Hyperventilation syndromes in medicine and psychiatry: a review

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In 1940 Lewis[1] described DaCosta's syndrome (a frequent presentation of hyperventilation) as 'one of the commonest afflictions of sedentary town dwellers'. In this issue of the *JRSM* (p. 216), the paper 'Role of the nurse counsellor in managing patients with the hyperventilation syndrome' prompts a review of recent advances in this field.

The 1980s have seen a remarkable upsurge of interest in the role of hyperventilation in functional illness, anxiety disorder, panic and phobic states[2-4]. In a previous review[5] the author traced the changing concepts over the last 50 years, from the early realization[6] that overbreathing was the physiological mechanism whereby anxiety produces somatic disturbance, to the later view[7] that anxiety disorders arose from the persistence of symptoms due to unrecognized hyperventilation. Yet, even in 1982, a *Lancet* editorial[8] commented on how rarely this diagnosis was even considered. Snaith[9], reviewing panic disorder, failed to mention it.

In England, with few exceptions, hyperventilation was generally ignored[10], but the Third International Workshop on Respiratory Psychopathology held in Bordeaux in 1983 exposed English clinicians to the work of those who, particularly in Germany, the Netherlands and France, had been active in the field for more than a decade. The resulting 1984 symposium at Southampton attempted a consensus definition of symptomatology and diagnostic criteria[11]. This was flawed by a widespread unfamiliarity with the subject, and a general lack of appreciation that overbreathing can occur during *apparently normal* respiration.

Overbreathing, in chronic hyperventilation, is rarely grossly visible[2]. When a 'normal' respiration rate (e.g. 16–17) is coupled with a modest but imperceptible increase of tidal volume (e.g. to 750 ml/minute), substantial overbreathing occurs. Moreover, once it is established, an occasional, imperceptible deep breath will keep the P_{CO_2} low[12,13].

From the earliest clinical accounts[14], disordered breathing (rapid, thoracic respirations with marked changes in rate and rhythm, and frequent sighing) has been noted as the hallmark of hyperventilation. On the other hand, respiratory alkalosis alone cannot fully explain the symptomatology[2]. However, in 1963[15] and in an unpublished lecture delivered in 1976, Wyke emphasized the all-pervasive effects of *changes* in arterial carbon dioxide on nervous system function. This led to the concept that symptoms arise, not so much from chronic hypocarbia, but from rapid changes in arterial carbon dioxide (fluctuating hypocarbia) produced by the unstable breathing pattern. This now provides a sound neurophysiological basis for the great majority of clinical findings.

DaCosta's syndrome has figured prominently as a prototype of hyperventilation syndromes. Nixon and Freeman and their associates have produced a valuable series of papers on the relationship between hyperventilation, chest pain, and ischaemia, emphasizing the importance of breathing control in treatment[16,17], and also observed that the ventilatory response of hyperventilators to emotional stimuli was three times as great as controls[18].

Diagnosis

Symptomatology alone, however suggestive, is insufficient for diagnosis. Patients may fail to identify their (often bizarre) symptoms with descriptions in questionnaires. Sensations produced by direct hypocarbic stimulation of cortical neurones do not have a counterpart in everyday experience. Often symptoms (e.g. paraesthesiae) which are denied on direct questioning, are recognized when produced during voluntary overbreathing. The latter test is essential.

Reproduction, on voluntary overbreathing, of sufficient symptoms for the patient to identify with spontaneous symptoms, has always been the touchstone of diagnosis. Recommended rates of enforced breathing have varied from 18–20 per minute[6,19] to 60–70 per minute[20]. Beumer and Hardonk[20] advocate a standardized procedure of three minutes breathing at 60 respirations per minute, and require that the end-tidal P_{CO_2} measured at three minutes post-hyperventilation should remain below 66% of the resting value.

This last procedure, useful as a standard in research units, is unnecessary in clinical practice. For a working clinical diagnosis, the literature and personal experience suggest that the rate is immaterial, provided that deep breathing at a rate comfortable for the patient is sustained for about three minutes. A single deep breath lowers the P_{CO_2} by 7–16 mmHg and maximal lowering occurs in 60 seconds[6]; 7–8 deep breaths at a normal rate can lower the P_{CO_2} by about 50%[21]. Prolonged, meticulous auscultation of the chest, with deep breaths through the mouth, effectively but unobtrusively lowers the P_{CO_2} to symptomatic levels. Deep breathing can be continued if necessary for a further period while the pulse and heart rate are monitored.

Symptoms of cerebral vasoconstriction and hypoxia (i.e. dizziness, unsteadiness, blurred vision) commonly start within 20–30 seconds, especially if the *standing* position is adopted. Paraesthesiae are often slower, reflecting a different mechanism. Chest pains are produced in only 50% following the customary three minutes overbreathing[22]. Although persistence to 20 minutes almost invariably produces them, the possibility of dysrhythmias[23] or even ischaemia[17] is a potent deterrent.

It is an everyday observation that antecedent

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anxiety clearly predisposes to symptom production, e.g. in panic attacks. Allen and Agus[19] reproduced hallucinations by a preliminary slow hyperventilation for 10 minutes, followed by more vigorous overbreathing.

Bass and Gardner[24] have taken the extreme view that the diagnosis of hyperventilation requires the $Paco_2$ on repeated measurements to be below an arbitrary value of 30 mmHg. This, however, ignores the fact that hyperventilation is commonly episodic, rather than continuous[2], and overlooks the fundamental role of carbon dioxide in acid base homoeostasis. The Henderson-Hesselbalch equation:

$$pH = pK + \log \frac{[HCO_3-]}{[CO_2]}$$

shows that any fall in Pco_2 from the resting or steady state value produces an immediate rise in pH (i.e. respiratory alkalosis), and its sequelae. Their analogy with diabetes is ill-chosen: experienced clinicians will know that hypoglycaemic symptoms can occur at normal blood sugar levels, following a fall from higher values. As in episodic hypocarbia, it is the metabolic change that matters. Theirs, however, is very much a minority viewpoint, based on a small recorded experience. It would exclude 75–80% of clinical cases[23]. Any physician will of course be mindful of thyrotoxicosis and asthma, but the proliferation of investigations, in the relentless pursuit of remote possibilities, is to be deplored. One views with alarm their recommendation that the diagnosis also requires histamine challenge to exclude bronchial hyperreactivity, given that this would apply to 6–10% of the outpatient population[7,25–27]. Bass *et al.*[28], in a series of 46 patients with chest pain but normal coronary arteries, reported a persisting morbidity in 63% at one year, while only 7% lost their pain. By contrast 76% of similar cases, who had their breathing treated, were asymptomatic at one year and remained completely symptom-free at 6–11 years[29].

The whole weight of the literature, however, is in agreement with Magarian[2]: 'the diagnosis does not require arterial blood gas determinations, but rather the constellation of symptoms with their provocation by a controlled trial of hyperventilation.'

Mechanisms of symptom production

Chest pains: These are reported by general physicians in about 40–50% of cases, though not necessarily as the presenting symptom[26,30]; cardiologists report more[27]. The author finds an overall incidence of 45% in GP referrals, but it is a prime complaint in less than half of these. A sharp lancinating pain, lasting from seconds to a few minutes, is attributed to a forceful hyperadrenergic heartbeat striking the sensitized precordium. Dull aching (left precordial or substernal and persisting for hours or days) arises in the intercostal muscles[31] and in the strained muscles and ligaments in the anterior chest, due to excessive upper thoracic movement[32].

True myocardial pain may occur. Coronary spasm has in recent years been increasingly implicated, and is compounded by decreased oxygen yield to the tissues due to a leftward shift in the oxyhaemoglobin dissociation curve. 'Catecholamine myopathy' has also been described[17]. Hyperventilation pain may colour the picture in 57% of cases of true coronary artery disease, and is the sole cause in 60% of cases with normal arteries[33].

In the overall picture, however, true ischaemic pain should rarely confuse. The most usual cause is spasm and strain in the muscles and joints of the precordium[6]. Firm digital pressure usually identifies exquisitely tender spots. While in *acute* coronary disease it is prudent to err on the side of overdiagnosis, there is good reason not to do so with *chronic* chest pain syndromes. Here the risk of sudden death is low, not easily prevented, and erroneous diagnosis can readily evoke disabling neurotic illness, more grievous than the disease[34]. Associated muscle pains, particularly in the pectorals, shoulder girdle and neck, are very common, invariably exhibiting tender trigger spots.

Air hunger: Breathlessness *per se* is not common[30], but air hunger – a need to take a deep, satisfying breath, accompanied by a feeling of difficulty in inflating the lungs – is both common and highly suggestive. It is due to the characteristic over-inflation of the chest.

In the normal breathing range (35–45% of the vital capacity), inspiration is aided by recoil of the rib cage towards its position of rest (45% VC). Inflation of the chest above this volume is *opposed* by the elastic forces in the rib cage[35]. It demands extra effort, which is interpreted as inspiratory difficulty, evoking a desire for even larger breaths. This is readily appreciated by trying to breathe with the upper chest, while holding the thorax semi-inflated.

Dizziness or unsteadiness: These are among the commonest symptoms. Of 104 patients investigated at a dizziness clinic, hyperventilation accounted for 24%, while vascular disease (the usual suspect) accounted for only 4%[36]. Disturbed mentation, poor memory and depersonalization are very frequent.

Symptoms related to sympathetic dominance: These include tachycardia, dysrhythmias, dry throat, swallowing difficulty, tremors, emotional sweating, and bloating.

Panic disorder and phobic states

These are common psychic manifestations[37], but Allen and Agus[19] have shown that all the components of 'schizophrenic reaction, acute undifferentiated type' (DSM III), *including hallucinations*, can be produced by hyperventilation. The author has recorded hallucinations in 21 patients.

Ley[4] identified the symptoms of 'panic disorder' and 'generalized anxiety disorder' with those of hyperventilation, and stated that 'the panic attack consists of a synergistic interaction between hyperventilation and fear'. Similarly with agoraphobics, the symptoms of hypocapnoea *precede* the experience of fear. Garssen *et al.*[3] found that 60% of agoraphobes hyperventilated, and 60% of hyperventilators were agoraphobic. Gorman *et al.*[38] studying lactate-induced panic attacks, demonstrated a precipitous drop in Pco_2 at the point of panic. This occurred only in those who panicked. Salkovskis *et al.*[39] recorded substantial falls in $Paco_2$ during panic attacks in a patient undergoing renal dialysis.

Among 701 cases of chronic hyperventilation recently studied, panic attacks and phobic avoidance were the principal complaints in 344 (49%) (Lum, in preparation). Bonn *et al.*[40] found that breathing re-education in agoraphobics, when combined with

standard behavioural techniques, was so clearly superior to the latter alone that they did not feel it ethically justifiable to withhold this treatment from patients solely for academic research.

Allergies

The incidence of allergic manifestations in hyperventilators is high[41] and is related to the known increase in histamine production provoked by hyperventilation[42], presumably due to destabilization of mast cells. Most asthmatics breathe like hyperventilators and have a resting P_{CO_2} in the lower ranges of normal (personal observations).

Hyperventilators frequently have irritable bowel symptoms. Headaches, even migraine, are common. Many exhibit definite food intolerance. Similarly, many subjects of food allergy develop symptoms of hyperventilation[43]. The aetiological relationship is at present obscure.

In summary, it is clear that hyperventilation can mimic many organic diseases, and it frequently complicates them. It now must be recognized as a major factor in many neuroses, particularly panic disorder and phobic states. It is high time that it should be awarded the attention merited by 'one of the commonest afflictions of sedentary town dwellers'[1].

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