A TUTORIAL

Learn to Screen Clients for Dysfunctional Breathing Habits

Are breathing mechanics aligned with respiratory chemistry?

Peter M. Litchfield, Ph.D.
pl@bp.edu

GRADUATE SCHOOL OF BEHAVIORAL HEALTH SCIENCES
109 East 17th Street, Cheyenne, Wyoming 82001
Tel: 307.633.9800  Cell: 505.670.2874  Fax: 866.251.4826  education@bp.edu

Copyrighted by Peter M. Litchfield, Ph.D. & Sandra Reamer, MS, MFA, CBBA, CBBP, CST, CSOM
OUR MISSION
Educational Capnography

Our mission is to help people improve health and performance through the application of behavioral learning principles to breathing physiology.

Better Physiology, Ltd.
Breathing Science Network
Graduate School of Behavioral Health Sciences
Interdisciplinary Wellness Collaborative

Copyrighted by Peter M. Litchfield, Ph.D. & Sandra Reamer, MS, MFA, CBBA, CBBP, CST, CSOM
GET INVOLVED.

Get educated.

1. *Make referrals.* Learn to screen for dysfunctional breathing habits. The *Interdisciplinary Wellness Collaboration (IDWC)* and the *Breathing Science Network* have partnered to provide breathing analysis and learning services to organizations interested in making referrals.

2. *Train staff members.* Learn to provide breathing analysis and learning services by watching recordings of three 15-hour live webinar courses. And, if desired you may elect to earn 45 CE hours (three academic units) from the *Graduate School of Behavioral Health Sciences* by taking an exam for each offering.

3. *Certify staff members:* Become a Certified Breathing Behavior Analyst by registering for the certification program offered by the Graduate School of Behavioral Health Sciences. The three courses mentioned above provide half of the requirements for certification. The balance of training involves Case Analysis, Case Review, and Practicum.
WEBINAR-COURSE RECORDINGS

Go to www.betterphysiology.com to access the recorded webinars. Click on Webinar Courses ($200.00 per course), a series of three 15-hour courses is available to you (45 hours total), to be taken in the following order:

Respiratory Psychophysiology ($200.00)
Breathing Habit Analysis ($200.00)
Breathing Habit Modification ($200.00)

Should you wish to earn academic and/or CE credit for these courses, you will need to take the examination and pay an additional $300.00 for each of them. Paying for the additional tuition fee also entitles you to attend these courses “live” as well as to having access to slides, forms, and articles from the Graduate School e-campus website.
ADVANCED TRAINING IN BREATHING SCIENCE

Graduate School of Behavioral Health Sciences

A private university, founded in 2012, that offers multi-disciplinary, live-interactive, webinar-based post-professional degree, certification, and CE programs that weave together behavioral and physiological sciences into client-centered learning service applications.

Website: www.bp.edu
Email: education@bp.edu
Telephone: 307.633.9800
Litchfield: 505.670.2874
THE SCHOOL OF BREATHING SCIENCES
is a division of the Graduate School of Behavioral Health Sciences
and offers live-interactive webinar programs in breathing sciences.

MS degree in Applied Breathing Sciences
36 academic credits in physiology and behavioral science

Certified Breathing Behavior Analyst
*Breathing Habit Analysis and Modification*
90-hour program
6 academic credits
90 CE hours

For more information go to www.bp.edu.
OR, www.e-campus.bp.edu
CERTIFIED BREATHING BEHAVIOR ANALYST

Offered by the Graduate School of Behavioral Health Sciences...
Go to www.e-campus.bp.edu for registration and/or a brochure.

The CERTIFICATION PROGRAM qualifies healthcare practitioners, human service professionals, performance consultants, and health educators to:

(1) to assess breathing habits and their effects on health and performance based on the principles of behavior analysis,

(2) to assist clients in managing and/or overcoming dysfunctional breathing habits that compromise physiology, psychology, and performance based on the principles of behavior modification, and

(3) to use capnography and related instrumentation for assisting their clients in identifying and overcoming dysfunctional breathing habits.

If you have taken the three courses described earlier, you will receive either $600.00 or $1,500.00 of credit toward the cost of the certification, depending upon whether you have taken the examinations ($3,000.00 for six academic and 90 hours CE credit).
CAPNOGRAPHY INSTRUMENTATION

Better Physiology Ltd.

Better Physiology is the only company that (1) manufactures, sells, and distributes educational capnography instrumentation and (2) provides capnography applications for use by both practitioners and their clients for identifying, disengaging, and learning breathing habits.

Educational capnography provides for identifying dysfunctional breathing habits and for assisting clients in exploring their breathing habits and their behavioral components, triggers, effects, motivations, sustaining factors, and histories.
The Multidisciplinary Wellness Collaborative is introducing...

**Tele-Breathing Learning Services**

Soft Launch date: 06/18/2019  
www.breathinglearning.com  
e-mail: info@breathinglearning.com  
Phone number: 602.828.0422, Fax number: 714.276.9849

*The Multidisciplinary Wellness Collaborative* (“MDWC”) is a medical management company that is providing the platform, support, and management of delivery of Breathing Learning Services provided by the *Breathing Science Network*. 
INTRODUCTION

Everyone learns breathing habits. Sometimes these habits are dysfunctional. Screening sessions with your clients are exploratory sessions where clients learn about their own breathing habits and how they may be affected by them.

This tutorial will prepare you to screen your clients for possible learned dysfunctional breathing habits and for then making a referral to a Certified Breathing Behavior Analyst.

The Analyst will provide your clients with a comprehensive breathing behavior analysis and then, if appropriate, subsequent breathing learning sessions for learning new breathing habits consistent with good respiratory chemistry.

Screening your clients for dysfunctional breathing habits does not constitute a diagnosis and should not be presented as such to your clients.
BEFORE STARTING THIS TUTORIAL

● Learn to use your CapnoTrainer software. Go through the *CapnoTrainer Interactive Training Manual* at [www.betterphysiology.com/software-tutorials/](http://www.betterphysiology.com/software-tutorials/)

● Practice using your CapnoTrainer on yourself and/or a volunteer.


● After completing this tutorial, consider a two-hour one-on-one personalized session by webinar with a Certified Breathing Behavior Analyst who will walk you through two screening sessions with clients in your office.

Make an appointment with Sandra Reamer, MS, MFA, CBBA, CBBP, CST, CSOM at [sr@bp.edu](mailto:sr@bp.edu) or 505.946.8919.
REFERENCES

PHYSIOLOGY


BEHAVIOR


“Breathing and its potential effects on our lives, positive and negative, are enormous. Appreciating this enormity is significantly enhanced by learning about the amazing physiology of breathing, which together with understanding breathing as motivated behavior, can account for the profound and far-reaching effects of breathing on health and performance.”

Litchfield, Peter M. *Breathing: Alignment of Mechanics with Chemistry* (IBF Newsletter - June 2017)
MECHANICS AND CHEMISTRY

“Millions of people from around the world include breathing learning interventions in one way or another in their professional and/or personal lives for a multitude of reasons. Most of them, however, focus on the mechanics of breathing without even so much as a thought about its chemistry, that is, the role of mechanics in optimizing internal respiration and its associated chemistry, e.g., pH regulation of blood plasma.”

Litchfield, Peter M. Breathing: Alignment of Mechanics with Chemistry (IBF Newsletter - June 2017)
BREATHING IS PSYCHOLOGICAL.

“The relationship between breathing and respiration, mechanics and chemistry, cannot be fully appreciated without understanding the psychological nature of physiology itself. Breathing, like any other behavior, is motivated and changes as a function of its outcomes. Breathing isn’t simply mindless automation of physiology. And, it isn’t simply physiology to be somehow consciously manipulated in the name of self-help. It’s truly so much more than this. Simply manipulating breathing physiology for well-intended purposes, without regard to the bigger picture, does not do justice to the richness and complexity of breathing.”

Litchfield, Peter M. *Breathing: Alignment of Mechanics with Chemistry* (IBF Newsletter - June 2017)
STATISTICS.

Statistics suggest that tens of millions of people worldwide suffer with the profound and misunderstood symptoms and deficits of learned dysfunctional breathing habits. Unfortunately, these habits are rarely identified by practitioners, their effects mistakenly attributed to other causes, and their resolutions prescriptive in nature where focus is on symptoms rather than on causes.

Statistical reports regarding the frequency of learned dysfunctional breathing in the population at large range between 10 and 25 percent. The incidence of dysfunctional breathing habits in patient populations (e.g., pain), however, is much higher (60% to 90%). Unfortunately, both patients and their practitioners are typically unaware of the presence of these habits and their potentially profound debilitating effects.
TIP OF AN ICEBERG!

*It has been estimated [that breathing habits] account for roughly* 60 percent of emergency ambulance calls *in major US city hospitals.*”

(Fried, Robert  *Breathe Well, Be Well.* 1999, p 45)

**Emergency ambulance-run statistics...**

Although a large percentage of the ambulance runs in the USA are the result of symptoms brought on by dysfunctional breathing, **most people do not call 911** (emergency).

Many of these people go to healthcare practitioners who mistakenly attribute the symptoms to other causes and offer medical and behavioral prescriptions for symptom management.

Many implement self-interventions that may only incidentally address, if at all, the habits responsible for the effects, while yet most do nothing at all.

**Interventions focus on symptom management, not causes (habits), e.g., drugs and techniques**
MEASUREMENT

Capnography
CAPNOGRAPHY

Educational vs medical

*Capnographs* (or capnometers) are instruments used for determining the concentration of CO₂ gas in blood plasma.

*Medical capnography* is about monitoring CO₂ in critical care, surgery, and medical emergency environments where life threatening shifts in blood gases must be continuously monitored and regulated.

*Educational capnography* is the implementation of the principles of behavior analysis and behavior modification for identifying and unlearning dysfunctional breathing habits that compromise respiration.

The CapnoTrainer is an educational capnograph.
EDUCATIONAL CAPNOGRAPHY

Respiratory Psychophysiology

Educational capnography is the implementation of the principles of behavior analysis and behavior modification for identifying, unlearning, and managing dysfunctional breathing habits that compromise respiration.

Dysfunctional breathing habits, where reflex-regulated CO₂ has been compromised, may cause, trigger, exacerbate, and perpetuate a wide range of effects (symptoms and deficits) that are typically mistakenly attributed to other causes.

In fact, the educational capnography is the only effective technological means to determining if, when, where, and how a learned habit compromises respiration.
GAS CONCENTRATIONS

Gases are measured in units of pressure.

Gases are measured in *millimeters of mercury (mmHg)*.

Each gas, e.g., oxygen, accounts for a part, “a partial pressure,” of total atmospheric air pressure, 760 mmHg at sea level,

Nitrogen accounts for 78.08% of the total pressure, 

or \(0.7808 \times 760 = 593.41\) \(\text{mmHg}\) \(\text{Partial pressure Nitrogen (PN}_2\text{)}\).

Oxygen accounts for 20.95% of the total pressure, 

or \(0.7808 \times 760 = 159.22\) \(\text{mmHg}\) \(\text{Partial pressure Oxygen (PO}_2\text{)}\).

Argon accounts for 0.93% of the total pressure, 

or \(0.93 \times 760 = 7.07\) \(\text{mmHg}\) \(\text{Partial pressure Argon (PO}_2\text{)}\).

Carbon dioxide accounts for only 0.039% of the total pressure, 

or \(0.039 \times 760 = 0.29\) \(\text{mmHg}\) \(\text{Partial pressure Carbon dioxide (PCO}_2\text{)}\).
**end-tidal PCO$_2$ concentration (PetCO$_2$)**

PetCO$_2$ = Alveolar Partial pressure CO$_2$ (PACO$_2$) in healthy people.

Capnographs measure Partial pressure CO$_2$ concentration (PCO$_2$) in the air moving in and out of the lungs. Capnographs do NOT measure the quantity of CO$_2$ dioxide inhaled or exhaled.

While inhaling the CapnoTrainer measures PCO$_2$ concentration in atmospheric air; thus, during inhalation, the PCO$_2$ will effectively read zero. While exhaling the CapnoTrainer measures PCO$_2$ concentration in air exiting the lungs, including air in the anatomical dead space and the alveoli.

*At the end of a complete exhale, the air is purely alveolar (PACO$_2$)*, if the exhaled hasn’t been aborted; the anatomical dead space air has already exited. The CO$_2$ concentration in the alveolar air is known as “end tidal” PCO$_2$, or PetCO$_2$, as it is a measurement of CO$_2$ concentration at the end of the “tide” of air.

See next slide for illustration.
MEASUREMENT

The Ideal Capnogram – the Raw Waveform

From Levitsky, Pulmonary Physiology (2007)
arterial PCO$_2$ concentration (PaCO$_2$)

\[ \text{PetCO}_2 = \text{PACO}_2 = \text{PaCO}_2 \]

PCO$_2$ concentration in blood moving through the pulmonary capillary system equilibrates to the Alveolar level of PCO$_2$ concentration (PACO$_2$). Thus, arterial PCO$_2$ concentration (PaCO$_2$) is governed by and is approximately equivalent to PACO$_2$.

When PetCO$_2$ is an accurate measurement of PACO$_2$ it is also an accurate measurement of PaCO$_2$ (given absence of pulmonary and cardiovascular disease). In all cases, PCO$_2$ concentration, while aerobic should be 35 to 45 mmHg.

PetCO$_2$ does not, however reflect accurate PACO$_2$ when exhales are significantly aborted. In this case, air at the end of the exhale is a mixture of anatomical deadspace and alveolar air, i.e., not a true measure of PACO$_2$.

In healthy people, PACO$_2$ and PetCO$_2$ measurements are highly correlated with PaCO$_2$. In clients with cardiovascular or pulmonary organic compromise, however, PetCO$_2$ may read lower than PaCO$_2$ as a result of a ventilation/perfusion mismatch, e.g., alveolar deadspace.

Note: It is easy to identify aborted breaths as is described later in this slide presentation.
**MEASUREMENT SUMMARY**

PCO$_2$, PACO$_2$, PaCO$_2$, PetCO$_2$

*Partial Pressure CO$_2$ (PCO$_2$)* is part of the total pressure of atmospheric gases, i.e., 0.039% of 760 mmHg (at sea level), where PCO$_2$ = 0.29 mmHg.

*Partial Pressure Alveolar CO$_2$ (PACO$_2$)* is CO$_2$ concentration in the alveoli of the lungs, which in healthy people should be 35 to 45 mmHg (while aerobic).

*Partial Pressure Arterial CO$_2$ (PaCO$_2$)* is CO$_2$ concentration in the arterial system, which in healthy people should be 35 to 45 mmHg. Blood traveling through the pulmonary capillary network equilibrates to PACO$_2$.

*Partial Pressure End Tidal CO$_2$ (PetCO$_2$)* is CO$_2$ concentration in the mixture of gases at the End of the Tide of air (end of the exhalation), where the mixture of gases is pure alveolar air (unless the exhale is incomplete).

Hence, in healthy people (absent pulmonary or cardiovascular disease), PetCO$_2$ = PACO$_2$ = PaCO$_2$. 
MECHANICS IN THE CAPNOGRAM

Observe air flow in the PCO₂ waveform.

The continuous and real-time presentation of waveform data permits observation of air flow, and thus provides for observation of breathing mechanics, including:

- breath-holding
- gasping
- spasm
- sighing
- forced exhaling
- breathing rate
- aborted exhalation
- rhythmicity
- struggle, effort

See next slide.
AIRFLOW: Changes in Breathing Mechanics

The Capnogram is also record of airflow as shown below.

↑ breath holding
↑ aborted breath
↓ forced exhale
↓ gasping (and struggle)
Physiology

Three Phases of Respiration

*External Respiration*: the mechanics of breathing

*Internal Respiration*: the chemistry of breathing

*Cellular Respiration*: synthesis of ATP for cellular energy
External Respiration: Breathing Mechanics

External respiration is about breathing mechanics for moving gases (air) in and out of the lungs, based on brainstem reflexes. Allowing brainstem reflex mechanisms to regulate breathing mechanics translates into ongoing extracellular fluid acid-base regulation, e.g., blood plasma.

Breathing mechanics include the following kinds of behaviors: **LOCUS** of breathing (diaphragm, accessory muscles), **RATE** (fast, slow), **DEPTH** (deep, shallow), **TRANSPORT** (nasal, mouth), **TRANSITION** time of exhale to inhale, **EXHALATION, INHALATION**, and **RHYTHMICITY** (e.g., gasping, breath holding).

The CapnoTrainer permits observation of alveolar PCO$_2$ (PACO$_2$), breathing rate, and airflow. Airflow permits observation of transition time, aborted exhales, pushed exhales, gasping, and breathing rhythmicity and struggle.
Internal respiration: *the Chemical Axis*

It includes the transport of oxygen in the blood from the lungs to tissue cells, the transport of metabolic CO₂ from tissue cells to the lungs, and excretion and reallocation of CO₂ for acid-base balance regulation. PCO₂ regulates electrolyte balance, hemoglobin chemistry, blood flow, muscle function, brain chemistry, and kidney chemistry.

The **Henderson-Hasselbalch (H-H) equation** describes pH regulation in extracellular fluids, including blood plasma, lymph, cerebrospinal, and interstitial fluids.

**EQUATION:** \[ \text{pH} = \frac{[\text{HCO}_3^-]}{\text{PCO}_2} \]

where PCO₂ is partial pressure carbon dioxide, e.g., CO₂ concentration in extracellular fluids, e.g., blood plasma, *regulated by moment to moment breathing* with immediate effects on pH.

where \([\text{HCO}_3^-]\) is bicarbonate concentration (used to buffer acids) *regulated by the kidneys* that don’t begin compensation for pH changes until hours later, and then taking days to complete the process. The contribution to pH regulation is delayed and slow.
BEHAVIORAL ACID-BASE REGULATION.

Habits interact with moment to moment body chemistry regulation.

\[ \text{acid-base balance} = \frac{[\text{HCO}_3^-]}{\text{behavior (breathing)}} \]

Medical practitioners are interested in the organic factors that disturb the numerator of H-H equation, the bicarbonate concentration. Breathing, the denominator, is a reflexive chemo-physiological compensatory mechanism that contributes to the restoration of acid-base balance.

Integrating behavioral science with the H-H equation, however, means examining behavioral and psychological variables that may disturb the denominator of this important equation. It is here that psychological variables, i.e., learning and motivation, make a powerful entry into the regulation (or deregulation) of respiratory physiology.
BREATHING REFLEXES
regulate breathing mechanics, unless your habits get in the way.

The H-H equation is balanced by chemo-inputs from arterial and brainstem receptor sites:

- **brainstem receptors**: pH and PCO₂ concentration in cerebrospinal & interstitial fluids
- **arterial (aorta and carotid) receptors**: pHₐ, PaCO₂, and PaO₂ in arterial blood plasma
  (where “a” means “arterial”)

If pH is too low (< 7.35), or too high (>7.45), PCO₂ is reflexively reduced or increased, as per the H-H equation, by altering breathing rate and depth (**minute volume**), i.e., external respiratory changes (breathing mechanics). These reflexes operate through the diaphragm and external intercostal muscles.

Many people, however, quickly and unconsciously learn breathing habits that preempt these reflexes, often resulting in seriously disturbed fundamental physiology and its potentially debilitating symptoms and deficits.
BREATHING & RESPIRATION are NOT the same thing.

What is good respiration (chemistry)?
What is compromised respiration (chemistry)?
What is good breathing (mechanics)?
What is dysfunctional breathing (mechanics)?

How are breathing and respiration different from one another?

**Breathing is behavior.**
Breathing habits, functional and dysfunctional can be learned.

**Respiration is reflexive.**
Although, respiratory reflexes can be conditioned (learned) reflexes.

*BREATHING AND RESPIRATION NEED TO BE IN ALIGNMENT.* What does this mean?
Breathing mechanics need to serve respiratory chemistry. Often, they do not!
ALIGNING

Breathing with Respiration
Mechanics with Chemistry

What is often considered to be “good” breathing doesn’t necessarily mean good respiration.

- Diaphragmatic breathing doesn’t mean good respiration.
- Slow breathing doesn’t mean good respiration.
- Nose breathing doesn’t mean good respiration.
- Taking larger breaths doesn’t mean good respiration.

What is often considered to be “poor” breathing doesn’t necessarily mean poor respiration.

- Fast breathing doesn’t mean poor respiration.
- Mouth breathing doesn’t mean poor respiration.
- Chest breathing doesn’t mean poor respiration.
- Shallow breathing doesn’t mean poor respiration.
- Dysrhythmic breathing doesn’t mean poor respiration.
- Gasping doesn’t mean poor respiration.
Breathing Rate and Hypocapnia

Don’t confuse breathing rate with deregulated PCO₂.

- Fast breathing doesn’t mean poor respiration.
- Slow breathing doesn’t mean good respiration.

Breathing Rate: 6 (slow)  PaCO₂ = 25 (very low)
GOOD BREATHING
means a balanced H-H equation, a stable “chemical axis.”

As a result of very specific learning, dictated by unique learning histories, breathing behaviors and patterns may change dramatically and immediately as a function of physical and social circumstances along with what a person may be doing, thinking, and feeling.

Nevertheless, maintaining a stable respiratory chemical axis (pH regulation) is vital to health and performance, and must be regulated despite the breathing acrobatics of talking, emotional encounters, and professional challenges.

Alignment of mechanics with chemistry means allowing chemo-regulatory reflexes to control breathing mechanics in accordance with respiratory requirements (pH, PCO₂, and PO₂) i.e., where external respiration serves internal respiration.

When mechanics and chemistry are in alignment, the CHEMICAL AXIS of breathing is both stable and in the normal range. Unfortunately, however, millions of people learn breathing habits that compromise these reflexes.

Copyrighted by Peter M. Litchfield, Ph.D. & Sandra Reamer, MS, MFA, CBBA, CBBP, CST, CSOM
BREATHING BEHAVIORAL SCIENCE

When breathing is NOT identified as behavior...

Failure to make the distinction between respiration and breathing has prevented the practical union of respiratory and behavioral sciences, which has led to a failure to identify and to effectively disengage learned dysfunctional breathing habits that misalign breathing mechanics with respiratory chemistry.

This misalignment can (1) result in profound effects on physiology, psychology, and performance leading to debilitating symptoms and deficits of all kinds and (2) lead to fundamental misunderstandings of the nature of dysfunctional breathing and, all too often, to failed breathing interventions.
HYPOCAPNIA is a PaCO₂ deficit.

\[ \uparrow \text{pH} = \frac{[\text{HCO}_₃^-]}{\text{PCO}_₂} \downarrow \]

When PaCO₂ is too low (below 35 mmHg), with deeper and/or faster breathing, the denominator of the H-H equation is smaller. Thus, the extracellular pH rises (above 7.45) with resulting RESPIRATORY ALKALOSIS, a condition identified as HYPOCAPNIA.

Hypocapnia that is a consequence of dysfunctional breathing habits is known as BEHAVIORAL HYPOCAPNIA.

Important Note:

Lower PaCO₂ levels are NOT necessarily indicative of respiratory alkalosis but may rather be the result of reflexive compensatory responses to metabolic acidosis, e.g., build up of lactic acidosis during anaerobic exercise.
BEHAVIORAL HYPOCAPNIA is the result of learned *overbreathing behavior*.

Behavioral hypocapnia is the result of **overbreathing behavior**, “over” breathing because excessive CO₂ is excreted, resulting in excessively high levels of pH.

When overbreathing is a consequence of either learned dysfunctional breathing mechanics, **OR** is reinforced directly with powerful reinforcements (e.g., dissociation), hypocapnia is behavioral, and hence the term **behavioral hypocapnia**.

Behavioral hypocapnia (respiratory alkalosis,) may have **profound immediate and long-term effects** that may trigger, exacerbate, perpetuate, and/or cause a wide variety of symptoms that may seriously impact health and performance:

- emotional (anxiety, anger),
- cognitive (attention, learning),
- behavioral (public speaking, test taking), and
- physical (pain, asthma) changes
- psychological changes (e.g., personality shifts, self-esteem), and
- nearly every known symptom of stress, immediate and long-term.
HYPERCAPNIA is excessive PaCO$_2$.

$\downarrow$ pH = $[\text{HCO}_3^-] \div \text{PCO}_2 \uparrow$ (underbreathing)

When PaCO$_2$ is too high (above 45 mmHg), with shallower and/or slower breathing, extracellular pH falls (below 7.35) with resulting **RESPIRATORY ACIDOSIS**, a condition identified as **HYPERCAPNIA**.

Behavioral hypercapnia is the consequence of **UNDERBREATHING**, not ventilating off adequate CO$_2$ by breathing too slowly and/or too shallow. Behavioral hypercapnia is not common. **Hyperinflation, radical aborting of the exhale**, is the most likely cause.
CRITICAL VALUES OF PCO\textsubscript{2}

Eucapnia, hypocapnia, hypercapnia

When PCO\textsubscript{2} is 35 to 45 mmHg, in a healthy person, extracellular pH is normal (7.35 - 7.45) and is known as **EUCAPNIA**.

From a behavioral perspective, here is a rule of thumb for evaluating PetCO\textsubscript{2} readings.

45+ mmHg: hypercapnia
35-45 mmHg (4.7 - 6.0 kPa): normal range (pH = 7.45 - 7.35)
30-35 mmHg: moderate to mild hypocapnia
25-30 mmHg: serious to moderate hypocapnia
20-25 mmHg: severe hypocapnia.

**Note:** On occasion you may see symptoms and/or deficits at PetCO\textsubscript{2} levels as high as 35 mmHg. These values from a pH perspective are at the border of “normal.”
HYPOCAPNIA: Physiological Effects

- Antioxidant reduction
- Bicarbonate deficiency (long term kidney effect)
- Bronchial constriction (airway resistance)
- Calcium migration into muscle cells (fatigue, spasm)
- Cerebral excitatory and inhibitory disturbances
- Cerebral hypoxia, hypoglycemia, ischemia
- Cerebral vasoconstriction (increased pH)
- Compromised O₂ distribution (hemoglobin)
- Compromised nitric oxide distribution (hemoglobin)
- Coronary (vascular) constriction
- Dishabituation
- Gut smooth muscle constriction
- Ionized magnesium reduction (role in tetany and cardiac compromise)
- Hypokalemia (potassium deficiency)
- Hyponatremia (sodium deficiency, long term effect)
- Increased neuronal excitability & contractility
- Increased overall vascular resistance (smooth muscle constriction)
- Myocardial electrophysiology disturbances
- Neuronal acidosis (lactic acid)
- Reduced lung compliance
- Sodium and potassium migration into cells (excitability)
- Stress hormone release (ACTH)
- Thrombosis, platelet aggregation
- Tissue inflammation

Copyrighted by Peter M. Litchfield, Ph.D. & Sandra Reamer, MS, MFA, CBBA, CBBP, CST, CSOM
HYPOCAPNIA: Symptoms & Deficits

- Respiratory: shortness of breath, airway resistance, bronchial constriction, asthma symptoms
- Peripheral: tingling, numbness, trembling, twitching, shivering, coldness, sweatiness
- Cardiovascular: palpitations, tachycardia, arrhythmias, angina symptoms. ECG abnormalities
- Emotional: anxiety, anger, fear, panic, phobia, apprehension, worry, crying, low mood
- Autonomic-stress: acute fatigue, chronic fatigue, headache, muscle pain, weakness
- Sensory: blurred vision, sound seems distant, reduced pain threshold, dishabitation, dry mouth
- Consciousness: dissociation, state change, dizziness, fainting, confusion, hallucinations
- Cognitive: attention deficit, learning deficits, poor memory, brain fog, inability to think
- Muscles: tetany, hyperreflexia, spasm, weakness, fatigue, pain, difficult to swallow, chest discomfort
- Smooth muscles: cerebral, coronary, bronchial, gut, and placental vasoconstriction
- Abdominal: nausea, vomiting, cramping, bloatedness
- Movement: diminished coordination, reaction time, balance, perceptual judgement
- Performance: sleep apnea, anxiety, rehearsal, focus, endurance, muscle function, fatigue, pain
- Psychological: shifts in personality, self-esteem, memory, emotion, thought

Copyrighted by Peter M. Litchfield, Ph.D. & Sandra Reamer, MS, MFA, CBBA, CBBP, CST, CSOM
HYPOCAPNIA: Triggering, Exacerbating, Perpetuating

- Neurological: epilepsy
- Cognitive: learning disabilities, ADD, ADHD
- Emotional: anger, phobias, panic attack, anxiety, depression
- Psychological: trauma, PTSD, drug dependence
- Vascular: hypertension, migraine, ischemia, hypoglycemia
- Cardiovascular: angina, heart attack, arrhythmias, ECG abnormalities
- Efficacy of drugs: shifts in pH and electrolyte balance alter absorption
- Fitness issues: endurance, muscle strength, fatigue, altitude sickness
- Gastric: irritable bowel syndrome (IBS), non-ulcer dyspepsia
- Respiratory: asthma, emphysema, COPD
- Chronic pain: injury, disease, systemic inflammation
- Pregnancy: fetal health, premature birth, symptoms during pregnancy
- Neuromuscular: repetitive strain injury (RSI), headache, orthodontic
- Sleep disturbances: apnea
- Psychophysiological disorders: headache, chronic pain, hypertension
- Behavioral: performance issues, speech, singing, task challenges
- Unexplained conditions: fibromyalgia, chronic fatigue
BREATHING HABITS
What makes them dysfunctional?
THE PROBLEM

Learned breathing behaviors (habits) can compromise physiology, psychology, health, and performance.

These learned breathing behaviors have a major impact on multiple physiological systems, resulting in symptoms and deficits that are usually attributed to other causes, by clients and their health practitioners, rather than to learned behaviors and responses that may account for them.

When respiration is compromised (low CO₂) as a consequence of breathing habits, it may have profound IMMEDIATE and LONG-TERM effects that TRIGGER, EXACERBATE, PERPETUATE, and/or CAUSE a wide variety of... EMOTIONAL changes (anxiety), COGNITIVE changes (attention, learning), PERFORMANCE changes (public speaking, test taking), and PHYSICAL changes (pain, asthma) changes that may seriously impact health and performance.
DYSFUNCTIONAL BREATHING BEHAVIORS

Breathing habits that significantly compromise physiology, psychology, and performance are dysfunctional ones. These compromises are often mistakenly attributed to organic factors.

**CASE:** A nurse reported that she was medicated for severe gasping, because of her asthma. Upon monitoring her breathing we took note of her gasping, which was present despite the medication. At our request, she fit wax earplugs into her ears. The earplugs allowed her to hear her own breathing, which provide her with immediate feedback for her learned behavior. Within moments her gasping stopped, which then immediately returned upon removing the ear plugs.

Clearly her gasping was not triggered by asthma. Asthma, however, had set the stage for leaning to gasp under other circumstances, which became triggers for the gasping behavior.
GOOD BREATHING, or BAD BREATHING?

Specific breathing behaviors are not good or bad unto themselves but are defined based on their outcomes.

*Example: A fox and a rabbit learn “phobias” of each other. In one case fear is life-saving (rabbit), but in the other case fear leads to starvation (fox). One “fear” is functional, one is not.*

How do breathing behaviors serve you? Do they work for you, or against you?

What about slow and fast breathing? Is one good, and the other bad? No, *it depends upon the nature of their outcomes.*
DON’T make this mistake.
Don’t confuse mechanics with chemistry.

Most breathing practitioners are unfamiliar with internal respiration, its biochemistry, and its relationship with breathing mechanics. Consequently, often than they make false assumptions and offer misguided interpretations about breathing mechanics and their effects on respiratory physiology.

Example 1: “Fast breathing” and “shallow breathing” have been stigmatized as “faulty” breathing, whereas “slow breathing” and “deep breathing” have been culturally identified with oxygen and health. Neither breathing rate nor breathing depth should be taken as signs of good or bad PaCO₂ regulation. A client may be hypocapnic during slow and deep breathing, while normal (eucapnic) during fast and shallow breathing.

Example 2: Hypocapnia is attributed to mouth breathing by many practitioners. Breathing is regulated by brainstem chemo-regulatory reflexes, not by the orifice through which the air is moving.

Fast breathing and mouth breathing are correlated with overbreathing (hypocapnia), yes, but the explanation for both examples is behavioral, not physical, e.g., “worry” or anxiety about getting enough oxygen motivates all three behaviors: mouth breathing, fast breathing, and overbreathing.
SLOW overBREATHING
Six breaths per minute, serious hypocapnia (25 mmHg)
VERY SLOW BREATHING, poor respiration
3.6 breaths per minute, moderate hypocapnia (32 mmHg)

FAST BREATHING, good respiration
24 breaths per minute (40 mmHg)
VERY FAST BREATHING

Good respiration (38 - 42 mmHg)

Copyrighted by Peter M. Litchfield, Ph.D. & Sandra Reamer, MS, MFA, CBBBA, CBBP, CST, CSOM
DYSPONESIS: While demonstrating her relaxation protocol the subject engages in slow rhythmic breathing (6 bpm). She moves into hypocapnia, contracts the frontalis muscle (EMG) with each breath, and reports a headache underway.
BEHAVIORAL PHYSIOLOGY
A Different Model:

Think of ANATOMY as HARDWARE.

Think of PHYSIOLOGY as an OPERATING SYSTEM.

Think of EXPERIENCE as SOFTWARE PROGRAMMING.

When breathing is understood in purely physical terms its like trying to explain what a computer is doing without any reference to its operating system and software.

The miracle of physiology is that its self-programmable and that it can even repair the hardware that sets its programmable limits.
BREATHING PSYCHOPHYSIOLOGY

What should you know about breathing habits and physiology? How do they affect health, performance, and consciousness?

- Understanding breathing as behavior enhances understanding of its physiology.
- Physiology learns habits. Physiology is smart. It’s programable.
- Habits are motivated and are regulated by their outcomes.
- Breathing regulates acid-base balance, from moment to moment.
- Breathing habits can have profound and immediate effects on body chemistry.
- These effects can be profoundly positive or debilitatingly negative.
- We identify breathing habits based on the principles of behavior analysis.
- We learn/teach new habits based on the principles of behavior modification.
WHAT ARE HABITS?

Habits are learned *configurations of physiology* that are saved and utilized at specific times and places based on specific learning histories.

Habits form based on attention, perception, memory, motivation, and outcome feedback (reinforcement, punishment).

Each habit provides a different physiological configuration, one that relevantly and specifically addresses possible outcomes.

Habits are solutions.
BREATHING HABITS

Some Habit Basics

Breathing is behavior.
We all learn breathing habits, and usually do so unconsciously.
These habits can have profound effects on health and performance.

All habits are solutions.
All habits are physiological.
All habits are regulated by triggers.
All habits are motivated.
All habits have outcomes that sustain them.
All habits have a history.

Breathing reflexes can also be conditioned, a la Pavlov.
e.g., gasping is a reflex, but it can also be triggered by social stimuli.
PHYSIOLOGY IS BEHAVIOR.

Behavior is physiology in action,
e.g., gasping, insulin production, heart beat
It is programmable.
BREATHING is behavior.

Learned breathing behavior can be for good or for bad, or both.
Breathing is BEHAVIORAL.
Breathing and respiration are not the same.

Breathing is mechanical, otherwise known as external respiration, when it behaves in the service of respiratory requirements. It is about moving air in and out of the lungs.

Breathing however, serves multiple objectives, such as moving air to create speech. Breathing behaviors that serve these other objectives should operate in concert with its primary objective, respiration.

Breathing is behavior and is subject to the same principles of learning as any other behavior, including the role of motivation, reinforcement, emotion, attention, perception, memory.
PHYSIOLOGY PROGRAMS ITSELF based on experience.

It learns.
It self-configures.
It’s smart.

Physiology is a learning system perpetually in motion.
Learning history helps explain dysfunctional physiology.

Physiology is behavioral.

As Fritjof Capra so elegantly said in his book *The Web of Life* (1996),
“...the organizing activity of living systems, at all levels of life, is mental activity”
PHYSIOLOGY LEARNS HABITS.

It self-regulates based on information, built-in AND acquired.

Physiology learns habits based on the meaning of the outcomes of its own actions, e.g., reinforcements (instrumental conditioning).

EXAMPLE:
Aborting the exhale terminates fear. [Fear] is its motivation and [fear reduction] is its reinforcement.
HOW ARE HABITS ACQUIRED?

Habits necessarily provide solutions.

Sources of motivation and reinforcements set the stage for learning habits, e.g., anxiety reduction, pain management, need for control.

**Organic conditions often set the stage for learning habits,**
e.g. pregnancy, where women learn to “do” the breathing at the expense of deregulating reflex control.

Habits can very quickly and easily be learned.

**CASE:** A phobia embedded in breathing, as a result of exiting general anesthesia, set the stage for avoidance learning (taking charge of the breathing).
HOW ARE HABITS REGULATED?

Specific triggers, i.e., *stimulus control*.

Stimulus control dictates when, where, and how habits are engaged.

Learning history dictates these triggers, e.g., circumstances, people, kinesthetic cues, emotions thoughts, feelings, places, physical activities, and so on.

Learning, modifying, and unlearning habits (behaviors) necessarily address stimulus control.

**CASES:**
Soccer (football) athlete **under**breathed (aborted exhale) upon initiating exercise. Gymnast athlete **over**breathed (took control) upon initiating rigorous exercise.
What are the specific triggers that engage breathing habits?

Examples of include the following:

- Social: specific people, social situations, authority figures, intimacy
- Environment: physical locations, times of day, environment changes
- Travel: meeting new people, airplanes, elevators, unfamiliarity
- Tasks: public speaking, test taking, driving, playing an instrument
- Emotions: stress, fear, anger, frustration, anxiety, depression, worry
- BEHAVIORS (experience of): initiating a sport, going to sleep, changing posture
- Symptoms: fatigue, headache, pain, breathlessness, asthma, arrhythmias
- Cognition: expectations, specific thoughts, memories, intentions, beliefs
- Physical changes: exercise, breathing sensations, hunger
- Physical challenges: allergy, medical condition, effects of drugs
- Self: responsibility, self-esteem, self confidence, vulnerability
- Metaphors, e.g., struggle with asthma = struggle with spouse
Align mechanics with chemistry.

Allow the breathing. Let go.
Don’t DO the breathing. Don’t take over.
BE the breathing.

Identify breathing habits and their behavioral components.
Identify the symptoms and deficits directly associated with the habits.
Identify the habit triggers, motivations, payoffs (reinforcements), and histories.
Identify habit interaction with organic conditions and life challenges.
Coach unlearning of dysfunctional habits and replacing them with new ones.

Clients learn about their breathing habits and how they are affected by them.
They learn to establish and allow self-regulatory breathing rather than to implement prescriptive techniques for managing and controlling.
CLIENT-CENTERED SERVICES

Learning, not treatment...
Clients learn, practitioners guide.

What does this mean?

- Practitioners are guides, coaches, consultants who assist in learning.
- Breathing learning services do not involve diagnosis or treatment.
- Clients subscribe to, or register for, learning programs, not therapy sessions.
- Clients and practitioners work together in a partnership.
- Clients do most of the work, and they do it in the field, at home and at work.
- Emphasis is on what clients learn, not what practitioners do.

Behavioral solutions are “client-centered” and learning oriented, rather than “therapist-centered” and treatment oriented.

The connotations of the terminology you use sets the stage for how colleagues and clients think. “Patient education,” for example, is not “medical.” There is no diagnosis and there is no treatment involved.
THE BREATHING INTERVIEW

Collecting data to make a referral
THE SCREENING INTERVIEW
Using Client and Practitioner Reports

There are TWO FORMS to use as a basis for (1) interviewing your client about possible dysfunctional breathing habits and their effects and (2) making a referral to a Breathing Behavior Analyst for a comprehensive breathing behavior analysis.

*YOUR BREATHING HABITS is a form to be completed BY YOUR CLIENT before the interview.*
This form sets the stage for your breathing interview and helps you in making a referral decision based on history and current information about breathing-related health and performance issues.

The *REFERRAL REPORT is a form to be completed BY YOU after (or during) the interview.*
The form guides you in making behavioral observations, asking relevant questions, helping your client explore breathing experience, and making physiological measurements.

Download the forms, *Your Breathing Habits* and on *Referral Report* the Better Physiology website: [www.Betterphysiology.com/data-forms/]
CHECKLIST FORM – for clients

Your Breathing Habits – **PART 1**

Part 1 consist of 14 yes-no questions with space for a brief description. They address past and present health and performance issues relevant to the likelihood of having learned dysfunctional breathing habits. See next slide. Here are five questions that need careful consideration for deciding whether or not to make a referral:

- Are there conditions that may have set the stage for learning a dysfunctional habit?
- Are there conditions that suggest a high likelihood of a dysfunctional habit?
- Are there conditions that could be exacerbated by the presence of a habit?
- Are there conditions where a symptom threshold may be lowered by a habit?
- Are there “unexplained symptoms” that be the consequence of a dysfunctional habit?

Ask your client about their answers to these questions and tie them together with what you see in Part 2 of this form.
### PART 1: YOUR BREATHING HABITS

Past and present health and performance issues

<table>
<thead>
<tr>
<th>Is there a breathing issue?</th>
</tr>
</thead>
</table>

Answers to the following questions are important to learning about the possible origins of your breathing habits:

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issues related to breathing?</td>
<td></td>
</tr>
<tr>
<td>Episodes of not being able to get enough air?</td>
<td></td>
</tr>
<tr>
<td>Respiratory disorders?</td>
<td></td>
</tr>
<tr>
<td>Physical injuries: e.g., back, chest, neck?</td>
<td></td>
</tr>
<tr>
<td>Emotional issues: e.g., panic, anxiety, anger?</td>
<td></td>
</tr>
<tr>
<td>Life traumas: e.g., PTSD, emotional abuse, chronic stress?</td>
<td></td>
</tr>
<tr>
<td>Pain issues: past or present, acute or chronic?</td>
<td></td>
</tr>
<tr>
<td>Physical limitations: e.g., fatigue, speech, movement?</td>
<td></td>
</tr>
<tr>
<td>Deficiencies: e.g., electrolytes (kidney problems)?</td>
<td></td>
</tr>
<tr>
<td>Social challenges: e.g., relationships, family?</td>
<td></td>
</tr>
<tr>
<td>Work related challenges: e.g., co-workers, supervisor?</td>
<td></td>
</tr>
<tr>
<td>Learning issues, e.g., attention, memory, focus?</td>
<td></td>
</tr>
<tr>
<td>Performance issues: e.g., speaking, technology, testing</td>
<td></td>
</tr>
<tr>
<td>Current prescriptions?</td>
<td></td>
</tr>
</tbody>
</table>
CHECKLIST FORM – for clients

Possible histories for learning habits?

Identifying the possible origins of breathing habits is an important factor in deciding whether or not there might be a dysfunctional breathing habit and deciding to make a referral for a breathing behavior analysis by a Certified Analyst.

People learn dysfunctional habits based on specific experiences, a single episode often setting the stage. These experiences involve physical, psychological and behavioral challenges, e.g., asthma attacks at night, pain triggered by a thoracic injury, a failed public presentation, a bad swimming pool incident, a sense of failing while taking a test, an emotional trauma incident, a sudden and sharp pain in the jaw, and so on.

Recalling these experiences may remind your client of breathing struggles that emerged either at the time or shortly thereafter where they found themselves “taking control of the breathing” as a solution to their struggle. “Taking-control,” however, often means taking deeper breaths and or breathing more rapidly, i.e., overbreathing (excessive loss of CO$_2$), thus compromising the basic respiratory reflexes resulting in immediate symptoms that motivate continuance of “taking-over breathing” habits.
CHECKLIST FORM – for clients

Unique conditions where habits are likely?

There are physiological and psychological conditions correlated with high a likelihood of breathing habits that compromise respiration. Some of these conditions include:

asthma,
pain,
trauma,
panic,
thoracic injury,
attention deficit,
anger issues, and
phobia.

These conditions in combination with symptoms reported in Part 2 of this Form make for a more likely referral for a complete breathing behavior analysis by a Certified Analyst.
CHECKLIST FORM – for clients

Conditions exacerbated by habits?

Breathing habits don’t just cause symptoms and deficits, they also exacerbate symptoms brought on by other causes. When dysfunctional breathing habits are operating in concert with the presence of these other causes, the observed symptoms may be symptoms caused by habits, symptoms exacerbated by habits, and symptoms unaffected by habits.

Examples of conditions exacerbated by dysfunctional breathing habits include: cognitive disabilities, emotional disorders, psychophysiological compromise (e.g., headache), cardiovascular conditions (e.g., arrhythmias), vascular challenges (e.g., hypertension), gastric disorders (e.g., irritable bowel syndrome, respiratory disease (e.g., asthma), systemic inflammation, sleep disturbances (e.g., apnea), pregnancy (e.g., nausea), neuromuscular compromise (e.g., repetitive strain injury), pain, performance issues (e.g., speech), and unexplained conditions (e.g., fibromyalgia, chronic fatigue).
CHECKLIST FORM – for clients

Symptom thresholds lowered by habits?

Compromised respiration clearly has an impact on the body as a whole. Altered extracellular chemistry (e.g., blood plasma and interstitial fluid) changes the threshold for the appearance of symptoms associated with numerous organic syndromes, e.g., neurological syndromes and chronic pain. Epileptic seizures may appear more likely as a function oxygen and glucose deficits in the brain. Muscle contraction and associated pain may appear more frequently than it might otherwise as a function of pH changes in interstitial fluids.
CHECKLIST FORM – for clients

Unexplained symptoms caused by habits?

Unexplained symptoms are unexplained, their causes an ongoing mystery.

Everyone makes guesses about causes of these symptoms, but rarely address how physiology can reconfigure itself in dysfunctional ways based on specific experience. The role of breathing in triggering “unexplained” symptoms and deficits varies from being the sole cause of these symptoms to exacerbating symptoms brought on by other causes.

We know that dysfunctional breathing habits mediate profound changes in physiology resulting in significant effects, acute and chronic, in health and performance. The role of these habits is rarely identified and understood by clients and their practitioners.

Identifying unexplained symptoms is good evidence, in combination with other factors, for making a referral for a complete breathing behavior analysis by a Certified Analyst.
CHECKLIST FORM – for clients

Your Breathing Habits – Part 2

Part 2 consists of a listing of 14 key-symptoms where clients can answer Yes or NO, and then if YES, (1) click on a number ranging from 1 to 7 as to the frequency of the symptom (from rare to every day), (2) enter the “situations” (by number, 1-15) in which these symptoms appear from a listing of 15 different options at the bottom of the form, and (3) enter a comment following each symptom if so desired. See next slide.

Part 2 is the most important part of the form. This is where you are most likely to see evidence of a dysfunctional habit. If your client does NOT enter the situations, ask your client about the situations and enter in the answers yourself if possible.

Please note that if your client does not enter information, this does not mean that there is not a problem. Clients may be shy about sharing this kind of information, they may be out of touch with their symptoms (habituated to them), or they may be experiencing chronic hypocapnia that is some way serving them. Look at their physiology.
CHECKLIST FORM – for clients

Part 2 - Situations

Habits are learned because they provide solutions. All habits have triggers, that is habits are solutions to specific challenges occurring at specific times and in specific places. And, they all have specific histories.

Part 1 of this forms focuses on the possible history of habits and the solutions they may provide, while Part 2 of this form focuses on possible breathing habit triggers.

A client may show good PCO$_2$ concentrations while seated in front of you, but this **DOES NOT** mean that your client is absent dysfunctional breathing habit(s). It may simply be that the habit trigger(s) are not present.

Part 2 of this form may provide you with invaluable information regarding the presence of a habit, its effects, and is triggers. See next slide.
## PART 2: YOUR BREATHING HABITS
Symptoms and deficits, their frequencies, and their triggering factors

<table>
<thead>
<tr>
<th>Do you experience the following? If so, how often?</th>
<th>N</th>
<th>Y</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Situations</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest tightness, pressure, or pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intentional breathing, purposeful regulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness, light-headedness, fainting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortness of breath, difficulty breathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tingling or numbness, e.g., fingers, lips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unable to breathe deeply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not exhaling completely, aborting the exhale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep breathing, like during talking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest breathing, effortful breathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breath holding, irregular breathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid breathing, panicky breathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worried about my breathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouth breathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can’t seem to get enough oxygen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*SITUATIONS: circumstances under which you experience the above symptoms*

- (01) working (employment)
- (02) resting (between tasks)
- (03) performing (e.g., test taking)
- (04) feeling anxious or worried
- (05) feeling tired or stressed
- (06) interacting in groups
- (07) traveling, unfamiliar places
- (08) socializing, meeting people
- (09) feeling angry or upset
- (10) intimacy, expressing feelings
- (11) physical discomfort, pain
- (12) going to sleep, while asleep
- (13) learning new tasks, new info
- (14) feeling unsure of self
- (15) allergens, weather, foods
CHECKLIST FORM – for clients

Symptom: Chest tightness, pressure, or pain

The presence of this symptom may indicate that under specific circumstances (situations)
(1) the client takes over the breathing, unconsciously or intentionally;
(2) breathing has become a struggle, perceived or otherwise;
(3) the client experiences fear or anxiety about not getting enough air (phobia);
(4) the client believes (anticipates) that more air will be necessary for getting enough oxygen,
(5) airway resistance has increased (as a function of hypocapnia, i.e., overbreathing); and/or
(6) upper body accessory breathing muscles may be triggered (e.g., posterior trapezius),
   contributing to the considerations described above (e.g., sense of struggle).

When clients “take-over” the breathing, it may lead to a decoupling of the reflex mechanisms
that normally govern breathing in the service of respiration, and hence hypocapnia.
CHECKLIST FORM – for clients

Symptom: Intentional breathing, purposeful regulation

Many of your clients, including their practitioners, have learned breathing self-interventions for myriad reasons, e.g., relaxation, stress management, yoga, and meditation based on books, courses, wellness sessions, fitness training, and personal experience. Unfortunately, this can more often than one might expect lead to learning dysfunctional breathing habits.

If your client indicates that they do this frequently, ask them what they do and why, when, and where they do so. You may wish to ask them to demonstrate the “technique” and observe the respiratory outcome, i.e. change in PCO₂. Note that from a respiratory perspective, lower breathing rate is NOT a positive indication unless it is accompanied by a rise in PCO₂. In fact, it is not uncommon to see a drop in PCO₂ as a result of slower breathing.
Symptom: Dizziness, light-headedness, fainting

Brain fog, dizziness, lightheadedness, and attention deficit are very frequent consequences of hypocapnia, even at only very minimal changes in PCO₂ (32 - 34 mmHg). Fainting is the consequence of severe hypocapnia (20 mmHg PCO₂, or lower). There are occasionally clients, however, who do not report these kinds of symptoms while hypocapnic.

Hypocapnia triggers cerebral vasoconstriction and compromised delivery of oxygen by hemoglobin (Bohr Effect) and hence both cerebral hypoxia and hypoglycemia.

These physiological changes may trigger emotions, memories, thoughts, and disorientation which alarm clients where they feel like they are “losing control.” Unfortunately, these outcomes are typically misinterpreted and attributed to unrelated causes. “Treatment” of symptoms typically becomes the solution rather than unlearning the physiological habits that may be mediating the symptoms.

When these symptoms appear only in specific social situations, for example, it is very likely that there is an overbreathing habit present.
CHECKLIST FORM – for clients

Symptom: Shortness of breath, difficulty breathing

When people feel short of breath, they may obviously (1) become fearful, (2) become air hungry, (3) worry about getting enough air, (4) think about a possible explanation, and (5) intentionally manipulate the breathing as a way of resolving the perceived deficit.

This is a common outcome for people moving into hypocapnia. Both the logical and the emotional solutions are to reach for more air which addresses beliefs about their breathing, provides a sense of control, and offers the prospect of reducing fear and anxiety. Unfortunately, this kind of behavior (habit) only exacerbates the problem and perpetuates vicious circle behavior where the solution becomes the problem.

These kinds of experience can rapidly develop into a sense of panic and wild thinking about what to do next, sometimes leading to calling 911 (ambulance) for assistance.

When this symptom is clearly a situationally driven symptom, you can be reasonably sure that there is a dysfunctional habit operating.
CHECKLIST FORM – for clients

Symptom: Tingling or numbness in extremities

When neurological issues are ruled out, when tingling and numbness are triggered by situational variables, and when these symptoms are associated with other symptoms such as dizziness and shortness of breath in the same kinds of situations, they are very likely to be the consequence of dysfunctional breathing habits that compromise respiration, i.e., hypocapnia. These symptoms can appear in the fingers, feet, and lips.

Hypocapnia triggers peripheral vasoconstriction (and other smooth muscle function such as bronchial muscles), hence reducing peripheral temperature (cold hands) and triggering changes in blood pressure.

These kinds of symptoms often show up even with small changes in PCO₂, although some people don’t report these symptoms even at low levels of PCO₂. They may not notice these symptoms, given the severity of other symptoms and/or how they have learned to respond to these other symptoms, e.g., panic.
CHECKLIST FORM – for clients

Symptom: Unable to breathe deeply
Symptom: Not exhaling completely, aborting the exhale

When people “take charge” of their breathing and fail to “allow” the breath, it is often because they are fearful about getting enough air. Taking a breath early before the end of the exhale (aborting the exhale) may reduce this fear and lend a sense of control to the breather. This breathing behavior is then perpetuated as part of a vicious circle where the person then struggles with what seems to be an oxygen issue.

A sense of being unable to breathe deeply is often a result of this vicious circle breathing behavior, wherein partial exhalations actually do limit the size of subsequent breaths, thus contributing further to feelings of air hunger and to experiential verification of their ”not getting enough air” interpretations.
CHECKLIST FORM – for clients

**Symptom: Deep breathing, like during talking**

While observing your client, you may notice that (s)he takes deep breaths or sighs frequently. There is a correlation between these behaviors and hypocapnia. You may make note of this breathing behavior on the Referral Form.

Your client may be very aware of this behavior in a way that translates into their feeling and believing that they are not getting enough air while talking or eating. This becomes a source of motivation for perpetuating a controlled-breathing habit during these times, resulting in hypocapnia. The physiological changes and symptoms associated with hypocapnia may then verify beliefs about breathing and interpretations of symptoms.

People may find themselves, for example, unable to track a conversation as a consequence of reduced blood flow to the brain. The pattern may then perpetuate itself leading to a downward spiral emotionally and cognitively during a conversation, where a person becomes trapped in hypocapnia and thus a victim of their own breathing behavior.
CHECKLIST FORM – for clients

Symptom: Chest breathing, effortful breathing

Using breathing accessory muscles (e.g., upper body muscles) is important to healthy breathing in many situations, e.g., during singing, but it should nevertheless be subordinate to diaphragmatic breathing which is directly regulated by chemo-regulatory reflex mechanisms. When accessory muscle breathing is not subordinated, decoupling of breathing mechanics and respiratory chemistry may be the consequence.

When diaphragmatic is subordinated to accessory muscle breathing, e.g., chest breathing, and when chest breathing is mistakenly interpreted as being the source of a greater volume of air, breathing may be perceived as a struggle. This struggle often serves as a metaphor for “not getting enough air,” resulting in an immediate sense of air hunger. The consequence may be vicious circle defensive breathing, not to mention other behaviors, where “controlling the breath” reduces anxiety and provides a sense of control but traps people in hypocapnia.
CHECKLIST FORM – for clients

Symptom: Breathholding

We all hold our breath on occasion. This is a learned behavior. Think back on when you have done this yourself. Usually, it’s during a challenge of some kind, e.g., lifting a heavy weight or speaking with an authority figure. In most cases it boils a sense control that it provides many of us. In the name of “feeling in control” we momentarily decouple breathing mechanics and chemistry. Unfortunately, however, for many people it’s serves as a trigger for continued unconscious self-intervention that compromises respiration.

Mistakenly, most clients and practitioners both believe that breathholding compromises respiration by restricting oxygen intake. Hence, many of us who notice breathholding may try to compensate by breathing more deeply and/or faster. This is likely to result in compromised respiration, i.e., hypocapnia, and perhaps trigger a self-perpetuating dysfunctional breathing habit.

If your client reports a lot of breathholding, along with observing it yourself, this is a significant sign of a possible dysfunctional breathing habit, i.e., one that compromises respiration (hypocapnia).
Symptom: Rapid breathing, panicky breathing

Fast breathing IS CORRELATED with overbreathing (hypocapnia). People who worry about getting enough air are more likely to both breathe more rapidly and overbreathe. Hence, when dizziness and fast breathing are linked, for example, this is a significant indication regarding the likelihood of a dysfunctional habit. And, when breathing is panicky, i.e., surrounded by emotion and hyperarousal, the likelihood is indeed high. There are, however, common misconceptions about breathing rate and what it means.

1. Fast resting breathing rate means overbreathing (hyperventilation, hypocapnia). This is simply NOT true. 101 “blood gases” instructional guides written for nurses and physicians point out how this is a common error made by novices observing breathing in their patients. See next slide as an example of fast breathing with normal CO₂ levels.

2. Slow resting breathing rate means relaxation and eucapnia (normal). This is simply NOT true. Many clients overbreathe at six breaths per minute or less. See two slides ahead where a client is breathing at six bpm with PCO₂ levels of 25 mmHg.

3. There is an ideal breathing rate (at rest). From a respiratory perspective, this is NOT true.
VERY FAST BREATHING

27 br/min, good respiration, PCO₂ = 38 - 42 mmHg
VERY SLOW BREATHING
Six br/min, serious hypocapnia, PCO₂ = 25 mmHg
CHECKLIST FORM – for clients

Symptom: Worried about my breathing

Many otherwise healthy people worry about their breathing, in most cases because (1) they have misguided beliefs about breathing physiology and (2) they misinterpret symptoms associated with their breathing.

Ask you client about their beliefs about breathing and how they interpret the symptoms they are reporting on this form. Misguided beliefs, thoughts, and opinions may have set the stage for learning a dysfunctional habit and then for its perpetuation. In addition to this, the beliefs themselves may serve as a trigger for these habits. Interpretations of symptoms may then guide your client into intentional manipulation of breathing in the name of ensuring what they believe to be helpful breathing.

“Worrying about breathing” is often a powerful indicator, in combination with other factors, of a high likelihood of a dysfunctional breathing habit.
Symptom: Mouth breathing

The importance of nasal breathing is well known. The negative impact of mouth breathing is becoming more and more documented.

Mouth breathing IS CORRELATED with fast breathing and overbreathing (hypocapnia). People who worry about their breathing are more likely to breathe in all three ways as a function of fear about getting enough oxygen.

Correlation is often mistakenly taken as evidence for cause and effect. Many uninformed practitioners believe that mouth breathing causes hypocapnia. Mouth breathing DOES NOT CAUSE overbreathing and its associated hypocapnia. If brainstem respiratory mechanisms are “allowed” to operate, they will regulate breathing based on pH, PCO₂, and PO₂; mouth or nose, it makes no difference.

Teaching clients nasal breathing, however, may in some cases help clients overcome a dysfunctional habit where fear about getting enough oxygen may be incidentally addressed, i.e., extinguished (unlearned). These outcomes may then be mistakenly attributed to nasal breathing, i.e., anatomy, rather than to behavior, i.e., the unlearning of fear.
CHECKLIST FORM – for clients

Symptom: Can’t seem to get enough oxygen

“Can’t seem to get enough oxygen” translates into misguided beliefs, habit motivation (air hunger, fear, need to control), unconscious reaching for air, intentional manipulations in name of getting more oxygen, and self-fulfilling prophecy thinking. This kind of self-talk can trigger and sustain dysfunctional breathing habits, unless otherwise addressed, for extended and indeterminate lengths of time.

Exploring this self-observation with your client is often a very productive conversation, leading to significant insights by both you and your client. This self-report, together with other indications, provides a very significant basis for recommending a breathing behavior analysis by a Certified Analyst.
REFERRAL REPORT – for Practitioners

Behavioral Observations – PART 1

Part 1 consists of actual observations you make while interviewing your client about what you see on the Checklist Form completed by your clients. It is divided into five sections:

- Dysfunctional breathing behaviors,
- Triggers of dysfunctional breathing habits,
- Fear and anxiety associated with breathing,
- Thoughts and beliefs associated with breathing, and
- Breathing challenges used and outcomes.

Connect your CapnoTrainer at the start of the Breathing Interview session. Turn on Data Record by clicking on the red dot icon.

Check the appropriate boxes based on your observations and enter in short note if desired regarding each observation.
Dysfunctional Behaviors

Some these behaviors can be seen simply through careful observation, while others can be seen by monitoring the live data presented in the software displays of your CapnoTrainer.

Aborted exhales, avoidance of transition times between exhale and inhale, breathholding, effortful breathing, forced exhalation, breathing rate, and gasping can be seen the airflow depicted in the capnogram. Overbreathing and underbreathing can be observed in the position of the End-tidal CO2 point on the graph, under 35 mmHg or over 45 mmHg.

Chest breathing, doing the breathing, dysponesis, intentional manipulation, reverse breathing, and taking deep breaths can be observed directly and/or with the CapnoPlus (EMG and respiratory strain gage).
Looking at the Capnogram for Breathing Behaviors (See next slides.)

**Aborted Exhale:** You can identify an aborted exhale in two ways: (1) the alveolar plateau disappears and all you see is a sharp point, and (2) a sudden drop in PCO$_2$ with immediate recovery in the next breath. If a client is actually hypocapnic it will take many breaths and at least a minute to return to normal.

**Avoidance of transition time:** Notice that there is no space (time) between the end of the exhale and the start of the inhale.

**Breathholding:** Notice a relatively longer space (time) between the inhale and exhale.

**Forced exhalation:** Notice the vertical lengthening, a “pushing” of the alveolar plateau. Pushing the exhale is a way of getting to the inhale sooner.

**Gasping:** Notice the sharp up & down spikes on the inhalation.

**Breathing Rate:** Notice the density of the waveforms. Take note of the history graph.

**Effortful breathing:** Notice radical changes in breathing rate, many aborted breaths, ongoing gasping, breathholding associated with gasping, and pushed exhalations.
MECHANICS: effort & control

Aborted breaths, breathholding, gasping, and forced exhales can be seen in the data record.

↑ breath holding
↑ aborted breath
↓ forced exhale
↓ gasping
AIR FLOW: GASPING
AIR FLOW: SPASM
Assisting the inhale, taking deep breaths: Clients will often assist the inhale when talking, for example, by taking deep breaths leading them into hypocapnia.

Chest breathing: Notice that many clients automatically breath in their chest when intentionally taking a breath or when they become uncomfortable (anticipating pain). This kind of “taking over” often speaks to the decoupling of mechanics with chemistry.

“Doing” breathing: A chief factor in hypocapnia is “doing” rather than “allowing” the breathing, that is, allowing respiratory reflexes to operate through breathing mechanics. Focusing clients on “allowing” is critical to overcoming a dysfunctional habit.

Dysponesis: Breathing in the chest often triggers learned muscle contractions in other parts of the body, e.g., masseter muscles. Observe your client’s posture as they breathe, including activities such as jaw clenching.

Intentional manipulations: Clients will often, right in front of you, attempt to adjust their breathing. Ask them about it. How does it serve them? You may unlock a Pandora’s box filled with thoughts and feelings about breathing and its effects.
Mouth breathing: This an obvious behavior to observe. Interview them about why they avoid the mouth. Do they ever close their mouths while breathing in front of you? If so, find out more about it. This conversation will very often lead you into other personal worries about breathing and misguided beliefs and interpretations, important considerations in deciding whether or not to make a referral.

Reverse breathing: When people contract their abdominal muscles while contracting the diaphragm they are “reverse” breathing.” That is, contraction of the abdominals blocks the diaphragm from creating space for the downward movement of the lungs, thus radically compromising the movement of air and the efficiency of breathing mechanics.

Effortful breathing: It is easy to learn to see people struggling with their breathing; taking deep breaths, sighing, operating unnecessary accessory breathing muscles, and seemingly distracted by their own breathing. Talk to them. Ask them about the struggle. What does it mean to them?
Triggers of Dysfunctional Breathing DURING the Interview

The Checklist form completed by your client will provide a great deal of information regarding possible habit triggers as described on earlier slides. In this case you are looking for dysfunctional breathing brought on by conversation, tasks, posture, thoughts, and emotions during the interview itself.

Continuous monitoring of PCO₂ permits you to see changes in respiratory chemistry which you can discuss with your client as these changes occur. When you see that PCO₂ has moved into hypocapnia, point out the change to your client and ask them what they think and feel. It may be, for example, that your client has suddenly become anxious and dizzy. And, if so, you’ve seen for yourself that a dysfunctional habit has been triggered by anxiety. A referral to a Certified Analyst for a comprehensive breathing behavior analysis in this case would make good sense.
Fear or Anxiety associated with Breathing

First, one of the chief motivations for learning dysfunctional breathing habits is fear and anxiety. People very quickly learn breathing habits to reduce and manage fear.

Second, breathing as an experience in and of itself, can become a trigger emotions, thoughts, and actions (other behaviors), e.g., the experience of [fast breathing] triggers fear or intentionally “taking” larger slower breaths.

The listing below includes breathing behaviors that when experienced by a client may trigger learned fear or anxiety, including phobic responses, as a result of specific previous experiences, e.g., a breathing struggle while exiting a general anesthesia.
Thoughts and Beliefs associated with Breathing

Hypocapnic symptoms can trigger learned cognitions, including beliefs, thoughts, and memories, e.g., dizziness trigger a thought of “losing control.” Breathing itself “as an experience,” e.g., fast breathing, may trigger beliefs, thoughts, and memories. These triggered cognitions may support and perpetuate dysfunctional breathing habits.

The listing below are examples. Many clients believe that they “need to do the breathing” because it won’t happen on its own. Hence, they take it over and get into trouble. Hypocapnic symptoms may be mistakenly attributed as evidence for the presence of unrelated physical and/or psychological issues.

Thoughts and beliefs may play key roles in establishing dysfunctional habits, motivating them, triggering them, and perpetuating them.
During your Breathing Interview, you may decide to ask your client to imagine or to remember a challenging situation, based on the specific information reported on the Client form and the conversational content of the interview.

Record any changes in breathing, especially in levels PCO$_2$, and write down the changes you observed on the line provided. Take a baseline measurement for one minute, introduce the imaginary challenge or memory for two minutes, and then for another two minutes look to see if there is recovery. The absence of recovery is a clear indication of the presence of a dysfunctional breathing habit.

Whether or not you decide to do this, is based on the what you learn about your client during the interview and on your level experience in conducting Breathing Interviews.

If you client becomes uncomfortable, recommend focusing on “allowing the breath” rather than trying to manipulate the breath. Recommend gentle breathing, small and slow breaths, and thinking about a positive experience. Take note of changes in PCO$_2$. 
REFERRAL FORM – for Practitioners

Capnography - Part 2
EMG (muscles) - Part 3: *Disregard unless you own a CapnoPlus.*

Connect your CapnoTrainer at the start of your session. Explain to your client that we all learn breathing habits and that sometimes they are dysfunctional, resulting in symptoms and deficits of all kinds. Explain that the CapnoTrainer is designed for exploration of breathing behaviors, not for diagnosis of any kind of disorder. Emphasize that it is a joint client-practitioner interview session for learning about possible troublesome breathing habits.

Part 2 and 3 of the form provide you with a way of tracking changes in physiology throughout your Breathing Interview session, including initial readings, changes that take place across the session, and the final interview exit readings.

Live and recorded physiology in combination with the Client Checklist and conversational content will provide you with valuable information for making an informed referral, or not. Sometimes you may find very little on the Client Checklist but see all kinds of dysfunctionality during live recording. And, remember that although your client may report all kinds of symptoms and breathing issues on the Client Checklist and during your interview, PCO$_2$ during the interview may be mostly normal as triggers for the habit(s) may not be present.
**CAPNOGRAPHY (PetCO2):** Was overbreathing (below 35 mmHg) present at the start of the session? □ Yes □ No

What were the initial baseline PetCO2 values (first two minutes)?

What symptoms/deficits were reported, if any?

If so, did recovery take place on its own within a few minutes? □ Yes □ No Why?

If not, when did PetCO2 levels return to normal, and why?

Did you assist in this process? □ Yes □ No How did you assist?

Was your client trapped in overbreathing? □ Yes □ No

What was your client’s explanation for the associated symptoms?

How did the symptoms/deficits change as breathing changed?

Dysfunctional breathing habits will often appear right at the start of a screening session in clients where “being tested” may be a trigger, although often not. As your client feels more comfortable, the habit may disengage.

If you client is overbreathing at the start of the session, indicate YES in the box provided. If so, write down the average level during the first two minutes. Look at the Client Checklist, and if you see symptoms indicated, ask your client if they are feeling any of these symptoms. If so, write down which ones in the blank provided (see above). Indicate YES or NO whether PCO2 returned to within the normal range (above 35 mmHg), without your assistance and your client’s explanation as to why. If you assisted somehow, indicate what you did in the blank provided. Ask you client what changed for them, e.g., symptoms, emotions, thoughts, and what they believe breathing had to do with these changes.
REFERRAL FORM – for Practitioners

EMG: Was your client “chest breathing” at the start of the session? □ Yes □ No  Do you suspect dysponesis? □ Yes □ No
If so, what breathing accessory muscles were being used? ____________________________
What EMG placement did you make and what were the readings? ____________________________
Did you ask your client to breathe with the diaphragm? If so, could (s)he do so? □ Yes □ No □ N/A
If so, which did they prefer □ chest □ diaphragm? What was the preference based on? ____________________________

What muscles unrelated to breathing were triggered by breathing (e.g., jaw)?
What EMG placement did you make and what were the readings? ____________________________
How was dysponesis affected when (and if) your client shifted into the diaphragm? ____________________________
Did posture influence breathing? □ Yes □ No  If so, how? ____________________________
How did emotions and thoughts shift muscle utilization? ____________________________
What correlation did you observe among EMG, PetCO₂, and breathing rate? ____________________________

If you have a CapnoPlus, you may observe and record EMG activity (electromyography) by making appropriate placements, e.g., on the frontalis muscle, for exploring muscle posturing in different muscle groups as a function of breathing.

Dysponesis is important to explore, that is, breathing may trigger contraction in muscles not used for respiration, e.g., masseter muscles in the jaw. Learned contraction of the masseters as a function of chest breathing may contribute to TMD and associated problems (e.g., pain).
EFFICACY

- Have changes in respiratory chemistry been clearly demonstrated to regulate the appearance and disappearance of physical and mental symptoms and deficits? **YES.** (Answers are in basic pulmonary and acid-base physiology textbooks, e.g., Levitsky, 2007.)

- Are the behavioral techniques utilized for assessing behavior, extinguishing behaviors, and learning new behaviors supported by the research literature? **YES.** (Answers are in behavioral psychology textbooks, e.g., Miltenberger, 2008.)

- Are these behavioral techniques successful when applied to breathing behavior? **YES.** (See special edition issue edition of *Behavior Therapy*, Ley, 2001).

- Does restoring good respiration in clients with compromised respiration ameliorate specific symptoms and deficits? **IT DEPENDS.** It depends on if and how compromised respiration may be playing a role in a specific client’s presenting complaints.