General and Disease-Specific Psychosocial Adjustment in Patients With Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy With Implantable Cardioverter Defibrillators: A Large Cohort Study

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Background—Arrhythmogenic right ventricular dysplasia/cardiomyopathy (ARVD/C) is characterized by frequent life-threatening ventricular arrhythmias, diagnosed on average in the teens to mid-50s and commonly treated by implantable cardioverter defibrillators (ICDs). As younger age and high frequency of ICD discharges are risk factors for difficulties in psychosocial adjustment, we developed a study to assess psychosocial adjustment among patients with ARVD/C and to determine risk factors for poor adjustment in this high-risk population.

Methods and Results—Eighty-six adults enrolled in the Johns Hopkins ARVD Registry (38 male; mean age, 45.4 ± 12.9 years), with an ICD in place for a median 3.2 years (range, 0.2 to 20.1 years), completed a set of questionnaires measuring ICD-specific anxiety (Florida Shock Anxiety Scale), device acceptance (Florida Patient Acceptance Survey), anxiety and depression (Hospital Anxiety and Depression Scale), and functional capacity (Duke Activity Status Index). Although overall device acceptance (Florida Patient Acceptance Survey mean, 76.7 ± 15.3) was normative, patients with ARVD/C had substantially elevated body image concerns (Florida Patient Acceptance Survey subscale mean, 17.9 ± 23.5) and device-related distress (subscale mean, 26.5 ± 19.2), particularly among younger patients (P < 0.01). Patients with ARVD/C had elevated ICD-specific (Florida Shock Anxiety Scale mean, 22.9 ± 7.8) and general clinical anxiety (Hospital Anxiety and Depression Scale anxiety subscale mean, 6.2 ± 3.9). Device-specific anxiety (Florida Shock Anxiety Scale) was predicted by younger age (P < 0.001), poorer functional capacity (P = 0.016), having an ICD shock (P = 0.003), and shorter time since ICD implant (P = 0.007). Participants with poor device adjustment had an increased likelihood of clinically significant anxiety (P = 0.006) and depression (P = 0.008).

Conclusions—Patients with ARVD/C are at elevated risk for anxiety, and young patients face challenges with device acceptance. Risk factors for poor device adjustment may be used clinically to identify patients at high-risk of psychological distress. (Circ Cardiovasc Genet. 2012;5:18-24.)

Key Words: cardiomyopathy ■ defibrillation ■ genetics

Arrhythmogenic right ventricular dysplasia/cardiomyopathy (ARVD/C) is a heritable cardiomyopathy characterized by fibro-fatty myocardial replacement of the right ventricle, which predisposes patients to life-threatening ventricular arrhythmias and right ventricular dysfunction.1,2 Patients with ARVD/C typically present in their mid-teens to mid-40s with symptomatic premature ventricular beats and/or ventricular arrhythmias of a left bundle branch block morphology.3 Sudden cardiac death may be the first manifestation.3-5 ARVD/C is frequently an inherited disease. Up to 60% of ARVD/C cases are associated with mutations in genes encoding the cardiac desmosome.6-15

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Once a diagnosis of ARVD/C is established in a family, an important management decision is whether to place an implantable cardioverter-defibrillator (ICD) for treatment of sustained ventricular arrhythmias and prevention of sudden cardiac death in affected individuals and at-risk family members. This is a critical decision because these are often young patients with few or no symptoms, who are expected to have a nearly normal life expectancy should sudden cardiac death be prevented; however, these individuals are also likely to have a long course with their ICD, exposing them to repeated medical procedures, ICD
therapies, ICD-associated complications, and subsequent potential psychosocial challenges over decades.

Living with arrhythmias and the threat of ICD shock represents a challenge for patients to prepare and recover. The survival benefits of the ICD may be tempered in patients who develop clinically significant symptoms of anxiety and depression.\(^6\) Patients with ARVD/C may be at particularly high risk for adverse outcomes for several reasons. First, those with ARVD/C present at a young age relative to others with ICDs. Studies have suggested that young age can be a risk factor for psychological maladjustment.\(^6\) Second, a high frequency of defibrillator discharge is often related to increased anxiety and poor adjustment.\(^6,16\) Individuals with ARVD/C have a high discharge rate, with several series showing a 50% to 80% appropriate ICD discharge rate for treatment of a sustained ventricular arrhythmia during a mean 3- to 5-year follow-up.\(^18\) Third, nearly half of patients with ARVD/C are women, a much higher proportion than in typical ICD populations. Women are considered to be at higher risk for poor ICD-related adjustment.\(^25\) Finally, patients with ARVD/C may be at particularly high risk because ARVD/C is a genetic disease. This disease etiology by itself raises well-established psychosocial burdens, including anxiety about risks to family members (particularly to children), guilt, blame, and stigmatization.\(^23\)–\(^25\) How these risks combine in patients with patients with ARVD/C is uncertain, as is the optimal way to identify patients with ARVD/C at high risk for poor psychosocial adjustment and to provide care to maximize adjustment. Therefore, we developed a study with 2 objectives: (1) to assess psychosocial adjustment to life with an ICD among patients with ARVD/C; and (2) to determine risk factors for poor adjustment in this high-risk population.

**Methods**

**Study Population**

The Johns Hopkins ARVD Program (http://arvd.com) was established in 1995 to provide clinical care for patients and conduct research on this rare disease. Study participants in the Johns Hopkins ARVD Registry are recruited through 3 main sources: (1) patients referred to the program for an evaluation or treatment of ARVD/C; (2) individuals who contact the program through the Johns Hopkins-sponsored website arvd.com and indicate they are interested in joining research; and (3) participants in the annual ARVD/C Family Conference. Participants are offered re-enrollment in the ARVD Registry every 5 years.

Adults enrolling or re-enrolling in the ARVD Registry between February 2009 and November 2010 who (1) had an ICD in place for either primary or secondary prevention of ventricular tachycardia; (2) curried a clinical diagnosis of ARVD/C; and (3) could speak English were invited to participate in this study. All subjects gave written informed consent to participate. All aspects of the study were approved by the Johns Hopkins School of Medicine Institutional Review Board.

**Study Design**

This is a cross-sectional analysis of patients with ARVD/C with ICDs. After consenting to the study, participants were given the choice of completing paper questionnaires, providing responses over the telephone, or submitting responses online via Survey Monkey, Inc software (www.surveymonkey.com). Links to the electronic questionnaires are available on the Johns Hopkins ARVD Program website: http://www.arvd.com/icd_study.html. Although participants enrolling agreed to 3 years of prospective follow-up, the current paper reports baseline data.

**Study Measures**

Demographic and clinical variables obtained from the Johns Hopkins ARVD Registry included sex, date of birth, ARVD/C diagnosis, family history, genetic mutation status, and date of and clinical indication for first ICD implant. A positive family history was assigned to those who met family history criteria, according to the 2010 Revised Task Force Criteria for the diagnosis of ARVD/C.\(^26\) Self-reported history of ICD shock was confirmed through medical records submitted to the Registry.

The Duke Activity Status Index (DASI)\(^27\) measured functional capacity and some aspects of quality of life. This 12-item instrument with a yes/no response set includes major activities of daily living, including personal care, household tasks, recreational activities, playing sports, and sexual functioning. Each item is weighted differently based on the known metabolic cost of each activity, and weights of positive terms are summed for the total DASI score, which ranges from 0 to 58.2. This index correlates well with a patient’s peak oxygen uptake (Spearman rho=0.58; \(P<0.001\)).\(^27\)

The Florida Patient Acceptance Survey (FPAS) was used to measure participants’ acceptance of the ICD. The FPAS is a valid and reliable (Cronbach’s \(\alpha=0.83\)) 18-item measure that has been used to assess device acceptance across a variety of populations.\(^28\)–\(^30\) Responses are given on a 5-point Likert scale. The FPAS is composed of 4 consistent factors: return to life (\(\alpha=0.89\)), device-related distress (\(\alpha=0.79\)), positive appraisal (\(\alpha=0.82\)), and body image concerns (\(\alpha=0.74\)). Both total and subscale scores range from 0 to 100. For the overall scale and return-to-life and positive-appraisal subscales, higher scores reflect better device acceptance. For the device-related distress and body image concerns subscales, lower scores are more desirable.

The Florida Shock Anxiety Scale (FSAS) was used to assess ICD-specific anxiety. The FSAS contains 10 items measured on a 5-point Likert scale, with total scale scores ranging from 10 to 50. High total scores reflect higher levels of anxiety. The FSAS has 2 subscales: (1) consequences (eg, fearing creating a scene if the device were to fire); and (2) triggers (eg, fearing sexual activity), with good reliability (Cronbach’s=0.91, split-half=0.92).\(^31\) Subscale scores range from 1 to 5, again with higher scores reflecting increased anxiety.

The Hospital Anxiety and Depression Scale (HADS)\(^32\) was used to identify clinically significant depression and anxiety. The HADS was selected because it is designed to identify anxiety disorders and depression specifically in medical patients. This widely used and extensively validated questionnaire contains 14 items measured on a 4-point Likert scale, with 2 subscales: HADS for anxiety (HADSA) and for depression (HADSD). A HADS subscale score \(\geq 8\) indicates clinically significant anxiety or depression.\(^32\)

**Statistical Analyses**

To determine univariate associations between 2 categorical variables, \(\chi^2\) testing was used. The distribution of continuous variables was assessed graphically and using the Kolmogorov-Smirnov statistic. Associations between continuous dependent variables and categorical variables were tested using a 2-tailed \(t\) test (for binary independent variables) or an analysis of variance (for variables with more than 2 categories). Associations between categorical dependent variables and continuous independent variables were tested using binary logistic regression. Stepwise linear regression, using forward selection, assessed independent effects of predictor variables. Variables \(P<0.15\) were entered into the regression model. Analyses were performed using PASW statistics 18.0 (SPSS Inc). A probability value \(\leq 0.05\) was considered significant.

**Results**

**Study Population**

The study population (Table 1) included 86 adults, aged 18 to 79 years (mean, 46 years), with a clinical diagnosis of...
Table 1. Demographic and Clinical Characteristics

<table>
<thead>
<tr>
<th>Measure</th>
<th>Range</th>
<th>N (%) or Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (no. male)</td>
<td></td>
<td>38 (44)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>18.1 to 79.4</td>
<td>45.8 ± 12.9</td>
</tr>
<tr>
<td>Age at first ICD implant (y)</td>
<td>14.6 to 73.8</td>
<td>41.1 ± 13.0</td>
</tr>
<tr>
<td>Duration ICD has been in place (y)</td>
<td>0.15 to 20.1</td>
<td>4.90 ± 4.62</td>
</tr>
<tr>
<td>Indication for ICD implant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary prevention</td>
<td>46 (54)</td>
<td></td>
</tr>
<tr>
<td>Primary prevention</td>
<td>39 (45)</td>
<td></td>
</tr>
<tr>
<td>Syncope</td>
<td>16 (41)</td>
<td></td>
</tr>
<tr>
<td>Non-sustained VT</td>
<td>16 (41)</td>
<td></td>
</tr>
<tr>
<td>Family history ARVD/C</td>
<td>15 (38)</td>
<td></td>
</tr>
<tr>
<td>Unavailable</td>
<td>1 (1)</td>
<td></td>
</tr>
<tr>
<td>No. of ICD shocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>39 (45)</td>
<td></td>
</tr>
<tr>
<td>1 to 5</td>
<td>26 (30)</td>
<td></td>
</tr>
<tr>
<td>&gt;5</td>
<td>21 (25)</td>
<td></td>
</tr>
<tr>
<td>Participants with at least 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate shock</td>
<td>45 (52)</td>
<td></td>
</tr>
<tr>
<td>Inappropriate shock</td>
<td>12 (14)</td>
<td></td>
</tr>
<tr>
<td>Family history ARVD/C (no. yes)</td>
<td>34 (40)</td>
<td></td>
</tr>
<tr>
<td>Desmosomal mutation carrier (no. yes)</td>
<td>21 (24)</td>
<td></td>
</tr>
<tr>
<td>DASI: functional capacity</td>
<td>13.5 to 58.2</td>
<td>48.1 ± 11.3</td>
</tr>
</tbody>
</table>

ICD indicates implantable cardioverter defibrillators; VT, ventricular tachycardia; SCD, sudden cardiac death; ARVD/C, Arrhythmogenic right ventricular dysplasia cardiomyopathy; DASI, Duke Activity Status Index.

ARVD/C. Slightly more women (56%) participated. Participants had an ICD in place for a mean 4.9 years (median, 3.2 years). More than half (54%) of participants received an ICD for secondary prevention of sustained ventricular tachycardia or ventricular fibrillation. Among the 39 implanted for primary prevention, all had cardiac testing consistent with the diagnosis of ARVD/C. 16 had experienced syncope, 16 had documented nonsustained ventricular tachycardia, and 15 had a family history of ARVD/C and/or of premature sudden cardiac death. Slightly more than half of the whole population had experienced at least 1 appropriate or inappropriate ICD shock, with one quarter experiencing 6 or more shocks. Twelve participants had a documented history of at least 1 inappropriate shock; 2 had only inappropriate discharges. Forty percent of participants had a family history of ARVD/C, although one quarter knew they carried an ARVD/C-associated desmosomal mutation at the time of questionnaire completion. The functional capacity of the population was reasonably good, with a mean DASI activity status index of 48.1, equivalent to peak oxygen uptake of 30.3 mL/min.

Device Acceptance (FPAS)

Psychometric scale and subscale scores are presented in Table 2. Mean FPAS total scale score was 76.7 ± 15.3; median score was 80.0, reflecting a long leftward (low score) tail in the distribution. In bivariate analysis, older age (β = 0.34, SE = 0.12, P = 0.007), longer duration since device implant (β = 0.85, SE = 0.36, P = 0.021), and better functional capacity (DASI) (β = 0.38, SE = 0.14, P = 0.008) were significant predictors of better device adjustment (higher FPAS scores). Older age at first ICD implant had a borderline association with device acceptance (β = 0.24, SE = 0.13, P = 0.065). There was no significant association between FPAS score and sex (male mean, 76.6 [SE 2.6]; female mean, 76.8 [SE 2.1], P = 0.94), history of at least 1 appropriate or inappropriate ICD shock (no shock mean, 78.3 [SE 2.5]; shock mean, 75.4 [SE 2.4], P = 0.37), or family history (positive family history mean, 77.5 [SE 2.4] versus no family history mean, 76.2 [SE 2.2], P = 0.72). In multivariate linear regression (Table 3), current age, age at first ICD implant, functional capacity, and duration since device implant were entered into the model, as we expected confounding of current age, age at first implant, and duration since first implant. Confounding of functional capacity and the age variables was also expected because of disease progression over time. Age and functional capacity alone remained significant independent predictors of device acceptance in the final model (Table 3).

To further explore what aspects of device acceptance were particularly problematic for younger individuals, we designated the youngest quartile of the population (those 35 and younger) as the “younger” group. We then assessed which FPAS subscale scores were particularly sensitive to differences in age. As shown in Figure, age most significantly affects the body image concerns subscale score, with younger individuals having a significantly worse mean score on this measure (30.1 versus 13.7) than the older population. (Body image subscale items include “I feel less attractive because of my device” and “I feel that others see me as disfigured by my
Table 3. Linear Regression: Predictors of Device Acceptance (FPAS) and Device-Specific (FSAS) and General (HADSa) Anxiety

<table>
<thead>
<tr>
<th>Variable</th>
<th>β Coefficient (SE)</th>
<th>95% Confidence Interval for β</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FPAS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>0.364 (0.119)</td>
<td>0.127 to 0.600</td>
<td>0.003</td>
</tr>
<tr>
<td>Functional capacity (DASI)</td>
<td>0.408 (0.136)</td>
<td>0.137 to 0.679</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>FSAS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>−0.235 (0.058)</td>
<td>−0.351 to −0.119</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Any ICD shocks? (no=0)</td>
<td>5.00 (1.62)</td>
<td>1.76 to 8.23</td>
<td>0.003</td>
</tr>
<tr>
<td>Duration implant to questionnaire (y)</td>
<td>−0.403 (0.177)</td>
<td>−0.755 to −0.051</td>
<td>0.007</td>
</tr>
<tr>
<td>Functional capacity (DASI)</td>
<td>−0.162 (0.067)</td>
<td>−0.293 to −0.031</td>
<td>0.016</td>
</tr>
<tr>
<td><strong>HADSa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>−0.102 (0.030)</td>
<td>−0.162 to −0.041</td>
<td>0.001</td>
</tr>
<tr>
<td>Any ICD shocks? (no=0)</td>
<td>2.82 (0.829)</td>
<td>1.17 to 4.47</td>
<td>0.001</td>
</tr>
<tr>
<td>Duration implant to questionnaire (y)</td>
<td>−0.248 (0.090)</td>
<td>−0.427 to −0.069</td>
<td>0.007</td>
</tr>
<tr>
<td>Functional capacity (DASI)</td>
<td>−0.083 (0.033)</td>
<td>−0.149 to −0.016</td>
<td>0.015</td>
</tr>
</tbody>
</table>

FPAS indicates Florida Patient Acceptance Survey; FSAS, Florida Shock Anxiety Scale; HADS, Hospital Anxiety and Depression Scale; HADSa, Hospital Anxiety and Depression Scale, anxiety subscale.

*Higher FPAS scores represent better device adjustment.
†Higher FSAS scores represent higher levels of anxiety.
‡Higher HADSa scores represent more symptoms of anxiety.

...device.”). The younger group also had significantly higher scores on the device-related distress subscale (35.0 versus 24.1). (Device-related distress subscale items include “thinking about the device makes me distressed,” “when I think about the device, I avoid doing things I enjoy,” “I avoid my usual activities because I feel disfigured by my device,” “it is hard for me to function without thinking about my device,” and “I am careful when kissing or hugging loved ones.”) There were no significant differences in the return to function and positive appraisal subscale scores based on age group.

**Anxiety**

In bivariate analysis, FSAS scores representing greater ICD-related anxiety were associated with younger age at first implant ($\beta = -0.20$, SE=0.063, $P=0.002$), younger current age ($\beta = -0.24$, SE=0.061, $P<0.001$), and poorer functional capacity ($\beta = -0.16$, SE=0.075, $P=0.03$). History of at least 1 appropriate or inappropriate ICD shock (mean, no shock group, 21.1[SE 1.3] versus shock group, 24.3[SE 1.1], $P=0.06$) and shorter duration of having an ICD in place ($\beta = -0.29$, SE=0.18, $P=0.12$) had a trend toward association with elevated FSAS scores. Neither sex (mean, males, 21.7 [SE 1.27] versus females, 23.7 [SE 1.13], $P=0.23$) nor family history (mean, positive family history, 23.1[SE 1.6] versus no family history, 22.7 [SE 1.0], $P=0.84$) were associated with device-related anxiety.

Similarly, higher HADS anxiety subscale scores were associated with younger age ($\beta = -0.11$, SE=0.032, $P=0.001$), poorer functional capacity ($\beta = -0.085$, SE=0.038, $P=0.03$), younger age at first ICD implant ($\beta = -0.082$, SE=0.033, $P=0.02$), and having experienced an ICD shock (mean, no shock group, 5.2 [SE 0.59] versus shock group, 7.0 [SE 0.59], $P=0.03$). A trend toward an association with a shorter duration of time since ICD implant was present ($\beta = -0.17$, SE=0.093, $P=0.07$). There was no association between sex and HADSa scores (mean, males 5.9 [SE 0.65] versus females, 6.4 [SE 0.58], $P=0.63$). All variables except for sex were entered into the FSAS and HADSa linear regression models. In multivariate linear regression (Table 3), younger age, poorer functional capacity (DASI), having experienced at least 1 appropriate or inappropriate ICD shock, and a shorter duration of time since first ICD implant were significant independent predictors of both device-specific and generalized anxiety.

**Clinically Significant Anxiety and Depression**

We defined clinically significant anxiety as a HADSa subscale score $\geq 8$ and clinically significant depression as a HADSd subscale score $\geq 8$. Twenty-seven participants (31%) had HADSa scores that classified them as having clinically significant anxiety, while eight (9%) had HADSd scores indicative of clinically significant depression. We investigated whether device acceptance (FPAS scale score) and device-specific anxiety (FSAS scale score) influenced the likelihood a participant would have scores indicative of clinically significant anxiety and depression. In univariate analysis, the odds a participant had clinically significant anxiety was significantly associated with poorer device ac-

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**Figure.** Median Florida Patient Acceptance Survey total and scale scores compared by age group. “Younger” indicates the lowest quartile for age. $P<0.05$ independent samples t test Note: Lower scores on the device-related distress and the body image concerns subscales are desirable because of their negative label.
ceptance (lower FPAS scale scores) ($\beta = -0.045$ [SE 0.016], OR=0.86 [0.93 to 0.99], $P=0.006$) and higher device specific anxiety ($\beta=0.19$ [SE0.046], OR=1.20 [1.10 to 1.32], $P<0.001$). Likewise, the odds a participant had scores indicative of clinically significant depression was associated with poorer device acceptance ($\beta=-0.078$ [SE0.03], OR=0.92 [0.87 to 0.98], $P=0.008$) and higher levels of device-related anxiety ($\beta=0.16$ [SE 0.054], OR=1.12 [1.06 to 1.30], $P=0.003$).

**Discussion**

This is the first paper to address any aspect of psychosocial adjustment or quality of life in patients with ARVD/C. Although individuals with inherited cardiomyopathies and arrhythmia syndromes have been included in series of studies on quality of life with an ICD, their unique experiences likely get lost in the large sample of individuals with diseases of other etiologies. In 1 of the only studies to specifically account for this group, participants with an inherited arrhythmia syndrome or cardiomyopathy indication for ICD implant had higher rates of depression and lower quality-of-life scores than those implanted for ischemic or valvular disease; however, these participants were also younger, and the relative influence of disease type and age was not evaluated. The additive psychosocial burden of heritability, frequent ICD intervention, and extended ICD course because of age of identification of ARVD/C produce a unique environment that triggers additional clinical needs in these patients and warrants special research focus.

**Device Acceptance**

Although overall mean device acceptance (FPAS) scores were consistent with those in other studies using this scale (76.7 in our analysis versus 76.0, 78.3, 76.6), our study reported the worst (highest) scores on the body image (17.9 versus 10.1, 14.3, 15.7) and device-related distress (26.5 versus 20.5, 19.3) subscales. It is notable that our population had worse body image subscale scores than a study reporting ICD experiences of an exclusively female ICD population. As these are the same FPAS subscales in which our youngest cohort had particularly elevated scores, this pattern may reflect the fact that those with ARVD/C require ICD implantation at a younger age than the typical individual with an ICD, since body image concerns have been shown to be associated with younger age. Furthermore, both body image and device-related distress measure concepts thought to be associated with perception of stigma, which can be associated with having an inherited disease. Hence, the worse body image and device-related distress subscale scores may be caused, in part, by the genetic etiology of ARVD/C, rather than actual worse cosmetic or device related problems. We found no sex difference in either the overall scale (males, 76.6; females, 76.8) or subscale scores, including the body image subscale.

**Anxiety**

Device-related anxiety (FSAS) scores were worse in our population than others reported (22.9 versus 15.4, 14.8, 19.9, 16.4). Furthermore, nearly one third had scores consistent with clinically significant anxiety. Women with ARVD/C appear to have no more anxiety than men, contrary to most other studies, while shock history, younger age, and poorer function were associated with elevated anxiety, consistent with other findings. It may be that anxiety levels are higher in our ARVD/C population merely because it is enriched for young individuals with relatively bad shock histories; however, the genetic etiology of ARVD/C may also play a role. Although family history was not a significant predictor of device-specific anxiety, regardless of whether a patient already had a documented family history at the time of questionnaire completion, all had been counseled that their family members were at increased risk of developing ARVD/C. Inherited diseases carry unique anxieties over health risks of family members, particularly children. In the relatively few studies focusing on adjustment in patients and families with inherited cardiac disease, anxiety and depression have been identified as persistent issues.

**Limitations**

Our cross-sectional retrospective study design limits study findings in several ways. First, the wide variation in time since first ICD implant limits our ability to assess the short-term impact of clinical events on psychosocial adjustment. Additionally, retrospective registry-based data collection combined with a long follow-up time in some patients precluded comprehensive collection of ICD-related complications periprocedure and during follow-up. This limited our ability to assess these factors as predictors of adjustment. Finally, our approach to sample recruitment and registry-based data collection did not allow comparison of psychosocial adjustment in athletes and other study participants.

Our study population also limits the generalizability of results. First, our study included only adults, although there is a subset of patients with ARVD/C who had an ICD implanted as teens. Second, comparison of subjects with and without devices was not feasible, owing to near-universal device placement among patients with ARVD/C in this largely North American cohort, although device implantation is rarer in other locations. Unfortunately there are no data available (in this or prior studies) on baseline anxiety or depression in patients with ARVD/C, which would contribute to maladjustment otherwise presumed to be device-related. Third, while our study population is fairly large, given the prevalence of ARVD/C, the sample size may have limited our power to detect predictors of psychosocial adjustment with a smaller effect size. Finally, study participants all chose to enroll in a research registry and, hence, are a potentially biased sample. Patients with ARVD/C not enrolled in research may differ from our population.

Finally, the timing of questionnaire administration at enrollment in the ARVD/C Registry precluded investigating the influence of genetic test result on psychosocial adjustment, as many participants were in the process of considering genetic testing, arranging testing, or awaiting the test result at the time of questionnaire administration. As participants are completing follow-up questionnaires, this issue will be addressed in a future study.
Clinical Implications

Although the majority of individuals who have an ICD to treat ARVD/C appear to have good device acceptance and no evidence of clinically significant anxiety or depression, a significant minority may have poorer adjustment. Patients with ARVD/C, particularly those who are young, have higher-than-typical levels of body image concerns and device-related distress. Anxiety levels appear to be elevated beyond what is the norm for ICD patients as well. Poor device adjustment, although unfavorable in and of itself, was additionally associated with increased likelihood of clinically significant depression and anxiety. Factors associated with poor adjustment included: (1) younger age; (2) having a device implanted recently; (3) having at least 1 ICD shock; and (4) having a poorer functional capacity. Assessment of these factors may be easily accomplished in a clinical setting. Patients with multiple risks may then be provided opportunities to discuss ICD-related concerns further. A low threshold for a mental health referral would also be appropriate. Furthermore, providing anticipatory guidance, to younger individuals in particular, that psychosocial adjustment issues related to the device are common and treatable, may ameliorate some of the distress evident in this subgroup.

The results of this study likely have applicability not only to caring for individuals with ARVD/C but also for those with other inherited cardiomyopathies (HCM, familial DCM) and arrhythmia syndromes (Long QT, Brugada syndrome, CPVT, etc), for which ICDs are implanted to prevent sudden cardiac death. Similar to ARVD/C, individuals with these conditions have an ICD implanted at a young age and include a higher proportion of affected girls and women than other ICD populations. Perhaps, most critically, these patients similarly live within the psychosocial milieu of a family affected by an inherited cardiac disease associated with sudden death, with the associated risks of anxiety, guilt, loss or potential loss, and stigma. Future research into adjustment to life with an ICD in this population would provide insight into the broader applicability of the current findings.

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