American Journal of Emergency Medicine 37 (2019) 562.e5–562.e10

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Case Report

# Treatment of caffeine toxicity with metoprolol☆

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ARTICLE INFO

*Article history:*
Received 7 August 2018
Received in revised form 20 November 2018
Accepted 24 November 2018

*Keywords:*
Caffeine
Metoprolol
Supraventricular tachycardia
Suicide
Adenosine
Toxicology

ABSTRACT

A 27-year-old man presented with an intentional overdose of concentrated caffeine powder that he bought over the internet. The patient received benzodiazepines and ondansetron for symptomatic treatment when he arrived in the Emergency Department (ED). Subsequently, he developed recurrent supraventricular tachycardia in the ED. The SVT was successfully treated with metoprolol. The patient's caffeine level was >90 mg/L. This is the first known report of treatment of caffeine-induced supraventricular tachycardia with metoprolol.



## 1. Introduction

Caffeine is a ubiquitous substance consumed by man. Coffee, tea, cocoa are all entrenched in many aspects of human culture ranging from the local coffee shop, formal tea ceremonies, and chocolate festivals all over the world. The history of caffeinated food and drink began with natural ingredients, but in recent years it has evolved into artificially-enhanced items with higher levels of caffeine such as "energy drinks". These newly-created caffeine-enhanced items have led to more cases of intentional and unintentional caffeine intoxications in the U.S. [1,2]. In addition, the sale of concentrated caffeine powder began to appear in stores and the internet. These high-dose packages of caffeine are not regulated by the FDA and are sometimes misused [3].

Caffeine has various effects on the body; perhaps foremost are its effects on the neurologic and the cardiovascular systems. Caffeine is commonly consumed to maintain alertness and its cardiovascular effects are well known. "Usual" doses of caffeine appear to have little or no adverse effect on the cardiovascular system [4-6], while arrhythmias and cardiovascular deaths from excessive caffeine are well documented, although some cases involve co-ingestions such as MDMA [7,8]. We present a patient with a recurrent supraventricular tachycardia (SVT) that occurred after an intentional caffeine overdose.

## 2. Case narrative

A 27-year-old man with a history of schizophrenia and bipolar disorder was brought in by his family for an intentional caffeine overdose. The patient's family was concerned when the patient told them that at about 05:00 that morning, he took a "lethal dose" of a caffeine powder he ordered over the internet. The patient endorsed feeling down and depressed over the past few months. His family stated he has been talking openly about suicide, but he had never made a suicide attempt in the past and they did not think he would. The exact time, amount, and type of ingestion were unclear. The patient presented to the Emergency Department with a complaint of chest pain, palpitations, and feeling "worse and worse", stating he does not want to "go out like this".

At triage at 06:57, his vital signs included a heart rate of 112 beats per minute, respiratory rate of 18 breaths per minute, blood pressure of 126/72 mmHg, and temperature of 36.4C (97.5 F). His room-air oxygen saturation was 99%. The physical examination was largely unremarkable except for his general appearance and tachycardia. The patient was retching, tremulous, and appeared anxious. He appeared well when he was not vomiting. His eyes, tympanic membranes, and oropharynx were normal. The lungs were clear and heart sounds were tachycardic without murmurs or gallops. The abdomen was soft and non-tender. He had slight fine tremors in his hands. The patient was alert, oriented, and ambulatory. The patient's stated weight was 86 kg.

The patient was placed on a cardiac monitor and 1:1 observation. When initially approached by the triage physician and nurse, the patient was agitated, diaphoretic, anxious, and tremulous. He would not tolerate IV placement. After discussion with the patient and his family, he was sedated with 2 mg of lorazepam intramuscularly.

☆ This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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https://doi.org/10.1016/j.ajem.2018.11.038
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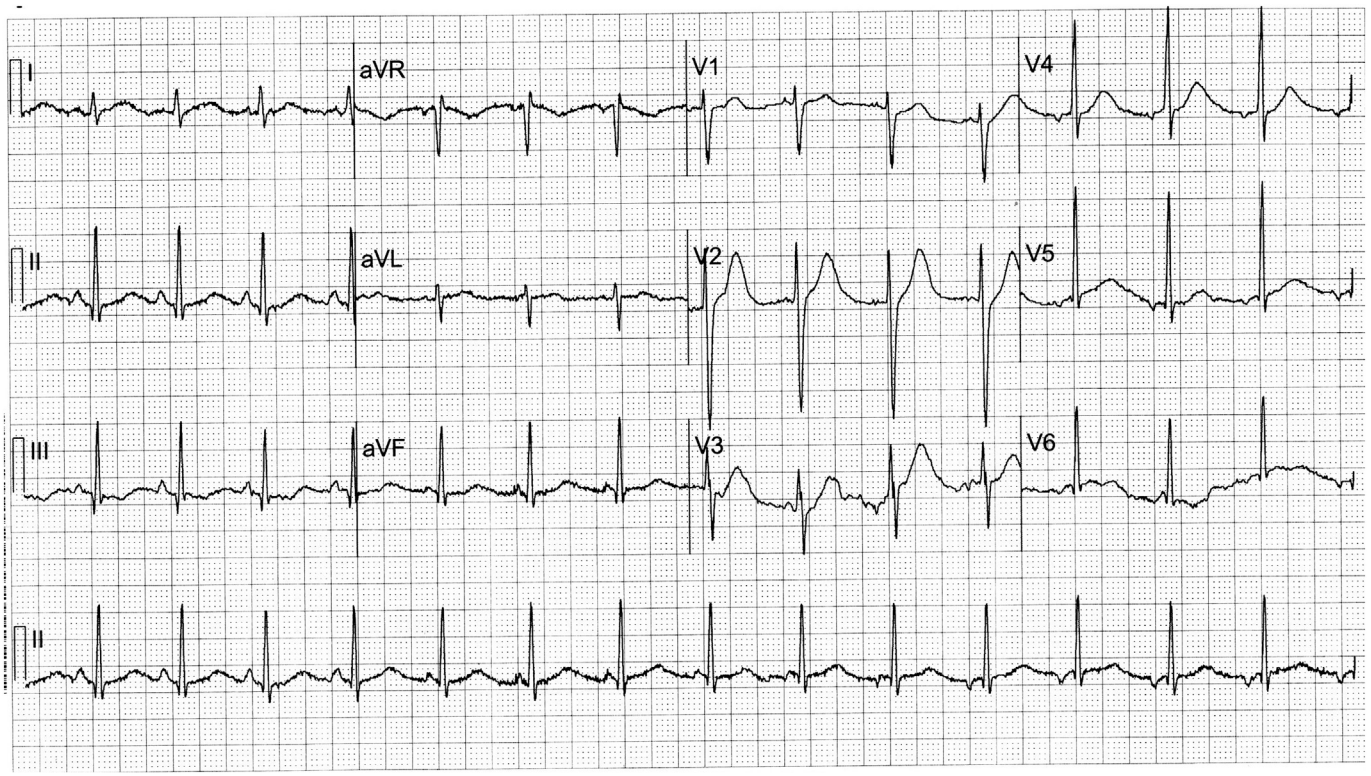


**Fig. 1.** The patient's EKG on presentation.

An intravenous (IV) catheter was placed and lab tests were sent. An electrocardiogram (EKG) was performed (Fig. 1). The patient was given a one-liter bolus of normal saline and 4 mg of intravenous ondansetron for his nausea. The family was asked to bring the caffeine powder to the Emergency Department (ED) or take a cell phone photo of the substance.

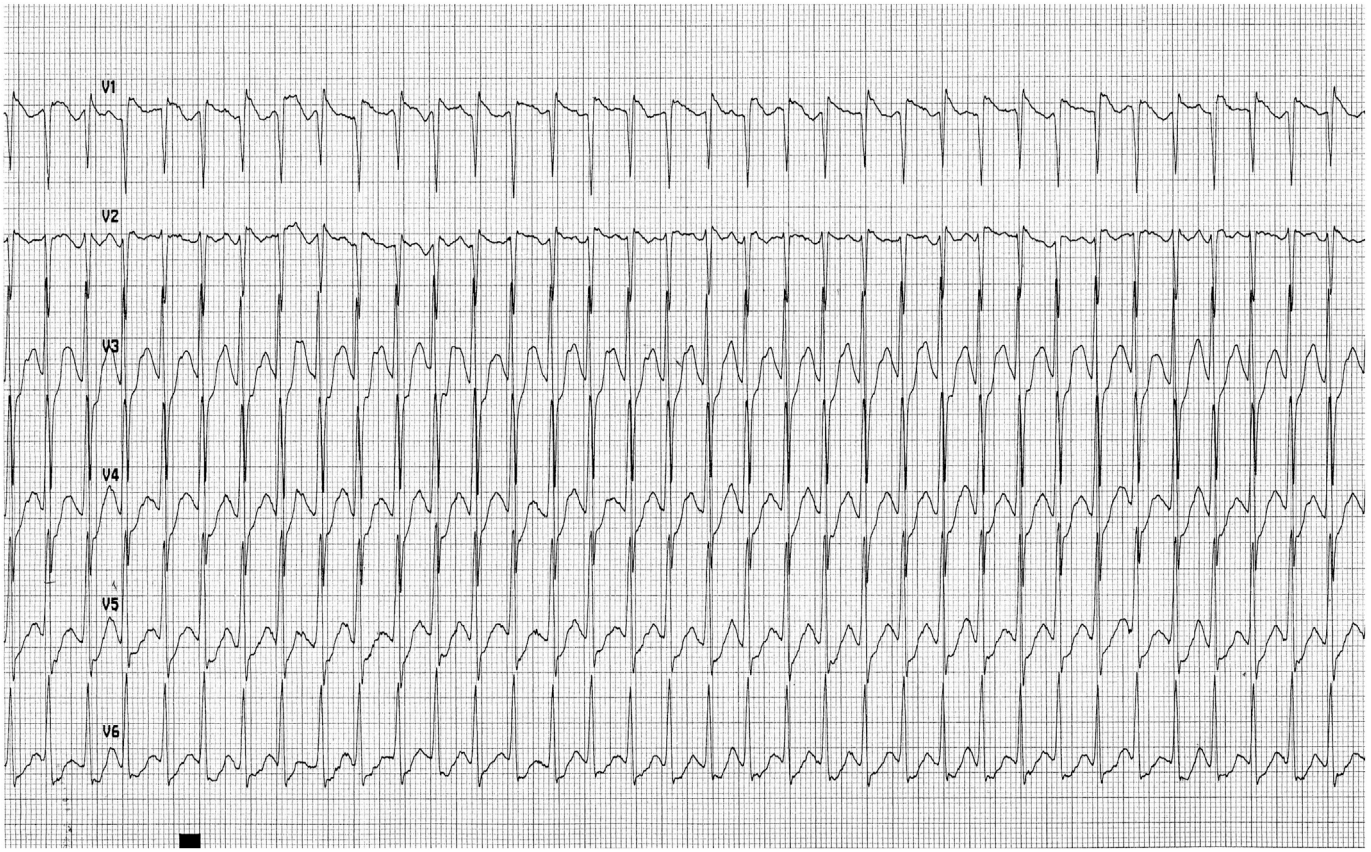


**Fig. 2.** The patient's EKG 2.5 hours after arrival.

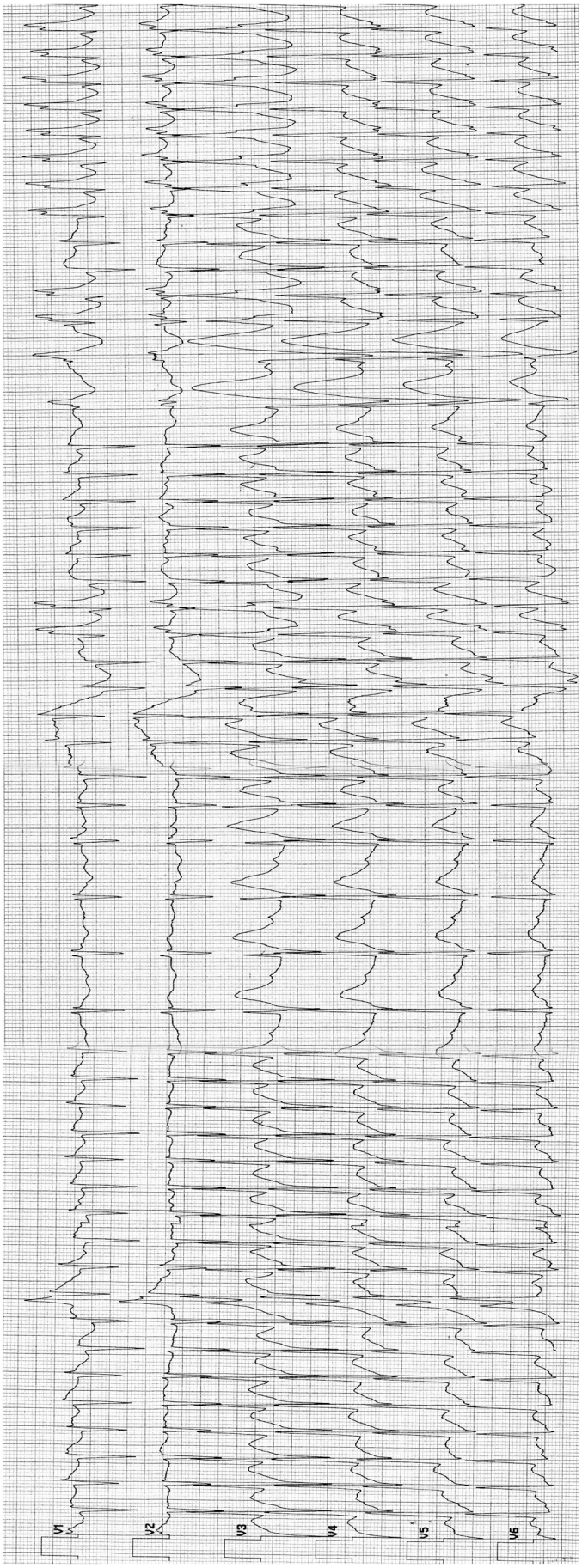


**Fig. 3.** Brief resolution of the SVT after adenosine.

At approximately 09:30, the patient's heart rate was noted to have escalated to a rate of 190. The cardiac monitor showed a fast, regular, narrow rhythm (Fig. 2). The patient complained of chest pain and palpitations at that time. He had a strong pulse and his blood pressure was 95/65 mmHg.

The patient was given a rapid bolus of 6 mg of adenosine IV at 09:41. There was no effect on the SVT. The patient was then given 12 mg of adenosine as a rapid IV bolus. There was a very brief resolution of the SVT for approximately ten seconds but the patient immediately went back into the SVT (Fig. 3). The patient was then given 12 mg of adenosine intravenously followed by 5 mg of metoprolol intravenously. The patient's SVT stopped and he returned to sinus rhythm (Fig. 4). The arrhythmia terminated at 9:53 am. The patient was then given a dose of metoprolol 50 mg orally. At approximately 10:00 am, the patient relapsed into his SVT. He was given another dose of adenosine of 12 mg with metoprolol of 5 mg intravenously, and again his SVT stopped. The patient received an additional 4 mg of ondansetron for his nausea. The patient had no further episodes of arrhythmia while in the ED.

The patient's lab results are showed in Table 1. The most significant findings were hypokalemia, hyperglycemia, leukocytosis, and a slightly elevated anion gap. The patient received oral and intravenous potassium repletion.

The family returned with a photo of the caffeine powder (Fig. 5). The product contained 50 g of pure caffeine. The patient's serum caffeine level (as drawn approximately 24 h after presentation) was >90 mg/L.

The patient was admitted to cardiac care unit for observation. He had no further SVTs during his hospitalization. He was given activated charcoal orally (25 g twice) and intravenous saline. The patient received additional potassium and magnesium supplementation. His labs were otherwise notable for CK of 17,767 U/L, lactate of 9.8 mEq/L, and a urine toxicology screen for barbiturates, benzodiazepines, cocaine metabolites, methadone, and opiates was negative. After three days, he was transferred to the psychiatric ward. He was hospitalized for approximately one month.

## 3. Discussion

Caffeine is a methylxanthine, part of a class of stimulants that include theophylline, a medication once commonly prescribed to treat asthma, and theobromine, found in cocoa and chocolate. It is perhaps the world's most commonly-ingested stimulant given its omnipresence in coffee, tea, chocolate, and other foods. Caffeine has several known mechanisms of action. It is a primarily a sympathomimetic through the release of endogenous catecholamines [9]. In healthy volunteers, caffeine ingestion raises serum catecholamine levels [10]. Methylxanthines are also structural analogs of adenosine and function pharmacologically as an adenosine antagonist. There is a wide range of illness severity among ED visits related to caffeine. Patients may present with mild tremulousness, shock, or cardiac arrest [3,7,8,11-16].

Supraventricular tachycardia refers to a broad range of arrhythmias which include sinus tachycardia, atrial flutter, and reentry tachycardias. Most types of SVTs have a reentry mechanism which can be triggered by precipitating factors such as caffeine or alcohol intake [17]. Reentry arrhythmias are caused by the presence of abnormal electrical circuits which are often catecholamine-dependent [18–20]. The precise mechanism of caffeine induction of SVT is uncertain. Caffeine overdoses may cause an SVT through its role as an adenosine antagonist or as a sympathomimetic. In our patient, the tachycardia was a reentry arrhythmia, so the latter mechanism may be more likely. There are several reports of tachyarrhythmias associated with caffeine in the literature, but most reports involve ventricular arrhythmias [7,8,11-16]. Most patients sickened by caffeine present with sinus tachycardia, but nearly all arrhythmias have been reported.

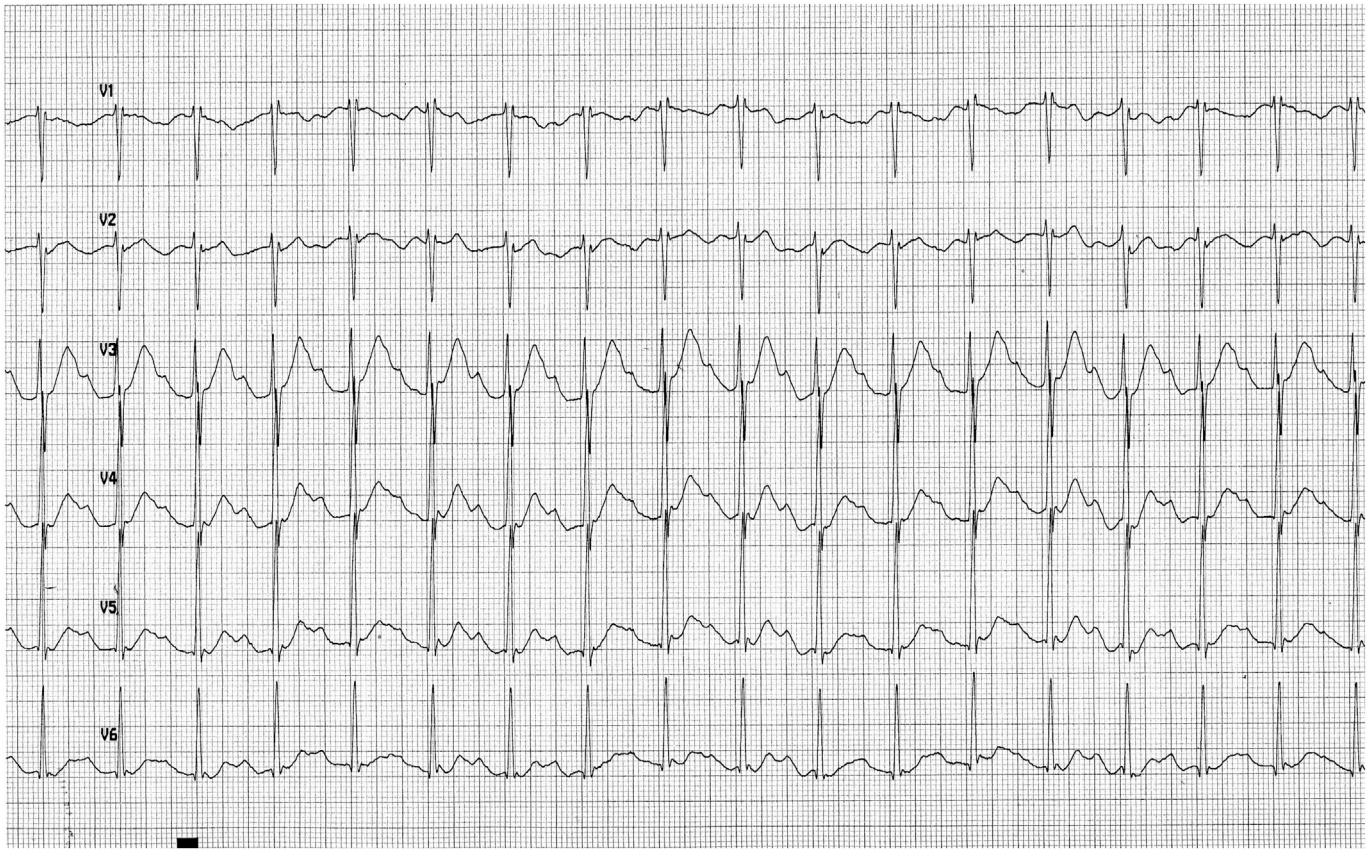


**Fig. 4.** Resolution of the SVT after metoprolol.

**Table 1**
The patient's laboratory results.

| | | Range |
|---|---|---|
| WBC | 25.1 (/nL) | 3.9–10/6 |
| Hgb | 13.8 (g/dL) | 13.5–17.5 |
| Plt | 300 (/nL) | 150–440 |
| Na | 141 (mEq/L) | 135–145 |
| K | 3.0 | 3.5–5.0 |
| Cl | 100 | 98–108 |
| CO2 | 22.5 | 24–30 |
| BUN | 12 | 5–26 |
| Creat | 1.1 | 0.1–1.5 |
| Gluc | 211 | 70–105 |
| Ca | 8.9 | 9.0–11.0 |
| AG | 18.5 | <13.9 |
| CK | 250 (U/L) | 5–150 |
| Caffeine | >90.0 mg/L | |

Management options of narrow-complex reentry SVTs include various vagal maneuvers, adenosine, calcium-channel-blockers, beta-blockers, and cardioversion [18]. Adenosine and calcium-channel-blockers are commonly used in the ED. A 2017 meta-analysis found their effectiveness and adverse events to be similar [21]. Several studies suggest that beta-blockers are less efficacious in termination of SVTs despite the often catecholamine-dependent nature of the arrhythmia [22–24]. In tachyarrhythmias caused by catecholamine excess from caffeine overdose, beta-blockers may be more efficacious [3,14]. However, treatment of caffeine-associated arrhythmias is complicated by the lack of controlled trials and a limited number of case reports. In addition, most case reports describe patients who received many anti-arrhythmic agents, and it is difficult to ascertain the efficacy of individual drugs.

Treatment of caffeine overdose is largely directed toward the patient's symptoms and clinical condition. Benzodiazepines are recommended for agitation and sinus tachycardia. Alpha-agonists and beta-antagonists are recommended in cases of shock [9]. Adenosine is commonly used in supraventricular tachycardia, but it may be ineffective in caffeine-related supraventricular tachycardias because of caffeine's action as an adenosine antagonist. One study suggests that routine caffeine use may make supraventricular tachycardias adenosine-resistant [25].

In our case, it was initially unclear what the patient had ingested. His presentation suggested the use of a sympathomimetic. It became evident as the patient developed increasing anxiety, hypokalemia, and SVT refractory to adenosine that his methylxanthine exposure was significant. Administration of adenosine was largely ineffective and the conversion to sinus rhythm was only transient. Typically, adenosine "breaks" SVTs and the patient returns to sinus rhythm and maintains sinus rhythm without further treatment. The use of metoprolol, a longer-acting beta-antagonist, terminated the SVT and resulted in a sustained cardioversion. This case report illustrates the safety and success of caffeine-related SVT using metoprolol.


**Fig. 5.** A cell-phone photo of the caffeine packet.

Caffeine remains largely an unregulated industry in the United States. The potential dangers of concentrated caffeine powder have led to public scrutiny and an FDA alert in the past [26]. Cases of toxicity and deaths from concentrated caffeine powder are sparse in the literature, likely due to the product's relative novelty. Concentrated caffeine powder has the potential to be a significant public safety hazard given its easy accessibility, potency, and difficulty in treatment. Successful suicides of purchases over the Internet have occurred [27-29], and this case would be received very differently by the media and regulatory agencies if the patient suffered a worse outcome. This case illustrates a common presentation of caffeine toxicity, and suggests that metoprolol may be a safe, effective treatment for caffeine-induced SVT.

In summary, in a patient with supraventricular tachycardia after an intentional caffeine overdose, metoprolol alone or the combination of adenosine-metoprolol may be an effective treatment, and may be an alternative to intravenous infusions of esmolol.

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