

Has hyperventilation syndrome disappeared?

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Verdwenen is hyperventileren

Disappearance of hyperventilating

In the 150th edition of the Dutch Medical Journal, a number of 'old' and 'new' diseases were described. NTVG, 2007; 151 (1), 38

Among the 'old' diseases was hyperventilating

My response was published soon after: NTVG, 2007; 151 (12), 722



'hyperventilation' is used with different meanings

- A large number of complaints ('HV complaints')
- A tense, wrong, 'dysfunctional' breathing pattern
- Hypocapnia as a result of ventilation in excess of metabolic needs (by definition)

What has disappeared exactly?

Meaning of hyperventilation

- A large number of complaints
- A tense, wrong, 'dysfunctional' breathing pattern
- Hypocapnia, as a result of ventilation in excess of metabolic needs
- Complaints remain, but are they specific and exclusive to hvs patients?
- Faulty breathing patterns remain, but what is faulty and how specific is it?
- Hypocapnia is a physiological state, but how specific and exclusive is its association with complaints?

The idea of HVS has disappeared

The idea that **specific complaints are caused by hypocapnia in specific patients** has been abandoned: HVS is not a valid diagnosis

In general

- The idea of a linear, causal and exclusive relationship between a physiological variable and subjective states is unrealistic
- Context, conditioning and interpretation is equally important (O. van den Berg, Leuven)
- Respiration is more than ventilation, it is a complex psychophysical system with multiple functions (J van Dixhoorn)

Conclusion

What disappears

- The construct of HVS as a single diagnosis, out of several elements
- The idea that complaints are only real, when confirmed by physiologic measurement

What remains

- Hypocapnia and respiratory alkalosis
- Complaints pattern
- Psychology and physiology: a LAT relationship (LPJ van Doornen)
- Breathing is more than lung function: 'dysfunctional breathing'

Dysfunctional Breathing

DYSFUNCTIONAL BREATHING: ITS PARAMETERS, MEASUREMENT AND RELEVANCE

A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

Rosalba Courtney D.O.

School of Health Sciences
Science, Engineering and Technology Portfolio
BMP University

February 2011

Irregularities in breathing pattern **and/or** functional respiratory complaints
Hypocapnia related symptoms are a subcategory of DB
More complex, multidimensional and thus, more difficult to assess
Discussion on definition and measurement is ongoing

15. Hyperventilation and dysfunctional breathing

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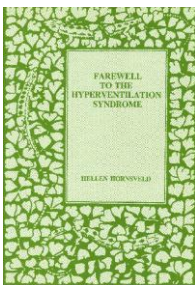
Abstracts of Papers Presented at the 3rd International Society for the Advancement of Respiratory Psychophysiology (ISARP) Congress
Nijmegen, The Netherlands, August 26th and 27th, 1996

The term hyperventilation syndrome (HVS) refers to complaints which are associated with disturbed respiratory function, without organic pathology. Hyperventilating however refers to only one aspect of respiration: gas exchange. It is more realistic to conceive of respiration as a complex psychophysical system with multiple functions. Thus, the consequences of disturbance in respiratory function, or dysfunctional breathing, should not be limited to complaints associated with inappropriate ventilation.

Prevalence of dysfunctional breathing in patients treated for asthma in primary care: cross sectional survey

Mike Thomas, R K McKinley, Elaine Freeman, Chris Fox
British Medical Journal, 2001

Hornsveld, 1996.
Farewell to the HVS



1. Hypocapnia & HV

115 HVS and 40 healthy controls underwent a HVPT and a pseudo-test, in which CO2 level was kept constant

Which symptoms were associated with hypocapnia?

Was the association specific to hvs patients?

Whole-Body Breathing

Hypocapnia associated symptoms

Many of them are included in Nijmegen Questionnaire (NQ)

They include mental symptoms

Few respiratory symptoms. Shortness of breath, breathing faster and inability to take a deep breath **not** elicited by hypocapnia

However, other stress tests result in similar complaints, they are not exclusive due to hypocapnia

TABLE 12.2. Symptoms of True Hypocapnic Hyperventilation Compared with Isocapnic Hyperventilation

General symptoms			
• Dizziness (NQ)	• Hot flashes	• Headache	
• Paresthesias (NQ)	• Muscle weakness	• Stiffness around the mouth (NQ)	
• Faintness	• Warm feeling in the head	• Sweating	
• Muscle stiffness (NQ)	• Blurred vision (NQ)	• Anxiety/panic (NQ)	
• Cold hands or feet (NQ)	• Rapid heartbeat (NQ)	• Feelings of unreality (NQ)	
• Shivering			
• Muscle cramps			
• Fatigue			
Respiratory symptoms		Psychological symptoms	
• Tightness in the chest (NQ)		• Unresponsiveness (NQ)	
		• Awaken/panic (NQ)	
		• Feelings of unreality (NQ)	

Note: (NQ), items from the Nijmegen Questionnaire.

NQ may be said to measure 'hyperventilation' complaints

Are hypocapnia associated complaints specific for HVS patients?

No, although HVS patients have more complaints, the increase due to hypocapnia is in proportion equal!

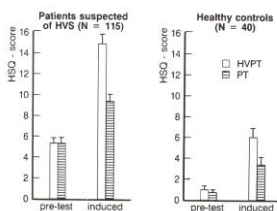


Figure 3: Means of the Hyperventilation Symptom Questionnaire for number of pretest symptoms and induced symptom scores. Bars indicate standard error of the mean.

CO2 regulation is stable

Donaldson, G.C. The chaotic behaviour of resting human respiration. *Respiratory Physiology*, 1992; 88: 313-321

Wientjes, C.J.E. Psychological influences upon breathing: situational and dispositional aspects. Dissertation, Tilburg University, 1993

Conrad, A. et al. Psychophysiological effects of breathing instructions for stress management. *Applied Psychophysiol. Biofeedback*, 2007; 32(2): 89-98

- It is not easy to raise CO2 voluntarily, many conditioning experiments have small effect on CO2, little clinical relevance (O. vd Berg, Leuven)
- Natural respiration is variable, in particular in tidal volume, time parameters, and **least in CO2 level**
- Stress and tension influences breathing pattern and form, but hardly ventilation
- Simple breathing instructions, to breathe slower, and/or with less volume, do not raise CO2 and mostly feel uncomfortable

CO2 feedback is effective

Meuret, A.E.; Rosenfield, D.; Hofmann, S.G.; Suwak, M.K.; Roth, W.T. Changes in respiration mediate changes in fear of bodily sensations in panic disorder. *J Psychiatr. Res.* 2009 Mar; 43(6):634-41



- Handheld capnography has become available and affordable, with many data and applications
- 35 panic patients received 4 weeks of capnography training, weekly sessions + home usage
- With repeated measurements, CO2 rose, respiration rate and anxious interpretation of sensation diminished
- *'The results provide little support for changes in fear of bodily sensations leading to changes in respiration, but rather suggest that breathing training targeting pCO2 reduced fear of bodily sensations in panic disorder'*

CO2 monitoring is useful

McLaughlin L, Goldsmith CH, Coleman K. Breathing evaluation and retraining as an adjunct to manual therapy. *Manual Therapy.* 2011 Feb; 16(1):51-2.
Twenty nine outpatients with neck or back pain who had plateaued with manual therapy and exercise were identified all of whom were found to have low ETCO2. Breathing retraining improved ETCO2, pain and function in all patients.

Screening for breathing dysfunction using capnography may improve patient outcomes in those patients where manual therapy, exercise and education do not provide full resolution of symptoms.
Since trunk muscles perform both postural and breathing functions, it is theorized that disruption in one function can negatively impact the other. Altered breathing mechanics can change respiratory chemistry and therefore pH causing smooth muscle constriction, altered electrolyte balance and decreased tissue oxygenation

Clague JE, Petrie PJ, Horan MA. Hypocapnia and its relation to fear of falling. *Arch Phys Med Rehabil* 2000; 81:1485-8.

Half of 20 elderly subjects who tend to fall have also fear of falling. Fear of falling is associated with low Pet CO2

Is Nijmegen Questionnaire sensitive and specific?



2. Complaints pattern
16 items
4 items represent dyspnea
4 items represent tension & anxiety
8 items are possibly stress and/or hypocapnia mediated

Score: 1=rarely, 4=very often. Sum: 64
• **Normals:** 10.9 ± 7.1 *
• **HV complaints:** 29,5 ± 9,0 **
• **Other patients:** 24,6 ± 10,5 **

* Data from Han (1998) and Thomas (2005)
** Data from internet study AOS (2011)

Nijmegen Questionnaire, when is it elevated?

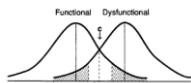
Normals: 10,9 ± 7,1
HV complaints: 29,5 ± 9,0
Other patients: 24,6 ± 10,5

AOS internet study: 2315 subjects, 655 men and 1660 women, 42.6 years of age, were referred or self referred for breathing and relaxation therapy (Van Dixhoorn Method), from 2006 - 2010.

Practitioners uploaded treatment data through internet and classified subjects according to their main complaint.

514 of them (22%) were classified as hyperventilation complaints.

Formula from Jacobson & Truax (1991) is used to calculate the cutoff score to distinguish normal and functional domain from dysfunctional and abnormal domain



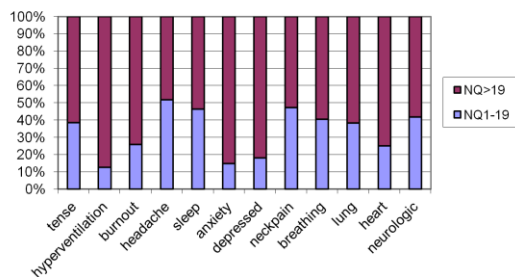
Comparing normals to HV patients, the cutoff score = 19,1.

Thus a score of 20 or higher indicates the dysfunctional domain

Same results, when using data from literature, means ± SD of HV patients

Nijmegen Questionnaire, is it specific for hyperventilation complaints?

All tension related problems in 2315 subjects have a large proportion of patients with elevated NQ scores



Is Nijmegen Questionnaire sensitive and specific?

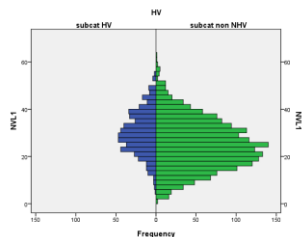
NQ is frequently used to identify patients with additional problems, among subjects with asthma, in a vestibular or allergy clinic, still called HVS

It appears that NQ is sensitive to the presence of hyperventilation complaints, but not specific.

It is not a good diagnostic, or screening tool, to differentiate HV complaints from other tension related complaints.

NQ measures the presence of a dysfunctional, tension related domain

This domain is possibly / partly respiration related



A series of horizontal lines for taking notes, corresponding to the text blocks on the left.

NQ as a treatment indicator or evaluator tool

Breathing exercises for asthma: a randomised controlled trial
 Thorax. 2009, 64:55-61
 M Thomas,¹ R K Motilsky,² S Maitz,³ G Wadkin,⁴ E Holloway,⁵ J Sculkin,⁶ D E Shaw,⁷ A Wardlaw,⁸ D Price,⁹ I Passer¹⁰

Physiotherapy breathing instructions were compared to patient education. At 6 month follow-up, there was a highly significant effect on asthma quality of life ($p < 0.01$) and highest on NQ ($p < 0.005$)

Irregularity of breathing was not addressed Benefits were equal for those with normal and elevated NQ. So, **NQ does not indicate who will have benefit**

The effects were not mediated by responses in ETco₂, but anxiety and depression decreased in the experimental group

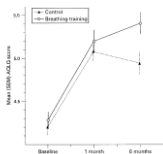


Figure 2 Mean (SD) Asthma Quality of Life Questionnaire (AQOL) scores in breathing therapy and control groups at baseline and 1st and 6 months post randomisation in relation to total proportion (standard error) response to better quality of life.

NQ is a good treatment evaluator tool

92 patients with HV complaints and anxiety disorder received breathing therapy (on average 17 sessions in 2.5 months).

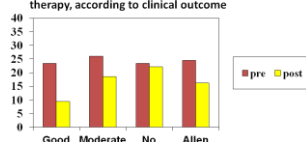
JN Han, et al. Influence of breathing therapy on complaints, anxiety and breathing pattern in patients with hyperventilation syndrome and anxiety disorders. J Psychosomatic Research, 1996. 41: 5: 481-493

NQ scores before and after treatment

Good clinical effect: n=32 (35%)
 Moderate effect: n=40 (43%)
 No effect: n=20 (22%)

Initial NQ is not associated with clinical effect, but changes do. **Post NQ is within normal range for patients with good effect.**

Average NQ scores, pre and post breathing therapy, according to clinical outcome



NQ as treatment evaluator tool for all categories of tension related complaints

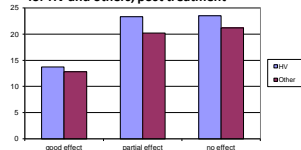
514 patients classified as 'Hyperventilation' and 1801 patients in all other categories

Post treatment **NQ normalized for both groups**, when clinical response is good
 When clinical effect is partial or absent, NQ remains elevated

Following breathing and relaxation therapy, on average 6-7 sessions, 1 hour

Comparing the outcome with NQ in the two groups (post measurement only)

NQ values according to clinical outcome, for HV and others, post treatment



AOS internet study (2006-2010) (www.ademtherapie-aos.org)

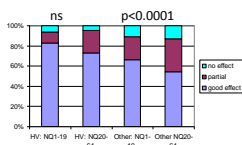
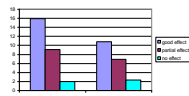
Are (HV) complaints specifically responsive to breathing and relaxation therapy?

Differentiating patients into those with initial high and low NQ

Result of treatment is good in $\pm 75\%$ of HV patients, in $\pm 60\%$ of all others, **but in only $\pm 50\%$ of others with abnormal NQ**

Patients classified as HV have best result

Patients with abnormal NQ have least result, particularly **when classified as non HV**



It is clinically useful to differentiate a 'HV' complaints pattern

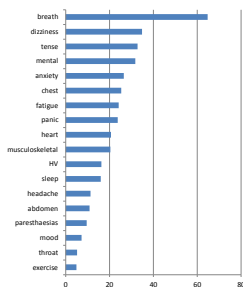
On basis of what complaints are patients classified as HV?

Breath 65%: short of breath, dyspnea, difficulty breathing, breathing fast, short of air, sighing, effortful breathing, 'high' breathing or

Dizziness 35%: lightheaded, dizzy, tendency to faint, fear to faint, unreal feeling or

Hyperventilation (16%) / panic (24%): large overlap

Relatively few have anxiety (27%)



Accompanied by tension (33%) and mental unrest (32%)

Average number of complaints = 4-5 (range 1-10)

Mainly functional respiratory complaints, often with dizziness, tension or mental unrest, partly with (panic) attacks

To summarize

Hyperventilation complaints consist mainly of **functional respiratory complaints (frc)** (dyspnea without somatic causes)

Which are associated with fear and tension, partly mediated by hypocapnia

Quantified by NQ

They respond to breathing and relaxation therapy, which combines tension regulation (relaxation) with breathing regulation

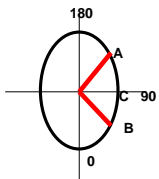
This response is adequately reflected by NQ

In combination with other disorders, high NQ may complicate treatment

It is clinically useful to identify this complaints pattern



Marm: quantifying distribution of breathing movement



3. Breathing pattern

Several measures quantify it:

- Exhalation pause time
- Inhalation holding time
- Thoraco-abdominal asynchrony
- Sighing and excess irregularity
- Thoracic dominant breathing
- Paradoxical breathing
- Mouth breathing
- Gasping
- Lack of sideways costal expansion



Dysfunctional breathing criterion list

Dominant high costal breathing at rest plus at least five of the following

- Difficult inspiratory breathing
- Unable to take deep breaths
- Frequent sighing / yawning
- Frequent need to clear the throat
- Muscle and joint tenderness in upper part of chest (sternocostal / intercostal joints)
- Hacking cough
- Chest tightness
- Sensation of lump in throat
- Previous or current effects of stress



Breathing retraining - A five-year follow-up of patients with dysfunctional breathing

Carina Hagman^{1,2,3*}, Christer Jansson³, Margareta Örtengren^{3,4}

25 patients with DB were differentiated from asthmatics, treated with breathing therapy, compared to 25 asthmatics and followed up for 5 years

Quality of life had improved in the DB group and worsened in the true asthmatics. **Emergency room visits** had decreased from **18 to 2 per year**, in de DB group. NQ decreased, but remained elevated.

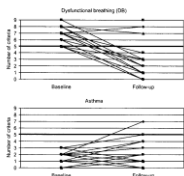
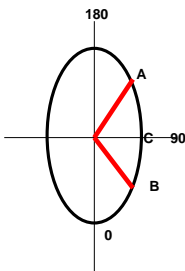


Figure 2 Results of the DB criterion list for the DB group (number of patients = 22), at baseline and at five-year follow-up. One inclusion criterion was that patients with DB had at least five symptoms from the DB criterion list and patients with asthma fewer than five symptoms.

MARM: Manual assessment respiratory movement

Quantification of distribution

- Level (average value): $A + B / 2$
- Area= angle AB
- Balance=angle AC-CB
- Percent ribcage $(AC / AB) * 100$
- Both sides, if they differ

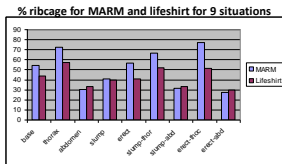


- No quantification of
- Time components: frequency, pauses
- Fluency, tightness
- Sounds of air passage
- Ventilation, tidal volume
- (I)rregularity, sighs
- Scoliosis, kyphosis and lordosis

Reliability and validity of MARM (2008)

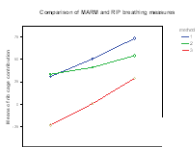
12 subjects, experienced in breath control, performed 9 different situations: sitting normal, slump and upright, each breathing normal, abdominal and thoracic. Two assessors did MARM and they were monitored with life shirt. High inter examiners reliability for MARM balance (0.85) and %ribcage (0.84). Correlations Lifeshirt and MARM: %ribcage 0.60; balance 0.59;

Breathing and posture situations were differentiated well; MARM did better than Lifeshirt. Eta squared 0.94 versus 0.62



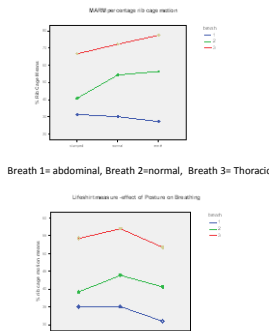
Courtesy, R.; van, Dixhoorn J.; Cohen, M. Evaluation of Breathing Pattern: Comparison of a Manual Assessment of Respiratory Motion (MARM) and Respiratory Induction Plethysmography. Appl. Psychophysiol. Biofeedback, 2008, 33-2: 91-100

Measurement of abdominal, normal and thoracic breathing by MARM and Lifeshirt



Method 1= MARM percentage rib cage, Method 2=Lifeshirt percentage rib cage, Method 3= MARM balance

MARM is more sensitive to upper thoracic breathing than Life shirt



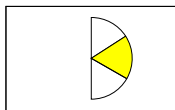
Breath 1= abdominal, Breath 2=normal, Breath 3= Thoracic

VISUALISING BREATHING PATTERN

Six students of breathing therapy, assessing each other twice

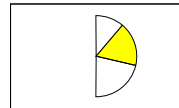
Test-retest reliability, ranging from 0.75 – 0.98, per pair

Sitting comfortable



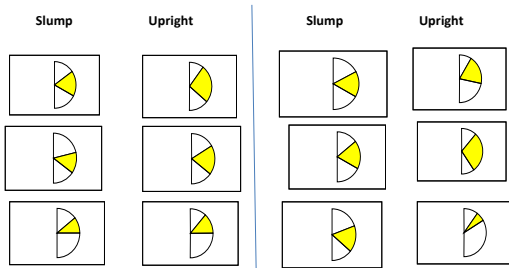
Upper line 123
Lower line 60
Average 91
Area 63
Balance 3

Sitting upright

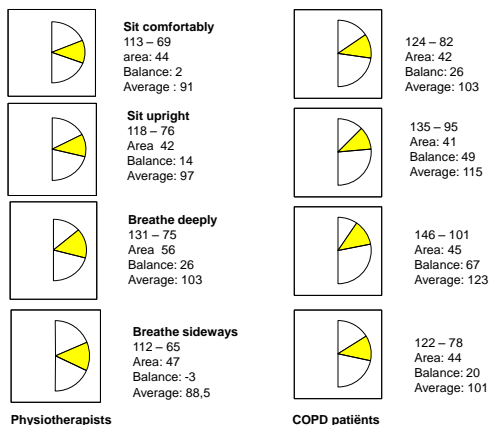


Upper line 139
Lower line 77
Average 108
Area 62
Balance 36

Individual variation in response to the same instruction in six individuals



A protocol to test the response to different situations is useful



Physiotherapists

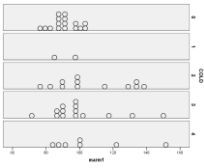
COPD patiënts

MARM: average values

Category	MARM Average	MARM Area
Breathing therapists (n=67)	90 ± 6.9	58 ± 15.8
Physiotherapists (n=16)	91 ± 7.9	44 ± 10.7
COPD patients (n=35)	103 ± 20.8	42 ± 17.9
Stress / tension patients (n=62)	112 ± 10.2	20 ± 5.4

Comparing breathing therapists with stress patients
 The cutoff for **abnormal MARM** is for
 Average >100
 Area <30

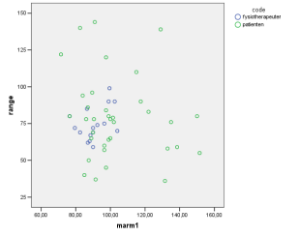
Comparing MARM values of COPD patients between levels of severity (GOLD classes) and Physiotherapists (Gold=0)



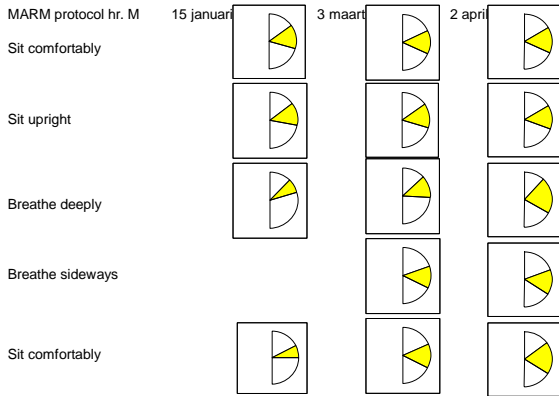
COPD have higher average MARM, but only for a subgroup and this does not seem to be related to severity.

Possibly a dysfunctional breathing pattern?

Combining average MARM with the range of area to differentiate normals from COPD patients



Values are averages per individual across the same protocol
Range of area = difference between highest and lowest line in the protocol



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DOI: 10.1080/07997420.2012.688888

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PHYSIOLOGY

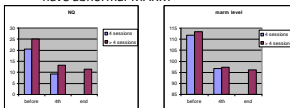
Medically Unexplained Dyspnea: Partly Moderated by Dysfunctional (Thoracic Dominant) Breathing Pattern

ROSALBA COURTNEY, DSc,¹ JAN VAN DIJKSHOF, M.D., PH.D.,² KENNETH MARK GREENWOOD, PH.D.,² AND ELKE M. BASTINGSJENSEN²

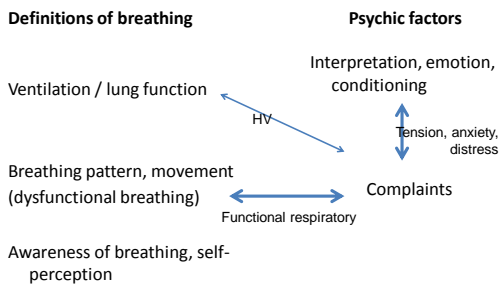
¹School of Health Sciences, Royal Melbourne Institute of Technology (RMIT) University, Melbourne, Australia.
²Centre for Breathing Therapy, Amsterdam, the Netherlands.

Out of 62 patients with tension problems 71% had thoracic dominance, 61% had high NQ, 53% have both. On the basis of (ab)normal NQ and MARM 74% of patients is classified correctly

Linear correlation between MARM and NQ is low, and is due to correlation between MARM and 4 dyspnea items
All subjects with elevated dyspnea score have abnormal MARM



Both MARM and NQ normalize after treatment (6-7 sessions).
Improvement in dyspnea is mediated by the change in MARM



Conclusion

If the Hyperventilation syndrome has disappeared,

How to re-label 'hyperventilation' complaints?

Stick to hyperventilation complaints, because its the most used label

Place them under the umbrella of General distress, unexplained symptoms? Anxiety or Panic

Emphasize a broader definition of breathing? Dysfunctional breathing? Functional respiratory complaints? Medically unexplained dyspnea?
