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Profound Vasoplegia after Coronary Artery Bypass Grafting

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Abstract

Vasoplegic shock after cardiac surgery is characterized by a high cardiac output, low systemic vascular resistance, refractory hypotension, and ongoing need for vasopressors. In this case, management considerations are discussed, including vasoactive medications and other adjuncts to sustain a satisfactory mean arterial pressure and improve outcomes.

Keywords: vasoplegic shock, vasopressors, steroids

Case

A 63-year-old man with stage III chronic kidney disease presented with a non-ST elevation myocardial infarction. He was diagnosed with three-vessel coronary artery disease and recommended for urgent coronary artery bypass grafting (CABG). He underwent a difficult CABG x 4 with a long operation; the cardiopulmonary bypass time was 152 minutes, and the cross-clamp time was 123 minutes. Upon coming off cardiopulmonary bypass, he had a mean arterial pressure (MAP) in the 50s mmHg and a cardiac output of 7 L/min. Despite multiple vasoactive medications, his shock was refractory. The best strategies to improve his blood pressure are discussed.

Introduction

High cardiac output, low systemic vascular resistance, and ongoing need for vasopressors characterize post-cardiotomy vasoplegic shock or vasoplegia. With a reported incidence ranging from 10-45% due to heterogeneity in how it is clinically defined, vasoplegic shock is associated with increased mortality. The established risk factors include prolonged cardiopulmonary bypass and cross-clamp time, renal failure, reoperative cardiac surgery, and increased transfusion.[1]

Vasopressors

Most of our knowledge regarding vasopressor use has come from the sepsis literature. The only dedicated randomized trial in cardiac surgery, the Vasopressin versus Norepinephrine in Patients with Vasoplegic Shock after Cardiac Surgery (VANCS) trial, demonstrated that vasopressin as a primary vasopressor compared to norepinephrine showed no survival difference; however, the trial demonstrated a reduced incidence of postoperative atrial fibrillation and renal replacement therapy in the vasopressin group.[2] A large meta-analysis demonstrated that a combination of norepinephrine and vasopressin was generally more beneficial than norepinephrine alone.[3] Vasopressin may be the preferred agent in right ventricular dysfunction due to avoiding increased pulmonary vascular resistance.[4] Moreover, when treating patients with vasopressin, one should consider that about 45% of individuals were characterized as responders while 55% were

not; mortality in the non-responders (72%) was much higher than in the responders (57%).[5] This data favors the early concomitant use of vasopressin with first-line norepinephrine.

For patients with refractory hypotension, angiotensin II has been FDA approved since 2017. In the Angiotensin II for the Treatment of High-Output Shock (ATHOS-3) study of 321 patients, the use of angiotensin II compared to standard vasopressors was superior in achieving the primary endpoint of a 10mmHg increase or increase to > 75mmHg for three hours.[6] In a sub-study analysis of ATHOS-3 among cardiac surgery patients, angiotensin II demonstrated a higher likelihood of achieving the MAP goals and reduced vasopressors over the placebo.[7] It should be noted that in a multicenter trial of real-world use, approximately 67% of patients were angiotensin II responders with better survival than nonresponders (41% vs. 25%).[8] Further insights from recent studies demonstrate that patients with high plasma renin levels responded most favorably to angiotensin II with a greater survival advantage.[9]

Adjunctive Measures

A systematic review of 15 studies and 832 patients demonstrated methylene blue (MB) use in vasoplegic shock halved (OR = 0.54) mortality.[10] Typically, a 2 mg/kg IV bolus followed by an infusion of 0.5 mg/kg for 12 hours is initiated early.[11] Care should be taken to avoid MB in patients taking selective serotonin reuptake inhibitors due to the risk of serotonin syndrome. High-dose hydroxycobalamin or Vitamin B12 has been successfully used as a single 5-gram IV infusion.[12] In patients on hemodialysis, the deep red color of B12 may cause false detection of a "blood leak" on hemodialysis machines requiring temporary conversion to continuous renal replacement therapy.

Using both glucocorticoids[13] and mineralocorticoids[14] for vasoplegic shock has demonstrated hemodynamic and survival benefits. The standard regimen is 200-300 mg of IV hydrocortisone daily and 100 mg of fludrocortisone daily for 5-7 days. Finally, Vitamin C is administered as a 1500 mg dose every six hours with positive hemodynamic effects.[15] Our previous algorithm for vasoplegic shock went from norepinephrine to vasopressin, followed by multiple adjuncts with inconsistent results. (Figure 1).

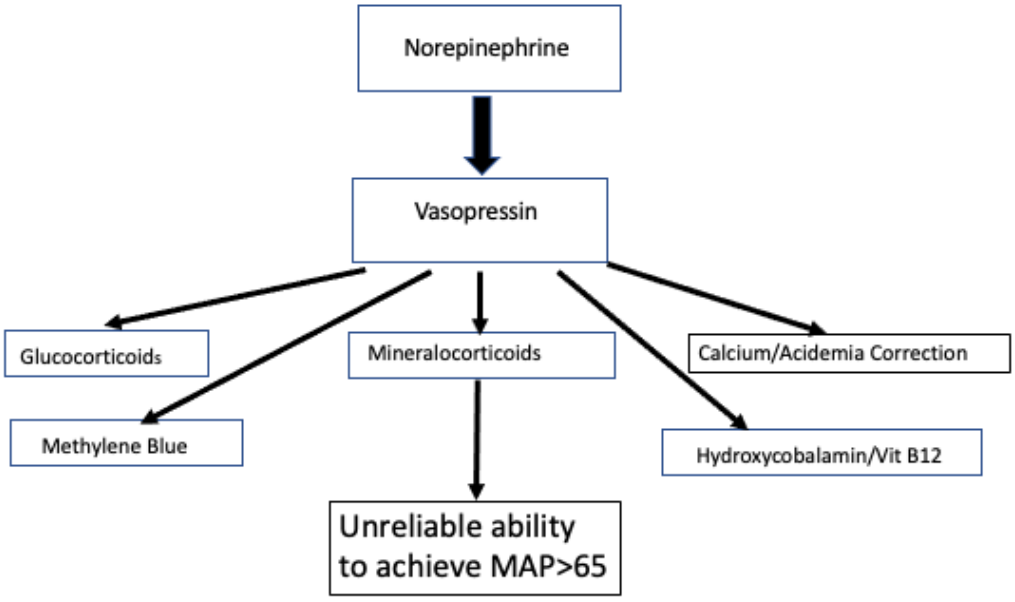

Figure 1: Old strategy for vasoplegic shock. Simultaneous utilization of vasoactive medications and pharmacologic adjuncts with inconsistent ability to achieve a satisfactory mean arterial pressure.

Perioperative Management

For those patients at high risk of vasoplegia, there is mixed evidence on whether angiotensin converting enzyme inhibitors (ACEI) or angiotensin receptor blocker (ARB) medications should be stopped before surgery. The only randomized trial consisted of 121 patients assigned to stopping ACEI/ARBs 48 hours before surgery versus continuation and found no difference in postoperative use of vasoactive medications or incidence of vasoplegic shock.[16] Moreover, vasoactive (milrinone) or sedation (propofol) agents that may exacerbate vasoplegia are discontinued in the intensive care unit. Aggressive management of hypocalcemia and metabolic acidosis should be corrected.

In this patient, after standard norepinephrine and vasopressin were initiated, angiotensin II was administered in the operating room at 20 ng/kg/min with a satisfactory MAP achieved at 40 ng/kg/min. Afterward, MB, hydrocortisone, and fludrocortisone were administered. The patient was weaned off vasopressors in 36 hours and had an unremarkable postoperative course.

Our updated algorithm (Figure 2) uses vasopressors to achieve a satisfactory MAP. Next, adjuncts are individualized to help resolve vasoplegia more quickly.

Conclusion

Vasoplegic shock after cardiac surgery is a common complication. A systematic approach using multiple vasopressors and systemic adjuncts can provide favorable outcomes.

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Disclosures

Dr. Chatterjee has served on advisory boards for Edwards Lifesciences, Eagle Pharmaceuticals, La Jolla Pharmaceutical Company, and Baxter Pharmaceuticals.

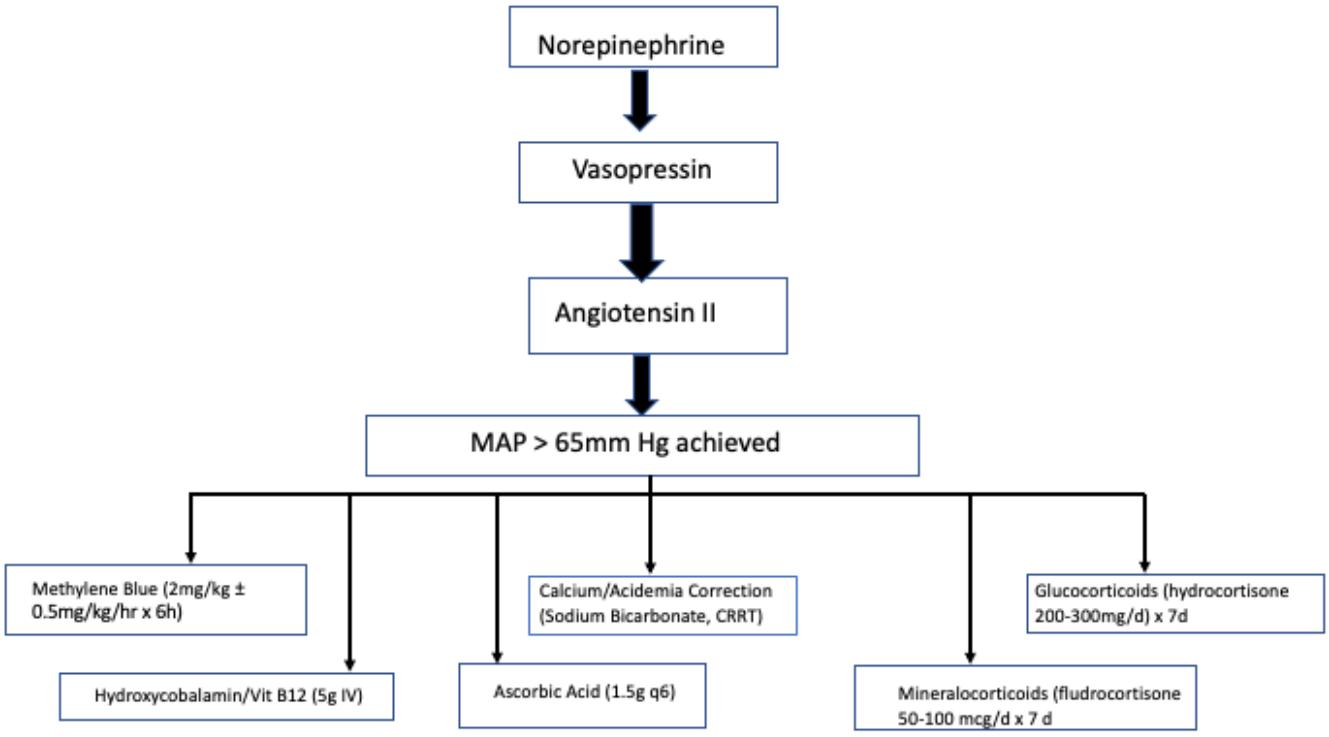

Figure 2: New strategy for vasoplegic shock. Initial escalation of vasoactive medications to achieve a satisfactory mean arterial pressure followed by pharmacologic adjuncts to reduce the period of vasoplegia.

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