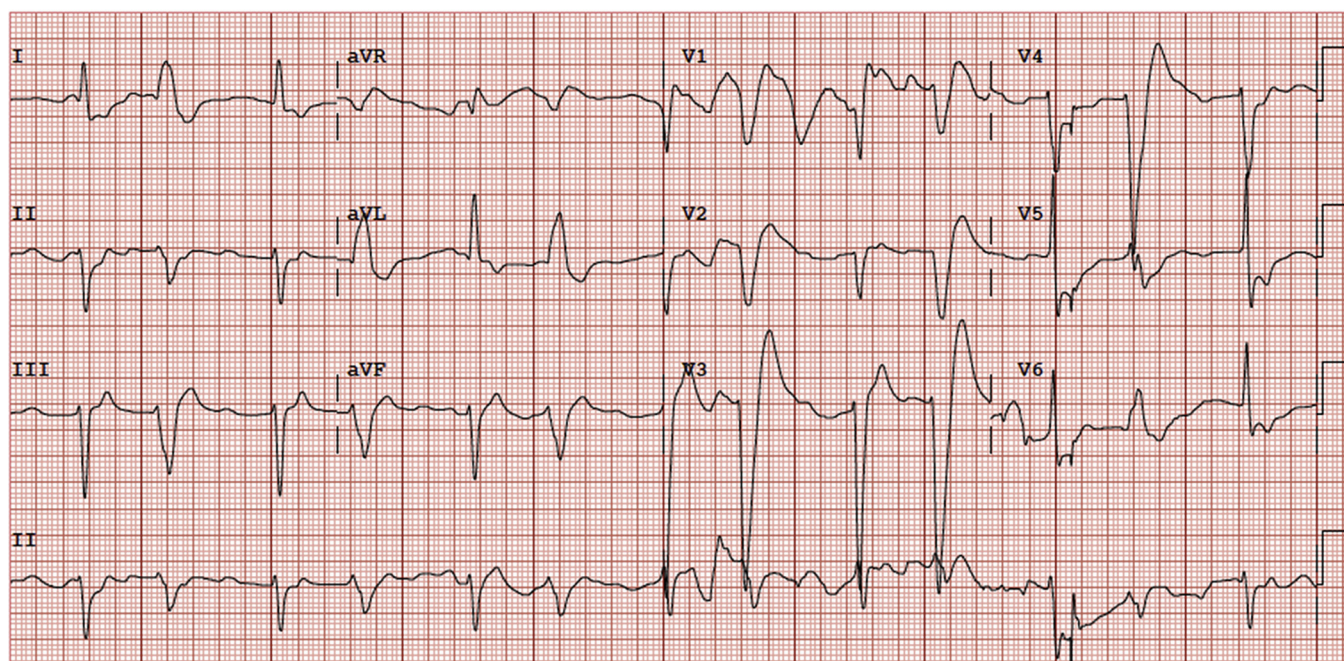


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0196-0644/\$-see front matter

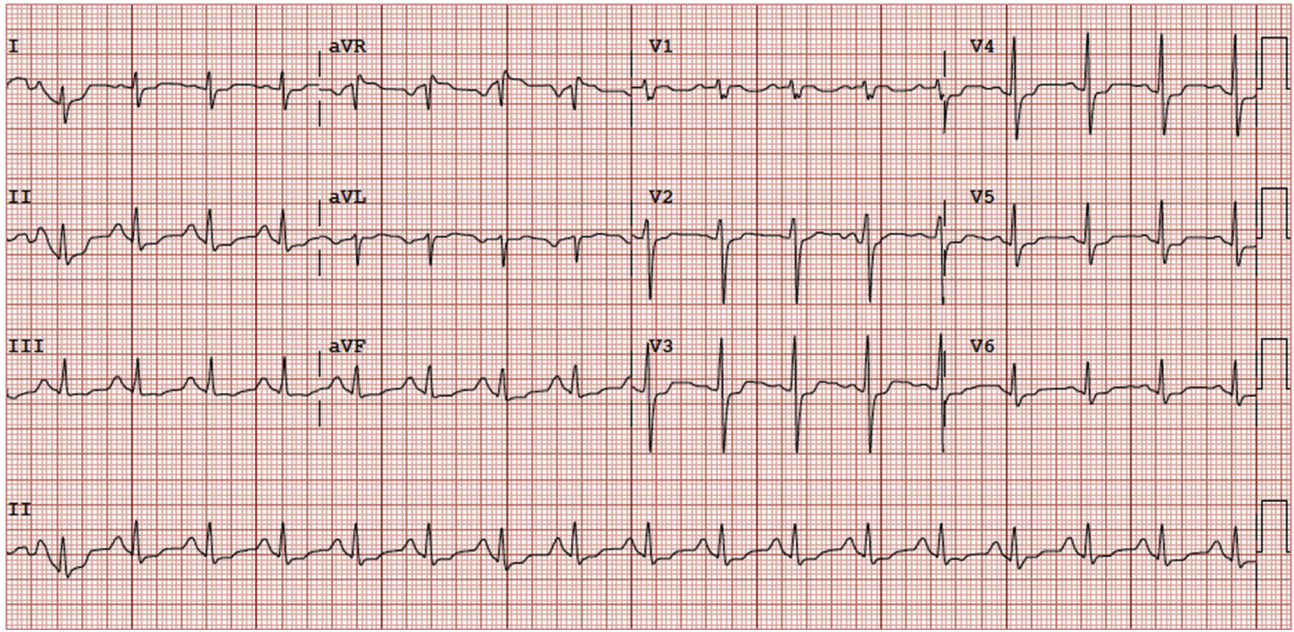
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<http://dx.doi.org/10.1016/j.annemergmed.2015.05.010>**Figure 1.** ECG on presentation.

[Ann Emerg Med. 2015;66:363.]

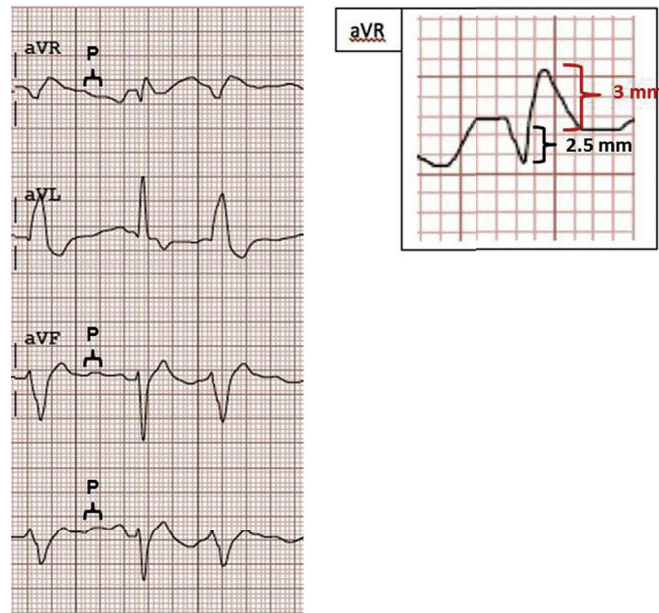
A 25-year-old female was brought to the emergency department (ED) by ambulance in status epilepticus. She had no history of seizures or recent trauma, and her blood sugar was normal. Her blood pressure was 81/40 and her pulse rate was 84. The following electrocardiogram (ECG) was obtained (Figure 1).

*For the diagnosis and teaching points, see page 366.  
To view the entire collection of ECG of the Month, visit [www.annemergmed.com](http://www.annemergmed.com)*



**Figure E1.** ECG after initial treatment with bicarbonate. Note the PR of 102, the PR interval of 180, the QRS duration of 110 msec, and the decreased prominence of the R' in aVR. Diffuse ST-segment depressions may be due to profound hypokalemia of 2.1 mEq/L.





**Figure 2.** Enlargement of ECG on presentation. Lead aVR demonstrates a prominent R' of 3 mm with an R/S ratio greater than 0.7.

## ECG OF THE MONTH

*(continued from p. 363)*

### INTERPRETATION:

The ECG reveals an irregular rhythm with wide QRS complexes at an overall rate of 84. Although there was initial concern for ventricular tachycardia, the first 6 QRS complexes of the rhythm strip reveal a pattern of bigeminy. An initial P wave was followed by a prolonged PR interval and widened QRS complex of 120 msec. This first QRS likely resulted from a conducted atrial depolarization. The subsequent QRS complex lacks a preceding P wave, has a different morphology, and has a much longer duration of 400 msec. This second QRS is most likely a premature ventricular complex. There is a compensatory pause, and then the pattern of paired QRS complexes is repeated 2 more times before artifact obscures the analysis.

The rhythm strip indicates that the narrower QRS complexes represent the conducted atrial beats and should be used for analysis of QRS abnormalities. In lead aVR, the second QRS complex is narrowest at 120-msec duration and displays a prominent R' of 3 mV and an R/S ratio greater than 0.7 (Figure 2).

### CLINICAL COURSE

The concern for ingestion was high, given the presentation of seizures, hypotension, and widened QRS. The patient was treated with several doses of intravenous bicarbonate, resulting in immediate narrowing of her QRS and improvement of her blood pressure (Figure 2). She was intubated for airway protection. Her potassium level was 2.1 and repletion was begun. Given recurrence of QRS widening and hypotension that was poorly responsive to vasopressor treatment, intravenous lipid emulsion of 20% was administered in consultation with the poison control center. Within 1 hour, a repeated ECG revealed sinus tachycardia and narrowing of the QRS (Figure E1, available at [www.annemergmed.com](http://www.annemergmed.com)). After extubation, the patient admitted to an intentional overdose of diphenhydramine, which was corroborated by the family's finding an empty bottle of Benadryl near the patient.

## DISCUSSION

An ECG with artifact is often the norm in the emergency setting. In the emergency setting, recognition of the critical ECG findings despite the presence of baseline artifact can be crucial, as in this case. The findings of this ECG are suggestive of sodium channel blockade toxicity, which is most commonly associated with a tricyclic antidepressant or diphenhydramine overdose. Other agents include other antihistamines, other antidepressants (escitalopram), antiarrhythmics (eg, quinidine, procainamide, flecainide), local anesthetics (eg, lidocaine, bupivacaine), propranolol, antiepileptics (eg, carbamazepine, phenytoin), chloroquine, cocaine, marine toxins (eg, saxitoxin, tetrodotoxin), neuroleptics (thioridazine), and propoxyphene. Hyperkalemia can present with similar findings.

Diphenhydramine is a first-generation H1 antagonist with anticholinergic and sedative effects. Overdose can result in sinus tachycardia, or, with higher doses, wide complex tachycardia and bundle-branch blocks caused by inhibition of fast sodium channels. Potassium channel inhibition—observed experimentally in diphenhydramine overdose<sup>1</sup>—can lead to QT-interval prolongation and emergence of T- or U-wave abnormalities, predisposing to polymorphic ventricular tachycardia.

The finding of a QRS duration greater than 100 msec, or aVR with a terminal R wave greater than 3 mm, or an R/S ratio greater than 0.7 in aVR should raise suspicion for toxicity from sodium channel blockade. A study of 79 patients with tricyclic antidepressant overdose found that the sensitivity for predicting seizure or arrhythmia was 81% for an R' wave in aVR of 3 mm and 75% for an R/S ratio in aVR of 0.7 or more.<sup>2</sup> Additional findings consistent with diphenhydramine overdose include right-sided axis deviation and S waves in leads I and aVL. Blunting of the vagal response because of anticholinergic effects causes unopposed sympathetic response, resulting in tachycardia.<sup>3</sup> This patient's initial ECG result met many of the criteria for sodium channel blockage, including dominant R wave in aVR with R/S ratio greater than 0.7, S waves in I and aVL, widened QRS, and dysrhythmias. However, the patient was initially noted to be relatively bradycardic (with a pulse rate between 80 and 90 beats/min), a finding noted to occur with massive sodium channel blockade.<sup>4</sup> These atypical findings may also be correlated with the patient's significant hypokalemia of 2.1 mEq/L. ECG findings corrected to normal after treatment with bicarbonate, lipid infusion, and correction of underlying hypokalemia.

## PEARLS

- In a young patient with a wide QRS-complex rhythm, consider ingestion, particularly overdose of sodium channel-blocking agents such as tricyclic antidepressants or diphenhydramine.
- ECG findings of significant sodium channel blocker toxicity include QRS duration greater than 100 ms and findings in lead aVR of an R' wave greater than 3 mm or an R/S ratio greater than 0.7.
- Empiric treatment with bicarbonate (100 mEq, or 1 to 2 mEq/kg) is safe and can be diagnostic as well as therapeutic in the setting of sodium channel-blocking agent toxicity. Administration of lipid emulsion may aid in the resuscitation of hemodynamically unstable patients due to an overdose of a lipophilic drug such as diphenhydramine.

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