MOVEMENT OUTLAWS

Science stuff, with a real-world takeaway.

This issue: **Breathing.**

The information presenting in this volume is a summation of the actual research articles. From this, we have included how to apply these concepts into correcting movement issues (for the clinicians) and into training athletes (for the coaches).

A good dose of common sense needs to be applied, and clinical discretion should be used when applying this information to your patients/athletes in your environment.

When in doubt, read the actual article and make your own conclusions.

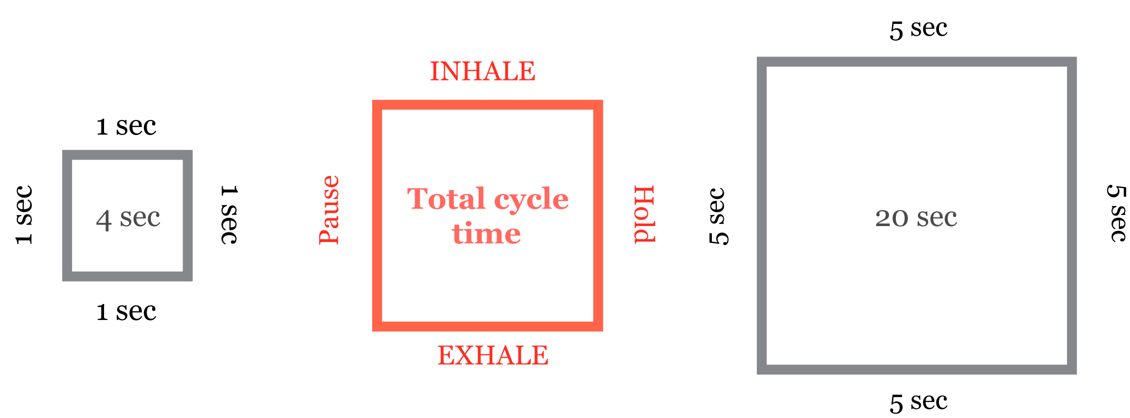
IN CONCLUSION:

Clinical Application:

1. Emphasis needs to be placed the complete breathing cycle: inhale-HOLD-exhale-PAUSE to restore normal breathing function. “Breath in for 5 seconds” can be better replaced by a 5 sec inhale, 5 sec hold, 5 sec exhale, and a 5 sec pause (repeat).
2. The nose was designed for breathing. Nasal breathing promotes diaphragm activity, increases parasympathetic activity and introduces Nitric Oxide (a potent vasodilator and bronchodilator) into the system.
3. Breath hold time less that 30 seconds is chronic hyperventilation. This shifts the individual towards the fight or flight (sympathetic nervous system). Those that fall into this classification suffer from decreased peripheral blood flow (will slow healing), decreased peripheral nerve conduction (will impair movement processing), and a decreased muscle contraction threshold (will have more difficulty resolving trigger points). All of which have a negative impact on improving movement and resolving pain.

Something to keep in mind - there may be legitimate reasons why someone cannot breath normally through their nose. Some are temporary - allergy flare up, illness that leads to congestion, sinus infections, soft tissue restrictions of the trunk/abdomen, etc. Some may need to be addressed before any improvement can achieved, like a deviated septum. Some might not have a solution, like pes cavus of the sternum. In each instance, the clinician will need to recognize these conditions and make whatever adjustments that are necessary.

Manipulating the entire breathing cycle can elicit a cardiovascular physiological response that is similar to the responses seen with higher intensity training, but without the increased intensity. We get a stressed response from the system without the stress to the system. The days of “hold this for 5 breaths” are over. This needs to be replaced with better education about the breath cycle (inhale, hold, exhale, hold). Step one is **box breathing**: 1 second inhale, 1 second hold, 1 second exhale, 1 second hold.



Box Breathing is a 1:1:1:1 ratio that is good for bringing awareness to the breathing cycle. Download *Pro Metronome* to your smart phone and set it at 60 bpm. During non-stressed activities, manipulating this is fairly simple and can be used to facilitate diaphragmatic breathing which can result in rapid and significant changes to the breathing process. Improved mechanical ventilation and improved breathing physiology will both ultimately lead to increased breath hold times and the resolution of the hyperventilation status. This strategy is best accomplished with nasal breathing only. Nasal breathing shifts the CNS towards a parasympathetic response and away from a sympathetic response. A parasympathetic response lowers heart rate, lowers blood pressure, decreases muscle tone, and activates the immune system.

The minimal expectation for a normal breath hold is be greater than 1 minute. For those that are chronic hyperventilator's, a breath hold of <30 seconds is the marker (<15 seconds earns the classification as compensated HV). Once any of these are identified, or if you just need to dial down the sympathetic nervous system in someone, begin by intervening with a box-breathing ladder:

1-1-1-1
2-2-2-2
3-3-3-3
4-4-4-4
5-5-5-5
6-6-6-6
7-7-7-7
8-8-8-8
9-9-9-9
10-10-10-10

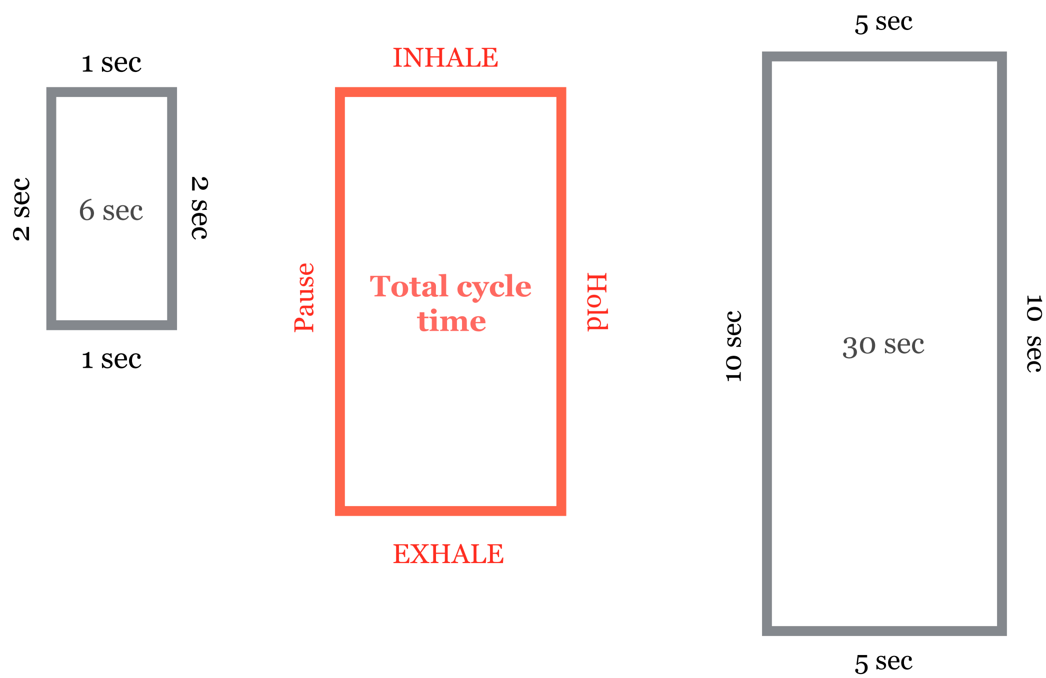
The 3-3-3-3 level seems to be ideal for mobility work. During the 3 second inhale and the 3 second hold pulling into a stretch, contracting the muscles, prying is ideal. The 3 second exhale and 3 second pause then is optimal to relax into the stretch or mobility position even more.

Training, Strength and Conditioning Application

1. Breathing rate/intensity needs to match the training intensity before the training begins: a sprint preceded by an appropriate time period of "pre-breathing" will preload the system. Physiologic changes lag behind output (it takes time for the built up CO_2 in the muscles to get into the blood stream and to be carried away).
2. Long breath holds with total body exercise will increase the rate of lactic acid creation and the dominance of anaerobic metabolism.
3. Apnea + exercise can elicit similar physiologic responses as much higher intensity exercise without the actual increased workload (impact, tissue micro trauma, CNS impact). This approach can replace/reshape the recovery workouts of endurance athletes.

Pre-loading the physiology prior to an activity can allow an individual to stay out in front of their workload - for a while. What this does is lowers the level of CO_2 in the body while increasing the levels of circulating O_2. This way,

Adjusting the box breathing ratio to a 1:2:1:2 ratio moves us into a **rectangle breathing** cycle and emphasizes more of an apneic response.



The longer breath holds will result in greater buildups of lactic acid, and will gradually shift the system to anaerobic cellular metabolism. Creating longer periods of apnea will typically lead to greater perceived stress on the system. Additionally, the greater periods of apnea with the shorter periods of recovery (breathing in) will create a shift towards anaerobic cellular metabolism. Just like in the box breathing ration, maintaining a nasal breathing strategy will allow the body to have more of a parasympathetic response to the increased stress from hypercapnia (increased CO_2) that builds up with this. It should be understood that breath holds - especially combined with exercise - can be a contraindication for those being treated for a concussion or those in the acute inflammatory phase of healing.

The belief of "rising to the occasion" is wrong. "Falling back to the highest level of training" is what happens when the human body is stressed. What breath training, in a non-stressed environment is part of physical practice? With no training to fall back on, when CO_2 begins to build up, the default is to shift to mouth breathing which dials up the sympathetic response and decreases the efficiency of breathing. Incorporating the rectangle breathing ladder while at rest begins to give us a breathing practice to fall back on when we are stressed (physically or emotionally).

Applying a rectangle breathing ladder is as follows. Once the 10-20-10-20 level is achieved drop back down to 2-4-2-4. Cycle through as many times as warranted.

2-4-2-4
3-6-3-6
4-8-4-8
5-10-5-10
6-12-6-12
7-14-7-14
8-16-8-16
9-18-9-18
10-20-10-20

For those who are going to be taking part in high intensity exercise (sprinting, high intensity running, kettlebell swings, assault bike sprints, etc), neither the box breathing or the rectangle breathing strategies will be efficient or effective. However, pre-breathing (higher intensity breathing prior to the activity) will pre-load the body with oxygen AND flush CO_2 out of the blood stream in preparation for the O_2 deficit and the CO_2 surge that will occur. How long this will have an effect on performance will be dictated by training. Breath hold time has also been suggested to be a marker of one's ability to withstand self-imposed discomfort. For these athletes, nasal breathing has some significant advantages when implemented as a part of the training program. First, nasal breathing during any high intensity activity makes that activity self-limiting. What this means for a runner is that the pace of the running will be limited to the rate at which the body can buffer the increasing CO_2 levels. This pace will initially be very, very low but with training will increase - which will have a carry over to all higher paces of running (to an extent) when they are can breath as needed. Manipulating breathing during training is a valuable and overlooked variable; during competition, breathing by any means necessary is expected. The effects of this is can further be amplified by controlling the rate of breathing. Set your Pro Metronome app at 20 bpm (1 breath every 3 seconds). When it beeps, fully exhale then inhale. Go for a run, but only at a pace that allows you to maintain this breathing rate (still nasal breathing only). Once this becomes easy gradually lower the number of breaths per minute:

- 20 breaths/ minute - 1 breath every 3 seconds
- 15 breaths/minute - 1 breath every 4 seconds
- 12 breaths/minute - 1 breath every 5 seconds
- 10 breaths/minute - breath every 6 seconds

This **rate limiting breathing** approach can be used with any traditional endurance based activity - running, cycling, rowing, jumping rope, kettlebell swings, battle ropes, etc.

Regardless of which of the above breathing strategies are employed, all breathing should be nasal breathing with the mouth closed (until a high aerobic output is reach.) As exercise intensity increases, this will change, but at lower levels of cardiac output and intensity a nasal breathing strategy is always the best breathing strategy (BUT, 90% of max VO2 can be achieved and maintained with nasal breathing…) Nasal breathing better recruits the diaphragm and shifts the tone of the CNS more toward the parasympathetic side, and away from the sympathetic side. This alone has significant benefits that promote tissue healing: decreased muscle tone, increased blood flow, increased oxygen absorbing capacity of the lungs, activation of the immune system, decreased blood pressure, etc. Nasal breathing also increase the amount of O2 the in inhaled with each breath (10-20%) and doses each breath with nitric oxide. Nitric oxide increase bronchodilation and vasodilation of the pulmonary vasculature. These combined with more oxygen inhaled with each breath dramatically increases the efficiency of breathing. Once training intensity is increased, a gradual shift away from nasal breathing will occur. PowerSpeedEndurance.com has introduced the breathing "gear" system. This gear system is amazing, look into it. This is an elevation of the breathing skill set that integrates nasal breathing into higher levels of activity / training.

Better Chemistry Through Breathing: The Story of Carbon Dioxide and How It Can Go Wrong.

Christopher Gilbert, PhD. *Biofeedback*. Fall 2005: 100-104.

Objective: The author reviews and highlights the details of breathing/CO_2/physiology interactions and gives advice on explaining the importance of breathing to individuals (patients, athletes, clients).

The Highlights:

- In Hyperventilation CO_2 levels drop, blood flow is reduced, nerve conduction rates are reduced, muscle contraction thresholds were lowered, alkalinity increases, and cerebral hypoxia occurs (secondary to the vasoconstriction). HV is observed as someone who is oversensitive to both exercise and relaxation, appears overly anxious, and complains of chest tightness and muscle pain. Often, these individuals frequently "sigh".
- Compensated HV is classified as someone with a breath hold of less than 15 seconds. These individuals have an erratic increase rate of ventilation.
- Chronic HV is classified as someone with a breath hold of less than 30 seconds.
- In Hypoventilation, CO_2 levels increase (hypocapnia). Ph levels decrease (aka increased acidity). The presence of increased CO_2 levels in the blood impede the ability of oxygen molecules to detach from hemoglobin.

Clinical Take Aways:

Excess oxygen is never a problems. Altered CO_2 levels are what affect the body: CO_2 that is too high restricts O_2 from releasing from the Hb; CO_2 that is too low reduces blood flow. BREATHING MUST MATCH THE DEMAND!

Hyperventilation disrupts judgment, perception, orientation, memory, reaction time and creates visual issues (spots/tunnels) due to the cerebral hypoxia.

Blood chemistry lags behind ventilation and the bodies utilization of O_2 and clearance of CO_2 - you will always be behind if you don't get ahead.

APPLICATION:

1. Breathing strategies need to precede clinical / performance needs: Over breathing prior to strenuous/taxing situation-stimulates sympathetic activity and increases O_2 stores while reducing blood CO_2 (which helps tolerate the surge of CO_2 from muscle exertion).
2. Breathing needs to MATCH the demand of the activity BEFORE the activity begins.
3. **Breathing rate/intensity needs to match the training intensity before the training begins: a sprint should be preceded by an appropriate time period of "pre-breathing".**

Pulse Oximetry and Breathing Training

Christoper Gilbert, PhD. *Biofeedback*. Winter 2012: 137-141.

Objective: Better explain breathing to clients/patients/athletes and get better acceptance via the use of a pulse oximeter to show objective oxygenation status in real time.

The Highlights:

- Normal O_2 Saturation is 95-98%. O_2 Saturation is the amount of dissolved oxygen in the bloodstream (the oxygen that is bound to Hemoglobin).
- If someone "truly" is not getting enough air, O_2 Sat levels will drop below normal.
- O_2 levels of 99-100% are not necessarily a good thing - this means all the oxygen is in the blood stream and a bit less is in the working tissues (which is where it needs to be). Oxygen cannot perform its function if it is in the bloodstream. Often, in hyperventilation, O_2 sat will reach this level.
- During Hyperventilation O_2 levels rise because the Hemoglobin cannot release the O_2 (The Bohr Effect) in response to the elevated CO_2 levels.
- During Hypoventilation (holding the breath, training at altitude, emphysema, or anything associated with poor absorption of Oxygen by the lungs) O_2 levels drop below normal levels.

Clinical Take Aways:

The physiological response to increased levels of CO2 are what results in the primary urge/stimulus to breath - not low oxygen levels.

Chronic hyperventilation creates physiological adaptations.

"If the therapists advice contradicts what the client is thinking, there will be poor compliance."

Hyperventilation s/s: light headedness, tingling lips/fingers, visual disturbances, difficulty taking a deep breath, anxiety.

APPLICATION:

1. For someone who is hyperventilating (Acute, chronic, or compensated) holding one's breath will raise CO2 levels and speed the release of oxygen from the hemoglobin which can then diffuse into the tissues.
2. If you suspect a breathing dysfunction (chronic HV), use a pulse oximeter to confirm this (99-100%).
3. **Emphasis is on the rate of breathing: inhale-HOLD-exhale-Hold to restore normal breathing function. A 5 second inhale can be better replaced by a 5 sec inhale, 5 sec hold, 5 sec exhale, and a 5 sec hold (repeat).**

Blood Lactate Accumulation During Competitive Freediving and Synchronized Swimming.

Lara Rodriguez-Zamora, et al. *Undersea & Hyperbaric Medicine*. January 2018: 55-63.

Objective: To determine how much of the physiologic response that occurs with exercise and apnea are the result of aerobic metabolism and/or anaerobic metabolism.

The Highlights:

- n=43 elite free divers (17F, 26M) and 34 F synchronized swimmers. 31±7 years old.
- During apneic exercise, working muscles will rely on blood flow for nutrients (aerobic metabolism)but once these are depleted they will shift to anaerobic metabolism
- Longer recovery periods are needed following breath holds for the oxidation of the accumulated lactate.
- Arm muscles extract less oxygen than leg muscles.
- Short, repeated breath holds lower the net lactate accumulation likely due to the consistent oxygen stores and the reliance upon more aerobic metabolism which also allows some lactate metabolism to occur.
- Extended length breath holds with exercise result in an increased reliance on anaerobic metabolism and the myoglobin stores of oxygen

Clinical Take Aways:

Breath hold duration affects the type of metabolism that will occur during the exercise, which alters the physiological adaptations that can occur.

Increased muscle work and increased apneic time increase the net lactate accumulation.

Breathing time between apneic episodes affects the rate of oxidation of the accumulated lactate.

APPLICATION:

1. The quantity of muscle being used for an activity will dictate the muscular O2 demands - more muscle means a greater need for oxygen.
2. The breathing cycle (inhale, hold, exhale, hold) can be used to manipulate aerobic versus anaerobic metabolism during exercise/activity.
3. **Longer breath holds with total body exercise will increase the rate of lactic acid create and the dominance of anaerobic metabolism.**

Voluntary Apnea During Dynamic Exercise Activates the Muscle Metaboreflex in Humans.

Ichinose Masashi, et al. *Am J Heart Circa Physiol*. 2018(314): H434-H442**.**

Objective: To determine if inducing apnea during dynamic exercise would result in a muscle metaboreflex (reflex sympathoexcitation and a systemic pressor response).

The Highlights:
- 13 (12 M, 1F) volunteers, 23 ±1 year olds.
- Exercise + apnea results in bradycardia, a decreases in cardiac output, a strong vasoconstriction in peripheral tissue (which results in a large rise in arterial BP)
- In addition, blood lactate levels increase with exercise + apnea, indicating a rise in anaerobic metabolism and an accumulation of metabolites within active muscles.
- Apnea decreased all extremity blood flow (working, non-working muscles), which results in an overall decrease in Oxygen delivery.

Clinical Take Aways:

Apnea + Exercise results in a higher accumulation of lactate than workload would normally create.

Activation of the muscle metaboreflex enhances cardiac sympathetic nerve activity and reduces cardiac parasympathetic nerve activity.

Apnea + exercise decreases arterial and venous pH levels.

Apnea can be to individuals tolerance, and get the results listed.

Apnea + exercise can elicit a training response that enhances the peripheral tissues ability to function in the presence of decreased O_2, at much lower workloads than are typically associated with decreased O_2 delivery.

APPLICATION:

1. Breath holds + lower level muscle activity (exercise) can result in an accumulation of Lactate, and decreases cardiac output during activity. In individuals unable to train at higher levels (injured, NWB, etc), similar physiologic responses are attainable.
2. Apnea increases blood pressure, so be sensitive of complicating factors where this could be a problem (concussion, acute inflammatory phase of injury, etc).

3. **Apnea + exercise can elicit similar physiologic responses to much higher intensity exercise (limiting impact, tissue micro trauma, CNS impact, etc.) This approach can replace/reshape the recovery workouts of endurance athletes.**

The Health Benefits of Nasal Breathing.

Alan Ruth. *Nursing General Practice.* 2017: 40-42**.**

Objective: To review the various health benefits nasal breathing has compared to mouth breathing.

The Highlights:

- Mouth breathing is a sign of over-breathing, along with chest breathing, sighing, noticeable breathing during rest, and taking large breaths prior to talking.
- The nose was designed to breath (and therefore smell); the mouth was designed for eating, drinking and speaking.
- A study of young asthmatic patients demonstrated that nasal breathing eliminated all signs of exercise induced asthma.
- Children who are mouth breathers have changes in fascial development, have difficulty sleeping, and have a higher incidence of being diagnosed with ADD and hyperactivity.
- Nasal breathing increases nitric oxide levels within the body. NO is a potent bronchodilator and vasodilator (lowers blood pressure and increases the lungs oxygen absorbing capacity.)

Clinical Take Aways:

Nasal breathing increases the resistance to breathing by 50%, which results in 10-20% more oxygen uptake.

Nasal breathing facilitates the action of the diaphragm.

Nasal breathing promotes activity of the parasympathetic nervous system.

Nasal breathing increases nitric oxide levels within the body.

APPLICATION:

1. Nasal breathing is a better breathing strategy when at rest and when working at low levels (though other research has shown a nasal breathing strategy can be utilized at up to 90% max VO_2.)
2. **NASAL BREATHING ACTIVATES THE DIAPHRAGM AND PROMOTES THE PARASYMPATHETIC NERVOUS SYSTEM-BOTH OF WHICH PROMOTE RECOVERY AND RESTORATION.**