



## POCUS Corner

# Transient Right Ventricular Failure from Intravenous Injection of Methylphenidate Tablets

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Methylphenidate (MPH) is a sympathomimetic stimulant used to manage adult narcolepsy and attention deficit hyperactivity disorder (ADHD), which is frequently abused. We present the case of a 37-year-old female who developed acute right ventricle (RV) failure after the self-injection of IV MPH. While difficult to prove causation, the temporal relationship between self-injection and symptom onset suggests a role for MPH in this patient's acute RV failure. Other causes for acute RV failure were ruled out: she had no prior history of PH, ECG was not consistent with ischemia, computed tomography angiography (CTA) was negative for pulmonary embolism (PE), and Right heart catheterization (RHC) was not consistent with left ventricular failure. While there are case reports of persistent PH with chronic IV MPH use, this case describes the only reported incident of transient acute RV failure after IV MPH use.

## CASE PRESENTATION

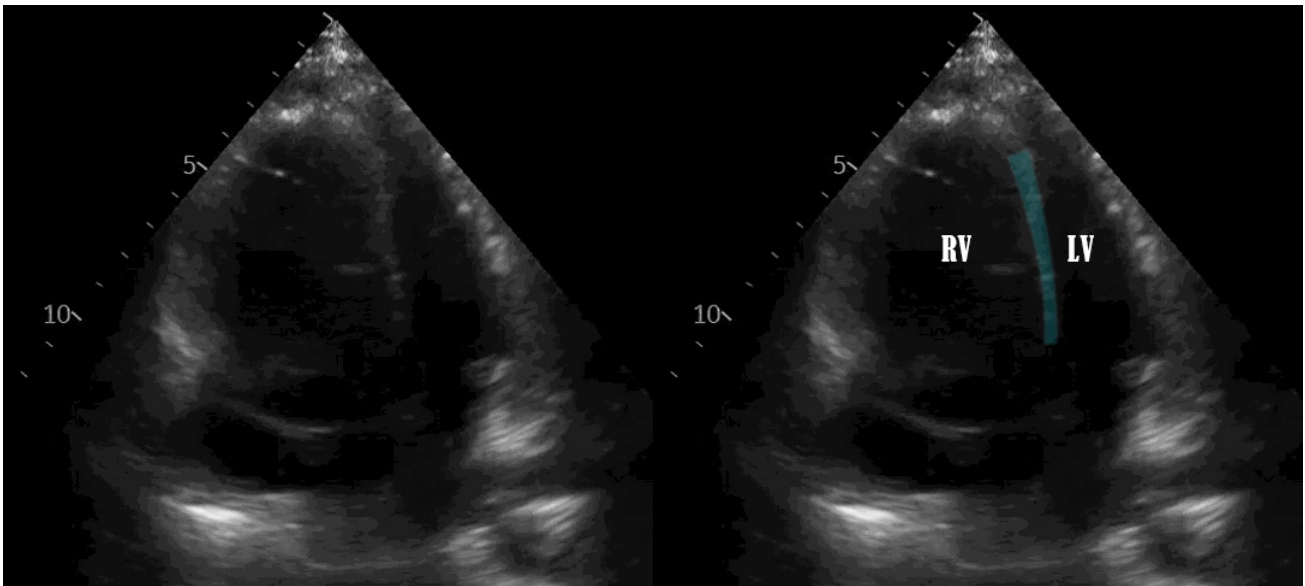
A 37-year-old female with gastroparesis and attention deficit hyperactivity disorder presented with weight loss and was admitted for severe protein-calorie malnutrition. On day 10 of admission, she had unwitnessed syncope with associated tachycardia, hypotension, and hypoxia. She received intravenous (IV) fluids without improvement and was transferred to the intensive care unit. A chest X-ray showed bilateral reticular opacities suggestive of airway inflammation. Her electrocardiogram (ECG) was notable for sinus tachycardia with diffuse non-specific ST and T-wave abnormalities. Troponin T was elevated at 0.324 ng/ml (normal <0.029 ng/mL), and NT-pro-BNP was high at 1581 pg/mL. A bedside echocardiogram showed RV systolic failure, RV dilation, and interventricular septal bowing ([Figure 1](#)). Computed tomography angiography (CTA) was negative for pulmonary embolism (PE). Right heart catheterization (RHC) revealed elevated pulmonary artery pressure, low mixed-venous oxygen saturation, and normal pulmonary capillary wedge pressure, suggestive of RV failure from acute pulmonary hypertension (PH) ([Table 1](#)). A nurse identified a foreign syringe among the patient's belongings, and she admitted to crushing MPH pills and self-injecting into her midline catheter before her syncopal episode. Her symptoms resolved after 3 days of supportive care. A repeat echocardiogram showed normal RV size and systolic function.

## DISCUSSION

Methylphenidate (MPH) is a frequently abused stimulant. We present a case of transient right ventricle (RV) failure

after injection of MPH. MPH is a central nervous system sympathomimetic stimulant used to treat adult narcolepsy and attention deficit hyperactivity disorder (ADHD). It is commonly abused by high school and college students, both those who have been prescribed it and those who obtain it illegally, with the majority of documented cases happening in individuals with a history of substance abuse disorder.<sup>1-4</sup> The tablets are crushed into a fine powder for nasal inhalation or dissolved into a liquid for intravenous (IV) injection, allowing it to enter the brain quickly and produce an amphetamine-like stimulant effect characterized by brief euphoria, anxiolysis, increased focus, and intellectual capacities.<sup>1,2</sup> This is followed by a "down" period of anxiety and dysphoria.<sup>1</sup> Chronic IV MPH use results in significant weight loss and tolerance effect, requiring higher doses to achieve the desired euphoric effect. This eventually leads to a withdrawal syndrome characterized by abdominal pain, sweating, shivering, nausea, and vomiting.<sup>1</sup> IV MPH has been associated with significant morbidity and mortality with several case reports describing the association with granulomatous lung disease, fatal pulmonary hypertension (PH), cerebral artery occlusion, intracranial hemorrhage, and acute hepatic necrosis.<sup>5-10</sup>

Proposed mechanisms for PH in chronic MPH use include occlusion of pulmonary arterioles by foreign body granulomas, thickening of the small pulmonary arteries and arterioles, and serotonin-mediated pulmonary vasoconstriction.<sup>8</sup> There have been case reports describing pulmonary hypertension with chronic MPH use IV injections and inhalation.<sup>8,11</sup> In this case, the patient admitted to crushing her MPH pills and self-injecting through her midline. This caused line-related upper extremity DVT, gram-positive bacteremia, and an acute rise of pulmonary artery pressure causing acute hypoxic respiratory failure and RV



**Figure 1. Four chamber view echocardiogram showing right ventricle (RV) dilation with bowing of the interventricular septum leading to left ventricle (LV) underfilling.**

**Table 1. Right Heart Catheterization measurements obtained on admission to the intensive care unit.**

Measurement	Value	Normal range
Right atrial pressure	11 mmHg	2-6 mmHg
Right ventricle pressure (systolic/diastolic)	36/9 mmHg	15-30/ 1-7mmHg
Pulmonary artery pressure (systolic/diastolic)	38/18 mmHg	15-30/ 8-15 mmHg
Pulmonary artery mean pressure	27 mmHg	9-18 mmHg
Pulmonary capillary wedge pressure	8 mmHg	6-12 mmHg
Pulmonary artery mixed venous O <sub>2</sub> saturation	56%	70%-75%

failure. This was evidenced by echocardiographic findings and right heart catheterization. While difficult to prove causation, the temporal relationship between self-injection and symptom onset suggests a role for MPH in this patient’s acute RV failure. Other causes for acute RV failure were ruled out: she had no prior history of PH, ECG was not consistent with ischemia, CTA was negative for PE, and RHC was not consistent with left ventricular failure. While there are case reports of persistent PH with chronic IV MPH use, this case describes the only reported incident of transient acute RV failure after IV MPH use. In conclusion, the case highlights the importance for health care providers to be familiar with the manifestations of MPH abuse.

DISCLOSURES/CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

AUTHOR CONTRIBUTION

All Authors have reviewed the final manuscript prior to submission. All the authors have contributed significantly to the manuscript, per the ICJME criteria of authorship.

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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## REFERENCES

1. Imbert B, Cohen J, Simon N. Intravenous abuse of methylphenidate. *J Clin Psychopharmacol*. 2013;33(5):720-721. doi:10.1097/jcp.0b013e31829839a4
2. Clemow DB. Misuse of Methylphenidate. *Curr Top Behav Neurosci*. 2017;34:99-124. doi:10.1007/7854\_2015\_426
3. Clemow DB, Walker DJ. The potential for misuse and abuse of medications in ADHD: A review. *Postgrad Med*. 2014;126(5):64-81. doi:10.3810/pgm.2014.09.2801
4. Teter CJ, Esteban S, Cranford JA, Boyd CJ, Guthrie SK. Prevalence and motives for illicit use of prescription stimulants in an undergraduate student sample. *J Am Coll Health*. 2005;53(6):253-262. doi:10.3200/jach.53.6.253-262
5. Methylphenidate. *LiverTox: Clinical and Research Information on Drug-Induced Liver Injury*. Published online August 24, 2021. Accessed September 1, 2022. <https://www.ncbi.nlm.nih.gov/ccmain.ohionet.org/books/NBK547941/>
6. Lundquest DE, Young WK, Edland JF. Maternal death associated with intravenous methylphenidate (Ritalin) and pentazocine (Talwin) abuse. *J Forensic Sci*. 1987;32(3):798-801. doi:10.1520/jfs12388j
7. Parran TVJ, Jasinski DR. Intravenous methylphenidate abuse. Prototype for prescription drug abuse. *Arch Intern Med*. 1991;151(4):781-783. doi:10.1001/archinte.1991.00400040119027
8. Lewman LV. Fatal pulmonary hypertension from intravenous injection of methylphenidate (ritalin) tablets. *Hum Pathol*. 1972;3(1):67-70. doi:10.1016/s0046-8177(72)80054-6
9. Levine B, Caplan YH, Kauffman G. Fatality resulting from methylphenidate overdose. *J Anal Toxicol*. 1986;10(5):209-210. doi:10.1093/jat/10.5.209
10. Massello W III, Carpenter DA. A fatality due to the intranasal abuse of methylphenidate (Ritalin). *J Forensic Sci*. 1999;44(1):220-221. doi:10.1520/jfs14440j
11. Schaiberger PH, Kennedy TC, Miller FC, Gal J, Petty TL. Pulmonary hypertension associated with long-term inhalation of "crank" methamphetamine. *Chest*. 1993;104(2):614-616. doi:10.1378/chest.104.2.614