Breathing Pattern Dysfunction and Pelvic Pain
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Learning Objectives

- Recognize and assess breathing pattern disorders (BPD) such as hyperventilation.
- Describe the potential body-wide influence of respiratory alkalosis.
- Understand the connections between BPD and pelvic (and other) pain.
- Evaluate various rehabilitation options in breathing pattern disorders.

Definition of Hyperventilation

Overbreathing is the state of breathing faster and/or deeper than necessary, therefore reducing the carbon dioxide (CO2) concentration of the blood to below normal.

When Does Hyperventilation Occur?

Hyperventilation (HVS) occurs when minute ventilation exceeds metabolic demands, resulting in symptom-producing, hemodynamic and chemical changes.


Definitions

- **Hypocapnia**: Deficiency of CO₂ in the blood, resulting from HVS, leading to respiratory alkalosis
- **Hypoxia**: Reduction of oxygen (O₂) supply to tissue, below physiological levels, despite adequate perfusion of the tissue by blood. (cf. Anoxia)

HVS Effects on pH & CO₂

HVS, the extreme of breathing pattern disorders (BPD), produces far-ranging physiological effects via its alteration of pH and depletion of CO₂, resulting in respiratory alkalosis, acute or chronic.


Buffering by Bicarbonate
- In response to alkalosis (loss of CO2 through overbreathing), the kidneys excrete bicarbonate to restore pH.
- This loss of “buffering” influences makes the body more vulnerable to any increase in acidity (e.g., as occurs in anaerobic energy production in deconditioned individuals).
- At that time, the symptoms associated with alkalosis will appear—fatigue, brain fog, increased pain sensitivity, anxiety, and more.


Respiratory Alkalosis & the Bohr Effect
- Respiratory alkalosis results when CO2 exhalation exceeds the rate of accumulation and pH rises (normal ± 7.4).
- Alkalosis induces vascular constriction, decreased blood flow, and inhibition of O2 transfer from haemoglobin to tissue cells (Bohr effect).

- Incompletely oxidised metabolic products (e.g., lactic and pyruvic acid) accumulate, due to activation of anaerobic energy pathways, particularly in deconditioned individuals.


Progressive Adaptive Changes
Progression from acute to chronic pain and dysfunction appears to involve both physiologically and psychologically unsustainable adaptive demands, variably dependent on the individual’s inherited and acquired characteristics, interacting with the type, intensity, and duration of the stressors involved.

Pain and Other Symptoms Resulting from BPD (Particularly in Deconditioned Individuals)

“Muscular aching at low levels of effort; restlessness and heightened sympathetic activity; increased neuronal sensitivity as well as constriction of smooth-muscle tubes (e.g., vascular, respiratory and gastrointestinal) can accompany the basic symptom of inability to make and sustain normal levels of effort.”


Determinants contributing to IDPs: Chronic pain, complex multifactorial diseases, complex traits, fibromyalgia syndrome (FMS)

Note: Pain threshold and emotional status are both affected by BPD

Nitric Oxide & Pain

Nitric oxide (NO) is produced in the nasal cavities and or the paranasal sinuses and is stimulated by nasal inhalation and by humming.

Decreased NO production induces microcirculation changes leading to exercise intolerance.

Passive and active exercise both increase shear stress to the endothelium, causing release of NO. Exercise and nasal breathing diminish symptoms of chronic pain and fatigue, in as yet unknown ways.

Hypermobility, Back Pain, FMS & Respiration

Hypermobility has been shown to be a major risk factor in the evolution of back pain.

BPDS and anxiety states are much more common in hypermobile individuals, often associated with chronic pain syndromes.

A subgroup of patients with FMS are hypermobile.

... Habit, Conditioning?

Lum discussed the reasons for people hyperventilating: “Neurological considerations leave little doubt that habitually unstable breathing is the prime cause of symptoms.”
Van den Bergh et al suggested that HVS may be a learned or conditioned behaviour.
Who is affected? Patients in whom there is no obvious organic cause?
- Patients with the most common physical symptoms (e.g., abdominal pain, chest pain, headache, back pain) are responsible for half of primary care visits. Only 10%–15% are caused by organic illness.

BPD can result in complex symptoms ranging from cardiovascular to digestive and emotional, to musculoskeletal fatigue, and to brain fog, as well as disturbed levels of systemic calcium and other nutrients.

Immediate Presenting Symptoms of Respiratory Alkalosis
Most commonly, the history is of sudden onset of atypical chest pain (relieved by exercise, unrelieved by nitroglycerin [C3H5(N03)3]), dyspnoea, and neurologic symptoms (e.g., dizziness, weakness, paresthesias, near syncope), often following a stressful event.

Why Are Females Most Affected?
Respiratory alkalosis affects:
- Females more than males, in a ratio ranging from 2:1 to 7:1 (peak ages 15–55) (peak ages 15–55)
- Almost all pregnant women, as acidosis increases
- Many healthy women, via progesterone, during the post-luteal phase of the menstrual cycle
- Approximately 10% of adult non-asthmatics
Phasic menstrual cycle changes observed in resting minute ventilation and arterial PCO(2) may be due, at least in part, to the stimulatory effects of progesterone.


Relationship of arterial PCO(2) with plasma progesterone concentration: CO2 levels drop as progesterone levels rise

Overbreathing & PMS

- PMS symptoms may be caused directly by HVS.
- "It has been known for more than 100 years that women hyperventilate during the second half of the menstrual cycle. Symptoms of chronic HVS are remarkably similar to the symptoms observed in some women with PMS...where the sensitivity of the respiratory centre to CO2 is increased more than normal by progesterone, resulting in pronounced hyperventilation."
- PMS symptoms include cyclical discomfort and pain from tender, swollen breasts, painful cramps, headache, and stiff neck.

PMS symptoms may be caused directly by HVS.

Pain Threshold & the Menstrual Cycle

- Research shows that as progesterone levels rise during the luteal phase of the cycle, the breathing rate accelerates—and the pain threshold drops.
- The suggestions is that respiratory changes are at least partially influential in increased pain perception.
FMS, the Menstrual Cycle, & Breathing Patterns

- In a recent study, several participants “changed” FMS diagnosis during the course of a menstrual cycle, fulfilling the diagnostic criteria during the menstrual or luteal phase, but never during the follicular phase. Dunnett A, et al. The diagnosis of fibromyalgia in women may be influenced by menstrual cycle phase. Journal of Bodywork and Movement Therapies. 2007;11:99-105.
- Clinical experience suggests that most FMS and CFS patients overbreathe.

How Widespread Is HVS or BPD?

- BPD is far more prevalent. Thomas M, et al. The prevalence of dysfunctional breathing in adults in the community with and without asthma. Prim Care Respir J. 2005;14:78-82.

The HVS-Hypoglycaemia Connection

- During overbreathing, both EEG and cortical function deteriorate when glucose values are below 100 mg/dL.
- 3 minutes of HVS produce mild effects when blood sugar is in the of range 85 to 90 mg%, but with blood sugar at 70 to 75% (still within normal range), gross EEG disturbances are noted. Lum L. HVS: Physiological considerations. In: Timmons R, Levy R, eds. Behavioral and Psychological Approaches to Breathing Disorders. New York, NY: Plenum Press; 1994.
**Under-oxygenation of the Brain**

In this image, O2 availability in the brain is reduced by 40% as a result of about a minute of overbreathing (HVS). In addition, glucose critical to brain functioning is markedly reduced as a result of cerebral vasoconstriction.


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**Correlation Between Faulty Breathing Mechanics & Musculoskeletal Pain?**

- A convenience sample of 111 patients attending a chiropractic clinic were evaluated for links between their health and pain histories and faulty breathing (criteria included obvious paradoxical breathing, or a tendency to raise the upper chest to initiate inhalation).
- 56.4% demonstrated faulty breathing on relaxed inhalation, rising to 75% when taking a deep breath.
- 87% reported a history of various musculoskeletal pain problems.
- Only neck pain had a significant relationship with dysfunctional breathing patterns (p = 0.039).
- “Chances are 3 in 4 that new patients seen today will have faulty breathing patterns.”


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**Back Pain & Failed Core Stability**

- Diaphragm and transversus abdominis tone are key providers of spinal stability.
- Reduced spinal support was noted during combined load challenge to the low back and during breathing challenge (e.g., digging).
- After approximately 60 seconds of overbreathing, both postural (tonic) and phasic functions of the diaphragm and transversus abdominis were reduced or absent.

A randomized controlled study showed that patients with moderate chronic low back pain, average 1-year duration, improved significantly (pain and function) after either breathing rehabilitation or physical therapy for 8 weeks (12 x 45-minute sessions).

16 patients (mean age 49.7, 31.3% male): breathing rehabilitation

12 patients (mean age 48.7, 41.7% male): “gold standard” physical therapy


From baseline to the end of the intervention, patients in both groups experienced a statistical and clinically significant improvement in pain intensity as measured by the 10 cm VAS (breath therapy -2.71; physical therapy -2.43) and the 100-point SF-36 (breath therapy +14.9; physical therapy +21.0).

At 6 to 8 weeks, there was a trend favoring breath therapy.

At 6 months, there was a trend favoring physical therapy.


Symptoms (including pain) attributable to HVS are common among patients with IBS, particularly if anxiety is a feature.

A study showed that HVS (low CO2 levels) increased colonic tone and phasic contractility in the transverse and sigmoid regions. It was suggested that these physiological gut responses are caused by altered brain or autonomic control mechanisms.

Painful Gut Symptoms: IBS & BPD/Alkalosis (continued)

- Hypocapnic hyperventilation significantly increases colonic tone and sensitivity.

- Respiratory alkalosis leads to changes in perfusion, motility, and electrolyte handling in the gastrointestinal system.

BPD, HVS & Chest Pain

- "Mental stress induces myocardial ischemia in some subjects with known CAD... Mental stress also leads to significant hemodynamic responses in these subjects."

- "Stress and fear often cause rapid breathing or hyperventilation. This usually occurs in young adults and although the hyperventilating patient often complains of chest pain, this is rarely a manifestation of cardiac disease."

Breathing Rehabilitation: Anxiety, Fear & Associated Symptoms

- HVS can usually be corrected by breathing retraining.
  Lum reported on a study in which more than 1000 anxious and phobic patients were treated using breathing retraining, physical therapy, and relaxation.

- Symptoms were usually abolished in 1 to 6 months, with some younger patients requiring only a few weeks.

- At 12 months, 75% were still free of all symptoms, and 20% had only mild symptoms; however, about 1 patient in 20 had "intractable symptoms."
Breathing Rehabilitation Studies

- Intervention studies of breathing retraining have clearly demonstrated that nonpharmacological treatment can be used successfully to treat dysfunctional breathing in most people, both with asthma and without asthma.


- The vast majority of BPDs appear to be amenable to correction via a combination of breathing rehabilitation and manual/physical medicine modalities.


Breathing Retraining Efficacy

- 92 HVS patients (60 female) with anxiety disorder were treated by retraining.
- Diagnosis was based on reproduction of symptoms (including chest pain) by voluntary HVS. Patients with organic diseases were excluded.
- Therapy involved:
  - Brief, voluntary HVS to reproduce symptoms
  - Reattribution to HVS as the cause of symptoms
  - Explanation of the rationale of therapy
  - Breathing retraining for 2 to 3 months involving acquisition of abdominal breathing pattern and slowing of expiration.


Breathing Retraining Efficacy (continued)

- The sum scores of the Nijmegen Questionnaire were markedly reduced. A canonical correlation analysis showed that the improvement of the complaints was correlated mainly with the slowing down of breathing frequency.

Pelvic Floor, Diaphragm & Motor Control in Patients with Sacroiliac Joint Pain

- Abnormal respiratory patterns and pelvic floor and diaphragmatic function were observed during the active straight leg raising test (ASLR), together with an inability to consciously elevate the pelvic floor, in 9 subjects with a clinical diagnosis of sacroiliac joint pain (SIJP).
- This study provided evidence that in subjects with SIJP, aberrant motor control strategies during the ASLR can be enhanced with a motor learning intervention.


Spinal/SIJ Instability & Respiration

- A clear connection between respiration and pelvic floor function, as well as SIJ stability, has been observed, particularly in women.
  
- If pelvic floor muscles are dysfunctional, spinal support may be compromised, increasing obliquus externus activity, overcoming pelvic floor muscle activity, and resulting in incontinence.
  
- Lack of spinal or SIJ stability is a prescription for low back pain.

Link Between Incontinence, Back Pain & Breathing?

- Data was analysed from 38,050 women from three age cohorts.
- Back pain incidence was higher for women reporting incontinence compared to women without incontinence.
- Middle-aged and older women had higher odds of having back pain when they also experienced breathing difficulties.
- Disorders of continence and respiration were strongly related to frequent back pain, possibly explained by physiological limitations of coordination of postural, respiratory, and continence functions of trunk muscles.

Breathing as Part of Treatment of Interstitial Cystitis

- Diaphragmatic breathing, progressive muscle relaxation, exercise, self-visualization, and self-hypnosis are effective in reducing stress and pain perception.

- In a study of 19 interstitial cystitis patients with pelvic floor dysfunction, who underwent relaxation therapy utilizing diaphragmatic breathing and progressive relaxation techniques, there was a significant decrease in pain and urgency scores after 3 months of therapy.

Chronic Pelvic Pain & Prostatitis

Chronic pelvic pain (involving the perineum, testicles and penis) associated with chronic prostatitis involving nonbacterial urinary difficulties has been shown, in a 2005 study at Stanford University School of Medicine, to be capable of being effectively treated using trigger point deactivation, together with relaxation and breathing techniques.


Chronic Pelvic Pain Summary

- Chronic pelvic pain is commonly associated with interstitial cystitis and stress urinary incontinence.
- There are many possible causes of chronic pelvic pain, and accurate diagnosis can be difficult; misdiagnosis is common.
- At the very least, serious pathology needs to be ruled out before use of CAM or manual treatment methods.
- Psychological issues may be aetiological or may be maintaining features of pelvic pain problems.
- Neurological (e.g., pudendal pain syndrome) and pelvic floor muscle pain syndrome, are two forms that may respond well to appropriate physical medicine approaches.

What to Look for with BPD

- Restlessness (type A, "neurotic")
- "Air hunger," sighing
- Rapid swallowing rate
- Poor breath-holding times
- Rise of shoulders on inhalation
- Obvious paradoxical breathing ("hi-lo" test)
- Visible "cord-like" sternomastoid muscles
- Rapid breathing rate (this may not be obvious)

Symptoms including:

- Muscular stiffness and aching (particularly neck and shoulders)
- Fatigue
- Brain fog
- IBS
- "Chronic everything"/chronic pain
- Anxiety/panic/phobias
- Cold extremities
- Paresthesia
- Photophobia/hyperacusis
- "Can’t take a deep breath"
- Positive Nijmegen test, capnometry evidence

BPD Assessment of Influences

- Observe breathing pattern (e.g., paradoxical pattern/upper chest).
- Observe posture, particularly crossed patterns.
- Assess spinal, rib mobility/restriction + form/force closure (SLR).
- Look for shortness or weakness of key muscles + firing sequences, as well as active trigger points.
- Test breath holding, breathing wave, and Nijmegen as markers of current status (or record capnography evidence if available).

Then...

- Mobilise/tone soft tissue/joints + deactivate trigger points, as appropriate to findings.
- Commence education, rehabilitation strategies (breathing, stress management, posture) + homework.
- Consider referral for psychological/emotional support.
- As appropriate, offer nutritional, relaxation, etc., advice.
- Review and reassess regularly.


**Identifying BPD:**

- The Nijmegen Questionnaire

  This non-invasive test is of high sensitivity (up to 91%) and specificity (up to 95%). It is an easily administered, internationally validated questionnaire and is a simple and accurate indicator of acute and chronic HVS.

  Questions ask about: feelings of constriction in the chest, shortness of breath, accelerated or deepened breathing, inability to breathe deeply, feeling tense, tightness around the mouth, stiffness in the fingers or arms, cold hands or feet, tingling fingers, bloated abdominal sensation, dizzy spells, blurred vision, feeling of confusion or losing touch with environment.


**Nijmegen Questionnaire**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Rare a less than monthly</th>
<th>Sometimes a more than monthly, less than weekly</th>
<th>Often a at least weekly, but not daily</th>
<th>Very often a at least daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest pain</td>
<td>Heart rate</td>
<td>Fatigue</td>
<td>Shortness of breath</td>
<td>Difficulty in breathing</td>
</tr>
</tbody>
</table>

*HVS, Patients react with a kick fear after they suffer from the symptoms listed. A score above 20/4 is diagnostic of HVS/relaxation response.*
Identifying BPD: Capnography/Capnometry

A small breath-training/monitoring device has the ability to assist in slower and better breathing, improved blood chemistry, measuring end tidal CO2 levels, and monitoring heart wave and rate.

Mindful Physiology Institute, www.bp.edu

Chaotic rhythm, diaphragmatic spasm?, underlying emotional and/or physical factors?, many peaks under 35 mmHg

Signs of chronic overbreathing, Nijmegen score 27/64 + CO2 levels below 35mmHg, "cheat painful a lot of the time"; retraining focused on lengthening exhalation; CO2 rose slightly after a few minutes. Note: These lines are condensed 20-second averages.

Is Biomechanical Assessment Essential?

“Signs and symptoms of dysfunctional breathing appear to exist even when PCO2 levels appear normal. Breathing may reflect the function of many systems of the body and a purely biochemical view of breathing dysfunction may be limited. For a complete picture of patients’ breathing it is necessary to evaluate the biomechanical aspects of breathing pattern, and symptom patterns, in addition to the assessment of carbon dioxide.”

Painful Trigger Points & Respiration

- Trigger points in cervical, shoulder-girdle, thoracic, or lumbar muscles strongly influence and can be strongly influenced by:
  - Disturbances of ventilation mechanics
  - Disturbances of posture
  - Disturbances of the functional dynamics of the neck, shoulder girdle, and lumbar spine
- Paradoxical respiration is a critical link in many such pathogenetic chain reactions

Anterior & Posterior Crossed Patterns

- Respiratory & Pelvic Floor Dysfunction Connections
  - Trunk extension reduced
  - Thoracolumbar region stiff
  - Poor pelvic control
  - Abnormal axial rotation
  - Dysfunctional breathing


Breath-Holding Tests

- No agreed ‘normal’ breath-holding time, but it can be a useful point of reference.
- Control pause: Normal exhalation held until “need to breathe again” is experienced.
  - “Normal” is between 25 and 30 seconds. Under 15 seconds represents low tolerance to CO2.
- In Buteyko system, control pause is practised regularly to encourage increased CO2 tolerance.
  
Lateral Expansion Assessment

- In some individuals, a normal abdominal excursion is seen on inhalation, with minimal lateral expansion.
- Reliability of measuring thoracic excursion has been established, ideally using a standard cloth tape measure (taken at 5th and 10th thoracic level).


Thoracic Restrictions & Breathing Wave

- Seated patient slumps, and spinal “flat” areas are observed.
- On prone inhalation, segments that fail to flex normally usually rise en bloc, rather than individually.
- Associated ribs may also be restricted.
- Thoracic spine, ribs, and associated muscles may require mobilization.


Assessment of Elevated & Depressed Ribs

- A rib that fails to move antero-cephalad on inhalation is depressed (locked in its exhalation phase).
- A rib that fails to return to neutral on exhalation is elevated (locked in its inhalation phase).

Assessment of 1st rib and clavicular movement on inhalation.
Functional Assessments for Postural
Muscle Overactivity/Shortness

Assessing:
- Upper Trapezius
- Lev Scapula

A = Normal psoas
B = Psoas shortness
Quadratus lumborum overactivity


Psoas/Quadratus—
& the Diaphragm

“[T]he remainder of the lumbar part of the diaphragm arises from the medial and lateral arcuate ligaments, which are immediately lateral to the crura. The medial arcuate ligament is a thickening of the fascia covering psoas major and runs from the side of the body of L2 to the transverse process of L1. The lateral arcuate ligament is a thickening of the anterior layer of the thoracolumbar fascia covering quadratus lumborum and runs from the transverse process of L1 to the tip of the 12th rib.”


Diaphragm release:
1. Lower ribs of supine patient are rotated L and R to evaluate restrictions. Tissues are held in that direction as side flexion is evaluated (“shunt”/translation). Combined directions of restriction are held as patient introduces Valsalva maneuver, after which rotation and translation are re-evaluated. Diaphragm excursion should be fuller subsequently.
Elderly Hospitalized Pneumonia Patients

- Osteopathic manual methods were applied to elderly hospitalized patients with pneumonia, with the result that the length of the hospital stay was reduced from a mean of 8.6 days without OMT to 6.6 days with OMT.
- Additional benefits in this study, for those receiving osteopathic manual treatment, included reduced length of use of intravenous antibiotics.


BPD Retraining Essentials

Breathing retraining requires a combination of elements:
- Understanding the process – a cognitive, intellectual awareness of the mechanisms and issues involved in BPDs
- Retraining exercises including aspects that operate subcortically, allowing replacement of currently habituated patterns with more appropriate ones
- Biomechanical structural modifications that remove obstacles to desirable and necessary functional changes
- Time for these elements to merge and become incorporated into moment-to-moment use patterns
Pursed Lip Breathing

- Pursed lip breathing (PLB) enhances pulmonary efficiency.
- Exhalation through the pursed lips has been shown to relieve dyspnea, slow the respiratory rate, increase tidal volume, and help restore diaphragmatic function.


Inhibiting Shoulder Rise

- During breathing retraining, the patient should adopt tactics that restrict overactivity of accessory breathing muscles in order to reduce “shoulder rising” on inhalation.

- Methods might include:
  - Lightly pushing forearms onto arms of chair
  - Arms behind back, grasping wrist with other hand and lightly pulling down (on inhalation only)
  - Reclining, with hands behind head (“beach pose”) to open chest and reduce shoulder movement
  - Interlocking hands on lap and applying finger-pad pressure to dorsum of hands (on inhalation only) to inhibit shoulder movement
  - Adopting Brugger’s relief position


Patient sits or lies, with the dominant hand on the abdomen and the other hand on the chest, and inhales through the nose, ensuring diaphragmatic involvement by means of movement of the abdomen against the hand, and exhales slowly through the mouth, using pursed lips.

PLB: Using a 3-D optoelectronic plethysmograph (OEP), marked decreases have been shown in end-expiratory lung volume, localized at the abdominal level.

**Brugger’s Relief Position:**
- Perch on chair edge, arms hanging down, feet below knees, slightly apart and turned outward
- Roll pelvis forward to produce slight lumbar lordosis
- Ease sternum slightly forward and up and tuck chin in
- With palms facing forward, on inhalation, rotate arms outward until thumbs face slightly back; release on exhalation
- Practice slow, pursed lip, anti-arousal breathing

**Beach-pose**


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**Summary**

BPDs influence health by:
- Altering blood pH, creating respiratory alkalosis
- Increasing sympathetic arousal, altering neuronal function
- Encouraging a sense of apprehension, anxiety, and panic
- Depleting Ca and Mg ions, enhancing central and peripheral sensitization, encouraging spasm, and reducing pain thresholds


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**Summary (continued)**

- Triggering smooth muscle cell constriction, leading to vasoconstriction (and possibly altering fascial tone)
- Encouraging painful colon spasm and pseudo-angina
- Reducing O2 release to cells, tissues, and brain (Bohr effect), encouraging ischemia, fatigue, and pain
- Encouraging evolution of myofascial trigger points
- Creating biomechanical overuse stresses and pain

BPDs are:
- Commonly habitual
- Easily recognized
- Usually capable of being improved or eliminated

Thank you for your attention!

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