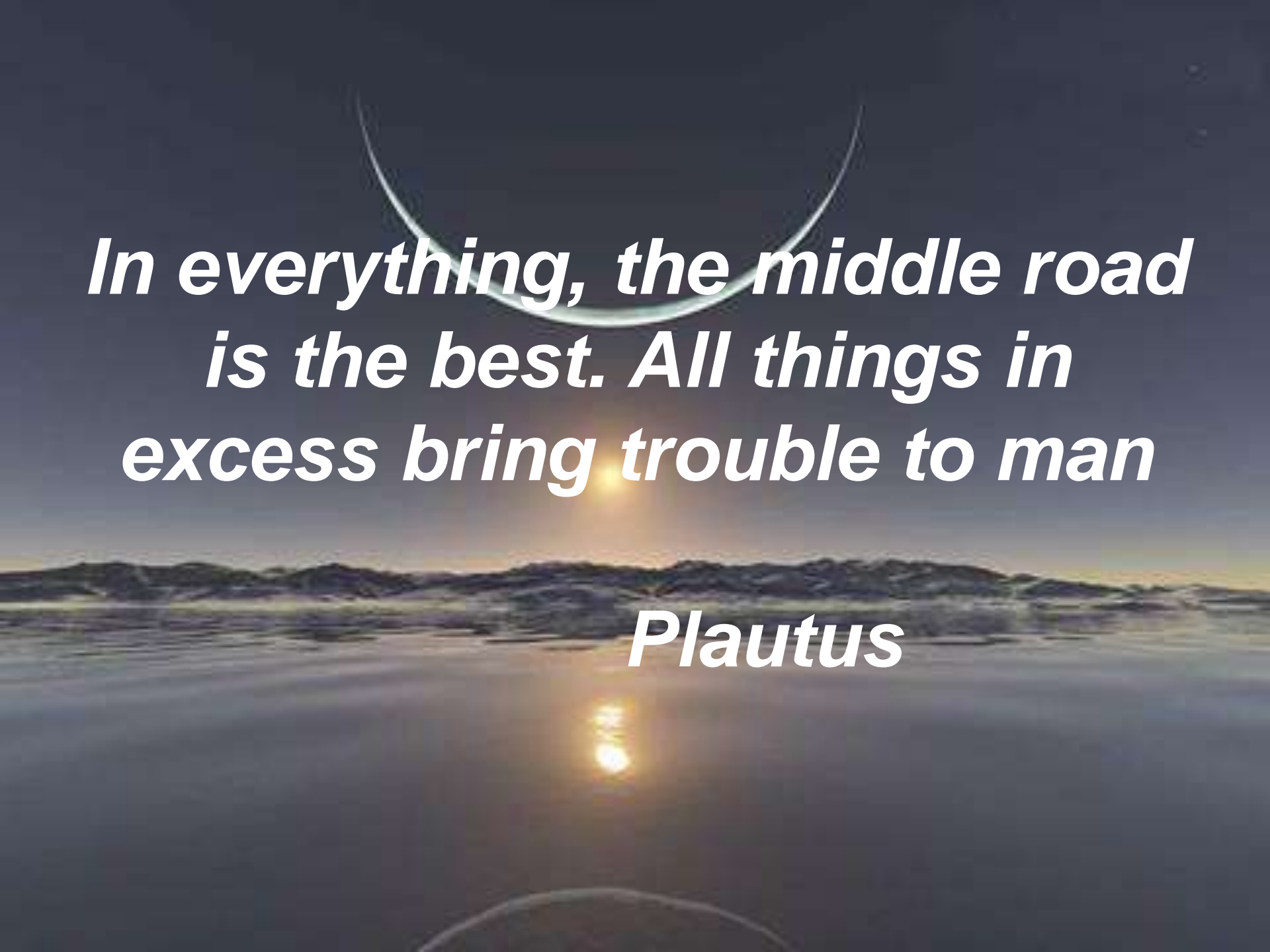


**Deliberate hypotension- what
is for and what is against using
it ?**

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A serene sunset scene over a body of water. The sun is low on the horizon, creating a bright reflection on the water's surface. A thin crescent moon is visible in the darkening sky above. The overall mood is peaceful and contemplative.

***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

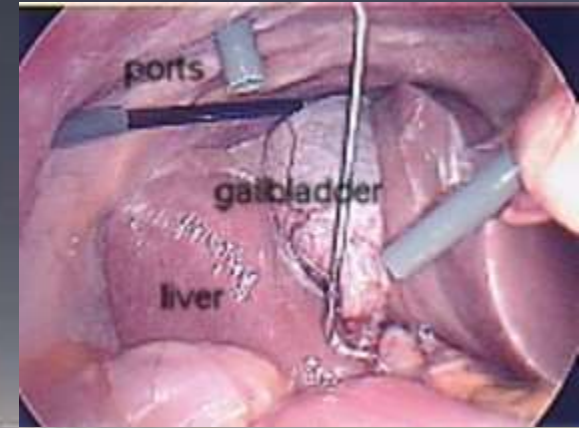
Deliberate Hypotension (DH) is the reduction of systolic pressure during general anesthesia to 80-90 mm Hg or mean arterial pressure (MAP) to 50-65 mm Hg IN NORMOTENSIVE PATIENTS

Syst BP + 2 Diastolic BP

MAP= -----

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

Neurosurgery:

- clipping cerebral aneurysms
- AV malformations
- Tumor resections

Gynecology:

- Radical pelvic procedures

ENT:

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

Orthopedics:

- Total hip replacement
- Spinal fusion

- 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 PaCO₂ 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**
- **Results:**
 - ***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 ?!!

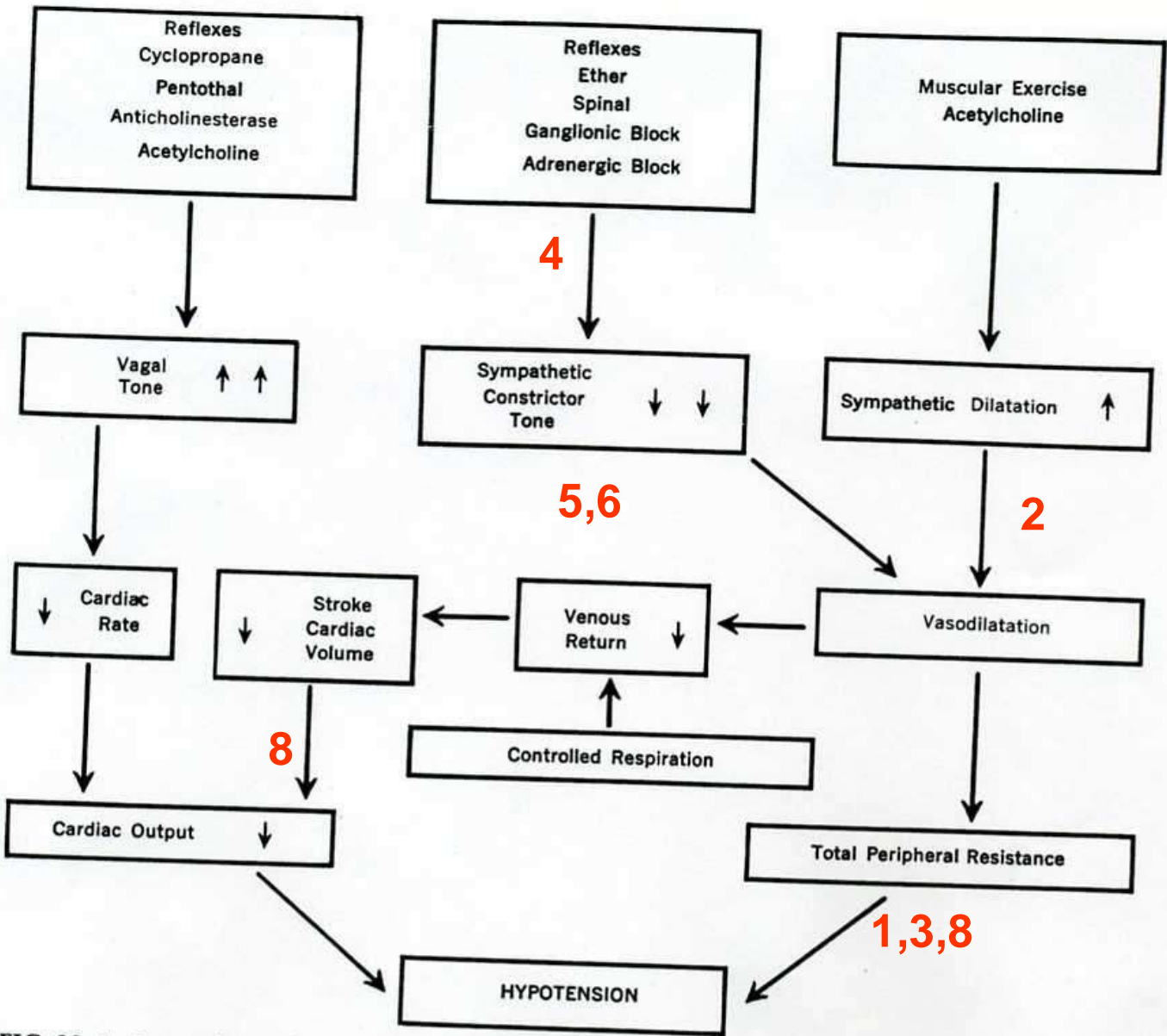
**When one has
too many
solutions of the
problem, it
seems that no
one is good!!!**



Or everything is a question of preference!!!!

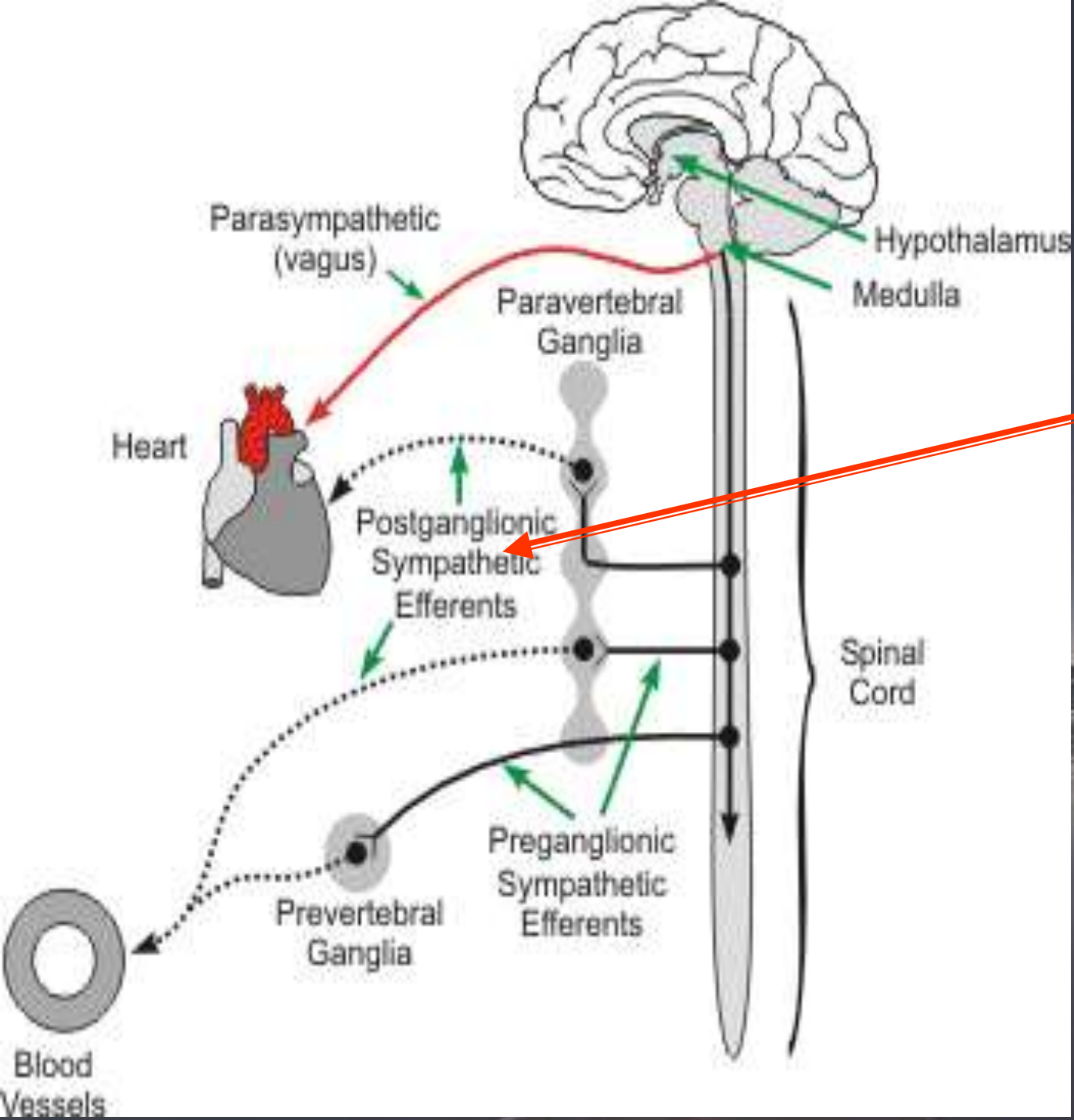
Let's count them....

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**

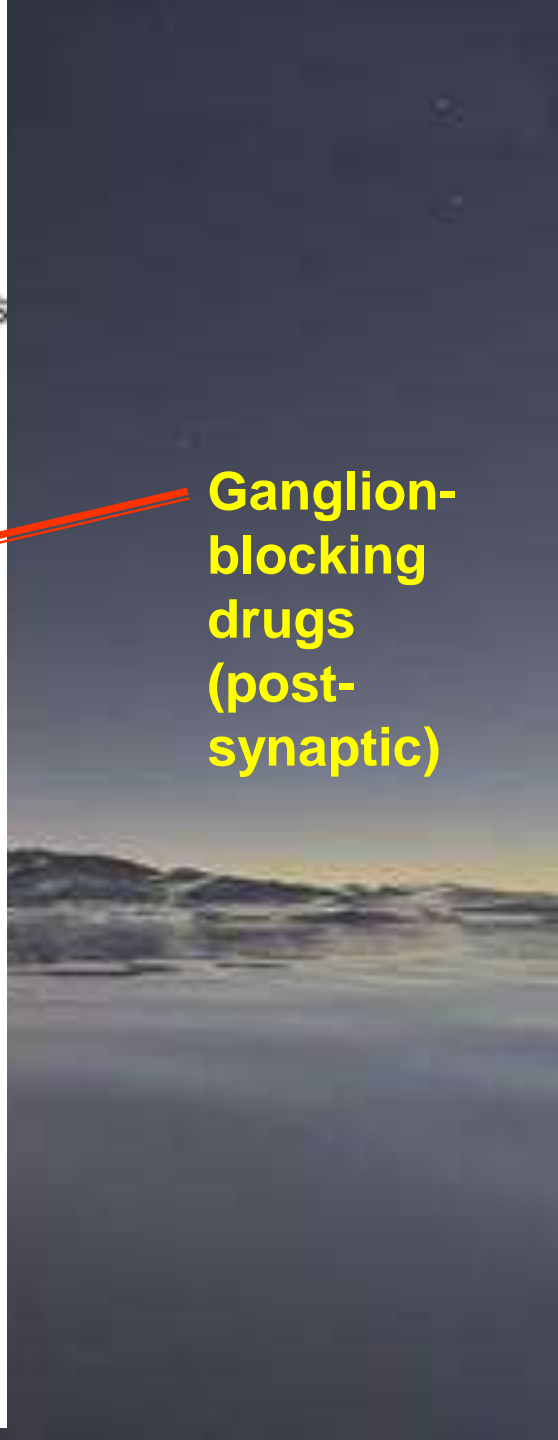


- 1. Spinal
- 2. Volatile
- 3. Direct drugs
- 4. Ganglion block
- 5-6 Alpha, Beta
- 7. combined
- 8. Ca blocker

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.)



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 to 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 beta-adrenergic receptor blocking agents



3. Direct vasodilating drugs

Nitroglycerin

**Sodium
nitroprusside**

Hydralazine

**Purine derivates
(adenosine)**

Nitroprusside

Two main drawbacks

- 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

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 catecholamines
- 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

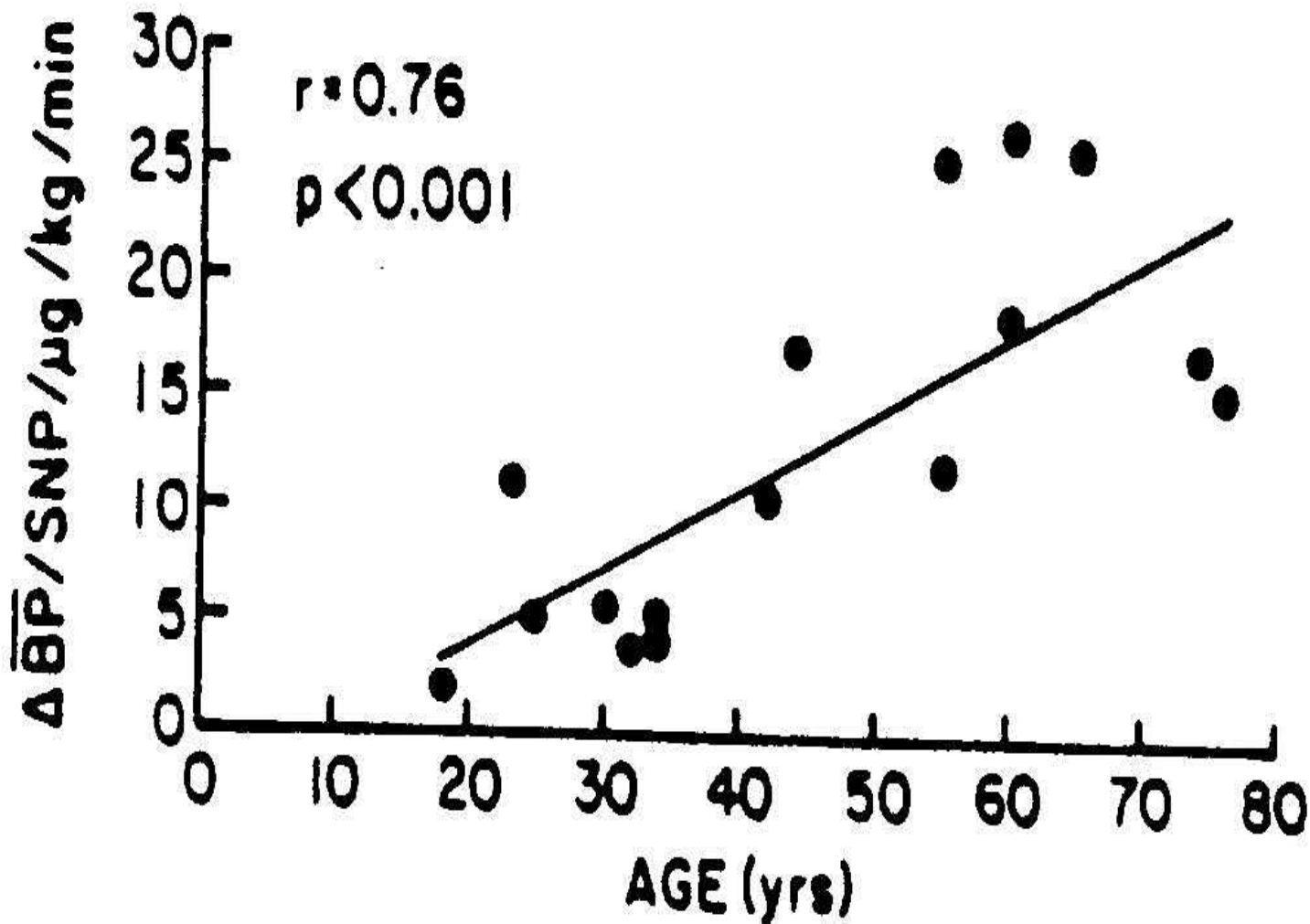


FIG. 33-9. Age and sensitivity to sodium nitroprusside. Change in mean arterial blood pressure per $\mu\text{g} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ nitroprusside dose (i.e., slope) for each patient plotted against age (yr). The equation of the line is: change in mean BP/nitroprusside dose $\mu\text{g}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

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. Beta-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 beta-adrenergic blocking drugs

Labetalol

- Blocks also the beta 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

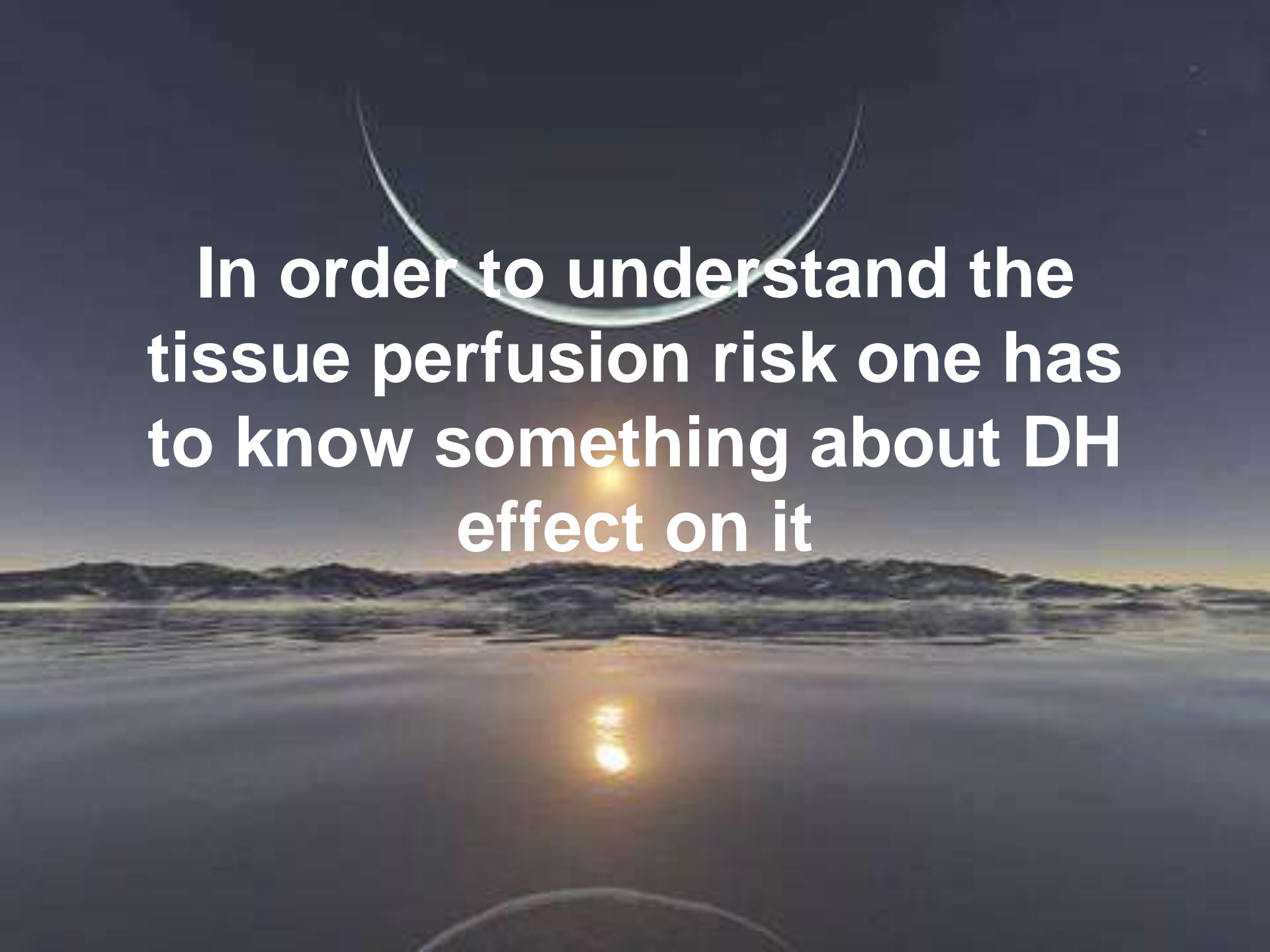
Nicarpidine

- 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

A serene landscape photograph featuring a sunset or sunrise over a calm body of water. The sun is low on the horizon, creating a bright reflection on the water's surface. A thin, crescent moon is visible in the darkening sky above the sun. The overall mood is peaceful and contemplative.

**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 CO₂ variations !
- The most important thing is to keep cerebral perfusion pressure (CPP) at an acceptable level.

$$\text{CPP} = \text{MAP} - \text{ICP}$$

- 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)**

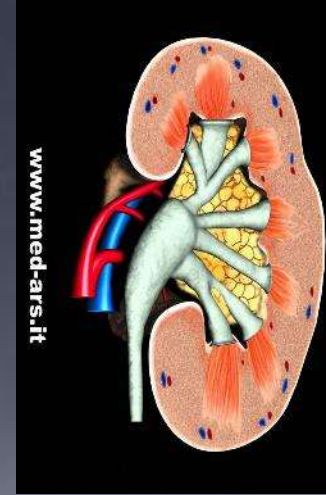
- ***avoid coronary steal**

- (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 unnecessary

BUT

What about:

*old

*hypertensive

*prolonged procedures

It seems that the combination labetalol-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 insufficiency**
- **Thrombotic 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:
- And what about the Jehovah witness gentleman ?

*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?!

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 Maxillofac 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