



# **Management of Perioperative Hypertension in Non-Cardiac Surgery**

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# **CV Risk at the Peri-operative Period The Size of the Problem in the Europe**

- ✓ **7 million major surgical procedures annually**
- ✓ **More than 150.000 patients suffered from major cardiac complication**
- ✓ **In the age group 75+, 12% of the women and 18% of the men have some degree of CVD**
- ✓ **By the year 2020, the elderly population will be increased by >50% and the annually conducted procedures by 25%**



# CV Risk at the Peri-Operative Period

## The Size of the Problem

- ✓ Hypertension is a leading cause of death and disability in most Western societies
- ✓ Hypertension is the **most frequent preoperative abnormality in surgical patients**, with an overall prevalence of 20–25%.
- ✓ Preexisting hypertension is the most common medical reason for postponing surgery.



# Peri-Operative Hypertension

Hypertension occurring 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



# Pathophysiology of Perioperative HTN

- ✓ Increase SVR, increase preload
- ✓ Adrenergic stimulation (cardiac and neural)
- ✓ Baroreceptor denervation
- ✓ Rapid intravascular volume shifts
- ✓ Renin angiotensin activation
- ✓ Serotonergic overproduction
- ✓ Altered cardiac reflexes



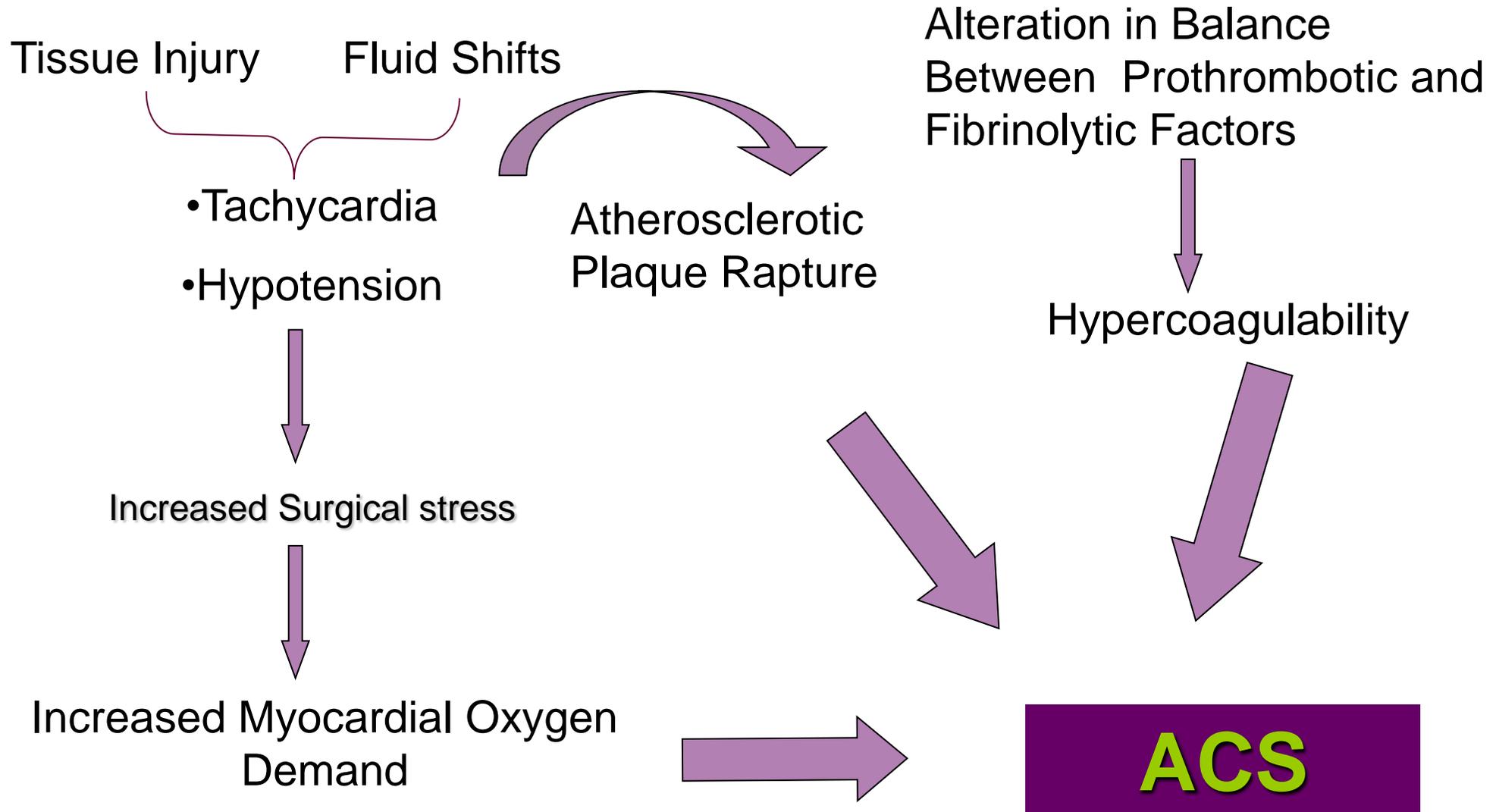
# Effects of Peri-Operative Hypertension

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



# Surgical Risk for Cardiac Events: Pathophysiology





# Pre-Operative Evaluation of a Hypertensive Patient Common Practice

- ✓ **Pts with well-controlled EH** are less likely to experience intraoperative BP lability and postoperative complications than pts with poorly controlled EH
- ✓ The ideal circumstance is to normalize BP for several months prior to elective surgery
- ✓ **In pts with grade I-II EH**, there is no evidence that delay in surgery in order to optimize therapy is beneficial



# Pre-operative Evaluation Of A Hypertensive Patient Common Practice

- ✓ In pts with grade III EH (BP > 180/110 mmHg) the potential benefits of delay surgery to optimize the pharmacological treatment should be weighted against the risk of delaying the surgical procedure.
- ✓ In case of urgent surgery the patient should be treated with a parenteral drug acutely
- ✓ Pts who are taking chronic antihypertensive treatment should continue taking their medications until the time of surgery



# Initial Pre-operative Evaluation Of Hypertensive Patient

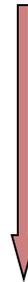
- ✓ **History**
- ✓ **Physical examination**
- ✓ **Laboratory evaluation**
- ✓ **ECG**



# Surgical Risk for Cardiac Events



**Surgery - specific factors**



**Type Of Surgery**

- Low Risk
- Intermediate Risk
- High Risk



**Circumstances**

- Emergent
- Urgent
- Elective



**Patient-specific factors**

**Co-Morbidities**



# Type Of Surgery and Estimated 30–day Cardiac Events Rates (Cardiac Death and MI)

<b>Surgical risk estimate (modified from Boersma et al.)</b>		
<b>Low-risk &lt;1%</b>	<b>Intermediate-risk 1-5%</b>	<b>High-risk &gt;5%</b>
<ul style="list-style-type: none"><li>▪ Breast</li><li>▪ Dental</li><li>▪ Endocrine</li><li>▪ Eye</li><li>▪ Gynaecology</li><li>▪ Reconstructive</li><li>▪ Orthopaedic-minor (knee surgery)</li><li>▪ Urologic – minor</li></ul>	<ul style="list-style-type: none"><li>▪ Abdominal</li><li>▪ Carotid</li><li>▪ Peripheral arterial angioplasty</li><li>▪ Endovascular aneurysm repair</li><li>▪ Head and neck surgery</li><li>▪ Neurological / orthopaedic – major (hip and spine surgery)</li><li>▪ Pulmonary renal/liver transplant</li><li>▪ Urologic - major</li></ul>	<ul style="list-style-type: none"><li>▪ Aortic and major vascular surgery</li><li>▪ Peripheral vascular surgery</li></ul>



# AHA/ACC: Clinical Predictors of Increased Perioperative CV Risk (MI, HF, Death) (I)

## ✓ Major

Unstable coronary syndrome

- ✓ Acute or recent MI with evidence of important ischemic risk by clinical symptoms or noninvasive study
- ✓ Unstable or severe angina (Canadian Class III or IV)

Decompensated heart failure

Significant arrhythmias

High-grade atrioventricular block

- ✓ Symptomatic ventricular arrhythmias in the presence of underlying heart disease
- ✓ Supra ventricular arrhythmias with controlled ventricular rate

Severe valvular disease



# AHA/ACC: Clinical Predictors of Increased Perioperative CV Risk (MI, HF, Death) (II)

## ✓ **Intermediate**

Mild angina pectoris (Canadian Class I or III)

Previous MI by history or pathological Q waves

Compensated or prior heart failure

Diabetes mellitus (particularly insulin-dependent)

Renal insufficiency

## ✓ **Minor**

Advanced age

Abnormal ECG (left ventricular hypertrophy, left bundle-branch block, ST-T abnormalities)

Rhythm other than sinus (e.g., atrial fibrillation)

Low functional capacity (e.g., inability to climb one flight or stairs with a bag of groceries)

History of stroke

Uncontrolled systemic hypertension



# LEE Index

## Six Major Predictors:

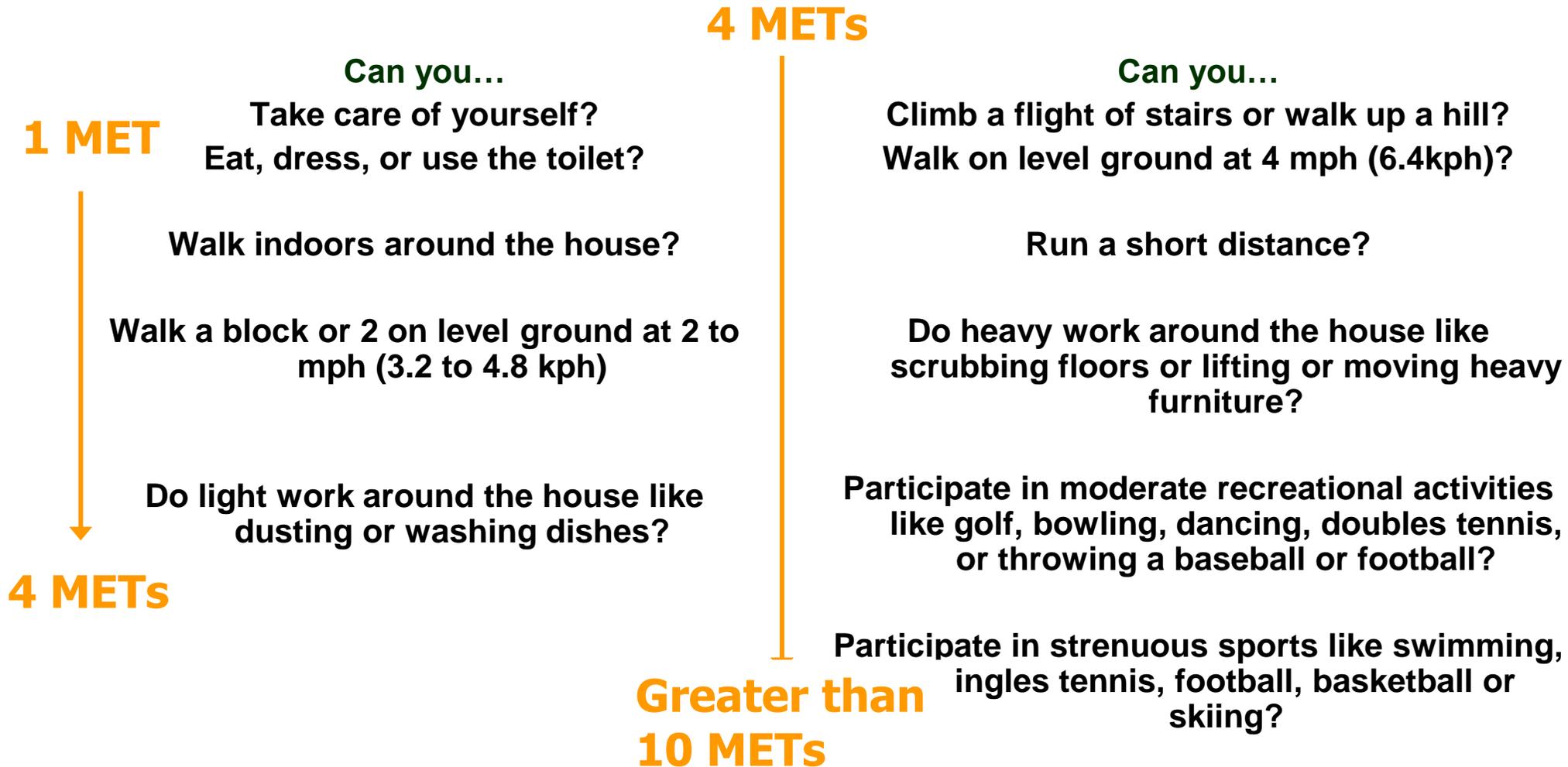
1. Ischemic Heart Disease
2. Cerebrovascular Disease
3. Heart Failure
4. Insulin Depended Diabetes Mellitus
5. Impaired Renal Function
6. High Risk Surgery

✓ Each predictor contributes equally 1 point

Score	Risk
0	0.4%
1	0.9%
2	7%
>3	11%



# Assessment of Functional Capacity





# Value of Pre-operative Cardiac Evaluation and the Urgency of Surgery

- ✓ **In emergency procedures** (major trauma, ruptured abdominal aortic aneurysm), cardiac evaluation will not influence the course of the intervention but may influence the management in the immediate post operative period.
- ✓ **In non-emergent but urgent untreated surgical conditions** (bowel obstruction), cardiac evaluation may influence the peri-operative measures taken to reduce the cardiac risk and the type of operation guiding to less invasive interventions but will not influence the decision to perform the intervention

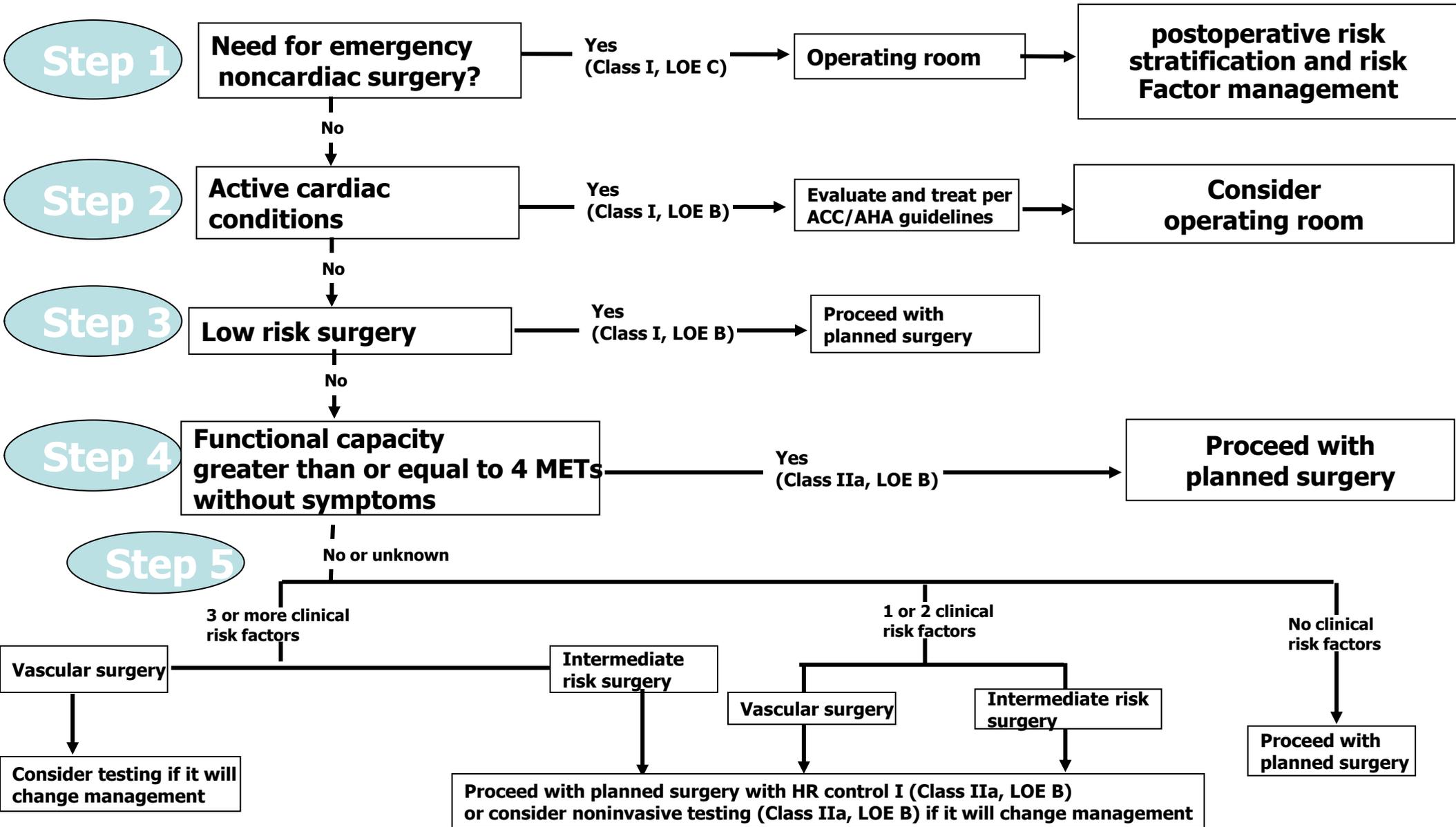


# **Hypertension And Non-cardiac Surgery Clinical Algorithm Based On 5 Steps**

- 1. Is the operation urgent ?**
- 2. Has the patients any active cardiac condition?**
- 3. Which is the surgery-specific risk?**
- 4. Which is the functional capacity of the patient?**
- 5. Has the patient other clinical risk factors?**



# Cardiac Algorithm For Noncardiac Surgery





## The last thing the patient see prior to surgery



*“Don’t worry Mr. Jones:  
everything will be just fine...”*



# Perioperative Control of Hypertension

## General Measures

- ✓ It is important to know if the patient had HBP before surgery and he was use to take antihypertensive treatment
- ✓ The effective pre-operative management of HBP is often the key to success for the control of HBP during the perioperative period. If preoperative BP > 180/110, the surgery should be deferred.
- ✓ HBP during surgery can be properly managed by analgesia and anesthesia and most of the modern anesthetic have a BP lowering effect
- ✓ Hypoxia and hypercapnia may increase BP by SNS activation
- ✓ All these issue should be considered and treated appropriately before any antihypertensive drug is given



# BP Response During Anesthesia

- ✓ **During the induction of anesthesia**, sympathetic activation can cause the BP to rise by 20 - 30 mmHg and the HR to increase by 15 - 20 bpm in normotensive individuals. **These responses may be more pronounced in patients with untreated hypertension**
- ✓ **As the period of anesthesia progresses**, patients with preexisting hypertension are more likely to experience **intraoperative BP lability** (either hypotension or hypertension), which may lead to myocardial ischemia
- ✓ **During the immediate postoperative period** as patients recover from the effects of anesthesia, BP and HR slowly increase
- ✓ **There is no evidence of superiority of any specific anaesthetic agent in non-cardiac surgery**



# Etiology of Intraoperative Hypertension

Preexisting causes	Undiagnosed or poorly controlled hypertension, pregnancy induced hypertension.
Increased sympathetic tone	Inadequate analgesia, inadequate anesthesia, Hypoxemia, Airway manipulation like laryngoscopy, extubation etc, Hypercapnia
Drug overdose	Adrenaline, epinephrine, ketamine, and ergometrine
Others	Hypervolemia, Aortic cross clamping, Phaeochromocytoma, and malignant hyperthermia



**An anesthesiologist is a doctor**

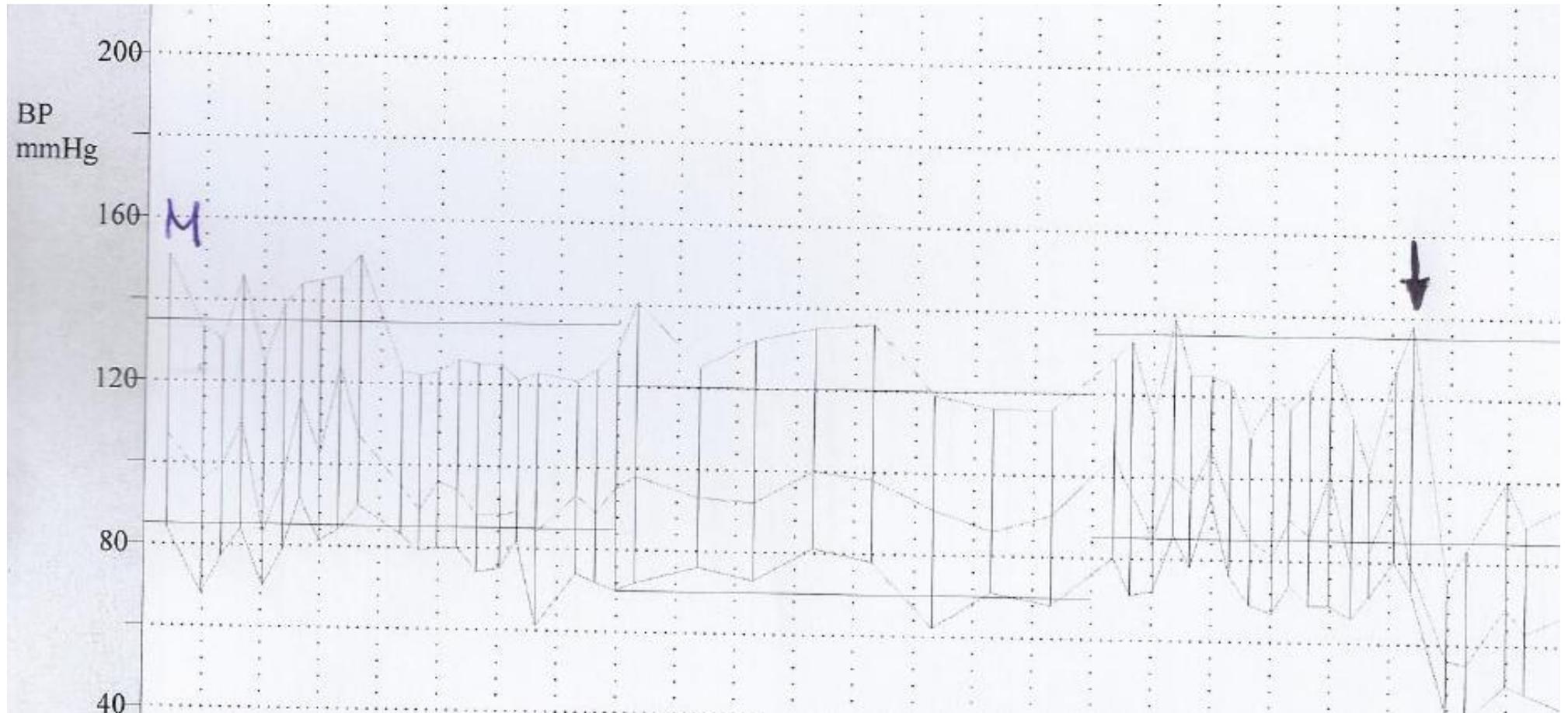
**“half asleep”**

**who keeps a patient**

**“half awake”.**



# ABPM: Pre and Perioperative Measurements in a Lady 83 years old





# Properties of the Ideal Drug for Perioperative BP Control

- ✓ Easy to prepare, stable at ambient temperature and light
- ✓ Given by continuous intravenous infusion
- ✓ Compatible with range of diluents
- ✓ Easily titrable, with rapid onset and short duration of action
- ✓ Free of untoward or undesirable effects

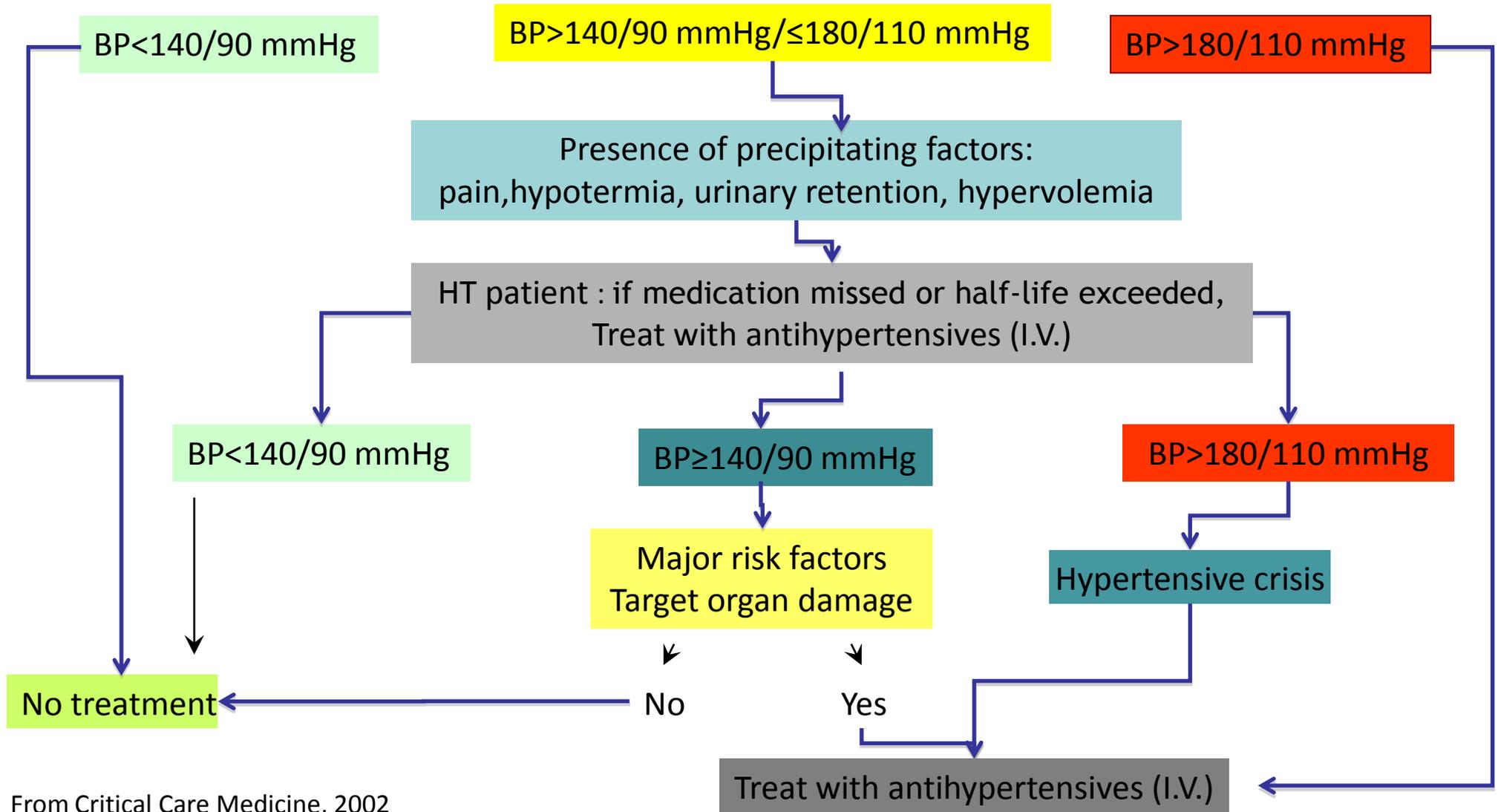


# Properties of the Ideal Drug for Perioperative BP Control-2

- ✓ Free of effects on intracardiac conduction
- ✓ Mild reduction in myocardial contractility
- ✓ Vasodilator effects should be mostly confined to the arteriolar bed (i.e. resistance vessels)
- ✓ Vasodilator effects preferentially in vital organ beds, e.g. coronary, renal, splanchnic
- ✓ Effective treatment should maximise protective effects against complication of HTN, i.e. myocardial infarction



# Treatment Algorithm Of Perioperative Hypertension





## Preoperative $\beta$ 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 asthmatic attack, major disadvantage



# POISE Trial

- ✓ The biggest randomized controlled trial (N=8351)
- ✓ Patients with known CVD or >3 risk factors or major vascular surgery
  - ✓ 100 mg metoprolol 2h prior operation
  - ✓ 100 mg metoprolol 6h after operation
  - ✓ 100 mg metoprolol maintenance dose 12h later

➤ **30% decrease in non-fatal MI**

➤ **33% increase in total mortality**

➤ **2 fold increase in strokes**

**Probably due to Metoprolol  
Induced Hypotension**



# Perioperative $\beta$ -Blockers – POISE Trial

	<b>Metoprolol (n=4174)</b>	<b>Placebo (n=4177)</b>	<b>P value</b>
<b>Primary composite*</b>	<b>5.8%</b>	<b>6.9%</b>	<b>.04</b>
<b>Nonfatal MI</b>	<b>3.6%</b>	<b>5.1%</b>	<b>.0007</b>
<b>Total mortality</b>	<b>3.1%</b>	<b>2.3%</b>	<b>.03</b>
<b>Stroke</b>	<b>1.0%</b>	<b>0.5%</b>	<b>.005</b>
<b>Signif hypotension</b>	<b>15.0%</b>	<b>9.7%</b>	<b>&lt;.0001</b>
<b>Signif bradycardia</b>	<b>6.6%</b>	<b>2.4%</b>	<b>&lt;.0001</b>



# Risk Reduction using B-blockers

Lee index >3                      →                      Significant decrease in mortality

Lee index = 1 or 2                      →                      No significant difference

Lee index = 0                      →                      Increase in mortality

Preoperative b-blocker withdrawal                      →                      Increase in mortality



## **Recommendations on ACE inhibitor use**

**For a hypertensive patient already receiving ACE inhibitors they should be discontinued 24 hours before surgery and resume after patient's endovascular volume has been stabilized. When they are prescribed for heart failure their discontinuation at the preoperative phase should be examined more carefully**



# Effects of Discontinuation of AIIA Before Surgery on Hemodynamic Events In Hypertensive Patients Crhonicly Treated With AIIA

	Group I (AIIA withdrawn)	Group II (AIIA given)	p
<b>Systolic blood pressure</b>			
Preinduction	159 ± 24	151 ± 26	NS
Postinduction	126 ± 33	109 ± 24	NS
Intubation	136 ± 34	121 ± 33	NS
Lowesr value	159 ± 24	151 ± 26	NS
<b>Episodes of hypotension (No.)</b>	1 ± 1	2 ± 1	<0.01
<b>Patients with at least 1 episode (No.)</b>	12	19	<0.01
<b>Duration of episodes (min)</b>	3 ± 4	8 ± 7	<0.01
<b>Patients receiving ephedrine (No.)</b>	12	17	NS
<b>Dose of ephedrine (mg)</b>	10 ± 10	15 ± 9	NS
<b>Patients receiving neosynephrine</b>	0	5	<0.02
<b>Dose of neosynephrine (µg)</b>	0 ± 0	47 ± 86	<0.05



## **Preoperative ACE inhibitors & AT-1 antagonists:**

- ✓ Controversy regarding exaggerated hypotension
- ✓ As long as euvolemia, no hypotension

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

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



# Recommendations On Calcium Channel Blockers

<b>Recommendations</b>	<b>Class<sup>a</sup></b>	<b>Level<sup>b</sup></b>
<b>It is recommended that calcium channel blockers be continued during non-cardiac surgery in patients with Prinzmetal angina pectoris</b>	<b>I</b>	<b>C</b>
<b>Heart rate-reducing calcium channel blockers, in particular diltiazem, may be considered before non-cardiac surgery in patients who have contra-indications to <math>\beta</math>-blockers</b>	<b>IIb</b>	<b>C</b>
<b>Routine use of calcium channel blockers to reduce the risk of perioperative cardiovascular complications is not recommended</b>	<b>III</b>	<b>C</b>

<sup>a</sup>Class of recommendation

<sup>b</sup>Level of evidence



# Agents Used In The Management of Perioperative Hypertension, Preferred Conditions, and Dosing-1

<b><i>Agent</i></b>	<b><i>Conditions</i></b>	<b><i>Dosing</i></b>
<b>Enalaprilat</b>	<b>Congestive heart failure</b>	<b>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.</b>
<b>Esmolol</b>	<b>Acute myocardial ischemia</b>	<b>Loading dose of 500–1000 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 300 µg/kg/min</b>
<b>Fenoldopam</b>	<b>Acute myocardial ischemia/Acute pulmonary edema/diastolic dysfunction, AIT/intracerebral bleed Acute renal failure/microangiopathic anemia Hypertensive encephalopathy Sympathetic crisis</b>	<b>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.</b>



# Agents Used in The Management of Perioperative Hypertension, Preferred Conditions, and Dosing-2

<b>Agent</b>	<b>Conditions</b>	<b>Dosing</b>
<b>Labetalol</b>	<b>Acute aortic dissection Acute myocardial ischemia<sup>a</sup> Acute ischemic stroke/intracerebral bleed Eclampsia/Preeclampsia Hypertensive encephalopathy</b>	<b>Initial bolus 20 mg, followed by boluses of 20–80 mg or an infusion starting at 1–2 mg/min and titrated up to until the desired hypotensive effect is achieved is particularly effective. Bolus injections of 1 to 2 mg/kg have been reported to produce precipitous falls in BP and should therefore be avoided; maximum cumulative dose of 300 mg over 24 h</b>
<b>Nicardipine</b>	<b>Acute myocardial ischemiac Acute renal failure/microangiopathic anemia Acute ischemic stroke/intracerebral bleed Eclampsia/preeclampsia Hypertensive encephalopathy Sympathetic crisis/cocaine overdose</b>	<b>5 mg/h; titrate to effect by increasing 2.5 mg/h every 5 min to a maximum of 15 mg/h.</b>



<b>Agent</b>	<b>Dosage</b>	<b>Onset</b>	<b>Duration</b>
Nitroprusside	0.5 – 10 ug/kg/min	30-60sec	1-5 mins
Nitroglycerine	0.5 – 10 ug/kg/min	1 min	3 – 5mins
Esmolol	0.5mg/kg in 1 min 50 – 300 ug/kg/min infusion	1 min	12-20 mins
Labetolol	5-20 mg	1-2mins	4-8 hrs
Propranalol	1-3 mg	1-2 mins	4-6 hrs
Trimethaphan	1-6 mg / min	1-3 mins	10-30 mins
Fentolamine	1-5 mg	1 – 10 mins	20-40 mins
Diazoxide	1-3 mg /kg slowly	2-10 mins	4 – 6 hrs
Hydralazine	5-20 mg	5-20 mins	4-8 hrs
Nifedipine s/l	10 mg	5-10 mins	4 hrs
Methyl dopa	250 – 1000 mg	2-3 hrs	6-12 hrs
Nicardipine	0.25 – 0.5 mg	1-5 mins	3-4 hrs
Enalapril	0.625 – 1 mg <sup>39</sup>	6-15 mins	4-6 hrs
Fenoldopam	0.1 – 1.6 ug/kg/min	5 mins	5 mins



# Perioperative management of hypertension

## Risk factors and diagnostic approach

### Key Issues

1. Hypertension is a very common preoperative abnormality in surgical patients and is accompanied by multiple other CV risk factors
2. Preoperative evaluation is an opportunity to check and optimize the control of high BP
3. The extent of diagnostic approach beyond history, physical examination, laboratory evaluation and ECG depends on
  - > the urgent of surgery and the surgery-specific risk
  - > The presence of active cardiac condition and other risk factors
  - > the functional capacity of the patient



# Perioperative Management of HTN: Key Issues-1

- ✓ Some surgical procedure are associated with a high incidence of HTN: carotid endoarterectomy, head and neck surgery, aortic and peripheral vascular surgery
- ✓ BP levels  $> 180/110$  mmHg should be controlled prior to surgery; for elective surgery (cardiac, vascular), effective BP control can be achieved over several days to weeks of outpatient treatment
- ✓ Uncontrolled HTN before surgery is associated with wider fluctuations of BP during induction of anesthesia and intubation and may increase the risk for perioperative ischemic events
- ✓ Surgical candidates with controlled HTN should maintain their medications until the time of surgery (except for ACEI and ARB's), and therapy should be re-instituted as soon as possible postoperatively



# Perioperative Management Of HTN: Key Issues-2

- ✓ **If a patients develops intraoperative HTN**, it is necessary ascertain that other causes of HTN have been ruled out (hypercarbia, distend bladder, hypertemia, hypoxia)
- ✓ **In urgent situations**, rapidly acting parenteral agents can be utilized to achieve BP control very rapidly
- ✓ **Sudden intraoperative HTN** is managed by the same parenteal antihypertensive agents that are utilized in the management of hypertensive emergencies
- ✓ **HTN is very common in the early postoperative period** and is related to increased sympathetic tone and vascular resistance that follows pain and increased intravascular volume, and may require parenteral drug and/ or (if possible) the re-insitution of previous oral treatment.



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### PERIOPERATIVE SCREENING AND MANAGEMENT OF HYPERTENSIVE PATIENTS

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**Perioperative management of hypertension: A position paper of the Working Group “Hypertension and the Heart” of the European Society of Cardiology**

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