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AMBULATORY HEART RATE CHANGES DURING PANIC ATTACKS

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Summary—Ten patients suffering from panic attacks were studied in an effort to test the feasibility of measuring panic attacks via 24-h ambulatory heart rate monitoring. Subjects were also asked to record their activity level, anxiety level, and level of panic at 15-min intervals. Seven of the 10 patients reported panic attacks during the 24-h recording period; one patient reported two panic attacks. Three of the eight panic episodes demonstrated significant heart rate increases relative to activity level. Results suggest that ambulatory monitoring of panic attacks may be most useful with patients who suffer from more frequent and severe panic attacks and who have high heart rates (> 110) during these attacks.

INTRODUCTION

THE ROLE of panic attacks in the development and maintenance of agoraphobia has received increased attention. Suppression of panic attack is used as a criterion for treatment effectiveness, and reduction of panic attack frequency may occur independently from change in behavior related to agoraphobia (ZITRIN *et al.*, 1978, 1980; TYRER *et al.*, 1973; SOLYOM *et al.*, 1973; KELLY *et al.*, 1970; MOUNTJOY *et al.*, 1977; SHEEHAN *et al.*, 1980). Unfortunately, few studies measure panic attacks, and those that do rely solely on patients' global self-report to determine whether panic attacks have been reduced. A potentially useful method for assessing panic attacks would be to measure them physiologically, using ambulatory heart rate monitors. LADER and MATHEWS (1970) monitored three panic attack subjects in the laboratory with a variety of measures while the subjects experienced acute panic attacks. The most dramatic physiological changes occurred in heart rate where increases from 40 to 51 bpm were seen. Such changes should be differentiable from the normal fluctuation in heart rate except as might occur during physical exercises.

However, we have previously reported on a method for categorizing ambulatory heart rate and activity relationships into 5-min periods of normal activity (for that person), physical activity (high heart rate, high activity), downtime (low heart rate, low activity), which solves this problem (TAYLOR *et al.*, 1982). Presumably panic attacks would produce significant changes in heart rate during periods of no or low activity. This heart rate activity pattern would be reflected as a separate "anxiety" period relative to other 5-min periods.

This study was undertaken to determine whether the categorization method described above could be used to detect panic attacks. If so, it would be possible to monitor heart

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rates over long periods of time to produce a more reliable measure of the effects of interventions aimed at reducing panic attacks.

METHODS

Ten patients who reported experiencing panic attacks were recruited to the study. Each patient was first interviewed by a psychiatrist to determine primary diagnosis, using DSM-III criteria (AMERICAN PSYCHIATRIC ASSOCIATION, 1980). Each subject was then equipped with a Vitalog MC-2 monitor and instructed to wear it for 24 h.* The MC-2 is a solid-state CMOS microcomputer, interfaced to a read-only memory and a random access memory, a motion sensor, and an analog R-wave detector connected to the chest by electrocardiograph electrodes. The microcomputer contains 36,864 bits of CMOS random access memory. The MC-2 measures $4 \times 8 \times 12$ cm, weighs 0.5 kg, and is worn on the belt. The motion sensor which is attached to the lateral thigh by an elastic band or tape consists of six liquid mercury switches aligned on the faces of a cube.

The microcomputer is programmed to store eight levels of physical activity representing a mean number of activations of the mercury switch over a predetermined period. One-minute samples of physical activity were used for this study. The total of heart beats per minute during 1-min epochs was then stored in one of 16 bins, each representing 10 heart beats per minute over the range 35–44 to 155–164, with an additional bin for heart rates less than 35 and one for heart rates of 165 and above. The device has a high-speed serial interface which reads the entire memory in less than 5 s. At the end of data collection, the memory is read out on minicomputers for storage, which stores data on heart rate and physical activity on a minute-by-minute basis for up to seven days and quickly transfers these data to another microcomputer for data analysis.

Subjects also completed a diary, which asked them to record every 15 min their activity level, anxiety, and level of panic using three separate scales. Each scale consists of points numbered such that 0 equals no exercise, anxiety, or panic and 7 equals high levels of exertion, maximum anxiety, or severe panic attack on the respective scales. Upon returning, results of the heart rate and self-report monitoring were reviewed with each patient. The heart rate-activity data were categorized into one of five categories, using the procedure previously reported (TAYLOR *et al.*, 1982). Briefly, data representing mean heart rate and mean physical activity are collapsed into 5-min periods. We then create a regression of physical activity on heart rate in order to create these categories:

1. *Usual activity*
   Any activity which does not fit any of the following categories.

2. *Physical exercise*
   The combination of a heart rate recorded at any activity level of 4 METs on a treadmill or greater and an activity score in the upper 25th percentile. (METs is the standard measure of workload on the treadmill.) Four METs was chosen as the dividing line between usual activity and physical exercise, because it represents a moderate level of effort which is not exceeded by most persons during most of their usual activities.

*The MC-2 can be obtained from the Vitalog Corporation, 1058 California Avenue, Palo Alto, CA 94306, U.S.A.

3. *Downtime*

The combination of the lowest quartile of activity scores and heart rates.

4. *Anxiety*

The combination of a physical activity score below the upper quartile and a heart rate which equals or exceeds that recorded at 4 METs. For a brief interval following physical exercise, heart rate is high and physical activity is low. To distinguish these periods from anxiety, the 10 min following physical exercise are assigned to a special category known as "recovery".

5. *Missing*

More than half the data points were missing during any 5-min period of output.

6. *Unknown*

Very low levels of heart rate (< 35 bpm) not associated with physical exercise, downtime, or missing categories.

The occurrence of a 5-min "anxiety" period during a self-reported panic attack was classified as an agreement between self-reported panic attacks and a Vitalog record.

RESULTS

Mean age, sex, and diagnosis for the 10 subjects can be seen in Table 1. Five patients were diagnosed as having agoraphobia with panic attacks, and five had panic disorder. Table 1 also shows the basic self-report data for all 10 subjects. The length of panic attacks is reported in 15-min intervals. The heart rate (HR) maximum during the panic attack was recorded from the Vitalog MC-2 record. If the heart rate/activity relationship was categorized by the heart rate/activity statistical program (TAYLOR *et al.*, 1982) as "anxiety" during a period when the subject reported a panic attack, this was reported as agreement (yes) between panic attack (PA) and Vitalog (VIT). As evident in Table 1, seven of the 10 patients reported panic attacks during the 24-h recording period. Panic attacks ranged in severity from 0.5 to 7 and from a few seconds (Case No. 5 noted the exact length of her panic attack in her diary) to two hours. Three of the eight panic episodes demonstrated heart rate activity relationships which were significantly different from all other 5-min periods noted during the recording period. These three episodes occurred with very high heart rates, ranging from 115–148 bpm and lasting for at least several minutes. An example of a typical panic attack noted on the Vitalog can be seen in Fig. 1.

One panic attack occurred during a high heart rate (135 bpm) but was not evident as an "anxiety" period on the Vitalog statistical program because the subject was physically active at the same time. Four other self-reported panic episodes did not occur with elevated heart rates and were not detected with the statistical heart-rate activity program.

The four patients with high heart rates during a panic attack (bpm > 110) had self-reports of more than one panic attack per week and an intensity rating of 3 or greater during the attack. The six patients who did not meet these criteria either had no panic attacks or heart rates < 110 during panic attacks. The product-moment correlation coefficients between panic attacks, anxiety during panic attacks, and other variables can be seen in Table 2. As is evident, severity of panic attacks was significantly correlated with severity of anxiety reported concurrently and with heart rate. The frequency of panic attacks was also significantly correlated with maximum heart rate.

TABLE 1. SUMMARY OF DEPENDENT MEASURES AND DEMOGRAPHICS BROKEN DOWN BY SUBJECT

Subject	Diagnosis	Age	SR of PA per week	PA on SR diary Intensity	PA on SR diary Length	Anxiety during PA	HR max during PA	PA on VIT	$\bar{X}$ daily anxiety	Daily anxiety Min	Daily anxiety Max
1	Panic disorder	45	< 1	0	—	—	—	—	< 0.5	0	1
2	Panic disorder	56	< 1	0	—	—	—	—	0.7	0	2
3	Panic disorder	22	1–2	0	—	—	—	—	1.0	0	1
4*	Agoraphobia with PA	40	7	1	15	6	100	No	2.7	1	7
				1	15	7	90	No			
5	Agoraphobia with PA	37	1	0.5	15	1	80	No	0.05	0	2
6	Panic disorder	39	7	5	60	6–7	135	No	3.0	2	7
7	Agoraphobia with PA	24	1	2–3	30	2–3	90	No	1.0	0	3
8	Panic disorder	42	2–3	3	30	6	115	Yes	2.2	0	6
9	Agoraphobia with PA	28	7–14	7	120	7	125	Yes	1.6	0	7
10	Agoraphobia with PA	50	1–2	7	15	—	148	Yes	—	—	—

Note: SR refers to self-report, PA to panic attack, VIT to Vitalog MC-2 statistical program, HR to heart rate (beats per minute). See text for further details.
*Subject No. 4 had two panic attacks while being monitored.

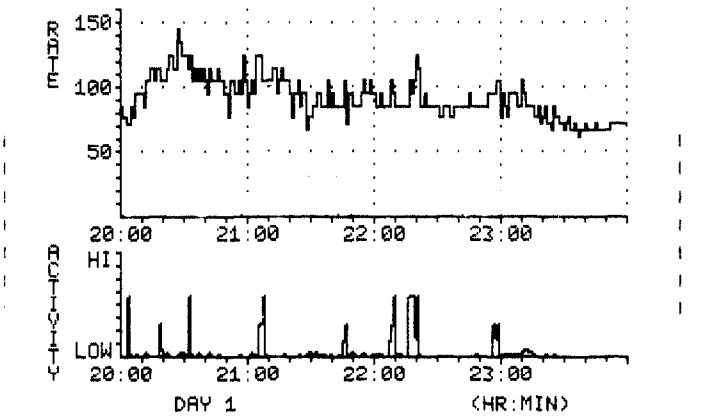

FIG. 1. Illustration of subject's heart rate and activity during a typical panic episode.

TABLE 2. CORRELATIONS FOR PANIC LEVEL, ANXIETY AND MAX HR DURING PANIC ATTACKS; SELF-REPORTED $\bar{X}$ DAILY ANXIETY AND PANIC ATTACK FREQUENCY

		1	2	3	4	5
1	Panic level	—	0.629	0.857*	−0.089	0.358
2	Anxiety during PA	—	—	0.907*	0.574	0.836**
3	MAX HR during PA	—	—	—	0.23	0.37
4	$\bar{X}$ daily anxiety	—	—	—	—	0.47
5	PA frequency	—	—	—	—	—

*$p < 0.01$; **$p < 0.05$.

DISCUSSION

In this study we found that in some patients with panic disorder or agoraphobia, panic attacks could be identified using ambulatory heart rate/activity patterns normalized over the recording period. The panic attack intensity was significantly correlated with heart rate during panic attack, and presumably subjects who report intense and frequent panic attacks would be the best subjects for ambulatory monitoring to determine the effect of psychological or medical interventions on panic attack frequency. Of the four panic attacks which occurred with high heart rates (> 110), three were identified by the heart rate/activity statistical program described in the paper. The fourth was not classified as "anxiety", because the subject was physically active at the same time. If subjects are instructed to and could remain relatively inactive during panic episodes, such misclassification could be avoided. It also seems that panic attacks in the natural environment produce changes in heart rate as great as those reported in the laboratory (LADER and MATHEWS, 1970).

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