

# Incessant Ventricular Tachycardia and Fibrillation: Electrical Storms



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## KEYWORDS

• Electrical storm • Ventricular tachycardia • Ventricular fibrillation

## KEY POINTS

- Management of ventricular tachycardia storms is often empiric and typically depends on the identification of a cause or underlying pathophysiology that needs treatment.
- The use of the electrocardiogram (ECG) and intracardiac ECGs can be useful in deciding on a clinical strategy for treatment of electrical storm.
- Treating the underlying causes and contributing factors is often helpful in addition to the use of medical therapy and ablation.

## INTRODUCTION

Electrical storm is defined as 3 or more episodes of sustained ventricular tachyarrhythmias/ventricular fibrillation (VT/VF) or appropriate implantable-cardioverter defibrillators (ICD) shocks that occur within a period of 24 hours.<sup>1,2</sup> Most commonly, VT storm is seen in individuals with structural heart disease and ICDs. Before ICDs, most patients with electrical storm did not survive. VT storm can also be seen in patients with a structurally normal heart, such as those with ion channel mutation.<sup>3</sup> The overall mortality related to electrical storm is very high.<sup>1</sup> Many times electrical storm occurs in the setting of end-stage cardiomyopathy or in the setting of severe medical and metabolic comorbid conditions.<sup>4</sup> In addition, patients who survive the storm often are treated with medications that have a high level of side effects and adverse effects, such as Amiodarone. Innovative procedures such as VT or VF

ablation when done in the setting of electrical storm also have higher morbidity and mortality than when performed electively. In an extreme example, radiofrequency ablation (RFA) in the setting of VT/VF storm in patients with ventricular assist devices has been reported as high as 80% over a 6-month follow-up period.<sup>2,5,6</sup> Neural modulation (left stellate ganglion blockade) has recently been reported as an effective method in rare cases of VT storm.<sup>7</sup> Similarly, renal denervation has been used in the management of ventricular arrhythmia storm in patients with cardiomyopathy.<sup>6</sup>

In this communication, VT/VF storm is used interchangeably with electrical storm.

## SPECIFIC CONTRIBUTING FACTORS IN ELECTRICAL STORM

**Box 1** shows the common causes of VT/VF storm.

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The authors have nothing to disclose.

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**Box 1****Causes of VT/VF electrical storm**

1. Electrolyte and metabolic imbalance
2. Myocardial ischemia and infarction
3. Drug-induced proarrhythmia
4. VT/VF Storm in Patients with ICDs
5. VT storm in inherited channelopathies
6. Electrical storm in patients with congestive heart failure
7. Unknown causes

***Electrolyte Imbalance***

Electrolyte imbalance can often contribute to electrical storm.<sup>4</sup> In patients with hyperkalemia, the electrolyte imbalance can lead directly to ventricular arrhythmias, although not always as a “storm.” Patients with electrical storm can often have hypokalemia. Both hyperkalemia and hypokalemia can manifest as electrocardiogram (ECG) changes before onset of ventricular arrhythmias. Correction of the electrolyte imbalance is an important step in the early management of these patients.

***Myocardial Ischemia and Infarction***

Acute ischemia can sometimes lead to electrical storm, usually VF. Chronic myocardial ischemia can also set the stage for reentrant arrhythmias. Patients with electrical storm should be evaluated for ischemia, and when possible, it should be reversed. In addition, treatment with  $\beta$ -blockers can decrease both ischemia and ventricular arrhythmias. Patients with atrial fibrillation (AF) who inherently have irregular heart rate often with short-long-short sequence in the presence of ischemia and infarction may trigger recurrent fast VT/VF, especially when antiarrhythmic medications are on board. **Fig. 1** shows an example of incessant VT in a patient after a myocardial infarction. Frequent premature ventricular complexes precede VT, and a 3-beat VT triggers sustained monomorphic VT. Urgent coronary angiography and revascularization of a subtotal left anterior descending coronary artery abolished ventricular arrhythmias.

***Drug-induced Proarrhythmia***

Proarrhythmia is most commonly related to prolongation of the QT interval. Common culprits are antibiotics,<sup>8</sup> antiarrhythmic medications,<sup>9</sup> and antipsychotic medications.<sup>10</sup> **Fig. 2** shows an

example of drug-induced polymorphic VT and torsades de pointes due to administration of Ibutilide for conversion of AF. Amiodarone can commonly cause prolongation of the QT interval; however, it rarely causes proarrhythmia. Unfortunately, when Amiodarone does cause proarrhythmia, it often manifests as electrical storm. Also, given the prolonged drug half-life with Amiodarone, patients affected with electrical storm can have multiple episodes even after the drug is discontinued. Commonly, electrical storm is related to pause-dependent early premature ventricular contractions (PVCs). Treatments that increase the heart rate and prevent pause-dependent arrhythmia such as pacing or use of isoproterenol can be helpful.

***VT Storm in Patients with ICDs***

Electrical storm in patients with ICDs can occur in about 10% to 20% of this population.<sup>4</sup> The incidence is higher in patients who receive ICDs as a secondary than primary prevention. Recipients of cardiac resynchronization therapy may present with electrical storm, especially in the early phase after implantation.<sup>11–13</sup> Recent advances in the management of patients with ICDs have led to recommendations for increased use of antitachycardia pacing as well as increasing the time to detect and to prevent unnecessary shocks.<sup>14</sup> In addition to the pain related to the ICD shocks, patients often have psychological manifestations of posttraumatic stress syndrome.

***VT Storm in Inherited Channelopathies***

Patients with inherited syndromes may present with electrical storm. Conditions such as the Brugada syndrome can have electrical storm with no apparent precipitating factor.<sup>15–18</sup> **Fig. 3** shows an example of recurrent VT in a patient with Brugada syndrome who also received an ICD.

***Electrical Storm in Patients with Congestive Heart Failure***

Patients with congestive heart failure (CHF) are the most common patients presenting with electrical storm. Most cases do not have an identifiable ischemic cause or clear electrolyte abnormalities. Worsening CHF can be a precipitating factor, but is not always present: many cases have not had any clinical decompensation. Electrical storm is a poor prognostic indicator in patients with CHF. **Figs. 4** and **5** shows an example of recurrent VT/VT in patients with end-stage heart failure (HF).

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