

## Managing Hypertension in the Perioperative Arena



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## Optimizing Perioperative Management Strategies for Hypertension in the Cardiac Surgical Patient

### Objectives:

- **Treatment of hypertensive emergencies.**
- **Precise control of arterial pressure.**
  - Avoid end-organ hypoperfusion.
- **Minimize the adverse effects of therapy.**
  - Hypotension
  - Adverse drug reactions

### 7<sup>th</sup> Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, May 2003

Table 1. Classification and management of blood pressure for adults<sup>a</sup>

BP CLASSIFICATION	SBP <sup>b</sup> mmHg	DBP <sup>b</sup> mmHg	LIFESTYLE MODIFICATION	INITIAL DRUG THERAPY	
				WITHOUT COMPELLING INDICATION	WITH COMPELLING INDICATIONS (SEE TABLE B)
NORMAL	<120	and <80	Encourage		
PREHYPERTENSION	120-139	or 80-89	Yes	No antihypertensive drug indicated.	Drug(s) for compelling indications. <sup>c</sup>
STAGE 1 HYPERTENSION	140-159	or 90-99	Yes	Thiazide-type diuretics for most. May consider ACEI, ARB, BB, CCB, or combination.	Drug(s) for the compelling indications. <sup>c</sup> Other antihypertensive drugs (diuretics, ACEI, ARB, BB, CCB) as needed.
STAGE 2 HYPERTENSION	≥160	or ≥100	Yes	Two-drug combination for most <sup>d</sup> (usually thiazide-type diuretic and ACEI or ARB or BB or CCB).	

#### Objectives for the treatment of essential hypertension:

- Decrease stroke risk by 35% - 40%
- Decrease heart attack risk by 20% - 25%
- Decrease heart failure (CHF) risk by 50%
- Prevent 1 death in every 9 - 10 patients.

### JNC 7: Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, May 2003

#### Hypertensive Urgencies and Emergencies

Patients with marked BP elevations and acute target-organ damage

- Life-threatening Arterial Bleeding
- Aortic Dissection or Aneurysm
- Myocardial Infarction
- Unstable Angina
- Pulmonary Edema
- Encephalopathy
- Stroke
- Head Trauma
- Eclampsia (Accumulating the Cobra, Courtesy of J. E. Bavaria, M.D.)

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#### ACC/AHA PRACTICE GUIDELINES—FULL TEXT

#### ACC/AHA Guideline Update on Perioperative Cardiovascular Evaluation for Noncardiac Surgery

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1996 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery)

#### III. Disease-Specific Approaches: Hypertension

Class	SBP	DBP	Recommendation
Stage 1	140-159	85-99	Not an independent risk
Stage 2	160-179	100-109	Not an independent risk
Stage 3	≥180	≥110	Control before surgery

Eagle KA, et al. Circulation 2002;105:1257-67

Brit. J. Anaesth. (1971), 43, 122

#### STUDIES OF ANAESTHESIA IN RELATION TO HYPERTENSION I: CARDIOVASCULAR RESPONSES OF TREATED AND UNTREATED PATIENTS\*

BY  
C. PRYS-ROBERTS, R. MELOCHE AND P. FOËX  
with the technical assistance of A. RYDER

#### SUMMARY

The cardiovascular responses to the induction, maintenance, and recovery from anaesthesia with thiopentone, nitrous oxide and halothane, have been studied in seven elderly normotensive patients, seven untreated hypertensive patients, and fifteen patients under treatment with a variety of anti-hypertensive drugs. In five untreated and three treated hypertensive patients, all of whom had high arterial pressures before anaesthesia, severe reduction of arterial pressure occurred during anaesthesia and was associated with electrocardiographic evidence of myocardial ischaemia. Other treated hypertensive patients, whose arterial pressures were well controlled, behaved in a similar manner to the normotensive patients, and gave no ground for concern during anaesthesia. Cardiac output fell to the same extent (30 per cent) in all three groups, and where a great reduction of arterial pressure occurred it was largely due to reduction of initially high systemic vascular resistance. Baroreflex control of heart rate was significantly depressed in hypertensive patients both before and during anaesthesia. It is concluded that untreated high arterial pressure constitutes a serious risk to patients undergoing anaesthesia and surgery, and therefore anti-hypertensive therapy should not be withdrawn prior to anaesthesia without a compelling reason.

### Risks of General Anesthesia and Elective Operation in the Hypertensive Patient

Lee Goldman, M.D., and Debra L. Caldera, R.N.†

To determine the risks of general anesthesia and elective surgical procedures in patients who have histories of hypertension, the authors prospectively studied 876 consecutive operations in a series of patients more than 40 years old. All patients were examined preoperatively, monitored intraoperatively, and closely followed postoperatively. Although patients with higher preoperative blood pressure values had larger declines intraoperative blood pressure decreases, the mean intraoperative systolic pressure nadire in patients with tightly-controlled hypertension (100 ± 2 mm) did not differ from those in patients with persistent treated (87 ± 3 mm) or untreated (88 ± 2 mm) mild to moderate hypertension. Similarly, among these three groups of patients, the needs for intraoperative adrenergic agents or fluid challenges (20, 33, and 37 per cent, respectively) and the incidences of peri-

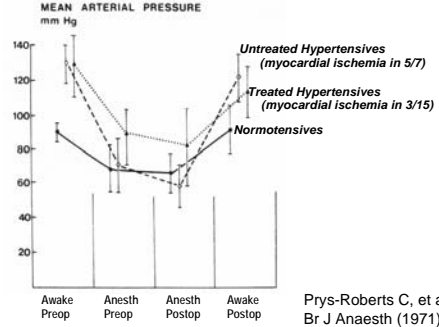
operative hypertensive events (27, 25, and 20 per cent, respectively) were not significantly different. Multivariate analysis of data for the patients with histories of hypertension showed that neither the preoperative in-hospital diastolic nor preoperative in-hospital systolic blood pressure values independently correlated with any of these three indices of perioperative blood pressure lability, with the development of cardiac arrhythmias, ischemia, or failure, or with postoperative renal failure. Effective intraoperative management may be more important than preoperative hypertensive control in terms of decreasing clinically significant blood pressure lability and cardiovascular complications in patients who have mild to moderate hypertension. (Key words: Blood pressure; hypertension; hypotension. Heart; arrhythmias; failure; infection.)

Treated and untreated hypertensives (n=676), DBP <110 mm Hg

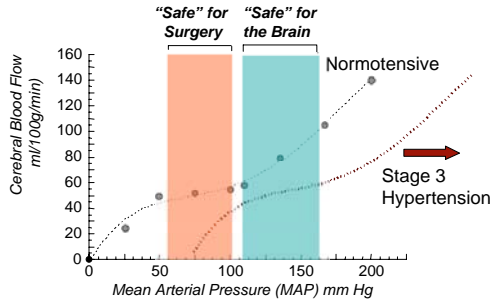
Risk factors for perioperative cardiac morbidity and mortality:

- 50% decrease in BP.
- 33% decrease in BP lasting more than 10 min.

### Managing Intraoperative Hypertension

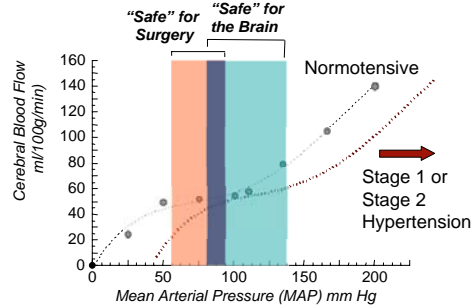


### Relation Between Arterial Pressure and Cerebral Blood Flow



Autoregulatory Range = Baseline MAP ± 20%

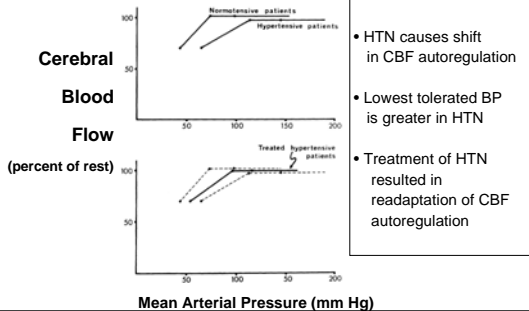
### Relation Between Arterial Pressure and Cerebral Blood Flow



Autoregulatory Range = Baseline MAP ± 20%

### Autoregulation of Cerebral Blood Flow in Hypertensive Patients in Response to Trimethaphan

Strandgaard S. Circulation 1976;53:720-7



### Should a Moratorium Be Placed on Sublingual Nifedipine Capsules Given for Hypertensive Emergencies and Pseudoemergencies?

Grossman E, Messerli H, Grdzicki T, Kowey P. JAMA 1996;276:1328-31

Reference	Patient Age, y/sex	Nifedipine Dose, mg	Initial BP, mm Hg	Treated BP, mm Hg	Symptoms/Signs	Outcome	Notes
49	72M	10	NA	NA	Aphasia and right hemiparesis	Recovered	
49	67F	10	NA	NA	Loss of consciousness	Recovered	
50	44M	10	270/140	160/100	Left hemiparesis	Recovered	2 episodes, 3 hrs apart in same patient
50	44M	10	260/120	160/90	Aphasia and right hemiparesis	Recovered	
51	63F	30	230/160	80/95	Slurred, ECG changes (inverted T waves, inferior wall)	Recovered	3 doses of 10 mg each, 30-45 min apart
51	33F	30	220/140	110/NA	Dizziness, nausea, sublingual discomfort, lateral T wave inversion	Recovered	
51	36M	20	230/170	100/70	Epileptic pain, dizziness, diaphoretic nonapical T wave inversion (bilateral leads)	Recovered	
52	79F	20	200/140	100/NA	Syncope, complete heart block	Recovered	2 doses of 10 mg each, 7 h apart
53	67F	10	260/120	80/90	MI with typical ECG changes and elevated enzymes	Recovered	Catheterization showed 3-vessel CAD
54	56F	10	180/110	85/NA	Profound, ST-segment depression	Recovered	
54	62F	10	230/130	80/NA	Acute anterior wall MI diagnosed by ECG and enzymes	MI	
54	55M	10	180/120	85/NA	Acute anterior wall MI diagnosed by ECG and enzymes	MI	
55	49M	10	110/84	80/80	Acute anterior wall MI diagnosed at autopsy	Dead	Sublingual nifedipine given for unstable angina
55	62M	10	NA	NA	Acute retroperitoneal wall MI diagnosed at autopsy	Dead	Sublingual nifedipine given for unstable angina
56	62F	10	110/70	70/45	Sinus arrest	Recovered	Sublingual nifedipine given for pregnancy-induced hypertension
57	37F	10	180/110	90/58	Fetal distress	Cesarean	Sublingual nifedipine given for pregnancy-induced hypertension

\*BP indicates blood pressure; NA, not available; ECG, electrocardiogram; MI, myocardial infarction; CAD, coronary artery disease; and NM, not mentioned.

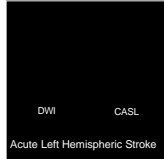
## Guidelines for the Early Management of Patients with Ischemic Stroke

ASA Scientific Statement. Stroke 2003;34:1056-83

### Approach to Elevated Blood Pressure in Acute Ischemic Stroke

#### A. Not Eligible for Thrombolytic Therapy

- SBP < 220 or DBP < 120 No treatment
- SBP > 220 or DBP > 121 10-15% reduction in BP
- DBP > 140 10-15% reduction in BP



#### B. Eligible for Thrombolytic therapy

- SBP > 185 or DBP > 110 Achieve SBP ≤ 185 and DBP ≤ 110

## Antihypertensive Agents and Acute Coronary Syndromes

### EFFECT OF SHORT-TERM INFUSION OF SODIUM NITROPRUSSIDE ON MORTALITY RATE IN ACUTE MYOCARDIAL INFARCTION COMPLICATED BY LEFT VENTRICULAR FAILURE

Results of a Veterans Administration Cooperative Study

JAY N. COHN, M.D., JOSEPH A. FRANCOIA, M.D., GARY S. FRANCIS, M.D., DONALD ARCHIBALD, M.A., FELIX TRIBITANI, M.D., ROSE FLETCHER, M.D., ALFREDO MONTERO, M.D., GUILLERMO CONTRON, M.D., JANICE CLARKE, M.D., DAVID HAGER, M.D., ROBERT SAUNDERS, M.D., FREDERICK COBE, M.D., RAPHAEL SMITH, M.D., HENRY LOER, M.D., AND HAROLD SETTLE, M.D.

**Abstract** Eight hundred twelve men with presumed acute myocardial infarction and left ventricular filling pressure of at least 12 mm Hg participated in a randomized double-blind placebo-controlled trial to assess the efficacy of a 48-hour infusion of sodium nitroprusside. The mortality rates at 21 days (10.4 per cent in the placebo group and 11.5 per cent in the nitroprusside group) and at 13 weeks (19.0 per cent and 17.0 per cent, respectively) were not significantly affected by treatment. The efficacy of nitroprusside was related to the time of treatment; the drug had a deleterious effect in patients whose infusions were started within nine hours of the onset of pain (mortality at 13 weeks, 24.2 per cent vs. 12.7 per cent;  $P = 0.025$ ) and a beneficial effect in those whose infusions were begun later (mortality at 13 weeks, 14.4 per cent vs. 22.3 per cent;  $P = 0.04$ ). Nitroprusside should probably not be used routinely in patients with high left ventricular filling pressures after acute myocardial infarction. However, the results in the patients given late treatment suggest that those with persistent pump failure might receive sustained benefit from short-term nitroprusside therapy. (N Engl J Med. 1982; 306:1129-35.)

Nitrates should not be administered to patients with SBP < 90 mm Hg or with SBP more than 30 mm Hg below baseline.

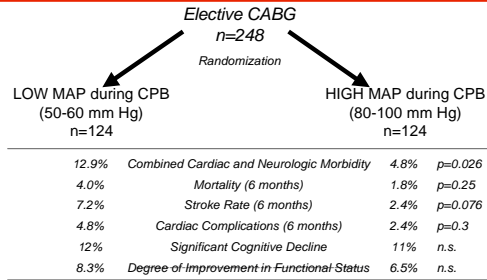
- AHA/ACC Guidelines for STEMI. Circulation 2004;110:588

## Improvement of Outcomes After Coronary Artery Bypass. A Randomized Trial Comparing intraoperative high versus low mean arterial pressure.

Gold JP, Hartman GS, Yao FSF, et al.

New York Hospital-Cornell Medical Center

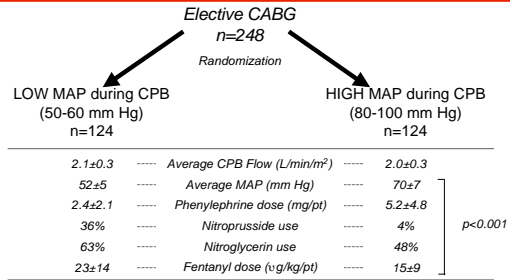
J Thorac Cardiovasc Surg 1995;110:1302-11



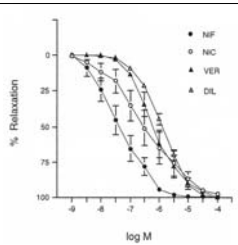
## Improvement of Outcomes After Coronary Artery Bypass. A Randomized Trial Comparing intraoperative high versus low mean arterial pressure.

Gold JP, Charlson ME, Williams-Russo P, et al.

J Thorac Cardiovasc Surg 1995;110:1302-11



## CABG with Arterial Grafts



Comparative study on calcium antagonists on human radial artery.

He GW, et al. J Thorac Cardiovasc Surg 2000;119:34-40

### Preventing Vasospasm

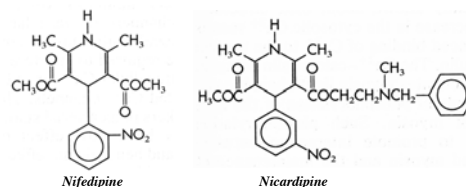
#### Acute Objectives:

- Arterio-selective vasodilation
- Prevent arterial spasm

#### Therapy:

1. Calcium antagonist
  - Nicardipine
  - Diltiazem
2. Nitroglycerin
3. Nitroprusside

## Selectivity of Calcium Channel Antagonists



IV Agent	Vasodilation	Myocardial Depression	SA Node Suppression	AV node Suppression
Nicardipine	5	0	0	0
Diltiazem	3	2	5	4
Verapamil	4	4	5	5

### Angiotensin-Converting Enzyme Inhibitors (ACE-I) Role in Cardiac Surgery

Statement from the Council on the Kidney in Cardiovascular Disease and the Council for High Blood Pressure Research of the AHA. Circulation 2001;104:1985

#### Clinical Indications:

- Essential hypertension
- CHF (compensated)
- Diabetic and non-diabetic nephropathy

#### Contraindications (Risk of Acute Renal Failure):

- MAP insufficient for renal perfusion
- Low cardiac output
- Volume depletion
- Renal vascular disease

### Beta-Blockers: Role in Cardiac Surgery

#### Clinical Indications:

- Atrial fibrillation prophylaxis
- CHF (compensated)
- Myocardial ischemia or infarction
- Aortic aneurysm
- Non-cardiac operations (high risk for CAD)

#### Contraindications:

- Decompensated CHF
- Regurgitant valve lesions
- Reactive airway disease
- Bradycardia

### Beta-Blockers: Role in Cardiac Surgery

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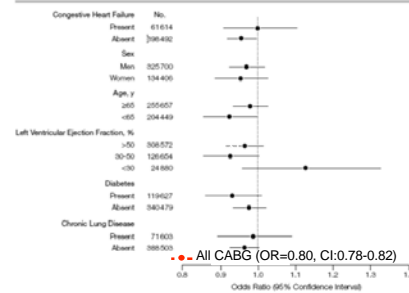
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### Beta-Blockers: Role in Cardiac Surgery

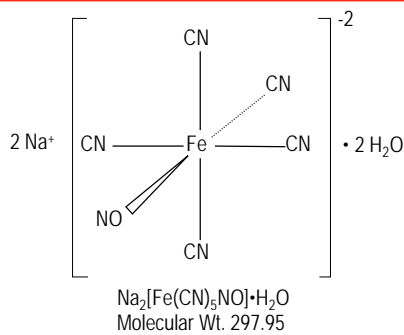
#### Relative Risk/Benefit of Preoperative Beta-Blockade in Selected Subgroups



Analysis was performed on operative mortality using propensity-matched pairs from STS database of 629,877 CABG patients spanning 1996 to 1999.

Ferguson TB. JAMA 2002;287:2221-7

### Chemical Structure of Sodium Nitroprusside



### Use of Sodium Nitroprusside in Post-Coronary Bypass Surgery. A Plea for Conservatism.

Patel CB, Laboy V, Venus B, Mathru M, Wier D. Chest 1986;89:663-7

- Incidence of SNP Toxicity 7/292 (2.4%)
- Duration of SNP infusion 26 - 160 hr
- Total SNP Dose 1.8 - 12 mg/kg
- Signs of Toxicity Tachyphylaxis  
Encephalopathy
- Mortality 3/7 (43%)

### Cases of Probable Nitroprusside Toxicity

FDA (U.S.A.) Adverse Drug Reports: 1974 to 1992

#### Demographics (n = 52)

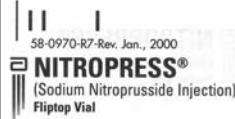
Age	< 1 year to 86 years
Gender	40% Female
Duration of Drug Therapy	< 1 day to 14 days

#### Outcome (n = 52)

Death	29 (56%)
Permanent Neurologic Injury	3 (6%)
Recovered	13 (25%)
Unknown	7 (13%)

*Chest 1992;102:1842*

### Nitroprusside: FDA “Black Box” Warning Label



After reconstitution with appropriate diluent, NITROPRESS® (Sodium Nitroprusside Injection) is not suitable for direct injection. The reconstituted solution must be further diluted in sterile 5% dextrose injection before infusion.

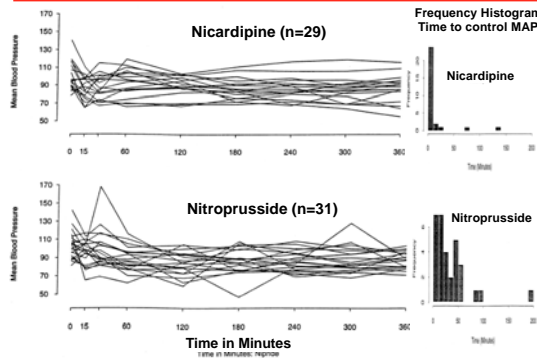
NITROPRESS can cause precipitous decreases in blood pressure (see DOSAGE AND ADMINISTRATION). In patients not properly monitored, these decreases can lead to irreversible ischemic injuries or death. Sodium nitroprusside should be used only when available equipment and personnel allow blood pressure to be continuously monitored.

Except when used briefly or at low (< 2 µg/kg/min) infusion rates, sodium nitroprusside gives rise to important quantities of cyanide ion, which can reach toxic, potentially lethal levels (see WARNINGS). The usual dose rate is 0.5-10 µg/kg/min, but infusion at the maximum dose rate should never last more than 10 minutes. If blood pressure has not been adequately controlled after 10 minutes of infusion at the maximum rate, administration of sodium nitroprusside should be terminated immediately.

Although acid-base balance and venous oxygen concentration should be monitored and may indicate cyanide toxicity, these laboratory tests provide imperfect guidance.

This package insert should be thoroughly reviewed before administration of NITROPRESS.

### NIC vs. NTP for HTN after CEA: *J Clin Anesth 2001;13:16-19* Dorman T, Thompson DA, Breslow MJ, et al.



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#### Clinical Investigations

### Postoperative hypertension: A multicenter, prospective, randomized comparison between intravenous nicardipine and sodium nitroprusside

NEIL A. HALPERN, MD, FCCM; MICHAEL GOLDBERG, MD; CONSTANCE NEELY, MD; ROBERT N. SLADEN, MBChB, MRCP(UK), FRCP(C); JOEL S. GOLDBERG, MD; JOANNE FLOYD, MD; GEORGE GABRIELSON, MD; ROBERT J. GREENSTEIN, MD, FRCS

### Principles of Blood Pressure Management To Improve Perioperative Outcomes

1. Balance risk of HTN versus risk of hypoperfusion.
2. Keep MAP within 20% of baseline values.
3. Recognize and avoid treatment adverse events.
4. Transition to agents with proven long-term benefit, e.g. beta-blockers, ACE-inhibitors, Calcium channel antagonists, diuretics (Level I evidence).