Psychological profiles derived by cluster analysis of Minnesota Multiphasic Personality Inventory and long term clinical outcome after coronary artery by pass grafting

Profili psicologici derivati da una analisi per gruppi del Minnesota Multiphasic Personality Inventory ed eventi a lungo termine dopo bypass aorto-coronarico

Maddalena Modica[1], Roberta Carabalona[2], Rosa Spezzaferri[1],
Monica Tavanelli[1], A. Torri[1], Vittorino Ripamonti[1], Paolo Castiglioni[2],
Renata De Maria[3], Maurizio Ferratini[1]

ABSTRACT: *Psychological profiles derived by cluster analysis of Minnesota Multiphasic Personality Inventory and long term clinical outcome after coronary artery by pass grafting. M. Modica, R. Carabalona, R. Spezzaferri, M. Tavanelli, A. Torri, V. Ripamonti, P. Castiglioni, R. De Maria, M. Ferratini.*

Background: To evaluate the psychological characteristics of coronary heart disease (CHD) patients after coronary artery bypass grafting (CABG) by cluster analysis of Minnesota Multiphasic Personality Inventory (MMPI-2) questionnaires and to assess the impact of the profiles obtained on long-term outcome.

Methods: 229 CHD patients admitted to cardiac rehabilitation filled in self-administered MMPI-2 questionnaires early after CABG. We assessed the relation between MMPI-2 profiles derived by cluster analysis, clinical characteristics and outcome at 3-year follow-up.

Results: Among the 215 patients (76% men, median age 66 years) with valid criteria in control scales, we identified 3 clusters (G) with homogenous psychological characteristics: G1 patients (N=75) presented somatoform complaints but overall minimal psychological distress. G2 patients (N=72) presented type D personality traits. G3 subjects (N=68) showed a trend to cynicism, mild increases in anger, social introversion and hostility. Clusters overlapped for clinical characteristics such as smoking (G1 21%, G2 24%, G3 24%, *p ns*), previous myocardial infarction (G1 43%, G2 47%, G3 49% *p ns*), LV ejection fraction (G1 60 [51 – 60]; G2 58 [49-60]; G3 60 [55-60], *p ns*), 3-vessel-disease prevalence (G1 69%, G2 65%, G3 71%, *p ns*). Three-year event rates were comparable (G1 15%; G2 18%; G3 15%) and Kaplan-Meier curves overlapped among clusters (*p ns*).

Conclusions: After CABG, the interpretation of MMPI-2 by cluster analysis is useful for the psychological and personological diagnosis to direct psychological assistance. Conversely, results from cluster analysis of MMPI-2 do not seem helpful to the clinician to predict long term outcome.

Keywords: coronary artery bypass grafting, coronary heart disease, cluster analysis Minnesota Multiphasic Personality Inventory, outcome.

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[1] *Fondazione Don Carlo Gnocchi, UO Cardiologia Riabilitativa and* [2] *Polo Tecnologico, IRCCS Santa Maria Nascente, and* [3] *Istituto Fisiologia Clinica CNR, Milan, Italy.*

Corresponding author: Maurizio Ferratini MD; Fondazione Don Carlo Gnocchi, UO Cardiologia Riabilitativa; IRCCS Santa Maria Nascente; Via Capecelatro 66; I-20148 Milan Italy; E-mail address: mferratini@dongnocchi.it

Introduction

Psychopathological disturbances such as anxiety and depression impact though maladaptive behavioral [1] and pathogenetic mechanisms [2] both on the onset of coronary heart disease (CHD) [3] and on unfavorable outcomes in patients with established CHD [4-6].

An increased risk of CHD has been shown in competitive, hyper vigilant subjects with a chronic sentiment of urgency and impatience, emotional and behavioural traits observed in a personality profile defined *Type A Behaviour Pattern* (TABP) [7]. Specific TABP traits, such as anger and hostility, were confirmed to be ontogenetically associated with CHD [8-10]. Another personality profile named *type D, Distressed Personality*, characterized by negative affectivity and social inhibition, has been associated to a higher rate of major adverse events and to a four-fold mortality risk when compared to non *type D* subjects [11].

The Minnesota Multiphasic Personality Inventory (MMPI-2) is a wide spectrum test, composed of 567 items with a binary true/false response grouped into different scales that assesses the most important structural personality traits and emotional distur-

bances. MMPI-2 is used in clinical applications for the study of personality, to assess the impact of organic disease on the emotional status and to predict treatment compliance [12]. Most cardiological studies used only some of MMPI scales [13].

Cluster analysis, an unsupervised statistical procedure that identifies aggregating personality traits from MMPI expressed also by means of qualitative features [14], has been previously applied to evaluate the association between pre-transplant personality traits and quality of life in heart transplant recipients [15]. A single study performed in candidates to coronary artery bypass grafting (CABG) longitudinally assessed changes in personological profiles obtained by MMPI-168 with clustering on 8 clinical scales [16].

Aim of the present study was to evaluate by means of cluster analysis of MMPI-2 questionnaires the psychological complexity of post-CABG patients and to assess whether the different profiles obtained impacted on long-term clinical outcome.

Patients and Methods

We enrolled 229 patients consecutively admitted to our Rehabilitative Cardiology Unit, within 8 days on average after CABG. Patients were followed-up for 3 years. Consenting patients aged >18 years with a good command of the Italian language were included in the study. Exclusion criteria were: cognitive impairment <8 years of education [17], participation to other research protocols, malignancies with anticipated unfavourable short-term outcome. Psychometric and cardiac evaluations were performed during stay in cardiac rehabilitation by self-administration of MMPI-2 in a validated version for our language [17]. We considered the following clinical scales: hypochondria, depression, hysteria, psychopathic deviation, paranoia, psychoastenia, schizophrenia, hypomania, social introversion, anger, cynicism, hostility and "type A". We used the following validity scales: lie (LIE), correction (K)

and frequency (F). The raw scale scores were transformed (Psysystem3, Giunti O.S. Organizzazioni Speciali, 2003) in T points; those above 65 were considered clinically relevant [16].

Clinical evaluation at baseline included major CHD risk factors, previous myocardial infarction, number of grafts, left ventricular ejection fraction (LVEF) by echocardiography, and drug therapy. Hypertension was defined as a clinic blood pressure ≥140/90; hypercholesterolemia and hypertriglyceridemia as LDL levels ≥100 mg/dl and triglyceride levels ≥150 mg/dl; overweight as a body mass index ≥25 kg/m^2.

After discharge from Cardiac Rehabilitation, patients were followed-up periodically in the outpatient clinic till year 3 and readmissions for cardiovascular causes were recorded.

The study was approved by the Institutional Review Board; patients expressed their written informed consent prior to enrolment.

Statistical analysis

We chose thirteen scales among those usually considered for MMPI-2 analysis: Hs.5K, D, Hy, Pd.4K, Pa, Pt.1K, Sc.1K, Ma.2K, Si, ANG, CYN, TPA, O.H. Given the ordinal nature of T points, Gower distance was chosen and cluster analysis using complete linkage was performed and validated by silhouette criterion.

For descriptive statistics, we used pointwise estimation for proportions in case of categorical data. For quantitative variables, we used median, 25% and 75% percentiles, due to the non gaussianity of overall data assessed by means of Shapiro-Wilk test.

After cluster analysis, stratified baseline and follow-up clinical data were compared. We used either ANOVA or Kruskal-Wallis test to compare continuous variables among groups. With respect to proportions, assumption of independence was tested using χ^2 test. A stratified survival analysis was performed on all-cause mortality and/or readmission for cardiac causes using Kaplan-Meier estimator. Level of

Table 1. - Baseline characteristics of the study population						
	All (N=215)	Cluster1 (N$_{g1}$=75)	Cluster2 (N$_{g2}$=72)	Cluster3 (N$_{g3}$=68)	*Test*	*p*
Age (years)	66 [60 - 70]	67 [60.5 - 71]	66 [60.75 - 71]	65 [59 - 69]	0.849*	0.43
Gender-Male	164 (76)	54 (72)	52 (72)	58 (85)	4.468§	0.11
Smoking	49 (23)	16 (21)	17 (24)	16 (24)	0.139§	0.93
Hypertension	124 (58)	46 (61)	40 (55)	38 (56)	0.633§	0.73
Dyslipidemia	111 (52)	36 (48)	43 (60)	32 (47)	2.852§	0.24
Diabetes	57 (27)	21 (28)	23 (32)	13 (19)	2.612§	0.27
Previous myocardial infarction. (N$_{g1}$=74)	99 (46)	32 (43)	34 (47)	33 (49)	0.438§	0.80
Left ventricular ejection fraction (N$_{g2}$=71)	60 [47 - 60]	60 [51 - 60]	58 [49 - 60]	60 [55 - 60]	1.721#	0.42
Number of grafts ≥ 3	147 (68)	52 (69)	47 (65)	48 (71)	0.505§	0.78
Off pump CABG	28 (13)	9 (12)	10 (14)	9 (13)	0.119§	0.94
Length of stay (days) (N$_{g1}$=74)	17 [15 - 20]	17 [15 - 19]	17 [14 - 19]	17 [15 - 21]	1.703#	0.43
Beta-blocker treatment. (N$_{g1}$=74, N$_{g2}$=71)	179 (84)	63 (85)	55 (77)	61 (90)	3.981§	0.14

Data are expressed as absolute (relative, as percentages) frequencies or median [25%-75%], where appropriate. Test used: § Chi-squared, * F 2, 212, # Kruskal-Wallis
CABG = coronary artery bypass grafting

significance was set at 0.05, with Bonferroni correction when needed. All analyses were performed using R.

Results

Fourteen patients who did not satisfy validity criteria based on control scales (scale L -lie, scale F -frequency-, scale K -correction) were excluded from the analysis. Characteristics of the 215 subjects finally included in the study sample are depicted in Table 1. Impaired pump function (LVEF < 40%) was present in 21 patients (10%).

After cluster analysis, we identified 3 groups of subjects with homogenous psychological characteristics (Figure 1). Cluster 1 (G1, N=75) is characterized by the tendency to somatic manifestations of anxiety and a V-shaped configuration (neurotic triad) depicted by lack of generalized elevation and clinical elevations on three scales: hysteria (somatoform anxiety)-depression-hypochondria. G1 subjects express somatoform complaints and a tendency to depression, but overall low levels of psychological distress. Patients in cluster 2 (G2, N=72) presented high values in scale D (depression), scale HY (hysteria) and scale SI (social introversion) i.e. traits of type D personality. Subjects included in cluster 3 (G3, N=68) showed a trend to cynicism, and mild increases in type A personality traits such as anger, social introversion and hostility; they tended to express a negative attitude towards relatives, friends and work colleagues.

We found no differences among clusters for the characteristics reported in Table 1.

During the 3-year follow-up, 23 patients (8 in G1, 13 in G2, 2 in G3), were lost to follow-up. Of the remaining 192 patients, 7 died (3.6%), and 24 (12.5%) were readmitted for cardiac causes. Event rates were 15%, 18% and 15% in G1, G2 and G3, respectively. Kaplan-Meier readmission-free survival curves, stratified by clusters, overlapped (P = 0.88) (Figure 2).

Discussion

In the present study, we found no impact of personality profiles derived by cluster analysis of the MMPI-2 questionnaire either on prevalence of modifiable risk factors or on 3-year outcome in a homogeneous group of patients discharged from cardiac rehabilitation after CABG.
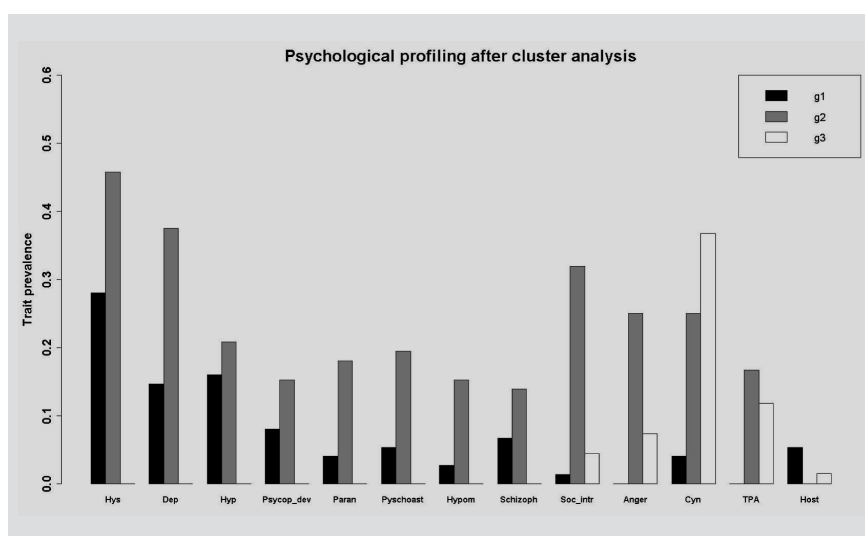

Figure 1. - Distribution of personality-scores among MMPI-2 clusters (g1, g2, g3)
Anger = anger; Cyn = cynism; Dep = depression; Host = hostility; Hyp = hypo condria; Hypom = hypomania; Hys = hysteria; Par = paranoia; Psychoast = psychoastenia; Psycop_dev = psycopathic deviation Schizop = schizophrenia; Soc_intr = social introversion;TPA = type A.
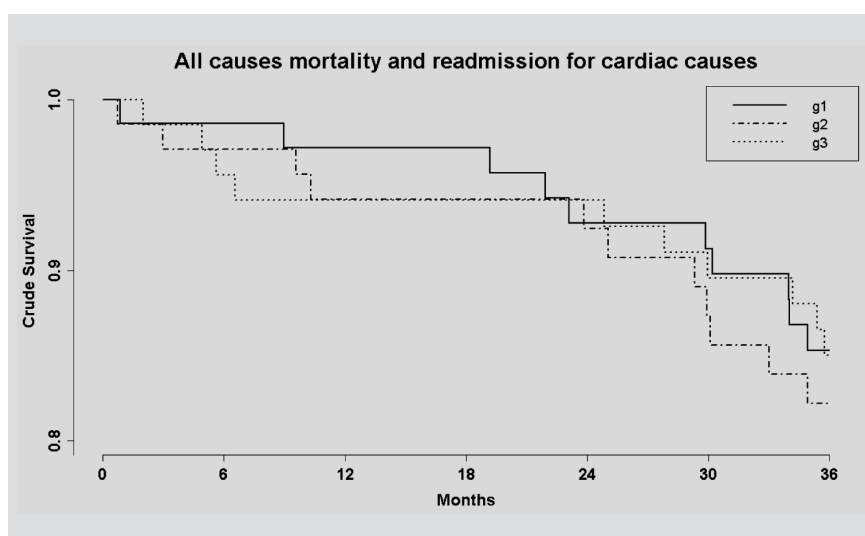

Figure 2. - Event-free survival curves among clusters computed using Kaplan-Meier estimators
g1 = Cluster 1; g2 = Cluster 2; g3 = Cluster 3.

The early recognition of depression and anxiety, that increase long-term coronary risk and affect the outcome of CHD patients [1-6] allows to start an appropriate treatment and to impact favourably on patients' quality of life and clinical outcome and is therefore useful both for secondary prevention in rehabilitative cardiology. In everyday clinical practice the diagnosis of depression and anxiety after CABG is based on non time-consuming tests such as the Hamilton test, the Beck Depression Inventory, or tests more appropriate for patients with organic comorbidities such as the Hospital Anxiety and Depression Scale.

As the MMPI-2 questionnaire is complex and time-consuming only some specific scales are used in routine cardiology practice, as a diagnostic tool for depression, psychosis or personality traits (hostility, anger) that may affect outcome [18]. However the personological profile as expressed by the MMPI-2 may influence not only symptom expression, but also the ability to cope with disease and

compliance to rehabilitative or preventive prescriptions and might thus impact on patient outcome.

Cluster analysis, the peculiar feature of our study was previously used in the cardiac surgery setting by Clark *et al* [16], who found that the four abnormal psychological profiles identified before surgery remained consistently different, with an overall decrease of elevations, after successful CABG. However they did not stratify outcome by results of cluster analysis.

Through sample clustering, we identified 3 different groups of patients. Subjects included in Cluster 1 patients expressed somatoform complaints and overall low levels of psychological distress. Patients in Cluster 2 presented traits of type D personality, such as negative emotions and social introversion that are associated with increased long-term mortality in CHD. Cluster 3 was characterized by cynicism and other TABP traits.

The hypothesis that the peculiar personality profiles defined by cluster analysis might translate into different lifestyles, and hence a different prevalence of modifiable risk factors [19], was not supported by our finding: the prevalence of smoking, dyslipidemia, and hypertension, beyond comparable clinical characteristics at enrolment, was similar among the 3 clusters.

Our study population was overall at low risk of unfavourable outcome: only 10% had impaired pump function, one third had two-vessel disease and they benefited from an inpatient rehabilitation program. Therefore event rates were unsurprisingly low, in accordance with published data [20]. The wide overlap among three-year event-free survival curves according to the different psychological profiles identified suggests that cluster analysis of MMPI-2 is not helpful for prognostic stratification after CABG.

The relatively small size and low event rates of our population, although homogeneous, might reduce the statistical power of this investigation. As we studied only patients admitted to cardiac rehabilitation after surgery, our findings may not be generalized to all patients undergoing CABG.

In summary, cluster analysis of MMPI-2 questionnaires administered early after CABG is effective for the identification of patient groups with peculiar psychological characteristics that represent personality profiles known in the clinical and cardiology setting. While cluster analysis of MMPI-2 is helpful, to direct psychological assistance, it does not seem to be useful to the clinician to predict long-term outcome.

Riassunto

Lo scopo di questo studio è valutare il ruolo predittivo di alcune caratteristiche personologiche in un campione di pazienti coronarici sottoposti ad intervento di BPAC, sull'outcome clinico a lungo termine. Il campione è costituito da 229 pazienti di ambo i sessi, che hanno compilato il Minnesota Multiphasic Personalità Inventory (MMPI-2) durante il ricovero riabilitativo. È stata valutata la relazione tra profili personologici, aggregati in cluster, e outcome clinico a tre anni. Sono stati identificati 3 gruppi di soggetti omogenei per caratteristiche psicologiche. Il primo cluster (N=75) è caratterizzato dalla tendenza alla somatizzazione, il secondo (N=72) da tratti personologici tipici della personalità di tipo D (emotività negativa ed introversione sociale), il terzo (N=68) tratti della personalità di tipo A (cinismo, rabbia, introversione sociale ed ostilità). I tre cluster non hanno mostrato significative differenze di outcome a 3 anni. La clusterizzazione dei tratti personologici risultanti dal MMPI-2 pur avendo un utilità per quanto riguarda la diagnosi e l'intervento psicologico, non sembra utile nel predire l'outcome clinico a lungo termine.

ABBREVIATIONS

CABG = coronary artery bypass grafting
CHD = coronary heart disease
LVEF = left ventricular ejection fraction
MMPI-2 = Minnesota Multiphasic Personality Inventory
TABP = Type A Behaviour Pattern

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