Shock and Patient Preimplantation Type D Personality Are Associated With Poor Health Status in Patients With Implantable Cardioverter-Defibrillator

Susanne S. Pedersen, PhD; Fetene B. Tekle, PhD; Madelein T. Hoogwegt, MSc; Luc Jordaens, MD, PhD; Dominic A.M.J. Theuns, PhD

Background—Implantable cardioverter-defibrillator (ICD) shock is a critical event to patients associated with well-being after implantation, although other factors may play an equally important role. We compared the association of shock and the patient’s preimplantation personality with health status, using a prospective study design.

Methods and Results—Consecutively implanted ICD patients (n=383; 79% men) completed the Type D Scale at baseline and the Short-Form Health Survey 36 (SF-36) at baseline and 3, 6, and 12 months. Of all patients, 23.5% had a Type D personality and 13.8% received a shock during follow-up. Shocked patients reported significantly poorer health status, as did Type D patients. Health status patterns were poorest in patients with combined Type D personality and shock during follow-up. Shock during follow-up was a significant independent associate of poorer health status for 4 of 8 subscales of the SF-36 and the Mental Component Summary (all \( P<.05 \)), with shocked patients scoring between 2.60 to 13.30 points lower than nonshocked patients. Type D personality was an independent associate of poor postimplantation health status for 6 of 8 of the SF-36 subscales and the Mental Component Summary, with Type D patients scoring between 2.12 to 8.02 points lower, adjusting for demographic and clinical characteristics.

Conclusions—ICD shock and the patient’s preimplantation personality disposition were equally important associates of health status 12 months after implantation. Identification of the patient’s personality profile before ICD implantation may help identify subsets of patients who may need additional care, for example, with a psychosocial component. (Circ Cardiovasc Qual Outcomes. 2012;5:373-380.)

Key Words: arrhythmias ■ implantable cardioverter-defibrillator ■ Type D personality ■ health status ■ shock ■ quality of life

Implantable cardioverter-defibrillator (ICD) shocks may be associated with poor patient-rated health status and quality of life, although the patient’s response to shock may vary considerably from relief that the ICD works to severe distress including posttraumatic stress and in extreme cases, a wish to have the ICD explanted. It is generally accepted that an ICD shock is a critical event to individual patients, although empirical results on the association between shock and patient-reported outcomes (PROs; ie, anxiety, depression, and quality of life) are inconsistent. These mixed results may in part be attributed to smaller sample sizes in some of the observational studies but they also suggest that the relationship between ICD shock(s) and PROs may be neither linear nor straightforward.

The psychological response to a shock is likely to be associated with a complex interplay of factors and not with shocks alone. In addition, patients may become distressed in the absence of shocks. Factors associated with poor PROs include symptomatic heart failure, the number of shocks received, the appropriateness of the shock and associated pain, the patient’s preimplant personality disposition, and concerns about the device. Although results with respect to the relationship between sex and PROs are mixed, indication for ICD implantation seems to play less of a role in explaining the variability in PROs.

Knowledge of the subsets of ICD patients at risk of poor PROs is important for the optimal treatment and care of these patients, as anxiety and high levels of ICD concerns alone and in combination with personality factors, depression, and posttraumatic stress are associated with the occurrence of ventricular tachyarrhythmia’s and survival in ICD patients. Preliminary evidence also indicates that poor health status may be related to morbidity and mortality in ICD patients.

In the current study, we focused on health status as the PRO rather than on anxiety and depression, as less attention...
has been given to health status and particularly the associates of poor health status in this patient cohort. To disentangle the association between ICD shocks and health status versus other potentially competing factors, we made a head-to-head comparison between shocks and the patient’s preimplantation personality as associates of health status, using a prospective study design with health status assessed at baseline and 3, 6, and 12 months postimplantation. We had specifically chosen to single out the distressed (Type D) personality as the primary competing associate for a head-to-head comparison, because the role of preimplantation factors, such as personality, tend to be neglected in arrhythmia research despite their potential significant contribution to variability in PROs and clinical outcome.14,15,19

WHAT IS KNOWN

- Although anxiety and poor health status have been attributed to ICD shocks, little is known about the association between ICD shocks, patient health status, and the patient’s preimplantation psychological profile and personality type.

WHAT THE STUDY ADDS

- This article demonstrates that although ICD shocks are generally associated with impaired health status, the patient’s preimplantation psychological profile and personality disposition also help explain variability in health status among ICD patients.
- With new algorithms being introduced in ICD programming to reduce the incidence of shocks, it seems timely to focus on other factors, including psychological, that influence health status to optimize the outcomes of ICD patients.
Statistical Analysis

Patients with missing values either on demographic and clinical variables or on health status at baseline were excluded from analyses. Baseline characteristics were compared by means of the χ² test (Fisher exact test when appropriate) for nominal variables and Student t test for continuous variables. Differences between the averages of the categories of shock (either appropriate or inappropriate shock versus no shock) over time were statistically tested using generalized linear mixed modeling repeated-measures analysis of variance (ANOVA) with a split-plot–like design that considers interaction effects between shock and time. Similar analyses were performed to test the trends for differences on average between categories of Type D versus non–Type D personality and combinations of shock and Type D. For these separate analyses on the association between shock and health status and Type D personality and health status, respectively, we adjusted only for the baseline measurement of the outcome variable (ie, the specific health status domain at baseline) but not for clinical and demographic variables.

We used generalized linear mixed modeling repeated measures analysis of covariance (ANCOVA) to assess the effects of shocks during the follow-up period and Type D personality on changes in health status controlling for the effects of demographic and clinical variables. Since a correlation between follow-up assessments on health status can be presumed, the usual regression analysis that assumes independent observations is not an appropriate method. In addition to taking care of the fact that measurements are correlated, the mixed modeling approach does not require that each of the subjects should have an equal number of follow-up measurements. As such, patients can be kept in the analysis even if they did not complete all assessments, thereby reducing potential bias that occurs when patients are lost to attrition during follow-up. The linear mixed model used in our analysis assumes a normal distribution for the random effect that accounts for the correlation between observations within a subject. Because the interest of the analysis is mainly on the fixed effects (comparison of groups), valid inferences can be obtained even when the random effects might have been incorrectly assumed to be normally distributed. For each of the SF-36 subscales and the PCS and the MCS, we fitted a separate model using linear mixed models advanced statistical option in SPSS. A priori based on the literature, we decided to enter the following covariates in adjusted analyses (in addition to shock and Type D personality and the interaction of Type D personality by shocks) in each of the random intercept models: sex, age, marital status, education, indication for ICD implantation, CRT, coronary artery disease, atrial fibrillation, diabetes mellitus, smoking, amiodarone, β-blockers, psychotropic medication, and baseline health status. If the interaction of Type D personality by shocks was not statistically significant, the model was run and results presented without the interaction. This approach was adopted to avoid the inclusion of covariates that may be statistically significant due to the specific sample under study, as also recommended by others. All tests were 2-tailed, and a probability value <0.05 was used to indicate statistical significance. Estimates are reported with corresponding 95% confidence intervals (CI). All data were analyzed using PASW Statistics 17 statistical software (PASW IBM Corp, Armonk, NY).

Results

Participants Versus Nonparticipants on Baseline Characteristics

Of 448 patients eligible and approached for study participation, we had to exclude 67 (14.9%) from statistical analyses because of 1 of the following reasons: No score on the SF-36 or on the DS14 at baseline (n=29) or lack of information on demographic or clinical variables (n=38). Cases excluded from analyses did not differ systematically from included cases (n=383) on baseline characteristics, except for ex-

Table 1. Patient Baseline Characteristics for the Total Sample and Stratified by the Occurrence of Any Shock (Either Appropriate or Inappropriate) During the 12-Month Follow-Up Period

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total (n=383)</th>
<th>Yes (n=53)</th>
<th>No (n=330)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
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<td></td>
</tr>
<tr>
<td>Men</td>
<td>304 (79.4)</td>
<td>43 (81.1)</td>
<td>261 (79.1)</td>
<td>0.73</td>
</tr>
<tr>
<td>Age, y, mean±SD</td>
<td>57.7±12.0</td>
<td>57.8±13.8</td>
<td>57.7±11.7</td>
<td>0.97</td>
</tr>
<tr>
<td>Single/no partner</td>
<td>25 (6.5)</td>
<td>4 (7.5)</td>
<td>21 (6.4)</td>
<td>0.75</td>
</tr>
<tr>
<td>Lower education†</td>
<td>95 (24.8)</td>
<td>14 (26.4)</td>
<td>81 (24.5)</td>
<td>0.77</td>
</tr>
<tr>
<td><strong>Clinical</strong></td>
<td></td>
<td></td>
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<tr>
<td>Primary prevention indication</td>
<td>252 (65.8)</td>
<td>27 (50.9)</td>
<td>225 (68.2)</td>
<td>0.014</td>
</tr>
<tr>
<td>CRT</td>
<td>111 (29.0)</td>
<td>13 (24.5)</td>
<td>98 (29.7)</td>
<td>0.44</td>
</tr>
<tr>
<td>LVEF ≤35%</td>
<td>284 (73.8)</td>
<td>38 (71.7)</td>
<td>246 (74.5)</td>
<td>0.61</td>
</tr>
<tr>
<td>QRS &gt;120 ms</td>
<td>190 (49.6)</td>
<td>32 (60.4)</td>
<td>158 (47.9)</td>
<td>0.09</td>
</tr>
<tr>
<td>CAD</td>
<td>224 (58.5)</td>
<td>28 (52.8)</td>
<td>196 (59.4)</td>
<td>0.37</td>
</tr>
<tr>
<td>Symptomatic heart failure‡</td>
<td>124 (32.4)</td>
<td>18 (34.0)</td>
<td>106 (32.1)</td>
<td>0.79</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>87 (22.7)</td>
<td>18 (34.0)</td>
<td>69 (20.9)</td>
<td>0.035</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>53 (13.8)</td>
<td>12 (22.6)</td>
<td>41 (12.4)</td>
<td>0.046</td>
</tr>
<tr>
<td>Smoking</td>
<td>45 (11.7)</td>
<td>9 (17.0)</td>
<td>36 (10.9)</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>Medication</strong></td>
<td></td>
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<tr>
<td>Amiodarone</td>
<td>69 (18.0)</td>
<td>8 (15.1)</td>
<td>61 (18.5)</td>
<td>0.55</td>
</tr>
<tr>
<td>Diuretics</td>
<td>218 (56.9)</td>
<td>27 (50.9)</td>
<td>191 (57.9)</td>
<td>0.34</td>
</tr>
<tr>
<td>ACE inhibitors</td>
<td>270 (70.5)</td>
<td>31 (58.5)</td>
<td>239 (72.4)</td>
<td>0.04</td>
</tr>
<tr>
<td>β-blockers</td>
<td>299 (78.1)</td>
<td>39 (73.6)</td>
<td>260 (78.8)</td>
<td>0.40</td>
</tr>
<tr>
<td>Digoxin</td>
<td>58 (15.1)</td>
<td>12 (22.6)</td>
<td>46 (13.9)</td>
<td>0.10</td>
</tr>
<tr>
<td>Statins</td>
<td>217 (56.7)</td>
<td>26 (49.1)</td>
<td>191 (57.9)</td>
<td>0.23</td>
</tr>
<tr>
<td>Psychotropic medication</td>
<td>60 (15.7)</td>
<td>9 (17.0)</td>
<td>51 (15.5)</td>
<td>0.78</td>
</tr>
<tr>
<td><strong>Psychological</strong></td>
<td></td>
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</tr>
<tr>
<td>Type D personality</td>
<td>90 (23.5)</td>
<td>14 (26.4)</td>
<td>76 (23.0)</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Cort indicates cardiac resynchronization therapy; LVEF, left ventricular ejection fraction; CAD, coronary artery disease; and ACE, angiotensin-converting enzyme.

*Results are presented as n (%) unless otherwise indicated.
†Education ≥13 years.
‡Defined as New York Heart Association classes III and IV.

included cases being more likely to have a lower educational level (P<0.05).

Patient Baseline Characteristics

Baseline characteristics for the total sample and stratified by shocks (both appropriate and inappropriate) are displayed in Table 1. The prevalence of atrial fibrillation (P=0.035) and diabetes mellitus (P=0.046) was higher among patients who received 1 or more shocks during follow-up, whereas shocked patients were less likely to have an ICD due to a primary prevention indication (P=0.014). In contrast, the prescription of angiotensin-converting enzyme inhibitors was lower among patients who received a shock during follow-up as compared with nonshocked patients (P=0.04). No other systematic differences were found on demographic and clin-
ical baseline characteristics between shocked and nonshocked patients.

**Health Status Stratified by Shocks and Type D Personality (Unadjusted Analysis)**

Of all patients, 23.5% (90/383) had a Type D personality and 13.8% (53/383) received a shock during the 12-month follow-up period. Of all patients, 10.7% (41/383) had an appropriate shock and 3.9% (15/383) an inappropriate shock. Because of the low incidence of inappropriate shocks, further analyses were conducted with any shock (ie, whether appropriate or inappropriate).

Mean health status scores on the different SF-36 subscales and the PCS and the MSC during the follow-up period, stratified by the occurrence of shocks and Type D personality, are displayed in Figures 1 and 2, respectively. Patients receiving a shock during the follow-up period scored about 14 points (−13.82 [95% CI, −26.08 to −1.55]) lower on mental health status as compared with nonshocked patients and about 5 points (−5.14 [95% CI, −9.73 to −0.56]) lower on role functioning–physical. There were no significant differences between shocked and nonshocked patients on the other 6 of 8 SF-36 domains nor on the PCS and the MCS (all \( P > 0.05 \)) (Figure 1).

A similar pattern was visible for Type D patients as compared with non–Type D patients (Figure 2), although differences were significant for 5 of 8 health status domains (physical functioning: −5.40 [95% CI, −10.63 to −0.17]; role functioning–physical: −16.66 [95% CI, −26.23 to −7.08]; social functioning: −6.71 [95% CI, −11.65 to −1.77]; mental health: −4.44 [95% CI, −8.19 to −0.68]; role functioning–emotional: −12.04 [95% CI, −20.08 to −4.01]) and the PCS (−2.35 [95% CI, −4.57 to −0.13]) and the MCS (−3.48 [95% CI, −5.76 to −1.20]), with Type D patients scoring between about 4 to 12 points lower on specific health status domains and summary scores.

The probability values from repeated-measures analyses ANCOVAs that consider interaction effects between shock and time indicated significant interaction effects only for the subscales role functioning–emotional (\( P = 0.023 \)) and general health (\( P = 0.024 \)). Similar analyses among Type D categories showed that the differences on the averages for Type D and

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**Figure 1.** Mean scores on health status, stratified by the occurrence of shocks.

**Figure 2.** Mean scores on health status, stratified by Type D personality.
Figure 3. Mean scores on health status, stratified by the occurrence of shock and Type D personality.

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Discussion

In the current study, we sought to examine the relationship between ICD shock(s) and the patient’s preimplantation personality as associates of health status, using a prospective study design with multiple assessments of health status up to 12 months after ICD implantation. We found that both ICD shock(s) and Type D personality were independently associ-
<table>
<thead>
<tr>
<th>Predictors</th>
<th>PF</th>
<th>RF-P</th>
<th>BP</th>
<th>SF</th>
<th>MH</th>
<th>RF-E</th>
<th>VI</th>
<th>GH</th>
<th>PCS</th>
<th>MCS</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Shock(s) during follow-up</td>
<td>NS</td>
<td>-13.30 (-22.78 to -3.82)†</td>
<td>NS</td>
<td>-6.74 (-12.05 to -1.44)†</td>
<td>-5.27 (-8.84 to -0.71)‡</td>
<td>NS</td>
<td>-4.79 (-9.02 to -0.54)‡</td>
<td>NS</td>
<td>NS</td>
<td>-2.60 (-4.71 to -0.48)†</td>
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<tr>
<td>Type D personality</td>
<td></td>
<td>-4.42 (-8.65 to -0.19)‡</td>
<td>-8.02 (-15.51 to 0.54)†</td>
<td>-4.04 (-8.04 to -0.04)†</td>
<td>-4.21 (-10.40 to -2.01)‡</td>
<td>-3.10 (-6.02 to -0.19)‡</td>
<td>-6.75 (-13.16 to -0.30)†</td>
<td>NS</td>
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<td>Low education</td>
<td>-4.33 (-8.51 to -0.23)†</td>
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<td>Amiodarone</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>3.75 (0.45–7.04)‡</td>
<td>8.34 (0.88–15.79)‡</td>
<td>NS</td>
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<td>Beta-blockers</td>
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<tr>
<td>Psychotropic medication</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>-8.27 (-13.35 to -3.28)‡</td>
<td>-3.52 (-6.88 to -0.18)‡</td>
<td>-7.73 (-15.18 to -0.28)‡</td>
<td>NS</td>
<td>-4.80 (-8.76 to -0.83)†</td>
<td>-2.13 (-4.10 to -0.17)†</td>
</tr>
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<td>Baseline health status (SF-36)</td>
<td>0.57 (0.50–0.64)§</td>
<td>0.38 (0.30–0.48)§</td>
<td>0.33 (0.27–0.40)§</td>
<td>0.32 (0.26–0.38)§</td>
<td>0.54 (0.48–0.61)§</td>
<td>0.29 (0.22–0.30)§</td>
<td>0.57 (0.50–0.64)§</td>
<td>0.77 (0.70–0.84)§</td>
<td>0.59 (0.52–0.68)§</td>
<td>0.42 (0.35–0.48)§</td>
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</tbody>
</table>

SF-36 indicates Short Form Health Survey 36; PF, physical functioning; RF-P, role functioning—physical; BP, bodily pain; SF, social functioning; MH, mental health; RF-E, role functioning—emotional; VI, vitality; GH, general health; PCS, Physical Component Summary score; MCS, Mental Component Summary score; CRT, cardiac resynchronization therapy; and CAD, coronary artery disease.

*Results are based on mixed modeling repeated-measures ANCOVA analysis and presented as estimates with 95% confidence intervals only for statistically significant predictors.
†P<0.05; ††P<0.01; §P<0.001.
NS indicates not statistically significant (P>0.05).
ated with poor health status. At 12 months after implantation, shock during follow-up was independently associated with 4 domains of the SF-36 (ie, role functioning–physical domain, social functioning, mental health, and vitality) and the MCS, whereas Type D personality was an independent associate of 6 domains of the SF-36 (ie, physical functioning, role functioning–physical, bodily pain, social functioning, mental health, and role functioning–emotional) and the MCS, adjusting for demographic and clinical characteristics and baseline health status. Patients receiving a shock or patients with a Type D personality scored between 2 to 13 points lower on some of the health status domains as compared with nonshocked or non–Type D patients. The combination of shock and Type D personality was generally associated with the poorest health status at 12 months.

Our mixed findings on the association between shock(s) and health status are in line with other studies, such as the large-scale primary prevention trials, Defibrillators in Nonischemic Cardiomyopathy Treatment Evaluation (DEFINITE),29 Sudden Cardiac Death in Heart Failure Trial (SCD-HeFT),30 and Multicenter Automatic Defibrillator Implantation Trial II (MADIT-II),18 as they also found an association with some but not all health status domains using the SF-36 or the shortened SF-12 version. It is possible that ICD shock is only associated with specific health status domains, although this is speculative. Alternatively, the SF-36 and the SF-12 are not the most sensitive measures to evaluate the impact of shock(s) on patients, as they are generic rather than disease-specific, with some scales also only being composed of 2 items, which leaves room for little variability in scores. However, in a previous cross-sectional Danish study of 566 ICD patients, we also found no association between shock and scores on the Florida Patient Acceptance Survey (FPAS), which is a disease-specific measure of device acceptance and quality of life.31

In a previous cross-sectional study in a different cohort of ICD patients, we demonstrated that the risk of anxiety and depression may depend more on the preimplantation personality of the patient than on shock(s), with an anxiety prevalence of 61% in nonshocked Type D patients versus 32% in shocked non–Type D patients, and a depression prevalence of 57% in nonshocked Type D patients versus 19% in shocked non–Type D patients.32 Others have found that Type D but not shocks are associated both with interviewer-rated and patient self-report anxiety.33 The results of the current prospective study extend those findings, demonstrating that personality remains associated with health status over time and that Type D patients report poorer health status than non–Type D patients despite improvements during the course of the 12-month follow-up period. In particular, the combination of ICD shock(s) and Type D personality was associated with the poorest health status at 12 months on all health status domains. This is consistent with our findings on anxiety and depression, which also showed that the prevalence of psychological morbidity was highest in this subset of patients with 72% being anxious and 67% being depressed if patients had a Type D personality and received a shock.32

Given that the patient’s preimplantation personality is an important correlate of postimplant health status and that Type D personality has been associated with the occurrence of ventricular tachyarrhythmia, survival,14,15 and poor health status with an increased risk of mortality in ICD patients,18 it is important to identify this subset of high-risk patients in clinical practice. Information about the patient’s personality profile may help to target nursing and psychosocial care to the needs of the individual patient, as Type D patients and in particular Type D patients who receive a shock after implant might benefit from adjunctive intervention, such as cardiac rehabilitation34 in combination with behavioral or psychological interventions that have been shown to reduce psychological distress in ICD patients.35

The limitations of the current study should be acknowledged. We had to exclude 67 patients from statistical analyses because some refused to participate and others had missing information on either demographic, clinical variables, or measures of health status at baseline. This despite the use of the latest statistical technique to analyze prospective data, which allows that patients be kept in the analysis even if they did not complete all follow-up assessments.25 However, patients excluded from analyses did not differ systematically from included patients on baseline characteristics, except for nonparticipants being more likely to have a lower educational level as compared with participants. We had no information on changes in comorbidity status nor changes in medication during the 12-month follow-up period, which might potentially have influenced the outcome. Finally, given the study design, it is not possible to infer causation and whether shocks lead to poor health status or vice versa.

In conclusion, the results of the current study show that both ICD shock(s) and the patient’s preimplantation personality disposition are important associates of health status 12 months after implantation, independent of demographic and clinical characteristics and baseline health status. Given that the incidence of shocks has decreased substantially with new programming algorithms and software,36 it seems timely to focus on other factors in addition to shocks when identifying patients at high risk of poor health status and poor psychological functioning.2

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Susanne S. Pedersen, Fetene B. Tekle, Madelein T. Hoogwegt, Luc Jordaens and Dominic A.M.J. Theuns

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