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# BREATH-HOLDING TIME IN THE SCREENING FOR REHABILITATION POTENTIAL OF CARDIAC PATIENTS

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**ABSTRACT. Since unsuccessful cardiac rehabilitation is usually associated with individuals whose psycho-social problems override or complicate their organic disease, it is important to identify this group. In a study comparing the patients evaluated at work evaluation units with those evaluated by their own physicians, it became apparent that most physicians did not recognize individuals with psycho-social problems. The simple measurement of breath-holding time offers a rapid screening device for individuals whose symptoms are based on hyperventilation of a functional nature, or those who simply are unwilling to try hard. An individual unable to hold his breath for at least 20 sec is a poor candidate for vocational rehabilitation. Physiological study of these individuals showed that most, although not all, tended to be chronic hyperventilators with low arterial $pCO_2$'s.**

Unsuccessful vocational rehabilitation of the cardiac patient has been found to be related more to the psycho-social than to either medical or vocational factors (6). Those with unsuccessful adaptation tend to be individuals with passive dependent personality structures who react to heart disease with either overconcern or denial of illness. Many of these individuals have symptoms due to hyperventilation rather than to their underlying disease. It would be valuable to be able to recognize such individuals by some rapid screening mechanism.

Patients examined over a four-year period at a cardiac work evaluation unit were traced by re-examining them at the unit and by having their private physician return a questionnaire. A follow-up questionnaire from their private physician was similarly obtained during the same period for a comparable group of patients discharged with a diagnosis of myocardial infarction from the two university hospitals of the State University of New York at Buffalo (8). Although severity of disease was comparable, as might be expected the patients referred to the work evaluation unit had more occupational problems than the other group. The composition of the two groups is given in Table I.

Fifty-two of 68 of the work evaluation unit patients and 46 of the 61 hospital follow-ups were reemployed. There were 33 individuals in both groups who never returned to work. Nine of these (27%) were primarily due to the presence of psychological or social factors.

When these factors were examined, it was found that those in the work evaluation unit had more problems identified than those seen by private physicians. All patients seen at the unit had been interviewed by a counselling psychologist. No projective testing was done, but in depth interviewing was carried out. In the control group the patient's physician was asked to express an opinion on the various factors named. Table II summarizes these results. With the exception of anxiety neurosis, physicians fail to recognize, or to admit recognizing, other social and psychological problems existing in their patients.

As part of their work-up, all patients examined at the work evaluation unit had a determination of standard breath-holding time. The breath-holding time was measured by instructing the individual to take a maximum inspiration, a maximum expiration, and then another maximum inspiration and to hold it at that point as long as he possibly could, until the uncontrollable urge to "let go" would force him to exhale, and then to do so all at once. Timing was accomplished with a stop watch from the time of maximum inspiration to the sudden expulsion of air. Eighty-five patients at the work evaluation unit were

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Table I. *Composition of sample*

| | W.E.U. | Hosp. |
|---|---|---|
| Non-white | 3 | 3 |
| Male | 66 | 52 |
| Female | 2 | 9 |
| Under 40 | 11 | 2 |
| 40–49 | 17 | 18 |
| 50–59 | 33 | 37 |
| 60–64 | 5 | 3 |
| Over 65 | 2 | 1 |

Table II. *Social factors*

| | W.E.U. | Hosp. |
|---|---|---|
| Excessive drinking | 5 | 1 |
| Suspicious and hostile | 3 | 2 |
| Poor cooperation | 8 | 2 |
| Poor supervision | 7 | 0 |
| Minimal motivation | 14 | 2 |
| Anxiety neurosis | 12 | 8 |
| Other social factors | 22 | 1 |

Table III

| | Cases | BHT | Range |
|---|---|---|---|
| Normal and Class I | 16 | 48± 10 | 28–65 |
| Class 2 and 3 | 53 | 39± 15 | 11–75 |
| Pulmonary emphysema | 3 | 23± 2 | 21–27 |
| Functional disease | 13 | 15± 6 | 7–45 |

thus examined, including those reported above. The additional patients were those with non-coronary disease.

Table III summarizes the results of breath-holding tests. It can be seen that there is a rough, but not statistically significant, relationship between breath-holding time and functional classification. All patients who had normal hearts, or had organic heart disease without functional components, as well as the emphysema patients, could hold their breath for at least 20 sec. Those with pure functional disease, or with organic disease and strong functional components, could hold their breath for less than 20 sec. The functional patterns were independently identified by the psychologist, and those without functional overlay were similarly identified. Only one patient classified as primarily functional had a breath-holding time over 20 sec, and only one of the nonfunctional cases had a breath-holding time under 20 sec, and this individual was a congenital spastic. It is significant that the three individuals with clinical emphysema and hyperventilation (but with hypercapnia) had normal breath-holding times.

The end-alveolar $pCO_2$ and arterial $pCO_2$ at the breaking point were measured in an additional 90 patients with varying diagnoses. The results were essentially the same. Fig. 1 is a plot on a $pO_2$–$pCO_2$ diagram of the breaking point values for the two groups. Those whose breath-holding times were over 20 sec are skewed upward by the emphysema patients, and those under 20 sec are skewed downward by pulmonary fibrosis of the Hamman-Rich type. Severe mitral stenosis, multiple pulmonary emboli, metabolic acidosis and class 4 disease might also be expected to have short breath-holding times, since they are all characterized by chronic hyperventilation with hypocapnia, but no such patients were tested. The average $pCO_2$ at the breaking point of the short breath-holders showed no significant difference from the average breaking point $pCO_2$, suggesting that not all of the functional group were true hyperventilators.

It is known that an interaction of several factors determines the breaking point of voluntary breath-holding (7, 10). Among these are anoxia, hypercapnia, and neurogenic proprioceptive stimuli arising from within the chest. These factors are influenced by the size of the lung volume at which the breath is held (1, 9), and by movement of the chest wall and lung during which gas com-

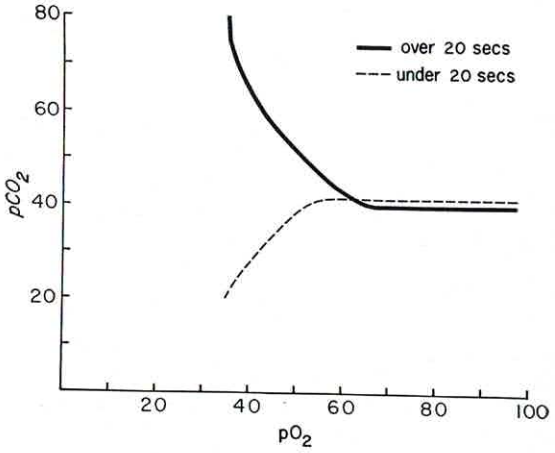


*Fig. 1.* Plot of $pCO_2$ and $pO_2$ at breaking point for those able to hold breath over 20 sec and those under 20 sec.

position is not altered (4). Psychogenic factors are also important.

Short breath-holding times appear characteristic of anxiety states, particularly those accompanied by hyperventilation (2, 3, 12). It has been suggested that determination of breath-holding time might be used to screen potential members of the armed forces who are prone to develop neurocirculatory asthenia (3).

The end point can be sharpened by having the patient voluntarily hyperventilate for 15 sec before holding his breath (5). Normal individuals will then be able to hold their breath longer than before the hyperventilation, breaking at essentially the same $pCO_2$ valve. The functional cases will have a further diminution of their breath-holding time, and may lose their breath-holding ability completely. The $pCO_2$ at the breaking point is usually considerably lower than before the hyperventilation. Acute hyperventilation prolongs breath-holding time, chronic hyperventilation shortens breath-holding time, a situation well known to altitude physiologists (11).

It is now suggested that the determination of breath-holding time is an effective screening test for rehabilitation potential. Those individuals capable of walking into the examining room who are not able to hold their breath for at least 20 sec have either primary functional disease, or are not trying. In either event, their rehabilitation potential is impaired. The few false positive cases with organic hyperventilation conditions can be eliminated on other clinical grounds.

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