Peri-operative hypertension and Acute hypertensive crisis

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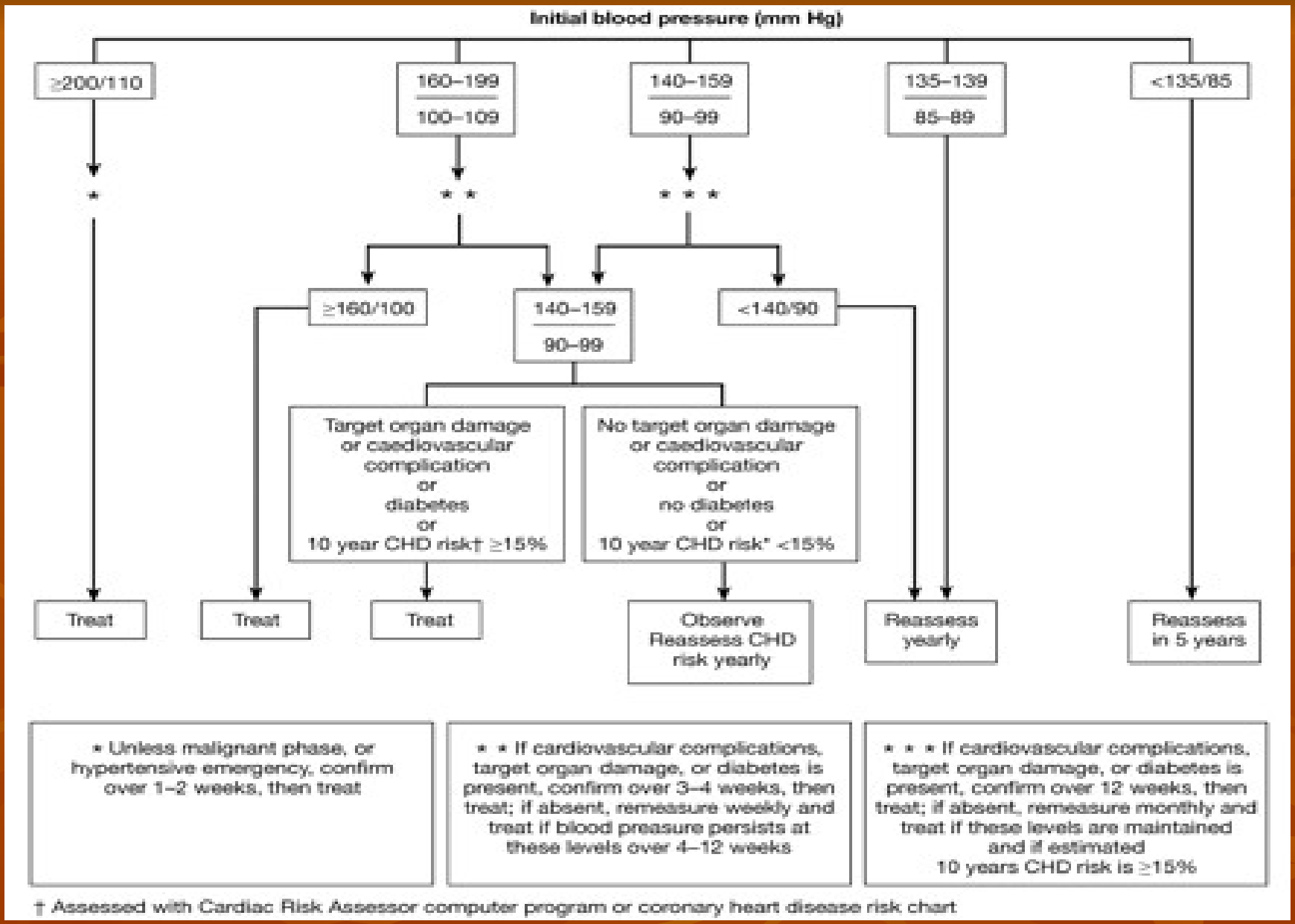
- Definition of Hypertension?
  - Seventh Joint National Committee on the Detection, Evaluation and Treatment of High Blood Pressure (JNC VII) [*2003*]
  - British Hypertension Society Guidelines [*1999*]
  - World Hypertension Society/International Society of Hypertension (WHO/ISH) guidelines
- Differ w.r.t inclusion of target organ damage and the limit for initiating treatment

- JNC-7

Table 1. Classification and Management of Blood Pressure for Adults Aged 18 Years or Older

BP Classification	Systolic BP, mm Hg*		Diastolic BP, mm Hg*	Management*		
				Lifestyle Modification	Initial Drug Therapy	
					Without Compelling Indication	With Compelling Indications†
Normal	<120	and	<80	Encourage		
Prehypertension	120-139	or	80-89	Yes	No antihypertensive drug indicated	Drug(s) for the compelling indications‡
Stage 1 hypertension	140-159	or	90-99	Yes	Thiazide-type diuretics for most; may consider ACE inhibitor, ARB, β-blocker, CCB, or combination	Drug(s) for the compelling indications Other antihypertensive drugs (diuretics, ACE inhibitor, ARB, β-blocker, CCB) as needed
Stage 2 hypertension	≥160	or	≥100	Yes	2-Drug combination for most (usually thiazide-type diuretic and ACE inhibitor or ARB or β-blocker or CCB)§	Drug(s) for the compelling indications Other antihypertensive drugs (diuretics, ACE inhibitor, ARB, β-blocker, CCB) as needed

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin-receptor blocker; BP, blood pressure; CCB, calcium channel blocker.
*Treatment determined by highest BP category.
†See Table 6.
‡Treat patients with chronic kidney disease or diabetes to BP goal of less than 130/80 mm Hg.
§Initial combined therapy should be used cautiously in those at risk for orthostatic hypotension.


Initial blood pressure (mm Hg)
≥200/110
160–199
100–109
140–159
90–99
135–139
85–89
<135/85
*
* *
* * *
≥160/100
140–159
90–99
<140/90
Target organ damage or caediovascular complication or diabetes or 10 year CHD risk† ≥15%
No target organ damage or caediovascular complication or no diabetes or 10 year CHD risk* <15%
Treat
Treat
Treat
Observe Reassess CHD risk yearly
Reassess yearly
Reassess in 5 years
* Unless malignant phase, or hypertensive emergency, confirm over 1–2 weeks, then treat
* * If cardiovascular complications, target organ damage, or diabetes is present, confirm over 3–4 weeks, then treat; if absent, remeasure weekly and treat if blood preasure persists at these levels over 4–12 weeks
* * * If cardiovascular complications, target organ damage, or diabetes is present, confirm over 12 weeks, then treat; if absent, remeasure monthly and treat if these levels are maintained and if estimated 10 years CHD risk is ≥15%
† Assessed with Cardiac Risk Assessor computer program or coronary heart disease risk chart

Peri-operative Hypertension

- Hypertension occuring in the pre-operative, intra-operative or post-operative period.

- Importance:
  - Increased risk of cardiovascular events
  - Increased post-operative morbidity and mortality
  - Association with end-organ damage

Effects of Peri-operative hypertension

- **CVS effects:**
  - Increased BP→ ↑ afterload & myocardial oxygen demand → myocardial oxygen supply and demand imbalance.
  - Chronic ↑ BP → myocardial hypertrophy → myocardial oxygen supply and demand imbalance
  - Hypertrophied myocardium → decreased compliance → abnormal diastolic filling

- Diastolic dysfunction especially apparent during stress, important during surgery and acute recovery interval
- Hypertensive patients more dependent on preload and atrial contribution towards diastolic filling for maintainance of cardiac output
- Maintain preload and normal sinus rhythm

- CNS effects:
  - Increased risk of stroke
  - Impaired cerebral autoregulation
  - Especially important in neurosurgical patients

- Effects on renal function
  - Effective control of BP prevents renal dysfunction
  - Intraoperative urine output monitoring for assessment of perioperative renal function

Pre-operative concerns

- Preoperative evaluation important to identify patients with hypertension and initiate appropriate therapy.

- When to diagnose hypertension?

  - Single reading of elevated BP in patient with previous undiagnosed or untreated HTN not reliable, subsequent readings in non-stressful environment required. (**White Coat Hypertension**)

- Stage 1 or stage 2 hypertension (systolic blood pressure < 180 mm Hg and diastolic blood pressure < 110 mm Hg) not independent risks for perioperative cardiovascular complications, hence cancellation not always justified.

- **On initial evaluation, hypertension mild or moderate & no associated metabolic or cardiovascular abnormalities, do not delay surgery.**

- Stage 3 hypertension (systolic blood pressure ≥ 180 mm Hg and diastolic blood pressure ≥ 110 mm Hg) should be controlled before surgery.

- More prone to perioperative ischemia, arrhythmias and cardiovascular lability, but no clear cut difference that deferring and anesthesia decreases perioperative risk.

- Anesthesia and surgery not to be cancelled only on grounds of elevated preoperative BP, defer if end-organ damage present. (Howell et al. BJA 2004;92(4):570-583)

- Patients with newly diagnosed mild hypertension, treatment may be delayed till after surgery.

Isolated Systolic Hypertension (ISH)

- Systolic blood pressure>140 mm Hg with a normal diastolic blood pressure
- Prevalent in elderly population (steady increase in systolic pressure with age)
- Studies have described association between ISH and cardiovascular complications in non-cardiac surgery (Aronson et al, Franklin et al)
- No definitive studies for non-cardiac surgery

- Recent clinical trial and observational study data show closer association of systolic BP with CAD and stroke Vs diastolic BP
- Recommendations for aggressive treatment of ISH, especially in pts.> 65 yrs
- Further studies required to assess anesthetic risk

- Preoperative history and examination
  - End-organ damage
  - Associated cardiovascular pathology
  - Current anti hypertensive medications
    - To be continued during perioperative period
    - Special care regarding β-blockers and clonidine
- Patients with preoperative HTN, more likely to develop intra-operative hypotension. (ACE inhibitors)

- Preoperative β blockers:
  - Controversial
  - Proven to be beneficial in cardiac surgeries
  - For non-cardiac surgeries good results in high-risk patients but not in low-risk patients (NEJM 1996, 2005)
    - Associated with lesser incidences of perioperative ischemia
    - Intraoperative hypotension, precipitation of asthamatic attack, major disadvantage

- Preoperative ACE inhibitors & AT-1 antagonists:
  - Controversy regarding exaggerated hypotension
  - As long as euvolumia, no hypotension

- Pts. with preoperative BP elevations; exaggerated intraoperative BP fluctuations & ECG evidence of ischemia.

- Preop. Control of BP; ↓tendency to perioperative ischemia.

- Controversy over when to delay surgery and at what BP to accept the patient
  - Individualize the patient
  - Anaesthesiologists perogative
  - Hospital protocol

Intraoperative concerns

- Target range for intraoperative BP control:
  - BP days to weeks before surgery
  - Presence of associated comorbidity
  - Type of surgery
- Maintained within 20% of the preoperative level
- Stressful intraoperative events:
  - Intubation
  - Surgical incision
  - Emergence from GA and extubation

- Other causes of intra-operative hypertension:
  - Inadequate depth of anesthesia
  - Pain
  - Hypercarbia
  - Hypoxemia
  - Bladder distension
  - Hypervolumia
- Exaggerated response in hypertensive patients
  - Increased sympathetic tone
  - Decreased intravascular volume

- Methods to blunt the sympathetic response:
  - **IV Esmolol** (1-2mg/kg, studies with lesser dose 0.4mg/kg)
  - IV Lignocaine(1.5 mg/kg, 90 sec before intubation/extubation)
  - Short acting narcotics (Fentanyl 2-3µg/kg, sufentanil 0.3-0.5µg/kg)
  - Increased concentration of inhalational agents (MAC-ei, MAC-bar-ei)
  - IV NTG (1-2µg/kg, just before beginning laryngoscopy)
  - IV Labetalol (5-20 mg boluses)

- Preoperative use of β-blockers or clonidine, smoothen intraoperative blood pressure course.

- Choice of anesthetic techniques and medications on the basis of presence of comorbid disease and type of surgery. (avoid ketamine)

- Hypertensive patients treated with diuretics or having LVH more susceptible to vasodilatory effects of inhaled anesthetics & neuraxial blockade

Postoperative concerns

- **Postoperative Hypertension:** Arbitrarily defined as SBP>190 mm Hg and/or DBP≥100 mm Hg on two consecutive readings following surgery
- Implications:
  - Risk of hemorrhage
  - Disruption of vascular or cardiac suture lines
  - Cerebral edema
  - ↑ myocardial wall stress and oxygen consumption→ myocardial ischemia

- Causes:
  - Preoperative hypertension
  - Withdrawal of antihypertensive medications
  - Pain
  - Emergence delerium
  - Hypoxia
  - Hypercarbia
  - Hypothermia
  - Hypervolumia
  - Type of surgery

- Management:
  - Aggressive pain management
  - Correction of previously mentioned causes
  - Antihypertensive medications
    - Parenteral
    - Rapid onset
    - Labetalol, hydralazine
  - Refractory or profound hypertension
    - SNP or NTG

Acute Hypertensive Crises

- *Hypertensive emergencies,* sudden increase in systolic and diastolic blood pressure associated with end organ damage of the CNS, the heart , or the kidneys.

- *Hypertensive urgencies,* severely elevated BP without acute end-organ damage.

- *Malignant hypertension,* syndrome characterized by elevated BP accompanied by encephalopathy or nephropathy

- SBP >169 mm Hg or DBP >109 mm Hg in a pregnant woman is considered a hypertensive emergency
- Majority are previously diagnosed for HTN, on irregular treatment
- The rate of rise more important than the absolute level

- Pathophysiology:
  - Abrupt ↑ in systemic vascular resistance (humoral vasoconstrictors)
  - Severe elevations of BP→ endothelial injury → fibrinoid necrosis of the arterioles → deposition of platelets and fibrin → breakdown of the normal autoregulatory function.
  - Resulting ischemia → release of vasoactive substances

- Hypertensive crises
  - Hypertensive encephalopathy
  - Acute aortic dissection
  - Acute pulmonary edema with LVF
  - Acute myocardial infarction/unstable angina
  - Eclampsia
  - Acute renal failure
  - Pheochromocytoma crisis

- Clinical features:
  - Those of end organ damage
    - Hypertensive encephalopathy (headache, altered consciousness, CNS dysfunction)
    - Retinopathy (blurring of vision)
    - CVS (angina, acute MI)
    - Cardiac decompensation
    - Renal (renal failure with oliguria and/or hematuria)

Management of Hypertensive crises

- Hospital Care (urgencies), ICU care (emergencies)
- Invasive BP for emergencies

- Lower the BP + stabilize and reverse the damage to target organs

- Sodium restriction and diuretics if fluid overload

- Parenteral anti-hypertensives (emergencies), oral/parenteral (urgencies)

Drugs Dosage

- Diazoxide 150 mg — IV injection of 1 to 3 mg/kg to maximum of given over 10 to 15 min; may be repeated if inadequate response.

- Enalaprilat — IV injection of 1.25 mg over 5 min every 6 h, titrated by increments of 1.25 mg at 12- to 24-h intervals to a maximum of 5 mg every 6 h.

- Esmolol — Loading dose of 500 µg/kg over 1 min, followed by an infusion at 25 to 50 µg/kg/min, which may be increased by 25 µg/kg/min every 10 to 20 min until the desired response to a maximum of 300µg/kg/min.

- Fenoldopam An initial dose of 0.1 µg/kg/min, titrated by increments of 0.05 to 0.1 µg/kg/min to a maximum of 1.6 µg/kg/min.

- Labetalol Initial bolus 20 mg, followed by boluses of 20 to 80 mg or an infusion starting at 2 mg/min; maximum cumulative dose of 300 mg over 24 h.

- Nicardipine 5 mg/h; titrate to effect by increasing 2.5 mg/h every 5 min to a maximum of 15 mg/h.

- NTG Infusion @ 5 µg/min, increase by 5 µg/min every 3-5 min

- Nitroprusside 0.5 µg/kg/min; titrate as tolerated to maximum of 2 µg/kg/min.
- Phentolamine 1- to 5-mg boluses; maximum dose, 15 mg.
- Trimethaphan 0.5 to 1 mg/min; titrate by increasing by 0.5 mg/min as tolerated; maximum dose, 15 mg/min.

VARIOUS ANTIHYPERTENSIVE DRUGS FOR PARENTERAL USE IN THE MANAGEMENT OF MALIGNANT HYPERTENSION AND OTHER HYPERTENSIVE CRISES

Drug	Mechanism of action	Onset of action	Peak effect	Duration of action	Method of administration	Advantages	Disadvantages	Side effects	Comments
Sodium nitroprusside	Direct arteriolar vasodilation and venodilation	Instantaneous	Immediate	2–3 min after infusion stopped	Continuous infusion: Initial, 0.5 μg/kg/min Average, 3 μg/kg/min Maximum, 10 μg/kg/min	Precise titration of BP. Consistently effective when other drugs fail. Parenteral agent of choice for hypertensive crises	Monitoring in ICU required	Nausea, vomiting, apprehension. Thiocyanate toxicity with prolonged infusion, renal insufficiency	Discontinue if thiocyanate level >10 mg/dL
Diazoxide	Direct arteriolar vasodilation	1–2 min	10–15 min	4–24 h	IV minibolus: 50–100 mg IV given rapidly over 5–10 min. Total dose, 150–600 mg	Long duration of action. Constant monitoring not required after initial titration	Sustained hypotension with CNS and myocardial ischemic can occur. Reflex sympathetic cardiac stimulation	Nausea, vomiting, hyperglycemia, myocardial ischemia, uterine atony	Contraindicated in aortic dissection, cerebrovascular disease, myocardial ischemia
Trimethaphan camsylate	Ganglionic blockage with venodilation and arteriolar vasodilation	Minutes	Minutes	5–10 min after infusion stopped	Continuous infusion: Initial, 0.5 mg/min Maximum, 5.0 mg/min	Blocks baroreceptor-mediated sympathetic cardiac stimulation	Parasympathetic blockade	Dry mouth, blurred vision, urinary retention, paralytic ileus, respiratory arrest	Tilt-bed enhances effect; tachyphylaxis after 24–48 h; contraindicated in respiratory insufficiency and glaucoma; potentiates succinylcholine
Nitroglycerin	Direct venodilation at low doses; combined venodilation and arteriolar dilation at higher doses	Minutes	Minutes	1–5 min after infusion stopped	Continuous infusion: Initially, 5 μg/min Increase by 5 μg/min over 3–5 min	Theoretic advantages over nitroprusside in setting of myocardial ischemia	Fails to control BP in some patients	Headache, nausea, vomiting, palpitations, abdominal pain	Dilates intracoronary collaterals
Labetalol	Selective α_1- and noncardioselective β-blocker; arteriolar and venous dilation	Minutes	5–50 min	16–18 h	IV minibolus: Initial, 20 mg over 2 min Then 40–80 mg over 10 min. Maximum, 300 mg	Continuous monitoring not required	β-blockage can worsen congestive heart failure, bronchospasm, heart block	Nausea, vomiting, paresthesias, headache, bradycardia	Contraindicated in pheochromocytoma, heart failure, asthma, heart block >1 degree, after coronary artery bypass graft surgery
Phentolamine	Nonselective α-blocker	2–3 min	5 min	15–30 min	IV bolus: 1–5 mg over 5 min	Useful in catecholamine-related crises	Short duration of action	Tachycardia, arrhythmias, nausea, vomiting, diarrhea, exacerbation of peptic ulcer disease	Nitroprusside equally efficacious in catecholamine-related crises
Hydralazine	Direct arteriolar vasodilation	10–30 min	30–60 min	3–9 h	IV bolus: 5–10 mg over 20–30 min *or* continuous infusion 400 μg/mL solution Loading dose: 200–300 μg/min for 30–60 min Maintenance infusion: 50–150 μg/min	Proven efficacy and safety in hypertensive crises of pregnancy	Delayed onset of action, unpredictable hypotensive effect	Headache, angina	Contraindicated in aortic dissection, atherosclerotic coronary vascular disease
Methyldopa	Decrease sympathetic nervous system activity via CNS α_2 stimulation, decrease systemic vascular resistance	2–4 h	4–6 h	4–6 h	IV of 250–500 mg over 6–8 h	None—not recommended for use in hypertensive crises	Delayed onset of action, unpredictable hypotensive effect	Sedation	Contraindicated in hypertensive encephalopathy, CNS catastrophe
Reserpine	Sympathetic dysfunction owing to central and peripheral catecholamine dysfunction; decreased SVR, decreased CO	2–4 h	2–4 h	2–8 h	Intramuscular: Initial, 0.5–1.0 mg 2–4 mg over 3 h 2–4 mg over 3–12 h	None—not recommended for use in hypertensive crises	Delayed onset of action, unpredictable hypotensive effect	Nasal congestion, CNS sedation, bradycardia, exacerbates peptic ulcer disease, depression	Contraindicated in hypertensive encephalopathy, CNS catastrophe, cumulative hypotensive response

BP—blood pressure; CNS—central nervous system; CO—cardiac output; ICU—intensive care unit; IV—intravenous; SVR—systemic vascular resistance.

FIGURE 8-34

Sodium nitroprusside remains the treatment of choice in virtually all hypertensive crises requiring rapid blood pressure control with parenteral therapy. However, other parenteral antihypertensive agents may be useful in certain circumstances.