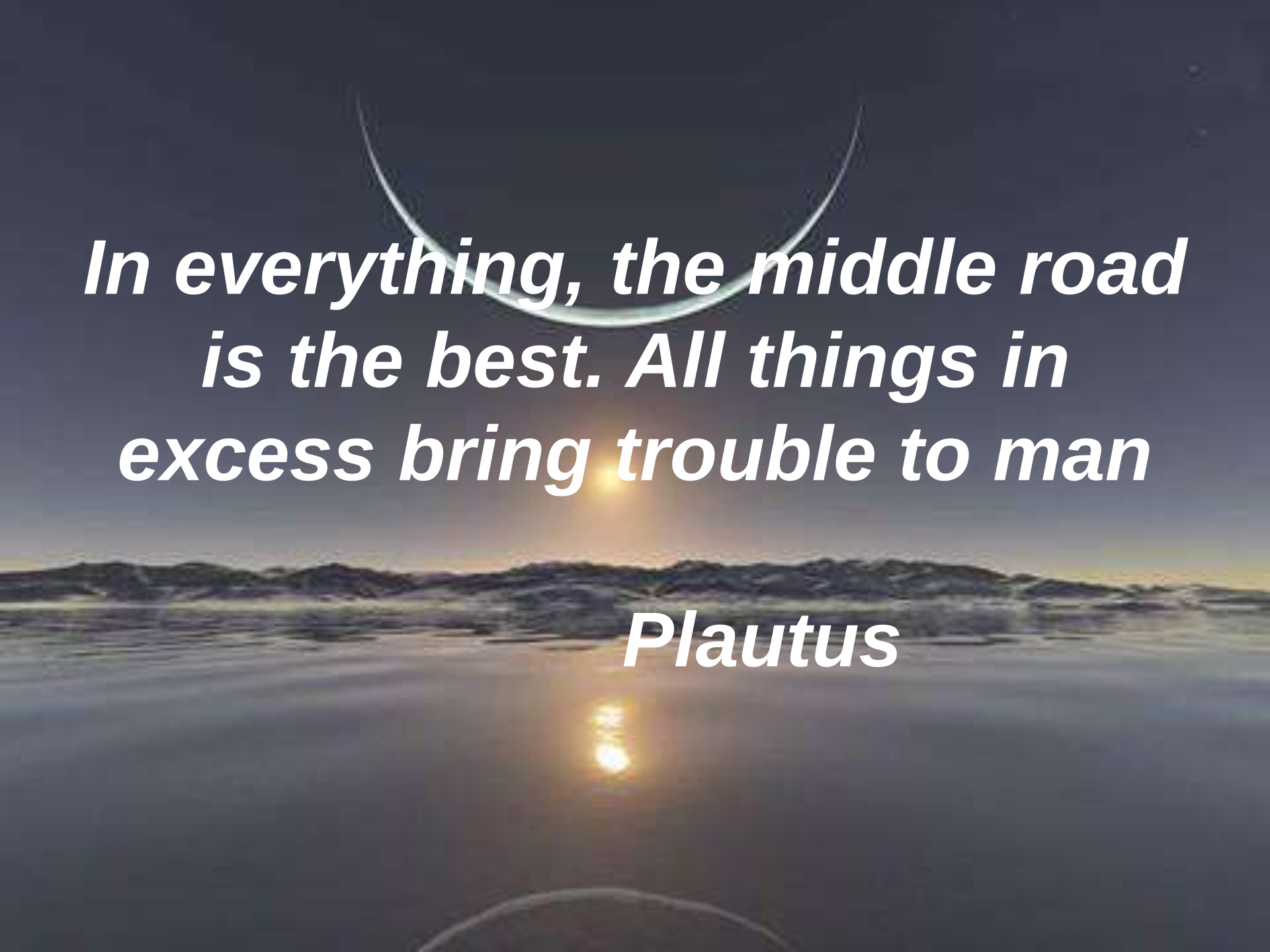
Deliberate hypotension- what is for and what is against using it ?

Gabriel M. Gurman, M.D.
Ben Gurion University of the Negev, Beer Sheva, Israel


In everything, the middle road is the best. All things in excess bring trouble to man
Plautus

Everything started from our fear to transfuse patients

- There are a lot of risks associated with blood transfusion:

*HIV

*Hepatitis C and B

*wrong labeling

*overtransfusion

*ARDS

*Jehovah's Witnesses

Negative immunomodulation (infection, cancer)

*Cost : $250.00/unit

Bellvue Hospital, NY 1872

But not only this……

The surgeon's desire to have a "bloodless field" in order to improve his work conditions, brought to the introduction of variety of techniques to reduce the bleeding at the surgical wound:

*phlebotomy

*high spinal anesthesia

*high position of the operating site

*deepening general anesthesia

Actuality

How do we call the situation in which :

“a patient’s arterial blood pressure is intentionally lowered to facilitate a surgical procedure” ? (Elliot, 1999)

Controlled hypotension ?

Induced hypotention ?

Hypotensive anesthesia ?

Deliberate hypotension ?

Permissive hypotension ?

Controlled circulation ?

We decided to use the term: Deliberate Hypotension (DH)

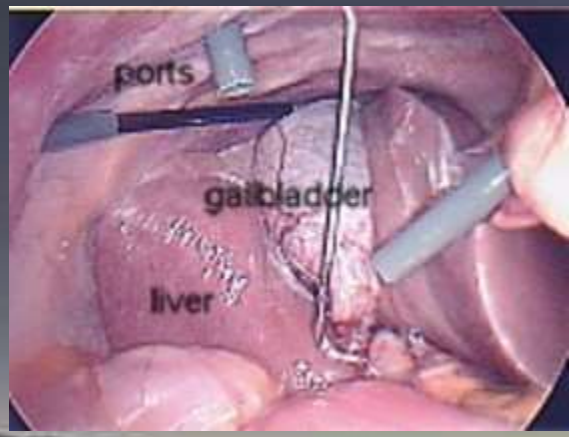
Definition

Deliberate Hypotension (DH) is the reduction of systolic pressure during general anesthesia to 80-90 mm Hg or mean arterial pressure (MAP) to 50-65 mm Hg IN NORMOTENSIVE PATIENTS

$$MAP = \frac{\text{Syst BP} + 2\ \text{Diastolic BP}}{3}$$

Purposes

- Decreased surgical blood loss
- Better exposure of and improved visibility of the surgical field
- More definite identification and resection of tumor margins
- Decreased operating time
- Decreased number of blood products transfused
- Decreased amount of suture and cauterized tissue within surgical wound



Indications

Orthopedics:

- Total hip replacement
- Spinal fusion

Neurosurgery:

- clipping cerebral aneurysms
- AV malformations
- Tumor resections

ENT:

- Oral surgery
- Major facial reconstruction
- Head and neck tumor resection

Gynecology:

- Radical pelvic procedures

- Religious blood refusal
- Rare blood type

A very important question:

- **How many of you have used DH in the last three years ?**

Here are two patients….

- *The first one*

*a 42 yrs old woman, with an extended carcinoma of uterus

*ASA 2 (NIDDM, blood sugar under oral drugs around 135 mg/100 ml, Hb A 1 C 5.7

*scheduled for extensive pelvic surgery

*expected blood loss around 1750 ml

*expected duration of surgery around 4 hrs

- *The second one*

*The patient is a member of Jehovah sect

*He is 62 yrs old

*ASA 3 (because of ischemic heart disease, moderate cardiac failure, ejection fraction 38%)

*scheduled for hip replacement

*expected blood loss around 1500 ml

*expected duration of surgery 2 hrs

Before we start, let's count the rules of DH

1. Select patients
2. Be sure the patient is normovolemic
3. Assure the replacement of lost blood
4. Use posture when possible
5. Take into consideration that general anesthesia by itself produces hypotension
6. Use controlled ventilation for reducing the venous return, but keep $PaCO_2$ near normal
7. Discontinue DH before wound closure

Now the second question: does hypotension reduce blood loss ?!

- **The 1st statement: for many patients the correlation between decrease in BP and blood loss IS NOT LINEAR**

(Donald JR. Acta Anaesth Scand 1982;27:91)

- **It seems that blood loss is also influenced by both PATIENT POSITIONING and VENTILATION (by influencing the venous pooling)**
- **Cardiac output plays no role in establishing amount of blood lost**

(SIvarajan M et al. Anesth Analg 1980;59:203)

One thing is sure: DH reduces blood loss

- *Eckenhoff and Rich 1966:*

115 patients with DH vs 116 without

Rhinoplasty, craniotomy for aneurysm or tumor, portocaval shunt

Blood loss decreased by 50%

- *Eerola et al. 1979*

55 pts for total hip replacement-much less blood loss with DH

- ***Vazeery and Lunde, 1979***

25 (with DH) vs 26 pts without for hip replacement- less blood loss with DH

No study could demonstrate a significant decrease in the operating time by using DH !!

Some more data…

- ***O'Connor PJ et al Can J Anaesth 2006;53:873***
- **102 prostate patients**
- **DH group (epidural) and control group**
- **<u>Results:</u>**

***less blood loss (p<0.001)**

***less transfusion (8% vs 26% of patients, p<0.019)**

- ***Paul JE et al Can J Anaesth 2007;54:799***
- **Meta-analysis of DH in orthopedic surgery**
- **17 papers found to meet the inclusion criteria**
- ***Results*:**

***less transfusion requirements in the DH groups**

DH- Techniques which have been used and published

You already see the problem ?!!

When one has too many solutions of the problem, it seems that no one is good!!!

Or everything is a question of preference!!!!

Let’s count them….

1. Spinal and epidural anesthesia
2. Volatile anesthetics
3. Direct vasodilating drugs
4. Autonomic ganglion-blocking drugs
5. Alpha-adrenergic receptor blocking drugs
6. Betha-adrenergic receptors blocking drugs
7. Combined alpha and betha-adrenergic blocking drugs
8. Calcium channel entry blocking drugs

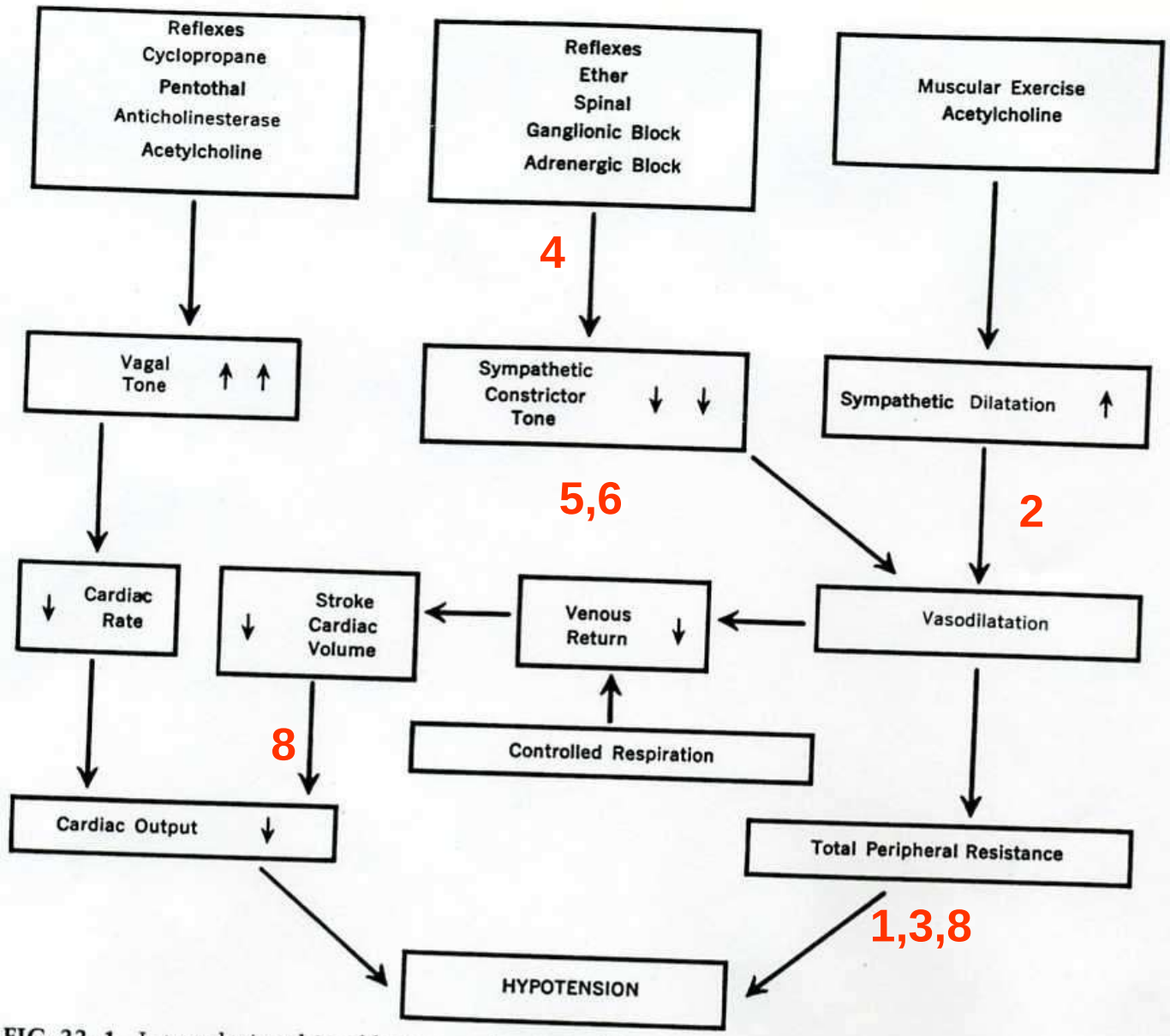


FIG. 33–1. Interrelationship of factors maintaining blood pressure. A fall in either cardiac output or peripheral resistance lowers blood pressure. Each of these primary factors is, in turn, determined by many variables of reflex, mechanical, metabolic, neurogenic, and hormonal natures. (Mean blood pressure = cardiac output × total peripheral resistance.)

1.Spinal

2.Volatile

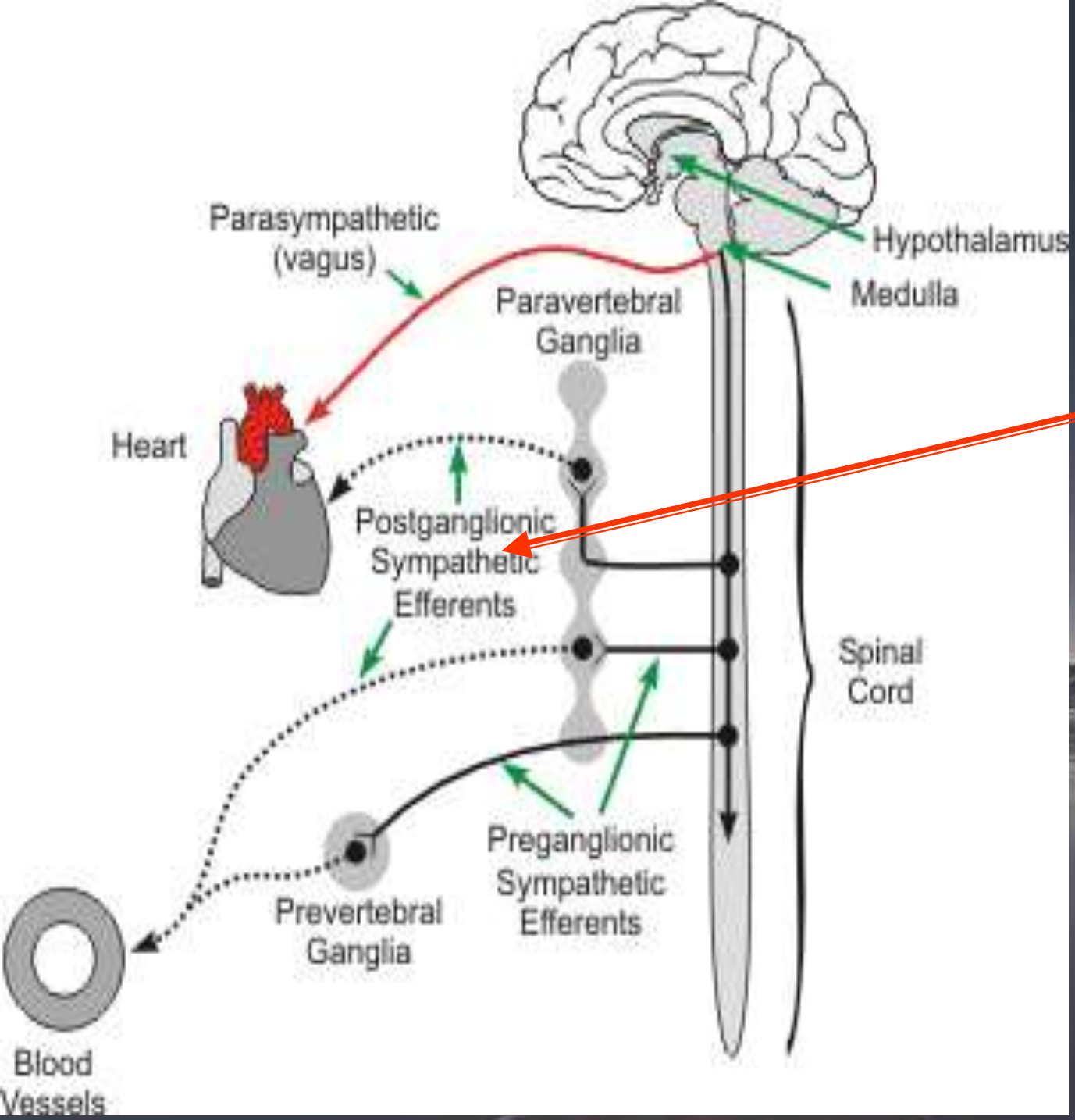
3.Direct drugs

4.Ganglion block

5-6 Alpha, Betha

7.combined

8. Ca blocker



Ganglion-blocking drugs (post-synaptic)

1.Spinal anesthesia

- Produces venous pooling and hypotension
- If extended to midthoracic region, no compensatory tachycardia, which is:
  - Good- no increase in blood loss
  - Bad- negative effect on tissue perfusion, via cardiac output
- Unpredictable value of hypotension
- Might need adrenaline to keep hemodynamic stability
- No way tro use it for head and neck surgery

2.Volatile anesthetic drugs

- **Halothane produces DH by decreasing myocardial contractility**
- **Isoflurane (up to 4%) decreases systemic vascular resistance**

(and CO in elderly patients)

- **No use in cranial surgery (cerebral vasodilatation, edema)**
- **Good results *(Kick 1993, Toivonen 1992*) when used in combination with alpha- and/or betha-adrenergic receptor blocking agents**

3.Direct vasodilatating drugs

Nitroglycerin

Sodium nitroprusside

Hydralazine

Purine derivates (adenosine)

Nitroprusside

- Vasodilator with a rapid onset of action, short duration and readily controllable
- Acts primarily on arteriolar tone
- No adverse effects on myocardial contractility
- Preserves or increases cardiac output in normo- or hypervolemic patient
- Significant rebound hypertension at the end of infusion

Two main drawbacks

Toxicity

Resistance or tachyphylaxis

Nitroprusside drawbacks

Toxicity

- Breakdown in blood produces FREE CYANIDE
- Cyanide binds with cytochrome oxidase and produce tissue hypoxia
- A small part is metabolized to thiocyanate
- Photodegradation can show up *in vitro*

Resistance

- Can be explained by increase in plasma cathecolamines
- In subarachnoid hemorrhage the Cc level is already high, so resistance does not show up
- Young age is accompanied by resistance and old age by heavier drops of BP

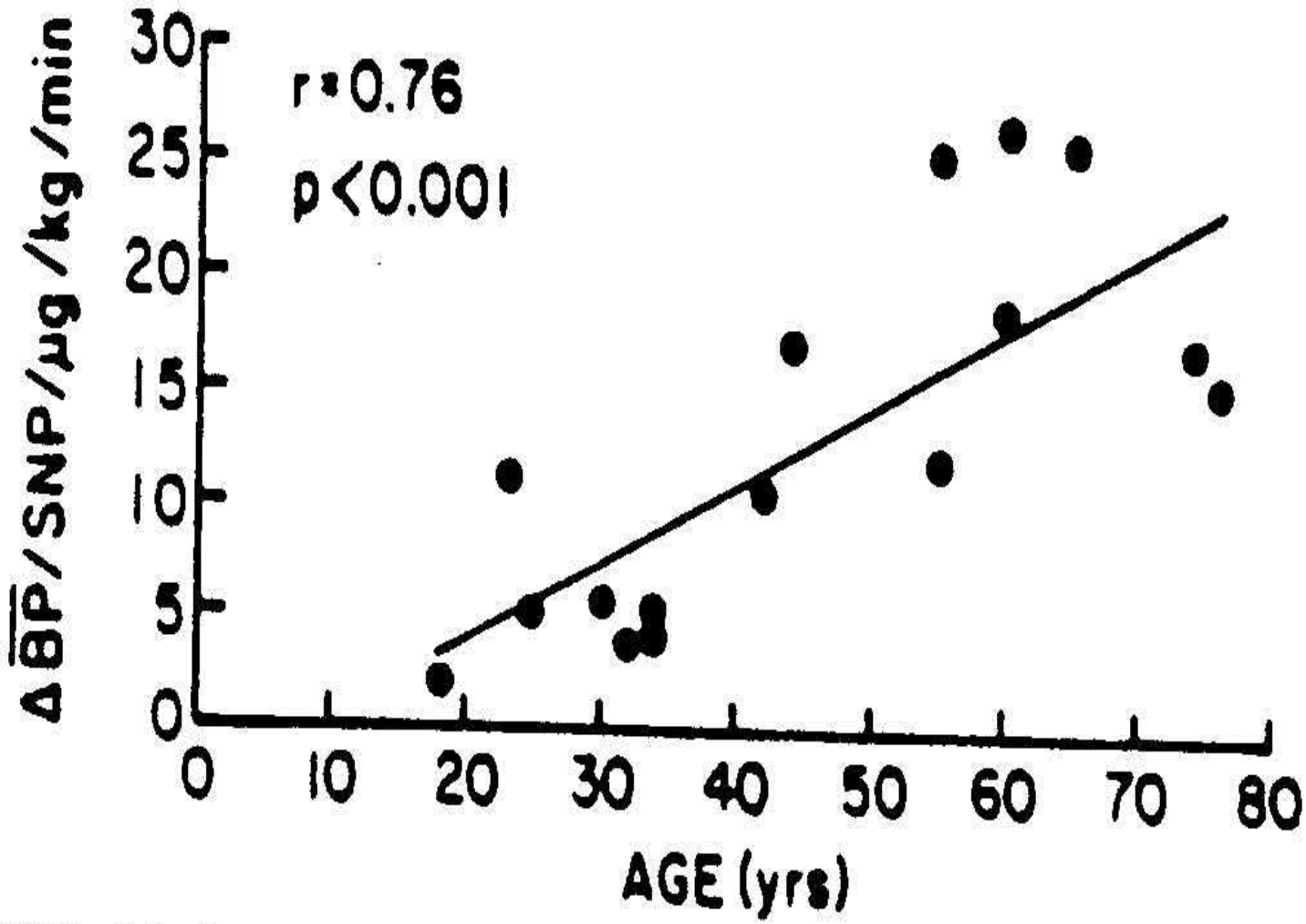


FIG. 33–9. Age and sensitivity to sodium nitroprusside. Change in mean arterial blood pressure per $\mu g \cdot kg^{-1} \cdot min^{-1}$ nitroprusside dose (i.e., slope) for each patient plotted against age (yr). The equation of the line is: change in mean BP/nitroprusside dose $\mu g \cdot kg^{-1} \cdot min^{-1} =$

What about nitroglycerin ?

- Dilates venous capacitance vessels
- Short half-life
- No significant toxic metabolites
- Reduces CO in hypovolemic patients
- Biphasic ARTERIAL response (first dilatation, then constriction)
- Nonpredictable regarding the influence on BP
- Less consistent results than NTS

4. Autonomic ganglion-blocking drugs

Trimetaphan

- Hypotension results from occupation of the receptors sites and stabilization of the postsynaptic membrane
- Affects both sympathetic and parasympathetic systems
- Inactivated by plasma cholinesterase, e.g. short half-life

Drawbacks

- Histamine release (bronchospasm)
- Increases ICP
- May produce cerebral ischemia
- Potentialization of Scholine
- Tachyphylaxia
- Produces mydriasis, which can confuse diagnosis

5.Alpha-adrenergic receptor blocking drugs

Phentolamine

- Quick effect, in minutes
- Return to previous BP in 15 minutes
- ICP unchanged
- CPP remains lower some 10 minutes after interruption of drug infusion

6.Betha-adrenergic receptors blocking drugs

Esmolol

- **Very rapid onset of action**
- **Renin activity decreases, so hypotension is more sustained**
- ***Orenstein et al Anesth Analg 1991;72:639***

****40% decrease in CO***

(marked myocardial depression)

****23% reduction in HR***

****20% increase in SVR !***

7.Combined alpha and betha-adrenergic blocking drugs

Labetalol

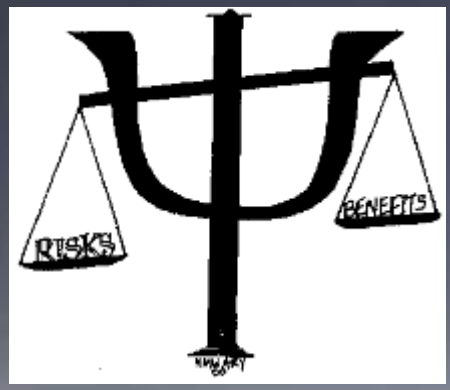
- Blocks also the betha 2 receptors
- Reduces both CO and SVR
- Quick onset of action
- Longer half-life than NTS or nitroglycerin, needs monitoring during immediate postop period
- Very strong synergism with inhalatory drugs
- Renal flow well preserved

8. Calcium channel entry blocking drugs

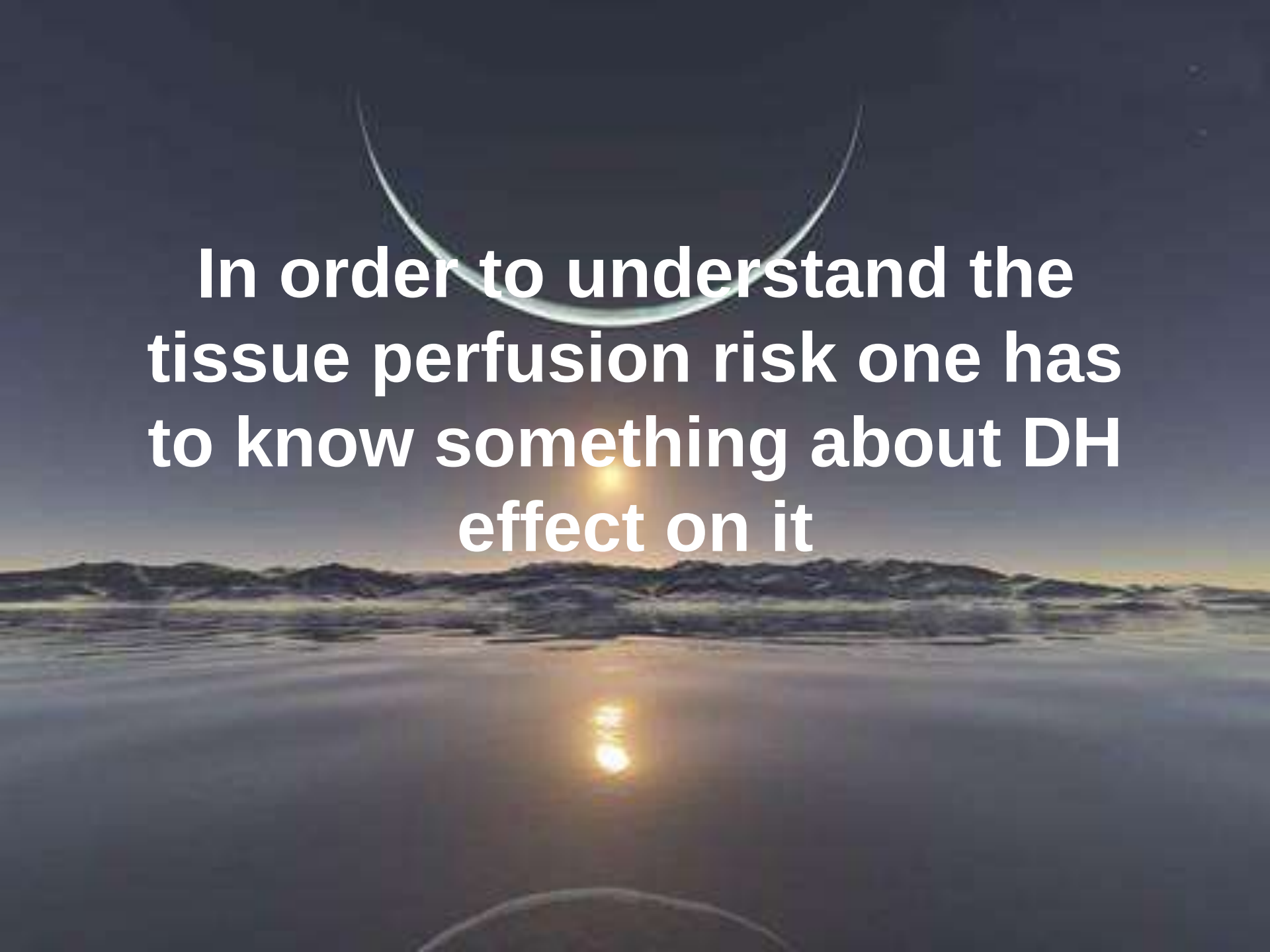
Nicarpidine

- Dilates coronary, peripheral and cerebral arteries
- No influence on myocardial contractility
- No tachycardia
- Hypotension resists to conventional treatment, such as phenylephrine, so careful titration !!!

The risk



The crucial risk of DH is inadequate tissue perfusion of vital organs, when the patient is not appropriately selected or the MAP drops below the accepted limit


In order to understand the tissue perfusion risk one has to know something about DH effect on it

How does it work ?

- **Either by reducing cardiac output (CO)**
- **Or by reducing systemic vascular resistance (SVR)**
- **Or both !**

The main problem is to keep the organ perfusion at a level compatible with normal oxygenation and supply of energy substrates

So it is important to know what does it happen with organs functions during DH

Central nervous system

- **“Conventional” DH (MAP > 50 mm Hg) does not produce any damage, neither hemodynamically or cognitive**
- **A lower MAP (below 50) avoids the response of cerebral blood flow to CO_2 variations !**
- **The most important thing is to keep cerebral perfusion pressure (CPP) at an acceptable level.**

  CPP= MAP-ICP
- **So, it is important to keep ICP low**
- **Hypertensive patients need a higher CPP**
- **Nitroprusside or isoflurane are safe to use for DH**

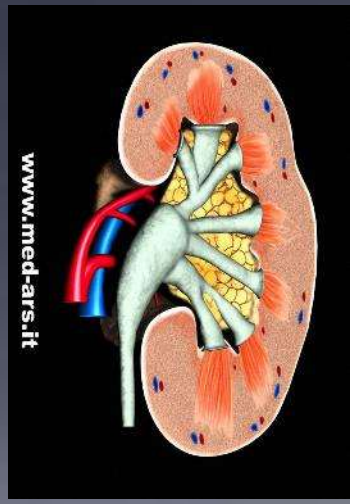
Heart

- **The demands :**
  - ***avoid reflex tachycardia (esmolol)**
  - ***reduce metabolic rate (volatile)**
  - ***keep coronary vasodilation (nitroglycerin)**
  - ***avoid coronary steal (produced by isoflurane ?)**

DH seems to be unadvisable for coronary ischemic patients, even when proper monitoring is used !!!

The big controversy- the kidney

The dilemma : how important is to keep the renal flow during DH ?!



In healthy patients, strict maintenance of urine production is unecessary

BUT

What about:

***old**

***hypertensive**

***prolonged procedures**

It seems that the combination labetolol-isoflurane better preserves the kidney function during DH

The recommended monitoring during DH

Vigilant monitoring

- Invasive BP
- CVP
- ECG
- Blood gases
- Temperature
  (body core)
- Urinary output

Eichhorn, *Anesthesiology 1989;70:572:*

Safety monitoring means using the equipment which provides the earliest possible warning of impending disaster during anesthesia for surgery`

Contraindications of DH

- Cerebrovascular disease, incl. TIA
- Spinal cord compression
- Cardiovascular diseases :MI, HT
- Aortic stenosis
- Renal dysfunction
- Increased ICP
- Pregnancy
- Severe pulmonary disease
- Severe hypovolemia or anemia

Complications of DH

- Secondary hemorrhage
- Renal insuffciency
- Thrombic phenomena (cerebral, coronary)
- Rebound hypertension
- Very severe and sustained hypotension, leading to cardiac arrest
- Increased ICP
- Short-term impaired memory

If deliberate hypotension is an useful tool , why…..

Its use is restricted these days and people are reluctant to include the techniques of DH in the day-to-day arsenal ?

Some very important points

- DH works on arteries and most of the surgical bleeding is venous !
- Medicine is not mathematics and we do not treat numbers (MAP ??!!)
- Age is not an absolute contraindication, but everyone knows that the compensatory mechanisms are affected by age, so….
- There are many other methods of reducing the blood loss during surgery

Other methods

- Normovolemic hemodilution
- Cell saver
- Local vasoconstrictors
- Arterial compression
- **Posturing the patient**
- Even the general anesthesia is supposed to reduce BP and thus bleeding, too

Remember our two patients?!

- The lady for extensive pelvic surgery
- One can use DH after induction:

*Nitroprusside 50 mg/250 ml

Start with 0.5 micro/kg/ min

Adjust the dose to keep mean BP around 65 mm Hg

*Insert an epidural catheter and deliver bupivacaine 0.75% in incremental doses

* Did you insert an arterial line immediately after induction?!

- And what about the Jehovah witness gentleman ?

Is anybody ready to use DH in this case?

And if yes, what technique?

Any need for conclusions ?

The last systematic review

(Choi WS, Sammam N. Int J Oral Maxilllofac Surg 2008;37:687)

The main advantages of DH

- Decrease of blood loss
- Decrease in transfusion rate
- Improved surgical field conditions
- Significant reduction in operation time
- No significant changes in the vital organs functionality

Provided that……


Patient selection and adequate monitoring are taken into consideration!!!!!

Here they are !

- Hypotension is not synonymous with inadequate tissue perfusion, so long as organ vascular resistance falls in parallel with arterial pressure (AP)
- Even a MAP of 65 mm Hg in an old patient can reduce blood loss
- Contraindications remain….contraindications!!!
- Since DH abolishes compensatory mechanisms, volume replacement is essential
- Controlled ventilation is always recommended during DH: it reduces venous return !!!
- Careful monitoring is vital when one uses DH
- Be a physician before becoming a technician
- Your surgeon partner is important, but much more important is your patient!!

La facon de donner vaut mieux que ce que'on donne !!

In translation: the way you give something is more important than what you give!!

Corneille, Le Cide