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EFFECTS OF BIOFEEDBACK AND COGNITIVE THERAPY ON STRESS IN PATIENTS WITH BREAST CANCER[1]

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Summary.—The effects of psychological intervention on multilevel stress responding in 25 patients newly diagnosed as having breast cancer were studied. Specifically, biofeedback and cognitive therapies were employed as treatments with 24-hr. urinary cortisol and state anxiety as dependent variables. The proportion of treated patients showing improvement exceeded that of non-treated patients on both variables. Most significantly, cortisol levels among the 12 treated patients were reduced relative to those of control patients. These results are discussed for their relevance to psychoimmunology.

Major attention has been given in the past decade to the description and treatment of psychological and physiologic responses to life stress, with the cancer diagnosis as one well documented example. In some studies cancer treatments are related to specific psychosocial stress symptoms such as aversive reactions to chemotherapy (Peck & Boland, 1977; Mitchell & Glicksman, 1977; Burish & Lyles, 1981). Unfortunately, psychosocial oncology has generally not involved study of stress physiologically. As a result, psychosocial clinical trials contribute little to the development of treatments for the control of variables that hypothetically mediate cancer survival and immunosuppression; see Solomon (1985) for a review of current hypotheses about immunosuppression.

There are few exceptions (Rose, 1980) to the reliable relationship between psychological stress and function of the adrenal cortex (Brady, 1967; Mason, 1972). Some cancer researchers have demonstrated an association between the presence of tumours (a psychosocial stressor) and neuroendocrine production. For instance, Soviet researchers documented elevated steroid and catecholamine production in 68% of postoperative rectal cancer patients (Genzdilov, Alexandrin, Simonov, Evtjuhin, & Bobrov, 1977). Similarly, Kissen and Rao (1969) showed that lung cancer patients are higher than non-cancer controls in mean excretions of 17-hydroxycorticosteroids over the initial period of posthospitalization. Others have published similar findings (Werk, 1960) and have extended this work into psychoimmunology (Britton, 1975). To date no published studies of psychological interventions with stressed cancer

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patients have demonstrated a relationship between positive outcomes of psychosocial treatment and stabilization of steroid levels.

Although psychophysiologic responses are common among cancer patients, there is little evidence of effective techniques for alteration of a psychoendocrinological stress response. The present study assessed effects of biofeedback and cognitive therapy on state anxiety and cortisol production.

METHOD

Subjects

Twenty-five female patients with a Stage I breast tumour and no previous cancer were recruited by the Research Assistant within 6 wk. of the first diagnosis of cancer. No patient received chemotherapy during the study. All 25 patients completed participation in the psychosocial intervention trial but six did not submit the final urine sample and could not be included in analysis of cortisol data. The final sample of 19 patients was divided as follows: seven who had been randomly assigned to biofeedback treatment (mean age 49.0 yr.), five to cognitive therapy (mean age 51.2 yr.), and seven to a no-treatment condition (mean age 51.6 yr.).

Despite an association of age with cortisol production among some patient groups (Asnis, Sachar, Halbreich, Nathan, Novacenko, & Ostrow, 1981) there was homogeneity on age for present patients, and the correlations between age and cortisol were nonsignificant ($rs < 0.20$).

An analysis was conducted on differences within-treatment group-baseline on the dependent measures between those 19 who did and those six who did not complete all tests for cortisol level. The analysis yielded no significant differences ($Fs < 1.0$). Therefore, tests of the *a priori* anxiety hypothesis are based on the full sample of 25 patients (10 given biofeedback, five cognitive therapy, and seven no-treatment).[2]

The present study included a follow-up assessment. No patient received chemotherapy in the 8-mo. follow-up period, although two patients received cobalt therapy. A multiple discriminant analysis did not distinguish cortisol level, cortisol change, or state-anxiety levels in cobalt-treated patients from patients who did not receive this treatment within the follow-up period.

Measures

The dependent measures were collected at intake, at the termination of psychological intervention, and 8 mo. later.

State anxiety was assessed by the Spielberger State-Trait Anxiety Inventory (A-State; Spielberger, Gorush, & Lushene, 1970). This is a self-report scale which requires patients to indicate how they feel at a particular time.

[2]Initially the groups were of unequal size because disease restaging after original group assignments had been made eliminated five patients from a Stage I diagnosis.

Reported internal consistency (K-R 20) reliability coefficients range between .83 and .94. State-anxiety as opposed to trait-anxiety was assessed to retain compatibility with the other dependent variable, cortisol, which is also a state measure.

Urinary cortisol was measured on a 24-hr. sample by a commercial lab using a competitive binding method called the Gamma Coat Cortisol Radioimmunoassay procedure (Hartley, Mason, Hogan, Jones, Kotchen, Mougey, Wherry, Pennington, & Ricketts, 1972). Inter- and intraassay coefficients of variation ranged between 5.7% and 11.3%.

Treatment

All treatment was provided by a clinician with a Bachelor of Social Work degree and 6 yr. of clinical experience. She also collected all test data, was not given access to the results of the anxiety and cortisol assessments during treatment in an attempt to minimize therapist bias. Her work was supervised by the principal investigator, a PhD-level clinical psychologist with experience in biofeedback, cognitive therapy, and therapist training/supervision.

Biofeedback.—Training was conducted over 8 wk. in 10 biweekly, 45-min. sessions followed by three once-weekly sessions. Room temperature was held constant at 22°C. The first third of each session consisted of EMG training, with alternate weeks focusing on nondominant forearm extensor and frontalis muscles. The second third of each session consisted of thermal training on the distal phalange of the middle finger. In the last 15 min. of each session, the therapist reviewed the patient's progress and suggested daily home-work exercises.

Patients were given a rationale for learning a relaxation response, centered on Cannon's "fight or flight" theory (Cannon & de la Paz, 1911). Jacobsonian progressive relaxation procedures were taught, and patients were instructed in methods for deep breathing and relaxing the forehead, eyes, jaw, and arms. Finally, patients were instructed to listen to the pitch of a tone which varied linearly with either EMG level or temperature.

Cognitive therapy.—Patients were seen for 8 wk. in the same format as biofeedback patients. They were given a rationale for stress-coping training which emphasized that specifiable maladaptive cognitions mediate negative emotional and physiologic levels, i.e., that stress-coping entailed positive imagery, self-talk evaluation, and relaxation training. Cognitive therapy proceeded in three phases as outlined below.

In Education, Sessions 1-2, patients completed the Inventory of Current Concerns (Weisman & Worden, 1976) as a means of identifying concerns and possible dysfunctional attitudes underlying these concerns. Also, they were taught to check their anxiety levels before and after reevaluation of dysfunctional thoughts. Finally, effective coping behaviors were discussed.

In Rehearsal, starting with Session 4, patients continued with the above and were also taught progressive muscle relaxation. No biofeedback instrumentation was used. When in a relaxed state, the patient was asked to imagine stressful situations and then to picture herself coping by using positive self-talk, imagining success, and the effective coping behaviors discussed in Sessions 1 to 3. Finally, as homework, the patient was asked to expose herself intentionally to stressful situations and to practice using the material covered in the sessions.

In Application, patients were given two final sessions of practice in relaxation and imagery, and three sessions to discuss the results of stress coping (i.e., relaxation while monitoring self-statements produced under stress). Imaginal and live role-playing were used extensively in this phase of treatment.

No treatment.—Patients assigned to this condition were told the purpose of the study and asked to participate. None was offered counselling, support, or education by the therapist.

Procedure

Patients were identified from the listing of all Stage I consecutive registrations in Southern Alberta who would be followed within Metropolitan Calgary. The Research Assistant asked each patient for her voluntary participation in a study on "coping with cancer" within six weeks of surgery for Stage I breast disease. All patients gave written informed consent to indicate that they understood that the purpose of the study was to investigate the efficacy of psychosocial interventions for stressed cancer patients. It was emphasized that patients did not have to perceive themselves as stressed and that their involvement would have no bearing on their clinic visits with the oncologist. Participants were randomly assigned to a group and were asked to complete the A-State scale and a 24-hr. urine collection within the next five days. At 8 wk. and at 8 mo. these assessments were repeated. After 10 min. of sitting quietly, 5-min. means for resting frontalis electromyograph (EMG) level and nondominant middle-finger skin temperature were obtained. EMG measurements were made with bipolar surface electrodes at Fp1 and Fp2 forehead positions according to the International EEG 10-20 system; skin-temperature measurements were taken with a thermistor placed on the most distant phalange of the dominant middle finger. The Autogenic Systems, Incorporated (ASI) Feedback Electromyograph, Model 1100 and ASI Feedback Thermometer, Model 2000b were used for these recordings. Integrated 5-min. readings were made with ASI, Model 5100 digital integrators. A-state, urine, EMG, and temperature measurements were repeated for all patients at 8 wk. and 8 mo. thereafter for follow-up.

RESULTS

Means on the dependent measures are presented in Table 1 and are ex-

TABLE 1

PRE- AND POSTTREATMENT AND FOLLOW-UP MEANS FOR CORTISOL AND STATE ANXIETY

Variable	Treatment Condition: *M* and *SD*						$F_{2,16}$
	Biofeedback $n = 7$		Cognitive Therapy $n = 5$		No Treatment $n = 7$		
	M	*SD*	*M*	*SD*	*M*	*SD*	
24-hr. g. cortisol/μ creatinine							
Time 1	36.25	10.78	34.73	17.19	28.93	10.38	0.65
gain: Time 1 – Time 2	5.02	11.72	8.20	11.85	4.28	16.54	0.11
gain: Time 1 – Time 3	6.98[a]	14.97	14.25[a]	18.41	–17.90[b]	28.41	3.81*
A-State							
Time 1	38.29	12.04	42.50	20.29	32.14	8.34	1.31
gain: Time 1 – Time 2	9.14	15.57	10.20	25.87	0.86	5.98	0.63
gain: Time 1 – Time 3	3.29	15.77	9.60	27.30	1.00	8.12	0.37

*$p < .05$; Scheffés multiple comparison test is at the .05 level. Means in one row with the same or no superscript are not significantly different.

pressed as base state anxiety (A-State), base 24-hr. urinary cortisol, and cortisol gain scores. The gain scores on dependent measures (causes of anxiety) were computed by comparing posttreatment (Time 2) and follow-up (Time 3) levels with baseline level (Time 1). Gain scores logically reflected the design and would allow a parsimonious presentation of the data (Hick & McLean, 1975).

Cortisol

Analysis of variance showed no significant baseline differences between groups on 24-hr. samples of μg cortisol/g creatinin ($F_{2,16} = .65$). As well, analysis of variance of gain-score differences was statistically nonsignificant at 8 wk. ($p > .05$), although the proportions of patients within groups who showed improvements (of at least one standard deviation from the initial assessment) were in the expected directions ($\chi^2 = 4.58$, $p > .05$; 30.7% of treated and 16.0% of nontreated patients). By the 8-mo. follow-up, however, gain-score differences were significant ($F_{2,16} = 3.81$, $p < .05$). Patients in biofeedback and cognitive-therapy conditions showed average reductions in 24-hr. cortisol secretion of 6.98 and 14.25 μg/g creatinin, respectively.

Fig. 1 shows the relative levels of μg cortisol/g creatinin at each time point and indicates that the principal effect of intervention was to provide stability in cortisol during the follow-up period for treated versus nontreated patients. It was asked in *post hoc* analysis whether patients had learned a relaxation response in treatment which might have contributed to cortisol change. *Post hoc t* tests indicated significant learning in at least one biofeedback modality (EMG or temperature) for each treated group. Nontreated patients did not exhibit significant changes in either peripheral skin tempera-

ture or EMG levels at 8 wk. ($ps > .05$). Specifically, biofeedback-treated patients made significant improvements in peripheral skin temperature in the 8-wk. treatment ($t_9 = 2.60$, $p < .05$) starting at 31.43°C and rising to a resting 5-min. average of 34.1°C at termination. These patients did not show significant change in EMG levels ($t_9 = 0.36$). On the other hand, cognitive therapy patients showed significant positive change in EMG levels between Week 1 and Week 8 (4.09 mv and 2.69 mv, respectively ($t_6 = 3.98$, $p < .01$) but not change in peripheral skin temperature (32.10°C at intake, 32.00°C at termination). In summary, both treated groups showed learning of a relaxation response in one biofeedback modality during treatment; nontreated patients did not.

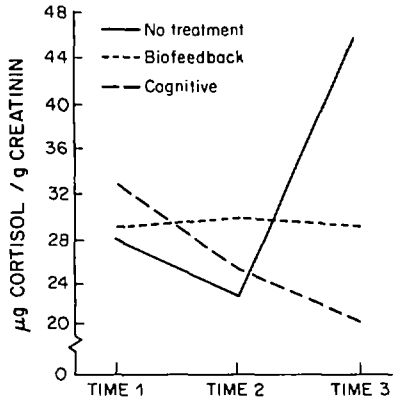

FIG. 1. 24-Hour urinary cortisol (μg cortisol/g creatinin) at pre-, post-, and follow-up phases

Post hoc tests showed further that at follow-up cognitive therapy patients had sustained their performance levels in the learned (EMG) modality showing no change between Week 8 and follow-up ($p > .70$) and retention of high peripheral skin temperature (34.19°C). Biofeedback therapy patients also retained their levels of relaxation performance in the learned (temperature) modality showing a nonsignificant reduction in peripheral skin temperature between Week 8 and follow-up ($t_9 = 1.98$, $p = .08$).

State-anxiety

Analysis of variance gave no significant differences on A-State between groups at any testing points, although the majority of treated patients showed a reduction in self-reported anxiety over time from the point of diagnosis ($F_{2,16}$s < 1.00). The proportions of patients who showed A-State improvement (of at least one standard deviation from initial assessment) over the 8-wk. treatment were significant ($\chi^2 = 7.6$, $p < .05$) in the expected direction, with 27.7% of treated and 0% of the nontreated patients showing reductions in anxiety.

Discussion

The present study provides justification for psychosocial treatment of multilevel stress responses among patients with newly diagnosed breast cancer. Both biofeedback and cognitive therapy yielded significant stabilization of the pituitary-adrenal cortical system. As well, the proportion of treated patients who responded with reductions in state-anxiety was greater than the proportion of nontreated patients. Patients who did not receive psychological intervention showed significant cortisol elevation at follow-up. This suggests that the principal advantage of psychological treatment may be a preventative one yielding stable cortisol levels over the first 10 mo. following diagnosis and precluding significant elevation in physiologic arousal over this time.

The results suggest a potential for the application of biofeedback and cognitive therapy in psychoimmunology. As now noted by many (Ader, 1981; Solomon, 1985; Stein, Schiavi, & Camerino, 1976), there is an inverse relationship between various neuroendocrines and the function and numbers of T- and B-cells. It has also been shown, however, that prolonged stress can impair T-cell and B-cell function without noticeably altering cortisol levels (Bartrop, Lazarus, Luckhurst, Kiloh, & Penny, 1977; Dorian, Garfinkel, Brown, Shore, Gladman, & Keystone, 1982). In one study adrenalectomy in rats did not prevent stress-induced immunosuppression (Keller, Weiss, Schleiffer, Miller, & Stein, 1983). Therefore, it is possible that the present psychological interventions would have enhanced the immune functioning of stressed patients only in cases of high adrenal arousal. This suggestion gains support by the review of Kiekolt-Glaser studies where, for instance, immunocompetence has been enhanced in geriatric residents by relaxation training for a month (Kiecolt-Glaser, Glaser, Williger, Stout, Messick, Sheppard, Bonnell, & Donnerberg, 1985). This enhancement may have been mediated by alterations of the levels of neuroendocrines.

It is further possible that, if biofeedback and cognitive therapy ultimately affect immunity to disease, they will do so most dramatically in patients with elevation of cortisol and concomitant psychological symptoms. Locke, Kraus, Leserman, Hurst, Heisel, and Williams (1984) have noted that the suppression of natural killer cell activity involves a *combination* of stress and impaired psychological functioning as measured by the Hopkins Symptom Checklist. Levy (1984) reports similar findings noting higher natural killer cell activity among well-adjusted breast cancer patients at the time of primary treatment.

In summary, it is now possible to assert that clinical interventions with potentially stressed cancer patients may have long-term benefits on physiologic arousal. Further research with larger samples will be necessary to establish the stability and generalizability of these preliminary data and to test whether mediators of immunosuppression can be controlled by relaxation and coping-imagery procedures.

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