nervous system response. Also, mechanically, on inhalation all the organs of the digestive system are compressed, whereas on the out-breath the opposite occurs. In this manner our diaphragm contributes to the movement of food (peristalsis) through the abdomen. Without good breathing the gastrointestinal tract simply doesn't work properly. No matter how good (or bad) a person's diet is, without good gut physiology outcomes may not be optimal.



Breathing and performance enhancement

For a variety of reasons, athletes tend to breathe better than the average person. For metabolic reasons, athletes tend to have slightly higher levels of CO2 than the average person in the general population. Regardless of this advantage, encouraging an athlete to understand his or her breathing behaviour can improve performance.

If athletes can be persuaded to delay the hard breathing commonly associated with effort, they can improve muscle fitness, delay muscle fatigue and therefore increase performance, simply by better breathing and the consequent retention of more CO2 in their system, thus increasing O2 utilisation at a cellular level.

Breath signature of emotions

Breathing regulation and control are affected by our emotions and vice versa. The earliest published studies date to 1916 and concerned the respiratory changes that accompany pleasure, pain, anger, disgust, wonder, and fear as well as laughter and hatred. (4) From these and other studies we know that our emotions have unique breath signatures. For example, we know that people who are depressed tend to be shallow breathers and that depressed people often hyperventilate.

We also know that CO2 is highest in our systems when we are happy and when we feel gratitude and love. Positive emotions are literally breathers, sustainers, and restorers of our life.

This means that we can also teach patients to shift out of negative breathing patterns by incorporating practiced positive emotions using visualization and other techniques. Such techniques help the brain calm down and breathe better thus increasing O2 use and leading to increased cerebral blood flow and increased active problem-solving. Over-arousal (common in modern Western life) is becoming endemic. Making decisions and solving problems relies on a region of the brain called the prefrontal cortex. Too many thoughts flooding the prefrontal cortex calls for a massive use of O2 and glucose, its main power sources, leading to it becoming ineffective.

The two main neurotransmitters, noradrenalin and dopamine, are critical. Not having enough or having too much are equally negative. As with most of life the secret is having a balance. Optimising the brain requires enough arousal to make it challenged; too much and it gets exhausted.

We now have the technology to visually demonstrate this phenomenon to patients. We can take a thermal image of a person breathing well and another image of the same person in an anxious state, over-breathing. Lower levels of oxygen are clearly indicated when the thermal image turns from yellow/red indicating good levels of oxygenation to blue, indicating poor levels of oxygenation (see picture, above).

Introducing such techniques to the workplace and giving employees the tools to deal with anxiety and their emotions encourages better decision-making and work performance. For employees who do presentations or need to close a sale, increasing C02 levels and thereby reducing anxiety can produce company-wide benefits.

Capnometry: measuring dysfunctional breathing

Research indicates that dysregulated breathing is multidimensional and includes: biochemical, biomechanical and breathing-related symptoms. (5) Breathing evaluation should include measures of breathing symptoms, breathing pattern, resting CO2, as well as functional measures to measure CO2 in response to physical and psychological challenges including stress-testing.

Within the last few years a new technology has become available that can evaluate breathing behaviour scientifically using a capnometer. What is striking about this new technology is that it allows us to look at someone's physiology in real time. We connect a person to the capnometer using a nasal cannula and measure the amount of CO2 in the patient's system as they breathe in and breathe out. We are able to see the rate of breathing. One cycle is essentially one breath in and one breath out. A few capnometers also include the option of a heart rate monitor, using a simple clip onto the ear. This gives us the ability to measure heart rate and, more importantly, an estimate of heart rate variability (HRV). There are several words for this, respiratory sinus arrhythmia (RSA) or breathing heart wave (BHW); whatever the term, the technique gives us a very interesting way of looking at someone's autonomic nervous system.

There are many reactions going on in the →

body that are not under our conscious control. When we look at the autonomic nervous system, or subconscious nervous system, it is divided into the sympathetic or stress nervous system and the parasympathetic or relaxation nervous system. The sympathetic nervous system is activated in a classic response, which we call "the flight, fight or sometimes freeze response." Interestingly, this part of our nervous system activates our heart, lungs, muscles and liver; the four body systems we need in a "flight, fight or freeze" response. Our relaxation nervous system, the parasympathetic, has much more to do with reproductive or gut function; in evolutionary terms these body systems were not needed in an acute stress situation.

Inhalation is a sympathetic stress response and exhalation is a parasympathetic relaxation response. Thus the difference between the heart rate when we breathe in and the heart rate when we breathe out gives us the heart rate variability, and together with breathing (called the Breathing Heart Wave), gives us a good measure of how stressed a patient's nervous system is. Many patients are astounded to see on a screen for the first time the effect of their behaviour and thought processes on how they breathe and the effect of their thought processes on their heart and autonomic nervous system.

Any clinician using this approach will, for the first time, have the ability to show a person exactly how they are breathing, what their CO2 levels are, the effect of breathing on their nervous system and the impact of thought processes on these systems.

Capnometry not only allows us to execute an accurate diagnostic process but also to work with patients on breathing re-education. The technology includes a series of biofeedback exercises. One of the exercises displays a little ball going up and down. When a patient breathes in rhythm, by following the movements of the ball, they can manipulate their rate of their breathing and we are able to discover the optimum rate of breathing for that patient. Through practice, direct experience, and experimentation with different breathing rates and depths of breathing, we can teach patients how they can improve their levels of CO2.

Some bodywork may also augment this; there is no doubt that patients with muscular and mechanical dysfunction can compromise their ability to breath properly and seeing an osteopath or other clinician experienced in mechanics of breathing can be very helpful for some patients.

Serious breathwork

We believe that any clinician who wants to do serious breathwork needs to incorporate capnometry. Accurate CO2 readings not only provide an accurate diagnostic and prognostic for effective breathwork, but also provide living proof of change to clients. The experience can also prove immediately beneficial as patients learn how to slow down their breathing rate.

While capnometry allows us better and more precise entry to this work, most clinicians are able, with practice, to identify breathing rates. The rate of six breaths a minute is suggested for adults to promote relaxation, slow the heart rate, lower blood pressure and raise immune system activity. However it is not possible to always breathe at this slow rate, so a better understanding of how to optimize CO2 and HRV at different breathing rates can also be very beneficial.

The second thing we can do for patients is to teach them how to breathe in a more beneficial way. What we know about the mechanics of breathing is that teaching people to breathe from the diaphragm, as opposed to their upper chest, tends to help the patient retain CO2.

The third part of re-education is teaching patients the relationship between the in-breath and the out-breath, often the hardest challenge for people who don't breathe properly. The fourth part is understanding the relationship between depth (volume) of breath and CO2. While there are some people who can breath deeply and retain good levels of CO2 and good HRV, it is only because they understand the connection of all these variables. For the majority of the population deep breathing generally lowers CO2 levels.

Our experience is that when people feel they are not getting enough oxygen they tend to focus on breathing in, instead of breathing out. Switching this relationship, so the focus is on a gentle longer out-breath, is highly beneficial. Science teaches us that encouraging the parasympathetic response in this manner increases HRV. As we now realize that low HRV is associated with many diseases such as heart disease, chronic fatigue syndrome, fibromyalgia, and chronic stress and depression, increasing HRV, in conjunction with optimising CO2, can have nothing but beneficial effects.

The fifth variable is noticing whether patients are mouth breathers. Healthy people breathe through their noses unless doing vigorous exercise, where both the mouth and nose are used. Nose breathing slows the escape of air from our bodies so lungs have more time to extract oxygen, filters and warms the air we receive, and stimulates nasal mucus, paradoxically making nose breathing difficult. However, as long as a patient is able to build CO2 in their system there are tricks that enable them to clear their nose. For example, the use of microporon tape over the mouth can help patients shift to nose breathing over time. It is also important to realise that some patients who breathe perfectly well in the daytime shift their breathing patterns at night.

To conclude, it is likely that clinicians from all disciplines will have patients who have dysfunctional breathing patterns. Understanding the mechanics, physiology and thought processes that cause these dysfunctional patterns can provide great insight for the patient (and clinician) and importantly provide simple tools to rectify this important component to their symptomatology, significantly contributing to optimising their health.

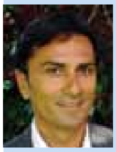
References and resources

1. Ascribed to Guyton in The Textbook of Medical Physiology, edition unknown.
2. Lewit, K. Manipulative Therapy: Musculoskeletal Medicine (Churchill Livingstone / Elsevier, 2010).
3. Kolar P et al, Postural Function of the Diaphragm in Persons With and Without Chronic Low Back Pain. JOSPT 2012, 42 (4) Apr, 3830.
4. Feleky, A. The influence of the emotions on respiration. J Exp Psycho 1916, 1: 218 -41.
5. Courtney R et al. Relationships between measures of dysfunctional breathing in a population with concerns about their breathing. J Bodywork Move Ther 2011, 15(1): 24-34.

* Readers who are interested in furthering their understanding of breathing behavior are welcome to refer to www.lifelogix.com or www.thehealthequation.co.uk or email the authors at rkissner@lifelogix.com or gerryg@thehealthequation.co.uk. We also offer courses and training in the UK to patients, clinicians and companies. Please email for details.

About the authors

Dr Robert Kissner holds a PHD from the University of Chicago. he is a specialist in stress and trauma and has a special interest in innovative ways to facilitate recovery and encourage resilience. He is Executive Director of FocusBC, an accredited addictions agency specialising in working with youth 13-16 with complex needs and co-occuring disorders. His programmes have been judged by outside experts as among the best resources in North America. He is also Principal of LifeLogix Inc. a company specializing in providing innovative science-based solutions for personal and organizational health and has advanced training in neuro and biofeedback. Robert's interest in breathwork and capnography started seven years ago when he recognised that the majority of youths he was seeing had dysregulated breathing patterns and that breath could be used as a prognostic, diagnostic, and living proof of the changes that occur as people grow out of the problems and experience healing.



Gerry Gajadharsingh, DO, qualified from the British School of Osteopathy in 1987 and was invited back to teach osteopathic technique at undergraduate level , a post he held for 10 years. He started his international teaching career under the guidance of Prof Laurie Hartman in 1988 and has lectured at post graduate level in many countries in Europe, as well as in Asia, Australia and Canada. He founded The Health Equation, an innovative clinical practice adopting a more integrated approach to healthcare in 1994, based in London's West End, where he works with a multi-disciplinary clinical team. He is also a Metabolic Balance Nutritional coach and a lecturer for Metabolic Balance UK. He was introduced to the Lifelogix technology 4 years ago and is an Advanced Breath Practitioner and UK Lecturer for Lifelogix Inc.