Optimal Perioperative Management of Arterial Blood Pressure

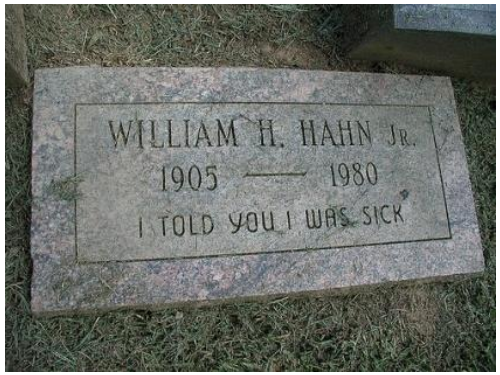
Alex Bekker, M.D, Ph.D.
Professor and Chairman
Rutgers New Jersey Medical School

MAP > ?? mmHg



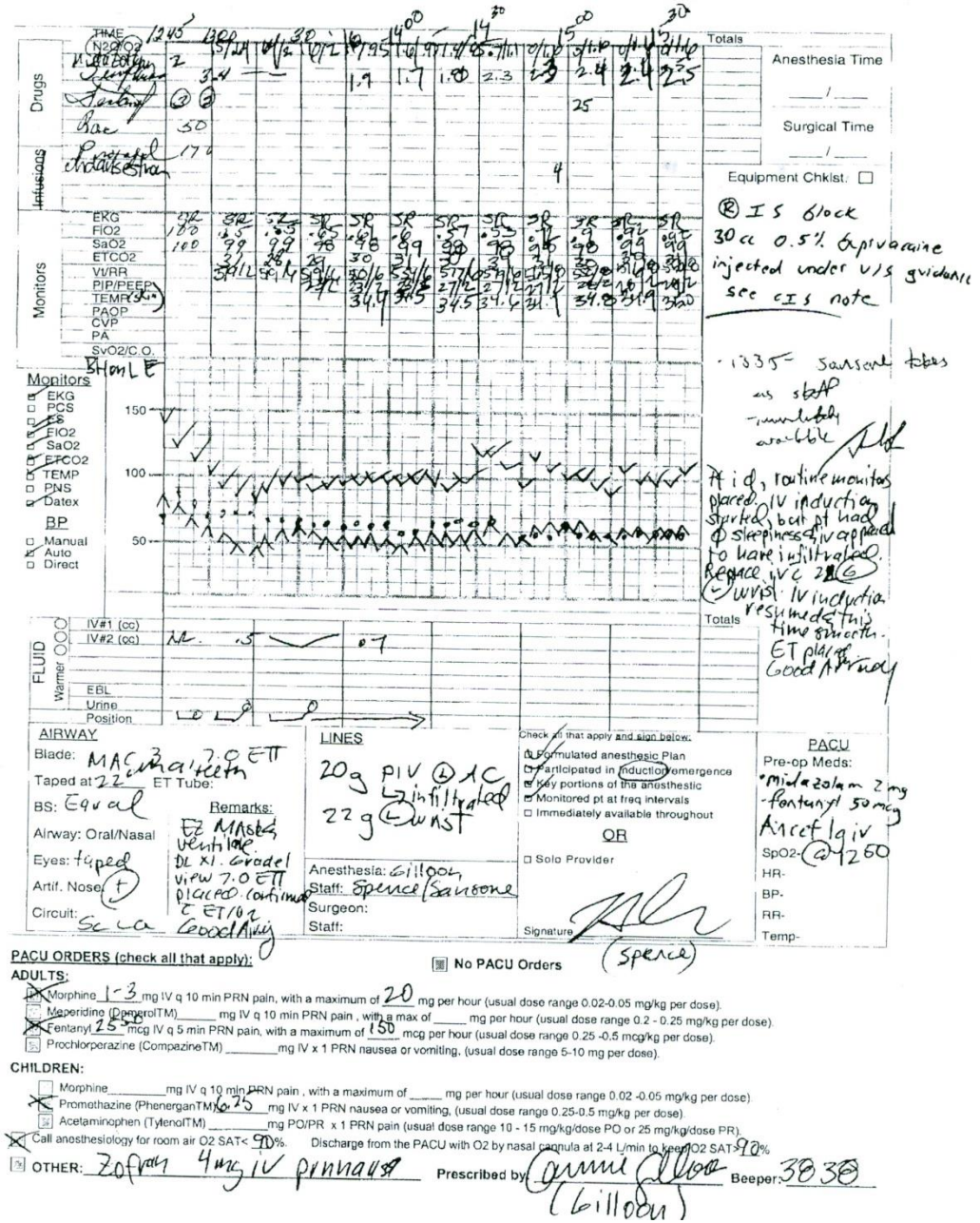
To go beyond is as wrong as to fall short. ~Confucius, *Analects*

MAP< ?? mmHg



HOW LOW IS LOW?

A 55 y.o. woman underwent arthroscopic shoulder surgery in the beach chair position. She received an interscalene block and general anesthesia. On emergence from anesthesia the patient was unable to follow commands and had left hemiplegia. CT scan revealed a large right-sided anterior cerebral and middle cerebral infarct. The CT angiography and MRI imaging of the carotid arteries did not demonstrate any pre-existing condition of those vessels.



Drugs
Infusions
Monitors
TIME
N2O/O2
Totals
Anesthesia Time
Surgical Time
Equipment Chklst.
R IS block
30 cc 0.5% bupivacaine injected under U/S guidance
see CIS note
1335 - Sansone takes as STAT - unavailable
At 1400, routine monitors placed. IV induction started, but pt had sleepiness, IV appeared to have infiltrated. Replace IV c 22G L wrist. IV induction resumed at this time smooth. ET placed. Good Airway
ECG
FIO2
SaO2
ETCO2
VT/RR
PIP/PEEP
TEMP
PAOP
CVP
PA
SvO2/C.O.
Monitors
EKG
PCS
ES
FIO2
SaO2
EtCO2
TEMP
PNS
Datex
BP
Manual
Auto
Direct
150
100
50
FLUID
Warmer
IV#1 (cc)
IV#2 (cc)
EBL
Urine
Position
AIRWAY
Blade: MAC 3
7.0 ETT
Taped at 22
ET Tube:
BS: Equal
Airway: Oral/Nasal
Eyes: taped
Artif. Nose
Circuit:
Remarks:
Ez MASK ventilate. DL x1. Grade I view 7.0 ETT placed. Confirmed ETCO2. Good Airway
LINES
20g PIV L AC
22g L wrist
Anesthesia: Gilldon
Staff: Spence/Sansone
Surgeon:
Staff:
Check all that apply and sign below:
Formulated anesthesic Plan
Participated in induction/emergence
Key portions of the anesthestic
Monitored pt at freq intervals
Immediately available throughout
OR
Solo Provider
Signature (Spence)
PACU
Pre-op Meds:
•Midazolam 2 mg
•Fentanyl 50 mcg
Ancef 1g iv
SpO2- @ 1260
HR-
BP-
RR-
Temp-

PACU ORDERS (check all that apply):
No PACU Orders

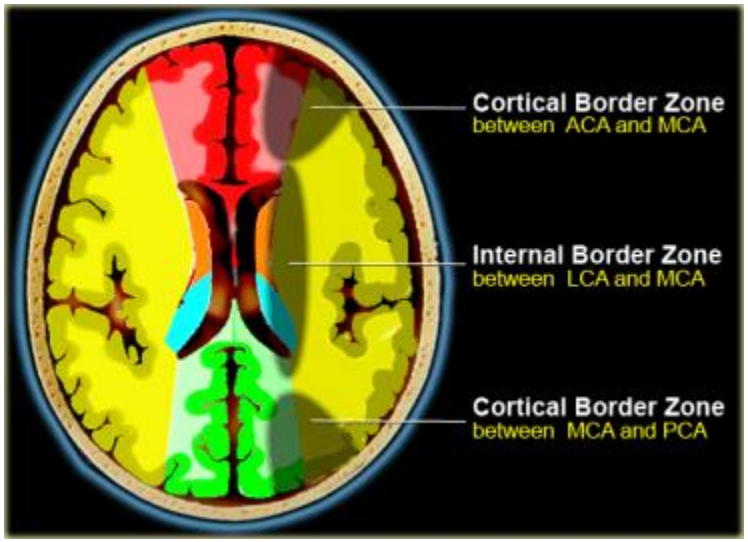
ADULTS:
Morphine 1-3 mg IV q 10 min PRN pain, with a maximum of 20 mg per hour (usual dose range 0.02-0.05 mg/kg per dose).
Meperidine (DemerolTM) _____ mg IV q 10 min PRN pain , with a max of _____ mg per hour (usual dose range 0.2 - 0.25 mg/kg per dose).
Fentanyl 25-50 mcg IV q 5 min PRN pain, with a maximum of 150 mcg per hour (usual dose range 0.25 -0.5 mcg/kg per dose).
Prochlorperazine (CompazineTM) _____ mg IV x 1 PRN nausea or vomiting, (usual dose range 5-10 mg per dose).

CHILDREN:
Morphine _____ mg IV q 10 min PRN pain , with a maximum of _____ mg per hour (usual dose range 0.02 -0.05 mg/kg per dose).
Promothazine (PhenerganTM) 6.25 mg IV x 1 PRN nausea or vomiting, (usual dose range 0.25-0.5 mg/kg per dose).
Acetaminophen (TylenolTM) _____ mg PO/PR x 1 PRN pain (usual dose range 10 - 15 mg/kg/dose PO or 25 mg/kg/dose PR).
Call anesthesiology for room air O2 SAT< 90%. Discharge from the PACU with O2 by nasal cannula at 2-4 L/min to keep O2 SAT>90%
OTHER: Zofran 4mg IV prn nausea
Prescribed by: (Gilldon)
Beeper: 3838

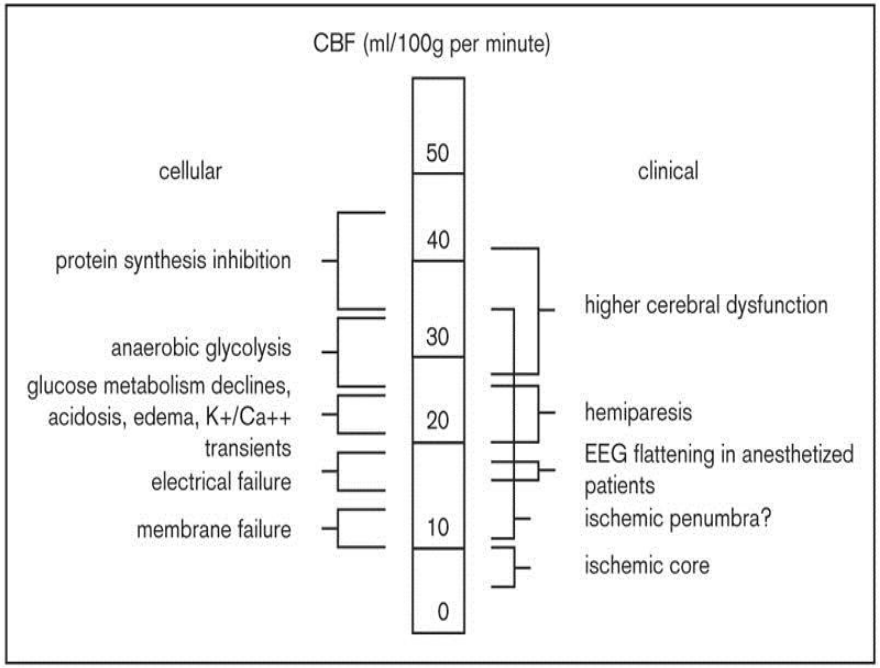
Beach Chair Position

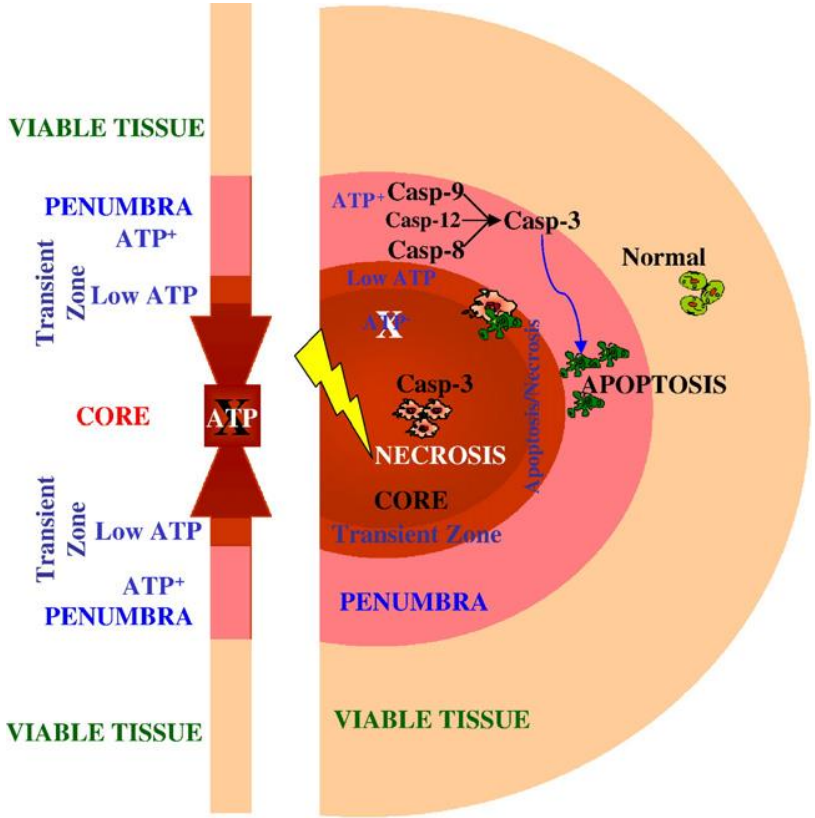


Watershed Infarct



Clinical and Cellular Correlates of Decreased CBF

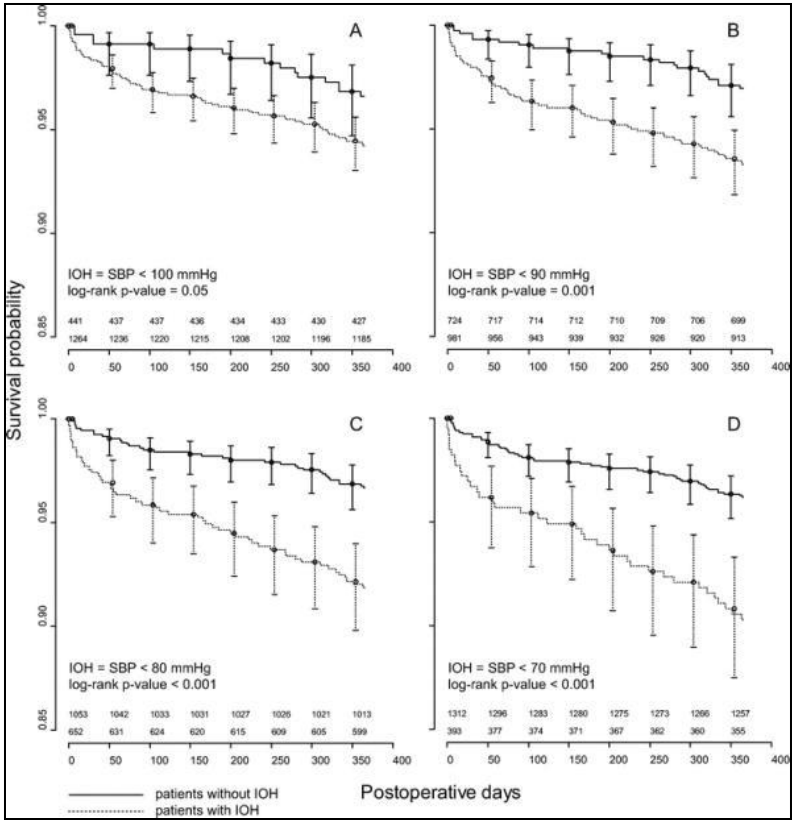




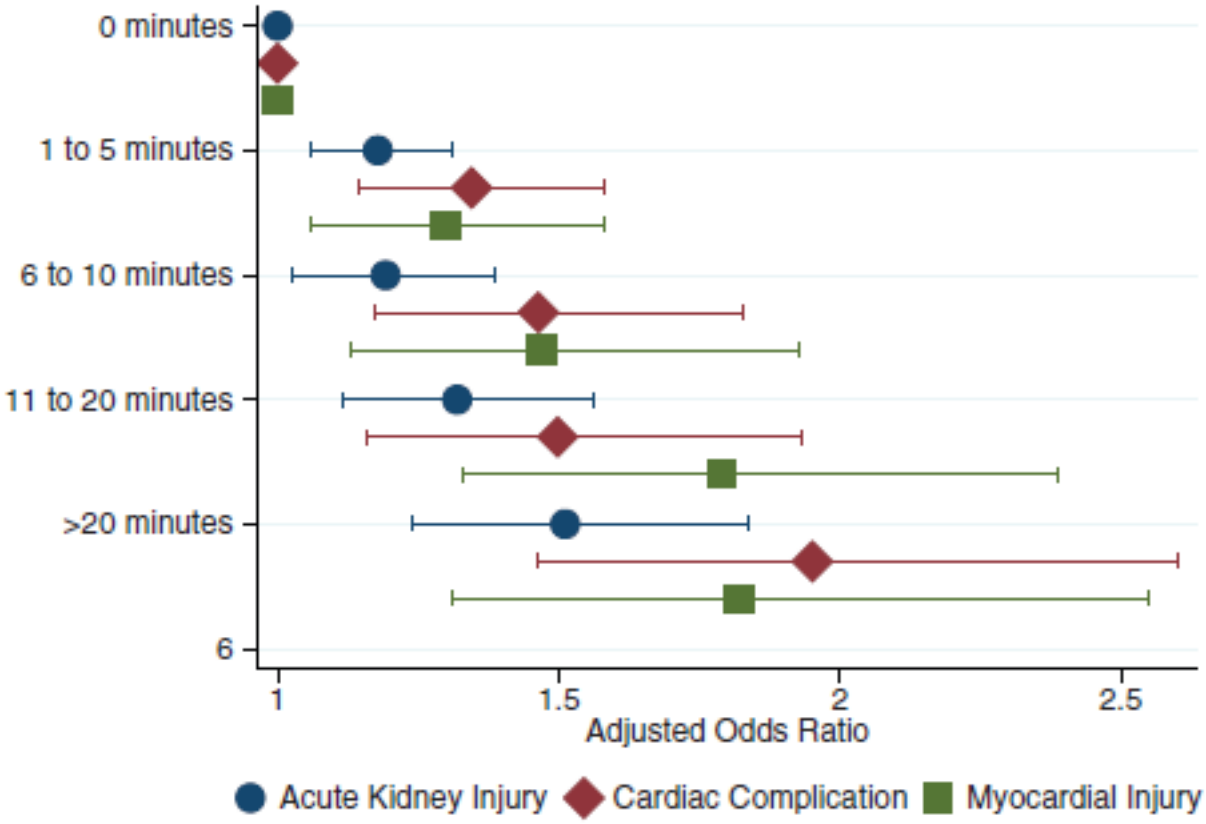
Anesthesiology 2009; 111:1217–26
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Intraoperative Hypotension and 1-Year Mortality after Noncardiac Surgery

Jilles B. Bijker, M.D.,* Wilton A. van Klei, M.D., Ph.D.,† Yvonne Vergouwe, Ph.D.,‡ Douglas J. Eleveld, Ph.D.,§ Leo van Wolfswinkel, M.D., Ph.D.,† Karel G. M. Moons, Ph.D.,‡ Cor J. Kalkman, M.D., Ph.D.#

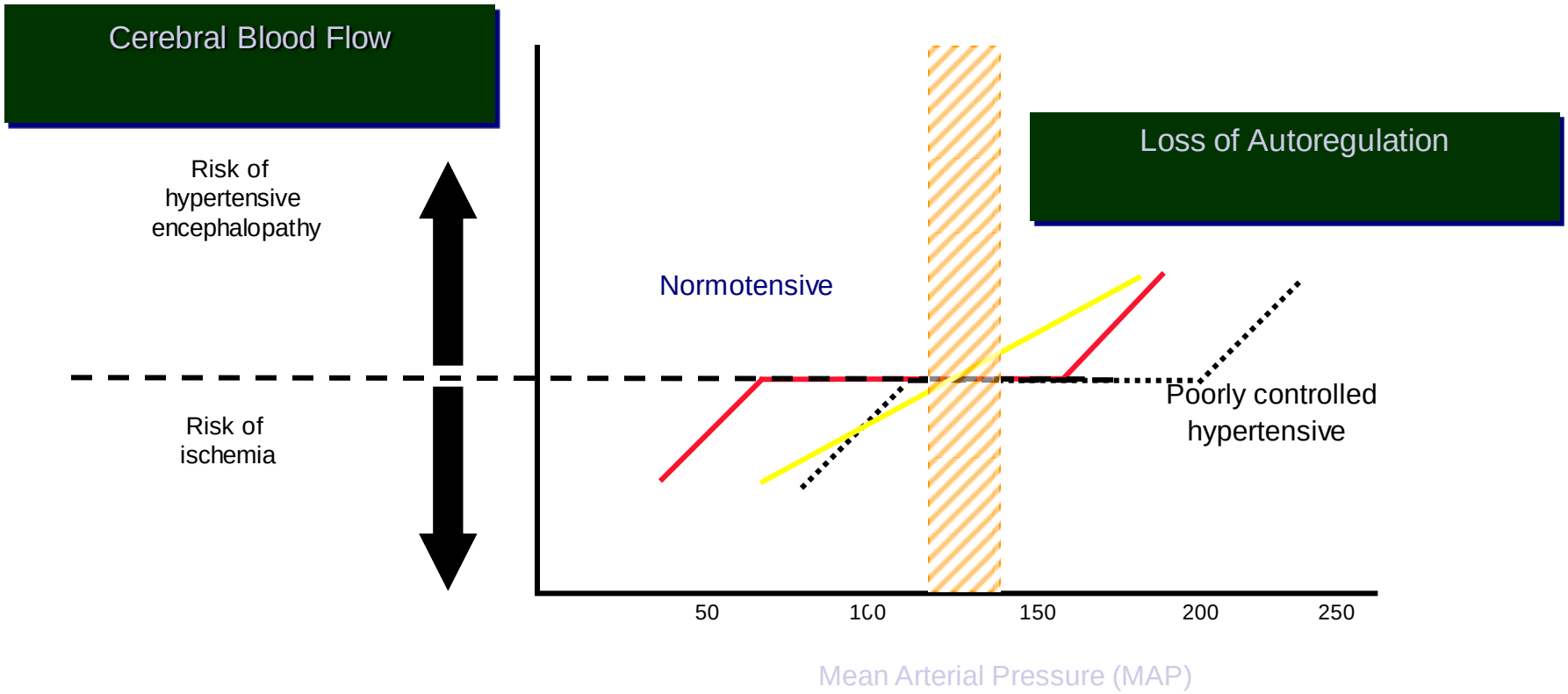


Odds Ratios for AKI, Cardiac Complications and MI by time spent with MAP < 55 mmHg



Walsh M, Anesthesiology 2013

Autoregulation of Cerebral Blood Flow



Adapted with permission from Varon J, Marik PE. *Chest*. 2000;118:214-227.

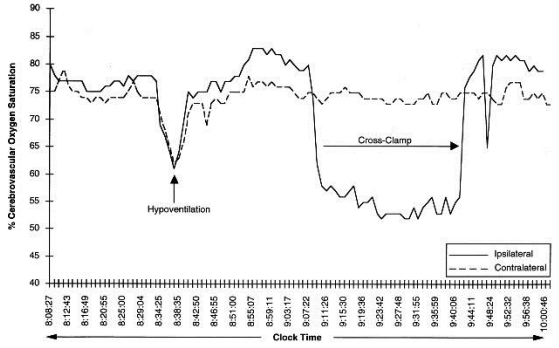
The Lower Limit of Autoregulation: Time to Revise Our Thinking?
Drummond, John; MD, FRCPC

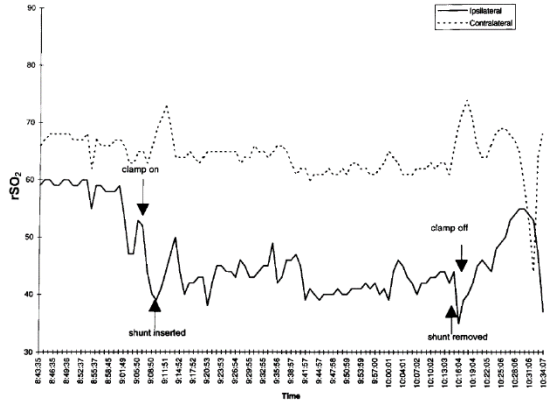
Anesthesiology. 86(6):1431-1433, June 1997.

Author	Hypotensive Technique	CBF Method	LLA Mean (Range)
McCall*[4]	Hydralazine	K-S/N2O	<64 (33–80)
	Veratrum viride	K-S/N2O	<57 (40–72)
Moyer, *et al.*[6]	Hexamethonium	K-S/N2O	>62 (53–80)
	Trimethaphan	K-S/N2O	>57 (44–75)
	Pendiomide	K-S/N2O	<61 (54–72)
Strandgaard[8]	Trimethaphan/tilt	1/A-VDO2	73 ± 9
Waldemar, *et al.*[10]	Trimethaphan/lower body negative pressure ± captopril	1/A-VDO2	79 (57–101)
Larsen, *et al.*[11]	Lower body negative pressure/labetalol	1/A-VDO2	79 (53–113)
		CBFVmca	91 (41–108)
Olsen, *et al.*[12]	Labetalol/lower body negative pressure	1/A-VDO2	88 (76–101)
Olsen, *et al.*[13]	Lower body negative pressure/labetalol	1/A-VDO2	73 (60–100)
		A-NIRS diff	79 (73–101)

Monitoring Cerebral Perfusion - NIRS

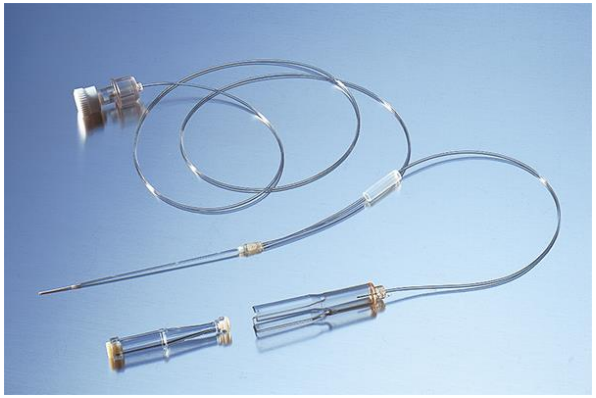




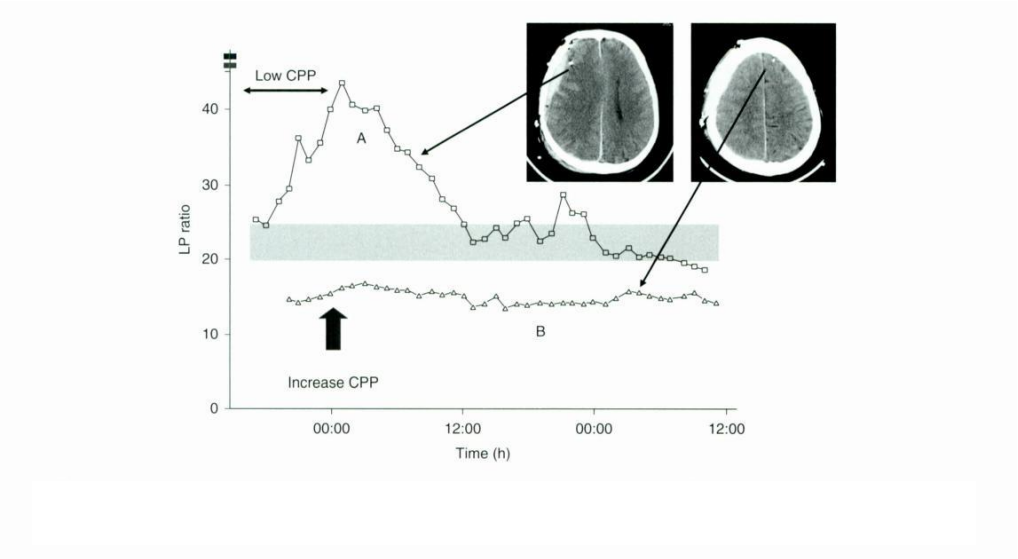


Samra S, Sroke, 1996
Samra S, Anesthesiology, 2002

Cerebral Monitoring - Microdialysis







Tisdall M, BJA, 2006

How High is High?

A 67 y.o. man underwent resection of R frontal 2X2 meningioma. His PMH included HTN, CAD (s/p drug eluting stents*2), and GERD. Meds: atenolol, HTZ, esomeprazole. The patient was induced with propofol 140 mg, fentanyl 150 mg, and rocuronium 50 mg. GA was maintained with sevoflurane and remifentanil. He received the following asoactive drugs: ephedrine 10 mg, phenylephrine 400 mcg, labetalol 125 mg, hydralazine 20 mg.

Patient was extubated at the end of surgery. PACU course was notable for poorly controlled hypertension. His SBP was around 170 mm Hg. Patients received additional doses of labetalol (35 mg), hydralazine (10 mg), and enalaprilat (1.25 mg). Patient became unresponsive approximately 45 minute after arrival to the PACU. CT scan revealed intracranial hematoma. Patient was taken back to the OR for evacuation of hematoma. Nicardipine infusion was initiated at the OR. Patient never regained consciousness and expire seven days later.

Intraoperative Hypertension is Associated with Negative Surgical Outcome

Non-Cardiac Surgery, SBP>160 mm Hg

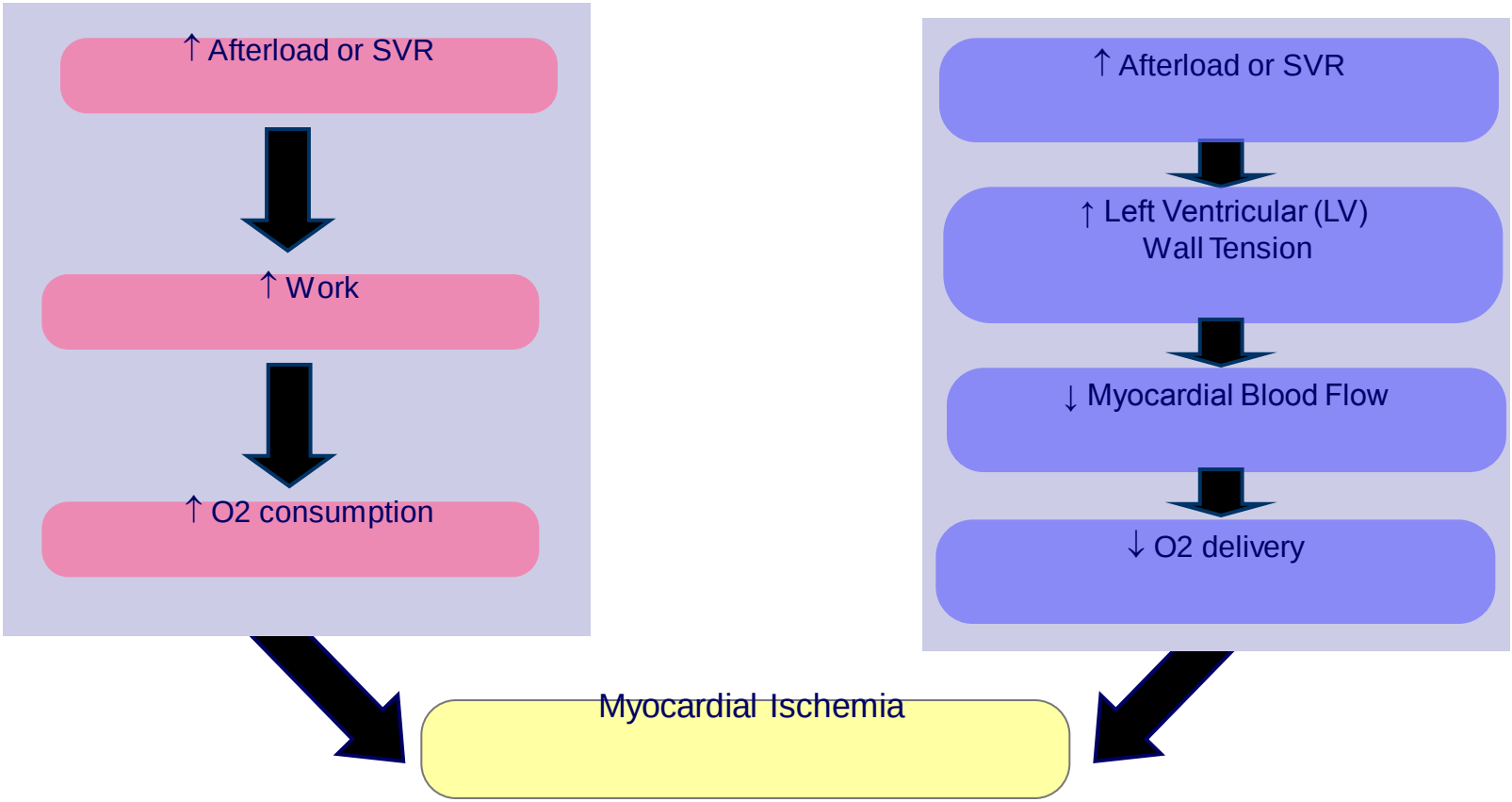
POSSUM Score	No high SBP	High SBP
< 15	9/95 (9.5%)	11/47 (17%)
16-18	5/33 (15.2)	8/43 (18.6%)
19-23	7/41 (17.1%)	11/40 (27.5%)
>23	10/34 (29.4%)	24/55 (43.6%)

Possum: Physiological and Operative Severity Score and enUmeration of Mortality
NSO: Hospital stay of > 10 days with morbid condition or death

Reich D, Analg Anesth, 2002

Hemodynamics and Myocardial Ischemia

Increased Afterload Increases O_2 Consumption and Decreases O_2 Delivery to the Heart

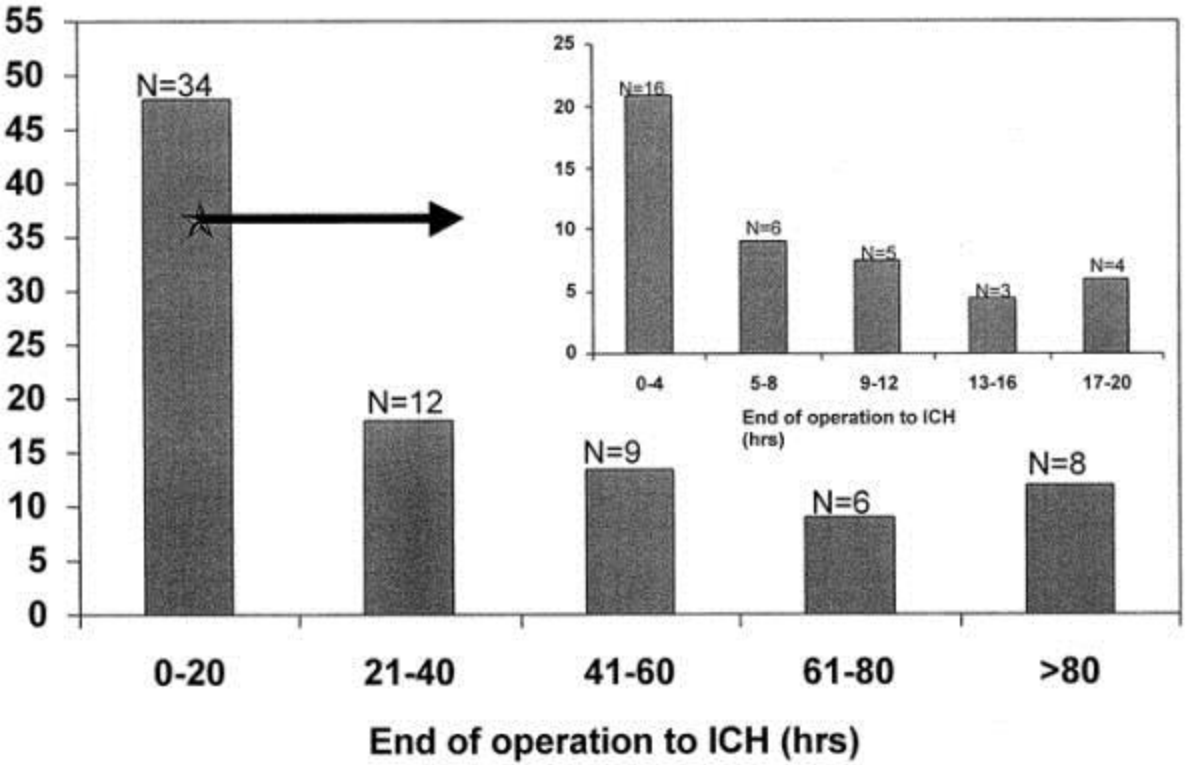


Adapted from Braunwald E, ed. *Heart Disease: A Textbook of Cardiovascular Medicine*. 6_{th} ed. W.B. Saunders Co.; 2001.

Acute Hypertension in a Patient with Intracranial Lesion May Lead to:

- Elevation of CBF, CBV, ICP
- Breakdown of the BBB, transudation of fluids causing cerebral edema
- Intracerebral hemorrhage

Relation between Perioperative Hypertension and Intracranial Hemorrhage after Craniotomy

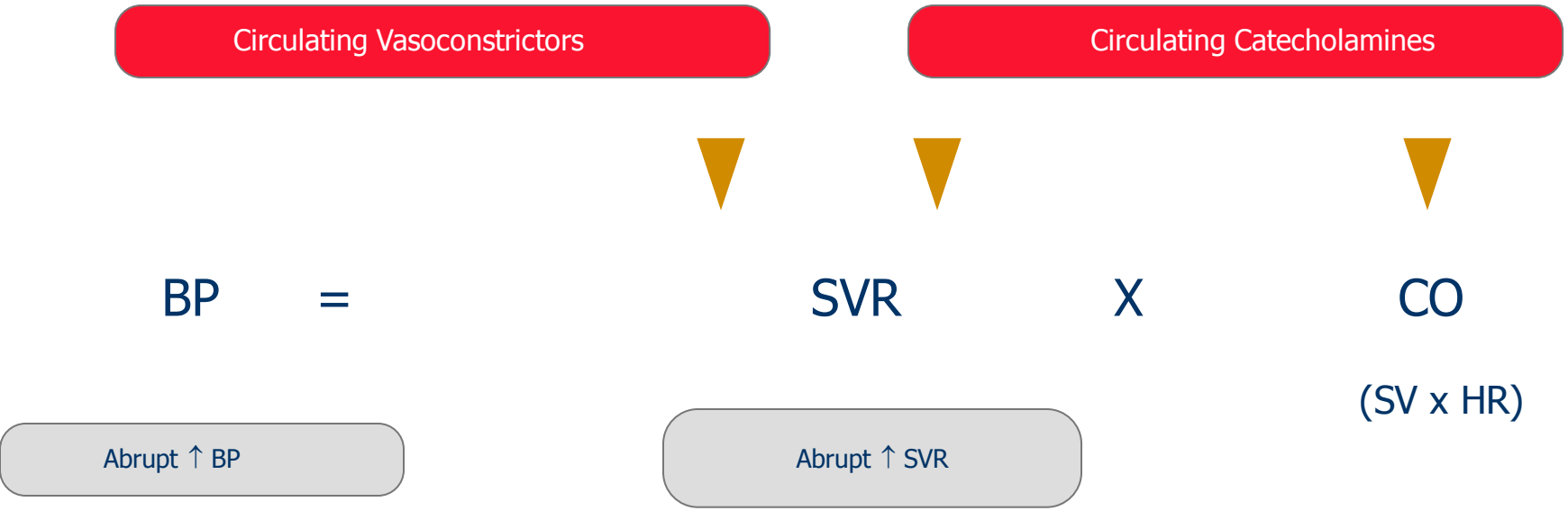


Basali A, Anesthesiology, 2000

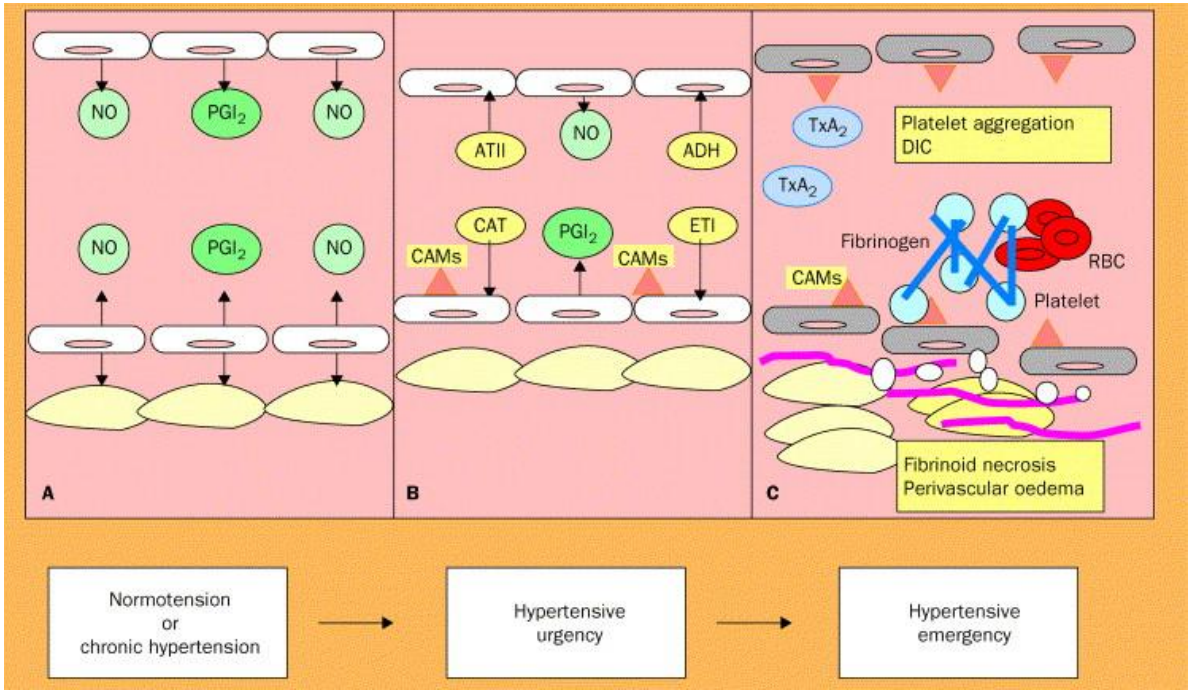
Incidence of Perioperative Hypertension in Neurosurgical Patients

Study	Definition of HTN	Incidence of acute HTN n/N, (%)	Study description
Gibson B, Clin Pharm Ther, 1988	SBP > 20%	40/44 (91)	Esmolol vs. Placebo; Rescue: Labetalol/Hydralazine
Muzzi D, Anest Analg1990	SBP > 20%	50/55 (91)	Labetalol vs. Esmolol; Rescue: Nitroprusside
Kross R, Anesth Analg 2000	SBP > 140 mmHg	44/44 (100)	Enalapril + Nicardipine vs. Labetalol
Bekker A, Anesth Analg 2008	SBP > 130 mmHg	48/56 (86)	Labetalol/Hydralazine vs. Dexmedetomidine
Bilotta F, J Clin Aneth 2008	SPB > 20%	49/60 (82)	Esmolol
Bekker A, J Neur Anesth, 2010	SBP>130 mmHg	21/22 (95)	Clevidipine

Etiology of Acute Hypertension

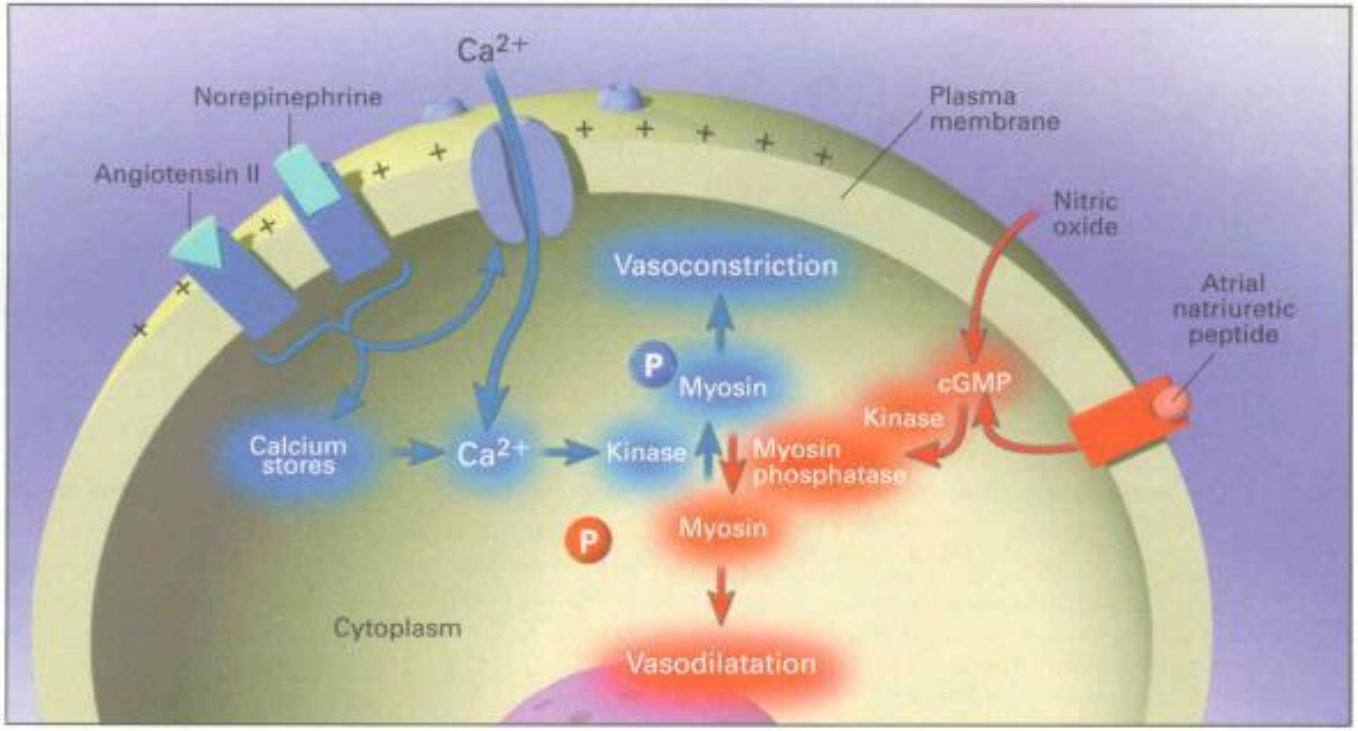


Pathophysiology of Vasoconstriction



Vaughan C, Lancet 2000

Antihypertensive Drugs: Mechanism of Action



Landry D, NEJM 2001

Therapeutic Approaches to Perioperative Hypertension

Vascular Guanylyl Cyclase Stimulation (nitrovasodilators: nitroprusside, nitroglycerine, hydralazine)

β – Adrenergic blockade (esmolol, labetalol, metoprolol)

α_2–adrenoreceptor agonist (dexmedetomidine, clonidine)

ACE inhibition (enalaprilat)

Calcium-Channel Blockade (diltiazem, nicardipine, clevidipine)

The Ideal Agent

- Treats underlying pathophysiology
- Rapid onset/offset of action
- Predictable dose response
- Minimal dosage adjustments
- Minimal adverse effects
- No increase in ICP
- No coronary or cerebral steal
- Easy transition to oral formulation

Effect of Antihypertensive Drugs on ICP

	Before hypotension, mm Hg	After hypotension, mm Hg	
Nitroprusside	16 ± 2	28 ± 3	Cottrell, J Neurosurg, 1978
Nitroglycerine	14 ± 1	31 ± 1	Gupta, J Neurosurg, 1980
Hydralazine	12 ± 1	24 ± 1	Van Aken, Anaesth, 1982
Nifedipine	19 ± 7	22 ± 6	Tateishi, J Neurosurg, 1988
Nicardipine	11 ± 2	10 ± 2	Gaab, Br J Clin Pharm, 1985
Labetalol	12 ± 6	9 ± 3	Orlowski J, Crit Car Med 1988

Beta Adrenergic Blockers

- Beta blockers produce negative inotropic effects and conduction defects, and should be used cautiously in patients with reactive airways disease and ventricular dysfunction.

- Beta blockers have “ceiling effects”; doses are limited by heart rate.

Calcium Channel Blockers: Dihydropyridines

1. Phenylalkylamines (e.g. verapamil)
2. Benzothiazepines (e.g. diltiazem)
3. Dihydropiridines
    a. nifedipine (first generation)
    b. nicardipine (second generation)
    c. clevidipine (third generation)

Summary

The best method to assure an adequacy of cerebral blood flow in a particular patient is to monitor cerebral perfusion

Retrospective analysis of computerized records suggests that perioperative systolic blood pressure above 160 mm Hg is associated with negative surgical outcome in general, orthopedic, and vascular surgery;

Most anesthesiologists believe that SBP should be less than 140 in most patient

Wisdom for Thought

When you don't know what you are doing, be real careful