

Zin of Onzin van Blaasdrukmeting

of het belang van het meten en herkennen van

Intra Abdominale Hypertensie

Klinische Les voor Verpleegkundigen januari 2007

Fleur Nooteboom, internist – intensivist
Intensive Care Midden Limburg



Wat gaan we bespreken

- Begrip Intra - abdominale hypertensie
- Geschiedenis van de belangstelling
- Methodiek van meten van IAH
- Pathofysiologie in detail
 - Circulatie
 - Diurese
 - Ventilatie
 - Intra Cerebrale Druk

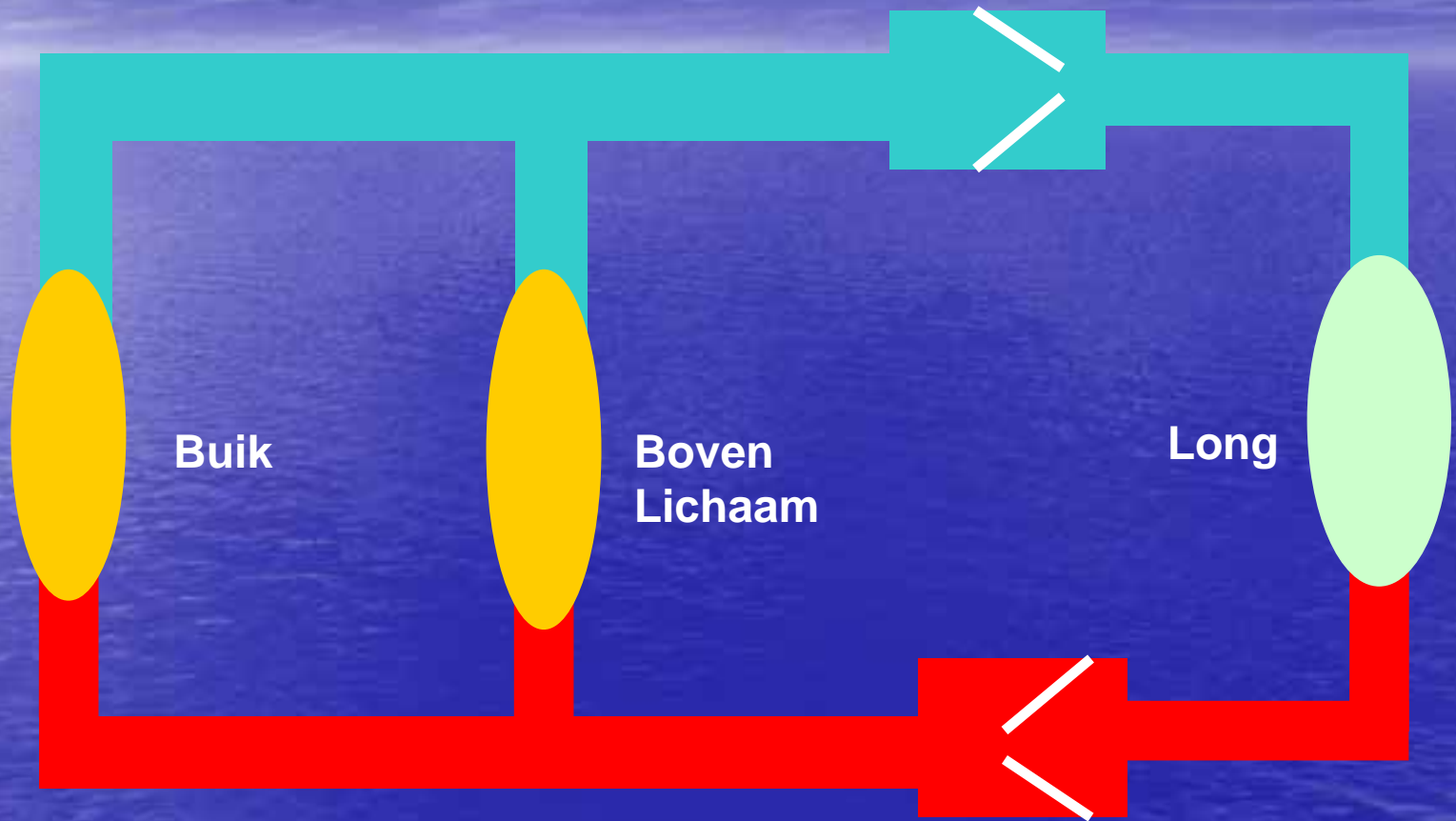
Wat gaan we bespreken ii

- Preventie
- Behandeling

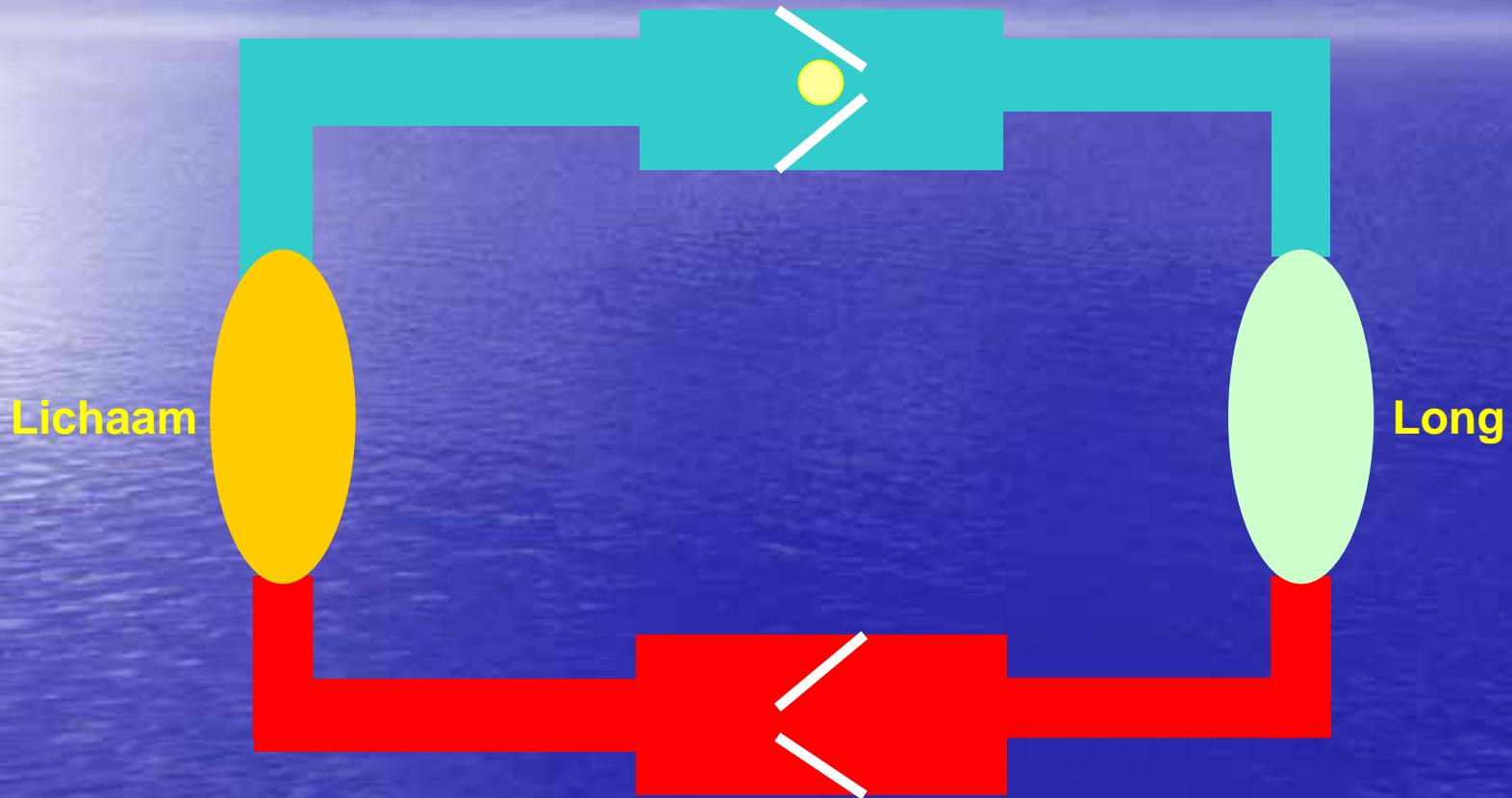
Voor een goed begrip:

- Fysiologie circulatie
- Shock

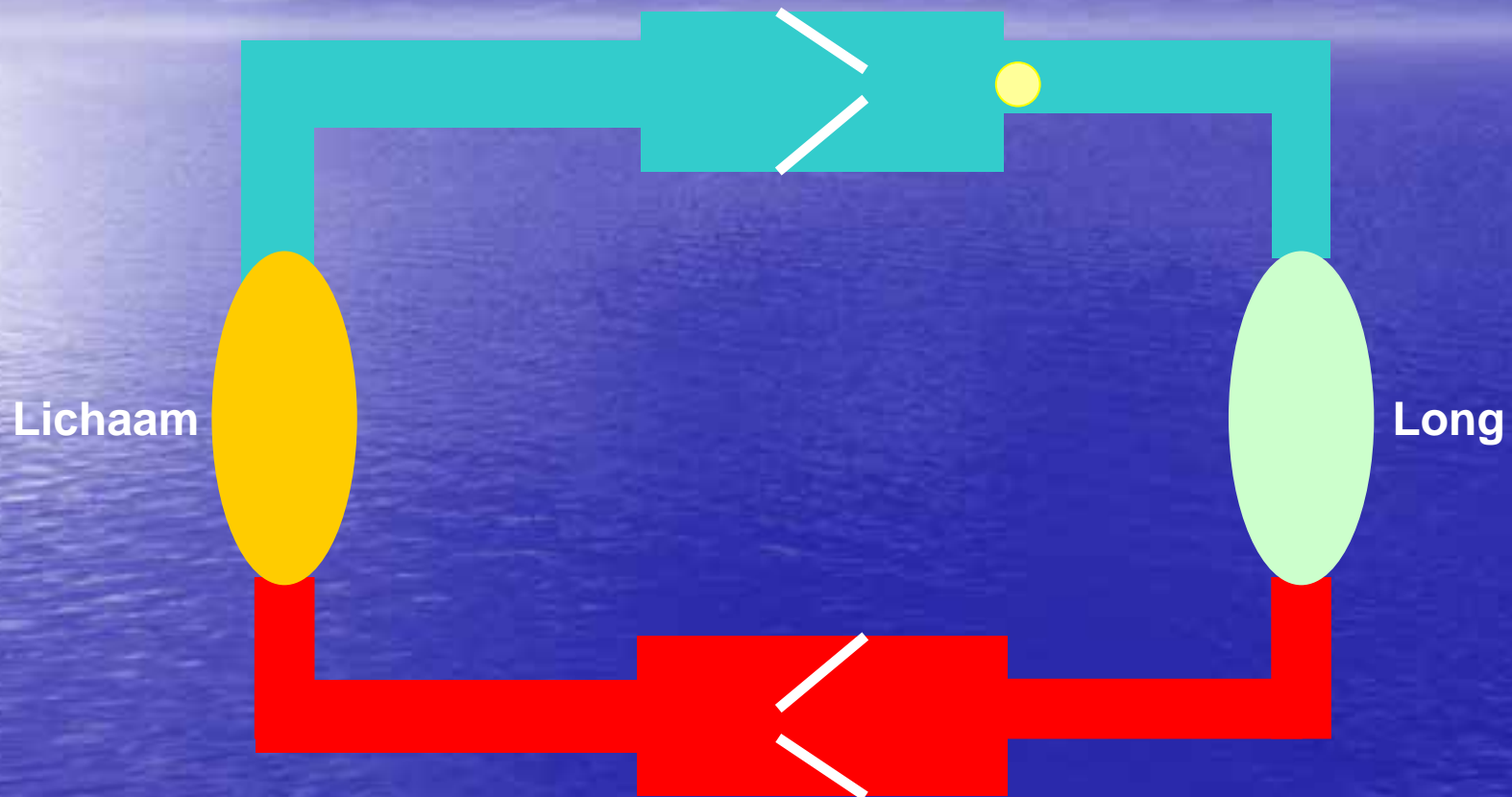
Circulatie; 2 pompen "in serie"



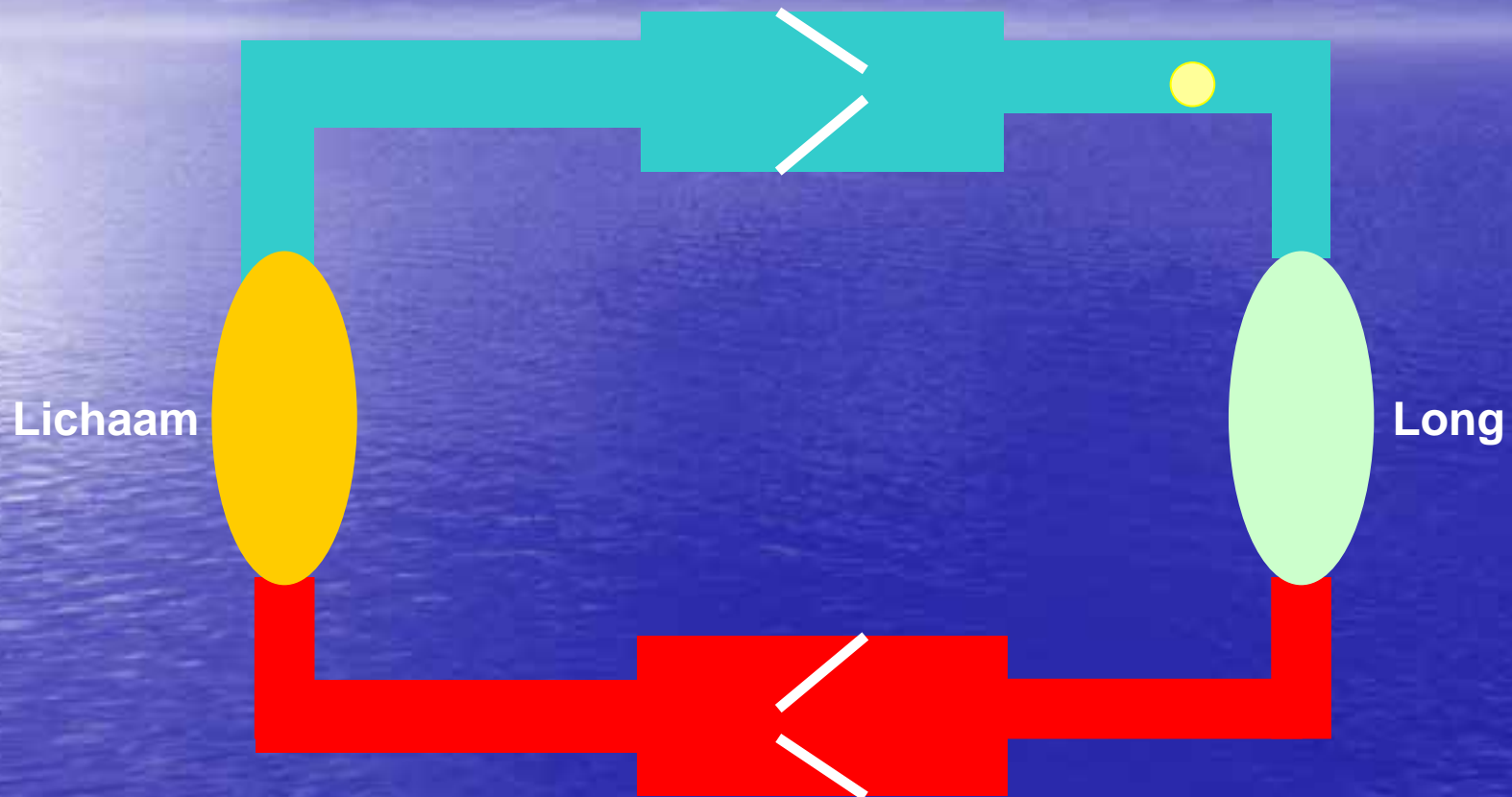
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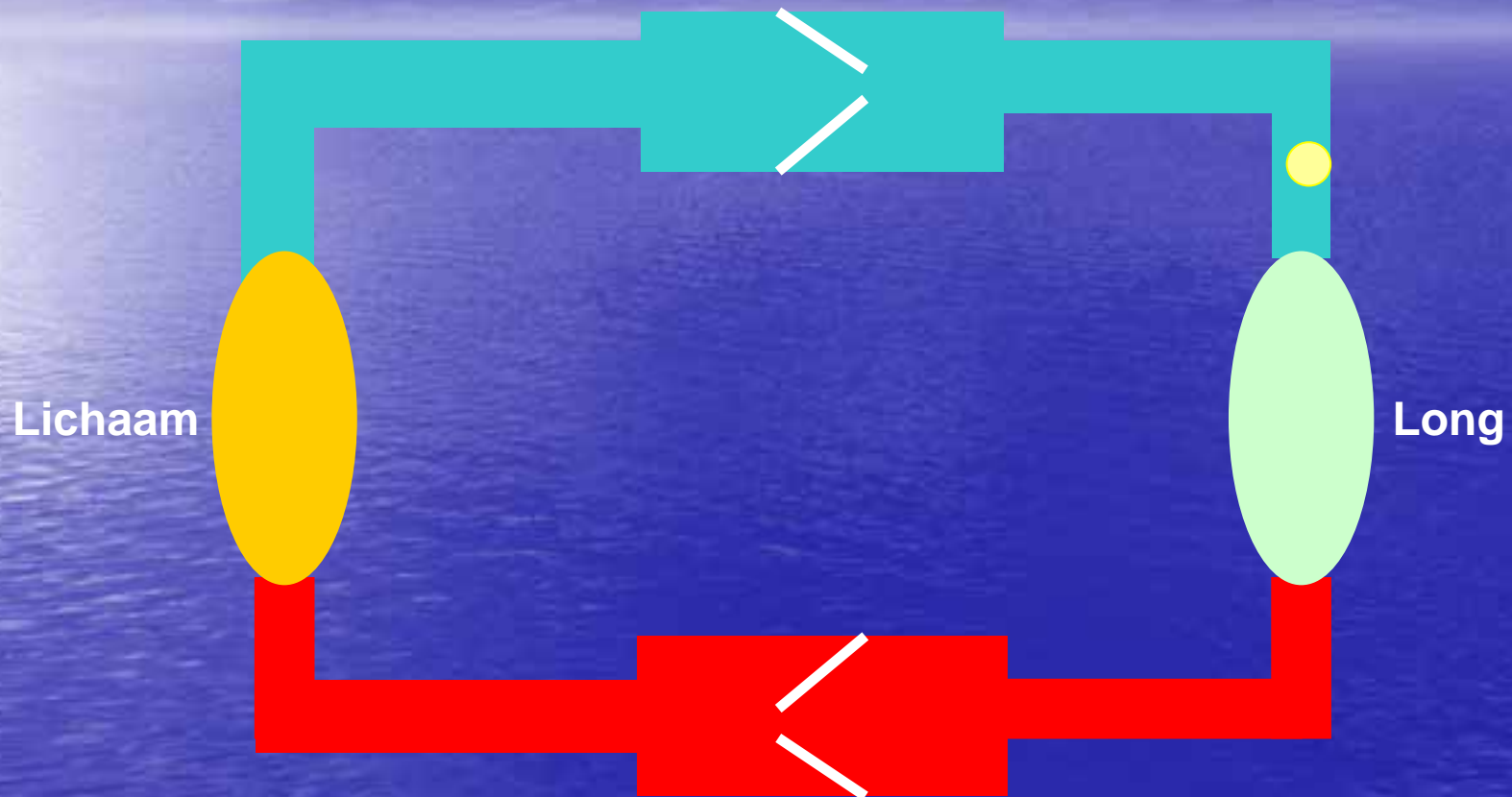
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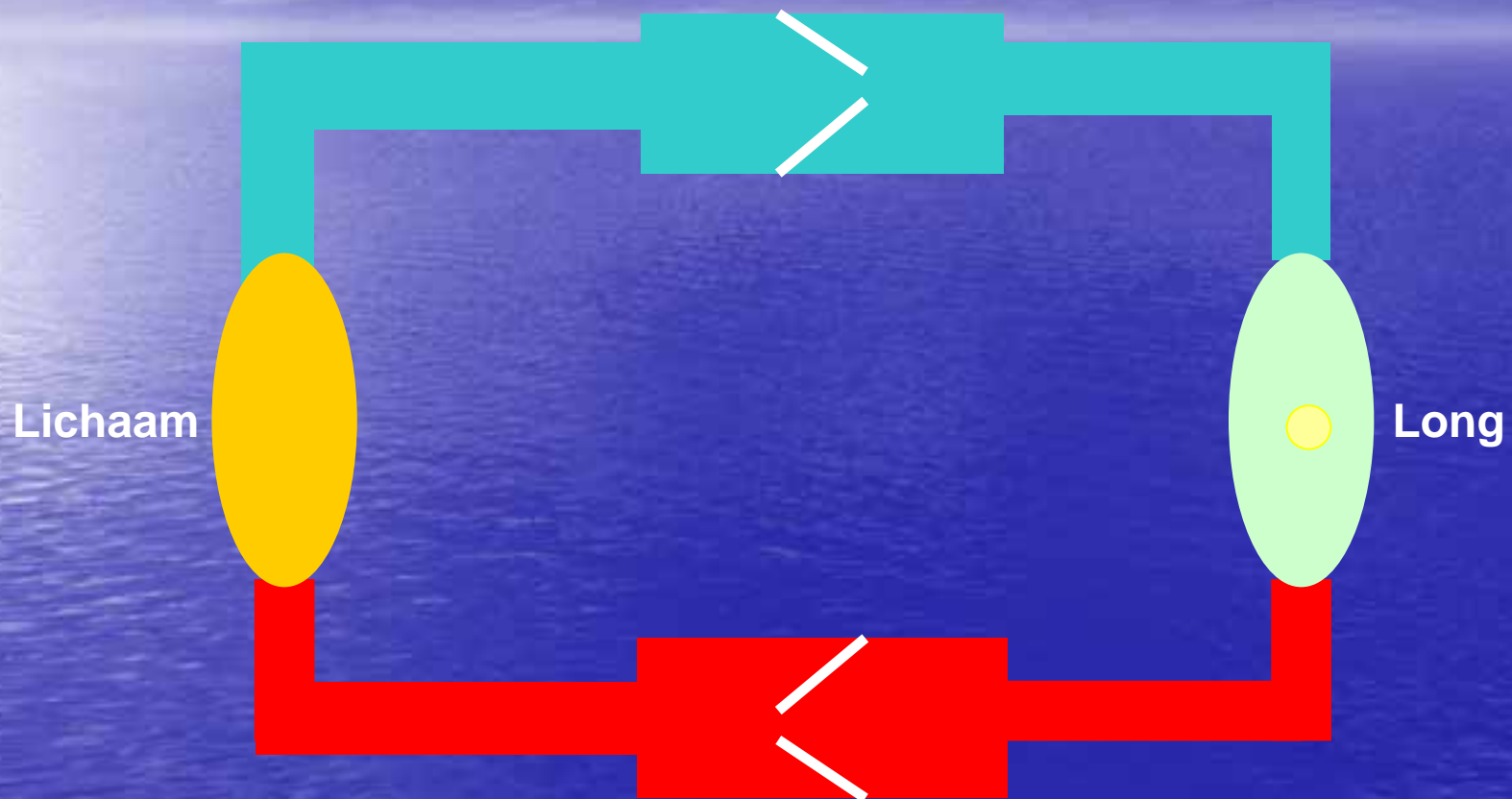
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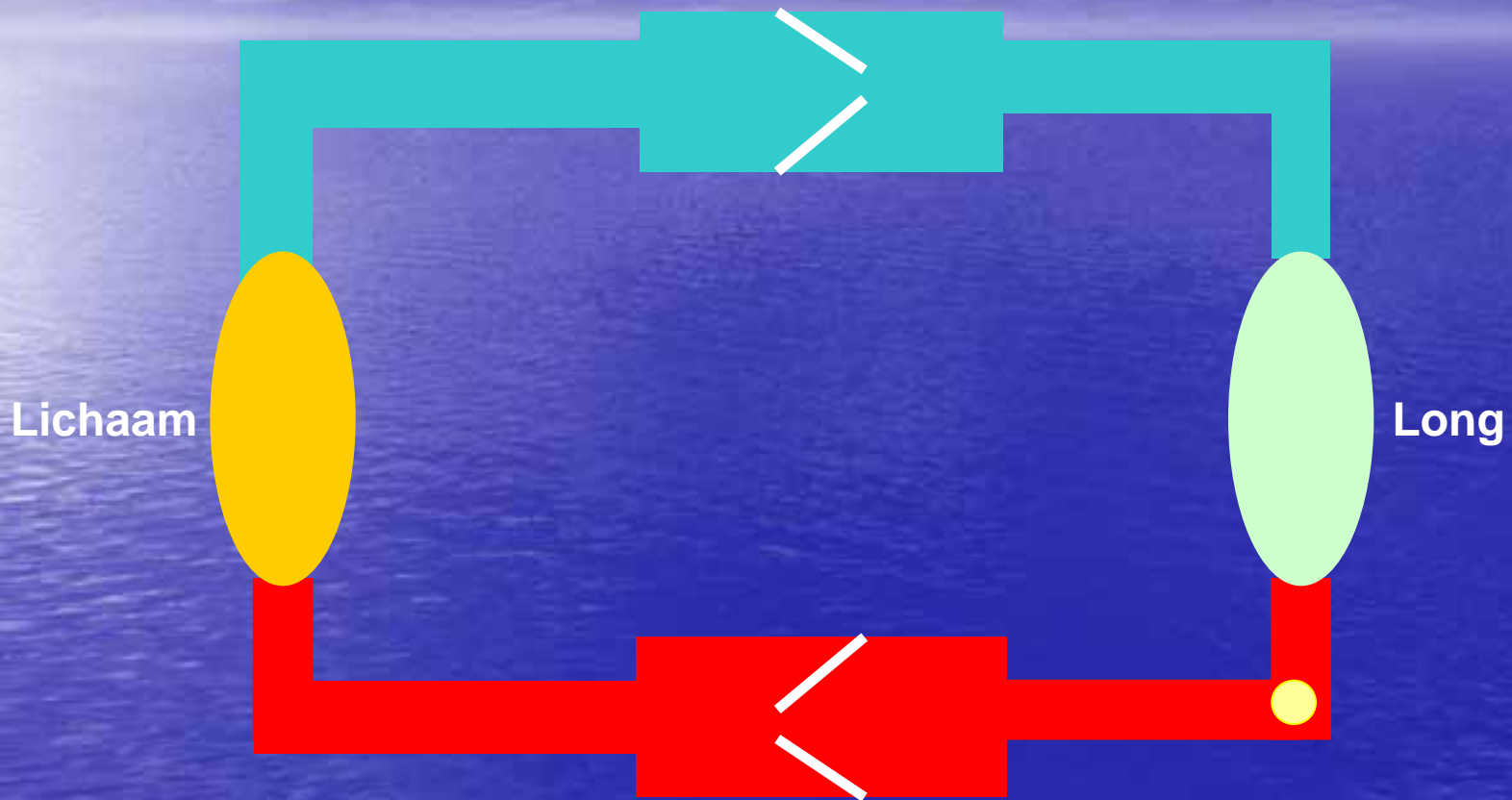
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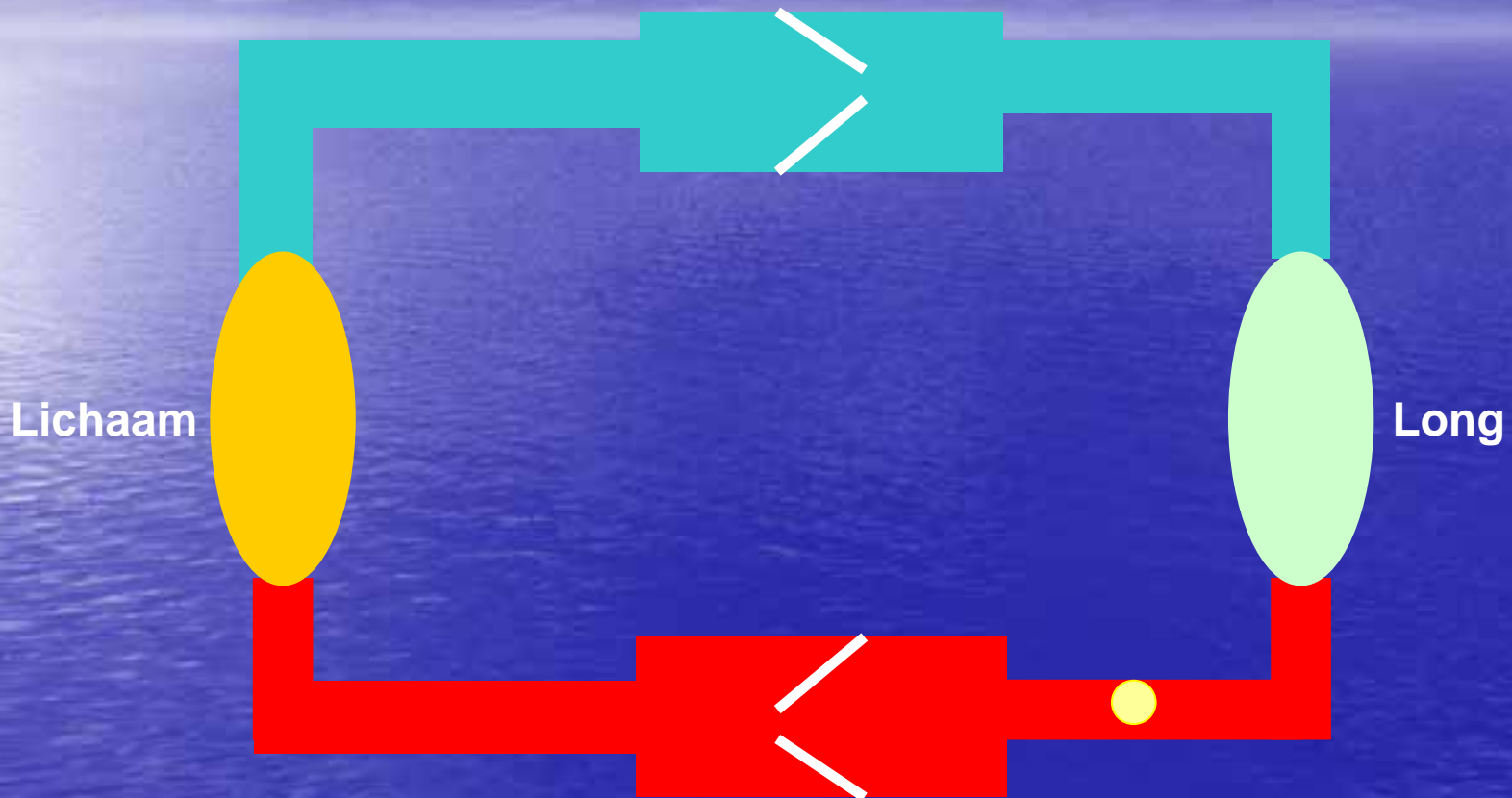
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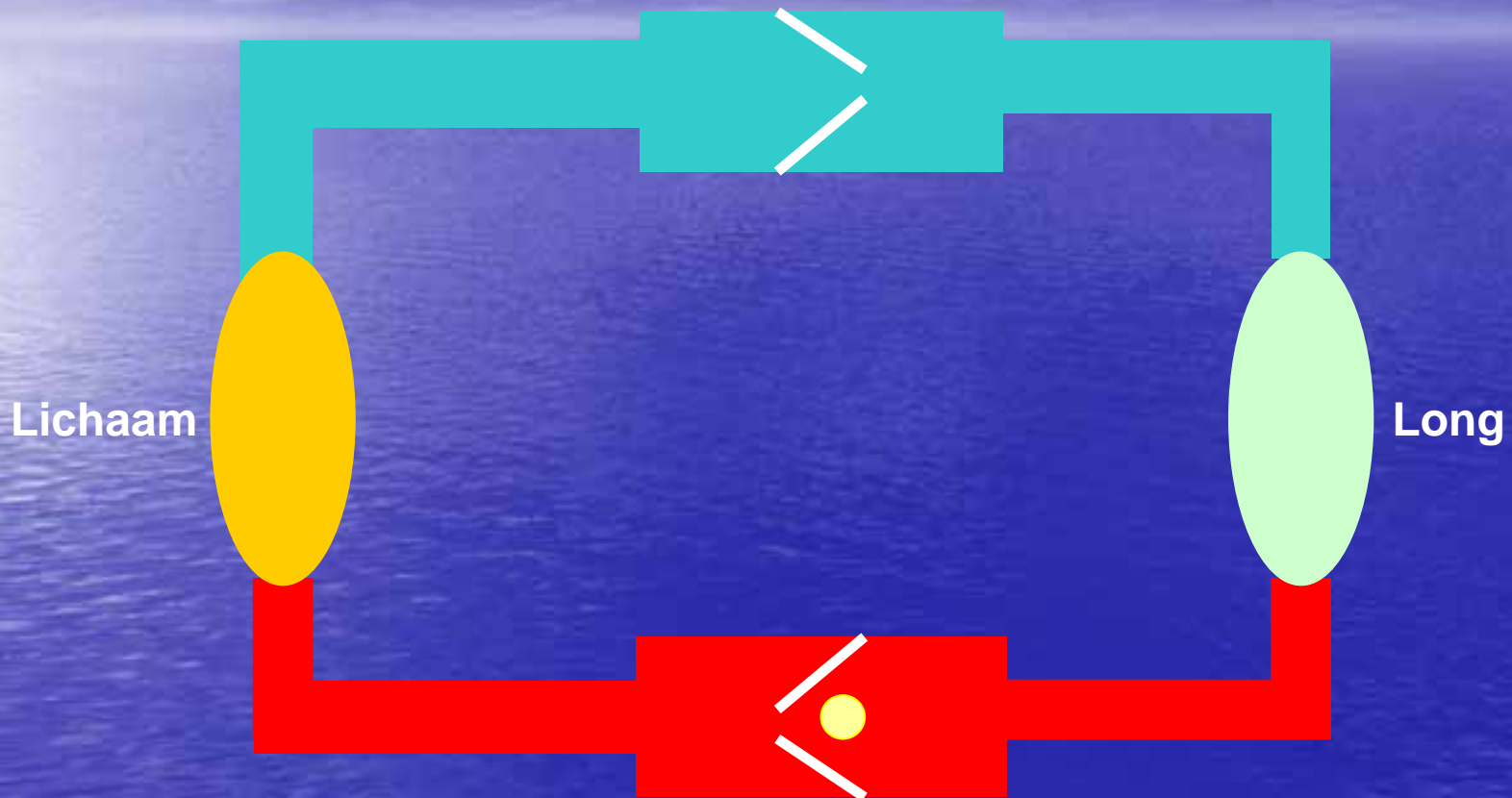
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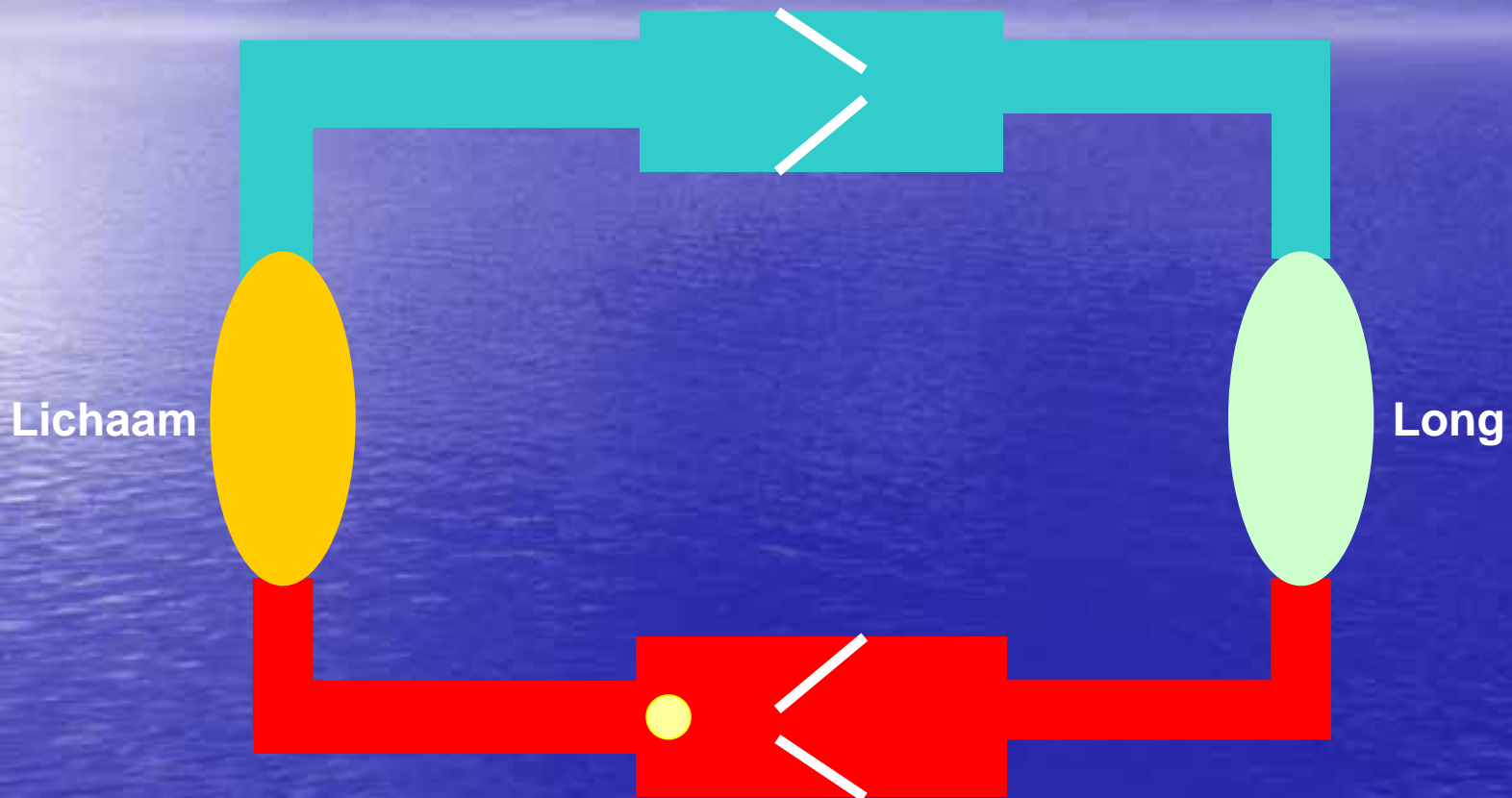
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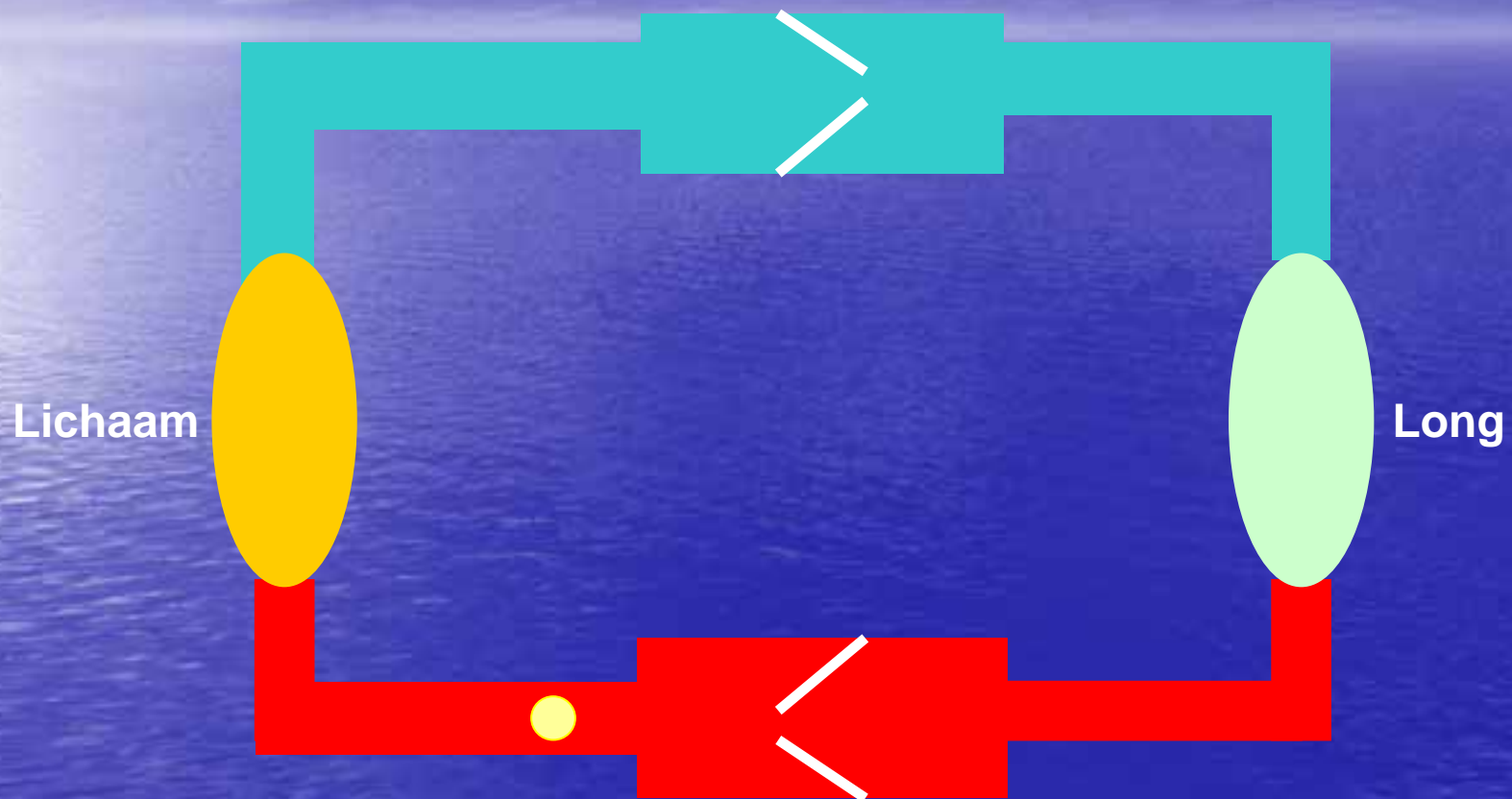
Circulatie; 2 pompen "in serie"



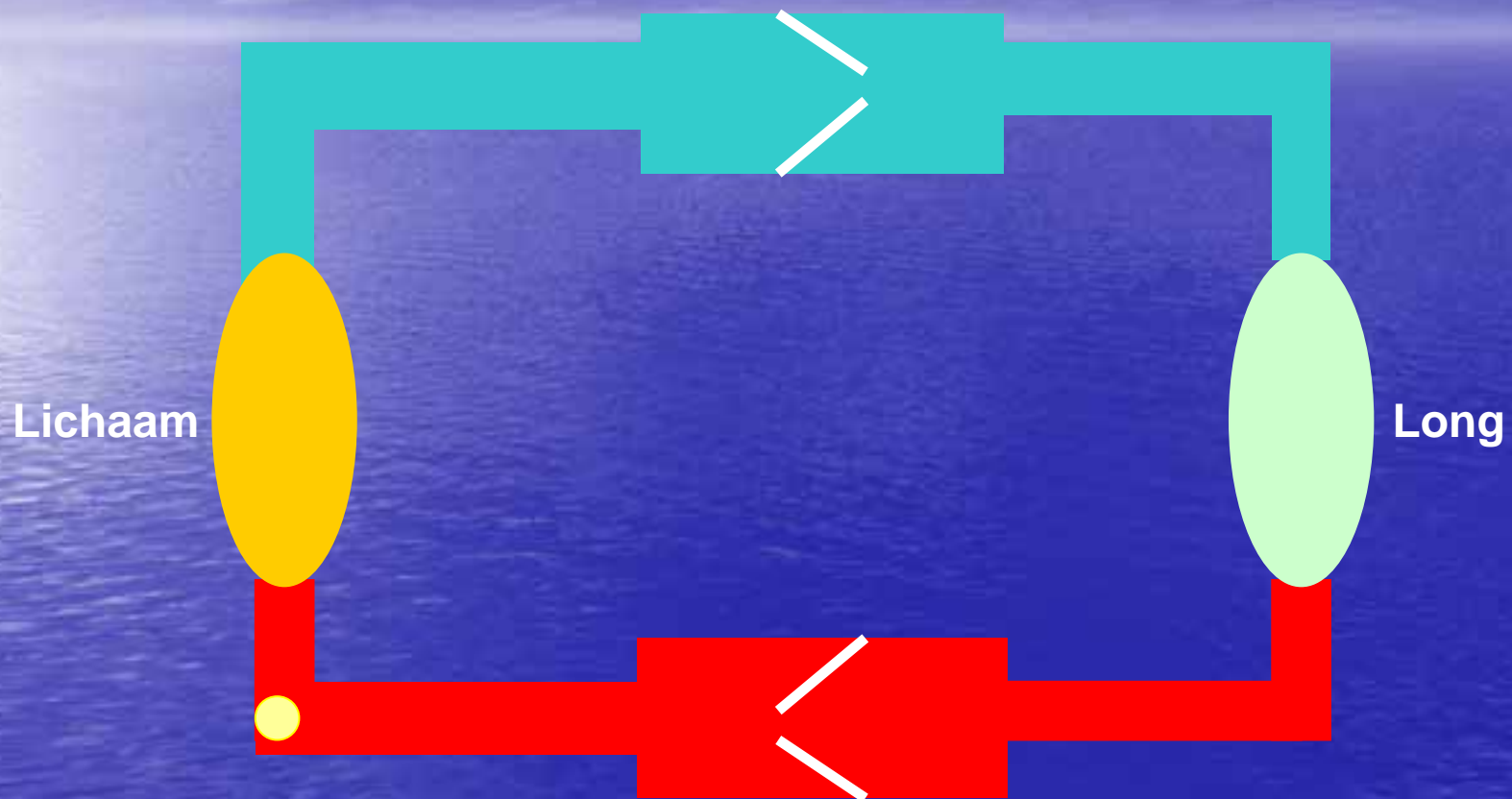
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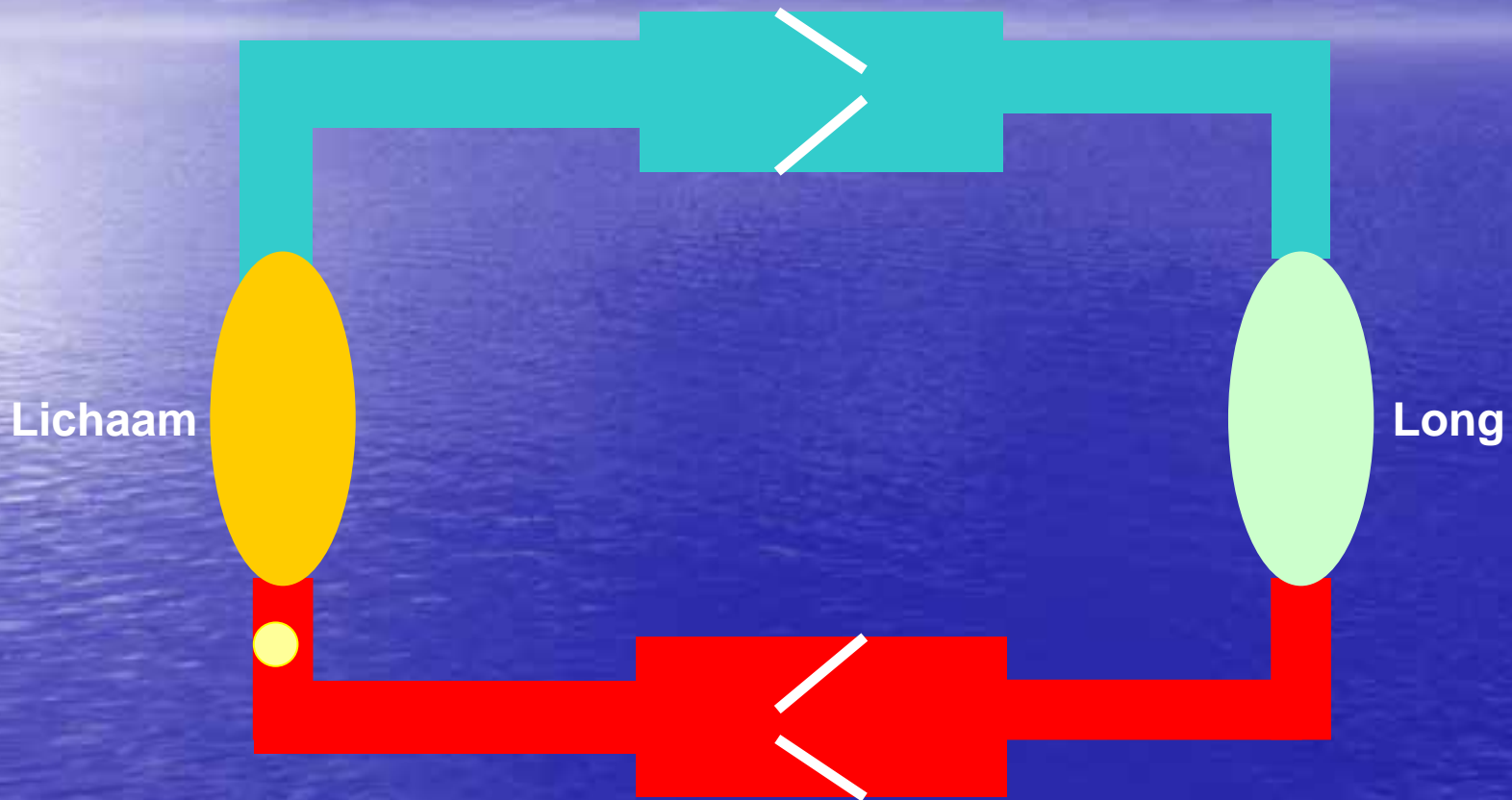
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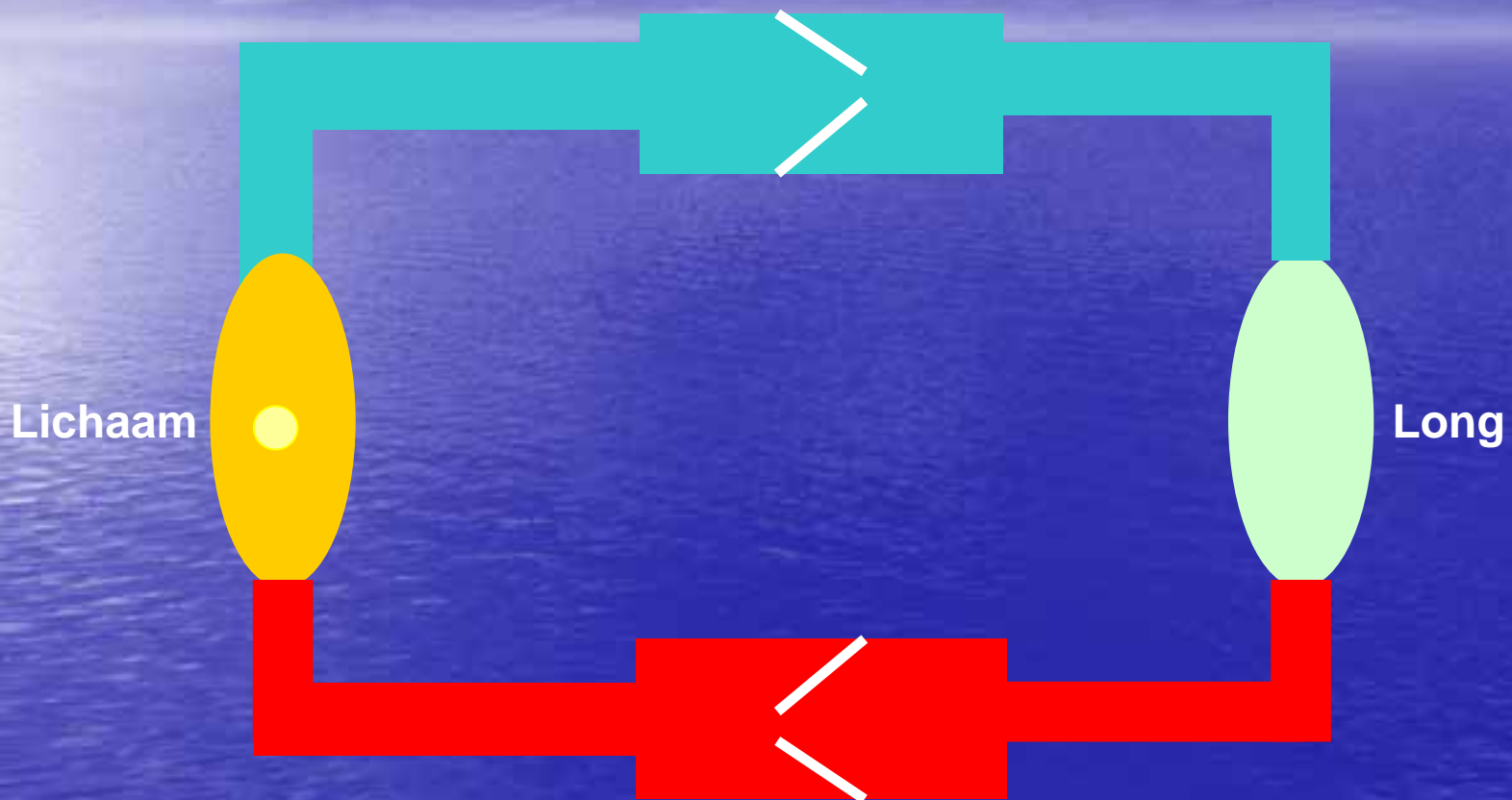
Circulatie; 2 pompen "in serie"



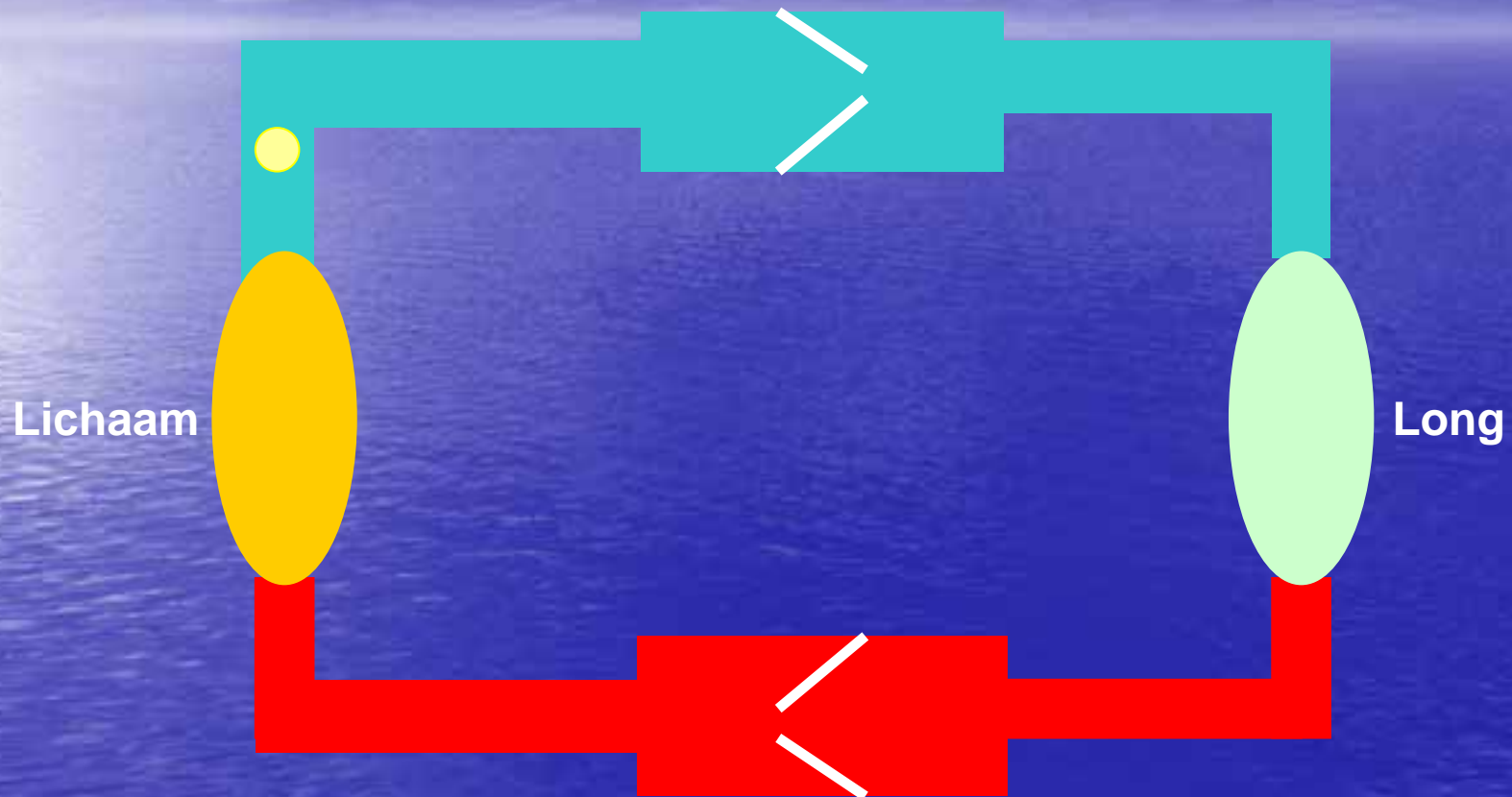
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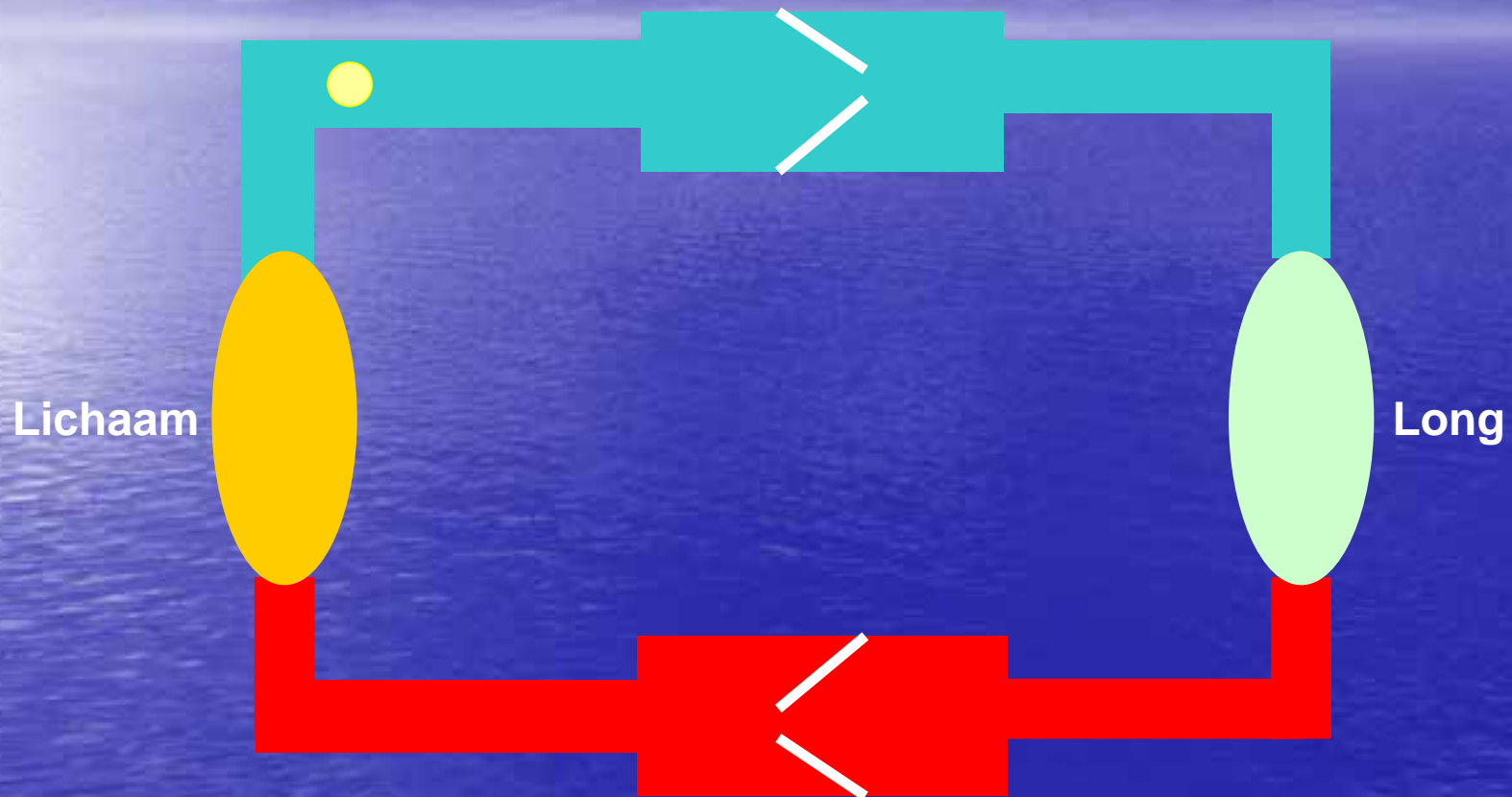
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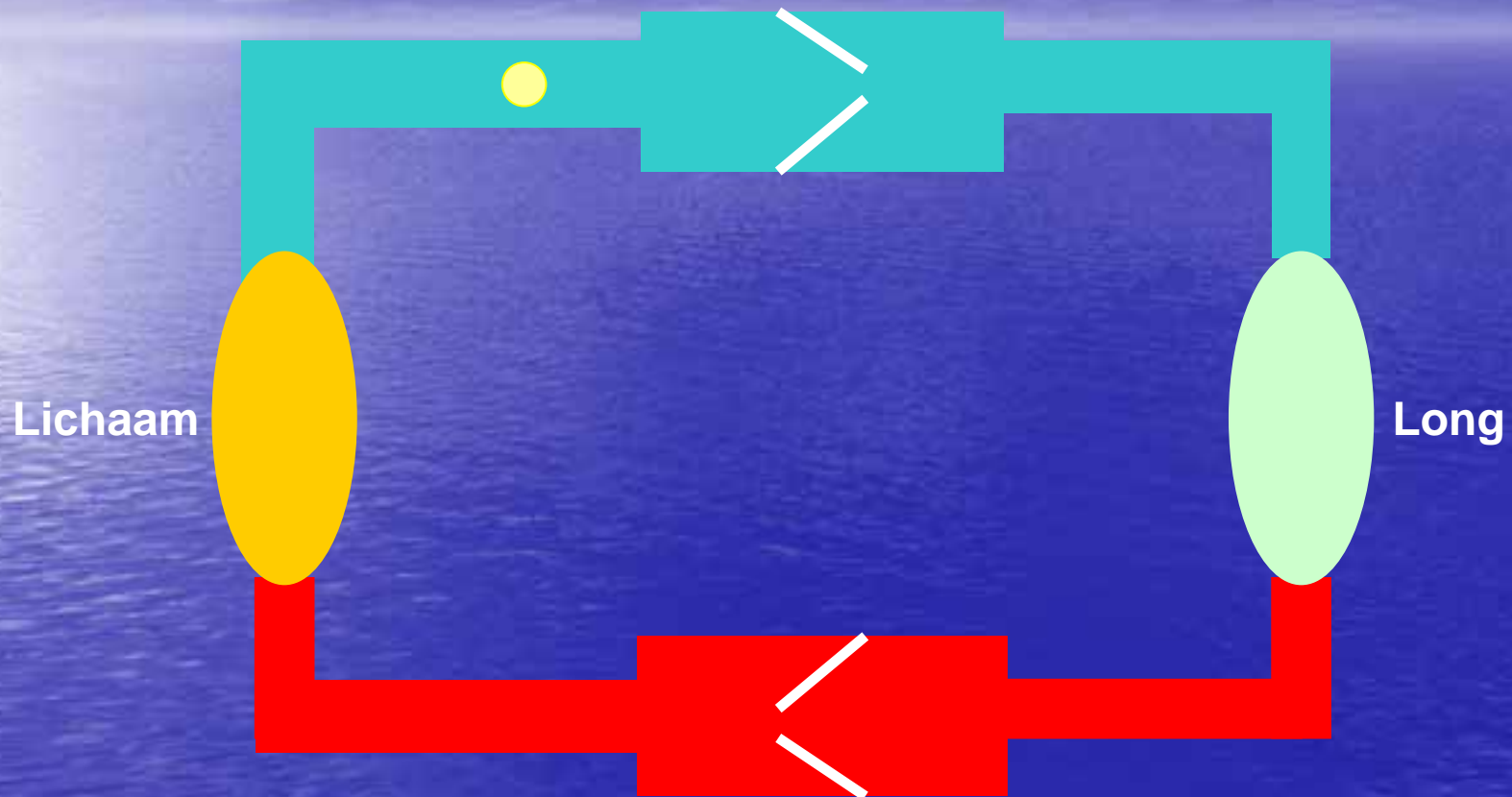
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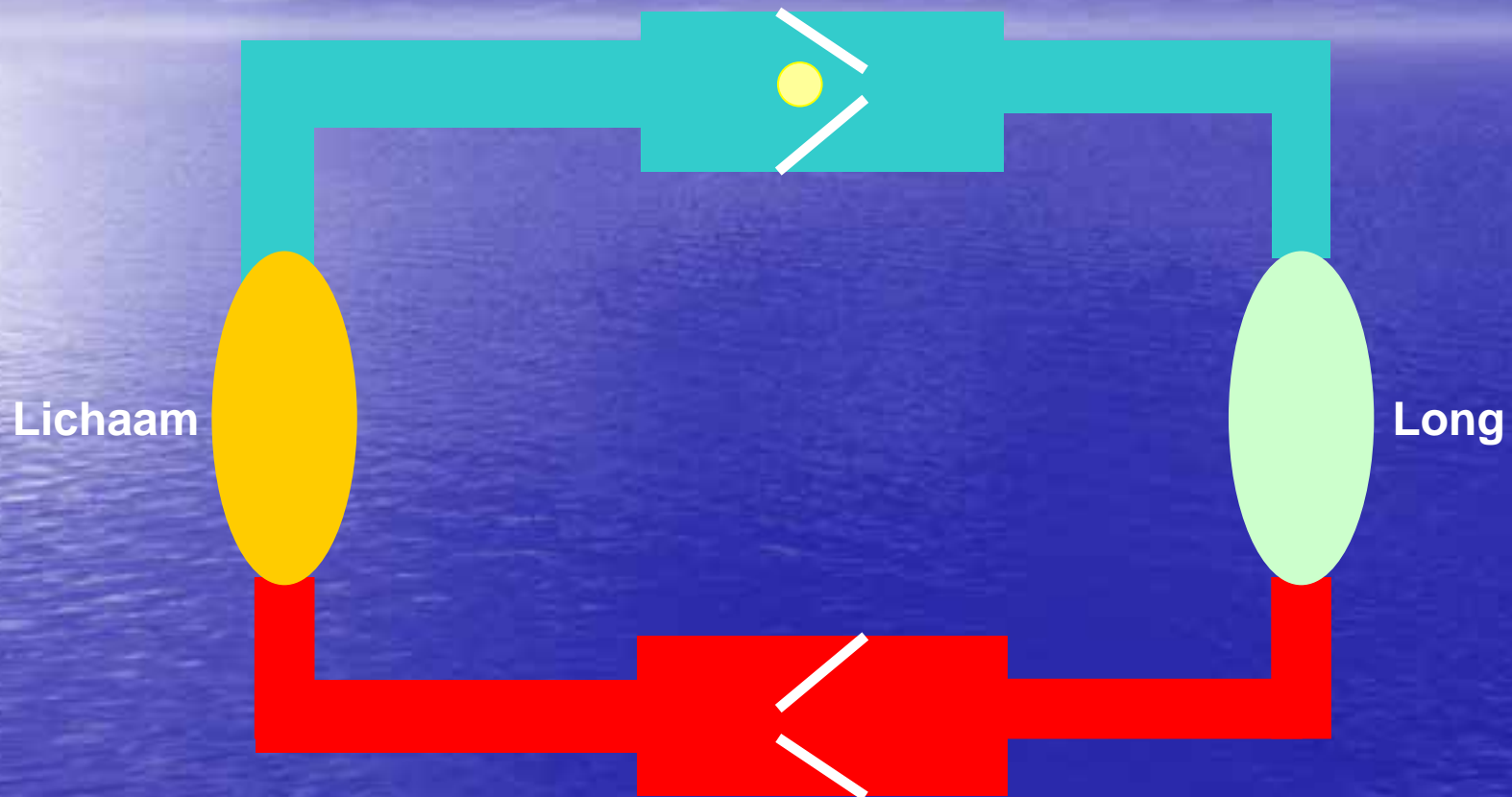
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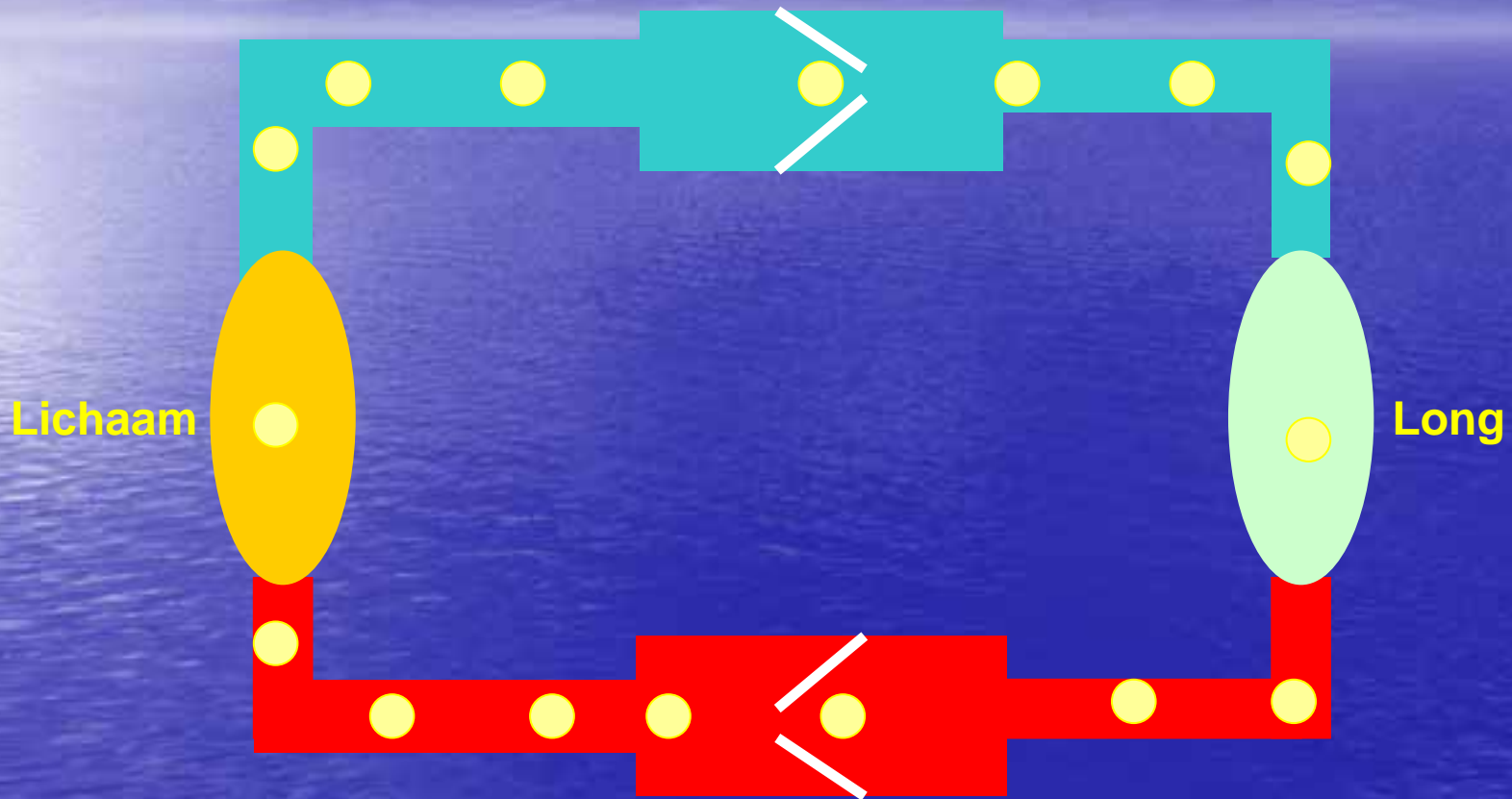
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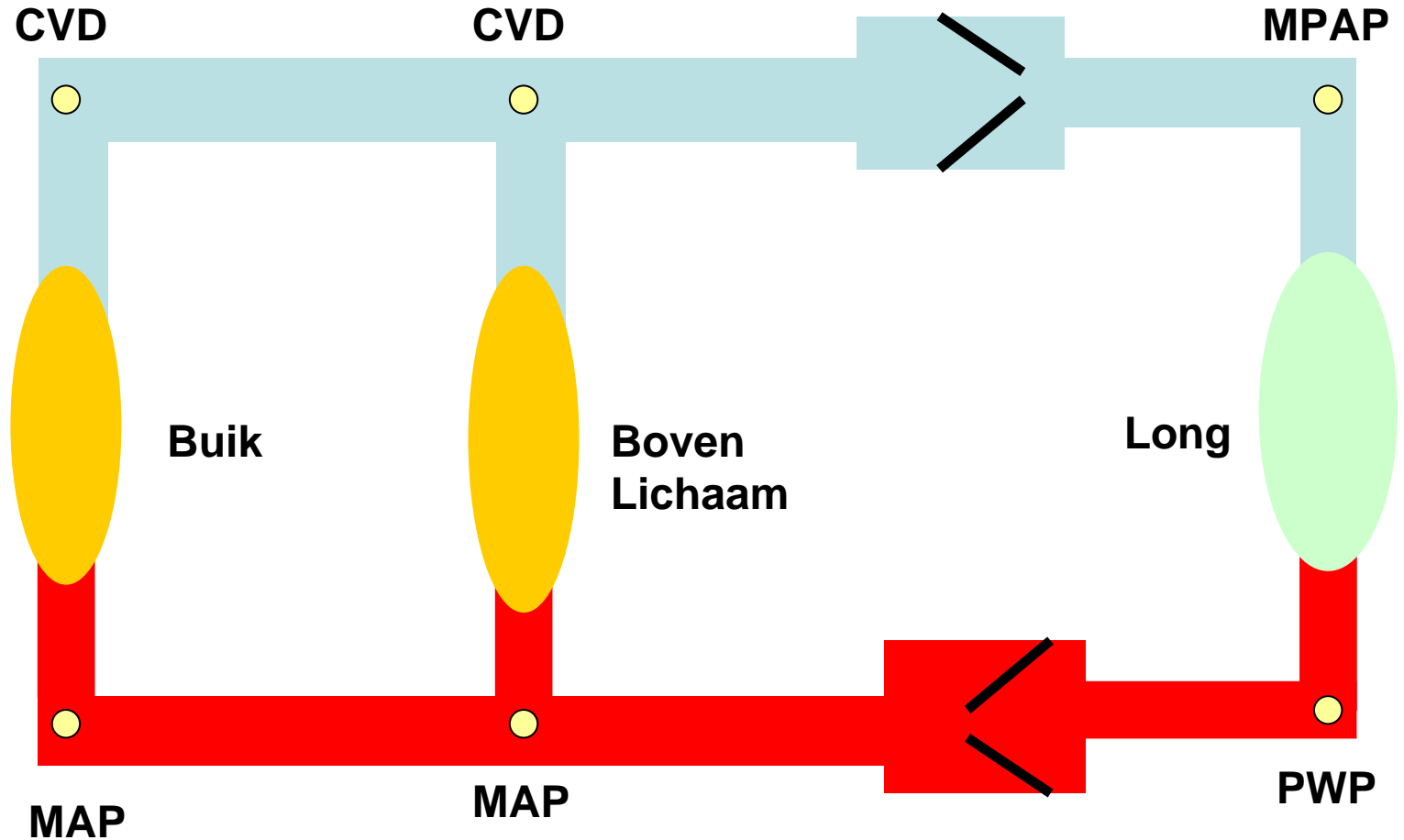
Natuurkunde: wet van Ohm

- Stroom heeft potentiaal verschil nodig als drijvende kracht
- $V = I \times R$ ► $I = V / R$

Natuurkunde: circulatie

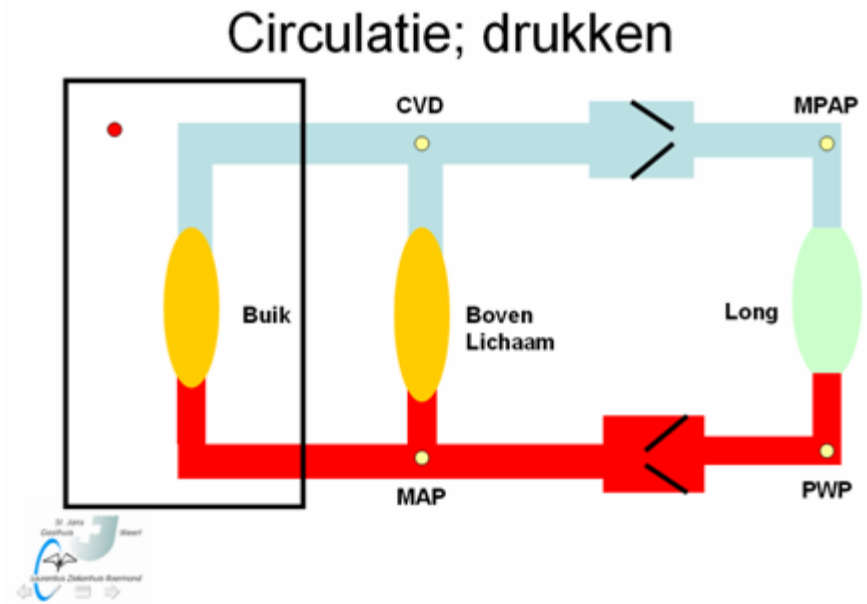
- Flow heeft drukverschil nodig als drijvende kracht
- Drukverschil = perfusie druk

Circulatie; drukken



Natuurkunde: circulatie

- Flow heeft drukverschil nodig als drijvende kracht
- Drukverschil = perfusie druk
- Perfusiedruk = $MAP - CVD$



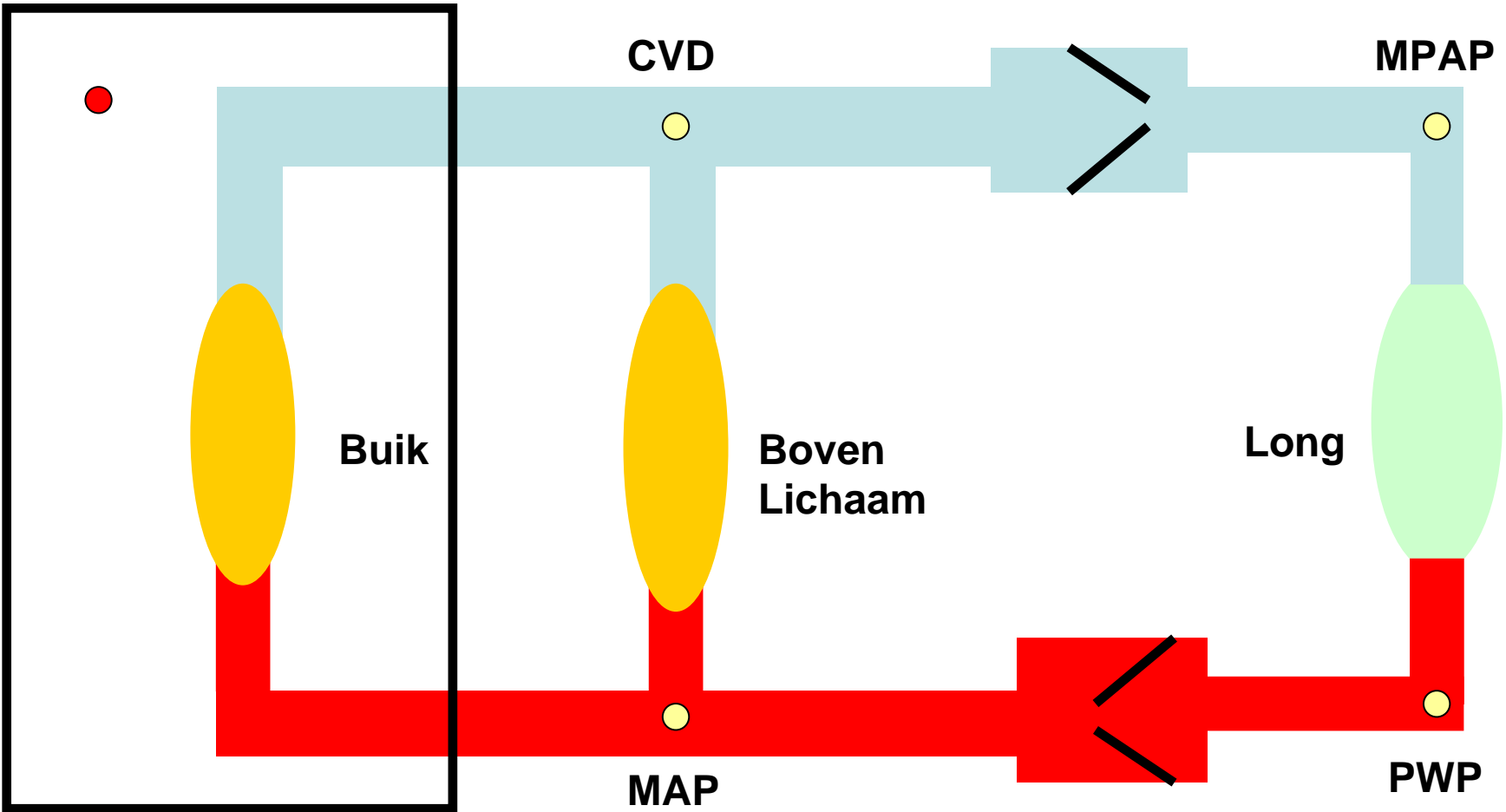
Natuurkunde; circulatie

- Perfusiedruk = MAP – CVD
- Flow = CO
- $I = V / R$ ► $CO = (MAP - CVD) / R$
- R = weerstand

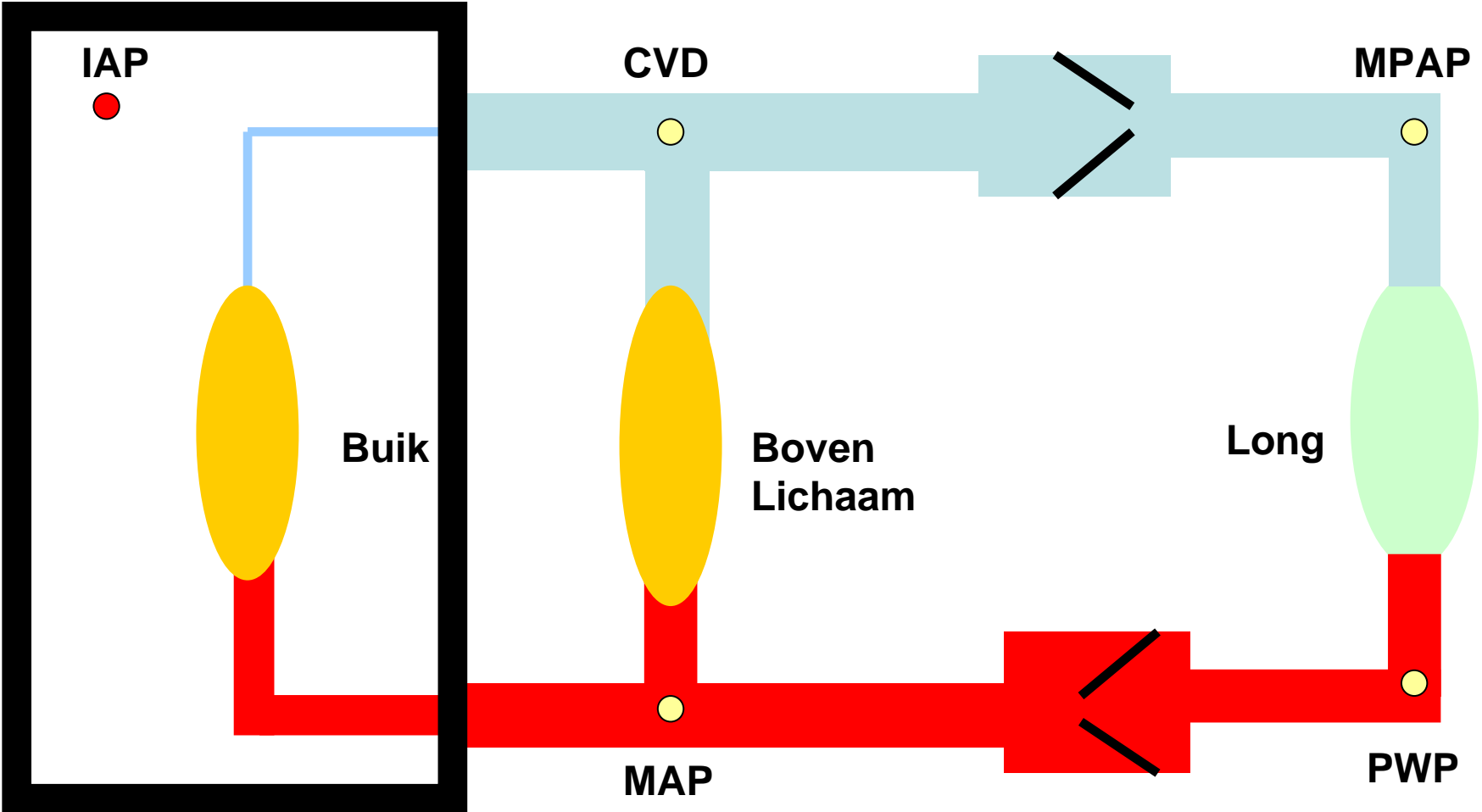
Natuurkunde; circulatie in gesloten compartiment

- Cerebrum
 - $MAP - ICP = \text{perfusiedruk}$
 - $MAP - ICP - CVD$ bepaalt flow
- Buik ?
 - Zie plaatje

Circulatie



Circulatie



Shock: Definitie

Toestand van onvoldoende *weefselperfusie*, zich uitend in een (*multiple*) *orgaanfalen* door verminderde functie ten gevolge van *afgenomen celmetabolisme*.

Dus:

- Behoud van flow en weefselperfusie van groot belang !

Definities IAH en ACS

Intensive Care Med (2006) 32:1722–1732
DOI 10.1007/s00134-006-0349-5

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**Results from the International Conference
of Experts on Intra-abdominal Hypertension
and Abdominal Compartment Syndrome.**

I. Definitions



WORLD SOCIETY OF THE ABDOMINAL COMPARTMENT SYNDROME

Home

Abstract Submission

Consensus Definitions

WSACS Constitution

Membership Application

Email List

Interesting Cases

References

Links

WELCOME TO WSACS.ORG!

The **World Society of the Abdominal Compartment Syndrome (WSACS)** was founded at the 2004 World Congress of the Abdominal Compartment Syndrome (WCACS). All who have an interest in the diagnosis, management, and/or treatment of Intra-Abdominal Hypertension (IAH) and Abdominal Compartment Syndrome (ACS) are invited to join the Society.

The mission of the WSACS is to promote research, foster education, and improve the survival of patients with IAH / ACS by bringing together physicians, nurses, and others from a variety of clinical disciplines to share information on effective management strategies for reducing the significant morbidity and mortality of IAH / ACS. This website is intended to facilitate the goals and mission of the WSACS.

The latest news from the WSACS...

WORLD CONGRESS ON ABDOMINAL COMPARTMENT SYNDROME (WCACS)

The Third World Congress on the Abdominal Compartment Syndrome (WCACS) will be held in Antwerp, Belgium, 22-24 March 2007. This exciting conference will provide an environment for interaction, discussion, definition and consolidation of knowledge in the field of intra-abdominal hypertension and abdominal compartment syndrome. The meeting will be based on the successful interactive formulas used for the second WCACS held in 2004 (Noosa Australia) which had over 160 participants. Full details on the conference may be found at:

[Third World Congress on Abdominal Compartment Syndrome](#)

Intra-Abdominale Hypertensie en het Abdominaal Compartment Syndrome

Warme belangstelling

Eerste beschrijving in 1863

Sinds 1985 toenemende interesse

Enorme groei aantal artikelen sinds 2000

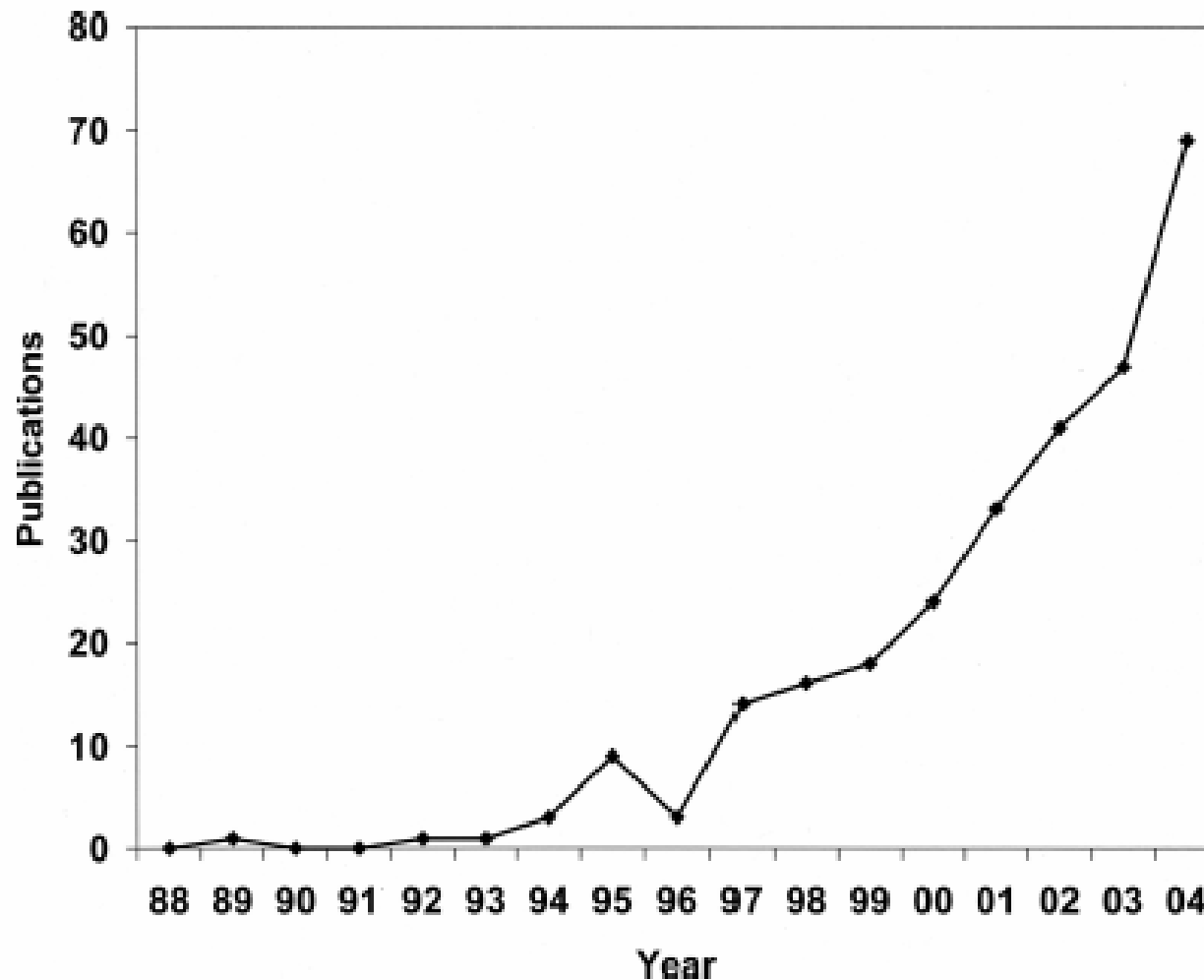


Figure 1. The number of publications listing “abdominal compartment syndrome” or “intra-abdominal hypertension” within the PubMed search criteria (limited by English language in human subjects), by publication years 1988 to 2004.

Survey of intensive care physicians on the recognition and management of intra-abdominal hypertension and abdominal compartment syndrome*

Edward J. Kimball, MD, FACEP; Michael D. Rollins, MD; Mary C. Mone, BSE; Heidi J. Hansen; Gabriele K. Baraghoshi, RN; Cory Johnston, BS; Evan S. Day; Peter R. Jackson; Marielle Payne, BA; Richard G. Barton, MD



Intra-Abdominale Druk = IAP

**Steady state druk in
buikholte
(eindexpiratoir)**

Solide organen

inhoud holle organen

buikwandelasticiteit

Abdominale Perfusie Druk = APP

Analogie met
Cerebrale Perfusie Druk

$$CPP = MAP - ICP$$

$$APP = MAP - IAP$$

Betere overleving
bij $APP > 60$ mm Hg

M.L.N.G. Malbrain

Abdominal pressure in the critically ill: measurement and clinical relevance

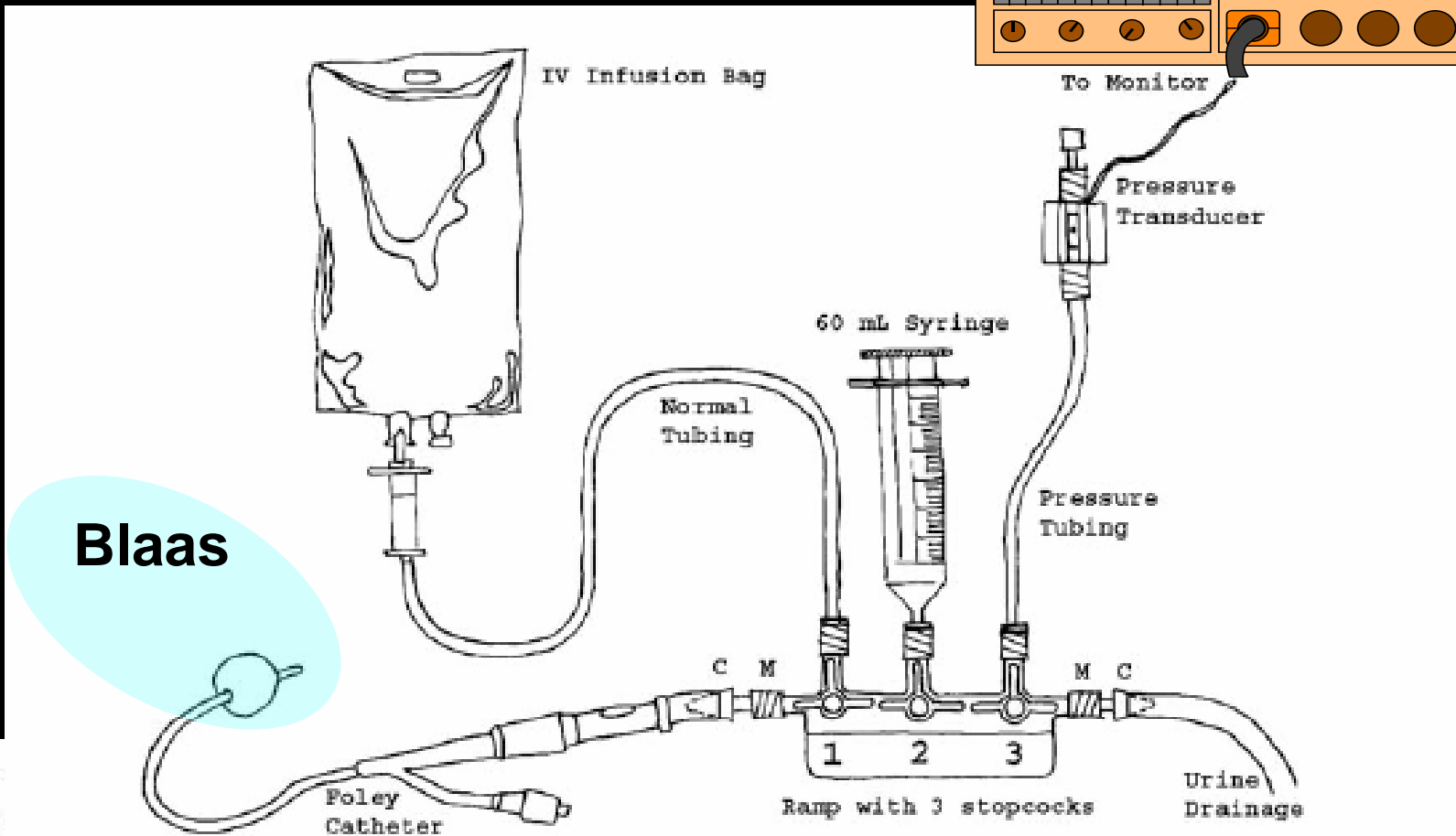
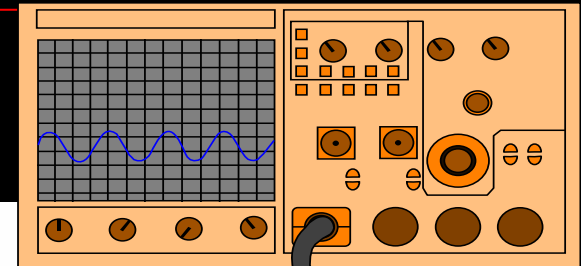
Manu L. N. G. Malbrain

Different techniques to measure intra-abdominal pressure (IAP): time for a critical re-appraisal

Tom J. R. De Potter
Hilde Dits
Manu L. N. G. Malbrain

Intra- and interobserver variability during in vitro validation of two novel methods for intra-abdominal pressure monitoring

Meting van Intra-Abdominale Druk



Meting van Intra-Abdominale Druk

- Blaas het simpelst, best bereikbaar, meest gebruikt en minst kostbaar
- (Tekening) Naaldloos; gesloten systeem; meting met drukmodule
- Meten in mm Hg, plat op rug, eindexpiratoir
- Referentiepunt is Mid axillairlijn
- Maximum te instilleren volume = 25 ml

Malbrain ea. Results from the International Conference of Experts on Intra-abdominal Hypertension en Abdominal Compartment Syndrome. I. Definitions. [Intensive Care Med \(2006\) 32: 1722-1732](#)

Accenten bij vorige dia

- *In mm Hg: net als MAP. Geen verschillende eenheden meer bij drukmeting*
- *Referentiepunt Mid Axillair Lijn*
 - *ALLE drukmetingen zelfde referentiepunt*
 - *Ook gemakkelijk met ventilatie in buikligging*
 - *Midaxillair = (afstand rug – sternum) / 2*
- *Volume had invloed op drukken.*

Panel B

Bladder Pressure-Volume curve (Patient B)

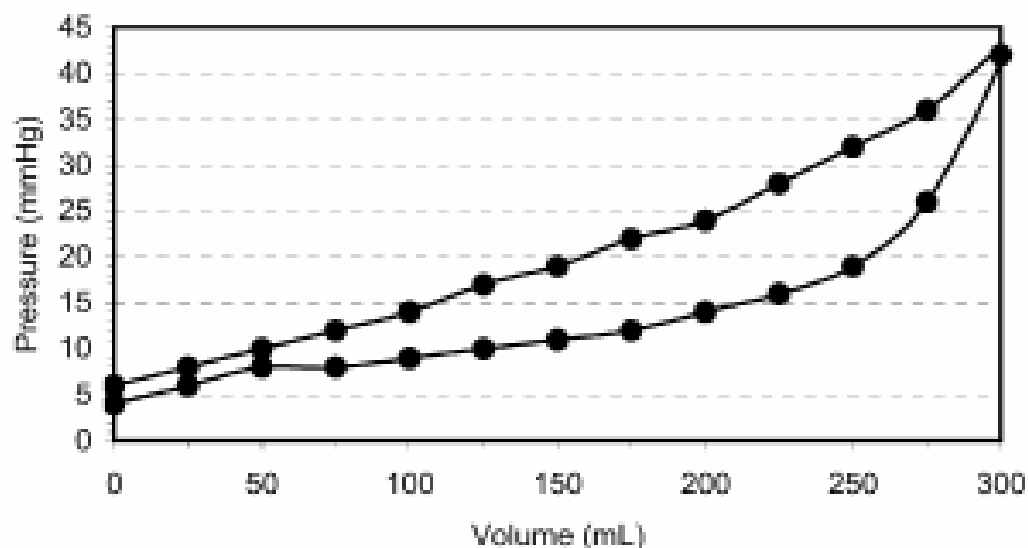


Fig. 1 A Bladder PV curve in a patient with a compliant bladder. Note that pressures are higher during insufflation than during deflation. Note that regardless of the amount of saline instilled in the bladder the pressures are comparable: 10 mmHg at 50 ml, 11 mmHg at 100 ml and 12 mmHg at 200 ml. **B** Bladder PV curve in a septic patient with a poor bladder compliance. Note that pressures are higher during insufflation than deflation. Note the significant difference in IAP value with regard to the amount of saline instilled in the bladder: 10 mmHg at 50 ml, 14 mmHg at 100 ml and 24 mmHg at 200 ml

Andere beschreven methoden

- Druk via NG tube in maag
- Druk in vena cave inferior
- Directe meting intra-peritoneale druk via intra-peritoneale catheter (drain)
- *Minder betrouwbaar. Blaas standaard*

Normale Intra-Abdominale Druk

**Normale IAP:
5 – 7 mm Hg
bij volwassenen IC**

"Bawdy, blistering....This is Catch-22
with stethoscopes." -Cosmopolitan

The House of GOD

DELL-13368 • U.S. \$4.50
CAN. \$5.95



A Novel by
Samuel Shem, M. D.
Author of *Fine*

Laws from the House of God; nr X

If you don't take a
temperature, you can't find
a fever

**If you don't take an IAP,
you can't find an
abdominal hypertension**

Intra-Abdominale Hypertensie (IAH)

Definitie IAH:

“sustained” > 12 mm Hg

Intra-Abdominale Hypertensie (IAH)

Gradering IAH:

I: IAP 12 – 15 mm Hg

II: IAP 16 – 20 mm Hg

III: IAP 21 – 25 mm Hg

IV: IAP > 25 mm Hg

Stadiëring

- Geeft ernst aan = noodzaak tot interventie
- Met klinische verschijnselen: zeker interventie. (zie ACS)

Stadiëring naar ontstaan

- HyperACUUT
 - Ontstaan en duur kort. Hooguit minuten.
Niet blijvend. Hoesten, persen, lachen
- ACUUT
 - Ontstaat in enkele uren. Fulminant en meestal leidend tot ACS. Trauma, bloeding, laparoscopie, perforatie.

Stadiëring naar ontstaan II

- SubACUUT
 - Meestal bij interne patiënten. Gaat paar dagen overheen. Vooral bij predisponerende
- CHRONISCH
 - Onstaan geleidelijk (bijv. gravida)
Adapatatie buikwand treedt op: distensie
Wel risico factor en gevoeliger.

Table 2 Risk factors for IAH/ACS

Acidosis (pH < 7.2)
Hypothermia (core temperature < 33°C)
Polytransfusion (> 10 U packed red blood/24 h)
Coagulopathy (platelets < 55,000/mm³ *or* activated partial thromboplastin time two times normal or higher *or* prothrombin time < 50% *or* international standardized ratio > 1.5)
Sepsis (American-European Consensus Conference definitions)
Bacteremia
Intra-abdominal infection/abscess
Peritonitis
Liver dysfunction/cirrhosis with ascites
Mechanical ventilation
Use of positive end expiratory pressure (PEEP) or the presence of auto-PEEP
Pneumonia
Abdominal surgery, especially with tight fascial closures
Massive fluid resuscitation (> 5 l colloid or crystalloid/24 h)
Gastroparesis/gastric distention/ileus
Volvulus
Hemoperitoneum/pneumoperitoneum
Major burns
Major trauma
High body mass index (> 30)
Intra-abdominal or retroperitoneal tumors
Prone positioning
Massive incisional hernia repair
Acute pancreatitis
Distended abdomen
Damage control laparotomy
Laparoscopy with excessive inflation pressures
Peritoneal dialysis

Abdominal Compartment Syndrome

“.....eindresultaat van een progressieve, ongecontroleerde toename van intra-abdominale druk ten gevolge van een reeks van afwijkingen die uiteindelijk leidt tot multiple organ dysfunction.”

Abdominal Compartment Syndrome definitie

Sustained IAP > 20 mm Hg

(with or without APP < 60 mm Hg)

En

geassocieerd met **NIEUW** orgaanfalen

Geen stadiëring: “**alles of niets**”
fenomeen

Diagnose

Abdominaal Compartiments Syndroom

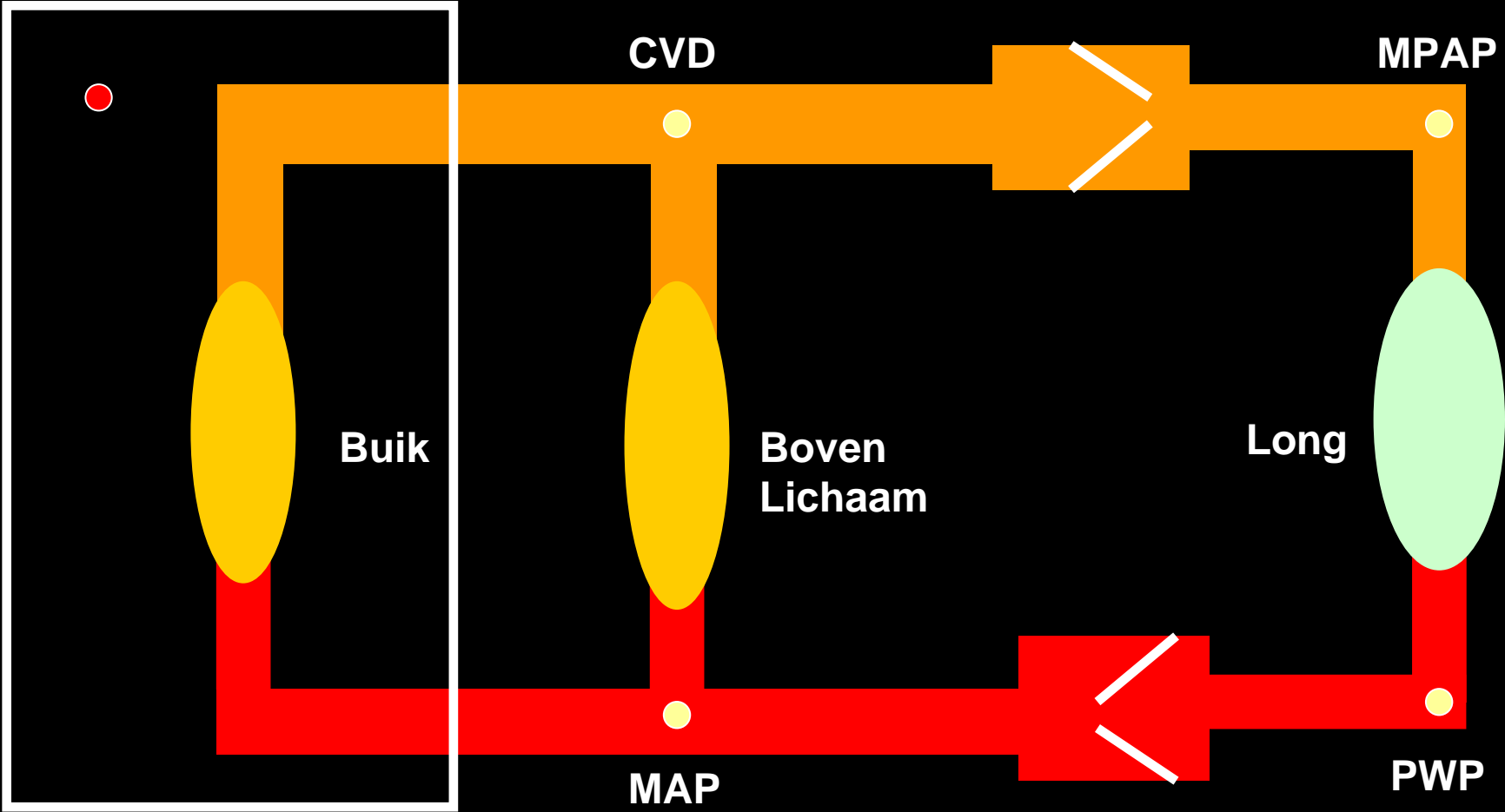
1. Intra-abdominale druk \geq 20mm Hg

EN

2. Tekenen klinische verslechtering (minstens één)

- oligurie
- hypoxie
- hypotensie
- beademingsdrukken \uparrow
- cardiac output \downarrow
- (metabole) acidosis

Circulatie



ACS

- Niet alleen complicatie na trauma
- Geaccepteerde oorzaak van ernstig orgaanfalen, morbiditeit en mortaliteit bij alle Intensive care patiënten
- Duur en hoogte IAP bepaalt ernst gevolgen: weefsel perfusieproblematiek

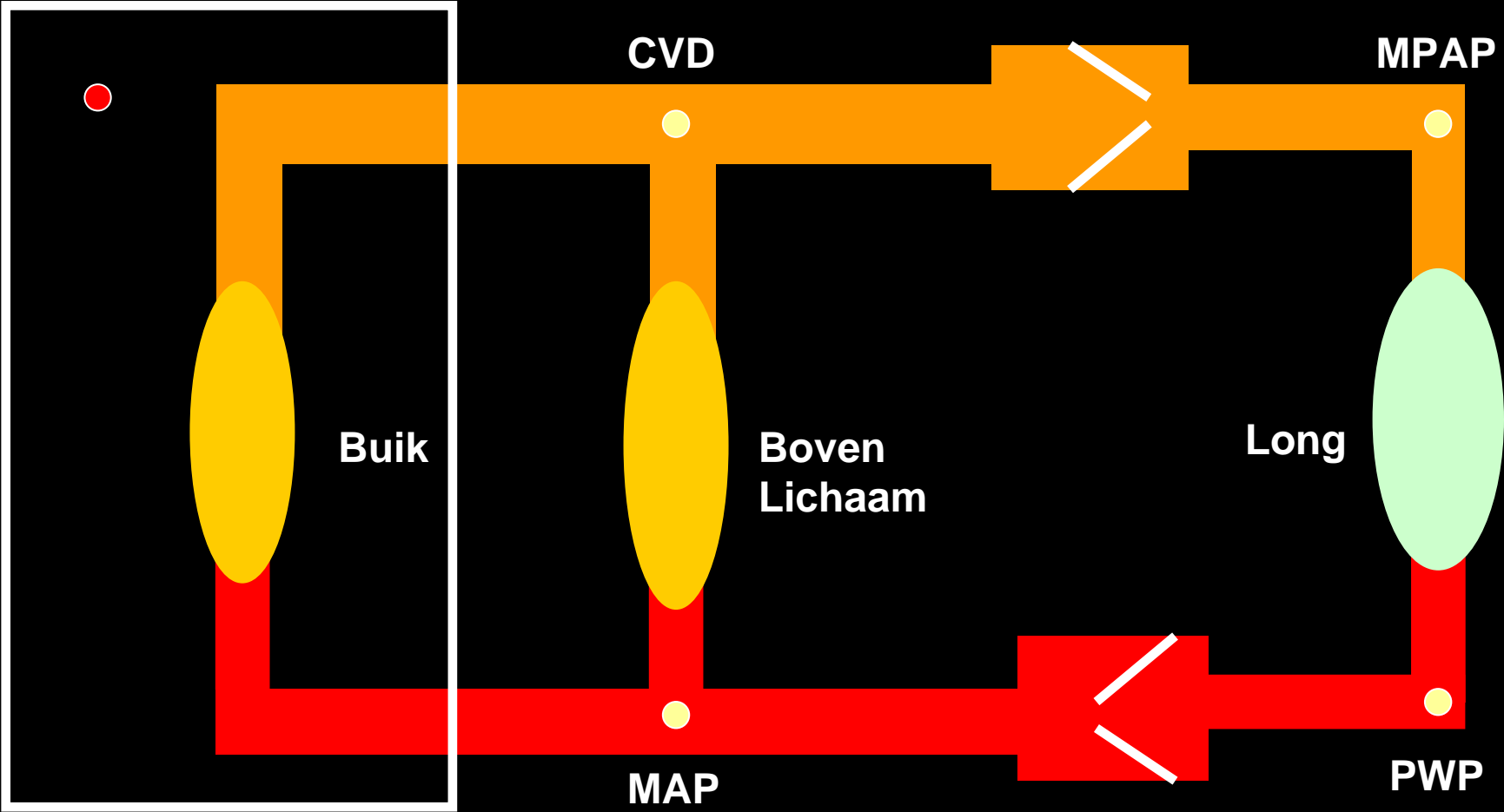
Classificatie ACS

- Primair
 - Acute of subacute IAH van korte duur.
Meestal tgv. Buikprobleem (“chirurgisch”)
- Secundair
 - Ten gevolge van condities buiten de buik / bekken gelegen (sepsis, capillair lek, brandwonden, grote hoeveelheid fluid resuscitation)

Classificatie ACS II

- Recurrent
 - Terugkeren van ACS na therapie = open buik behandeling (second hit)
 - Geassocieerd met significante morbiditeit en hoge mortaliteit

Circulatie

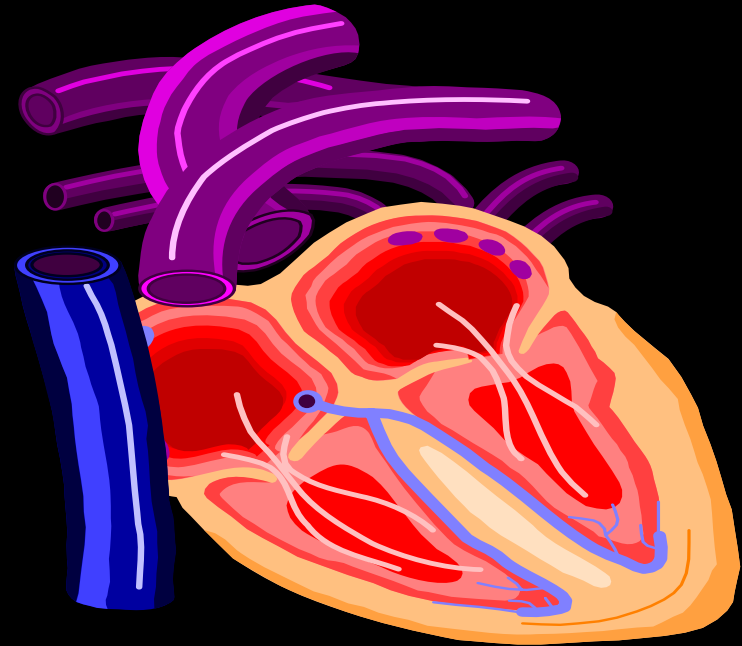


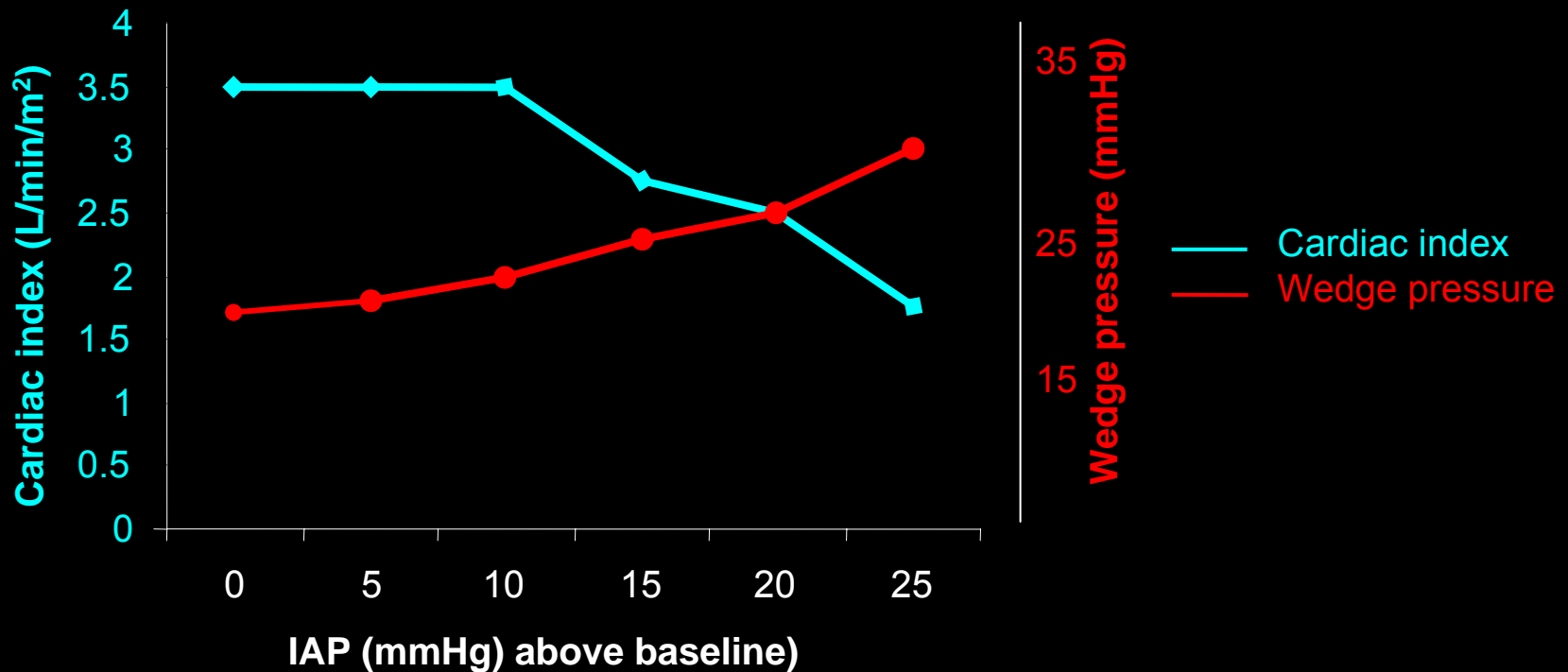
Effecten IAH

- Haemodynamisch
- Ventilatoir
- Nierfunctie
- Splanchnicus doorbloeding
- Cerebraal

Haemodynamische effecten IAP ↑

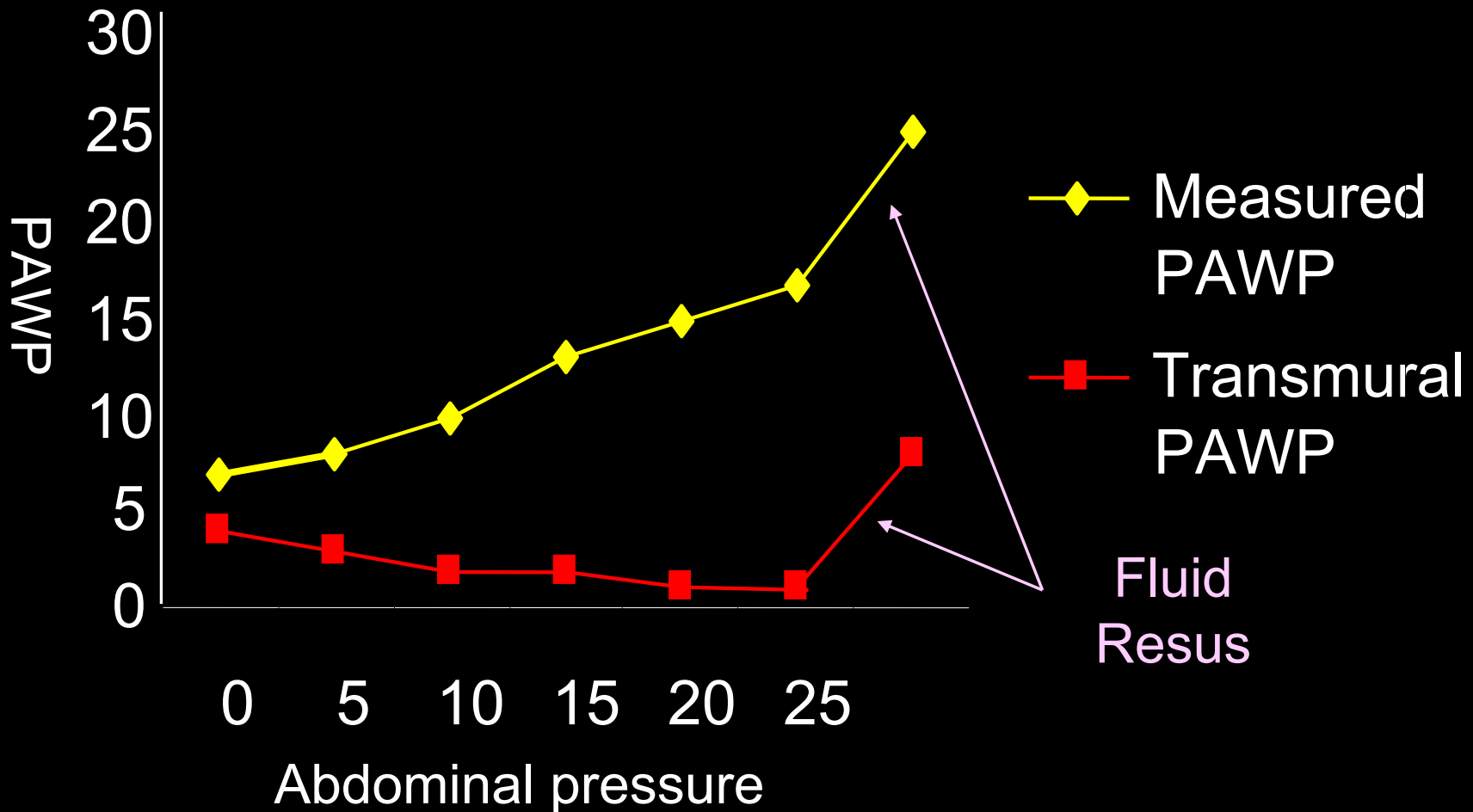
- MAP ←↓
- Polsfrequentie ↑
- PAWP ↑
- CVD ↑
- Druk VCI ↑



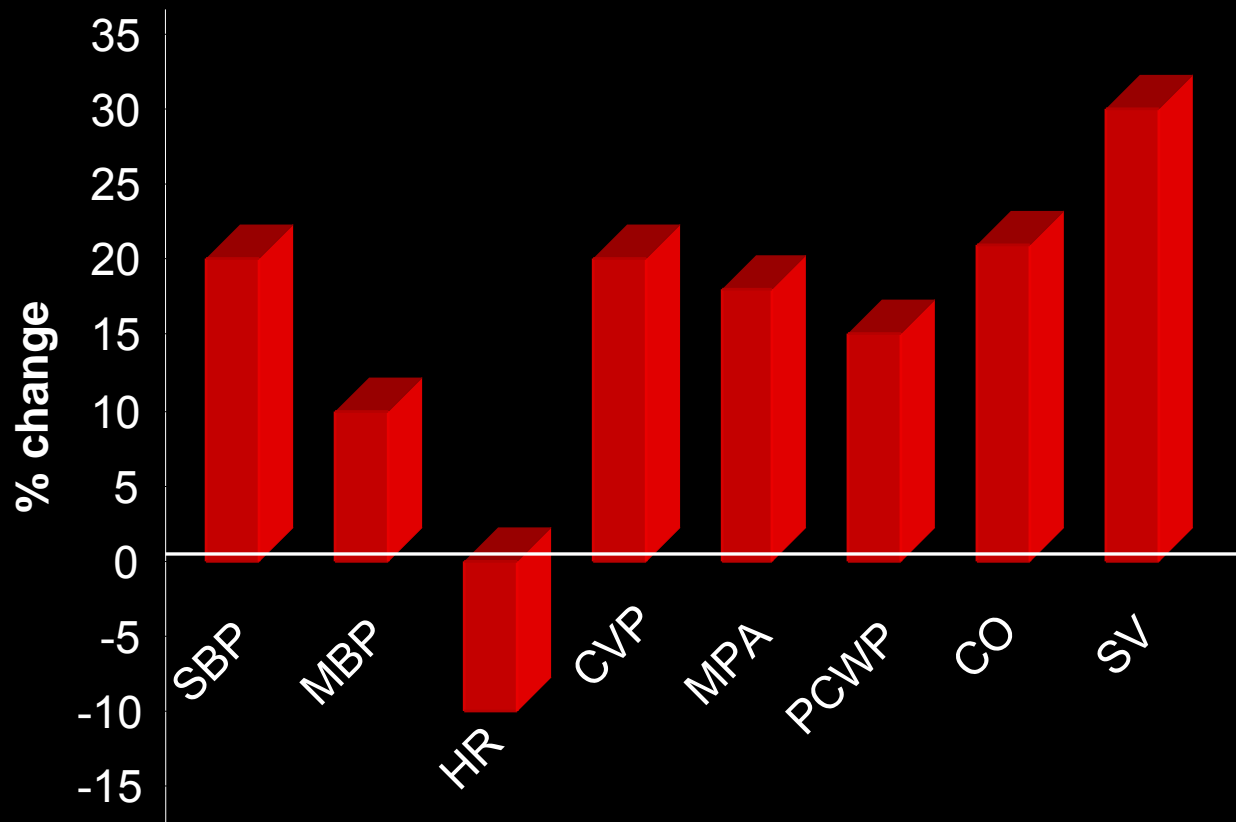


Effect of increased intra-abdominal pressure on cardiac index and pulmonary artery occlusion pressure

(Ridings ea. *J Trauma* 1995; 39december:1071-1075)



Effect of increased IAP on measured and true PAWP. This explains the increase in cardiac output with volume expansion (Ridings *et al* *Trauma* 1995; 39:1071-1075)



Percentage change in cardiovascular function after volume challenge

(*Cullen ea Crit Care Med 1989;17:118-121*)

Effecten IAH

- Haemodynamisch
- Ventilatoir
- Nierfunctie
- Splanchnicus doorbloeding
- Cerebraal

Ventilatoire / pulmonale effecten

IAP \uparrow (1)

- Opdrukken diafragma \Rightarrow thoracic compliance \downarrow
- pulmonary vascular resistance \uparrow
- atelectase vorming basaal en collaps \Rightarrow V/Q mismatch
- toegenomen ademarbeid
- respiratory failure door hogere arbeid

Ventilatoire / pulmonale effecten

IAP \uparrow (2)

- mechanische beademing vaak noodzakelijk
- hoge peak airway pressures
? Barotrauma ?
- Hoge PEEP nodig
“tegendruk”

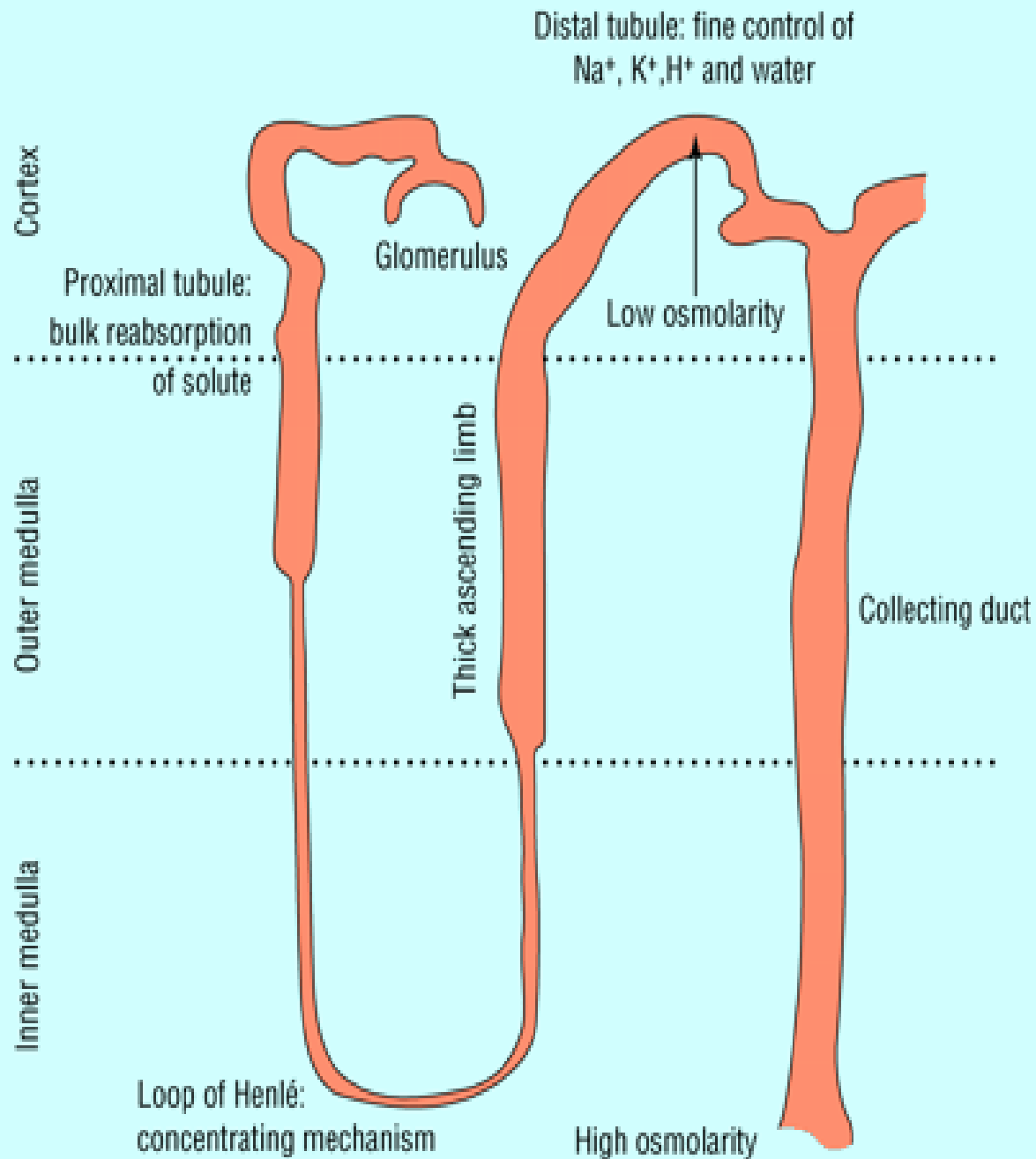


Effecten IAH

- Haemodynamisch
- Ventilatoir
- **Nierfunctie**
- Splanchnicus doorbloeding
- Cerebraal

Filtratie gradiënt Nieren

- Filtratie gradient = Glomerulaire filtratie druk - druk proximale tubulus
- Bij IAH = druk prox tubulus = IAP
- $FGP = (MAP - IAP) - IAP$
 - Hoe hoger IAP des te lager filtratie druk



Renale effecten IAP ↑

Bevindingen

- oligurie of anurie
- urinary NA^+ levels meestal normaal (i.t.t. ATN !!)
- geen dilatatie bekken-kelkensysteem bij echo buik

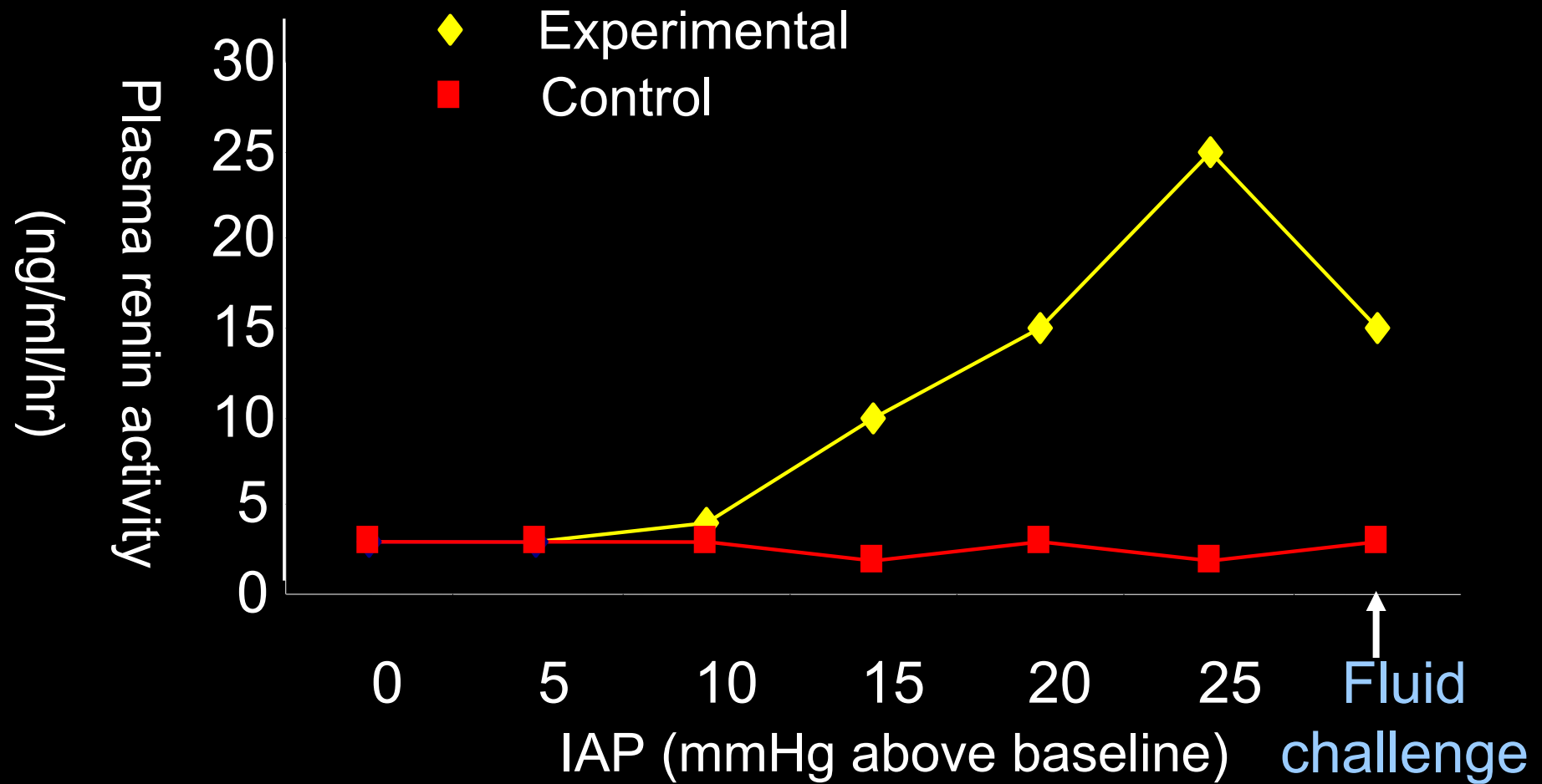
Oorzaken

- lage cardiac output \Rightarrow marginale renale flow
- druk v. renalis ↑
- directe compressie nieren
- nauwelijks ureterale compressie

Renal arterial resistive index response to intraabdominal hypertension in a porcine model*

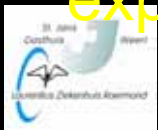
Andrew W. Kirkpatrick, MD, FACS; Robert Colistro, MD; Kevin B. Laupland, MD; Daniel L. Fox, MB, ChB; David E. Konkin, MD; Volker Kock, PA; John R. Mayo, MD; Savvas Nicolaou, MD

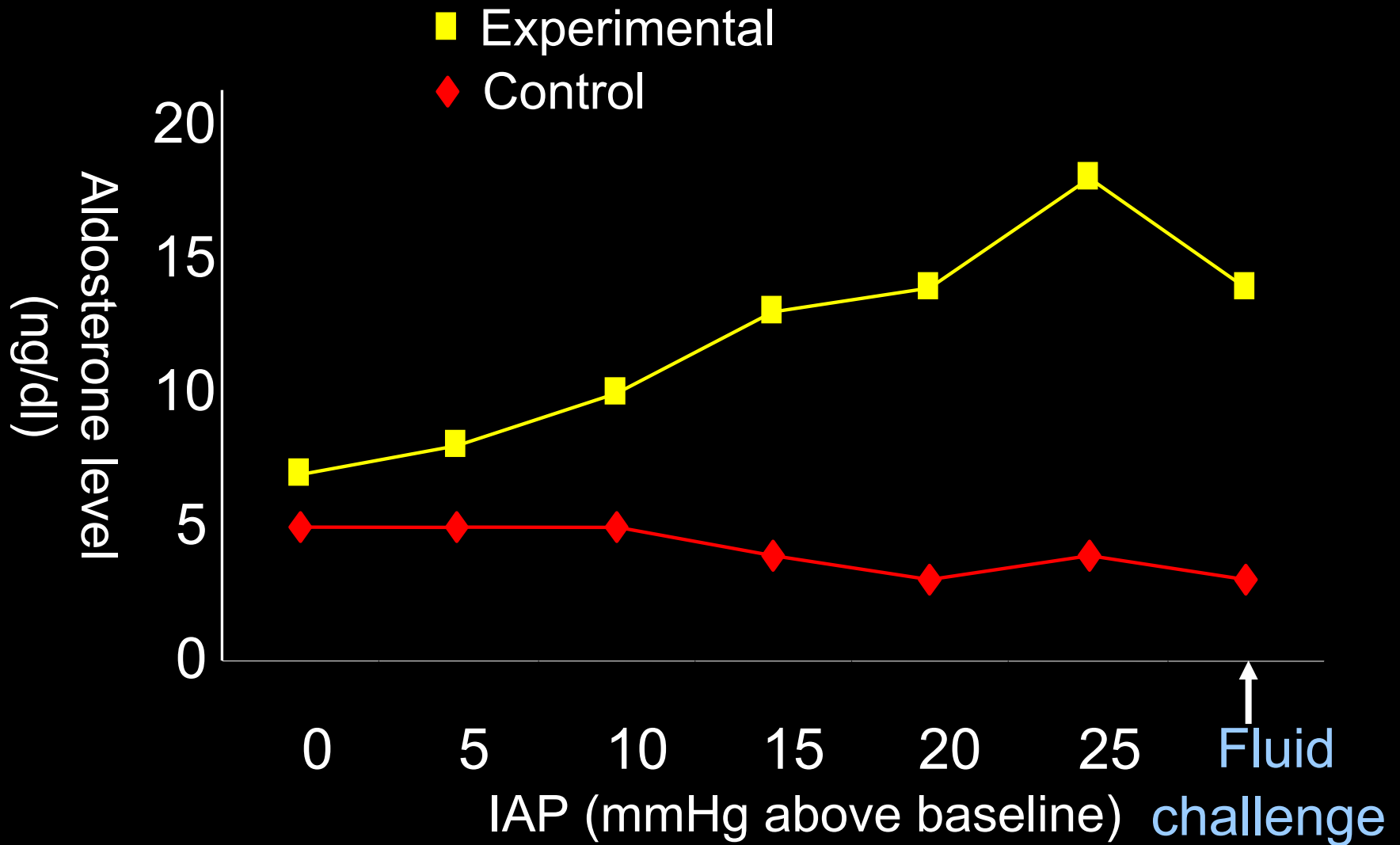
Crit Care Med 2007 Vol. 35, No. 1



Effect of increased intra-abdominal pressure on plasma renin activity. The increased levels are reduced by volume expansion

(*J Trauma* 1997;42:997-1003)





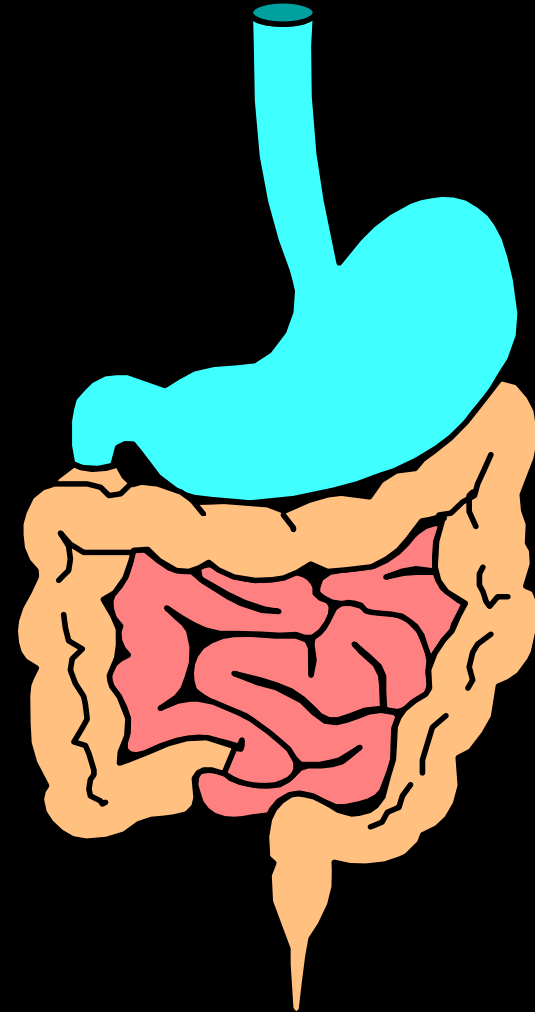
Effect of increased intra-abdominal pressure on plasma aldosterone. The increased levels are reduced by volume expansion (*J Trauma* 1997;42:997-1003)

Effecten IAH

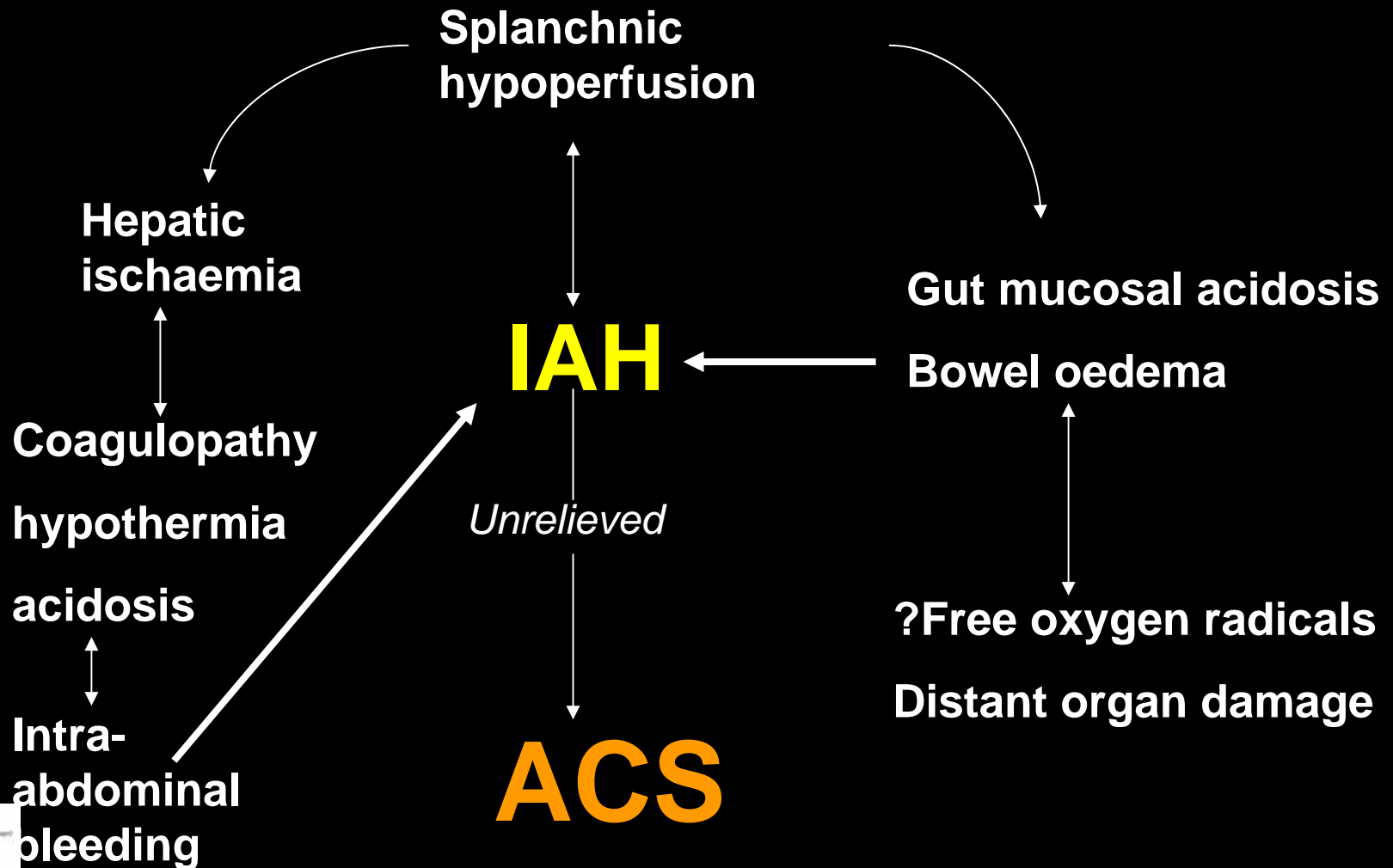
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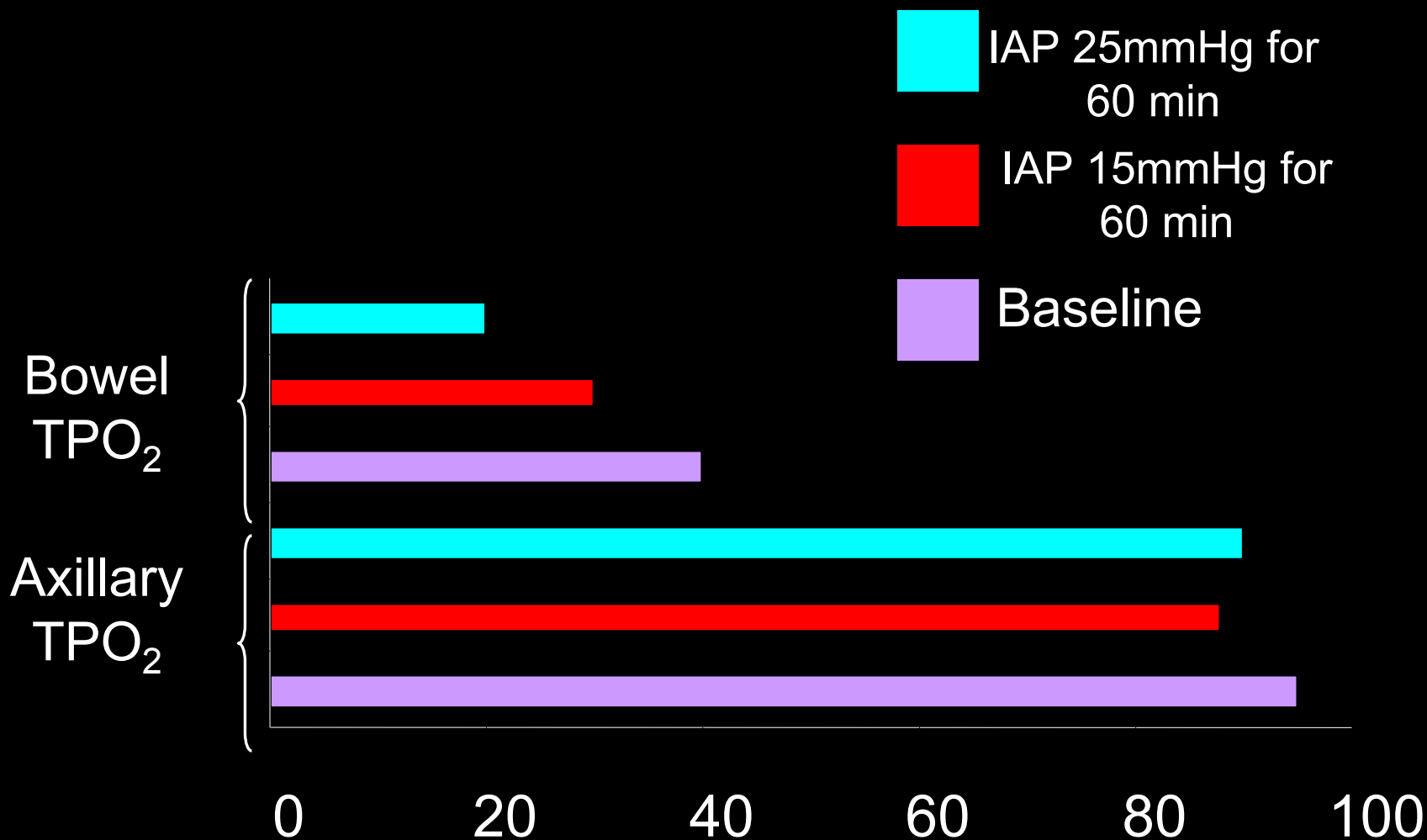
IAH en Splanchnicus Flow

- Toename IAP \Rightarrow flow splanchnicus \downarrow
- IAP $>$ 15 mm Hg \Rightarrow flow in a. mesenterica sup \downarrow
 - duidelijke afname flow in a.hepatica en v. porta
 - leidt tot intramucosale acidose (tonometrie) en oedeem



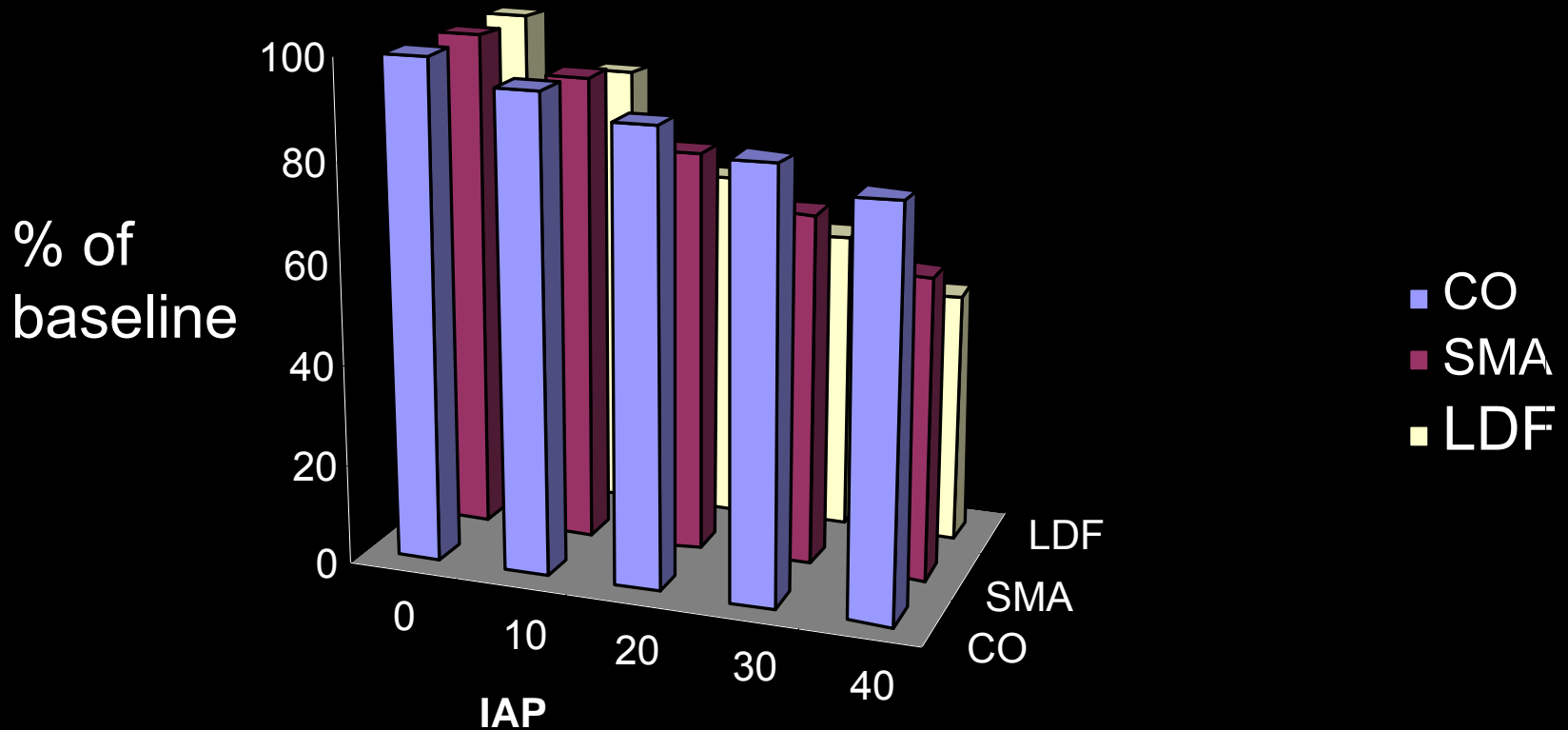
Cascade gevolgen IAH op cirrculatie splanchnicusgebied





Effects of increasing IAP on bowel mucosal oxygen (tissue partial pressure, TPO₂) compared with systemic tissue oxygenation in the axilla

(*J Trauma* 1995;39:519-522)



Effects of increasing intra-abdominal pressure (IAP), on cardiac output (CO), superior mesenteric artery flow (SMA) and laser doppler flow (LDF) in the intestinal mucosa

(*J Trauma* 1992;33;45,)

Effecten IAH

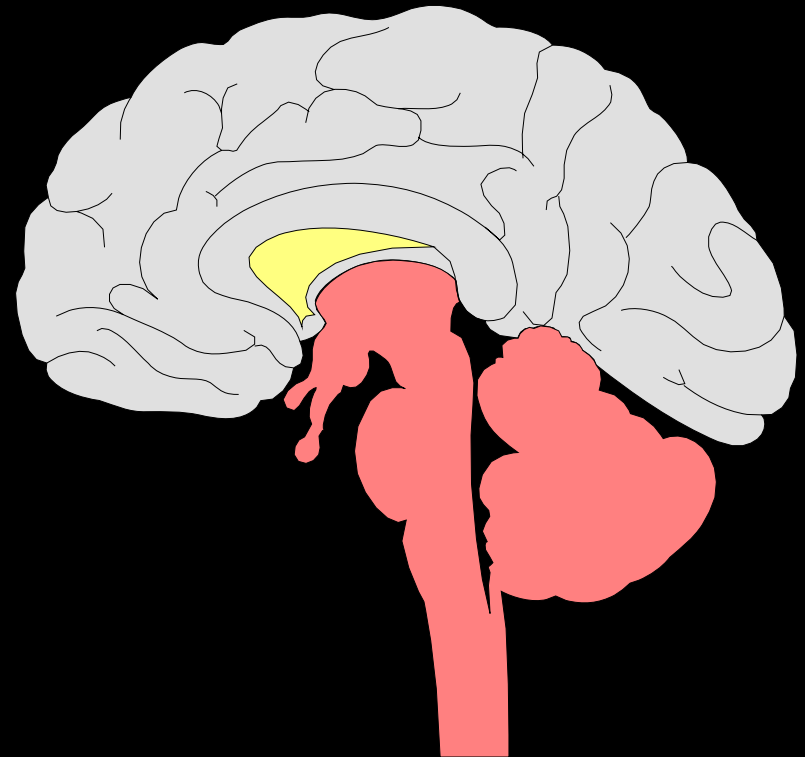
- Haemodynamisch
- Ventilatoir
- Nierfunctie
- Splanchnicus doorbloeding
- Cerebraal

Cerebrum en IAH

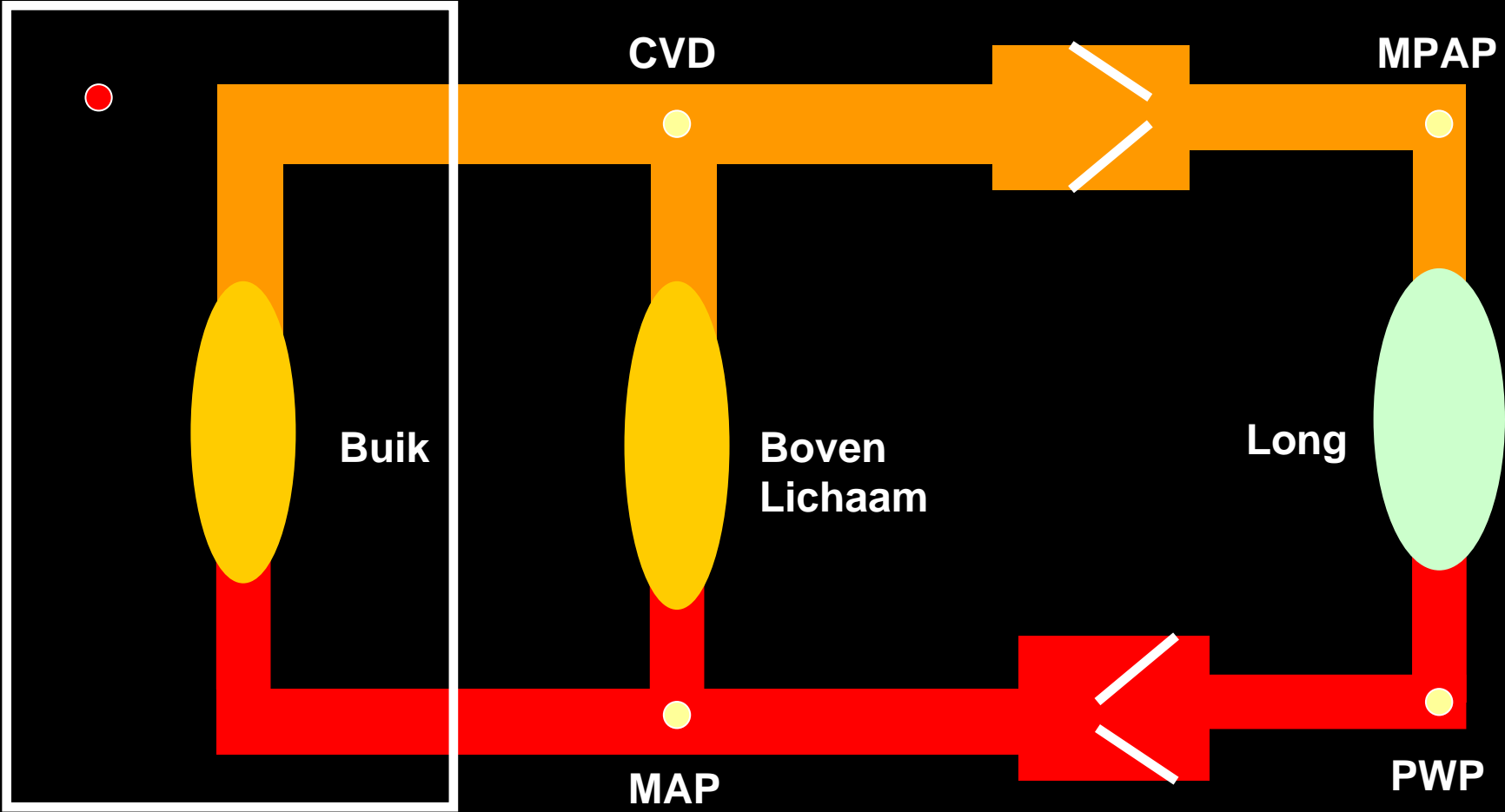
- IAH geassocieerd met
 - \uparrow ICP
 - \downarrow CPP

⇒ **cerebrale ischemie**

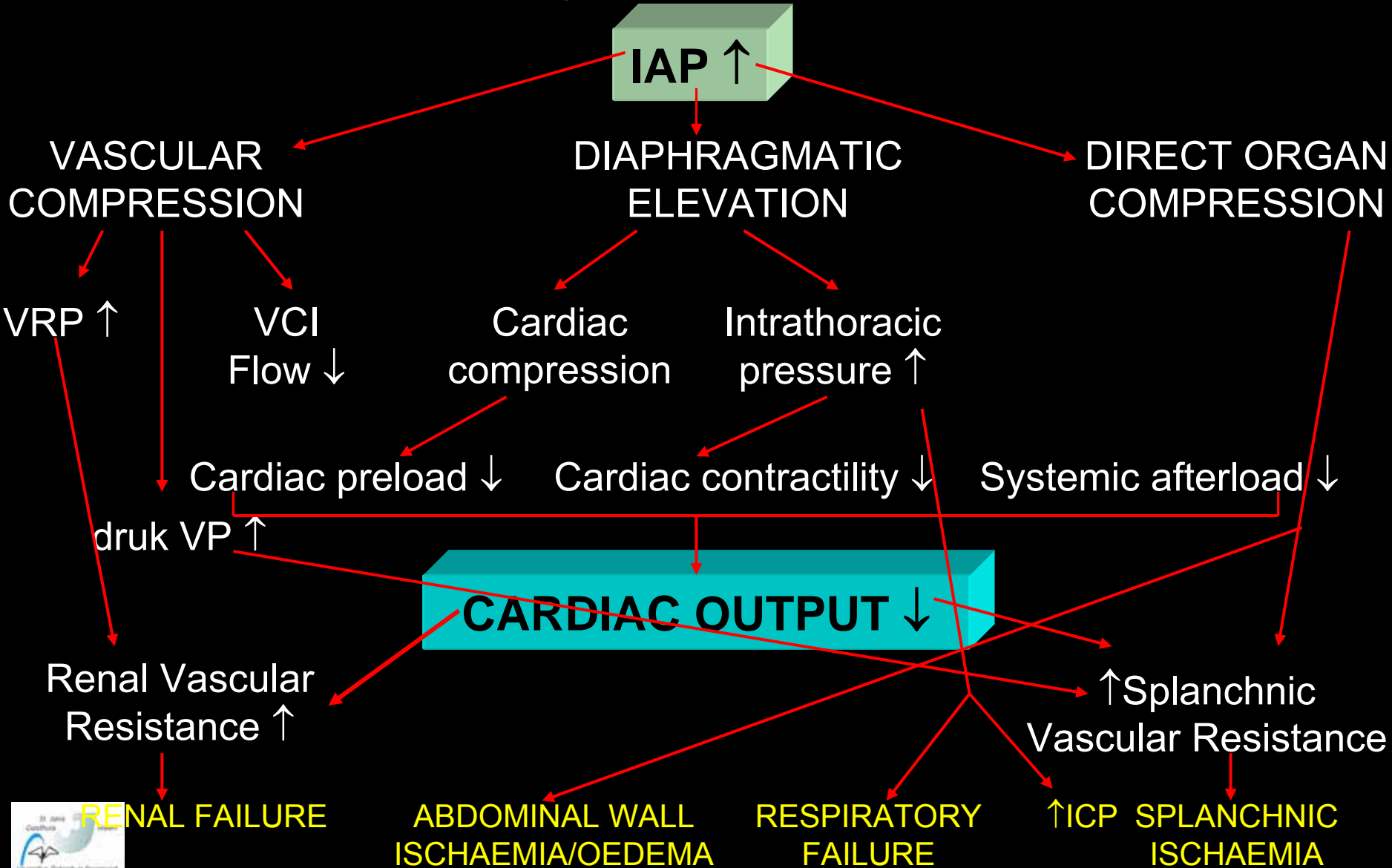
Belemmering veneuze
return ????



Circulatie



Pathofysiologie Intra Abdominale Hypertensie



Management of ACS

Prevention

vs.

Formal Closure?

Preventie of ACS (1)

Open abdomen technique

Geïndiceerd bij:

- Resp. verslechtering of cardiovasculaire instabiliteit bij sluiten
- massaal oedeem intestinaal
- geplande relaparotomie
- sluiten fascie subjectief "strakt"
- opgetamponeerde abdominale ruimte

Preventie van ACS (2)

Open buik technieken

Gebruikelijke vormen
open buik
technieken

- Bogota bag (25%)
- absorbable mesh (17%)
- Prolene mesh (14%)
- silastic mesh (7%)
- miscellaneous (28)%

Current opinion does not support liberal use of an open abdomen technique to prevent ACS

Mayberry ea. The Journal of Trauma, Infection and Critical Care 1999;47 :509-511

Abdominale Decompressie

**IAH > 20 mm Hg met
“klinische verschijnselen”
(ACS) moet behandeld
worden met abdominale
decompressie**

Vragen



Samenvatting

- Begripsbepaling
- Consequenties voor verschillende orgaansystemen
- Pathofysiologie
- Behandeling
- Preventie

Brug Interne - Chirurgie - Intensive Care

M.L.N.G. Malbrain

Abdominal pressure in the critically ill: measurement and clinical relevance

Manu L. N. G. Malbrain

Different techniques to measure intra-abdominal pressure (IAP): time for a critical re-appraisal

Tom J. R. De Potter
Hilde Dits
Manu L. N. G. Malbrain

Intra- and interobserver variability during in vitro validation of two novel methods for intra-abdominal pressure monitoring

Abdominal compartment syndrome: A century later, isn't it time to pay attention?

Crit Care Med 2000 Vol. 28, No. 6

Incidence and clinical pattern of the abdominal compartment syndrome after "damage-control" laparotomy in 311 patients with severe abdominal and/or pelvic trauma

Wolfgang Ertel, MD; Andreas Oberholzer, MD; Andreas Platz, MD; Reto Stocker, MD; Otmar Trentz, MD

Crit Care Med 2000 Vol. 28, No. 6

Abdominal compartment syndrome: A century later, isn't it time to accept and promulgate?*

Crit Care Med 2006 Vol. 34, No. 9

Survey of intensive care physicians on the recognition and management of intra-abdominal hypertension and abdominal compartment syndrome*

Edward J. Kimball, MD, FACEP; Michael D. Rollins, MD; Mary C. Mone, BSE; Heidi J. Hansen; Gabriele K. Baraghoshi, RN; Cory Johnston, BS; Evan S. Day; Peter R. Jackson; Marielle Payne, BA; Richard G. Barton, MD

Crit Care Med 2006 Vol. 34, No. 9

Alok Tiwari
Fiona Myint
George Hamilton

Recognition and management of abdominal compartment syndrome in the United Kingdom

Intensive Care Med (2006) 32:1912–1914
DOI 10.1007/s00134-006-0303-6

Manu L. N. G. Malbrain
Michael L. Cheatham
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Michael Sugrue
Jan De Waele
Rao Ivatury

**Abdominal compartment
syndrome: it's time to pay
attention!**

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M.M. is founding President of the World Society on Abdominal Compartment Syndrome and chairman of the 3rd World Congress on ACS

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Abdominal compartment syndrome related to noninvasive ventilation

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Prevalence of intra-abdominal hypertension in critically ill patients: a multicentre epidemiological study

Manu L. N. G. Malbrain
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Jan De Waele
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Rao Ivatury
Scott D'Amours
Julia Wendon
Ken Hillman
Kenth Johansson
Karel Kolkman
Alexander Wilmer

Results from the International Conference of Experts on Intra-abdominal Hypertension and Abdominal Compartment Syndrome.

I. Definitions

ABDOMINAL COMPARTMENT SYNDROME IS COMMON IN MEDICAL ICU PATIENTS RECEIVING LARGE VOLUME RESUSCITATION

Elizabeth L Daugherty, Pulmonary and Critical Care Medicine, Johns Hopkins Hospital, Baltimore, MD; Hongyan Liang, Darren Taichman, John Hansen-Flaschen, Barry D Fuchs, Pulmonary and Critical Care Medicine, Hospital of the University of Pennsylvania, Philadelphia, PA

Introduction: Intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) have been well described in surgical patients. Large volume resuscitation is thought to be a risk factor. In contrast, little is known of the incidence of IAH/ACS in critically ill medical patients. **Hypothesis:** We hypothesized that ACS is more common in medical ICUs than previously recognized. The purpose of this study was to determine the incidence of IAH/ACS in medical ICU patients receiving large volume resuscitation. **Methods:** We performed a prospective, cohort study screening consecutive admissions to our MICU over a 5-month period for a minimum net positive fluid balance of 5 liters within the preceding 24 hours. The primary outcome of interest was the development of ACS, defined as an IAP ≥ 20 mmHg associated with organ dysfunction. Patients who met inclusion criteria and had no exclusion criteria, including recent abdominal surgery or obesity, were entered in our study. Intra-abdominal pressure (IAP) was measured by transducing bladder pressure and recorded along with fluid balance at the time of enrollment and every 12 hours thereafter up to 96 hours. **Results:** Of the 234 MICU admissions screened, 21 (8.9%) were identified who met inclusion criteria. Upon enrollment, this cohort of patients had a mean APACHE II score of 25, a net positive fluid balance of 8.4 liters, and 12 of the 21 (57%) had intra-abdominal hypertension (defined by IAP ≥ 12 mm Hg). During the study period, 7 of the 21 (33%) developed IAP ≥ 20 mmHg and 6 (29%) of these met criteria for ACS. None underwent for laparotomy. **Conclusions:** ACS occurs frequently in critically ill medical patients who receive large volume resuscitation. Medical patients with a 5 liter net positive fluid balance in 24 hours should be considered for routine monitoring of IAP. Future studies evaluating both clinical outcomes of medical patients with ACS and potential risk factors for its development are warranted.

Induced abdominal compartment syndrome increases intracranial pressure in neurotrauma patients: A prospective study

Giuseppe Citerio, MD; Ettore Vascotto, MD; Federico Villa, MD; Simona Celotti, MD; Antonio Pesenti, MD

Crit Care Med 2001 Vol. 29, No. 7

Intensive Care Med (2005) 31:1577–1581
DOI 10.1007/s00134-005-2802-2

BRIEF REPORT

Dries H. Deeren
Hilde Dits
Manu L. N. G. Malbrain

Correlation between intra-abdominal and intracranial pressure in nontraumatic brain injury

Continuing Medical Education Article

Concise Definitive Review

 R. Phillip Dellinger, MD, FCCM, Section Editor

Intensive care unit management of the trauma patient

Edwin A. Deitch, MD; Saraswati D. Dayal, MD

Crit Care Med 2006 Vol. 34, No. 9

Laboratory Investigations --- ---

Renal arterial resistive index response to intraabdominal hypertension in a porcine model*

Andrew W. Kirkpatrick, MD, FACS; Robert Colistro, MD; Kevin B. Laupland, MD; Daniel L. Fox, MB, ChB;
David E. Konkin, MD; Volker Kock, PA; John R. Mayo, MD; Savvas Nicolaou, MD

Crit Care Med 2007 Vol. 35, No. 1