# The Power of Breath: Diaphragmatic Breathing

Diaphragmatic breathing is sometimes referred to as belly, deep, relaxed, or abdominal breathing. It optimizes use of the main muscle of breathing, the diaphragm, resulting in slower, deeper breathing. It can be an important skill in a patient's self-management toolbox. With practice, most clinicians can teach it to their patients in 5-10 minutes.

In contrast to shallow breathing, diaphragmatic breathing is marked by expansion of the abdomen rather than the chest during the in breath. With shallow breathing, also known as thoracic or chest breathing, minimal breath is drawn into the lungs, usually through the use of the intercostal muscles and not the diaphragm. When lung expansion occurs lower in the body, breathing is described as "deep" and corresponds with observed or felt movement of the abdomen outward with inhalation. For use of this technique in chronic pain self-management, refer to "Diaphragmatic Breathing to Assist with Self-Management of Pain."

## Ways Diaphragmatic Breathing Can Be Useful

Diaphragmatic breathing:

- Shifts a person from a place of passivity to a place of activity; they are "doing something" about their symptoms
- Introduces training in increasing calm and relaxation
- Provides a simple way to quiet high-arousal states caused by pain or other symptoms and the emotions that it elicits
- Is extremely portable
- Costs nothing except an initial investment of time
- Can be used to manage other life stressors
- Can be used during difficult procedures, such as injections, imaging studies, etc.
- Provides a positive distraction
- Can be used to interrupt negative patterns of thought
- Demonstrates that clinicians consider non-pharmacologic interventions important for health

## Physiological Effects

Shallow breathing often accompanies stress, anxiety, and other psychological difficulties. This is typically a result of sympathetic over-arousal, commonly referred to as the "fight or flight response." With practice, diaphragmatic breathing lead to a reversal of fight or flight, to a quieting response modulated by the parasympathetic nervous system. It has a number of physiologic effects:

- Diaphragmatic breathing causes increased venous return to the heart. With inhalation, the diaphragm generates negative intrathoracic pressure, and blood is pulled into the thorax through a vacuum effect. This leads to increased stroke volume, which triggers arterial stretch receptors and results in increased parasympathetic activity, and decreased sympathetic activity. These changes bring about decreased heart rate and total peripheral resistance.[1]
- Inhalation at a rate of 6-10 breaths per minute causes increased tidal volume while maintaining optimal minute ventilation. The increase in tidal volume causes cardiopulmonary baroreceptor stretch which in turn leads to decreased sympathetic outflow and subsequently decreased peripheral vascular resistance.[1,2]
- Diaphragmatic breathing increases heart rate variability (HRV), which is a proxy measure of the balance of sympathetic and parasympathetic influence on the heart. Reduced HRV portends a poor prognosis in a variety of clinical contexts, including post-MI, ischemic heart disease, congestive heart failure, and diabetes with autonomic neuropathy.[1-3]

## Clinical Research

### Hypertension

The antihypertensive mechanisms of slow, deep breathing have not been fully elucidated. Effects on chemoreceptors, baroreceptors, central cardiovascular and respiratory control centers, and the autonomic nervous system are thought to contribute. Essential hypertension is thought to involve chemoreceptor hypersensitivity causing an excess of sympathetic nervous system activity. The chemoreceptor reflex is mediated by specialized neurons in the central and peripheral vasculature which respond to changes in the concentration of carbon dioxide. Increased carbon dioxide causes an increase in minute ventilation and sympathetic outflow, while decreased carbon dioxide causes a decrease in minute ventilation.[4] As noted above, slow, deep breathing stimulates baroreceptor activity through increased stroke volume promoting vasodilation.[1,2] Slow deep breathing is thought to promote baroreceptor inhibition of chemoreceptors, leading to decreased sympathetic tone, increased vasodilation, and decreased blood pressure.

Additionally, it is hypothesized that slow deep breathing exerts an autonomic balancing effect at centers of cross-talk between cardiovascular and respiratory control centers in the central nervous system.[5] Device-assisted slow breathing has the most robust evidence for the management of hypertension. The RESPeRATE device has been studied the most extensively. It consists of a belt worn around the thoracic rib cage that monitors respiratory rate. This information is relayed to a small electronic device which emits musical tones used to pace the patient's breathing. In 2013, the American Heart Association issued a scientific statement about the use of complementary and alternative therapies for hypertension management, wherein the committee states, "Device-guided breathing is reasonable to perform in clinical practice to reduce blood pressure."[5] Based on study protocols, the American Heart Association recommends fifteen-minute sessions at least three to four times per week.[5] Further research is needed to ascertain whether slow deep breathing without the use of an assistive device will yield similar antihypertensive effects.

## Congestive heart failure (CHF)

Inspiratory muscle strength is an independent predictor of survival in heart failure. Decreased inspiratory muscle strength and endurance leads to a variety of derangements including inefficient ventilation and preferential blood shunting to respiratory muscles—and away from exercising limbs. This leads to decreased exercise tolerance in patients with CHF. Inspiratory muscle training leads to increased inspiratory muscle strength and endurance, which brings about more efficient ventilation and increased exercise tolerance.[6]

## Chronic obstructive pulmonary disease (COPD)

In patients with COPD, hyperinflation places the diaphragm in a state of chronic partial stretch. This mechanical disadvantage leads to increased work of breathing and relative respiratory muscle weakness. Inspiratory muscle training has been shown to increase inspiratory muscle strength and endurance, decrease dyspnea and improve exercise capacity and health care related quality of life.[7]

## Asthma

A 2009 systematic review found that training in diaphragmatic breathing lead to short term and long term improvement in health care related increased quality of life. One of the included studies also demonstrated physiologic improvements including higher end-tidal carbon dioxide, decreased resting respiratory rate, and increased FEV1% following the diaphragmatic breathing intervention, but these results were not consistent across studies.[8]

## Hot flashes

In 2012, Sood and colleagues published a randomized controlled trial investigating the effectiveness of slow-paced breathing for the management of hot flashes. The intervention group used audio recordings either once or twice per day to pace the breathing at a slow rate of six breaths per minute, while the control group used audio recordings once per day to pace breathing at a normal rate of 14 breaths per minute. All groups saw a statistically significant decrease in vasomotor symptoms. There was no difference between groups. The authors hypothesize that the "control" group may actually have demonstrated a treatment effect of monitoring the breath for 10 minutes daily.[9] Other studies have shown similarly promising results.[10]

However, also in 2012, Carpenter and colleagues published a randomized-controlled trial wherein paced slow breathing showed a clinically significant (50% or greater) reduction in hot flash symptoms in only 38% of the intervention group. The intervention did not perform better than the active control and usual care.

## Insomnia

In 1995, Choliz published results from a randomized controlled trial wherein voluntary hypoventilation brought about drowsiness and subsequently sleep in the treatment group.[11] The proposed mechanism of action was hypercarbia leading to sedation, though this hypothesis was called into question by results of a follow-up study which showed hypoventilation produced a protracted state of hypocarbia.[12] Subsequently, in 2006, the American Academy of Sleep

Medicine published guidelines for the behavioral and psychological management of insomnia, wherein "relaxation" is recommended as a stand-alone treatment for insomnia based on review of the evidence, though breathing exercises are not specifically mentioned.[13]

## Depression and anxiety

In a 2005 series of papers, Brown and Gerbarg present a neurophysiologic model for the therapeutic use of a yogic breathing practice for the management of depression, anxiety, and stress. They also present a systematic evidence review which supports the use of yogic breathing for the management of stress, anxiety, and depression.[14,15] In 2009, Descilo and colleagues published results from a non-randomized trial evaluating a yogic breathing intervention with and without exposure-based therapy for survivors of the 2004 South East Asian tsunami. There were clinically significant improvements on the Beck Depression Inventory-21 and the Posttraumatic Checklist-17 in the groups receiving the breathing and the breathing plus exposure therapy interventions, but not in the control group.[16] In 2012, Katzman and colleagues published a small nonrandomized study evaluating a yoga breathing exercise program for the treatment of generalized anxiety disorder in treatment-resistant outpatients. The response rate was 73%, and 41% of patients achieved clinical cure.[17]

## Pain

A 2010 randomized controlled trial demonstrated that slow breathing can modulate experience of painful stimuli and negative affect. Women with fibromyalgia were compared to healthy controls. Each study participant was exposed to mildly and moderately painful thermal stimuli during periods of breathing at her normal rate and at half her normal rate. Healthy controls experienced less pain intensity and improvements in negative affect with slower breathing. Women with fibromyalgia did not reliably demonstrate these responses with slower breathing.[18]

In a 2005 study of chronic low back pain, patients with chronic low back pain were randomized to a breath therapy or physical therapy intervention. Patients in both groups experienced statistically and clinically significant improvements in pain intensity and self-reported overall health. The interventions performed equally well. These studies suggest that slow, paced breathing can be a useful self-regulatory tool for the management of pain.[19] An experimental study found that deep and slow breathing associated with relaxation resulted in the modulation of sympathetic arousal and pain perception.[20]

## Oxidative stress

Oxidative stress is a risk factor for heart disease and many other adverse health outcomes.[21] Hyperglycemia is known to induce oxidative stress in diabetic and healthy subjects.[22,23] There is evidence that oxidative stress is reduced with diaphragmatic breathing. In a 2011 retrospective cohort study, data were analyzed from 16 male competitive cyclists before and after a 900-calorie meal. Half of the subjects sampled engaged in 40 minutes of postprandial diaphragmatic breathing, while the other half of the subjects sat quietly reading a magazine following the meal. In the diaphragmatic breathing group, postprandial blood glucose was lower, post-prandial insulin was higher, and post-prandial circulating antioxidants were higher than controls.[24]

This same sample of athletes underwent testing to determine effect of diaphragmatic breathing on exercise-induced oxidative stress. Blood and saliva sampling was completed before and after an eight-hour period of strenuous exercise. Similar to the above results, exercise-induced oxidative stress was attenuated by diaphragmatic breathing. After exercise, participants in the diaphragmatic breathing group demonstrated lower levels of circulating reactive oxygen metabolites, higher levels of circulating antioxidants, lower levels of circulating cortisol, and higher nocturnal melatonin levels as compared to controls who sat quietly reading. [24]

## Five Steps to Teaching Diaphragmatic Breathing

### Step 1: Observation

Observe patients' breathing while they are seated for a minute or so. It is helpful to have them place one hand on the abdomen and another on the chest. To reduce performance anxiety, you could have them close their eyes or distract them with a different activity to allow you to observe comfortably.

- Ask them to breathe normally, just as they would in their life outside the clinic.
- Observe the movements of the hands including whether there is more movement in the upper hand (chest) or the bottom hand (abdomen).
- Notice if their breathing rate is fast, slow or somewhere in between. Observe whether the breathing pattern is smooth or choppy.

### Step 2: Education

The acronym DASS—Deep, Abdominal, Slow and Smooth—describes the goal pattern. If patient's breathing pattern is shallow, fast or choppy consider discussing or demonstrating:

- The importance of the diaphragm muscle as the main muscle of breathing.
- Breathing as it relates to the sympathetic and parasympathetic nervous systems.
- What diaphragmatic breathing looks like (the provider can use DASS breathing to demonstrate to the patient).
- The role of stress, and how it can lead to shallow chest breathing. Clinicians can acknowledge symptoms and conditions that are significant stressors and can influence their breathing patterns.
- Taking time with the exhalation assists in activating the quieting response mediated by the parasympathetic nervous system.

### Step 3: Instruction

Teaching several different techniques and finding what works best for each individual can be helpful. If an examination table is present, training can begin with patients lying down. Each technique can be practiced for a minute or so to give the patient ample time to determine what works best. *Note: Some individuals become much more anxious when they focus on their breathing, and other techniques may be more appropriate.* (Refer to other relaxation techniques described in "Mind and Emotions Overview"). Here are four simple diaphragmatic breathing techniques that can be tried:

**Technique 1**
Start simply by having them place a hand on the abdomen and gently attempt to breathe under that hand. If this is too effortful or they are "trying too hard" (over breathing or too forceful), move on to other techniques or see if they can reduce effort.

**Technique 2**
This next technique encourages deeper breaths. Have the patient breathe in for a count of "2" (with each counted number taking a second) and out for the count of "3". If this feels too fast, try slowing it to breathing in for "3" and out for "4." Adjust the numbers so that the exercise is comfortable and not stressful. The elongation of the outbreath can often create an opportunity for a deeper next breath.

**Technique 3**
In this technique, the individual inhales normally. On exhalation, the goal is to focus on exhaling all of the air completely out of their lungs. Then, rather than quickly inhaling again, they pause and wait until the body wants to breathe again. They should let any sense of effort drop away.

**Technique 4**
Imagery can be helpful to some patients. The patient imagines a breathing hole (like a whale's or dolphin's) in the bottom of each foot. With each breath, they imagine breathing in through the bottom of their feet and up to their abdomen. On the exhalation, this is reversed as they imagine breathing out the bottom of their feet.

## Step 4: Evaluation of techniques and assignment of at-home practice

Many patients will say that the above activities were challenging or felt "different," due to the fact that they habitually engage in shallow breathing. This is perfectly normal, and as they become more accustomed to deeper breathing, it will feel more natural. *Note: Any sense of feeling light-headed is a sign of trying too hard or over breathing, and effort should be decreased. Changing techniques might prove more helpful.*

- Ask the patient which of the techniques worked and was easiest for them, or which they enjoyed the most. Encourage them to practice this technique at home.
- Practice 5-10 minutes, twice daily, in a comfortable position. Many patients have sleep disruptions. Times when a person is having difficulty falling asleep or experiencing intermittent awakening are additional practice opportunities. Diaphragmatic breathing may assist with increasing comfort or falling back to sleep.
- In addition, ask them to practice off and on throughout the day and in a variety of positions (this is to encourage generalization). It is also helpful to have them practice at times of relatively low stress until they become accustomed to it.

**What to do if all of this proved difficult or extremely taxing for the patient.**

Have the patient practice at home, lying on the belly if possible. Not all pain patients are capable of lying on their stomachs, but most can for the few minutes needed to become aware of their breathing. Lying down on the belly typically allows people to feel the diaphragm muscle even when breathing with minimal effort. This can be practiced for five minutes, focusing on the sensation of deeper breathing. Following this, they can turn over on their back and recall the sensations experienced when they were on their belly.

The goal is for the individual to practice feeling the sensations and experience of diaphragmatic breathing until they become habituated to it. Twice-daily practice should aid in their learning. Eventually, once more comfort and familiarity has been achieved, another goal will be to do diaphragmatic breathing while sitting up.

### Step 5: Follow-Up

Follow-up is critical to the integration of this activity, and it can be challenging for the busy clinician; making use of a team approach and working with other team members becoming skilled in teaching these techniques can be helpful. Even brief attention from a clinician communicates to patients that these approaches are important and that they should follow through. Breathing patterns can be a very strong habit forged over many years and change needs time and reinforcement. Consider the following for follow-up:

- Review the exercise to determine if the patient still understands the practice. Have them demonstrate slower, deeper abdominal breathing.
- Discuss how and when they are using it (e.g. when awake in the middle of the night due to pain, when upset or distressed about finances, after a challenging conversation, etc.) and encourage continued use. Reinforce the ways that it might help them, even if it helps more with decreasing emotions related to symptoms rather than the symptoms themselves.
- Explore how they can apply these skills more generally in their lives, which is a final important part of following up with training. Ask them to consider other times when they could use the skill, such as when they are in a doctor's waiting room, driving the car, off and on throughout the day, etc.
- Remember the goal. Slower deeper breathing without effort is optimal for breathing most of the time, except perhaps during certain limited situations where sympathetic arousal (the fight or flight response) is truly helpful.

## Summary

Breathing can be a useful tool for quieting sympathetic arousal. It has a number of positive physiological effects, and a number of potential clinical benefits. The five easy steps to teaching diaphragmatic breathing are:

1. Observation
2. Education
3. Instruction
4. Evaluation and homework
5. Follow-up in future appointments

For a clinician self-practice activity, refer to "Breathing."

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