Examining dysfunctional breathing patterns in asthma, craniofacial development, rhinitis and sleep disordered breathing.

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CHRONIC HYPERVENTILATION SYNDROME

- Da Costa (1871) “Irritable heart”
- Kerr & colleagues (1937) “Hyperventilation syndrome”
- Soley & Shock (1938) discovered HVPT could reproduce symptoms
- Sir Thomas Lewis (1940) “Soldiers heart” & “Effort syndrome”
- Konstantin Buteyko (1957) “Disease of deep breathing”
- Claude Lum (1977) Papworth Method
1946- Commenced medical training at the First Medical Institute of Moscow

Practical assignment involved monitoring breathing volume of patients

Sicker they became- the heavier they breathe

1952- lowered his high blood pressure by reducing his breathing towards normal
Dysfunctional Breathing: no precise definition

Generally includes any disturbance to breathing including; hyperventilation/over breathing, unexplained breathlessness, breathing pattern disorder, irregularity of breathing.
Hyperventilation- breathing in excess of metabolic requirements of the body at that time.
TRAITS OF DYSFUNCTIONAL BREATHING

- Breathing through the mouth
- Hearing breathing during rest
- Sigh regularly
- Regular sniffing
- Taking large breaths prior to talking
- Yawning with big breaths
- Upper chest movement
- Lots of visible movement

- 4-6 liters of air per minute during rest
Asthma
13 (±2) L/min (Chalupa et al, 2004)
15 L/min (Johnson et al, 1995)
14 (±6) L/min (Bowler et al, 1998)
13 (±4) L/min (Kassabian et al, 1982)

Sleep apnea
15 (±3) L/min (Radwan et al, 2001)
WHAT CAUSES DYSFUNCTIONAL BREATHING?

- Processed foods / overeating
- Lack of exercise
- Excessive talking
- Stress
- Belief good to take big breaths
- High temperatures of houses
- Asthma – (symptom is big breathing which resets respiratory centre)
- Genetic predisposition/familial habits
Breathing During Stress

- Faster
- Sigh more (irregular)
- Oral breathing
- Noticeable breathing
- Upper chest breathing
<table>
<thead>
<tr>
<th>Faster</th>
<th>Slow down</th>
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<tbody>
<tr>
<td>Sigh more (irregular)</td>
<td>Regular</td>
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<tr>
<td>Oral breathing</td>
<td>Nose breathing</td>
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<tr>
<td>Noticeable breathing</td>
<td>Soft breathing</td>
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<tr>
<td>Upper chest breathing</td>
<td>Diaphragm breathing</td>
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Stress

• High perceived stress which was associated with a 27% increase in CHD risk in this meta-analysis, could be thought of as the equivalent of or 5 more cigarettes per day

How Should We Breathe?

Breathing is light, quiet, effortless, soft, through the nose, diaphragmatic, rhythmic and gently paused on the exhale.

This is how human beings breathed until the comforts of modern life changed everything, including our breathing.
How Should We Breathe?

Generally speaking, there are three levels of breathing. The first one is to breathe SOFTLY, so that a person standing next to you does not hear you breathing. The second level is to breathe softly so that YOU do not hear yourself breathing. And the third level is to breathe softly so that you do not FEEL yourself breathing.

Master Chris Pei: Beginners guide to Qi Gong
How Should We Breathe?

Breathing is “so smooth that the fine hairs within the nostrils remain motionless”

How Should We Breathe?

Professional Hatha yogi breathing just one gentle breath per minute for the duration of one hour.

The regulation of breathing is determined by receptors in the brain which monitor the concentration of carbon dioxide along with the pH level and to a lesser extent oxygen in your blood.
There is a large reserve of oxygen in the blood stream, such that oxygen levels must drop from 100mmHg to about 50mmHg before the brain stimulates breathing.
The brain stem is the most primitive part of the brain. It begins at the base of the skull and extends upwards 6-8 cm.

In the lower portion of the brain stem is the medulla containing the respiratory center with separate inspiratory and expiratory centers.

- Normal PCO$_2$ is 40mmHg

- An increase of PCO$_2$ above this level stimulates the medullary inspiratory center neurons to increase their rate of firing. This increases breathing to remove more CO$_2$ from the blood through the lungs.

The inspiratory center sends impulses down the spinal cord and through the phrenic nerve which innervates the diaphragm, intercostal nerves and external intercostal muscles - producing inspiration.

At some point the inspiratory center decreases firing, and the expiratory center begins firing.

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. . Springer; 1994
On the other hand, a decrease in the PCO\(_2\) below 40mmHg causes the respiratory center neurons to reduce their rate of firing, to below normal-producing a decrease in rate and depth of breathing until PCO\(_2\) rises to normal.

However, breathing more than what the body requires over a 24 hour period conditions the body to increased breathing volume.
CARBON DIOXIDE: NOT JUST A WASTE GAS!
The pH CO₂ Link

- pH 0: acidic, cells die
- pH 6.8: normal
- pH 7.365: normal
- pH 7.8: cells die
- pH 14: alkaline
Normal pH is 7.365 which must remain within tightly defined parameters. If pH is too acidic and drops below 6.8, or too alkaline rising above 7.8, death can result.

Blood, Sweat, and Buffers: pH Regulation During Exercise Acid-Base Equilibria
Experiment Authors: Rachel Casiday and Regina Frey
Carbon dioxide forms bicarbonate through the following reaction:

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^- \]

\(\text{CO}_2\) disassociates into \(\text{H}^+\) and \(\text{HCO}_3^-\) constituting a major alkaline buffer which resists changes in acidity.
If you offload carbon dioxide, you are left with an excess of bicarbonate ion and a deficiency of hydrogen ion.

During short term hyperventilation- breathing volume sub sequentially decreases to allow accumulation of carbon dioxide and normalisation of pH.
However, when over breathing continues for hours/days, bicarbonate excess is compensated by renal excretion.

Hypocapnia and pH shift are almost immediate; adjustment of bicarbonate takes time. (hours to days)

Thus the chronic hyperventilator's pH regulation is finely balanced: diminished acid (the consequence of hyperventilation) is balanced against the low level of blood bicarbonate maintained by renal excretion.

In this equilibrium small amounts of over breathing induced by emotion can cause large falls of carbon dioxide and, consequently, more severe symptoms.

Over breathing reduces the delivery of oxygen to tissues and organs.
An exercising muscle is hot and generates carbon dioxide and it benefits from increased unloading of $O_2$ from its capillaries.

A primary response to hyperventilation can reduce the oxygen available to the brain by one half.

NITRIC OXIDE: MOLECULE OF THE YEAR!
Nitric oxide (NO) is released in the nasal airways in humans. During inspiration through the nose this NO will follow the airstream to the lower airways and the lungs.

Lundberg JO. Nitric oxide and the paranasal sinuses. *Anat Rec (Hoboken)*. 2008 Nov;(291(11)):1479-84
Nitric oxide plays an important role in vasoregulation, homeostasis, neurotransmission, immune defence and respiration.


Culotta E, Koshland DE Jr.. NO news is good news. Science.1992 Dec 18;(258(5090)):1862-5
Nitric oxide from the back of your nose and your sinuses into your lungs. This short-lived gas dilates the air passages in your lungs and does the same to the blood vessels.

Since NO is continuously released into the nasal airways the concentration will be dependent on the flow rate by which the sample is aspirated. Thus, nasal NO concentrations are higher at lower flow rates.

NOSE BREATHING
Nose Breathing Benefits

- Nose breathing imposes approximately 50 percent more resistance to the air stream than mouth breathing, resulting in 10-20 percent more $O_2$ uptake;

- Warms and humidifies incoming air;

- Removes a significant amount of germs and bacteria;
### Versus Mouth breathing

- Increased risk of developing forward head posture, and reduced respiratory strength;

- A dry mouth also increases acidification of the mouth and results in more dental cavities and gum disease;

- Mouth breathing causes bad breath due to altered bacterial flora.

- Proven to significantly increase the number of occurrences of snoring and obstructive sleep apnoea.
Hyperventilation Syndrome

- Cardiovascular: palpitations, missed beats, tachycardia, sharp or dull atypical chest pain, ‘angina’, cold extremities, raynauds, blotchy flushing of blush area, capillary vasoconstriction.

- Neurological: dizziness, instability, faint feelings (but rarely fainting) headache, paraesthesiae- (numbness, deadness, uselessness, heaviness, pins and needles).

Hyperventilation Syndrome

- Respiratory: shortness of breath, irritable cough, tightness or oppression of chest, air hunger, inability to take a deep breath, excessive sighing, yawning, sniffing.

- Muscular: cramps, muscle pains - neck & shoulders, stiffness.

- Psychic: tension, anxiety, ‘unreal feelings’, panic, phobias, agoraphobia.

- Allergies.

Hyperventilation Syndrome

- Gastrointestinal: difficulty in swallowing, globus (having a lump in ones throat), dry mouth and throat, acid regurgitation, heart burn, flatulence, belching, air swallowing, abdominal discomfort, bloating.

- General: weakness, exhaustion, impaired concentration, impaired memory and performance, disturbed sleep, including nightmares, emotional sweating,

Hyperventilation Syndrome

- According to Lum, hyperventilation ‘fell between the two stools of medicine and psychiatry’

- The major reason why hyperventilation had not been fully recognised is that most clients were not taught how to change their breathing. Effective breathing retraining is required to demonstrate conclusively that hyperventilation is the cause of the clients symptoms.

Hyperventilation Syndrome

- Because these patients report symptoms in more than one system, they are often labelled as hypochondriacs. Historically, they are often told to relax and take a few deep breaths!

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. . Springer; 1994
CONTROL PAUSE (comfortable breath hold time)

MEASUREMENT

- Take a small silent breath in through your nose.
- Allow a small silent breath out through your nose.
- Hold your nose with your fingers to prevent air from entering your lungs.
- Count the number of seconds until you feel the first distinct desire to breathe in.

Measuring How Big You Breathe

Control Pause (CP)

Breath In  Breath Out  Calm Breath In

Comfortable Breath - HOLD
First signs of air hunger
Tummy may jump.
Breath holding as one of the most powerful methods to induce the sensation of breathlessness, and that the breath hold test ‘gives us much information on the onset and endurance of dyspnea.

Eighteen patients with varying stages of cystic fibrosis were studied to determine the value of the breath hold time as an index of exercise tolerance.

‘that the voluntary breath-hold time might be a useful index for prediction of the exercise tolerance of CF patients’.

Breath hold time varies inversely with the magnitude of dyspnea when it is present at rest.

Rhinitis
RHINITIS
COMORBIDITY EFFECT

- rarely found in isolation
- asthma, rhinosinusitis,
- more than twice as likely to suffer problems sleeping due to their nasal allergy symptoms.

We speculate that asthmatics may have an increased tendency to switch to oral breathing, a factor that may contribute to the pathogenesis of their asthma.

Laffey, J. & Kavanagh, B. 
Open-mouth breathing during sleep is a risk factor for obstructive sleep apnea (OSA) and is associated with increased disease severity and upper airway collapsibility.

Treatment of pediatric obstructive-sleep-apnea (OSA) and sleep-disordered-breathing (SBD) means restoration of continuous nasal breathing during wakefulness and sleep.

The case against mouth breathing is growing, and given its negative consequences, we feel that restoration of the nasal breathing route as early as possible is critical.

Seo-Young Lee*, Christian Guilleminault, Hsiao-Yean Chiu,**, Shannon S. Sullivan. Mouth breathing, “nasal dis-use” and pediatric sleep-disordered-breathing. *Sleep and Breathing (2015) Stanford University Sleep Medicine Division, Stanford Outpatient Medical Center, Redwood City CA*
In fact restoration of nasal breathing during wake and sleep may be the only valid “complete” correction of pediatric sleep disordered breathing…

Sleep and Breathing (2015) Mouth breathing, “nasal dis-use” and pediatric sleep-disordered-breathing. Seo-Young Lee* , Christian Guilleminault, Hsiao-Yean Chiu,**, Shannon S. Sullivan. Stanford University Sleep Medicine Division, Stanford Outpatient Medical Center, Redwood City CA.
Sleep disturbances, poor school performance, and hyperactivity are all mental complications seen in many children related to their nasal allergies.

Most children with ADHD displayed symptoms and skin prick test results consistent with allergic rhinitis. Nasal obstruction and other symptoms of allergic rhinitis could explain some of the cognitive patterns observed in ADHD, which might result from sleep disturbance known to occur with allergic rhinitis.

Many of these children are misdiagnosed with attention deficit disorder (ADD) and hyperactivity.

Mouth breathers demonstrated considerable backward and downward rotation of the mandible, increased over jet, increase in the mandible plane angle (longer face)

Children with obligate mouth-breathing due to nasal septum deviations show facial and dental anomalies in comparison to nose-breathing controls.

• Ten-year-old boy is a nose breather and has a good-looking, broad face with everything in proportion.

*Photograph from Dr John Mew*
On the boy’s fourteenth birthday, he was given a gerbil as a present. Soon after, his nose began to block, causing him to breathe through his mouth.

Photograph from Dr John Mew
Three years later

Photograph from Dr John Mew
Breathing and Vocal Dysfunction

- Speech is the culmination of two essential human functions: breathing and communication.

- Must consider all the factors in relation to one another. A disturbance in one area will upset the balance necessary to maintain healthy phonation.

*Daphne J Pearce in Timmons and Ley*
Breathing and Vocal Dysfunction

- Is there frequent throat clearing, excessive phlegm?
- Does the patient pause when speaking?
- Are the pauses appropriate to place in utterance and frequency?
- Does the vocal pitch appear appropriate for the patient's age and sex?

*Daphne J Pearce in Timmons and Ley*
Breathing and Vocal Dysfunction

- Is the voice hoarse, creaky or breathy?
- Does the voice fade or appear to fatigue?
- Is there limited ability to sustain phonation, hold a note?

*Daphne J Pearce in Timmons and Ley*
Breathing and Vocal Dysfunction

- **Dysphonia**
  
  *Excessive Breathing Volume:*
  
  - Dries out the vocal folds resulting in phlegm
  - Results in poor breathing pattern and breath management for speech/singing

- **Dysphagia**
  
  - Overbreathing dries the upper airways leading to inflammation
  - Important to slow down and be more mindful when eating

*Golan Hadas*
ANS is to maintain homeostasis (i.e., an optimal or ideal physiological and emotional balance), and in doing regulates and coordinates many bodily activities such as digestion, body temperature, blood pressure and is associated with aspects of emotional behavior.

(Andreassi, 2000, p 35)
Parasympathetic branch is thought to foster calm physiological states that promote growth, restoration, and repair (Andreassi, 2000)
Sympathetic nervous system activity is associated with “fight or flight” or “mobilization behaviors,” and is typically activated during periods of stress or challenge (Porges, 2007)
Children who stutter have a physiological state characterized by a greater vulnerability to emotional reactivity (i.e., less parasympathetic tone) and a greater mobilization of resources in support of emotional reactivity (i.e., more sympathetic activity) during positive conditions.

Controlled breathing activates the parasympathetic nervous system, promoting homeostasis and assists recovery and restoration of function in body systems disturbed by stress. (Recordati and Bellini 2004)
Regular practice of slow controlled breathing has also been shown to increase basal parasympathetic activity and reduce sympathetic activity.

(Pal, Velkumary et al. 2004)
Singers, actors and public speakers are especially at risk. "Stage fright" is often a panic attack which may cause or be caused by hyperventilation. Most theatres in London's West End recognise the phenomenon and keep paper bags handy.

Talking & Breathing

- All subjects ventilated more during speaking than during quiet breathing, usually by augmenting both tidal volume and breathing frequency. These findings have clinical implications for the respiratory care practitioner and the speech-language pathologist.

A study to investigate the effectiveness of the Buteyko technique on the nasal symptoms of patients with asthma.

Fig. 1. Pre- and Post-test Mean scores of Visual analogue scale (VAS), Nasal obstruction symptom evaluation (NOSE) and Sinonasal outcome test (SNOT-22).
For example, NOSE evaluation surveys nasal congestion or stuffiness, poor sense of smell, snoring, nasal blockage or obstruction, trouble breathing through the nose, trouble sleeping, having to breathe through the mouth, unable to get enough air through the nose during exercise or exertion and feeling panic that one cannot get enough air through the nose.

It is important for the entire health care community (including general and pediatric dentists) to screen and diagnose for mouth breathing in adults and in children as young as 5 years of age.

If mouth breathing is treated early, its negative effect on facial and dental development and the medical and social problems associated with it can be reduced or averted.

That's all folks!

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