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Personality and Mortality After Myocardial Infarction

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Abstract

Previous research showed that (a) emotional distress is a risk factor for mortality after myocardial infarction (MI) and that (b) emotional distress is linked to stable personality traits. In this study, we examined the role of these personality traits in mortality after MI. Subjects were 105 men, 45-60 years of age, who survived a recent MI. Baseline assessment included biomedical and psychosocial risk factors, as well as each patient's personality type. After 2-5 years (mean 3.8 years) of follow-up, 15 patients (14%) had died. Rate of death for patients with a distressed personality type (11/28 = 39%) was significantly greater than that for patients with other personality types (4/77 = 5%) ($p < 0.0001$). Patients with this personality type tend to simultaneously experience distress and inhibit expression of emotions. Low exercise tolerance, previous MI ($p < 0.005$), anterior MI, smoking, and age ($p < 0.05$) were also associated with mortality. A logistic regression model including these biomedical factors had a sensitivity for mortality of only 27%. The addition of distressed personality type in this model more than doubled its sensitivity. Of note, among patients with a poor physical health, those with a distressed personality type had a 5-fold mortality risk ($p < 0.005$). Consistent with the findings of other investigators, depression ($p < 0.005$), life stress, use of benzodiazepines ($p < 0.01$), and somatization ($p < 0.05$) were also related to post-MI mortality. These psychosocial risk factors were more prevalent in the distressed personality type than in the other personality types ($p < 0.001-0.05$). Multiple logistic regression indicated that these psychosocial factors did not add to the predictive value of the distressed personality type. Hence, an important personality effect was observed despite the low power. This suggests that personality traits may play a role in the detrimental effect of emotional distress in MI patients.

Key words:

myocardial infarction - risk stratification - personality - inhibition - depression

Introduction

Evidence suggests that psychological factors can markedly affect longevity (1-3). With reference to this issue, recent studies indicated that depression (4-7) and social alienation (8-10) are significant risk factors for mortality in patients with coronary heart disease. Likewise, somatization (11) and use of benzodiazepines (12) have been associated with cardiac mortality and reinfarction among coronary patients. The similarity of results of these studies strongly suggests that, apart from biomedical correlates of disease severity (13), emotional distress may have an adverse effect on survival after myocardial infarction (MI).

Importantly, emotional distress in MI patients is not related to the severity of cardiac disorder (14,15). Personality traits, however, may play an important role in this context. First of all, broad and stable personality traits -such as neuroticism and social inhibition- have been linked to depression (16,17). Second, evidence suggests that emotional distress in patients with coronary heart disease largely is a function of personality characteristics (18,19). By contrast, little attention has been paid to the role of personality in survival after MI (20).

The present study is based on the notion that the heart is a complex organization of subsystems where many factors maintain a balance (21), and that personality factors may adversely affect bodily homeostasis and, thus, promote progression of cardiac disease (22). The goal of this study was to examine the role of personality in long-term mortality among middle-aged men who survived a MI. For this purpose, a sample of MI patients undergoing a standardized treatment regimen -i.e., an outpatient rehabilitation program- was studied.

Personality Model

Particular coping styles may lead to emotional responses that are health-damaging (22). Coping refers to psychological efforts to manage stress. Because a microanalytic approach to coping is less effective in predicting health outcomes (23), we focused on basic traits. Research has identified 2 to 5 basic traits that summarize the tendencies of individuals (24-27). We focused on the tendencies to inhibit emotional expression -i.e., Social Inhibition, to experience emotional distress -i.e., Negative Affectivity, and to act in culturally defined ways -i.e., Need for Approval (20). Dividing subjects along a single trait provides only a partial view (24,28); therefore, we focused on personality types in terms of interactions of multiple traits.

As pointed out by Chesney (29), it is too soon to limit psychosocial models of heart disease to the study of hostility. In fact, research on psychosocial predictors of post-MI mortality should be

broadened to include not only depression and social isolation, but also anxiety, stress, and exhaustion (30-32). Evidence also suggests that measures of depression, anxiety, hostility, and fatigue are substantially interrelated, and may therefore better be thought of as measures of general negative affect in non-psychiatric populations (33,34).

Negative Affectivity is the disposition to experience negative affect (35). Social Inhibition and Need for Approval are two other traits that affect the individual's emotional responses. The inhibition of emotional expression has been associated with serious health problems, including hypertension, coronary heart disease, cancer and all-cause mortality (36-45). The tendency to respond to emotion-related circumstances in culturally defined ways has been associated with emotional adjustment (46,47) and protection against affective disorder (48).

TABLE 1 These global traits were used in previous research to generate a personality model through cluster analysis and theoretical deduction in men with coronary heart disease (19,20). The DIRE taxonomy is the latest version of this empirically derived personality model (Table 1). Basically, DIRE delineates four personality types. Two of these personality types are inhibited in the expression of emotions and behaviors. Distressed patients tend to experience negative emotions but are not likely to express them openly to others. They consciously avoid interpersonal conflict through extensive control over self-expression and, thus, may suppress substantial emotional distress in maladaptive ways. Introverted patients are also low in self-expression but are not likely to experience distress. They focus attention on internal thoughts and feelings and tend to be reserved, quiet and calm.

The two other DIRE types tend to express their emotions. Restrained patients not only have an active expressive style but also behave in socially defined ways. They usually manage to meet their own personal needs without excessive conflict with the needs of others and, thus, are likely to be both emotionally and socially well-adjusted. Excitable patients, however, are inclined to reject conventional restrictions on behavior. They are impulsive and may respond aggressively when challenged. Patients differ in their degree of fit to the DIRE type; therefore, these types were defined as prototypical exemplars (e.g., 49).

The Present Study

The present study focused on the idea that to inhibit the expression of substantial emotional distress may be health damaging. We hypothesized that it is not the experience of negative emotions per se but rather the chronic psychological distress that results from holding back negative emotions that is likely to affect physical health. The research reviewed above, in fact,

seems to suggest that the interaction of emotional distress (2-7) and inhibition of one's feelings (36-43) can be viewed as a form of stress that may create or exacerbate serious health problems. We therefore hypothesized that the distressed personality type of the DIRE model is a risk factor for long-term mortality after MI.

As noted earlier, the characteristics that define this personality type, i.e. high levels of Social Inhibition and Negative Affectivity, have been linked to the onset of depression (16,17). In fact, research indicates that coronary patients with a distressed personality are prone to depression and life stress, as well as other characteristics associated with increased risk for mortality after MI (19,20). We therefore hypothesized that the distressed personality type may explain a great deal of variance in the association between depression and post-MI mortality.

Methods

Subjects

One hundred five men ($M= 53.6$ years, $SD 4.4$) who had experienced a MI within 2 months were followed for 2-5 years ($M= 3.8$ years) to determine the factors associated with subsequent mortality. They were selected from a consecutive series of patients who were enrolled in the Antwerp cardiac rehabilitation program between July 1986-March 1989. The follow-up interval (which was determined by the initial assessment) varied because we wanted to test our hypothesis in a preliminary study. Additional exploration in confirmatory research was planned in case a significant personality effect did emerge in the present study.

Patients were eligible for this study if they were between 45-60 years old. Patients with previous MI or coronary artery bypass graft surgery were included; given their limited number, female patients and patients with percutaneous transluminal coronary angioplasty were excluded. All patients participated in ECG-monitored aerobic exercise training (36 sessions). The rehabilitation program also comprised 6 psychosocial counseling sessions that focused on health education in groups of patients and spouses. Individual medical and psychological counseling tailored the rehabilitation program to the needs of each patient.

Assessment of Personality Type

Three to six weeks after an acute MI, all subjects filled out questionnaires to assess their personality type. The psychological status of chronically ill patients not only represents the demands of their medical condition, but also reflects enduring personality traits (50). That is,

people are likely to display their usual way of coping with stress when confronted by life-threatening disease (51). In fact, the level of emotional distress (14) and the association between emotional distress and mortality (4) are independent of the seriousness of cardiac disorder after MI. Hence, personality assessment after the onset of MI is warranted.

TABLE 2 In the present study, we used three well-defined traits to delineate four personality types (Table 2). Inhibition when with others is assessed well by the "Social Inhibition" scale of the Heart Patients Psychological Questionnaire (52). Therefore, this scale was used as a measure of the first dimension in the personality/mood space. A high "Social Inhibition" scorer is low in self-expression, tends to feel insecure among other people, and lacks in assertiveness. This scale is negatively correlated with extraversion ($r=-0.46$) and is psychometrically sound (52).

The second dimension in the personality/mood space, Negative Affectivity, is assessed well by distress measures such as the trait form of the State Trait Anxiety Inventory (35). The Dutch adaptation of this scale is related to neuroticism ($r=0.82$) in healthy men (53), and well-being ($r=-0.70$), depressive complaints ($r=0.72$), and anger ($r=0.49$) in men with coronary heart disease (18,20). The tendency to respond in culturally appropriate ways is assessed well by the Marlowe-Crowne scale (54). Although this scale is often used to control for "faking good" in self-ratings, the Marlowe-Crowne scale, in fact, measures a substantial trait that promotes social adjustment and emotional health (46-48). The Dutch adaptation of this scale is inversely related to hostility ($r=-0.53$) in men with coronary heart disease (18).

A median split on these measures was used to classify each of the 105 subjects in one of four personality types: distressed ("Social Inhibition" ≥ 12 and "Trait Anxiety" ≥ 40 ; $n=28$), introverted ("Social Inhibition" ≥ 12 and "Trait Anxiety" ≤ 39 ; $n=24$); restrained ("Social Inhibition" ≤ 11 and "Need for Approval" ≥ 20 ; $n=23$), or excitable ("Social Inhibition" ≤ 11 and "Need for Approval" ≤ 19 ; $n=30$). As noted earlier, this method of determining type membership implies that subjects close to cutoff points may be misclassified, and that any one patient can be a member in only one of the categories of the typology (49).

Biomedical and Psychosocial Risk factors

Biomedical risk factors for post-MI mortality were also assessed, including low exercise tolerance (symptom limited exercise test), left ventricular ejection fraction $\leq 40\%$ (measured by left ventriculography), previous MI, anterior site of MI, smoking after MI, age, hyperlipidemia, and no β -blocker therapy (55-60). Because ventriculography was performed in only 93 subjects,

left ventricular ejection fraction was missing in 11% of the subjects.

A number of psychosocial factors that were hypothesized to be associated with long-term mortality after MI were assessed using the Millon Behavioral Health Inventory (MBHI) (61). Subjects were classified as high in life stress and social alienation (8-10) if they scored above the median of the "Recent Stress" and "Social Alienation" scales of the MBHI (Table 2). These scales measure the perception of marked changes in one's life and lack of social support, respectively (61). Subjects were classified as prone to depression (4-7) if they scored above the median of the "Premorbid Pessimism" and "Future Despair" scales of the MBHI. These scales measure important cognitive dimensions of depression, and are significantly correlated with the Zung Self-Rating Depression Scale; i.e., .60 and .53, respectively (61).

Somatization (11) and use of benzodiazepines (12) were also hypothesized to be psychosocial risk factors for post-MI mortality. Somatization was defined by a median split on the "Feelings of Disability" scale of the Heart Patients Psychological Questionnaire (52). This scale measures the perception of decrements in health and functional status (Table 2), and correlates .54 with somatic complaints and .59 with worries about physical health in men with coronary heart disease (62). In addition to these self-rating scales, use of benzodiazepines was conceptualized as a non-test marker of substantial psychological distress.

Procedures and Statistical Analysis

Two to 5 years following their initial assessment, subjects were contacted by telephone and questioned regarding their medical history during the previous years. The end points of interest in the present study were (a) mortality from all causes and (b) cardiac mortality. Information on deaths was obtained from relatives and hospital records. Furthermore, attending physicians were always involved in the classification of cause of death. For this purpose, the International Classification of Diseases was used (63). Because the numbers are small, each death was categorized as due to either a cardiac cause or a non-cardiac cause.

Continuous variables were dichotomized using a median split for peak work load on an exercise test 6 weeks post-MI (i.e., ≤ 140 vs ≥ 150 Watt) and age (i.e., ≤ 53 vs ≥ 54 years), and a cut-off of 40% for ejection fraction. Differences in baseline characteristics were analyzed with Fisher's exact test. Logistic regression analysis (64) was used to determine the prognostic value of the DIRE personality model in addition to biomedical risk factors.

Results

FIGURE 1 There were no patients lost to follow-up. After 2-5 years of follow-up, 15 of 105 patients (14%) had died. There were 11 cardiac deaths, and 4 deaths that were caused by cancer that had not been diagnosed at baseline. Most important, 73% of all cases occurred in patients with a distressed personality type (Figure 1). Total mortality for the distressed type (11 out of 28 = 39%) was eight times that for the other types (4 out of 77 = 5%). The four patients that died of cancer were all diagnosed with a distressed personality. After deleting these cases in the analysis, cardiac mortality for the distressed type (7 out of 24 = 29%) still was six times that for the other types ($p < 0.005$). This personality effect was not accounted for by follow-up interval: the mean interval was 3.8, 4.0, 3.7 and 3.5 years for the distressed, introverted, restrained and excitable personality type, respectively ($p = 0.48$).

As noted earlier, the distressed personality type was empirically delineated on the basis of cluster analysis in previous research (19,20). However, to rule out the possibility that it is anxiety which is predictive of mortality in the present study, we conducted additional analyses. Using a median split on the Trait Anxiety scale (53) and the Social Inhibition scale (52), subjects were classified in one of four a priori defined types: high anxiety/high inhibition (i.e., the distressed personality type: $\text{anxiety} \geq 40 / \text{inhibition} \geq 12$; $n = 28$), high anxiety/low inhibition ($\text{anxiety} \geq 40 / \text{inhibition} \leq 11$; $n = 24$), low anxiety/high inhibition ($\text{anxiety} \leq 39 / \text{inhibition} \geq 12$; $n = 23$), and low anxiety/low inhibition ($\text{anxiety} \leq 39 / \text{inhibition} \leq 11$; $n = 30$).

Of note, there were no deaths among the 24 high anxiety/low inhibition subjects. Further, rate of death for high anxiety/low inhibition (0 of 24), low anxiety/high inhibition (1 of 23) and low anxiety/low inhibition (3 of 30) subjects was not significantly different, $p = 0.25$. Distressed subjects did not differ significantly from high anxiety/low inhibition subjects with reference to trait anxiety [i.e., 52.3 ($Sd = 7.7$) vs 49.3 ($Sd = 7.3$), $p = 0.16$] whereas these subjects differed significantly with reference to rate of death; i.e., 39% vs 0%, $p < 0.005$. These findings indicate that it is not anxiety per se but rather the chronic psychological distress that results from holding back negative emotions that is predictive of post-MI mortality.

TABLE 3 Nonsurvivors also differed from survivors in several baseline biomedical risk factors that previously have been shown to predict mortality after MI (Table 3). Markers of a poor left ventricular function were more prevalent among nonsurvivors, including a low exercise tolerance and a low left ventricular ejection fraction, and previous or anterior MI. Nonsurvivors also more often failed to quit smoking and were older in age than survivors. The same standard

biomedical risk factors were found in the subgroup of cardiac deaths. It is important to note, however, that none of these biomedical risk factors, including markers of disease severity such as exercise tolerance ($p=0.48$) and left ventricular ejection fraction ($p=0.51$), were significantly different as a function of personality type. In further analyses, subjects were dichotomized as having a distressed personality versus another personality type.

In order to determine whether the distressed personality type added significantly to the prognostic information available from biomedical risk factors, we first entered low exercise tolerance, previous or anterior MI, smoking, and age in a stepwise logistic regression model. When personality type was added to this model based on biomedical risk factors, the distressed type improved significantly the predictive value (the log likelihood-ratio of the model improved by 5.5 for total mortality and by 2.0 for cardiac mortality, respectively, without loss in degrees of freedom). The regression coefficients for the final variables in the equation, a) personality X exercise tolerance interaction, b) smoking X age interaction and c) previous or anterior MI, were 1.16 ($p<0.001$), 1.07 ($p=0.014$) and 1.02 ($p=0.168$) for total mortality, and 1.28 ($p<0.001$), 1.37 ($p=0.010$) and 1.86 ($p=0.055$) for cardiac mortality, respectively.

In both analyses, the logistic regression model predicted mortality with a high specificity, since at most 1 of the 90 surviving subjects was misclassified. Sensitivity of the logistic regression without personality type as a risk factor, however, was only 27% for both total and cardiac mortality (i.e., only 4 of 15 total deaths and 3 of 11 cardiac deaths correctly classified). When distressed personality type was included as a risk factor, sensitivity of the logistic regression was increased to 60% and 64% for total and cardiac mortality, respectively (i.e., 9 out of 15 total deaths and 7 out of 11 cardiac deaths were correctly classified).

In the 93 patients with ventriculography, adding left ventricular ejection fraction to the logistic regression model with biomedical risk factors only resulted in a correct classification of not more than 7 out of 14 total deaths and 5 out of 11 cardiac deaths. Inclusion of distressed personality type on top of left ventricular ejection fraction still further increased the sensitivity for mortality, i.e. 10 out of 14 total deaths and 8 out of 11 cardiac deaths correctly classified. The distressed personality type therefore appeared to be an independent risk factor for long-term mortality after MI in addition to standard biomedical risk factors.

FIGURE 2 The predictive value of exercise testing in combination with personality assessment is depicted in a flow chart (Figure 2). Among subjects with a low exercise tolerance, those with a distressed personality had a higher mortality risk (9 deaths out of 16) than their counterparts with

another personality type (3 deaths out of 31) ($p < 0.001$). Likewise, cardiac mortality (7 deaths out of 14) of the former subgroup was higher than that of the latter ($p < 0.005$). Consistent with previous reports (55,57), subjects with a good exercise tolerance had a low mortality risk; 2 of 3 deaths in this subgroup were due to cancer in patients with a distressed personality. Hence, exercise testing and personality testing identified high- vs low-risk groups.

Nonsurvivors also differed from survivors in several baseline psychosocial risk factors that have been associated with long-term mortality after MI in previous research (Table 3). Cognitive characteristics of depression -i.e., the interpretation of life as a series of misfortunes and the anticipation of the future as distressing- were more prevalent among nonsurvivors. Likewise, the use of benzodiazepines was more prevalent among nonsurvivors, indicating that these patients experienced significant psychological stress at baseline. These psychosocial risk factors were also found in the subgroup of cardiac deaths. Life stress -i.e., marked changes in one's life in the absence of perceived social support- and somatization were associated with total mortality, but didn't reach statistical significance with reference to cardiac mortality.

FIGURE 3 The prevalence of these psychosocial risk factors was significantly different as a function of personality type (Figure 3). Subjects with a distressed personality reported more life stress and lack of social support, more depressive cognitions, and more symptoms of somatization than their counterparts with another personality type. In keeping with this finding, use of benzodiazepines was also more prevalent in the distressed type. Hence, the conceptualization of this subgroup of MI patients as a distressed type proved to be valid in the present sample.

Next, we entered depression, life stress, somatization, and use of benzodiazepines into a logistic regression model including biomedical risk factors but not personality type. This model was, however, less accurate than the model including personality type; in fact, the number of false negatives increased. We also forced depression, life stress, somatization, and benzodiazepines into the model including personality type, but none of these psychosocial variables was retained as an independent predictor of mortality. Hence, personality type could explain the association between psychosocial risk factors and mortality in the present study.

Discussion

The findings of this study indicated that the distressed personality type (Table 1) was associated with post-MI mortality. Consistent with the inhibition model (36), the tendency to

simultaneously experience distress and inhibit the expression of emotions had an adverse effect on prognosis. We also replicated findings from previous research indicating that low exercise tolerance, previous or anterior MI, smoking, and age predict mortality (55-60). These biomedical factors, however, could not explain away the relationship between personality and mortality. Hence, the findings of this study are significant for two reasons.

First, the present study did focus on the interplay of broad and stable personality characteristics in assessing the risk of death in patients who survived an acute MI. Our findings were in agreement with those of other investigators who reported that particular psychosocial factors -i.e., depression (4-7), social alienation (8-10), somatization (11), and use of benzodiazepines (12)- were associated with a poor prognosis after MI. However, the present findings also indicated that these factors may serve as markers for a third variable; i.e., individual differences in the tendency to experience distress and social alienation. That is, a) MI patients with a distressed personality type were more prone to depression, social alienation and somatization, and b) depression, social alienation, and somatization did not add significantly to the predictive power provided by the distressed personality type.

Second, our findings not only relate to those involving the clinically prominent distress dimension but also to those involving the suppression of emotions and behaviors. That is, the findings of the present study were in agreement with those of other investigators who reported that inhibition of particular emotions or behaviors was associated with poor health (36-45). We did focus, however, on individual differences in the tendency to inhibit self-expression across emotions and situations. Hence, this study corroborates the notion that research on psychosocial predictors of post-MI mortality should be broadened (e.g., 29,65) to include pervasive individual differences in coping style. As a matter of fact, previous research shows that in some MI patients emotional distress may be substantial and persistent (66-68).

The small number of subjects in this study is a double-edged sword. Mortality is a relatively rare event in this sample and the present findings need to be confirmed in future research. Although firm conclusions were precluded, the importance of the observed personality effect suggests that we may be dealing with a significant risk marker. For example, the relation between beta-blockade and survival required tens of thousands of MI patients to demonstrate it (69), whereas the personality effect in this study was large enough to require only a small number of patients to become statistically significant. Since statistical associations did emerge, despite the low power, additional exploration in confirmatory research is warranted (e.g., 65).

The generalizability of the present findings is limited by the exclusion of elderly (60) and female (65) patients, and the fact that all subjects participated in cardiac rehabilitation. Cardiac rehabilitation may reduce mortality (70) and improve emotional well-being (71). Whether the DIRE personality taxonomy would predict mortality in a less selected population is unclear. Undoubtedly, many other questions remain to be answered. Cause of death, for example, was not analyzed beyond the cardiac-noncardiac classification. Another unsolved issue concerns the mechanisms that may account for the personality-mortality relationship.

An increased susceptibility to emotional stressors may be responsible for the high mortality-risk among patients with a distressed personality. Mental and psychosocial stress have been shown to induce coronary vasoconstriction in patients with coronary heart disease (72), as well as impaired endothelium-dependent responses of coronary arteries in atherosclerotic monkeys (73). Other pathophysiological mechanisms that may be involved in the association between emotional distress and mortality after MI include increased platelet activity (74), increased myocardial contractility and oxygen consumption (75), and ventricular tachycardia (76). The findings of our study warrant further research focusing on mechanisms that account for the link between psychosocial stress and mortality after MI.

As pointed out by Williams and Chesney (77), it is now time to develop interventions aimed at ameliorating the harmful effects of psychosocial risk factors in coronary patients. With reference to this issue, multiple logistic regression analysis indicated that patients with both physical and mental health problems -low exercise tolerance and distressed personality- had a five-fold mortality risk compared to patients with sole physical health problems. It would be interesting to see if interventions would help to increase longevity in this high-risk category of post-MI patients. That is, the notion that individuals may use a characteristic style to cope with stress does not entail that coping processes are fixed or unmodifiable (e.g., 78). However, whether psychotherapeutic interventions or psychotropic agents such as antidepressants would be indicated for MI patients with a distressed personality type remains an open question. Inclusion of the distressed personality type as an individual difference variable in outcome research on the effect of behavioral and pharmacologic interventions in patients with coronary heart disease may provide an answer to this important question.

One should keep in mind, however, that the findings of this study are preliminary. At present, we are conducting confirmatory research in a large sample of patients with coronary heart disease, including female and older patients as well as coronary patients without MI. Another

issue concerns the assessment of the DIRE personality type in coronary patients. Assessment in this study was based on three different self-report scales that were combined in the classification of subjects. We are now in the final stage of development of a new 38-item self-report scale which is a sound measure of the distressed personality type. In sum, accumulating evidence strongly suggests that something is going on in terms of personality and coronary heart disease. This study suggests that among middle-aged men who survived a MI, those with a distressed personality type may be in dire health straits.

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Table 1 **DIRE taxonomic model of personality types**

TAXONOMY		PERSONALITY TRAIT			EMOTIONAL CHARACTERISTICS
		Social Inhibition tendency to <u>inhibit</u> expression of emotions	Negative Affectivity tendency to <u>experience</u> emotional distress	Need for Approval tendency to <u>respond</u> in a culturally appropriate way	
D istressed	Type	+	+		Non-expression of substantial distress
I ntroverted	Type	+	-		Quiet, calm, emotionally flat
R estrained	Type	-		+	Emotionally and socially well-adjusted
E xcitable	Type	-		-	Impulsive, prone to aggressive behavior

+ denotes a high score and - a low score as measured by a median split on the corresponding personality trait. An empty cell indicates that the corresponding trait is not relevant for the definition of that particular personality type (i.e., self-deception for the distressed or introverted type, and negative affectivity for the restrained or excitable type).

Table 2 Measures That Were Used To Assess Personality Traits and Hypothesized Psychosocial Risk Factors

MEASURES		CONTENT OF SCALES			RELIABILITY		MEAN (SD)
Instrument *	Scale	Focus of items	# of	Response items format	Internal † consistency	Test-retest reliability	
<u>Personality Traits</u>							
HPPQ (52)	"Social Inhibition"	Tendency to inhibit expression of emotions and behaviors	6	yes, ? , no	̄ =.64	r=.77	11.2 (3.2)
STAI (53)	"Trait Anxiety"	Tendency to experience emotional and somatic distress	20	4-point scale: never→always	á =.89	r=.82	40.9 (12.0)
MC (54)	"Need for Approval"	Tendency to respond in culturally appropriate and acceptable ways	30	true, false	KR=.88	r=.89	18.9 (5.2)
<u>Hypothesized Risk Factors</u>							
MBHI (61)	"Recent Stress"	Perception of recent marked changes in one's life	20	true, false	KR=.74	r=.87	6.9 (3.4)
	"Social Alienation"	Perception of lack of support from family and friends	33	true, false	KR=.84	r=.85	7.0 (4.8)
	"Premorbid Pessimism"	Dispositional attitude of helplessness-hopelessness	40	true, false	KR=.90	r=.85	11.5 (7.3)
	"Future Despair"	Perception of the future as distressing and non-productive	38	true, false	KR=.86	r=.78	12.1 (6.6)
HPPQ (52)	"Feelings of Disability"	Perception of decrements in health and functional status	12	yes, ? , no	̄ =.87	r=.85	25.8 (6.4)

* HPPQ, Heart Patients Psychological Questionnaire; STAI, State-Trait Anxiety Inventory (Dutch adaptation of the Trait scale); MC, Marlowe-Crowne Scale;

MBHI, Millon Behavioral Health Inventory; † Guttman's κ , Cronbach's α , or Kuder-Richardson's Formula 20.

Table 3 **Baseline Biomedical and Psychosocial Characteristics According to Vital Status**

Baseline Characteristics	Vital status at 2-5 years				
	Survivors (n=90)	Total Mortality (n=15)	Cardiac Mortality (n=11)	Univariate p value *	Univariate p value †
Biomedical					
Low exercise tolerance	39 % (35)	80 % (12)	91 % (10)	<0.005	<0.005
LVEF ≤ 40% (N=93)	10 % (8)	43 % (6)	46 % (5)	<0.005	<0.005
Previous MI	11 % (10)	40 % (6)	46 % (5)	<0.005	<0.005
Anterior site of MI	33 % (30)	60 % (9)	73 % (8)	<0.05	<0.05
Smoking after MI onset	14 % (13)	40 % (6)	46 % (5)	<0.05	<0.05
Age ≥ 54 years	46 % (41)	73 % (11)	73 % (8)	<0.05	0.09
History of hyperlipidemia	26 % (23)	7 % (1)	9 % (1)	NS	NS
No β-blocker therapy	43 % (39)	60 % (9)	64 % (7)	NS	NS
Psychosocial					
Life Stress	32 % (29)	67 % (10)	55 % (6)	<0.01	NS
Depression	41 % (37)	80 % (12)	82 % (9)	<0.005	<0.01
Somatization	48 % (43)	80 % (12)	73 % (8)	<0.05	NS
Use of Benzodiazepines	16 % (14)	47 % (7)	55 % (6)	<0.01	<0.005

Personality and Mortality - 27

LVEF, left ventricular ejection fraction; MI, myocardial infarction. Number of subjects appears in parentheses.

* Survivors versus total deaths; † survivors versus cardiac deaths; NS, not significant ($p \geq 0.10$).

Figure legends

Figure 1 **Number of deaths (all causes) and survivors as a function of personality type.**

Note that there is a break in the continuum between 0 and 15 in the lower portion of the Y axis which represents the number of survivors.

Figure 2 **Percentage of total mortality and cardiac mortality as a function of exercise tolerance and personality type.**

T denotes total mortality; C: cardiac mortality.

Figure 3 **Prevalence of psychosocial risk factors in patients with a distressed personality type.**

CONDENSED ABSTRACT

The role of personality traits in the prognosis after myocardial infarction (MI) is unknown. In this study, 105 men filled out personality questionnaires 3-6 weeks after they survived a MI. At 2-5 years follow-up there were 15 deaths, 11 of which had a distressed personality. A regression model including biomedical risk factors had a 99% specificity for mortality, but the sensitivity was only 27%. The addition of distressed personality type as a risk factor more than doubled the sensitivity of this model, and quintupled the mortality risk in patients with a low exercise tolerance. It is concluded that personality traits are associated with mortality after MI.

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May 24, 1994

Dear Dr. Dimsdale,

Please find enclosed five copies of a manuscript entitled: "Personality and mortality after myocardial infarction." We would appreciate if you would be willing to consider this manuscript for publication in your Journal.

Myocardial infarction still poses a major health problem for industrialized societies in terms of excess mortality. With reference to this issue, recent research has shown that psychosocial factors, such as depression and lack of social support, can markedly affect the longevity of cardiac patients. The findings of our study strongly suggest that the health-damaging effect of these psychosocial factors may be related to global and enduring individual differences in the tendency to experience emotional distress and social alienation. In fact, we found that the tendency to simultaneously experience emotional distress and inhibit the expression of emotions was related to long-term mortality after myocardial infarction.

During the past few months, we had the opportunity to exchange ideas with Dr. David Phillips from the Sociology Department of the University of California at San Diego. Dr. Phillips was kind enough to critically analyze an early draft of our paper, and we incorporated his comments in a revised version of the paper. Dr. Phillips found the results of our study very exciting and with far-reaching implications.

The contents of this paper have not been published elsewhere and the paper is not being submitted elsewhere. We hope that you would be willing to consider our manuscript for publication in *Psychosomatic Medicine*. We are convinced that our findings will interest your readership.

Sincerely yours,

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December 6, 1994

Ref.: Ms. No. 94-091 "Personality and Mortality After Myocardial Infarction"

Dear Dr. Dimsdale,

Thank you for your letter of November 29 enclosing your referees' comments on the revised version of the above referenced manuscript. We have revised the manuscript in order to address a number of these comments.

Additional analyses now focus on the theoretical possibility that it is anxiety which is predictive of mortality. These analyses indicated, however, that it is not anxiety per se but rather the chronic psychological distress that results from holding back negative emotions that is predictive of post-MI mortality (page 8, paragraph 3 and 4). Our responses to these and other comments are detailed in the attached sheets.

We wish to thank you for your continued interest in our work and we hope that this revision meets the high standards of your Journal. Please find enclosed five copies of the revised manuscript.

Sincerely yours,

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December 13, 1994

Ref.: Ms. No. 94-091 "Personality and Mortality After Myocardial Infarction"

Dear Dr. Dimsdale,

Needless to say, I'm very pleased to hear that you would be kindly willing to accept the above referenced manuscript for publication in *Psychosomatic Medicine*.

Thank you for your suggestions concerning the clarity and/or shortening of the manuscript. I am in complete agreement with your suggestions and I have made the changes in the text as you indicated. Accordingly, I trimmed 6 lines from the first three paragraphs of the Personality Model section (pages 3 and 4). Enclosed please find five copies of the revised manuscript. I also enclosed a marked copy on which I have indicated the changes in the text.

Once again, I am indebted to you for your continued interest in my work. I look forward to seeing you again at the 1995 APS Meeting in New Orleans,

Sincerely yours,

Johan Denollet, Ph.D.

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Responses to Comments of Reviewer #1.

Thank you for your many helpful comments that enabled us to strengthen our paper. We hope that the following responses may provide an appropriate answer to the various issues that you have indicated.

1. The strategy of classifying death is now discussed more in detail in the Methods section: "Death certificates should not be used for research purposes in Belgium. Therefore, information on deaths was obtained from relatives and hospital records. Furthermore, attending physicians were always involved in the classification of cause of death. For this purpose, the International Classification of Diseases was used (63)." (page 7, last paragraph, lines 4-7)

2. Personality factors did predict mortality after the major cardiac predictors of mortality are entered in the logistic regression first. Accordingly, it is now stated that: "In order to determine whether the distressed personality type added significantly to the prognostic information available from biomedical risk factors, we first entered low exercise tolerance, previous or anterior MI, smoking, and age in a stepwise logistic regression model. When personality type was added to this model based on biomedical risk factors, the distressed type improved significantly the predictive value ... " (page 8, last paragraph, lines 1-5)

2a. We agree that left ventricular ejection fraction (LVEF) is especially important. It is now stated in the Methods section that LVEF was measured by left ventriculography (page 7, first paragraph, line 3). However, ventriculography was performed in only 93 subjects (page 7, same paragraph, lines 4-5). LVEF was not related to personality subtypes; this is now indicated in the Results section (page 8, third paragraph, lines 7-9). Given the importance of LVEF as predictor of post-MI mortality, the Results section now contains an entire paragraph that addressed this issue: "In the 93 patients with ventriculography, adding left ventricular ejection fraction to the logistic regression model with biomedical risk factors only resulted in a correct classification of not more than 7 out of 14 total deaths and 5 out of 11 cardiac deaths. Inclusion of distressed personality type on top of left ventricular ejection fraction still further increased the sensitivity for mortality, i.e. 10 out of 14 total deaths and 8 out of 11 cardiac deaths correctly classified." (page 9, third paragraph) Hence, the distressed personality type appeared to be an independent risk factor for mortality after MI in addition to LVEF.

2b/2c. We agree that New York Heart Association Functional Class and ventricular ectopy are important predictors for post-MI mortality. Regrettably, these biomedical risk factors were not assessed in the present study. We thank you for your suggestion that may be helpful for our future research.

3. You are correct in stating that the personality model under test needed to be explained in more detail. For this reason, the manuscript now comprises an entire section, labeled "Personality Model", which addresses the selection of personality factors and the way they were used to classify subjects into discrete personality types (page 3, last paragraph and page 4, paragraphs 1-4). Furthermore, we included a new table that lists each test administered, the number of items in each, the format of each scale, test-retest reliability, and means and standard deviations as normative values (Table 2, page 22). The Methods section now contains more information on the construct validity of the measures used: " ... the "Social Inhibition" scale of the Heart Patients Psychological Questionnaire (52) ... is

negatively correlated with extraversion ($r=-0.46$) ... ", " ... the State Trait Anxiety Inventory (35) ... is related to neuroticism

- Responses to Comments of Reviewer #1 (continued) -

($r=0.82$) in healthy men (53), and well-being ($r=-0.70$), depressive complaints ($r=0.72$), and anger ($r=0.49$) in men with coronary heart disease (18,20) ... ", " ... the Marlowe-Crowne scale (54) ... measures a substantial trait that promotes social adjustment and emotional health (46-48) ... is inversely related to hostility ($r=-0.53$) in men with coronary heart disease (18) ... " (page 6, paragraph 2 and 3).

4. In keeping with previous research, an association between disease severity and personality was not found in our study. Therefore, it is now stated that: "It is important to note, however, that none of these biomedical risk factors, including markers of disease severity such as exercise tolerance ($p=0.48$) and left ventricular ejection fraction ($p=0.51$), were significantly different as a function of personality type." (page 8, third paragraph, lines 7-9)

5. It is now stated in the Personality Model section that: "Evidence also suggests that measures of depression, anxiety, hostility, and fatigue are consistently and substantially interrelated, and may therefore better be thought of as measures of general negative affect rather than as measures of these separate constructs per se (33,34)" (page 4, first paragraph, lines 5-7). In the Discussion section, greater emphasis is placed on the notion that pervasive individual differences in the tendency to experience distress and social alienation may explain a large proportion of variance in self-reported emotional distress: "... present findings also indicated that these factors may serve as markers for a third variable; i.e., individual differences in the tendency to experience distress and social alienation. That is, a) MI patients with a distressed personality type were more prone to depression, social alienation and somatization, and b) depression, social alienation, and somatization did not add significantly to the predictive power provided by the distressed personality type" (page 11, first paragraph, lines 1-5).

With reference to the therapeutic approach of the distressed personality type, it is now stated in the Discussion section that "... whether psychotherapeutic interventions or psychotropic agents such as antidepressants would be indicated for MI patients with a distressed personality type remains an open question. Inclusion of the distressed personality type as an individual difference variable in outcome research on the effect of behavioral and pharmacologic interventions in patients with coronary heart disease may provide an answer to this important question" (page 12, second paragraph, lines 9-13).

6. Thank you for pointing out that greater attention should be paid to the fact that our findings also relate to inhibited emotional expression. Accordingly, the Discussion section now comprises a paragraph that addresses this finding in more detail: "... our findings not only relate to those involving the clinically prominent distress dimension but also to those involving the suppression of emotions and behaviors. That is, the findings of the present study were in agreement with those of other investigators who reported that inhibition of particular emotions or behaviors was associated with poor health (36-45). We did focus, however, on individual differences in the tendency to inhibit self-expression across emotions and situations" (page 11, second paragraph, lines 1-6).

7. Greater attention has been paid to the captions for figures and tables.

Responses to Comments of Reviewer #2.

Thank you for your constructive comments on our paper. The following paragraphs explain our revision of the paper with reference to the various methodological issues that you pointed out in your comments.

As a matter of fact, the duration of the follow-up varied because our aim was to conduct a preliminary study. This is now mentioned in the Methods section: "The follow-up interval (which was determined by the initial assessment) varied because we wanted to test our hypothesis in a preliminary study. Additional exploration in confirmatory research was planned in case a significant personality effect did emerge in the present study." (page 5, third paragraph, lines 5-7)

We agree that variations in the follow-up interval is a potential moderating factor. However, patients with a distressed personality type were not overrepresented among subjects recruited early in the study and, thus, did not have on average a longer follow-up interval than their counterparts with another personality type. Accordingly, mention is now made to the fact that the personality-mortality relationship was not a function of follow-up interval: "This personality effect was not accounted for by follow-up interval: the mean interval was 3.8, 4.0, 3.7 and 3.5 years for the distressed, introverted, restrained and excitable personality type, respectively ($p=0.48$)." (page 8, second paragraph, lines 8-10)

Mention is now made to the fact that there were no patients lost to follow-up (page 8, second paragraph, first line). Hence, follow-up data were not unevenly right censored.

Our interest was in the small but clinically most important group of non-survivors. In the previous draft of our paper, however, we failed to mention the fact that the present study was conceptualized as a preliminary examination of our hypothesis under test. This is now discussed in the Introduction section: "... we wanted to test our hypothesis in a preliminary study. Additional exploration in confirmatory research was planned in case a significant personality effect did emerge ..." (page 5, third paragraph, lines 5-8) and the Discussion section: "One should keep in mind, however, that the findings of this study are preliminary. At present, we are conducting confirmatory research in a large sample of patients with coronary heart disease, including female and older patients as well as coronary patients without MI" (page 12, last paragraph, lines 1-3).

We used logistic regression analysis because most of the predictors are categorical in nature; e.g., history of previous MI, localization of MI, smoking after MI. The decision to dichotomize personality traits is based on our previous research focusing on the delineation of discrete coping types or personality types (ref. 19 and 20). In the Personality Model section, reference is made to the fact that: "... research should focus on personality types in terms of interactions of multiple traits ..." (page 3, last paragraph, last line) and the fact that: "These global traits were used in previous research to generate a personality model through cluster analysis and theoretical deduction in men with coronary heart disease (19,20)" (page 4, third paragraph, first two lines). Your point that cross-replication is a useful tool to examine the accuracy of the classification rates in the case of logistic regression is well taken. In fact, we plan cross-replication in confirmatory research. The subject sample of the present study, however, was too small to crossvalidate the regression model. With reference to this issue, we agree that mortality was a relatively rare event. It is now stated in the Discussion section that: "Mortality is a relatively rare event in this sample and the present findings need to be confirmed ..." (page 11, third paragraph, lines

- Responses to Comments of Reviewer #2 (continued) -

We agree that left ventricular ejection fraction (LVEF) is especially important. It is now stated in the Methods section that LVEF was measured by left ventriculography (page 7, first paragraph, line 3). The reason we left out LVEF in the initial analyses is the fact that left ventriculography was performed in only 93 subjects (page 7, same paragraph, lines 4-5). Given the importance of LVEF as predictor of post-MI mortality, the Results section now contains an entire paragraph on this issue: "In the 93 patients with ventriculography, adding left ventricular ejection fraction to the logistic regression model with biomedical risk factors only resulted in a correct classification of not more than 7 out of 14 total deaths and 5 out of 11 cardiac deaths. Inclusion of distressed personality type on top of left ventricular ejection fraction still further increased the sensitivity for mortality, i.e. 10 out of 14 total deaths and 8 out of 11 cardiac deaths correctly classified." (page 9, third paragraph) Hence, the distressed personality type appeared to be an independent risk factor for mortality after MI in addition to LVEF.

The designation of the Millon Behavioral Health Inventory scales as "psychosocial risk factors" is now deleted and replaced by the statement that: "A number of psychosocial factors *that were hypothesized to be associated with* long-term mortality after MI were assessed using the Millon Behavioral Health Inventory (MBHI)" (page 7, second paragraph, first two lines). The Methods section now contains specific information on the validity of the "Premorbid Pessimism" and "Future Despair" scales of the MBHI which were used to measure cognitive dimensions of depression in the present study: "These scales ... are significantly correlated with the Zung Self-Rating Depression Scale; i.e., .60 and .53, respectively" (page 7, second paragraph, last two lines).

Mention is now made to the criteria that were used to differentiate between cardiac and noncardiac mortality in the Methods section: "Death certificates should not be used for research purposes in Belgium. Therefore, information on deaths was obtained from relatives and hospital records. Furthermore, attending physicians were always involved in the classification of cause of death. For this purpose, the International Classification of Diseases was used (63)" (page 7, last paragraph, lines 4-7).

Responses to Comments of Reviewer #3.

We were pleased to hear that you found our findings striking and important. Thank you for your comments and suggestions -including rewriting of the paper and clearer definitions of the personality model under test- which, in fact, enabled us to strengthen our paper. We hope that the following responses may provide an appropriate answer to the various issues that you have indicated.

CABG and PTCA are now deleted and replaced by "coronary artery bypass graft surgery" and "percutaneous transluminal coronary angioplasty", respectively (page 5, last paragraph, lines 2-3).

The personality theory that guided the research of the present study is discussed now in more detail in the Personality Model section (pages 3 and 4). We agree that the descriptive terms chosen for the personality types required further justification.

First, as you correctly pointed out, the designation "self-deception" of the third personality trait is misleading. We used this designation of the Marlowe-Crowne scale in our previous research (ref. 18-20) based on the findings of other researchers (e.g., ref. 48). The term "self-deception" is now deleted and replaced by: "... the tendency ... to act in culturally appropriate ways -i.e., Need for Approval" (page 3, last paragraph, line 8). Furthermore, it is now stated that: "The tendency to respond to emotion-related circumstances in a culturally appropriate way has been associated with social and emotional adjustment (46,47) and protection against affective disorder (48)" (page 4, second paragraph, lines 7-9), and: "The tendency to respond in culturally appropriate ways is assessed well by the Marlowe-Crowne scale (54). Although this scale is often used to control for "faking good" in self-ratings, the Marlowe-Crowne scale, in fact, measures a substantial trait that promotes social adjustment and emotional health (46-48). The Dutch adaptation of this scale is inversely related to hostility ($r=-0.53$) in men with coronary heart disease (18)" (page 6, third paragraph, lines 5-9). The designation of the Marlowe-Crowne scale as measure of "need for approval" is provided by its authors in their original article on the development of this scale (ref. 54). As such, this scale taps a personality trait that is closely related to the "constraint" or "impulse-control" dimension in three-factor models of personality (e.g., ref. 25).

Second, the designation of individuals as emotionally "distressed" is not only dependent on their tendency to experience negative emotions but also on their inability to cope with these negative emotions in an adaptive way as indicated by their lack of self-expression. Hence, a high level of social inhibition -i.e., the tendency to inhibit the expression of emotions/behaviors- is germane to the "distressed" personality type in the DIRE model. The definition of the "distressed" personality type now reads: "Distressed patients tend to experience negative emotions but are not likely to express them openly to others. They consciously avoid interpersonal conflict through extensive control over self-expression and, thus, may suppress substantial emotional distress in maladaptive ways" (page 4, third paragraph, lines 6-8). Furthermore, mention is now made to the fact that: "... we hypothesized that it is not the experience of negative emotions per se but rather the chronic psychological distress that results from holding back negative emotions that is likely to affect physical health" (page 5, first paragraph, lines 2-4).

Third, we agree that our original definition of the "introverted" type was rather elusive. It is now stated that: "Introverted patients are also low in self-expression but are not likely to

experience distress. They focus attention on internal thoughts and feelings and tend to be reserved, quiet and calm" (page 4, third paragraph, lines 9-10).

- Responses to Comments of Reviewer #3 (continued) -

Fourth, "restrained" patients are not socially uninhibited in the sense that they exert little control over their social behaviors but in the sense that they tend to feel at ease in social interactions. As a matter of fact, these patients tend to act in culturally appropriate and acceptable ways. It is now stated that: "The two other DIRE types are expressive as indicated by a low level of Social Inhibition. Restrained patients not only have an active expressive style but also behave in socially defined ways. They usually manage to meet their own personal needs without excessive conflict with the needs of others and, thus, are likely to be both emotionally and socially well-adjusted" (page 4, last paragraph, lines 1-4).

The reason why significant predictive value was attached to the distressed personality type is now discussed in more detail in the section "The Present Study" on page 5. Basically, the rationale for the designation of the distressed personality type as potentially health-damaging is two-fold. First, we hypothesized on theoretical grounds that: "... the chronic psychological distress that results from holding back negative emotions ... is likely to affect physical health. The research reviewed above, in fact, seems to suggest that the interaction of emotional distress (2-7) and inhibition of one's feelings (36-43) can be viewed as a form of stress that may create or exacerbate serious health problems" (page 5, first paragraph, lines 3-7). Second, we hypothesized on empirical grounds that: "... the characteristics that define this personality type, i.e. high levels of Social Inhibition and Negative Affectivity, have been linked to the onset of depression (16,17). In fact, research indicates that coronary patients with a distressed personality are prone to depression and life stress, as well as other characteristics associated with increased risk for mortality after MI (19,20)" (page 5, second paragraph, lines 1-5).

As you correctly pointed out, it is important that the instruments that were used to measure basic personality traits have a theoretical context and evidence of reliability and validity in previous research (page 6, second paragraph, lines 2-3). Accordingly, the paper now includes a new table that lists each test administered, the number of items in each, the format of each scale, test-retest reliability, and means and standard deviations as normative values (Table 2, page 22). Furthermore, the Methods section now contains more information on the construct validity of the measures used: "... the "Social Inhibition" scale of the Heart Patients Psychological Questionnaire (52) ... is negatively correlated with extraversion ($r=-0.46$) ... " (page 6, second paragraph, lines 4-8), "... the State Trait Anxiety Inventory (35) ... is related to neuroticism ($r=0.82$) in healthy men (53), and well-being ($r=-0.70$), depressive complaints ($r=0.72$), and anger ($r=0.49$) in men with coronary heart disease (18,20) ... " (page 6, third paragraph, lines 2-5), and "... the Marlowe-Crowne scale (54) ... measures a substantial trait that promotes social adjustment and emotional health (46-48) ... is inversely related to hostility ($r=-0.53$) in men with coronary heart disease (18) ... " (page 6, third paragraph, lines 7-9).

Although the State Trait Anxiety Inventory was originally designed to measure anxiety, evidence indicates that the trait form of this scale measures general negative affect, including depression and hostility, in non-psychiatric populations rather than anxiety per se (e.g., ref. 33-35). Accordingly, it is now stated in the Personality Model section that: "... measures of depression, anxiety, hostility, and fatigue are consistently and substantially

interrelated, and may therefore better be thought of as measures of general negative affect rather than as measures of these separate constructs per se (33,34)" (page 4, first paragraph, lines 5-7).

- Responses to Comments of Reviewer #3 (continued) -

The subheadings in the Results Section are now deleted.

The improvement of the fit, indicated as 11.0 and 4.0 respectively, represented improvement in $G = -2 \times \log$ likelihood ratio. Presently, in stead of deviance, we report the improvement of log likelihood-ratio for which the numbers are $11.0/2 = 5.5$ and $4.0/2 = 2.0$, respectively (page 8, last paragraph, lines 5-6).

The empirical results of the analysis that established the distressed personality type as an independent risk factor are now reported in the text: "The regression coefficients for the final variables in the equation, a) personality X exercise tolerance interaction, b) smoking X age interaction and c) previous or anterior MI, were 1.16 ($p < 0.001$), 1.07 ($p = 0.014$) and 1.02 ($p = 0.168$) for total mortality, and 1.28 ($p < 0.001$), 1.37 ($p = 0.010$) and 1.86 ($p = 0.055$) for cardiac mortality, respectively" (page 9, first paragraph, lines 1-4).

The Discussion is now rewritten in order to better indicate what is novel about our results. Among other things, mention is now made to the fact that the findings of this study are significant for two reasons. First, it is now stated that: "... the present study did focus on the interplay of broad and stable personality characteristics in assessing the risk of death ... Our findings were in agreement with those of other investigators who reported that particular psychosocial factors -i.e., depression (4-7), social alienation (8-10), somatization (11), and use of benzodiazepines (12)- were associated with a poor prognosis after MI. However, the present findings also indicated that these factors may serve as markers for a third variable; i.e., individual differences in the tendency to experience distress and social alienation" (page 10, last paragraph - page 11, first paragraph). Second, it is stated that: "... findings not only relate to those involving the clinically prominent distress dimension but also to those involving the suppression of emotions and behaviors ... were in agreement with those of other investigators who reported that inhibition of particular emotions or behaviors was associated with poor health (36-45). We did focus, however, on individual differences in the tendency to inhibit self-expression across emotions and situations" (page 11, second paragraph, lines 1-6). As a consequence, it is concluded that research on psychosocial predictors of post-MI mortality should be broadened (e.g., 29,65) to include pervasive individual differences in coping style (page 11, second paragraph, lines 7-10).

Thank you for your suggestion to indicate that: "... depression, social alienation, and somatization did not add significantly to the predictive power provided by the distressed personality type" (page 11, first paragraph, lines 4-5).

We decided not to state the size of the personality effect in the present study because of its small sample size. Mention is now made to the fact that: "... the importance of the observed personality effect suggests that we may be dealing with a significant risk marker" (page 11, third paragraph, lines 5-6).

We decided to retain Table 1, but Table 2 and 4 are now combined into one table (Table 3, page 24).

Table 3 is now deleted. The results of this table are presented in the body of the manuscript (page 9, first paragraph, lines 1-4).

Responses to Comments of Reviewer #1.

Thank you for your comments and suggestions. We hope that the following responses may provide an appropriate answer to the various issues that you have indicated.

1. There were no patients lost to follow-up because we used different strategies to trace patients, including social security records and information obtained from the local administration of the town of Antwerp. It is also important to note that the subjects of the present study were all drawn from the outpatient cardiac rehabilitation program of the University Hospital of Antwerp. As a consequence, the residencies of these subjects are in the catchment area of the University Hospital. Furthermore, Belgium is a very small country and Belgian people are not very likely to move once they settle down in their middle-age. These factors facilitated our job in completing follow-up data. We did not classify cause of death based on relatives' impressions but on hospital records as well as information obtained from attending physicians. We have no control, however, over the extent to which attending physicians used hospital records as a basis for their classification.

2. We agree that the distinction between all-cause mortality and cardiac mortality is an important one. However, the present findings are only preliminary and the limited sample size does not allow for firm conclusions regarding cause of death. At present, we are examining this issue more thoroughly in confirmatory research on a larger sample size. In the mean time, the findings of the present research are consistent with the notion that the distressed personality type is not only a risk factor for all-cause mortality but for cardiac mortality as well.

3. Your point regarding the personality classification is well taken. Accordingly, we conducted additional analyses to examine whether the high distressed/low socially inhibited category was predictive of mortality. Accordingly, it is now stated in the Results section that "... the distressed personality type was empirically delineated on the basis of cluster analysis in previous research (19,20). However, to rule out the possibility that it is anxiety which is predictive of mortality in the present study, we conducted additional analyses" (page 8, paragraph 3, lines 2-3). In these analyses, a median split on the Trait Anxiety scale (ref. 53) and the Social Inhibition scale (ref. 52) were used to classify subjects in one of four a priori defined types: high anxiety/ high inhibition (i.e., the distressed personality type: anxiety \geq 40 / inhibition \geq 12; n=28), high anxiety / low inhibition (anxiety \geq 40/ inhibition \leq 11; n=24), low anxiety/high inhibition (anxiety \leq 39/inhibition \geq 12; n=23), and low anxiety/low inhibition (anxiety \leq 39 / inhibition \leq 11; n=30). The result of these analyses are now reported as follows: "Of note, there were no deaths among the 24 high anxiety/low inhibition subjects. Further, rate of death for high anxiety/low

inhibition (0 of 24), low anxiety/high inhibition (1 of 23) and low anxiety/low inhibition (3 of 30) subjects was not significantly different, $p=0.25$. Distressed subjects did not differ significantly from high anxiety/low inhibition subjects with reference to trait anxiety [i.e., 52.3 ($Sd=7.7$) vs 49.3 ($Sd=7.3$), $p=0.16$] whereas these subjects differed significantly with reference to rate of death; i.e., 39% vs 0%, $p<0.005$ " (page 8, last paragraph, lines 1-6). We believe that

- Responses to Comments of Reviewer #1 (continued) -

these findings clearly suggest that it is not the experience of negative emotions per se but rather the chronic psychological distress that results from holding back negative emotions that is predictive of post-MI mortality.

We decided to maintain the description of the four DIRE personality types because delineation of these personality types is based on empirical grounds; i.e., cluster analyses in previous research (ref. 19 and 20). Although the other three personality types were not significantly different with reference to post-MI mortality, evidence suggests that they are significantly different with reference to outcome measures such as well-being and perceived health status. We also maintained the term "restrained" because the subjects comprising this personality type are characterized by an elevated score on the Marlow-Crowne score. According to the three-factor personality model of Tellegen (ref. 25), these subjects are High Constraint persons. "Higher-order Factor III is labeled constraint. This trait dimension is characterized by salient loadings on the Control-versus-Impulsiveness, Harm Avoidance-versus-Danger Seeking, and Traditionalism scales, and is basically uncorrelated with state measures of Positive Affect and Negative Affect. A high Constraint score indicates a description of oneself as cautious, *restrained*, as refraining from risky adventures, and as accepting the *strictures of conventional morality*" (Tellegen, ref. 25, page 696, lines 13-19, italics added).

4. The distressed personality type as such was also an independent predictor of mortality in the present research. However, we decided to include the personality x exercise tolerance interaction in our final regression model because by doing so, we reduced the number of terms in this model and we managed to increase the predictive ability of the model.

5. In the captions of Figure 1, it is now stated that: "Note that there is a break in the continuum between 0 and 15 in the lower portion of the Y axis which represents the number of survivors" (Figure captions, page 25).

6. Thank you for pointing out the anticholinergic effect of high doses of benzodiazepines. As you indicated, this is a factor with which to be reckoned in our future research on the association between the distressed personality type and

long-term mortality in coronary patients.

Responses to Comments of Reviewer #2.

Thank you for raising the important question whether it is anxiety which is predictive of mortality rather than the distressed personality type.

To answer this question, we conducted additional analyses. Accordingly, it is now stated in the Results section that " ... the distressed personality type was empirically delineated on the basis of cluster analysis in previous research (19,20). However, to rule out the possibility that it is anxiety which is predictive of mortality in the present study, we conducted additional analyses" (page 8, paragraph 3, lines 2-3). In these analyses, a median split on the Trait Anxiety scale (ref. 53) and the Social Inhibition scale (ref. 52) were used to classify subjects in one of four a priori defined types: high anxiety / high inhibition (i.e., the distressed personality type: anxiety \geq 40 / inhibition \geq 12; n=28), high anxiety / low inhibition (anxiety \geq 40/ inhibition \leq 11; n=24), low anxiety/high inhibition (anxiety \leq 39/inhibition \geq 12; n=23), and low anxiety/low inhibition (anxiety \leq 39 / inhibition \leq 11; n=30).

The result of these analyses are now reported as follows: "Of note, there were no deaths among the 24 high anxiety/low inhibition subjects. Further, rate of death for high anxiety/low inhibition (0 of 24), low anxiety/high inhibition (1 of 23) and low anxiety/low inhibition (3 of 30) subjects was not significantly different, p=0.25. Distressed subjects did not differ significantly from high anxiety/low inhibition subjects with reference to trait anxiety [i.e., 52.3 (Sd=7.7) vs 49.3 (Sd=7.3), p=0.16] whereas these subjects differed significantly with reference to rate of death; i.e., 39% vs 0%, p<0.005" (page 8, last paragraph, lines 1-6). We believe that these findings clearly suggest that it is not anxiety per se but rather the chronic psychological distress that results from holding back negative emotions that is predictive of post-MI mortality.