Dig It?

Jeremy M. Parker, MD, Brian P. Wall, MD, Stephen L. Rennynson, MD, Laszlo Littmann, MD
Department of Internal Medicine, Carolinas Medical Center, Charlotte, NC.

PRESENTATION
This case highlights an unusual manifestation of toxicity due to a commonly used medication. The patient was a 90-year-old woman with a history of chronic lymphocytic leukemia, coronary artery disease, and hypertension who presented with abdominal pain, hypotension, and tachycardia. She appeared to be suffering from systemic inflammatory response syndrome and was admitted to the hospital, where she was treated with broad-spectrum antibiotics and intravenous hydration.

On the second night of her hospital stay, the patient developed a rapid, irregular tachycardia. A 12-lead electrocardiogram (ECG) revealed atrial fibrillation with rapid ventricular response (Figure 1). At that time, her serum creatinine, blood urea nitrogen, and potassium levels were 1.4 mg/dL, 43 mg/dL, and 3.8 mmol/L, respectively. Her calcium level was low, at 8.0 mg/dL. She was tachypneic, had bibasilar crackles, and had an elevated level of cardiac B-type natriuretic peptide (5000 pg/mL). A chest X-ray revealed bilateral consolidation and prominent vascular congestion. As the patient’s blood pressure remained at acceptable levels, she did not require vasopressors.

In an effort to control the patient’s heart rate in the setting of acute heart failure, she was loaded with intravenous digoxin given as a 0.5-mg bolus followed 8 hours later by a second dose of 0.25 mg. Because the tachycardia continued, the next morning another 0.5 mg of intravenous digoxin was given, bringing the cumulative dose to 1.25 mg within 18 hours. Shortly after receiving the third dose of digoxin, the patient became lethargic, and another ECG was obtained (Figure 2).

ASSESSMENT
Telemetry indicated wide-complex tachycardia. The 12-lead ECG (Figure 2) revealed a fast, regular heartbeat (142 beats per minute) with 2 separate QRS morphologies alternating. The QRS durations ranged from 120 ms to 140 ms. The ECG findings were consistent with bidirectional ventricular tachycardia, which characteristically manifests as a wide-complex tachycardia with a regular rate concomitant with 2 regularly alternating QRS axes.1,2

DIAGNOSIS
Bidirectional ventricular tachycardia is a rare but easily recognizable condition that is typically associated with digitalis intoxication.1,2 Although bidirectional ventricular tachycardia also has been described in connection with a variety of other conditions, including hypokalemic and hyperkalemic periodic paralysis, certain structural heart diseases, familial sudden death syndrome, and even aconite poisoning,3 it should immediately raise the clinical suspicion of digitalis toxicity.3 Our patient’s serum digoxin level 15 hours after recording of the bidirectional ventricular tachycardia was markedly elevated at 4.20 ng/mL, confirming digitalis intoxication.

The cardiovascular effects of digitalis are multifold, and its toxicity has been linked to a variety of bradyarrhythmias and tachyarrhythmias.4,5 It has a parasympathetic effect that results in suppression of sinu nodal and atrioventricular nodal function and shortening of the atrial refractory period. At the cellular level, digoxin functions at the level of the sodium-potassium adenosine triphosphatase pump on cardiac cell membranes. Poisoning of the pump by digoxin leads to an increase in intracellular sodium, which in turn triggers an increase in intracellular calcium. The increased level of calcium may induce delayed afterdepolarizations, oscillations in the transmembrane potential that follow full repolarization of the membrane. When the amplitudes of these oscillations reach a threshold value, they can initiate triggered activity.6 Some of the digitalis-associated toxic tachyarrhythmias, such as atrial tachycardia with block, nonparoxysmal junctional tachycardia, and ventricular tachycardia
(including bidirectional ventricular tachycardia), might be related to both increased automaticity and delayed after-depolarization–induced triggered activity.4-6

One must take into account the renal function and the age of the patient when dosing digoxin or diagnosing digitalis toxicity. Impaired creatinine clearance can certainly elevate the risk of toxicity, and increased age in and of itself can play a role in enhancing the toxic side effects.7 In the present case, our patient’s advanced age, decreased renal function, and very high digoxin doses contributed to precipitate the toxicity.

**MANAGEMENT**

Initially, bidirectional ventricular tachycardia often can be managed supportively, since patients are frequently asymptomatic. If the tachycardia is a result of digitalis intoxication, discontinuation of digoxin is a must, and levels of digoxin, as well as potassium, magnesium, and calcium, should be monitored. Efforts should be made to return potassium levels to normal range. Acute oral digoxin intoxication can be treated with charcoal. Hemodialysis is ineffective in clearing the drug secondary to a large volume of distribution.5

If the abnormal rhythm persists or if the patient becomes hemodynamically unstable, then digoxin-specific Fab antibody fragments should be used to reverse toxicity. This treatment also should be considered in the setting of severe hyperkalemia with concomitant dysrhythmia.5 Because the laboratory assay for digoxin cannot distinguish unbound (active) digoxin from antibody-bound (inactive) digoxin, the patient’s digoxin level can no longer be meaningfully followed after administration of Fab fragments.

Because her bidirectional ventricular tachycardia resolved spontaneously, the patient did not receive Fab fragments. Her arrhythmia converted to sinus rhythm with first-degree atrioventricular block. Several days

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**Figure 1** ECG showing atrial fibrillation with rapid ventricular response.

**Figure 2** ECG showing bidirectional ventricular tachycardia. Note the regular wide-complex tachycardia with alternating upward and downward QRS complexes best seen in lead I. Fusion complexes are also present.
later, the patient unfortunately succumbed to multi-organ failure in response to overwhelming infection, and she ultimately expired.

References