Implantable Cardioverter-Defibrillators, Induced Anxiety, and Quality of Life

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Since its approval in 1985, the implantable cardioverter-defibrillator (ICD) has supplanted antiarrhythmic drugs as the standard of care for patients with potentially lethal ventricular arrhythmias. The increased popularity of ICDs stems primarily from their safety and tolerability compared with commonly used medications notorious for adverse drug reactions. As ICD indications have broadened, the number of implantations has increased substantially, and more attention has been directed to sequelae of implantation, particularly after ICD firing. Although scant, studies of quality of life and psychiatric symptoms in patients with ICDs consistently report assorted psychiatric disturbances affecting up to 87% of recipients. Depression and anxiety predominate: up to 38% of patients experience symptoms that meet diagnostic criteria for an anxiety disorder. Psychological theories such as the classic conditioning model, learned helplessness model, and cognitive appraisal model have been invoked to conceptualize these new-onset ICD-induced anxiety disorders. Small trials of psychosocial interventions, including support groups and cognitive behavioral therapy, have had mixed results. Little is known about preexisting anxiety disorders in ICD recipients, particularly which premorbid features predict a worse prognosis, other than suggestions that younger patients and those receiving multiple shocks are at greater risk. Prospective studies of the psychopathology of patients with ICDs, both before and after implantation, are warranted.

AAD = antiarrhythmic drug; CBT = cognitive behavioral therapy; ICD = implantable cardioverter-defibrillator

T he implantable cardioverter-defibrillator (ICD) was first conceptualized by Dr Michel Mirowski in the 1960s after his mentor died of recurrent ventricular arrhythmias. The ICD has been described as “highly effective at terminating ventricular tachycardia or fibrillation” and is now the gold standard for treatment of potentially lethal ventricular arrhythmias. Despite considerable opposition from the medical community, Dr Mirowski led a team that designed an ICD during the 1970s. The first human implantation occurred in 1980, and the Food and Drug Administration approved ICDs for treatment of ventricular fibrillation in 1985. In 1991, indications were broadened to include ventricular tachycardia not amenable to empirical drug treatment. Implantation of first-generation ICDs required a thoracotomy for insertion into the upper abdominal cavity, often with considerable postsurgical morbidity. Much smaller second-generation models, implanted pectorally without thoracotomy, delivered lower-energy shocks with higher specificity. More advanced third-generation models include antitachycardic overdrive pacing, an innovation permitting painless arrhythmia termination with shock only when absolutely necessary. Research supports the newer devices as being better tolerated and “as good or better” at halting potentially life-threatening ventricular arrhythmias.

Despite improved tolerability, experiencing an ICD firing can be frightening and painful. A patient seen by one of us (J.M.B.) described the experience as being “kicked by a mule in the chest from the inside.” He was so fearful of what a firing could portend that he spent hours parked within sight of his local emergency department, ready to rush inside if he was “whacked by the whacker.” His behavior exemplifies anticipatory anxiety, negative attributions, and attempts to control the device firing, which are hallmarks of ICD maladjustment. The review by Dunbar et al of patient experiences with shock describes reactions ranging from “no pain at all” to “terror.” Patients reported a “lightning-like” quality and compared the experience to being shocked by a spark plug, a battery, an electric fence, or a 110-volt socket. One patient said, “it knocked my cap off,” and a second said it “felt like [the shocks were] lifting me off the ground.” A patient said, “it knocked my cap off,” and a second said it “felt like [the shocks were] lifting me off the ground.” A second said it “felt like [the shocks were] lifting me off the ground.” After a shock, many people are immobilized from fear of causing another, and some lie down to avoid being knocked down by another firing. Nervousness, dizziness, weakness, and fear were the most common responses to shock.

Offsetting the negative aspects of shock, several large-scale trials have shown improved survival with an ICD, with a 1-year mortality rate of 2% to 5%, compared with 10% mortality in a study of drug treatment guided by electrophysiology and 10% to 40% mortality in studies of empirical antiarrhythmic drug (AAD) treatment. Somatic benefits notwithstanding, a substantial proportion of the postimplantation population develops psychological disturbances. An expanding number of studies are addressing the incidence of these issues and are proposing interventions.

METHODS

To identify the articles included in our review, we first searched the MEDLINE database to determine the extent...
and content of articles dealing with the psychological sequelae of ICDs. We used the search terms implantable cardioverter-defibrillator, ICD, psychopathology, anxiety, depression, and quality of life. Next, we hand-searched bibliographies of MEDLINE-identified articles to find additional articles. We ultimately found 42 articles that shed light on our topic.

These articles used various study designs and instruments to assess emotional response to ICDs and quality of life after implantation. Each article had limitations hindering blanket application of its findings. These limitations included a preponderance of male subjects, reliance on self-reported measures, and difficulties with patients qualitatively assessing psychological changes themselves. Nearly all the studies were retrospective, and several were anecdotal, with little prospective data. Moreover, the small sample size in most studies precluded adequate power to generate statistically significant findings. Because of their diversity, these studies cannot be readily combined meta-analytically to achieve statistical power. Thus, our review reflects the present inadequate state of knowledge about the psychological issues surrounding ICD implantation and its aftermath.

**PSYCHOLOGICAL THEORIES TO EXPLAIN PSYCHOPATHOLOGY**

Several psychological paradigms explain how ICDs induce de novo anxiety disorders. From a behavioral perspective, a classic conditioning model pairs an aversive unconditioned stimulus with a previously benign stimulus, the conditioned stimulus. The patient who receives a shock—the unconditioned stimulus—pairs it with the behavior in which he or she was engaging such as showering—the conditioned stimulus—and fears and avoids that behavior because it has been “punished.”

Another response to an unavoidable, noxious stimulus can be learned helplessness. In Seligman’s original studies,12 harnessed dogs “learned” acceptance of electrical shocks, defined as immobility in response to them, when they could not escape the shocks. This stance of “helplessness” continued even when the situation changed to permit escape if the dogs took an initiative such as moving to a shock-free area nearby. Similarly, ICD recipients can feel as if device actions will abate over time.4,10

Punished and helpless, patients seek control through scanning their environments for predictors of imminent shock. In Sears’ cognitive appraisal model,9-11 patients accumulate a sickness scoreboard comprising signals often benign but interpreted as harbingers of doom. For example, an increasing number of shocks may be perceived as an indication of worsening health, although “outcomes based on the frequency of shock alone are not a valid indicator of health.”9 This misinterpretation neatly dovetails with the concept by Pauli et al14 of “catastrophic interpretation of bodily signs,” with an increasingly dire appraisal of the sickness scoreboard leading to anxiety and depression.

According to the disability-stress-coping model,11 formulated in the context of chronically ill children, illness serves as a major stressor atop “normal” daily stressors. Assuming preeminence, a medical stressor such as an ICD consumes most of the patient’s coping capacity; little remains for dealing with the exigencies of daily life. Occupational and relationship difficulties can result, as well as overt psychological disturbances such as anxiety and depression.

**PATTERNS OF PSYCHOPATHOLOGY AFTER ICD IMPLANTATION**

The most common psychological problems after implantation of an ICD are anxiety, depression, specific fears regarding device firing, and fear of death.1,5,7,15-20 Also seen commonly are anger and body image issues.11,17,21 Some degree of anxiety or depression is experienced by 24% to 87% of patients, and 13% to 38% will experience anxiety of sufficient intensity and duration to meet diagnostic criteria for an anxiety spectrum disorder.9,22-24

Multiple stages in adjusting to an ICD have been delineated.7 The preimplantation period is described as a “time of crisis.” Soon after implantation, anxiety, depression, a sense of loss of control, or concerns regarding body image may affect adjustment. The Minnesota Multiphasic Personality Inventory shows moderate levels of self-doubt, depression, and helplessness along with high levels of emotional upset and distress. As time passes, a mixture of anger and relief occurs, along with denial, fear of device firing, hypervigilance, sleep disruption, and mood lability. However, few recipients have unilaterally negative views of the device. After a brief decline in quality of life, the typical patient returns to his or her preimplantation level in about a year.24 As Vlay25 writes, “almost every patient feels comfort that the defibrillator is a ‘safety net’ that will protect him,” and others note that most adverse psychological reactions will abate over time.4,10

Sears and Conti10 believe that a patient’s response to and recovery from a first ICD shock should be considered “a critical event with prognostic implications.” Stated even more pointedly by Pauli et al,14 “anxiety related to ICD discharge is the single most distressing aspect of ICD treatment.” In keeping with the cognitive appraisal model, the level of distress may not depend on the number of shocks a patient receives but may be based on the patient’s catastrophic interpretation of the experience.
In another conceptualization of ICD-induced anxiety disorders, Fricchione et al\textsuperscript{26} outlined 4 main adjustment reactions. The most intuitive resembles a panic disorder with agoraphobia, as described in the \textit{Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition}, with patients avoiding leaving home after a device firing for fear of a recurrence in public. A second reaction, containing elements of both the cognitive appraisal and disability-stress-coping models and resembling generalized anxiety and hypochondria, is “ICD dependence,” wherein the patient’s decision making centers on whether the patient’s activities will cause the device to fire. A third response, which is not an anxiety disorder, occurs when the patient views the ICD as a “guardian angel” and acts invulnerable. Fricchione et al\textsuperscript{26} call the counterphobic and risky behaviors that result “ICD abuse.” In the fourth reaction, abrupt anxiety characterizes “ICD withdrawal,” which occurs when the ICD is removed and the patient’s perceived “safety net” is suddenly absent.\textsuperscript{26}

**PREDICTING PSYCHOPATHOLOGY IN ICD RECIPIENTS**

Crow et al\textsuperscript{27} believe that the “risk for new psychopathology is largely confined to those with a lifetime history of psychopathology.” However, at least 2 studies refute their findings. In one, 6 of 35 patients developed new-onset symptoms of anxiety and depression sufficient for a formal diagnosis, despite having no premorbid psychiatric issues.\textsuperscript{28} The other study revealed clinically important anxiety in 14 of 72 patients, with only 3 having a history of anxiety-spectrum disorders.\textsuperscript{22} Although limited in number and breadth, studies of individual characteristics predisposing toward new psychopathology include 4 broad categories: demographics, personal psychology, social and family context, and experience with the ICD after implantation.

**DEMOGRAPHICS**

Demographic factors include age and sex. Patients younger than 50 years had “significant increases in their level of anxiety at follow up when compared to older recipients”\textsuperscript{11} and “significantly more adjustment concerns, such as generalized fear, worry, fear of physical exertion, depression and difficulties managing stress.”\textsuperscript{11} Children and adolescents with ICDs experience depression and suicidal ideation more often than adults. Young adults may engage in fewer social interactions, worry about or avoid exercise and sexual activity, and evince more body image concerns.\textsuperscript{11} Several studies have shown an increased risk of anxiety disorders in adults younger than 50 years.\textsuperscript{9,22,24} Although younger patients did not vary in comorbid disease, previous heart surgery, or marital status, they reported lower quality of life than their older counterparts. In contrast to older patients, who tended to view the device as something that would extend life, “younger patients associated the ICD with dramatic life changes, decreased independence, and concerns with body image.”\textsuperscript{29}

Studies are inconclusive about gender-related susceptibility to ICD-induced psychopathology. One problem is that most subjects are men. Some authors suggest that women with ICDs have an independent risk of developing mood disorders\textsuperscript{30} and experiencing reduced quality of life.\textsuperscript{24} The most gender-balanced study showed no significant gender-based differences, but its findings should be interpreted cautiously because it enrolled only 6 women and 9 men.\textsuperscript{31}

**PERSONAL PSYCHOLOGY**

Other characteristics associated with emergent psychopathology include the psychological attributes of anger and anxiety. \textit{Trait} refers to psychological qualities intrinsic to the personality, whereas \textit{state} encompasses the more immediate response to events. In a study lacking sufficient statistical power to generalize results with confidence, baseline state and trait anger and anxiety levels were higher in patients with ICDs than in controls. After ICD implantation, trait anger and anxiety and state anger were unchanged, but state anxiety had improved.\textsuperscript{16} The basic character of the ICD recipients had not changed, but they were less anxious about their cardiac status after ICD implantation, reflecting earlier research suggesting that “almost every patient feels comfort that the defibrillator is a ‘safety net’ that will protect him.”\textsuperscript{25}

In a study of 58 patients with ICDs, elevated trait anxiety predicted worsened quality of life, prompting the authors to consider anxiety as an independent risk factor in ICD recipients.\textsuperscript{32} The authors did not compare postimplantation to preimplantation trait scores. These findings echo an earlier trial that showed elevated trait anxiety to be an independent risk factor for decreased quality of life after ICD implantation.\textsuperscript{31} Individuals with high trait anxiety and poor social support made particularly poor adjustments to the device.\textsuperscript{33} In a third trial, state and trait anxiety were assessed before ICD implantation and approximately 30 months later. At baseline, these patients had higher state and trait anxiety and anger than seen typically in medical populations, and only state anxiety had decreased at the postimplantation assessment.\textsuperscript{16}

**SOCIAL AND FAMILY CONTEXT**

Both excessive family involvement and inadequate social support correlated independently with emergent psychopathology. After ICD firings in certain patients, family members exhibited distress, including hypervigilance, helplessness, uncertainty, and overprotectiveness.\textsuperscript{3,7,20,34,35} In other
patients, frustration and resentment contributed to strained family relationships, particularly with spouses. When multiple shocks occur, not only patients but also family members may suffer. The deleterious effects of poor family adaptation to the patient’s mental health suggest that “greater preparation for situations of multiple shock is also indicated.”

Although family members can hinder adjustment to ICDs, social isolation can make matters even worse. Real or perceived deficits in social support are associated with lower tolerance of the device. Being unmarried—a proxy for lower social support—is an independent risk factor for developing a mood disorder, and low social support levels contribute to reduced overall quality of life.

**Experience With ICDs After Implantation**

Recipients’ experience with their ICDs after implantation also affects emergent psychopathology. One small study (6 patients per arm) showed no statistical difference in adjustment among an ICD group receiving shocks, an ICD group not receiving shocks, and a non-ICD group taking AADs. However, most studies do not support these findings. Pauli et al found that the absolute number of shocks is less important than most researchers have reported but proposed instead that the misinterpretation of the reason for increasing shocks or the underlying personal meanings of the shocks could worsen quality of life. Virtually all other studies noted a statistically significant decrease in the quality of life of ICD recipients receiving shocks compared with those who did not. The significance typically increased as the number of shocks increased.

Whether the shock was appropriate had no bearing on quality of life; 50% to 70% of patients with ICDs received multiple shocks in the first 2 years. Patients receiving shocks experienced increased anxiety, sadness, and health concerns as well as significant reductions in mental wellbeing and physical functioning.

Although the cognitive theory of learned helplessness concurs with the intuition that random shocks should increase anxiety, few empirical data exist to prove the point. Hegel et al suggested that the “illusion of control” over the shocks decreased anxiety. Even without a shock, one third of his patients experienced persistent postimplantation anxiety, depression, and fear of autonomic arousal. If the device fired, adjustment difficulties endured; if it did not, adjustment improved. Patients’ efforts to attribute meaning to ICD firings can reduce anxiety and improve overall quality of life. For some ICD recipients, explanations—even inaccurate ones—create the “illusion of control.” In other patients, ICD firings produce a fear of worsening health, which reinforces avoidance behaviors and further impairs the quality of life.

An example of learned helplessness may be seen in a patient who experiences “ICD storm” (3 or more shocks in a 24-hour period). Such a patient may associate exercise with triggering another such ICD outburst and may develop a global fear of exertion. No data exist about the frequency of these storms or the proportion of patients with poststorm symptoms.

In patients with substantial postimplantation anxiety, depression, or fear, research has shown that an illusion of personal control reduced symptom intensity. The longer the period with no recurrent shocks, the less pronounced the psychiatric symptoms. However, if shocks continued, so did anxiety and fear. Mood disturbance at 1 or 3 months postimplantation has been shown to predict arrhythmias at 3 or 6 months, raising the possibility that anxiety is both a cause and an effect of multiple device firings.

Two large studies using quality-of-life measures had slightly different conclusions, but both reported the detrimental effects of ICD firings. The Coronary Artery Bypass Graft (CABG) Patch Trial found no difference in quality-of-life measures between patients with ICDs vs patients given AADs. In the Canadian Implantable Defibrillator Study, quality of life was statistically better for patients with ICDs than for patients given AADs. For patients whose device fired, both studies reported reduced quality of life.

**Quality-of-Life Studies**

Few authors have documented the specific incidence of ICD-induced anxiety disorders; however, a slowly expanding number of studies are addressing the more general topic of quality of life in patients with ICDs. A relative strength of this facet of ICD studies is the larger sample sizes. All such studies share the weaknesses of necessary reliance on self-reported measures, and most are retrospective. Only 1 study has found no quality-of-life differences between groups with and without firings. Although acceptance of ICDs is generally “quite good,” given the alternative of death due to arrhythmia, fears of the device are common. Most studies conclude that patients whose ICDs have fired have reduced quality of life and fare worse than cardiac patients with no ICD. In addition, low levels of social support, high levels of anxiety, higher numbers of firings, and trait anxiety are all associated with worsened quality of life.

The Canadian Implantable Defibrillator Study, one of the largest ICD studies to date with 317 patients, reported better quality of life with ICD therapy than with use of amiodarone unless the device fired 5 or more times during the 12-month study. In the subgroup who were shocked frequently, the ICD benefit was lost. Two other
studies had similar conclusions, and showed that receiving any shock, compared with receiving no shocks, was independently associated with notable reductions in mental well-being and physical functioning. Those receiving more than 5 shocks experienced an even lower quality of life. Overall, however, ICD and AAD therapy were associated with similar decreases in self-reported quality of life.

In a study comparing patients given AADs and those with ICDs, Arteaga and Windle showed that “patient-perceived quality of life is maintained in patients who survive life-threatening arrhythmias despite their diminished health status and increased psychologic distress,” and that patients who have survived life-threatening events are “more positive, reevaluated their priorities, and had a greater appreciation for the preciousness of life.”

TREATMENT CONSIDERATIONS
Scant support exists for any particular therapeutic modality. Although essentially nothing has been reported about the value of psychopharmacological intervention in patients with ICDs, cognitive behavioral therapy (CBT) appears beneficial. A study that compared CBT to no treatment in 49 patients with ICDs found that the CBT group had less depression, less anxiety, lower overall distress, and fewer sexual problems after 9 months. The findings may be particularly robust because the CBT group received more shocks than the controls, a factor repeatedly linked to poorer quality of life. Also, the CBT group included a higher proportion of women, who are known to experience both anxiety and depression more frequently than men. This study assumed that ICD-induced anxiety, particularly with ICD storm, can be learned and is a type of anxiety for which CBT is specifically effective.

A recently published case report outlines a 6-session psychosocial intervention used with success in a 74-year-old ICD recipient. This intervention involved weekly appointments with the patient and encompassed various approaches, including psychoeducation in the first week, stress-management techniques in the next 2 meetings, identification and reframing of cognitive distortions in the next 2 weeks, and addressing a specific plan for managing future shocks in the final week. Larger studies are needed.

Aside from formal psychotherapeutic intervention, authors have recommended several tactics for decreasing the negative effects of ICDs on patients and families. One such suggestion is for physicians to “reinforce non-illness behaviors” by avoiding unnecessary tests, even if normal results may be reassuring. Formal education in relaxation techniques, breathing exercises, and use of positive statements to counteract catastrophizing after a device firing is advised. A first line of potential preventive treatment includes warning the patient about possible symptoms in advance (anticipation) and using exercise (avoiding avoidance behaviors) and relaxation techniques to enhance a sense of control. Should this approach prove insufficient, anxiolytics and formal psychotherapy may be indicated.

In one systematic approach, the clinician carefully defines the problem in collaboration with the patient and the patient’s family. The physician provides education about the topic, creates team support from both medical and familial resources, normalizes fears, elicits emotional release, instills hope, and encourages the patient and family to remain active in the patient’s care. For patients in whom the initial approach, as outlined previously, proves inadequate, the authors further recommend enrollment in support groups, followed by relaxation training, cognitive restructuring, supportive psychotherapy, and systematic desensitization.

Patients with ICDs and their caretakers who have enrolled in support groups overwhelmingly value them. Although only 39% of one sample had experienced a support group, 96% of participants found them “very helpful.” Anger and anxiety levels are higher in the ICD population, and improved perceived support purportedly reduces stress and enhances adjustment. Hampered by small sample size, research studies in this area have shown no measurable benefits except improved coping skills and patient satisfaction. In one such study, group attendance yielded decreased hostility, increased happiness, improved sociability, and a higher rate of return to work. These benefits occurred even with a simultaneous increase in ICD-related worry. This apparent conundrum can be perceived as a fundamental ambivalence regarding the ICD. Many patients view the device as both protecting them and causing concern over firing.

CONCLUSION
A small but slowly expanding number of studies are addressing quality of life and iatrogenic mood and anxiety disorders after ICD implantation. In a notable minority of patients with ICDs, quality of life worsens. Up to 38% develop diagnosable anxiety disorders. The strongest correlates with anxiety appear to be the frequency and recency of device firing. However, several other variables, including age, sex, family response, perception of both control and predictability of shocks, and psychological attributions made by the patient regarding the device, factor powerfully in the genesis of such disorders. Because negative emotions are associated with increases in arrhythmias and because psychiatric illness can interfere with recovery from medical illness, attendance to these issues is clearly impor-
tant. As ICDs become the standard of care for common arrhythmias and increasing numbers are implanted each year, addressing preexisting anxiety conditions, as well as induced anxiety, becomes even more important. Large-scale, randomized, prospective studies using validated structured interview tools rather than self-reported measures or unstructured assessments are needed to determine categorically which patients meet criteria for anxiety disorders before and after implantation. As ICDs become the standard of care for arrhythmia, researchers at larger centers such as the Mayo Clinic, where approximately 300 ICDs are implanted each year, should be able to accrue enough patients in a timely manner to conduct such studies.

REFERENCES