Utility of Push-Dose Vasopressors for Temporary Treatment of Hypotension in the Emergency Department

Authors: Lauren J. Tilton, PharmD, MBA, and Kristin H. Eginger, PharmD, BCPS, Gastonia, NC
Section Editor: Allison A. Muller, PharmD, D.ABAT

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Vasopressor agents such as epinephrine, phenylephrine, and norepinephrine are commonly used medications for increasing cardiac output in hypotensive patients.[1] These vasoconstricting medications aid in regulating and maintaining adequate blood pressure (BP) or mean arterial pressure (MAP) in patients who are experiencing shock and are added for temporary BP augmentation when life-threatening hypotension persists despite aggressive fluid resuscitation. Traditionally, vasopressor agents are administered as a continuous infusion through central access; however, these medications can also be administered as a small bolus through peripheral access, which is known in practice as a push-dose vasopressor.

History of Push-Dose Vasopressors

Push-dose vasopressors, also known as push-dose pressors, are regularly used by anesthesia services to temporarily increase BP, usually after administration of sedating medications that cause hypotension. Push-dose vasopressors are also given in the operating room (OR) setting for labor and delivery patients after administration of spinal anesthesia. Many women experience drops in BP after administration of the spinal anesthesia, and therefore the use of bolusing vasopressors has become very common for this patient population to treat transient hypotension.

Lauren J. Tilton is Clinical Pharmacist at Carolinas HealthCare System - Blue Ridge, Morganton, NC.

Kristin H. Eginger is PGY2 Emergency Medicine Residency Program Director and Emergency Medicine Clinical Pharmacist, CaroMont Regional Medical Center, Gastonia, NC.

For correspondence, write: Lauren J. Tilton, PharmD, MBA, Carolinas HealthCare System - Blue Ridge, 2201 S. Sterling Street, Morganton, NC 28655; E-mail: LaurenTilton0606@gmail.com.

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Several studies published during the past decade support the safe and efficacious use of push-dose vasopressors in patient populations encountered in the OR and labor/delivery arena (Table 1).[2–4] This practice has recently transitioned to the emergency department to treat transient hypotension. Although push-dose vasopressors are commonly utilized in many emergency departments, as of the time this article was submitted for publication, there had not been any published literature demonstrating the efficacy and safety of push-dose pressor use in the emergency department. However, several emergency medicine–focused blogs support the use of push-dose pressors in the ED setting. Dr Scott Weingart was the first to mention the use of push-dose vasopressors in the emergency department, and several other blogs have published information on them as well.[5–6]

Appropriate Indications for Use of Push-Dose Vasopressors in the Emergency Department

Vasopressor continuous infusions are appropriate treatment for specific clinical conditions. Similarly, push-dose vasopressors have particular indications for which they should be used. Push-dose vasopressors can be used in patients who have transient hypotension—immediately after a procedural sedation, for example—as well as to increase BP until central access is obtained.[5–6] Push-dose vasopressors should only be used as a temporary means to increase BP.[5–6] It is important to note that push-dose vasopressors should not be given in lieu of administering fluid boluses in patients with sepsis or in place of treating the patient's underlying cause of hypotension.

The vasopressor agents that are best utilized in the ED setting are phenylephrine and epinephrine (Table 2).[1,5] Epinephrine is an α, β_1, and β_2 agonist (Table 3).[1,5] Because of its action on β_1 receptors in the heart, it enhances myocardial contraction, also known as inotropy. β_2 receptor stimulation in cardiac and vasculature smooth muscle leads to vasodilation that improves coronary blood flow; however, epinephrine can also produce unwanted

TABLE 1
Summary of recently published trials utilizing push-dose vasopressors in the operating room and labor/delivery

Trial	Design	Intervention	Purpose	Results
Lee et al[2] (2002)	Systematic review (7 RCTs)	Ephedrine vs phenylephrine (continuous infusion or bolus) for managing maternal hypotension during spinal anesthesia for cesarean delivery	Determine difference in efficacy for management of maternal hypotension	No difference in maternal hypotension based on vasopressor agent that patient received; incidence of bradycardia was higher with phenylephrine groups
Doherty et al[3] (2012)	Double-blind RCT	Intermittent bolus of phenylephrine 120 mcg OR Continuous infusion of phenylephrine at 120 mcg/min	Compare the 2 methods of phenylephrine administration to determine changes in cardiac output predelivery	No significant difference between bolus group and continuous infusion group with regard to the maximum change in cardiac output
Siddik-Sayyid et al[4] (2014)	Double-blind RCT	Continuous infusion of phenylephrine 0.75 mcg/kg/min OR Continuous infusion of 0.9% sodium chloride (patients in both groups could receive phenylephrine boluses with a goal of keeping SBP within 20% of baseline)	Compare the incidence of hypotension between continuous infusion of phenylephrine	The use of phenylephrine boluses without a continuous infusion can lead to increased risk of hypotension compared with the use of a phenylephrine infusion in addition to phenylephrine boluses

RCT, Randomized controlled trial; *SBP,* systolic blood pressure.

effects such as bronc\hodilation as a result of the presence of β_2 receptors on smooth muscle in the lungs. The effect of epinephrine on α receptors in arterial smooth muscle leads to contraction of the smooth muscle, increasing systemic vascular resistance (SVR). Therefore, the use of epinephrine increases both BP and heart contraction (inotropy), which will also cause an increased heart rate in most patients.[1]

In contrast, phenylephrine is purely an α agonist. Because of the selectivity of phenylephrine for α receptors, it provides arterial vasoconstriction to increase SVR. Therefore, the use of phenylephrine will only lead to increases in BP.[1] Phenylephrine is typically used in patients who are tachycardic and hypotensive because its use can sometimes cause a baroreceptor-mediated reflex in heart rate that leads to bradycardia as a result of rapid changes in the patient's BP.[1]

The onset of both epinephrine and phenylephrine occurs within 1 minute of intravenous administration. The duration of phenylephrine is slightly prolonged, lasting approximately 10 to 20 minutes, in comparison with epinephrine, which lasts approximately 5 to 10 minutes. An important difference between these 2 agents is the dosing, which can lead to medication errors in patients if the provider does not pay sufficient attention during the preparation and admixture of these medications. According to an online resource that translates evidence-based information for bedside use, the bolus dose of phenylephrine is 10 times the dose of epinephrine. For epinephrine, the recommended dosage range for administration is between 5 and 20 mcg, whereas with phenylephrine, the dosage range is between 50 and 200 mcg. The doses of

TABLE 2
Pharmacokinetics and dosing of push-dose vasopressors

Medication	Epinephrine	Phenylephrine
Mechanism	α and β agonist	α Agonist
Onset	1 min	1 min
Duration	5-10 min	10-20 min
Dose	5-20 mcg	50-200 mcg
Repeat interval	2-5 min	2-5 min

TABLE 3
Effects of adrenergic receptors at different receptor sites

	α Receptors	β_1 Receptors	β_2 Receptors
Blood vessels	Constriction	N/A	Dilation
Heart	N/A	Increases contractility and heart rate	Increases contractility and heart rate
Bronchioles	Constriction	N/A	Relaxation

both epinephrine and phenylephrine can be repeated at a time interval of 2 to 5 minutes if the initial dose is not working (Table 2).[5]

Preparation of Push-Dose Vasopressors

The preparation of push-dose vasopressors is associated with a high risk for medication errors because these medications are usually mixed at the patient's bedside for immediate use in stressful situations. Because of this high risk, it is recommended that these preparations be double checked by another health care professional prior to administration. Immediately after preparation, all syringes and bags that are used in the process should be labeled with the appropriate concentration and medication name to further prevent any medication errors.

Push-dose epinephrine can be mixed by withdrawing 1 mL (which is equivalent to 0.1 mg) of 1:10,000 epinephrine (cardiac arrest syringe) into a 10-mL syringe, and then drawing up 9 mL of normal saline solution into the same syringe. The final concentration of the syringe containing epinephrine is 10 mcg per 1 mL (or 1:100,000 epinephrine).[5]

The preparation of push-dose phenylephrine is more complex. To make the syringe for bolus-dose phenylephrine, draw up 1 mL (which is equivalent to 10 mg) of phenylephrine from a 10 mg/mL vial of phenylephrine. Inject the 1 mL (10 mg) of phenylephrine into a 100-mL bag of normal saline solution. From the bag, withdraw 10 mL of phenylephrine-containing fluid into a 10-mL syringe. The final concentration of the 10-mL syringe is 100 mcg/mL of phenylephrine. Because phenylephrine is one of the main vasoconstricting agents used by anesthesiologists for temporary correction of hypotension in the OR, commercially available preparations of phenylephrine, 100 mcg/mL, are available. Premade preparations can be kept in the emergency department for emergency situations to reduce the risk of medication errors that can occur during preparation.

Summary

The use of push-dose vasopressors has transitioned to the emergency department during the last few years. In the ED setting, push-dose vasopressors can be used in a particular niche of patients, including those who need temporary increases in BP because of transient hypotension or until central access can be obtained to initiate a continuous infusion of a vasopressor agent. The preparation and administration of these agents carry a high risk for medication errors, and it is extremely important to ensure proper dosing upon administration. Finally, all syringes should be properly labeled upon preparation of these medications by the physician or pharmacist prior to their administration to prevent medication errors.

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Allison A. Muller, PharmD, D.ABAT
acri.muller@comcast.net