PRS TO CPR

A Toxicologic Review of Modern Performance Enhancement

Angelica Croteau, MD | PGY2

1	**PERFORMANCE-ENHANCING DRUGS COMMONLY CAUSE SYMPATHOMIMETIC TOXIDROME** Tachycardia, hypertension, tremor, diaphoresis, agitation, hyperthermia, and dysrhythmias are common presentations—especially with stimulants and cutting agents.
2	**ANABOLIC STEROIDS CAN TRIGGER ACUTE CARDIAC EVENTS** AAS use is linked to acute coronary syndrome, ventricular dysrhythmias, myocarditis, cardiomyopathy, and sudden cardiac death—even in young athletes without traditional risk factors.
3	**POLYCYTHEMIA IS A MAJOR THROMBOTIC RISK IN AAS USERS** Testosterone and related anabolic agents increase erythropoiesis, raising the risk of stroke, pulmonary embolism, and myocardial infarction.
4	**CLENBUTEROL TOXICITY OFTEN PRESENTS WITH HYPOKALEMIA** As a potent beta-2 agonist, clenbuterol drives potassium intracellularly, producing weakness, palpitations, prolonged QT, and dangerous dysrhythmias.
5	**CAFFEINE OVERDOSE CAN CAUSE VENTRICULAR DYSRHYTHMIAS** Massive caffeine ingestion may lead to ventricular tachycardia, ventricular fibrillation, seizures, rhabdomyolysis, lactic acidosis, and cardiovascular collapse.
6	**MANY “CUTTING STACKS” CREATE SYNERGISTIC TOXICITY** Combining clenbuterol, caffeine, thyroid hormone, yohimbine, stimulants, and diuretics dramatically increases risk for arrhythmias, hyperthermia, dehydration, and electrolyte derangements.
7	**HEPATOTOXICITY IS COMMON WITH ORAL PERFORMANCE ENHANCERS**

	Oral anabolic steroids and certain supplements can cause elevated liver enzymes, cholestatic jaundice, hepatic adenomas, and, rarely, acute liver failure.
8	**PEPTIDES AND "WELLNESS" AGENTS STILL HAVE TOXIC EFFECTS** Sermorelin and NAD+ products may cause hyperglycemia, edema, infusion reactions, tachycardia, metabolic abnormalities, and unpredictable adverse effects from co-administered additives.
9	**BENZODIAZEPINES ARE FIRST-LINE FOR MANY TOXIC PRESENTATIONS** Agitation, stimulant toxicity, severe anxiety, tremor, and seizures related to performance-enhancing agents are often best managed initially with benzodiazepines and supportive care.
10	**A THOROUGH HISTORY IS CRITICAL** Patients frequently underreport supplement and enhancement drug use. Ask specifically about pre-workouts, fat burners, peptides, injections, SARMs, testosterone, and "recovery" infusions.

References

1. Fadah K, Gopi G, Lingireddy A, Blumer V, Dewald T, Mentz RJ. Anabolic androgenic steroids and cardiomyopathy: an update. Front Cardiovasc Med. 2023;10:1214374. doi:10.3389/fcvm.2023.1214374
2. Thiblin I, Petersson A. Pharmacoepidemiology of anabolic androgenic steroids: a review. Fundam Clin Pharmacol. 2005;19(1):27-44. doi:10.1111/j.1472-8206.2004.00298.x
3. Thiblin I, Petersson A. Androgenic anabolic steroid abuse and the cardiovascular system. Handb Exp Pharmacol. 2010;(195):291-339. doi:10.1007/978-3-540-79088-4_18
4. Sculthorpe N, Grace F, Jones P, Davies B. Evidence of altered cardiac electrophysiology following prolonged androgenic anabolic steroid use. Cardiovasc Toxicol. 2010;10(4):239-243. doi:10.1007/s12012-010-9090-y
5. Torrisi M, Pennisi G, Russo I, et al. Sudden cardiac death in anabolic-androgenic steroid users: a literature review. Medicina (Kaunas). 2020;56(11):587. doi:10.3390/medicina56110587
6. Montisci M, El Mazloum R, Cecchetto G, et al. Anabolic androgenic steroids abuse and cardiac death in athletes: morphological and toxicological findings in four fatal cases. Forensic Sci Int. 2012;217(1-3):e13-e18. doi:10.1016/j.forsciint.2011.10.032
7. Hoffman RJ, Hoffman RS, Freyberg CL, Poppenga RH, Nelson LS. Clenbuterol ingestion causing prolonged tachycardia, hypokalemia, and myocardial injury. J Toxicol Clin Toxicol. 2001;39(4):339-344. doi:10.1081/CLT-100105158
8. Nawrot P, Jordan S, Eastwood J, Rotstein J, Hugenholtz A, Feeley M. Effects of caffeine on human health. Food Addit Contam. 2003;20(1):1-30. doi:10.1080/0265203021000007840
9. Cappelletti S, Piacentino D, Sani G, Aromatario M. Caffeine: cognitive and physical performance enhancer or psychoactive drug? Curr Neuropharmacol. 2015;13(1):71-88. doi:10.2174/1570159X13666141210215655
10. Navarro VJ, Khan I, Björnsson E, Seeff LB, Serrano J, Hoofnagle JH. Liver injury from herbal and dietary supplements. Hepatology. 2017;65(1):363-373. doi:10.1002/hep.28813
11. Nelson LS, Howland MA, Lewin NA, Smith SW, Goldfrank LR, Hoffman RS, eds. Goldfrank's Toxicologic Emergencies. 11th ed. McGraw-Hill Education; 2019.
12. Brunton LL, Hilal-Dandan R, Knollmann BC, eds. Goodman & Gilman's The Pharmacological Basis of Therapeutics. 13th ed. McGraw-Hill Education; 2018.
13. Handelsman DJ. Performance enhancing hormone doping in sport. Endocr Rev. 2021;42(6):669-715. doi:10.1210/endrev/bnab015
14. Pope HG Jr, Wood RI, Rogol A, Nyberg F, Bowers L, Bhasin S. Adverse health consequences of performance-enhancing drugs: an Endocrine Society scientific statement. Endocr Rev. 2014;35(3):341-375. doi:10.1210/er.2013-1058