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*Published in:*  
Current Cardiology Reviews

*Publication date:*  
2006

*Document Version*  
Publisher's PDF, also known as Version of record

[Link to publication in Tilburg University Research Portal](#)

*Citation for published version (APA):*  
Pedersen, S. S., & Denollet, J. (2006). Is Type D personality here to stay? Emerging evidence across cardiovascular disease patient groups. *Current Cardiology Reviews*, 6(2), 205-213.

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# Is Type D Personality Here to Stay? Emerging Evidence Across Cardiovascular Disease Patient Groups

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**Abstract:** The *distressed* personality (Type D) is an emerging risk factor in cardiovascular disease (CVD) that incurs a risk on par with left ventricular dysfunction in patients with ischemic heart disease. Type D is defined as the co-occurring tendencies to experience increased negative emotions and to inhibit self-expression in social interactions. Evidence is accumulating that Type D may also be a risk factor for adverse outcome across CVD patient groups, including patients undergoing revascularization with drug-eluting stent implantation or bypass surgery, patients with heart failure, peripheral arterial disease, and arrhythmia. In these patient groups, Type D personality has been associated with a 2-5 fold increased risk of adverse prognosis, impaired quality of life and symptoms of anxiety and depression independent of traditional biomedical risk factors, including disease severity. Although little is known about the pathways responsible for the detrimental effects of Type D on clinical outcome, the immune system and health-related behaviors, such as smoking and non-compliance, are likely candidates. Further research is warranted to investigate whether Type D personality is here to stay as a risk factor for CVD, but weighing current evidence on Type D against a set of external criteria shows that Type D personality fulfills the majority of these criteria. Importantly, Type D can easily be assessed in clinical research and practice with the standardized and validated DS14.

**Key Words:** Cardiovascular disease, prognosis, quality of life, risk factor, Type D personality.

## INTRODUCTION

The last decades have witnessed continuous advances in the knowledge of risk factors for cardiovascular disease (CVD) and the development of new treatment options and techniques with which to fight the disease. Despite these advances, there remains a gap between research and the implementation of results in clinical practice, with the patient standing to lose the most. Important recommendations how to bridge this gap are provided in a recent report from the National Heart, Lung, and Blood Institute Working Group on Outcomes Research in Cardiovascular Disease [1]. Investigation of the determinants of patient-centered outcomes, such as quality of life (QoL), and the inclusion of high-risk patients in research comprise some of the recommendations that may lead to enhanced 'patient-centered care' [1]. The report makes explicit reference to the importance of studying CVD populations that are at greatest risk for experiencing impaired QoL, which include patients with ischemic heart disease (IHD), chronic heart failure (CHF), and peripheral arterial disease (PAD) [1].

### Type D Personality: An Emerging Risk Factor?

There is increasing evidence that cardiac patients with a *distressed* (Type D) personality comprise high-risk patients, and that Type D is an important determinant of patient-centered and clinical outcome. A high score on the two stable personality traits, negative affectivity and social inhibition defines patients with this personality type [2]. Type D patients tend to experience increased negative emotions and

generally feel sad and have a gloomy view of life (i.e. high negative affectivity) paired with the tendency not to share these emotions with others due to fears of how they may react (i.e. high social inhibition) [2]. Type D has been associated with a 4-fold increased risk of morbidity and mortality in patients with IHD independent of established biomedical risk factors [3-5]. Hence, Type D comprises a risk factor on par with left ventricular dysfunction. However, as shown in a previous review on Type D personality, this subgroup of patients is not only at increased risk of adverse prognosis, but is also more likely to experience symptoms of anxiety and depression and impaired QoL [6]. A recent study has also shown that Type D personality comprises a risk factor for posttraumatic stress disorder (PTSD) following a first myocardial infarction (MI) [7]. In essence, this provides further evidence for the construct validity of Type D that patients with this personality disposition are susceptible to experience a wide range of negative emotions.

### Type D Personality: Not Just a Measure of Negative Affect or Depression

The wide range of negative emotions characteristic of Type D patients may have led to the common misconception that Type D is nothing more than negative affect or 'old wine in new bottles' [8]. However, due to the inclusion of the *social inhibition* component the construct is clearly more than a measure of negative affect or depression, as it also points to how patients cope with this affect. Only those patients who score high on both traits (the Type Ds) form a high-risk group, suggesting that *social inhibition* moderates the effect of *negative affectivity* on clinical outcome [3]. In addition, studies have shown that Type D still predicts adverse clinical outcome when adjusting statistically for measures of negative affect, such as anxiety and depression [4, 5]. Table 1 summarizes the differences between depression and Type D

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**Table 1. Depression Versus Type D Personality**

Construct	Negative emotions	Social inhibition	Duration*
Depression	Depressed affect in particular	Not specified	Episodic (<2 years)
Type D personality	Negative affect in general (including worry, irritability)	Elevated levels (non-expression)	Chronic (≥2 years)

personality. The Type D personality construct further distinguishes itself from other psychological measures currently being studied in the context of CVD, such as depression. Whereas depression reflects psychopathology, Type D represents a normal personality construct [2, 6]. Personality factors in CVD research tend to have been neglected since the emergence of inconsistent findings in relation to the Type A Behavior Pattern. However, an advantage of a personality approach is that personality measures may be used as screening tools in order to identify high risk patients, with personality factors likely having greater explanatory power than mood [6].

#### ADVERSE EFFECT ON PROGNOSIS IN ISCHEMIC HEART DISEASE

In a previous review, we showed that Type D personality was a risk factor for adverse clinical prognosis in mixed groups of patients with IHD [6]. In those patients, Type D was associated with a 4-8 fold increased risk of mortality and non-fatal MI [3-5], a 7-fold increased risk of developing cancer [9], less positive and more negative affect [10] including vital exhaustion [11], a 4-fold risk of PTSD [7], and decreased age at initial IHD diagnosis [12].

#### TYPE D ACROSS CARDIOVASCULAR DISEASE PATIENT GROUPS

Although this evidence may seem convincing, one important criterion that Type D personality must fulfill, at a minimum, in order to be considered a risk factor in CVD, is that it has value across CVD patient groups [13]. Hence, the current review focuses on evidence on Type D in relation to IHD patients treated invasively with percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG), and in patients with CHF, PAD, arrhythmia, sudden cardiac arrest (SCA), and hypertension. The majority of these studies were published after 2003, i.e. after our first review on Type D personality. All studies, past and present, are presented in Table 2.

##### Post-PCI and Post-CABG Patients

Drug-eluting stents (DES) comprise a major breakthrough in the treatment of atherosclerosis with PCI and have largely done away with restenosis, the 'Achilles heel' of interventional cardiology. The beneficial effects of DES have been demonstrated in both selected [14, 15] and unselected IHD patients [16], but DES implantation has not been shown to enhance survival or decrease the risk of non-fatal MI [17]. In this context, Pedersen and colleagues examined the impact of Type D personality on prognosis in patients included in the Rapamycin-Eluting Stent Evaluated At Rotterdam Cardiology Hospital (RESEARCH) registry [18]. The RESEARCH registry was conducted in the 'real world', with no

patients being excluded on the basis of anatomical and clinical criteria [16]. Evaluation of clinical treatment strategies in 'real world' settings has been recommended as a means by which to close the gap between research and clinical practice [1]. Of note, 68% of the RESEARCH registry population would not have qualified for inclusion in clinical trials due to a more complex clinical profile [19]. In the psychological sub study of the RESEARCH registry, Type D personality was associated with a 5-fold increased risk of a composite of death and non-fatal MI 9 months following assessment of Type D caseness (or 15 months post-PCI) adjusting for gender, age, previous CABG, stent type (sirolimus-eluting stent or bare metal stent implantation), and the interaction term stent type by personality type [18].

The latter study investigated the impact of the global Type D personality construct on death and MI, with the possibility that the increased risk for adverse prognosis was attributable to the main effect of either *negative affectivity* or *social inhibition* and not that *inhibition* modulates the effect of *negative affectivity*. Hence, using the same population a recent study examined the role of *social inhibition* as a modulator of *negative affectivity* with major adverse cardiac event (MACE), defined as death, MI, PCI or CABG, as endpoint [20]. The interaction effect of *inhibition* by *negative affectivity* rather than negative emotions per se was a predictor of poor prognosis. These results were confirmed in secondary analyses using death and MI as endpoint, providing conclusive evidence that Type D personality is more than negative affect and that *social inhibition* is an important modulator of negative emotions on clinical outcome.

In another RESEARCH registry sub study, Pedersen and colleagues investigated predictors of the onset of depressive symptoms at 12 months post-PCI in patients who were not depressed at 6 months [21]. Patients who were depressed at 12 months were more likely to have a Type D personality (34% versus 16%;  $p = 0.003$ ) and to be diagnosed with diabetes (24% versus 11%;  $p = 0.01$ ) compared with non-depressed patients. Type D personality and diabetes remained independent predictors of the onset of depressive symptoms at 12 months in adjusted analyses with Type D being associated with a 3-fold increased risk [21]. The occurrence of a new cardiac event (MI, PCI or CABG) between 6 and 12 months post-PCI was not associated with the incidence of depressive symptoms at 12 months. A graded relationship was also found between depressive symptoms and risk factors (Type D and diabetes), with the incidence of depression being 5.1% in patients with neither risk factors doubling to 13.2% and 30% for each additional risk factor.

In a recent cross-sectional survey of patients undergoing primary isolated CABG for multi-vessel disease, Type D

**Table 2. Overview of Studies Published on Type D Personality Stratified by IHD Patients Versus Special CVD Interest Groups**

Authors	Ref	Participants	Study design	Follow-up	Main endpoint	Risk*
<i>IHD patients</i>						
Denollet <i>et al.</i> (1996)	3	303 IHD patients	Prospective	6-10 yrs	All cause mortality	OR: 4.1
Denollet <i>et al.</i> (1998)	4	87 MI patients	Prospective	6-10 yrs	Cardiac death, non-fatal MI	RR: 4.7
Denollet (1998)	9	246 IHD patients	Prospective	6-10 yrs	Cancer	OR: 7.2
Denollet <i>et al.</i> (2000)	5	319 IHD patients	Prospective	5 yrs	Cardiac death, non-fatal MI	OR: 8.9
Pedersen <i>et al.</i> (2001)	11	171 IHD patients	Intervention study	6 weeks	Symptoms of exhaustion	ORs: 4.7 - 6.4
Pedersen <i>et al.</i> (2004)	7	112 first MI patients, 115 healthy controls	Case-control	-	Posttraumatic stress disorder	OR: 4.5
<i>Special CVD interest groups</i>						
Pedersen <i>et al.</i> (2004)	18	875 PCI patients	Prospective	9 months	Composite of death and MI	OR: 5.3
Denollet <i>et al.</i> (2006)	20	875 PCI patients	Prospective	9 months	MACE	HR: 1.92
Pedersen <i>et al.</i> (2006)	21	542 PCI patients without depression	Prospective	6 months	Depression	OR: 3.0
Al-Ruzzeh <i>et al.</i> (2005)	22	437 CABG patients	Cross-sectional	-	QoL	ORs: 2.3 - 5.5
Schiffer <i>et al.</i> (2005)	24	84 CHF patients	Cross-sectional	-	QoL, depression	ORs: 3.3 - 7.1
Denollet <i>et al.</i> (2003)	23	42 CHF patients	Cross-sectional	-	Inflammatory markers	ORs: 6.1 - 9.5
Aquarius <i>et al.</i> (2005)	26	150 PAD patients, 150 healthy controls	Case-control	-	Perceived stress, QoL	ORs: 6.5 - 7.4
Pedersen <i>et al.</i> (2004)	27	182 ICD patients, 144 partners	Cross-sectional	-	Anxiety, depression	ORs: 4.4 - 8.7
Appels <i>et al.</i> (2000)	28	99 SCA patients, 119 IHD patients	Case-control	-	Sudden cardiac arrest	OR: 9.4
Denollet (2005)	2	2508 general population, 573 IHD patients, 732 hypertensives	Cross-sectional	-	Hypertension	OR: 5.5

\* Risk associated with Type D personality (adjusted analyses)

CABG = coronary artery bypass graft surgery; CHF = chronic heart failure; HR = hazard ratio; ICD = implantable cardioverter defibrillator; IHD = ischemic heart disease; MACE = major adverse cardiac event; MI = myocardial infarction; OR = odds ratio; PAD = peripheral arterial disease; PCI = percutaneous coronary intervention; QoL = quality of life; RR = relative risk; SCA = sudden cardiac arrest

personality was identified as a predictor of both physical and mental QoL one year post-procedure [22]. The risk associated with Type D for impaired physical QoL was 2-fold, whereas the risk related to impaired mental QoL was significantly higher, with a more than 5-fold risk, adjusting for demographic and clinical characteristics collected prospectively since the index procedure [22]. The latter study is the first to examine the impact of Type D on QoL in a sample of pure CABG patients.

### Chronic Heart Failure

To date, two studies have been published on Type D personality in the context of CHF [23, 24]. The first study sought to elucidate whether pro-inflammatory cytokines may comprise one of the mechanisms responsible for the link between Type D personality and adverse clinical outcome

[23]. CHF patients with a Type D personality had significantly higher mean circulating plasma levels of TNF- $\alpha$  and the soluble TNF- $\alpha$  receptors 1 and 2. When controlling for ischemic etiology and NYHA class, Type D remained an independent predictor of increased levels of both TNF- $\alpha$  and its soluble receptors with the associated risk ranging from 6-9 fold [23]. Pro-inflammatory cytokines, such as TNF- $\alpha$ , play an important role in the pathogenesis of CHF [25]. Although these results should be considered preliminary due to the cross-sectional design of the study and the inclusion of a relatively small sample of men only, they show that there is a conceivable pathway through which Type D exerts its deleterious effect on health.

The second study focused on Type D personality as a determinant of impaired QoL, mood status and increased depressive symptoms in CHF outpatients [24]. Type D pa-

tients were at a 3-7 fold increased risk of experiencing negative affect, depressive symptoms and impaired QoL, adjusting for gender, age, etiology of CHF, NYHA functional class, and left ventricular ejection fraction (LVEF). Of note, none of the characteristics of CHF were associated with increased distress and impaired QoL.

### Peripheral Arterial Disease

A case-control study of patients with PAD and healthy controls examined the impact of disease status and Type D personality on QoL and perceived stress [26]. Type Ds reported significantly poorer QoL and more stress than non-Type Ds [26]. Given that the prevalence of Type D was significantly higher in PAD patients than in healthy controls (34.9% versus 13.3%;  $p < 0.001$ ), Aquarius and colleagues investigated the relative impact of disease status and personality on QoL and perceived stress adjusting for gender and age [26]. Type D personality and PAD were independent predictors of impaired QoL on all domains of the World Health Organization Quality of Life Assessment Instrument-100, with the risk associated with Type D ranging from 3-7 fold depending on the QoL domain in question [26]. Type D personality was also associated with a 6-fold increased risk of perceived stress, whereas PAD only showed a trend.

### Arrhythmia

In patients with an implantable cardioverter defibrillator (ICD) and their partners, Pedersen and colleagues investigated the role of Type D personality and perceived social support as determinants of anxiety and depressive symptoms [27]. Stratifying patients by shocks and Type D personality showed that anxiety and depressive symptoms were more prevalent in Type D patients than in non-Type D patients irrespective of shocks [27]. In multivariable analysis, Type D was independently associated with anxiety, adjusting for gender, age, the use of psychotropic medication, lack of social support, the interaction term Type D x shocks, and clinical variables significant at  $p < 0.05$ . Although there was a trend for shocks as received by the ICD, this was not statistically significant. Type D was also an independent determinant of depression in adjusted analyses. The risk associated with Type D in patients for both anxiety and depression was 7-fold. Of note, none of the clinical variables were significantly associated with distress, suggesting that underlying disease pathology did not account for differences in distress. Type D was also an independent determinant of anxiety and depressive symptoms in partners [27].

### Sudden Cardiac Arrest

A proxy measure for Type D personality has also been associated with an increased risk of SCA [28]. In a matched case-control study using patients with manifest IHD as controls, patients who died due to a cardiac cause instantaneously or within 24 hours of symptom onset with or without a pre-existing cardiac condition were more likely to have increased symptoms of vital exhaustion, a measure of *negative affectivity*, paired with being a 'closed person', a measure of *social inhibition*. The vital exhaustion by 'closed person' interaction was associated with a 7-fold increased risk adjusting for demographic and clinical risk factors, suggesting that Type D may be an antecedent of sudden cardiac death

[28]. It should be noted, however, that for the SCA patients the next of kin (most often the spouse) were asked to rate the patients on vital exhaustion and openness retroactively. Although this may have biased the results, the prevalence of symptoms of vital exhaustion was on par with that found in other studies, and it has been shown that there is a high concurrence rate between symptoms of exhaustion evaluated by patients and their spouses [28].

### Hypertension

As part of the validation study of the Type D Scale (DS14), Denollet compared the prevalence of Type D personality in hypertensives, IHD patients, and healthy controls [2]. Surprisingly, Type D was significantly more prevalent in hypertensive patients (53%) than in IHD patients (28%) and controls (20%). The prevalence of 28% in IHD patients compares with the prevalence rates found in previous studies of IHD patients [6]. The prevalence rate in hypertensives is unusually high, although a previous Canadian study of healthy students also found increased blood pressure reactivity to stress in Type D individuals [29].

Taken together, the findings of these studies on special CVD interest groups show that the Type D personality construct not only has value in patients with established IHD but across a wide range of CVD patient groups and despite innovative techniques in the fight against CVD, such as the use of DES. These studies also indicate that Type D personality is a vulnerability factor not only for adverse clinical prognosis, but also for increased distress and impaired QoL. In turn, impaired QoL [30, 31] and depression [32] have both been associated with adverse prognosis in patients with established CVD. More importantly, the findings demonstrate that the impact of Type D personality on the various outcome measures is not a function of disease characteristics, including severity of disease, as these characteristics were controlled for statistically.

### TYPE D PERSONALITY: A NEW RISK FACTOR?

This review shows that there is increasing and consistent evidence that Type D personality is associated with a greater risk for morbidity and mortality in patients with established IHD [3-5, 7, 9-11], and has value in CHF- [24], PAD- [26], and arrhythmia-research [27]. There is also convincing evidence that Type D continues to be of value in IHD patients despite new innovative techniques to counter the impact of disease progression, such as DES [18, 20, 21]. Nevertheless, it is important to take an objective stance when evaluating the utility of Type D in clinical practice.

In a seminal paper published in 2003 in the *New England Journal of Medicine*, Manolio provides a list of criteria to assist clinicians in judging the importance of new risk markers [13]. Although these criteria were provided in a different context, namely to determine the practical value of markers of disease progression in clinical practice, they could in principle be applied to evaluate the importance of any new risk marker or risk factor, including Type D personality. Hence, for the intent and purposes of this review from this point onwards we will use the term risk factor rather than risk marker. Manolio considers five criteria to be important. First, the risk factor should provide independent information about

risk, i.e. still have an impact on the outcome of choice when adjusting statistically for other known risk factors related to the outcome. Second, the frequency of the risk factor and the risk associated with the factor should be of a given magnitude. Examples of a 25% prevalence rate and a 2-3 fold increased risk were provided to indicate an acceptable magnitude [13]. Third, the measure should be reproducible, remain fairly stable within a patient over time, and be consistent in multiple groups of patients in a variety of clinical settings. Fourth, the measure should be sensitive, specific, and have a high predictive value if used for diagnostic purposes. Fifth, there should be a standardized test available with which to assess the risk factor. Two additional criteria, i.e. criteria 6 and 7, could be added to Manolio's list, namely: Sixth, it should be possible to point to plausible mechanisms that may be responsible for the link between the risk factor and adverse prognosis. Seventh, the risk factor also has to be modifiable, as it would otherwise be pointless to suggest screening for the risk factor in clinical practice.

How does the Type D personality construct hold up against this set of external criteria? In our opinion, Type D measures up to criteria 1, 2, 3, 5, and 6 – i.e. 5 out of the 7 criteria. It has proven to be an independent predictor for adverse clinical outcome and secondary outcomes, such as impaired QoL and psychological symptoms, adjusting for demographic and clinical risk factors [3-5, 7, 9-11, 18, 20, 21, 22, 24, 26-28] (criterion 1). Type D is present in approximately one third of CVD patients (with prevalence rates ranging from 28-32%), and its presence incurs a substantial risk in relation to prognosis – a risk that is on par with left ventricular dysfunction [3-5, 9, 11, 18, 20, 21] (criterion 2). Type D is stable within patients [2], and results in relation to the construct have been reproduced across studies and across CVD patient groups [3-5, 7, 9-11, 18, 20, 21, 24, 26-28] (criterion 3). There is a standardized, validated, and reliable questionnaire available to identify Type D caseness [2] (criterion 5). A number of plausible pathophysiological mechanisms exist that may explain the link between Type D and adverse clinical outcome, including inflammatory markers [23], decreased heart rate variability, and health-related behaviors (criterion 6).

The pathophysiological pathways through which Type D personality exerts its deleterious effects on health are likely to be complex, however.

**HOW DOES TYPE D WORK?**

Given that adverse clinical outcome is perpetuated by multiple factors and their interactions, it is unlikely that only one mechanism can explain the link between Type D personality and adverse prognosis [33]. Although the study of potential pathways linking psychological risk factors in general and Type D personality in particular to poor prognosis is very much in its infancy, potential mechanisms are shown in Fig. 1.

**Psychophysiological Stress**

Individual differences, including personality factors, genetics, experience, cognitions, and social support, are known to influence the response to chronic stress with the response being mediated by the hypothalamic-pituitary-adrenal (HPA)

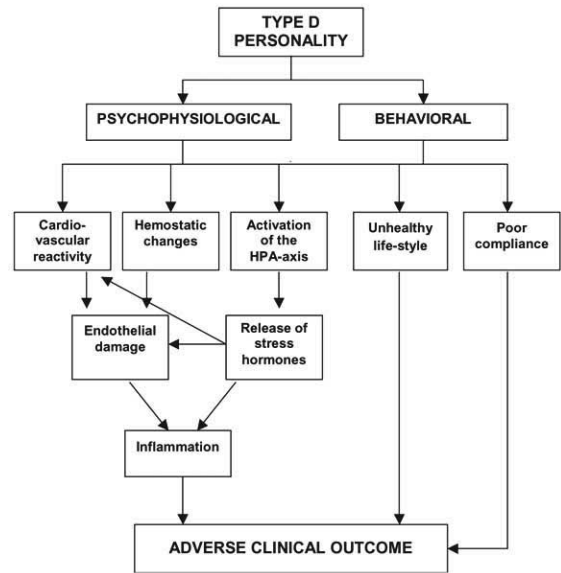


Fig. (1). Potential mechanisms linking Type D personality with adverse clinical outcome.

axis [34]. Given that Type D patients experience a wide range of negative emotions, the HPA axis has been suggested as one of the mechanisms linking Type D to CVD, with regulation of the HPA axis likely differing in Type D patients compared with non-Type D patients [35]. At the time of stress, information is sent from the brain to the HPA axis, which sets a chain reaction in motion [36]. The hypothalamus releases corticotropin releasing hormone (CRH) that stimulates the pituitary gland to release adrenocorticotropin releasing hormone (ACTH). In turn, the release of ACTH results in the adrenals releasing cortisol. Cortisol is known as an *effector hormone*, i.e. it influences areas of the body. Of note, both of the core components of Type D personality, *negative affectivity* and *social inhibition*, but not the global Type D construct have been associated with increased cortisol levels in healthy adults [29].

Chronic stress may not only exert its deleterious effect on health through the HPA-axis but also through altered hemostasis [37]. In turn, this may lead to increased inflammation, which is known to play a pivotal role in the onset and progression of atherosclerosis [38]. Stress may influence the immune system *via* glucocorticoid (cortisol) receptors on lymphocytes, as stressful tasks have been shown to reduce lymphocyte proliferation and natural killer (NK) cell activity, hence increasing the individual's vulnerability to infections and disease [39]. Cytokine production can also be stimulated directly (and independent of the effects of cortisol) in response to infection and psychological trauma [40]. Preliminary evidence indicates that Type D patients with CHF have increased levels of mean circulating plasma levels of TNF- $\alpha$  and the soluble TNF- $\alpha$  receptors 1 and 2 [23]; the latter cytokines are strong prognostic factors in CHF [25]. Although we do not know when this difference in inflammatory status between Type D and non-Type D patients becomes manifest, i.e. prior to or post onset of CVD, inflam-

matory status prior to percutaneous coronary intervention (PCI) has been shown to be an important determinant of clinical outcome post-PCI [41].

No study to date has investigated the relationship between Type D personality and cardiovascular reactivity to stress in CVD patients, but the core components of Type D personality – *negative affectivity* and *social inhibition* – have been associated with dampened heart rate change and heightened blood pressure reactivity, respectively, in healthy men [29]. The global Type D construct was not related to these physiological measures. Previously, inhibition of emotions has also been associated with impaired autonomic functioning in healthy women, with inhibited women having reduced heart rate variability (HRV) [42]. It should be noted that the latter study was cross-sectional and did not evaluate the relative impact of inhibition and HRV on health outcomes. However, a more recent study conducted in MI patients puts into question whether HRV mediates the relationship between inhibition and clinical outcome, as both social inhibition and impaired HRV were independent risk factors for mortality and non-fatal MI at 8 years follow-up [43]. Of note, patients with both risk factors had a substantially higher mortality rate (62%) compared with patients with no risk factors (6%) [43]. Studies investigating the global Type D construct, HRV and their respective influence on clinical outcome are now warranted.

**Behavioral Pathways**

Health-related behaviors and compliance constitute other possible mediators of the relationship between Type D personality and adverse clinical prognosis. Patients with a Type D personality may be more inclined to engage in disease-promoting health behaviors, such as smoking, drinking alcohol, not exercising, and not adhering to dietary advice as advocated by their physician [44]. Type D patients may also be less likely to participate in rehabilitation, as personality variables have been shown to predict adherence to cardiac rehabilitation [45].

In addition, patients with this personality disposition may refrain from seeing a physician [46], with the result that they may be less like to undergo invasive procedures including revascularizations; and if seeing a physician, social inhibi-

tion may impede communication between patient and physician [47]. In turn, this likely results in the under treatment of psychological stress, which could be potentially damaging to health. Moreover, lack of compliance, including non-modification of risk factors, and non-adherence to cardiac rehabilitation and medication regimens, directly increase the risk of recurrent cardiac events.

**ASSESSMENT OF TYPE D PERSONALITY**

Type D personality can be assessed by means of the Type D Scale (DS14) that consists of 14 items measuring *negative affectivity* and *social inhibition* [2]. The 14 items are answered on a 5-point Likert scale from 0 (false) to 4 (true). A pre-determined, standardized cut-off  $\geq 10$  on both scales identifies Type D caseness. The psychometric properties of the scale are good with Cronbach's  $\alpha = .88/.86$  and test-retest reliability  $r = .72/.82$  for the *negative affectivity* and the *social inhibition* subscales, respectively [2]. Sample items and symptom manifestation are shown in Table 3.

Due to the brevity of the DS14 and the simplicity of the items, completing the DS14 comprises little burden to patients, and it generally takes 5-10 minutes. In a recent paper on the screening of psychosocial factors in clinical practice, the DS14 was recommended as a screening tool [48]. The DS14 has been included in the Euro Cardio-QoL Project, an international project under the auspices of the European Society of Cardiology with the aim to develop a core questionnaire for assessing QoL in heart patients [49]. There is also increasing interest in the scale in other distinct languages. Although originally developed and validated in Belgian IHD patients, the scale has now been validated in the German [50], Italian [51] and Danish languages [7]. The latter study used an older version of the DS14, namely the DS16, but validation of the DS14 in Danish CHF patients is currently under way. In addition, the use of the DS14 has extended to other diseases [9, 50] and settings [52].

Methodologically, steps have also been made to sort out the ‘big mush’, i.e. to test the overlap between Type D personality and other psychological risk factors, such as depression and vital exhaustion [53, 54]. This endeavor is important given the abundance of psychological constructs available and given that it is not feasible to assess all in clinical

**Table 3. Assessment of Type D Personality**

	<b>Negative Affectivity</b>	<b>Social Inhibition</b>
<i>Definition</i>	tendency to experience negative emotions across time/situations	tendency to inhibit emotions and behaviors in social interaction
<i>Manifestation</i>	often feels unhappy, tends to worry; easily irritated; lacks in self-esteem	tends to be closed and reserved; tends to keep others at distance
<i>Assessment</i>	DS14 negative affectivity subscale (7 items; score $\geq 10$ as cut-off)	DS14 social inhibition subscale (7 items; score $\geq 10$ as cut-off)
<i>Sample items</i>	“I often feel unhappy” “I often find myself worrying about something” “I am often irritated”	“I am a closed kind of person” “I often feel inhibited in social interactions” “I find it hard to start a conversation”

DS14: Type D Scale 14-item scale.

practice. In other words, in order to enhance 'patient-centered care' as recently advocated by Krumholz and colleagues [1], we need to be critical of the constructs that we use. The findings of Kudielka and colleagues support the notion that the *negative affectivity* and the *social inhibition* subscales of the Type D construct are distinct from other measures of psychological risk, including depression, social support, and vital exhaustion [53]. By contrast, in the study by Ketterer and colleagues the global Type D construct was not a predictor of age at initial diagnosis of IHD (used as a proxy for the severity of disease) when including other psychological constructs [54]. However, it should be noted that the former study was conducted in a large sample from the general population ( $n = 822$ ) and the latter in a relatively small group of patients with established CVD ( $n = 83$ ).

### RECOMMENDATIONS AND CONCLUSIONS

The evidence presented thus far shows that the use of the Type D personality construct in clinical practice is of practical value. However, this status also points to the gaps in Type D research. First, there is an urgent need to continue research into the mechanisms that may relate Type D to clinical outcome, as such research is likely to point to targets for intervention.

Second, it will be important to ascertain in epidemiological studies whether Type D is not only a prognostic but also an etiological risk factor leading to the development of CVD. Only by means of following a healthy cohort over time will it be possible to rule out whether disease has an impact on the development of the personality.

Third, there is a need for conducting intervention trials that target the personality taxonomy in order to enhance secondary prevention in this subset of CVD patients. A randomized controlled trial that is appropriately designed and rigorously executed will provide the strongest evidence of causality [55]. In addition, a trial will reveal whether Type D is a risk factor or a risk marker, i.e. whether a third variable is the primary cause of both Type D and adverse prognosis. As pointed out by Ketterer and colleagues, if a given risk factor cannot be modified, irrespective of whether it is causal, it has no clinical utility [55]. Although recent intervention trials targeting other psychosocial risk factors have shown mixed results, such as the Enhancing Recovery in Coronary Heart Disease (ENRICH) study [56], the Sertraline Antidepressant Heart Attack Randomized Trial (SADHART) [57, 58], and the randomized Exhaustion Intervention Trial (EXIT) [59], there is suggestive evidence from these and other trials that a reduction in negative emotions may lead to improved prognosis [60, 61]. Although *social inhibition* may be less amenable to change, it is important to note that a reduction in negative affectivity (below the standardized cut-off of  $\leq 10$ ) would make the difference between whether a patient is classified as Type D or not. The implication hereof is that the risk profile of that patient would change, hence leading to a reduced risk of adverse clinical outcome.

Fourth, further cross-cultural research into the validity of the Type D construct and its impact on QoL, psychological distress, and clinical outcome is warranted together with its potential role in other somatic diseases and its relationship with risk factors for the onset of IHD, such as hypertension.

If replicated in other studies, the high prevalence of Type Ds in hypertensives suggests that individuals at risk of CVD may be identified early on and prior to the manifestation of disease [2]. For this aim, the Type D Scale could be used as a screening tool in clinical research and practice and included in a risk-stratification model.

As a final note, it is imperative to emphasize that findings related to the Type D personality construct should not be misinterpreted so as to suggest that these patients should not receive the latest treatment in CVD. Although Type D patients do not benefit from treatment on par with non-Type D patients, they do experience gains e.g. in terms of a reduction in symptoms of angina and vital exhaustion [11].

In conclusion, evidence is accumulating that the distressed personality (Type D) is not only a risk factor in patients with established IHD but also across CVD patient groups, including patients undergoing revascularization with drug-eluting stent implantation, patients with CHF, PAD, and arrhythmia. In these patient groups, Type D personality has been associated with a 2-5 fold increased risk of adverse prognosis, impaired QoL and symptoms of anxiety and depression independent of traditional biomedical risk factors, including disease severity. Weighing current evidence on Type D against a set of external criteria shows that Type D personality fulfills the majority of these criteria. In turn, this suggests that Type D is a risk factor that is here to stay. Research is now warranted to investigate which mechanisms may be responsible for the link between Type D and poor prognosis and how this risk factor can be modified, so as to enhance secondary prevention in these high-risk patients.

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Received: 25 January, 2006

Revised: 23 March, 2006

Accepted: 09 May, 2006