Dear Colleagues:

Hypertension remains one of the most common disease processes in patients presenting to the Emergency Department (ED). While sometimes symptomatic and associated with end organ damage such as hypertensive encephalopathy, hemorrhagic stroke, acute coronary syndrome, heart failure, and renal insufficiency, many patients present without symptoms. Emergency physicians and hospitalists should understand the appropriate classification of patients with hypertension, the pathophysiology of this disease process, and appropriate treatment strategies. In this EMCREG-International Newsletter, Charles V. Pollack, Jr. MD and Christopher J. Rees, MD of Pennsylvania Hospital and the University of Pennsylvania discuss hypertension and parenteral medications used for treatment of these patients in the ED, including the Velocity trial. This paper serves as a companion to the EMCREG-International Hypertension Consensus Panel publication, a supplement to the March 2008 Annals of Emergency Medicine, as well as the EMCREG-International Newsletter published earlier this year by Drs. Judd Hollander and Anna Marie Chang.

Through collaboration with colleagues from a variety of specialties, patients with hypertension can receive optimal therapy when presenting to an acute care setting such as the ED. For patients receiving parenteral therapy, the natural transition of the patient with hypertensive emergency through the ED to the intensive care unit or step-down bed involves careful collaboration between the emergency physician and hospitalist. It is our hope you will find this EMCREG-International Newsletter helpful in the care of your patients with hypertension.

Sincerely,

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Objectives:
1. Describe the distinctions among hypertensive “crisis,” “urgency,” and “emergency”
2. Discuss the general approach to acute severe hypertension in the ED
3. Explain the limitations of typically used parenteral antihypertensive agents in the ED
4. Summarize the potential role of clevidipine in ED management of hypertensive emergency

Introduction

Hypertension is an extremely common illness, affecting 50 to 75 million people in the US, many of whom are unaware that they even have hypertension. It is the most common primary medical diagnosis in the US. Familiarity does not, however, equate to treatment success; some two-thirds of hypertensive patients fail to achieve adequate control of their blood pressure (BP). Poor BP control often prompts emergency department (ED) visits. At some point in their lives, 1% of patients with hypertension will have a hypertensive “emergency,” defined as severely elevated blood pressure associated with target organ dysfunction.

Meanwhile, about 5% of ED patients have at least one blood pressure (BP) reading that is severely elevated, although most do not have a hypertensive emergency.
not have a hypertensive emergency (HE). Patients often present to the ED for unrelated issues, only to be found to have severely elevated BP. Other patients present with complaints clearly associated with a BP derangement. The incidence of hypertensive emergency is disproportionately higher in the elderly, male, and African-American populations. Rapid recognition, evaluation, and treatment of hypertensive emergencies are necessary to prevent permanent or worsened target organ damage. There are essentially no evidence-based guidelines for treating hypertensive emergencies in general, although there are guidelines for the management of BP in stroke, aortic dissection, and eclampsia. The most recent periodic review by the Joint National Committee (JNC) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7, 2003) offers little in the form of evidence-based guidance on the management of hypertensive urgencies, defined as severe elevations of BP without target organ damage, or emergencies in general.

Definitions

The JNC 7 describes hypertension using a baseline BP of 115/75 mm Hg, reporting that the risk of cardiovascular disease (CVD) doubles with each incremental increase of 20/10 mm Hg. JNC 7 defines blood pressure and hypertension categories as follows:

- Normal: <120/80 mm Hg
- Pre-hypertension: 120-139/80-89 mm Hg
- Hypertension: Stage 1: 140-159/90-99 mm Hg
- Hypertension: Stage 2: > 160/100 mm Hg

Hypertensive emergencies almost always fall into stage 2, although some patients, especially younger individuals, can have hypertensive emergencies at much lower BP levels than those with chronic hypertension. The JNC 7 publication defines hypertensive emergency as “a severe elevation in blood pressure (usually >180/120 mm Hg) complicated by evidence of impending or progressive target organ dysfunction.” Clinical manifestations of target organ damage usually involve derangements in the neurologic, cardiac, or renal systems. While the myocardium is the most common target organ damaged by hypertension with a clinical manifestation as acute coronary syndrome (ACS), other examples of target organ dysfunction include, but are not limited to, encephalopathy, acute hemorrhagic or ischemic stroke, acute papilledema, acute pulmonary edema, aortic dissection, acute renal failure with or without hematuria, and eclampsia. It is essential to realize that most patients who present to the ED with severe hypertension do not have a hypertensive emergency.

Hypertensive urgency is defined as “those situations associated with severe elevations in BP without progressive target organ dysfunction.” Some authors use the term hypertensive crisis to include both hypertensive emergencies and hypertensive urgencies. This may not be fruitful as the term “crisis” is often used to justify an acute intervention, which is not always necessary in the ED when severe hypertension is detected.

Another important term in this discussion is autoregulation. In normotensive people, there is ordinarily a broad range of pressures through which arteries and arterioles can dilate and constrict to maintain normal and consistent perfusion. Chronic hypertension causes arterial walls to accommodate chronically excessive pressures. This autoregulation limits the vessels’ ability to respond appropriately to acute decreases or increases in BP. When BP abruptly increases, regardless of stimulus, larger arteries reflexively vasoconstrict in an effort to limit pressure reaching the tissues, which would interfere with normal cellular activity. In this situation, an acute lowering of BP by a clinician seeking to re-achieve a “normal” BP will reduce the blood flow to tissue without prompt compensatory vessel dilation, which can lead to ischemia of end-organ tissue. Therefore, it is important when treating hypertensive emergencies, to not decrease BP either too rapidly or by too great of an amount.

Causes of Hypertensive Emergencies

The most common origin of hypertensive emergency is an abrupt increase in BP in patients with chronic hypertension, most often as a result of medication noncompliance. Other relatively common causes of hypertensive emergency include stimulant intoxication, including cocaine, methamphetamine, and phencyclidine as well as withdrawal syndromes from the anti-hypertensives such as clonidine and beta blockers. Less common causes include pheochromocytoma and adverse drug interactions with monoamine oxidase inhibitors (MAO-I).
Clinical Syndromes of Hypertensive Emergencies

Cardiac manifestations of hypertensive emergencies usually present with either ACS or acute cardiogenic pulmonary edema. Central nervous system syndromes usually manifest as subarachnoid hemorrhage, intraparenchymal hemorrhage, cerebral infarction, or hypertensive encephalopathy. Hypertensive encephalopathy is often more difficult to diagnose and is in the differential not only with the other three syndromes noted, but also with substance abuse. Hypertensive encephalopathy is potentially fully reversible with appropriate treatment. Renal failure can both cause and be precipitated by hypertensive emergency. Typically, renal damage from acute severe BP elevation manifests as non-oliguric acute renal failure, often associated with hematuria. Reducing BP helps to minimize further renal damage, but because of renal autoregulation, abrupt or overly aggressive correction should be avoided.

Aortic dissection deserves special attention, as it has much higher short-term morbidity and mortality than other clinical syndromes associated with hypertensive emergency, requires more urgent and rapid reduction in BP, and also necessitates specific and vigorous inhibition of reflex tachycardia as the BP is lowered. Aortic dissection classically presents with severe, tearing chest pain radiating to the back. There may be a difference in BP between the upper extremities; this should be checked and documented when the diagnosis is considered. Patients often have a history of chronic hypertension. It is recommended that patients with aortic dissection have their systolic BP (SBP) reduced to at least 120 mm Hg within 20 minutes, which is a more rapid reduction than that recommended for other syndromes associated with severe hypertension. Typically, BP normally declines during the first trimester of pregnancy, so hypertensive emergencies are diagnosed at much lower BP levels in pregnancy. Pre-eclampsia is a syndrome which includes hypertension, peripheral edema, and proteinuria in women after the twentieth week of pregnancy. Eclampsia is the more severe form of this disease with substantial hypertension, edema, proteinuria, and seizures. These diagnoses pose grave risks to mother and fetus and must be aggressively treated. Table 1 lists parenteral drugs used for acute BP management according to presenting hypertensive syndrome.

Evaluation of the Patient with Hypertensive Emergency

All patients with severely elevated BP should undergo a thorough history and physical examination in the ED. A complete past medical history with attention to hypertension is obviously important. A review of all the patient’s medications which includes review of dosages, length of use, compliance, and last time taken should be obtained. The patient must be questioned about recreational drug use, as several drugs of abuse, such as cocaine, amphetamines, and phencyclidine, can cause hypertensive emergencies.

Blood pressure should be taken in both arms with an appropriately sized BP cuff. A thigh cuff may be necessary for the obese patient. Direct ophthalmoscopy should be attempted, with attention given to evaluation for papilledema and hypertensive exudates. A brief focused neurologic examination to assess mental status and the presence or absence of focal deficits should be performed. The cardiopulmonary system should be evaluated, looking particularly for signs of pulmonary edema. Abdominal examination should include palpation for abdominal masses and tenderness, and auscultation for abdominal bruits. Peripheral pulses should be palpated.

All patients should have an electrocardiogram to evaluate for left ventricular hypertrophy, acute ischemia or infarction, and arrhythmias. Urinalysis should be performed to evaluate for hematuria and proteinuria. Women of child-bearing age require a pregnancy test. Laboratory studies should include a basic metabolic profile with assay of BUN and creatinine as well as a complete blood count with peripheral smear to evaluate for microangiopathic hemolytic anemia. If ACS is suspected, cardiac biomarkers should be assayed.

Radiographic studies may be ordered based on presentation and diagnostic considerations. Often a chest x-ray is required to evaluate for pulmonary edema, cardiomegaly, or mediastinal widening. If any focal neurologic signs are present, or a decrease in mental status is noted, a CT scan of the head is needed to evaluate for hemorrhage or infarct.
Hypertensive Emergencies: Acute Care Evaluation and Management

General Treatment of the Patient with Hypertensive Emergency

According to the JNC 7 report, the immediate goal for treating hypertensive emergency is to reduce the SBP by 10-15%, but by no more than 25%, within the first hour and if the patient is then stable, to 160/100-110 mm Hg over the ensuing 2-6 hours. Aortic dissection is a special situation which requires reduction of the SBP to at least 120 mm Hg within 20 minutes, with commensurate protection against reflex tachycardia. Hypertensive emergency is a clinical diagnosis and the clinical state of the patient is more important than the absolute value of the BP.

Because of autoregulation, a too rapid reduction in BP can lead to worsening tissue perfusion with ischemia and possible infarction. There are many agents used for treating acute severe elevations of BP, and despite having been used for years, most are not ideal across the broad range of comorbidities seen in an ED population. Parenteral agents used for the treatment of HE fall into several classes, as shown in Table 2. There are few clinical trials or comparative studies to help guide the choice among drugs. Instead this decision is based upon physician and institutional preference and policies, underlying medical conditions, and target organ involvement.

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Suggested anti-hypertensive agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic Dissection</td>
<td>- Nitroprusside, often in combination with esmolol or labetalol</td>
</tr>
<tr>
<td></td>
<td>- Nicardipine or clevidipine with esmolol or labetalol</td>
</tr>
<tr>
<td>Acute Pulmonary Edema</td>
<td>- Nitroglycerin may reduce pressure</td>
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<tr>
<td></td>
<td>- Fenoldopam if renally impaired</td>
</tr>
<tr>
<td></td>
<td>- Nicardipine</td>
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<tr>
<td></td>
<td>- Clevidipine</td>
</tr>
<tr>
<td>Acute Coronary Syndrome</td>
<td>- β-blocker</td>
</tr>
<tr>
<td></td>
<td>- Nitroglycerin</td>
</tr>
<tr>
<td></td>
<td>- Clevidipine</td>
</tr>
<tr>
<td>Hypertensive Emergency with Acute or Chronic Renal Failure</td>
<td>- Labetalol</td>
</tr>
<tr>
<td></td>
<td>- Nicardipine</td>
</tr>
<tr>
<td></td>
<td>- Fenoldopam</td>
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<tr>
<td></td>
<td>- Clevidipine</td>
</tr>
<tr>
<td>Eclampsia</td>
<td>- Labetalol</td>
</tr>
<tr>
<td></td>
<td>- Nicardipine</td>
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<tr>
<td></td>
<td>- Hydralazine (all in conjunction with magnesium sulfate)</td>
</tr>
<tr>
<td>Acute Ischemic Stroke or ICH</td>
<td>- Nicardipine</td>
</tr>
<tr>
<td>(If expert guidance deems BP control necessary)</td>
<td>- Labetalol</td>
</tr>
<tr>
<td></td>
<td>- Clevidipine</td>
</tr>
<tr>
<td>Hypertensive Encephalopathy</td>
<td>- Labetalol</td>
</tr>
<tr>
<td></td>
<td>- Esmolol</td>
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<tr>
<td></td>
<td>- Nicardipine</td>
</tr>
<tr>
<td></td>
<td>- Fenoldopam if renally impaired</td>
</tr>
<tr>
<td></td>
<td>- Nitroprusside (only if necessary)</td>
</tr>
<tr>
<td></td>
<td>- Clevidipine</td>
</tr>
</tbody>
</table>

It must be remembered that hypertensive emergency is a clinical diagnosis, and that the clinical state of the patient is more important than the absolute value of the blood pressure.
### Hypertensive Emergencies: Acute Care Evaluation and Management

**Table 2. Parenteral Agents Used for Hypertensive Emergencies**

<table>
<thead>
<tr>
<th>DRUG</th>
<th>CLASS/MECHANISM</th>
<th>USUAL DOSE</th>
<th>ONSET</th>
<th>DURATION</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES/ADVERSE EFFECTS</th>
<th>COMMON USES</th>
<th>ED UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Nitroprusside</td>
<td>Direct arterial and venous vasodilator via CAVD</td>
<td>0.25-10 µg/kg/min. Avg effective dose 3 µg/kg/min.</td>
<td>1-2 min.</td>
<td>3-4 minutes after infusion stopped</td>
<td>Large amount of experience with use.</td>
<td>• Nausea, vomiting, muscle twitching, diaphoresis. • Cyanide toxicity, especially with renal insufficiency and prolonged infusion (≥48 hours). • Inactivated by light, requires light-protected delivery system.</td>
<td>Has been used in all syndromes of hypertensive emergencies (HE).</td>
<td>+++</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>Direct venous vasodilator.</td>
<td>5 µg/kg/min to max 100 µg/kg/min.</td>
<td>2-5 min.</td>
<td>5-10 minutes.</td>
<td>Dilates coronary vessels.</td>
<td>• Ineffective arterial vasodilator. • HA, hypotension, tachycardia.</td>
<td>Not used for most HE, reserved for cardiac ischemia and cardiogenic pulmonary edema.</td>
<td>+</td>
</tr>
<tr>
<td>Fenskopolam</td>
<td>Peripherally, dopamine-1 receptor agonist, causes vasodilation esp. in renal, cardiac, splanchnic beds.</td>
<td>0.1 µg/kg/min to max 1.6 µg/kg/min. Titrate in 0.1-0.5 µg/kg/min increments.</td>
<td>10 min. Max effect in 30 min. 1 hour after stopping.</td>
<td>Increases renal blood flow; improving CrCl esp. in setting of impaired renal function.</td>
<td>• Refract tachycardia. • HA, dizziness, flushing, nausea. • Tachyphylaxis after 48 hrs.</td>
<td>Especially useful in HE syndromes complicated by renal insufficiency or failure.</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Nicardipine</td>
<td>Dihydropyridine Ca-Channel blocker. Vasodilator.</td>
<td>5 mg/hr can ↑ by 2.5 mg/hr to max 15 mg/hr.</td>
<td>Within 10 min.</td>
<td>2-4 hours after stopping.</td>
<td>Dilates coronary vessels; can use with known CAD.</td>
<td>HA, flushing, dizziness, hypotension, digital disthesias.</td>
<td>Has been used extensively in post-operative hypertension, especially post CABG surgery.</td>
<td>+++</td>
</tr>
<tr>
<td>Enalaprilat</td>
<td>ACE Inhibitor.</td>
<td>1.25 mg IV at 4-6 hr intervals, max 5 mg in 6 hours.</td>
<td>15 min.-4 hr to peak effect.</td>
<td>12-24 hours.</td>
<td>—</td>
<td>BP response variable, unpredictable, and not dose-related.</td>
<td>Not generally useful for HE syndromes.</td>
<td>+</td>
</tr>
<tr>
<td>Hydrochlorothiazide</td>
<td>Direct arterial vasodilator.</td>
<td>10-20 mg /d.</td>
<td>1-4 hours.</td>
<td>Increases uterine blood flow.</td>
<td>—</td>
<td>Flushing, HA, nausea.</td>
<td>Used only for edema/ pre-edema.</td>
<td>+</td>
</tr>
<tr>
<td>Esmolol</td>
<td>Selective B-1 receptor blocker.</td>
<td>Load 250-500 µg/kg over 1-3 min. Can infuse at 50-100 µg/kg/min. Titrate every 5 min. with repeat bolus and T drip by 50 µg/kg/min to max dose 100 µg/min.</td>
<td>6-20 min. after bolus. Max effect 9 min.</td>
<td>Effects last for 20 min. after stopping.</td>
<td>Ultra-short acting.</td>
<td>• Bradycardia. • Hypotension. • Bronchospasm. • Seizure. • Acute pulmonary edema. • Abset can precipitate chest pain. • Requires central access, as extravasation can cause local tissue necrosis and can cause small vein phlebitis.</td>
<td>Often used in combination with vasodilators to reduce reflex tachycardia.</td>
<td>++</td>
</tr>
<tr>
<td>Labetalol</td>
<td>Combined α- and β-adrenergic receptor blocker.</td>
<td>20 mg IV over 2 min. Additional boluses every 10 min. with escalating doses of 40 mg, 80 mg to max cumulative dose of 300 mg. Can start infusion with 1-2 regmin.</td>
<td>2-5 min. after bolus with peak in 5-15 min.</td>
<td>2-4 hours after stopping infusion or last bolus.</td>
<td>Decreases reflex tachycardia from other agents. Does not affect cerebral blood flow. Does not decrease cardiac blood flow or CO. Does not affect renal function.</td>
<td>Profound orthostatic.</td>
<td>Often used in combination with vasodilators to reduce reflex tachycardia associated with these agents.</td>
<td>+++</td>
</tr>
<tr>
<td>Chlortalidone</td>
<td>Ultra-short acting dihydropyridine Ca-Channel blocker. Vasodilator.</td>
<td>2-4 µg/kg/min.</td>
<td>1-6 min.</td>
<td>7-10 min. effect lasts 5-10 min. after stopping.</td>
<td>Ultra-short acting with rapid onset, offset of effect. Little to no reflex tachycardia. Metabolism is independent of renal and hepatic function.</td>
<td>Metabolism is independent of renal and hepatic function.</td>
<td>Just recently approved; scant broad ED experience.</td>
<td>+++</td>
</tr>
</tbody>
</table>

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HE = hypertensive emergency  
CKD = chronic kidney disease  
HA = headache  
CAD = coronary artery disease  
ICP = intracranial pressure  
ACS = acute coronary syndrome  
CO = cardiac output  
CrCl = creatinine clearance
Specific Parenteral Agents for Treatment of Hypertensive Emergencies

Choosing an appropriate agent for use in the ED is difficult, and too often not based on objective criteria, but on institutional and individual experiences. Often, “resource” issues take precedence over “medical” issues in choosing an agent. The ideal agent for use in the ED would be one that had a very quick onset of action matched by an equally quick offset of effect when the infusion is stopped. Offset of effect is very important in the ED, as overshoot of target BP does occur and can be associated with poor outcomes if persistent. An ideal agent would also be easy to administer, not requiring central venous access, intra-arterial monitoring, or special set-up and delivery systems, and therefore may differ from the model agent for the intensive care unit or surgical suite. Given the incomplete histories and complex comorbidities of many ED patients, an agent should also have a limited side-effect profile and broad applicability, with limited renal, hepatic, or cardiac contraindications or adverse impact.

**Esmolol** is a beta-adrenergic blocker that selectively inhibits beta-1 receptors in the heart and peripheral vasculature. It is short acting, with an onset of action of 6-20 minutes after bolus, and a maximal effect occurring about 5 minutes after bolus. Activity may persist for up to 20 minutes after discontinuing the infusion. Dosing is reviewed in Table 2. **ED Bottom Line for esmolol:** beta-1 receptor blocker; rapid onset of action; bolus/infusion dosing; activity may persist up to 20 minutes after cessation of infusion; caution in renal patients.

**Fenoldopam** is a peripheral dopamine-1 receptor agonist. It causes selective vasodilation predominately in the renal, cardiac, and splanchnic vascular beds. This causes decreased peripheral vascular resistance, increased renal blood flow, and inhibition of sodium reabsorption; the latter results in natriuresis and diuresis. Fenoldopam lowers BP but also improves creatinine clearance and urine flow. It is short-acting with an onset of action of about 10 minutes and a half-life of 7-9 minutes. **ED Bottom Line for fenoldopam:** dopamine-1 receptor blocker; rapid onset of action; titrated infusion dosing; activity may persist up to 60 minutes after cessation of infusion; may be especially useful in renal patients; contraindicated in glaucoma patients.

**Labetalol** is a combined $\alpha$ and $\beta$-adrenergic receptor inhibitor ($\alpha:\beta$ activity ratio, 1.3 to 1:7). It controls reflex tachycardia as BP drops. It does not affect cerebral blood flow, does not decrease cardiac blood flow or reduce cardiac output, or have any appreciable effect on renal function. The effect can persist 2-4 hours after stopping the infusion. Labetalol can be given as repeated IV boluses, or as a short-term IV infusion. It is especially useful in aortic dissection, in combination with a vasodilator. The most recent American Heart Association/ American Stroke Association guidelines specifically recommend labetalol or nicardipine for patients with hypertension who are candidates for t-PA or other acute reperfusion strategies. **ED Bottom Line for labetalol:** mixed alpha/beta receptor blocker; rapid onset of action; repeated bolus or titrated infusion dosing; activity may persist up to four hours after cessation of infusion; particularly useful in stroke and aortic dissection patients.

**Nicardipine** is a dihydropyridine calcium channel blocker. It selectively blocks L-type, voltage-sensitive calcium channels of the heart, thereby dilating coronary arteries and causing relaxation of peripheral arteriolar smooth muscle and reduced peripheral vascular resistance. Abrupt withdrawal can cause rebound angina and hypertension. **ED Bottom Line for nicardipine:** calcium channel antagonist; rapid onset of action; infusion dosing; coronary artery-friendly; activity may persist up to six hours after cessation of infusion; caution in hepatic and renal patients.

**Nitroprusside** is a direct venous and arterial vasodilator. Due to its combined venous and arterial effects, nitroprusside decreases both preload and afterload. Its use often results in a reflex tachycardia due to activation of baroreceptors. In comparison to the other agents discussed so far, it has the quickest onset of action and the shortest half-life. It is therefore easily titratable and reversible. No type of hypertension is refractory to nitroprusside.

Use of nitroprusside, however, is problematic for many reasons. It can cause precipitous drops in BP, leading to overshoot of the target BP and tissue perfusion compromise because of autoregulation. It is difficult to administer, as in most institutions it requires BP monitoring with an intra-arterial line. Furthermore, the drug is inactivated by light, so the infusion bag and all IV...
tubing must be protected from light. In addition, it can cause nausea, vomiting, diaphoresis, and muscle twitching. Most importantly, cyanide (CN) is released from nitroprusside non-enzymatically in a dose-dependent fashion. Cyanide is metabolized in the liver to thiocyanate in a reaction that requires thiosulfate. Thiocyanate is 100 times less toxic than CN, and thiocyanate is excreted largely through the kidneys. Even with normal renal and liver function, therapeutic dosages of nitroprusside can lead to toxic accumulation of CN within 24 – 48 hours. In the setting of renal and hepatic dysfunction, toxic levels can accumulate much more rapidly. Cyanide toxicity is largely asymptomatic but can cause cardiac arrest, coma, encephalopathy, seizures, and focal neurologic damage.

Nitroprusside can cause several other serious problems. Because it causes significant afterload reduction, it can cause “coronary steal” in patients with coronary artery disease. Its use is not recommended in patients with ACS or known severe coronary artery disease. Precipitous afterload reduction in these patients can cause reduction of coronary artery blood flow as coronary arteries fill during diastole, leading to cardiac ischemia. In one randomized, placebo-controlled trial, nitroprusside increased mortality when infused early in acute myocardial infarction. With nitroprusside, there is also a dose-dependent decrease in cerebral blood flow, so it must be used cautiously in patients with increased intracranial pressure and at times may initially worsen hypertensive encephalopathy.

ED Bottom Line for nitroprusside: Useful for any type of hypertensive emergency; long clinical experience with use; rapid onset and offset of effect. Multiple limitations including reflex tachycardia, overshoot of target BP, cyanide and thiocyanate toxicity; not suggested for use in ischemic or hemorrhagic stroke; careful use in renal insufficiency; logistically challenging in ED.

Nitroglycerin is a direct venous dilator which reduces preload and cardiac output. It is an ineffective arterial dilator and is not specifically useful for hypertensive emergencies. Its use is generally limited to myocardial ischemia and pulmonary edema because of its dilatory effect on coronary vessels. ED Bottom Line for nitroglycerin: Not generally useful for hypertensive emergencies except in the setting of acute cardiac ischemia. In this setting, it may reduce BP and is given more for symptom relief.

Enalaprilat is the IV form of the angiotensin converting enzyme inhibitor enalapril. It has an onset of action of about 15 minutes, but it has multiple disadvantages that limit its usefulness for hypertensive emergencies. The peak effect does not occur for up to 4 hours, and its duration of action can last for up to 12-24 hours. It is contraindicated in pregnancy. ED Bottom Line for enalaprilat: Not generally useful for hypertensive emergencies in the ED due to inconsistent and prolonged onset and offset of effect.

Hydralazine is a direct arterial vasodilator that is often used for hypertensive emergencies of pregnancy. It is not teratogenic and it actually increases uterine blood flow. It is not used or recommended for hypertensive emergencies; recent studies have shown that nicardipine and labetalol are superior. ED Bottom Line for hydralazine: Not generally useful for hypertensive emergencies in the ED as multiple better agents are available.

Clevidipine is a new, third generation, ultra-short acting dihydropyridine calcium-channel antagonist which has recently been approved by the FDA for use in hypertensive emergencies. Clevidipine has been shown to be an effective parenteral agent for use in hypertensive emergencies without many of the problems associated with older agents. It blocks L-gated calcium channels leading to relaxation of the smooth muscle of small arteries, resulting in decreased peripheral vascular resistance. It reduces after-load without affecting preload and causes little to no reflex tachycardia. It is the first new parenteral antihypertensive agent to be approved by the FDA in over ten years, and it is the first parenteral antihypertensive ever to include an ED-based study in its new drug application.
Clevidipine has a very rapid onset of action, with a half-life of less than 1 minute. The usual dose is 2 µg/kg/min, with upward doubling titration to effect. Blood pressure control is often achieved within 5 minutes of starting an infusion. It is rapidly cleared within 10 minutes. Clevidipine is metabolized to an inactive metabolite by esterases in blood and extravascular tissue, independent of renal or hepatic function. It is logistically simple to use, being given through a peripheral IV line and with BP cuff monitoring instead of intra-arterial access. It has a non-weight-based dosing regimen and no associated myocardial depression, sino-atrial (SA) node suppression, or atrio-ventricular (AV) node suppression. Clevidipine was shown to be safe and effective for the treatment of acute hypertension during an 18-hour infusion in a recent clinical trial performed in the ED. VELOCITY was a Phase-III, open-label, single-arm study to confirm the safety and efficacy of IV clevidipine for patients with acute hypertension requiring parenteral treatment for at least 18 hours. Patients were enrolled in the trial if they had acute hypertension (SBP >180 mm Hg or DBP >115 mm Hg) on 2 successive occasions 15 minutes apart and had evidence of acute or chronic end-organ damage, were 18 years of age or older, and could provide written, informed consent. Ninety percent (104/117) of patients reached their target BP within 30 minutes (median for all patients, 10.9 minutes). No clinical hypotensive events related to clevidipine were reported throughout the study, and there was no excessive reflex tachycardia. Transition to oral therapy was successful in 91.3% of patients.15

ED Bottom Line for clevidipine: Rapid onset and offset of effect, limited side-effect profile, broadly applicable without renal or hepatic issues, limited-to-no reflex tachycardia, easy to administer as requires no central access or monitoring.

ED Management Strategies
Hypertensive urgencies can and should ordinarily be managed with oral antihypertensives only. Because the diagnosis confirms that no end-organ damage is ongoing or incipient, most patients with hypertensive urgencies have had their BP control deteriorate over days to weeks to months, and urgent correction is neither necessary nor advisable.1

Hypertensive emergencies, again by definition with end organ damage, require parenteral therapy using one or more of the agents previously discussed. As soon as the pressure begins to respond to therapy, plans should be initiated for transitioning the patient to oral therapy. If the patient is already on BP medications and has been noncompliant, then those medications are often the best choice at least for reinstitution of oral therapy. If the diagnosis of hypertension is new, then a reasonable oral agent might be chosen from the same class as the intravenous (IV) agent employed such as a calcium channel antagonist if clevidipine or nicardipine controlled the BP, or an oral beta-blocker if labetalol or esmolol was used.1 The choice of oral agent may also be impacted by the nature of new or reinstituted therapy for the end-organ damage sustained by the patient.

The overall management of acute hypertension was summarized in a recent supplement to Annals of Emergency Medicine.16 This work is a handy reference for the emergency physician and ED nursing personnel.

Observation or “clinical decision” units (CDUs) may be suitable for the short-term monitoring and management of hypertensive urgency. Ordinarily, initiation of IV antihypertensive therapy is associated with the need for admission to an intensive care unit bed. On occasion, when the suspected end-organ damage is avoided or excluded in a short-term stay, such as the patient with angina and severe hypertension who does not have elevated serial cardiac biomarkers, the total hypertensive emergency management might be effected in a CDU.

Conclusion
Treatment of hypertensive emergencies, especially in an ED, can be challenging and resource-intensive. Many agents are available, but most are limited by side effects, pharmacologic and physiologic barriers, or resource-based barriers. Clevidipine, a new ultrashort-acting dihydropyridine calcium channel blocker appears to be an important new addition to the armamentarium of the clinician. It has been shown to be safe, effective, and easy to administer in an ED setting. Labetalol continues to enjoy wide applicability in the ED. Newer, safer, and easier-to-use agents may begin to replace nitroprusside. In the case of patients with limited comorbidities, management in a CDU without formal hospital admission may be possible, especially in hypertensive urgencies.
Hypertensive Emergencies: Acute Care Evaluation and Management

References


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CME Post Test

After you have read the monograph carefully, record your answers by circling the appropriate letter answer for each question.

1. The difference between “hypertensive emergency” and “hypertensive urgency” is based upon which ONE of the following?
   a. the actual magnitude of the systolic pressure
   b. the actual magnitude of the diastolic pressure
   c. the presence or absence of symptoms
   d. the presence or absence of objective signs of end-organ damage

2. Which ONE of the following is NOT considered to be evidence of end-organ damage from acute, severe hypertension?
   a. acute coronary syndrome
   b. acute pulmonary edema
   c. acute epistaxis
   d. acute renal failure

3. Which ONE of the following statements regarding the action of specific parenteral antihypertensive agents is TRUE?
   a. sodium nitroprusside has a prolonged duration of action
   b. labetalol is not a preferred drug in the management of blood pressure elevations accompanying acute stroke
   c. fenoldopam is contraindicated in patients with renal insufficiency
   d. although nitroglycerin may decrease blood pressure, it is usually not a sufficient antihypertensive therapy for patients with hypertensive emergency and acute myocardial infarction

4. Which ONE of the following statements about the VELOCITY study and clevidipine is FALSE?
   a. patients treated for acute severe hypertension with clevidipine in the ED in VELOCITY required blood pressure monitoring with an arterial catheter
   b. the median time to successful control of acute severe hypertension in VELOCITY was about 11 minutes
   c. there were essentially no safety concerns regarding “overshoot” of blood pressure control with clevidipine
   d. there was no excessive reflex tachycardia in VELOCITY patients treated with clevidipine

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