Brit. J. Psychiat. (1979), **135**, 62–66

The Relationship between Wrist-Monitored Motor Activity and Serum CPK Activity in Psychiatric In-Patients

By DAVID J. GOODE, HERBERT Y. MELTZER, ROBERT MORETTI, DAVID J. KUPFER and RICHARD J. McPARTLAND

SUMMARY **Motor activity, monitored by a wrist motion transducer, was related to serum CPK activity the following morning in a group of psychiatric in-patients. In 4 of 10 patients, studied for periods exceeding one week, total 24-hour activity was significantly correlated with morning serum CPK activity. Motor activity during the night was unrelated to serum CPK activity. In a larger group of 30 patients, studied for one or two-day periods, inter-individual differences in activity level were not related to serum CPK activity, although both sex and race were significantly related to variance between subjects in that activity.**

The occurrence of elevated serum CPK activity in the psychoses, especially during the early phase of the acute psychotic episode, has been reported by a number of investigators (Bengzon *et al*, 1966; Coffey *et al*, 1970; Gosling *et al*, 1972 a and b; Schweid *et al*, 1972; Tropeano *et al*, 1972; Guterman, 1973; Kupfer and Foster, 1973; Meltzer, 1975; Ikeda *et al*, 1977). However, other investigators have not found significant increases in serum CPK activity in newly admitted psychotic patients (Warnock and Ellman, 1969; Cunningham *et al*, 1974; Harding, 1974). Thus, there is a need to explore these discrepancies.

A number of factors secondarily associated with the psychotic episode, which might contribute to the serum CPK activity increase in psychotic patients such as intramuscular injections (Meltzer, 1969a), stress (Meltzer, 1969b) and sleep deprivation (Kupfer and Foster, 1973). However, it has been determined that these variables do not contribute significantly to the increases in serum CPK activity observed during the psychotic episode (Meltzer, 1975). Since physical activity is frequently increased during a psychotic illness, the role of such activity as a causative factor in increased serum CPK activity at that time is significant. Goode *et al* (1977) have shown that intense struggle against leather limb restraints for one hour causes large serum CPK activity elevations in normal subjects. Re-analysis of data reported by Meltzer and colleagues, eliminating serum CPK elevations observed within 72 hours of use of leather limb restraints, revealed increased serum CPK activity to occur in a high proportion (74.7 per cent) of hospitalized psychotic patients (N = 281) despite such elimination. Of these patients, 26.7 per cent were observed to have serum CPK elevations at the time of admission and 48.0 per cent during later phases of hospitalization (Meltzer, unpublished data). Strenuous exercise has also been shown to produce increased serum CPK activity in both normal subjects (Bauman *et al*, 1962; Griffiths, 1966; Ahlborg and Brohult, 1966, 1967; Nuttal and Jones, 1968; Rasch and Schwartz, 1972) and in patients recovering from psychotic episodes (Meltzer and Moline, 1970; Goode and Meltzer, 1976). Increased levels of serum CPK produced by isotonic and isometric exercise in psychotic patients do not

differ significantly from those of control subjects (Meltzer and Moline, 1970; Goode and Meltzer, 1976).

Serum CPK activity was significantly correlated with nurses' ratings of general motor activity in a study of hospitalized psychotic patients (Meltzer, 1975). Soni (1976) also reported that clinical ratings of psychomotor activity correlated significantly with serum CPK activity in hospitalized psychotic patients, particularly in those patients who experienced extreme hyperactivity. Kupfer and Foster (1973) studied serum CPK activity and motor activity, measured by a motion transducer worn on the non-dominant wrist, in hospitalized psychotic patients. Serum CPK activity was correlated significantly with level of motor activity, but only a small portion of the variance in serum CPK activity could be related changes in motor activity level. We have observed transient increases of serum CPK activity in several hospitalized psychotic patients who engaged in strenuous physical activities (Goode, Mazura and Meltzer, unpublished data).

Using a motor activity measure similar to that of Kupfer and Foster (1973), we attempted to evaluate: (a) the extent to which motor activity level is related to serum CPK activity changes over time in a given individual; (b) whether inter-individual differences in serum CPK activity are related to differences in level of motor activity; and (c) whether activity levels during the night are more critically related to morning serum CPK activity than day-time activity levels.

Methods

All subjects were in-patients on a research ward at the Illinois State Psychiatric Institute. No attempt was made to select one diagnostic category, but all patients were hospitalized for treatment of psychotic symptoms. The diagnostic breakdown of the study population was: schizophrenia 15; affective psychosis 8; schizo-affective psychosis 3; unspecified psychosis 2 and psychosis secondary to drug abuse 2. Blood was drawn daily, from Monday to Friday, at 8 a.m. for serum CPK determination by the method of Rosalki (1967). Motor activity level was measured by a motion-transducer with digital read-out, worn on the non-dominant wrist (Kupfer and Foster, 1973). Activity readings were made at 9 a.m., 3 p.m. and 9 p.m.; and reported subsequently as total 24 hour activity and 'night activity' (9 p.m. to 9 a.m.). Day, night, and total 24 hour activity levels were compared with serum CPK activity levels obtained the following morning.

Results

Basic data collected for each patient consisted of total 24 hour and night (9 p.m.—9 a.m.) motor activity, as well as serum CPK activity on the following morning, plotted for each day. Generally, night activity comprised only a small proportion of total activity; in patient 5, night activity did not correlate significantly with serum CPK activity ($r = 0.44$, P = n.s.) whereas total activity for the 24-hour period did ($r = 0.750$, $P < 0.05$). Similar data from ten patients studied over periods of time, five days or more, are summarized in Table I, in which three correlation coefficients are presented for each subject: the first relating total 24-hour activity to serum CPK activity the following morning; the second, night activity to CPK; and the third, 24-hour activity to night activity. In four out of ten subjects, total activity correlated significantly with serum CPK activity, while in only one out of eight subjects was night activity correlated with serum CPK activity.

To investigate the relationship between motor activity and differences in serum CPK activity between individuals, 30 patients were studied for single or two-day periods. It is well known that there are sex-race differences in serum CPK activity, levels being highest among black males and lowest among white females (Meltzer and Holy, 1974). Table II gives the mean CPK and mean motor activity of all subjects studied, categorized by sex and race. Mean serum CPK activities of the sex-race groups studied are distributed as would be expected, with black males having the highest scores and white females the lowest. However, mean motor activity levels did not parallel the sex/race differences observed for serum CPK activity. Analysis of variance (ANOVA) of serum CPK activities between sex/race groups

TABLE I

Correlation coefficients relating 24 hour total motor activity and night motor activity to morning serum CPK activity and total motor activity to night motor activity

Patient	Number days studied	Total activity vs CPK		Night activity vs CPK		Total activity vs Night activity	
	N	R	P	R	P	R	P
1	8	0.143	N.S.	—	—	—	—
2	12	0.660	0.05	0.346	N.S.	0.831	0.05
3	8	−0.020	N.S.	0.067	N.S.	0.594	N.S.
4	6	−0.560	N.S.	−0.275	N.S.	0.840	0.05
5	9	0.750	0.05	0.444	N.S.	0.038	N.S.
6	5	−0.495	N.S.	—	—	—	—
7	4	0.975	0.05	0.985	0.05	0.998	0.05
8	4	0.582	N.S.	−0.610	N.S.	−0.064	N.S.
9	4	−0.342	N.S.	−0.367	N.S.	0.992	0.05
10	4	0.989	0.05	0.642	N.S.	0.747	N.S.

TABLE II

Mean activities and mean CPK values of all study patients by sex and race

	White females	White males	Black females	Black males
Mean activity	393.8	270.8	271.7	340.6
S.D.	88.3	146.3	138.1	140.1
N	5	10	6	9
Mean CPK	23.0	41.5	63.3	93.0
S.D.	6.9	23.8	24.4	71.8
N	5	10	6	9

was significant ($F = 3.558$, $P < 0.05$, d.f. $= 3.29$), but the difference between high and low activity patients was not ($F = 1.164$, $P =$ n.s.).

Discussion

In four out of ten psychiatric in-patients, studied for one week (effectively 4 days) or longer, morning serum CPK activity was significantly correlated with 24-hour motor activity, measured on the preceding day. In the other patients studied, insignificant or negative correlations were observed. It is possible that a greater number of significant correlations might have been observed, had the observation period been longer for many of the patients studied. In these subjects, serum CPK activities rarely exceeded normal limits during the observation period and the variations in activity level from day to day rarely exceeded two-fold changes. However, serum CPK activities beyond the upper limits for sex/race norms have been observed in several patients the morning after strenuous exercise in a gym (Goode and Meltzer, 1976).

Night activity from 9 p.m. to 9 a.m. was strongly correlated with morning serum CPK activity in only one of the ten study subjects. Kupfer and Foster (1973) found night activity to be most highly correlated with morning serum CPK activity in a group of psychotic patients. The discrepancy in these findings may be due to the fact that most patients in our study were receiving psychotropic medication,

https://doi.org/10.1192/bjp.135.1.62 Published online by Cambridge University Press

administered twice daily orally in equal doses at 9 a.m. and 9 p.m. The sedative effects of such medication may have obscured variations in motor activity at night in our patient group, although the 9 a.m. dose did not apparently interfere with day-time motor activity. However, phenothiazine-induced effects may have obscured activity-CPK relationships in at least some of the patients, in whom we failed to observe this correlation.

Differences specific for both sex and race have been observed in serum CPK activity levels in normal subjects engaging in routine daily activities (Meltzer and Holy, 1974). It is clear from our study that in some subjects, intra-individual variations in serum CPK activity are related to motor activity fluctuations. However, a contribution of motor activity to inter-individual differences in serum CPK activity was not demonstrated in our study. In 30 psychiatric in-patients, variation in serum CPK activity due to both sex and race was significant by ANOVA, while variation due to motor activity was not, and there was no significant interaction between sex/race and motor activity. Thus, differences in motor activity were not related to inter-individual differences in serum CPK activity. Inter-individual differences in CPK activity, such as those documented for sex and race (Meltzer and Holy, 1974) are likely due to other variables, such as differences in muscle cell permeability to enzymes or muscle mass.

Serum CPK activity elevations associated with acute psychotic episodes are generally higher than those observed in our study population. The increased motor activity of the acutely agitated patient must play at least a partial role in producing the large elevations which occur in acute psychotic states, although large elevations have also been observed in acutely depressed patients who had little gross motor activity. Because of the fragility of the wrist motion-transducer and lack of co-operation, accurate measures of motor activity in the acutely agitated psychotic patient are difficult. It is possible that extremes of motor activity may produce large elevations of serum CPK, but elevations comparable to those sometimes seen during acute psychosis have not been observed after very strenuous exercise (Ahlborg and Brohult, 1966, 1967; Bauman *et al*, 1962; Griffiths, 1966; Nuttal and Jones, 1968; Rasch and Schwartz, 1972). Previous observations in our laboratory have demonstrated that intense struggle against leather limb restraints may produce large elevations of serum CPK activity in normal subjects (Goode *et al*, 1977). Specific forms of motor activity, or motor activity associated with stress (such as the psychological stress of helplessness) may be capable of producing large serum CPK activity increases in humans. This hypothesis has found some support in studies of restraint stress in rats, in which helplessness to avoid painful tail shock produced larger serum CPK activity increases, compared to animals which could avoid tail shock by bar-pressing (Spiga and Meltzer, unpublished data). In this study, both helpless and bar-press control animals received identical tail shocks. Serum CPK activity elevations in some acutely psychotic patients may reflect the combined effects of greatly increased motor activity and stress.

Acknowledgements

This work was supported in part by grants MH–16127 and MH–30938. Dr Meltzer is a recipient of RCSA MH–47808. Grateful acknowledgement is made to the staff of the 10 West research unit for their enthusiastic support of this work.

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David J. Goode, M.D., *Associate Professor of Psychiatry, Bowman Gray School of Medicine of Wake Forest University, Winston-Salem, North Carolina 27103,*
Consultant for Research Development, Broughton State Hospital, Morganton, North Carolina,

Herbert Y. Meltzer, M.D., *Professor of Psychiatry, Pritzker School of Medicine, University of Chicago, 950 East 59th Street, Chicago, Illinois 60632,*
Director, Laboratory of Biological Psychiatry, Illinois State Pyschiatric Institute, 1601 West Taylor Street, Chicago, Illinois 60612,

Robert Moretti, *Psychologist, Illinois State Psychiatric Institute, 1601 West Taylor Street, Chicago, Illinois 60612,*

David J. Kupfer, M.D., *Professor of Psychiatry, University of Pittsburgh School of Medicine, and Director of Research, Western Psychiatric Institute and Clinic, 3811 O'Hara Street, Pittsburgh, Pennsylvania 15261,*

Richard J. McPartland, *Research Assistant Professor of Psychiatry, University of Pittsburgh School of Medicine, 3811 O'Hara Street, Pittsburgh, Pennsylvania 15261*

(*Received 10 April 1978*)