

Review

Understanding Implantable Cardioverter Defibrillator Shocks and Storms: Medical and Psychosocial Considerations for Research and Clinical Care

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Summary: The experience of shock is the distinguishing feature for patients with implantable cardioverter defibrillators (ICDs) and is associated with diminished psychological functioning and quality of life. Multiple shocks and ICD storm are a relatively common event among patients with ICDs (10–20%) and may present specific challenging medical and psychological management for the attending health care providers. This paper examines the medical and psychological aspects of ICD shocks and storms and describes a model of biopsychosocial management for patients following the experience of ICD storm. Successful management of patients post shock includes the use of antiarrhythmic medications and careful attention to the causality of the shocks via stored electrograms. The psychological management includes specific attention to debriefing post-shock feelings and attributions, preventing avoidance behavior, and facilitating positive “return to life” actions. Preliminary research examining formal psychosocial treatment supports a cognitive behavioral strategy to reduce psychological distress and facilitate quality of life. Collectively, these data suggest that interdisciplinary management of patients with multiple ICD shocks or the experience of ICD storm is advised, and routine psychological consultation may be indicated for the patient post ICD storm to reduce the possibility of symptoms of post-traumatic stress.

Key words: implantable cardioverter defibrillator, psychosocial, ICD storm, shock management, traumatic stress

Introduction

Sudden cardiac death due to ventricular tachyarrhythmias accounts for most cardiovascular deaths in the United States, claiming more than 350,000 lives annually.¹ The implantable cardioverter defibrillator (ICD) is an effective and life-saving biomedical device for potentially lethal ventricular arrhythmias.² More recently, the Multicenter Automatic Defibrillator Implantation Trial (MADIT) II indicated a 30% survival benefit for patients with a previous history of a myocardial infarction and a low left ventricular ejection fraction ($\leq 30\%$), who were randomized to an ICD versus conventional medical therapy.³ Therefore, the possible indications for ICD implantation will likely broaden and the rate of ICD implantations is likely to continue to increase dramatically. The absolute benefits of the ICD in terms of quality of life may be diminished due to reduced daily activity patterns and symptoms of anxiety and depression associated with the necessary shock to complete defibrillation.⁴ Although most people are able to tolerate shock to some extent, the experience of repeated shock is particularly aversive and may be associated with significant psychological distress. Recent professional⁵ and media articles⁶ have highlighted the paradox of successful sudden death prevention for many years provided by the ICD that can eventually end in high rates of shock and more complicated clinical management in the long run. Shock is the major distinguishing factor between patients with ICDs and general cardiac patient populations. The clinical management of patients with ICDs who experience shock has only recently begun to be fully articulated,⁷ and very little research evidence is available about how to best manage the patient with multiple shock and ICD storm. The purpose of this paper is to examine the medical and psychological aspects of ICD shocks and storms and describe a model of biopsychosocial management for patients following the experience of ICD storm.

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Definition and Incidence of ICD Storm

Approximately 50–70% of patients with an ICD receive an appropriate shock within the first 2 years of implantation.^{8,9} In the vast majority of these patients, only one shock is necessary to terminate their arrhythmia. In some, however, multiple shocks are delivered in a short period of time, either appropriately or inappropriately. When this happens, the patient is said to have had “ICD storm,” an arrhythmic or electrical storm. One definition of electrical storm is recurrent ventricular tachycardia or fibrillation occurring two or more times in a 24-h period, usually requiring electrical cardioversion or defibrillation.^{10,11} A broader use of the term ICD storm includes those patients who receive multiple shocks inappropriately for atrial fibrillation, lead fracture, electromagnetic noise, and so forth. The incidence of true ICD storm is estimated to occur in between 10 and 30% of all ICD recipients.^{12–14} Generally, storm occurs late after ICD implantation,¹⁴ in one study at an average of 133–135 days post implant. Moreover, the mean number of shocks for this group was 17 ± 17 (range 3–50; median 8). Although management of these patients is difficult, ICD storm has not uniformly been demonstrated to confer increased mortality on the patients who experience it.^{14,15} Precipitating factors for electrical storm are rarely identified.¹⁴ Possible causes include hypokalemia, hypomagnesemia, acute myocardial infarction or other ischemic syndrome, proarrhythmia from antiarrhythmic drugs, and torsade de pointes secondary to a prolonged QT interval. Similarly, the incidence of receiving multiple shocks for atrial fibrillation is approximately 30%.¹⁶ Although this is not technically an electrical storm, for the patient the aversive experience is the same.

Psychological Adjustment and the Experience of Shock

The general psychosocial impact of the ICD has been investigated in multiple small-scale studies. Comprehensive literature reviews indicate that patient acceptance of the ICD and global quality of life (QOL) are generally quite good;^{17–19} however, approximately 24–38% of patients with ICDs experience either an anxiety or depressive disorder during the first year post implantation. Specific risk factors for poor psychosocial outcomes have been identified and include young age (<50 years), frequent shocks, poor premorbid psychological functioning, poor understanding of the medical condition and the ICD, and additional medical comorbidities. Fear of being shocked is a virtually universal experience for the patient with ICDs. These symptoms of fear and anxiety are compounded when certain stimuli or behaviors are coincidentally paired with an ICD shock and are thereby avoided in the future. Specific behavioral avoidance of “shocked” activities can limit the range and quality of activities of daily life and inadvertently diminish quality of life. Specifically, the experience of aversive shock, the recognition of potential mortality, and the perceived lack of control or predictability over one’s medical condition can lead to a state of “learned helplessness” that may make patients with

ICDs vulnerable to anxiety and depressive disorders.²⁰ In fact, recent research highlighted patients with ICDs as “an appropriate risk population for a prospective study of the development of anxiety disorders.”²¹

The experience of shock has been regularly linked to poor psychological and QOL outcomes in the ICD literature. Data from two major randomized, controlled trials with the ICD are now available. The Coronary Artery Bypass Graft (CABG) Patch Trial examined the value of prophylactic ICD implantation in patients undergoing coronary artery bypass graft surgery (CABG) ($n = 262$) versus no ICD ($n = 228$) after CABG surgery.²² Mental and physical QOL scores for the patients with ICDs were significantly worse compared with those for patients without ICDs. However, further analyses revealed that there was no difference in QOL for nonshocked patients with ICDs versus those with no ICDs. These results indicated that the ICD group who had received shocks was responsible for the significantly worse mental and physical QOL outcome scores between the groups. Collectively, these data implicate that the experience of shock is strongly associated with psychological distress and diminished QOL. Similar findings were recently reported from the Antiarrhythmics Versus Implantable Defibrillators (AVID) trial in which shock was again associated with worse physical and mental QOL.²³

The experience of shock may be confounded by the simultaneous negative appraisals of the ICD following shock. We have suggested that ICD shock may serve as a “sickness scoreboard” for patients, such that more shocks are perceived to equate to less health and initiate a cycle of negative beliefs and expectations. This theory helps to explain some of the divergent findings related to shock available in the literature. For example, Pauli *et al.*²⁴ examined the anxiety scores of patients with ICDs and found that anxiety was not related to ICD discharges but was highly related to a set of “catastrophic cognitions.” Patients with high anxiety scores tended to interpret bodily symptoms as signs of danger and believed that they had heightened risk of sudden death. In addition, this cognitive style was associated with anxiety scores that were consistent with the scores of patients with panic disorder and different from the scores of a healthy volunteer sample. These findings suggest that psychosocial interventions that utilize cognitive-behavioral protocols will likely prevent and/or reduce anxiety problems regardless of shock exposure by changing catastrophic thinking and overinterpretation of bodily signs and symptoms.

The relationship of negative emotions and shock may also be cyclical. For example, Dunbar *et al.*²⁵ conducted a prospective, longitudinal study of mood disturbance before implant and at 1, 3, 6, and 9 months post implantation ($n = 176$). They found that higher levels of mood disturbance at 1 and 3 months were independent predictors of subsequent arrhythmia events at 3 and 6 months, even after controlling for ejection fraction and other cardiac variables. The authors concluded “negative emotions were the cause, rather than a consequence, of arrhythmia events” (p. 163). Certainly, arrhythmic events have a number of possible precipitants, but this study provided the first prospective evidence for negative emotions and psychological distress increasing the chances of receiving a shock.

General Theories of Psychological Adjustment to Implantable Cardioverter Defibrillator Shock

Our literature review summarized three relevant theories that hold heuristic value in explaining the adjustment of ICD recipients.¹⁹

The Classical Conditioning theory²⁶ can be used to explain how repeated shocks given by the ICD may be paired with previously neutral environmental or behavioral stimuli, resulting in conditioned responses including anxiety or fear.¹⁹ Figure 1 shows an example of the conditioning paradigm with a coincidental pairing of exertion with shock and the development of fear/arousal.

The Learned Helplessness theory²⁷ can be used to describe ICD recipients who feel as if they have no control over the necessary delivered shocks and may develop feelings of hopelessness and depression about their current and future health status.

Sears *et al.*¹⁹ proposed a *Cognitive Appraisal Theory of ICD Activity* as a model for how some ICD recipients seek greater perceived cognitive control by interpreting the activity or inactivity of the device as an indicator of their level of current cardiac functioning. Thus, ICD shocks serve as a “sickness scoreboard” where shocks are used to forecast future health. Higher levels of shocks, such as in ICD storm, are interpreted as indicators of an impending catastrophe and lead to heightened anxiety and avoidance behavior, consistent with the findings of Pauli *et al.*²⁴

The psychological distress following an ICD storm may include aspects of all three theories. The experience of an ICD storm is believed to be particularly alarming to patients with ICDs because they feel helpless in attempting to terminate the shocks and may experience altered consciousness due to insufficient cardiac output. Family members often express their own distress about the experience; collective doubts about the ICD and its value often arise. If ICD storms are sufficient to produce significant psychological distress and diminish daily functioning, then psychosocial interventions could be initiated soon after an ICD storm in a “debriefing” type format. If a threshold of cumulative shocks is sufficient to produce significant psycho-

logical distress, then the timing of the intervention could vary, either before the shocks occur as part of a “shock-preparation” program or after the cumulative shocks have occurred as part of routine “after the shock” program. Knowledge about when to intervene would likely produce the most effective and cost-efficient psychosocial interventions. Future research focusing on the timing and efficacy of intervention for patients with ICDs who receive multiple shocks would be helpful in delivering necessary and efficient interventions.

Medical Management of Multiple Implantable Cardioverter Defibrillator Shocks and/or Storm

Medical management of ICD storm is developed based upon the patient’s cardiac condition, the arrhythmia that is triggering the device, and previous medical therapies tried. In the patient with an ischemic cardiomyopathy who is having recurrent ventricular tachycardia (VT), the first concern of therapy is to terminate the arrhythmia to prevent recurring shocks. Initial treatment is best accomplished with intravenous amiodarone and treatment with beta blockade as the patient tolerates. If necessary, a type 1A or 1B antiarrhythmic drug can also be added to stop incessant ventricular tachycardia. If the VT is polymorphic, early identification of acute coronary syndromes is imperative. Patients who have previously had very few shocks should be evaluated aggressively for worsening CAD. If class I or III antiarrhythmic drugs are added, the patient’s defibrillation threshold must be tested in the electrophysiology laboratory prior to discharge.

If the patient is receiving multiple shocks for an inappropriate reason, that is, atrial fibrillation, the first step in management is to turn the ICD therapy off, with the patient on telemetry. Attention should then be turned to the arrhythmia, with consideration of slowing the rate, cardioversion, and anticoagulation issues.

If the ICD is malfunctioning secondary to lead fracture or a loose set of screws, again the first step is to turn ICD therapy off while the patient is being monitored. Repair of the lead is the only treatment option.

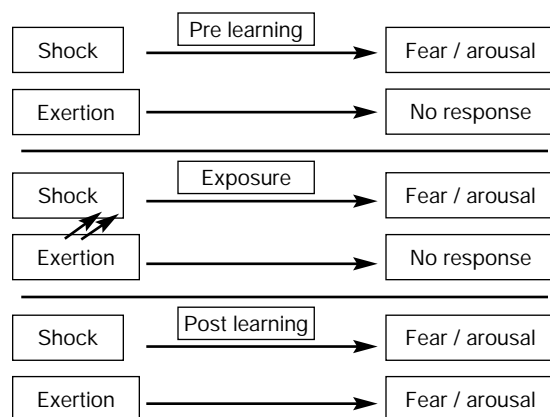


FIG. 1 Example of classical conditioning of exertion and shock.

Interdisciplinary Management of Implantable Cardioverter Defibrillator Shocks and Storm

The patient’s experience and recovery from the first ICD shock should be considered a critical event with prognostic implications. Patients with ICDs who are able to get adequate medical reassurance and debriefing likely will be able to resume previous levels of functioning with less psychological distress. Some patients may desire additional psychological intervention and should be referred to a mental health professional with at least familiarity with the ICD and its therapeutic shock. Similarly, the clinical management of ICD storm should involve a routine psychological consultation for all patients. Receiving multiple shocks is painful and distressing to patients with ICDs and to their families. It may precipitate an

increasing lack of faith and security in the ICD and initiate “catastrophic appraisals” by patients with ICDs of their health and their ability to function. The experience of receiving multiple shocks is also outside the realm of normal human experience and may be perceived as life threatening. These conditions are consistent with the notion of post-traumatic stress disorder (PTSD) from the psychiatric literature. Patients with ICD storm have experienced a trauma that few others will ever face and are often not able to accommodate and communicate their thoughts and feelings to others. Routine psychological assessment allows for the detection of possible problems by a specialist and the debriefing of the patient and family from the storm experience. Psychological assessment should be undertaken as a minimum step because these assessments can often serve as a single-session intervention or could serve as a key preventive behavior to diminish the possibility of future anxiety disorders and avoidance behaviors.

Specific Health Care Provider Interventions

Although routine psychosocial care is indicated for all patients with ICDs, there will likely never be enough mental health providers adequately trained and accessible for all patients with ICDs and families. Existing medical teams often compensate by attempting to address these issues as best they can. However, our previous work indicated that health care providers, both cardiac physicians and nurses, do not feel comfortable addressing emotional issues,²⁸ with a minority of

physicians and nurses rating issues such as depression (34 and 45%) and anxiety (46 and 55%) as “comfortable.” We have detailed our treatment package in the peer-reviewed literature through a series of published case studies^{20,29} as well as in our provider-based training materials.⁷ The main tenet of this work is that discussing simple strategies with patients with ICDs and family members, such as normalizing stress/fear, reviewing coincidental antecedent behaviors to the shock and reassuring of their safety, and teaching warning signs of distress and avoidance behaviors, provides patients and families with some strategies to overcome shock. Table I reviews some examples of key issues and actions for attending health care providers for the patient with ICDs with recent shock experience of ICD storm.

The effects of ICD implantation and shock may be appropriately addressed with structured, formal psychosocial interventions provided by specialist mental health providers as illustrated by Kohn *et al.*³⁰ These researchers used individual cognitive-behavioral therapy to reduce psychological distress in patients newly implanted with ICDs to determine if such therapy would also reduce arrhythmic events requiring shocks for termination. They randomized 49 patients with ICDs to active treatment versus no treatment. The treatment consisted of an individual therapy session at pre implant, pre discharge from the hospital, consecutive weeks for 4 weeks, and then sessions at routine cardiac clinic appointments at 1, 3, and 5 months post implantation. Results indicated that patients under active treatment reported less depression, less anxiety, and less general psychological distress than the no treatment

TABLE 1 Attending health care provider interventions for the patient with post implantable cardioverter defibrillator (ICD) storm

Shock-related issues	Clinical strategy	Example of health professional behavior
Planning immediate post-shock behavior	1. Discuss and confirm a standard operating procedure for post-shock care	“If I get shocked more than once, I want you to...”
	2. Normalize that shocks are likely to occur and not necessarily a sign of trouble	“Nobody likes getting shocked but I am confident that I have reduced your risk as much as possible at this time”
Preventing avoidance behavior	1. Review antecedents and post-shock behaviors	“What were you doing just before you got shocked?”
	2. Emphasize no known shock-behavior links at this time	“That behavior was not related to getting shocked”
	3. Return to pre-shock activity	“Therefore I want you to return to activity X”
Promoting positive patient acceptance of device therapy	1. Reassure patient and family that ICD is still treatment of choice for life-threatening arrhythmias	“The ICD is still the best treatment option to keep you safe”
	2. Personify the ICD with positive nickname: “Personal 911 service”	“Having an ICD is like having paramedics with you all the time. If your heart stops, the ICD will shock it back to normal rhythm without having to call 911”
Facilitating positive behavior	1. Discuss expectations of returning to activities 2. Inquire about any concerns or barriers that are likely	“What are you going to do this week to return to living life to the fullest?”
Referral for specialty mental health care	1. Refer at-risk patients for psychosocial distress 2. Know at-risk characteristics	“Being shocked is stressful. I would like to refer you to someone with expertise in medical stress management”

group at 9-month follow-up evaluations. Their hypotheses related to reducing shocks in the intervention group was not supported. In fact, the treatment group had a statistical trend of receiving more shocks. Furthermore, the intervention was most effective in the patients who had received at least one shock. Collectively, clinical experience and research merge and indicate that routine and specialized psychosocial treatments are needed to assist all patients with ICDs and particularly those with ICD storm.

Conclusions

The experience of shock is the distinguishing feature for patients with ICDs and is associated with diminished psychological functioning and QOL. Multiple shocks and ICD storm are relatively common events among patients with ICDs (10–20%) and may present specific challenging medical and psychological management for the attending health care providers. The medical management of this condition includes the use of antiarrhythmic medications and careful attention to the causality of the shocks to determine additional intervention. The psychological management includes both an informal and formal implementation of psychological concepts with specific attention to planning immediate post-shock behavior, debriefing post-shock feeling and attributions, preventing avoidance behavior, and facilitating positive “return to life” actions. Preliminary research examining formal psychosocial treatment supports a cognitive behavioral strategy to reduce psychological distress and facilitate quality of life. Further research into the generalization of this work to patients with ICD storm is needed to optimize the timing and the impact of psychosocial interventions.

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