COLOURS OF SEPSIS

FESTIVAL INTENZIVNÍ MEDICÍNY

25 let

January 24th, 2023

Fluid Stewardship: 7D framework

Prof Dr Manu MALBRAIN, MD, PhD

Manu Malbrain, MD, PhD

- Internist – Intensivist
- CMO, Medaman, Belgium
- Professor, Critical Care, 1st Dep Anaesthesiology and Intensive Therapy Medical University Lublin, Poland
- Co-Founder, President International Fluid Academy (fluidacademy.org)
- Past ICU Director, Crisis Manager University Hospital Brussels (UZB)
- Past President, current treasurer WSACS (wsacs.org)
- Educational Grant: 2003 ESICM Chris Stoutenbeek Award
- Member Medical Advisory Board
  - Getinge, Spiegelberg, Holtech, Serenno Medical, Baxter, BD,
  - Sentinel Medical Technologies, LynxCare
- Consults for Cytosorbents, Potrero, Maltron, Medtronic
- European Patent Holder: GEF/GEDVI - CiMON (PMS)
- Fees - Honoraria: PeerVoice, Nestlé


35
Breaking
56
Bad
habits
ifad

Drug$_1$ definitions

Drug$_2$ diagnosis

Drug$_3$ drug

Drug$_4$ dose

Slide adapted from Ross Fisher (P^3)

Drug duration

Drug de-escalation

Drug document

Slide adapted from Ross Fisher (P^3)

D_1

D_2

D_3

D_4

D_5

D_6

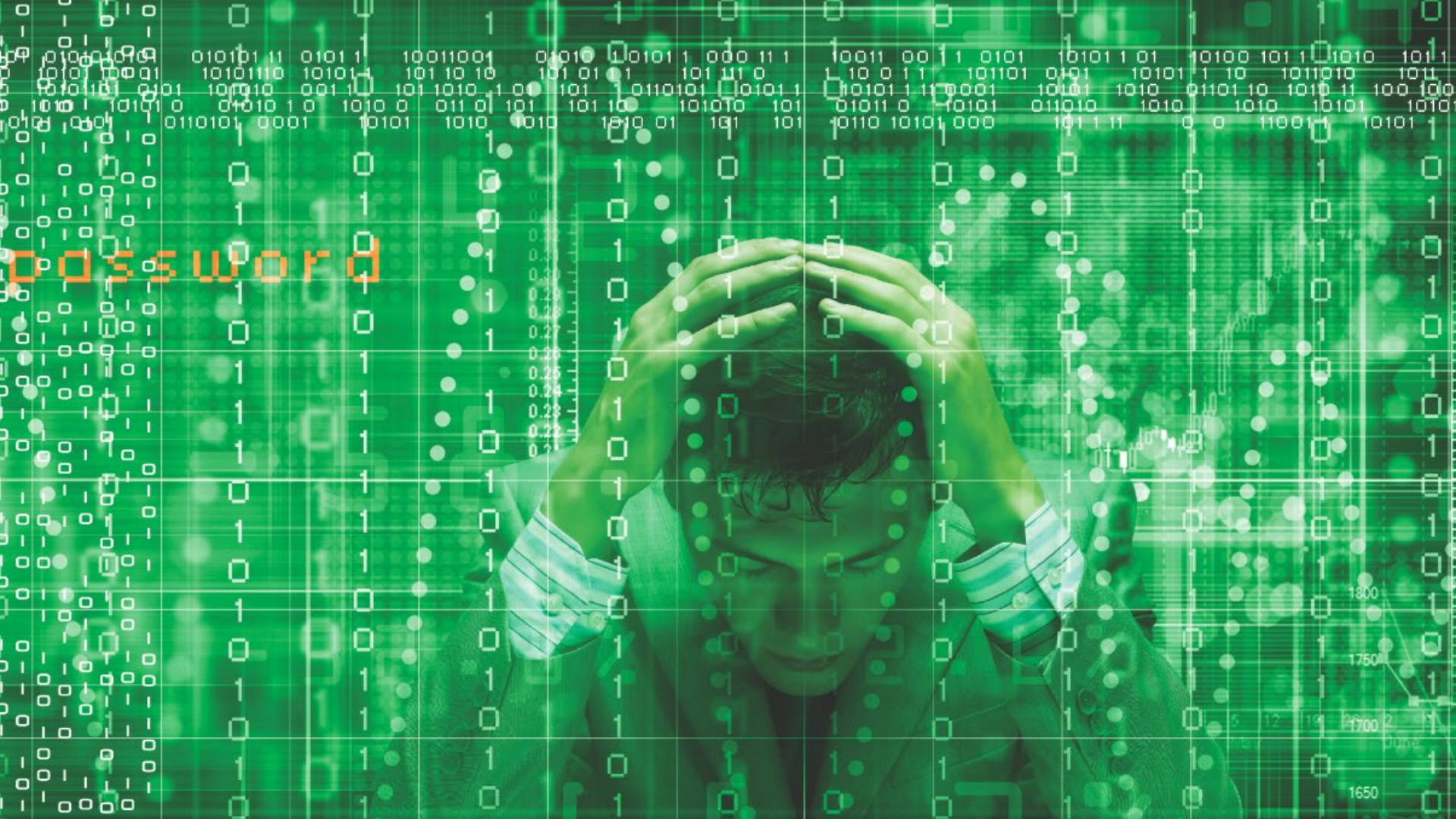
D_7

$= D^7$

$= FS$

Slide adapted from Ross Fisher (P^3)


D_1
definitions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D1
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D1: Definitions

- *Fluid Balance*: Daily fluid balance is the daily sum of all intakes and outputs, and the cumulative fluid balance is the sum total of fluid accumulation over a set period of time

Malbrain M et al. Annals of Intensive Care 2018; 8:66

D1
D2
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D7

D1: Definitions

- *Fluid Balance*: Daily fluid balance is the daily sum of all intakes and outputs, and the cumulative fluid balance is the sum total of fluid accumulation over a set period of time
- *Fluid overload*: Dividing the cumulative fluid balance in litres by patient's baseline body weight and multiplying by 100% defines the percentage of fluid accumulation.

Malbrain M et al. Annals of Intensive Care 2018; 8:66

D1
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D1: Definitions

- *Fluid Balance*: Daily fluid balance is the daily sum of all intakes and outputs, and the cumulative fluid balance is the sum total of fluid accumulation over a set period of time
- *Fluid overload*: Dividing the cumulative fluid balance in litres by patient's baseline body weight (BW) and multiplying by 100% defines the percentage of fluid accumulation.
- Fluid overload is defined by a **cutoff value of 10%** of fluid accumulation, as this is associated with worse outcomes

Malbrain M et al. Annals of Intensive Care 2018; 8:66

D1
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D7

D1: Definitions

- *Early adequate goal directed fluid management (EAFM)*:
  - goal directed treatment
  - on average 30 ml/kg within first 1-3 hours (SSCG)

Malbrain M et al. Annals of Intensive Care 2018; 8:66

D1
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D1: Definitions

- *Early adequate goal directed fluid management (EAFM)*:
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- *Late Conservative Fluid Management (LCFM)*:
  - 2 consecutive days of negative fluid balance within the first week of ICU stay

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D1
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D7

D1: Definitions

- *Early adequate goal directed fluid management (EAFM)*:
  - goal directed treatment
  - on average 30 ml/kg within first 1-3 hours (SSCG)
- *Late Conservative Fluid Management (LCFM)*:
  - 2 consecutive days of negative fluid balance within the first week of ICU stay
- *Late Goal Directed Fluid Removal (LGFR)*:
  - active fluid removal by means of diuretics or renal replacement therapy with net ultrafiltration
  - This is referred to as **de-escalation** or **de-resuscitation**.

Malbrain M et al. Annals of Intensive Care 2018; 8:66

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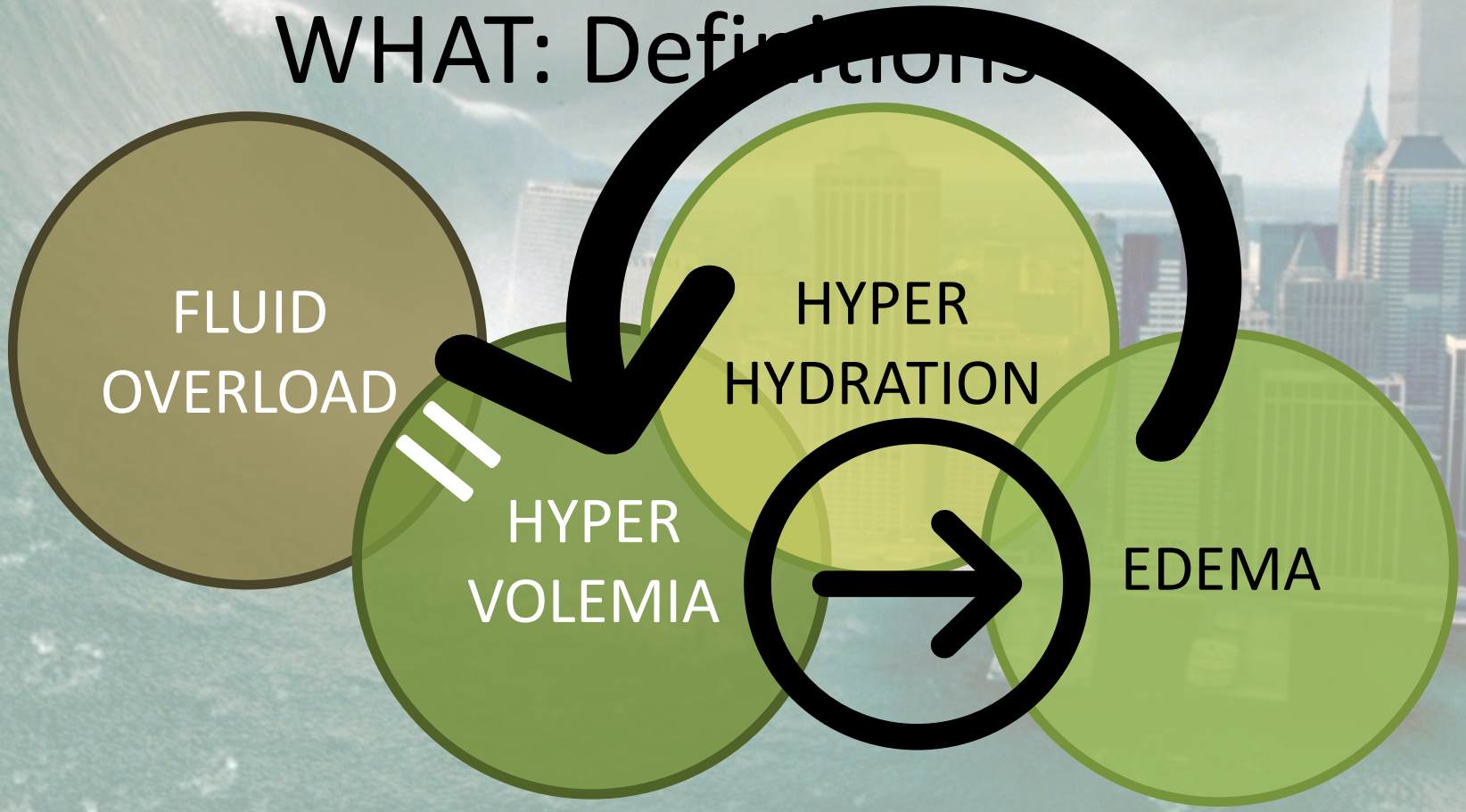
D7

WHAT: Definitions



Malbrain M et al. Annals of Intensive Care 2018; 8:66

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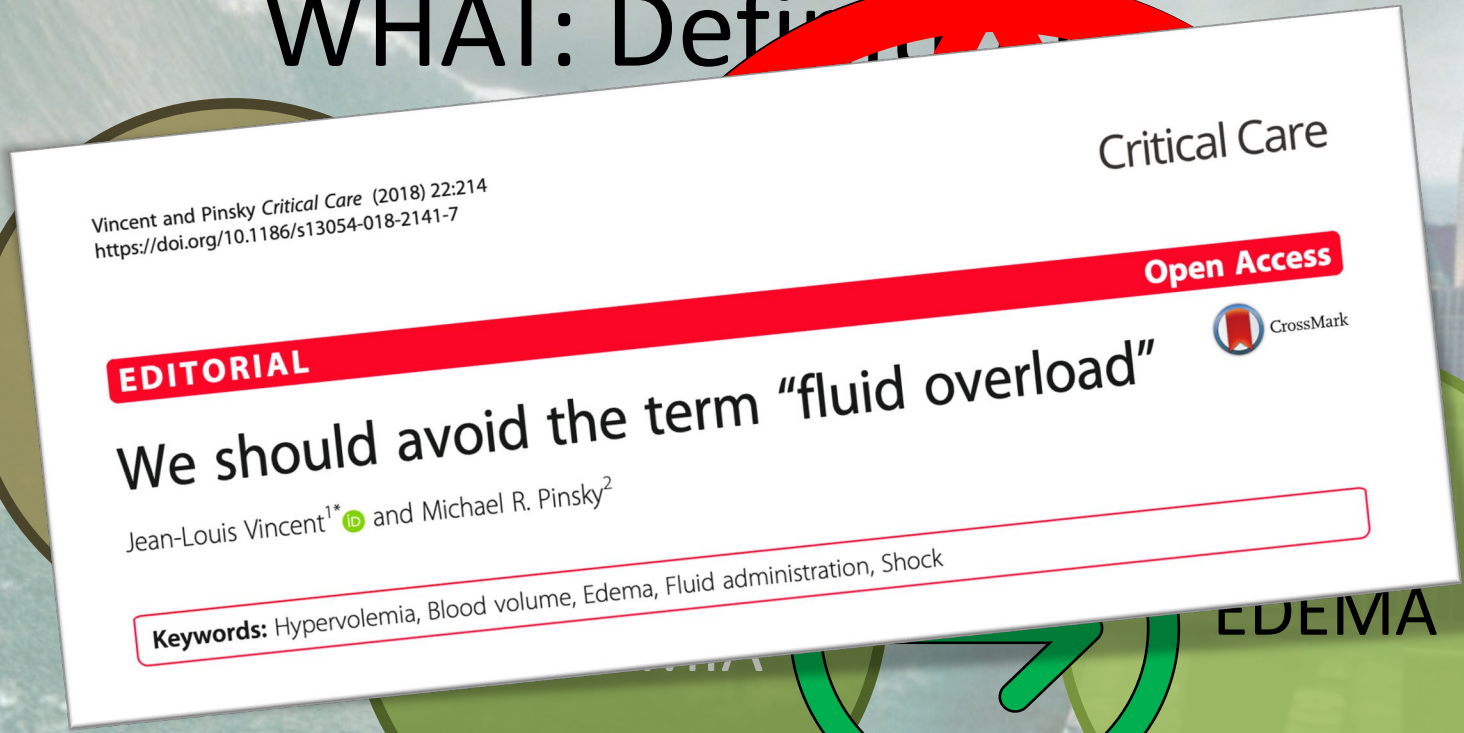
WHAT: Defi



Critical Care

Vincent and Pinsky *Critical Care* (2018) 22:214
https://doi.org/10.1186/s13054-018-2141-7

Open Access

EDITORIAL

We should avoid the term "fluid overload"

Jean-Louis Vincent[1*] and Michael R. Pinsky[2]

Keywords: Hypervolemia, Blood volume, Edema, Fluid administration, Shock

EDEMA

Malbrain M et al. Annals of Intensive Care 2018; 8:66

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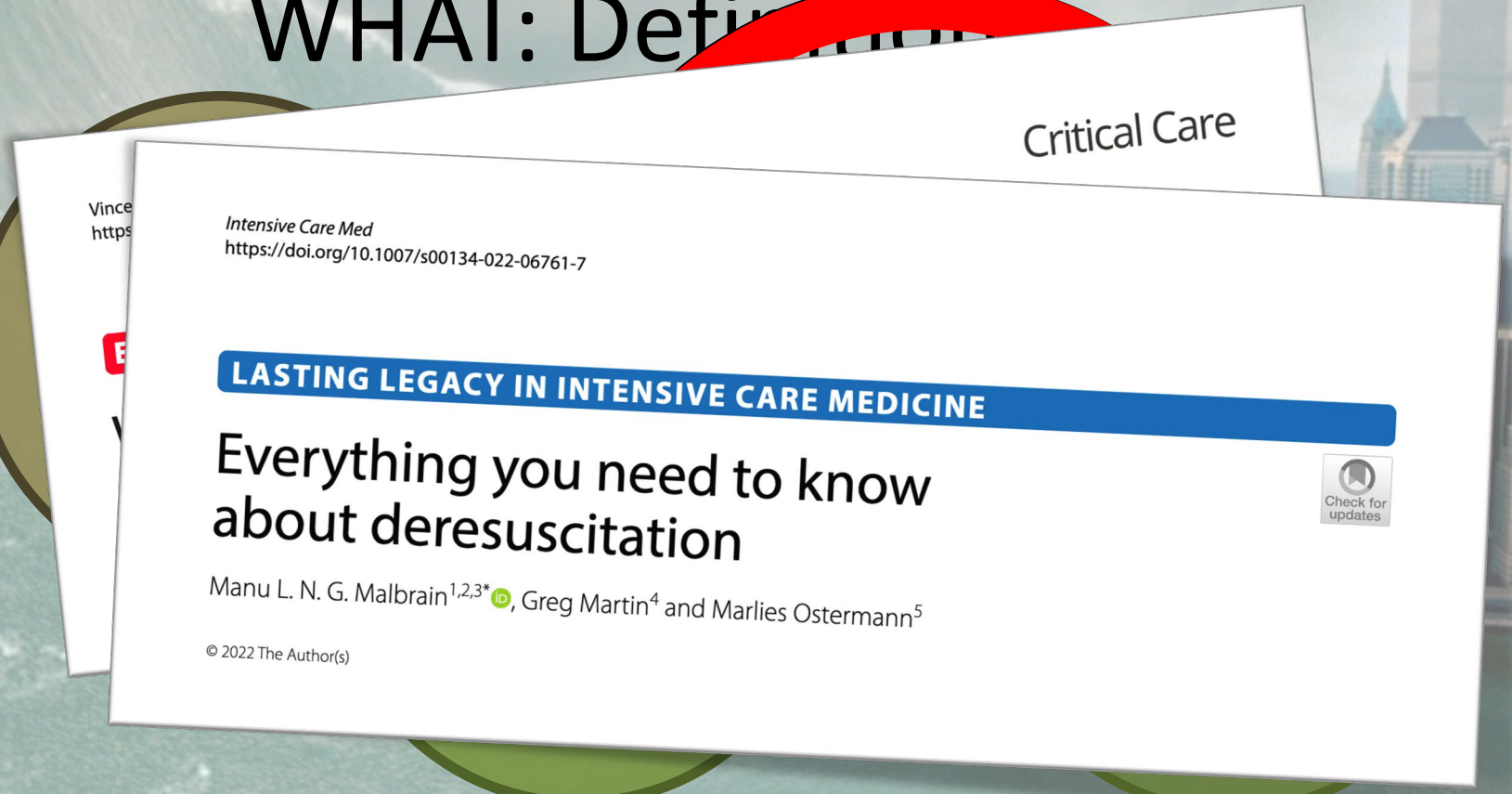
WHAT: Defi



Malbrain M et al. Intensive Care Medicine 2022 https://doi.org/10.1007/s00134-022-06761-7

D1
D2
D3
D4
D5
D6
D7

D1: Definitions (2022)

- *Fluid Accumulation*:
  - increase in BW relative to admission BW
  - actual increase in BW
  - relative increase in cumulative fluid balance
  - volume excess (BIA)

Malbrain M et al. Intensive Care Medicine 2022 https://doi.org/10.1007/s00134-022-06761-7

D1
D2
D3
D4
D5
D6
D7

D1: Definitions (2022)

- *Fluid Accumulation*:
  - increase in BW relative to admission BW
  - actual increase in BW
  - relative increase in cumulative fluid balance
  - volume excess (BIA)
- *Fluid Accumulation Syndrome (FAS):*
  - Term to describe the presence of any degree of fluid accumulation with negative impact on end-organ function which may or may not be associated with global increased permeability syndrome.

Malbrain M et al. Intensive Care Medicine 2022 https://doi.org/10.1007/s00134-022-06761-7

Ahuja *et al. Critical Care* (2022) 26:157
https://doi.org/10.1186/s13054-022-04023-y

Critical Care

RESEARCH Open Access

Association between early cumulative fluid balance and successful liberation from invasive ventilation in COVID-19 ARDS patients — insights from the PRoVENT-COVID study: a national, multicenter, observational cohort analysis

Sanchit Ahuja[1,2], Harm-Jan de Grooth[3], Frederique Paulus[4,5], Fleur L. van der Ven[4], Ary Serpa Neto[6,7,8], Marcus J. Schultz[4,9,10*], Pieter R. Tuinman[3] and PRoVENT-COVID Study Collaborative Group* 'PRactice of VENTilation in COVID–19'

Ahuja et al. Critical Care (2022) 26:157
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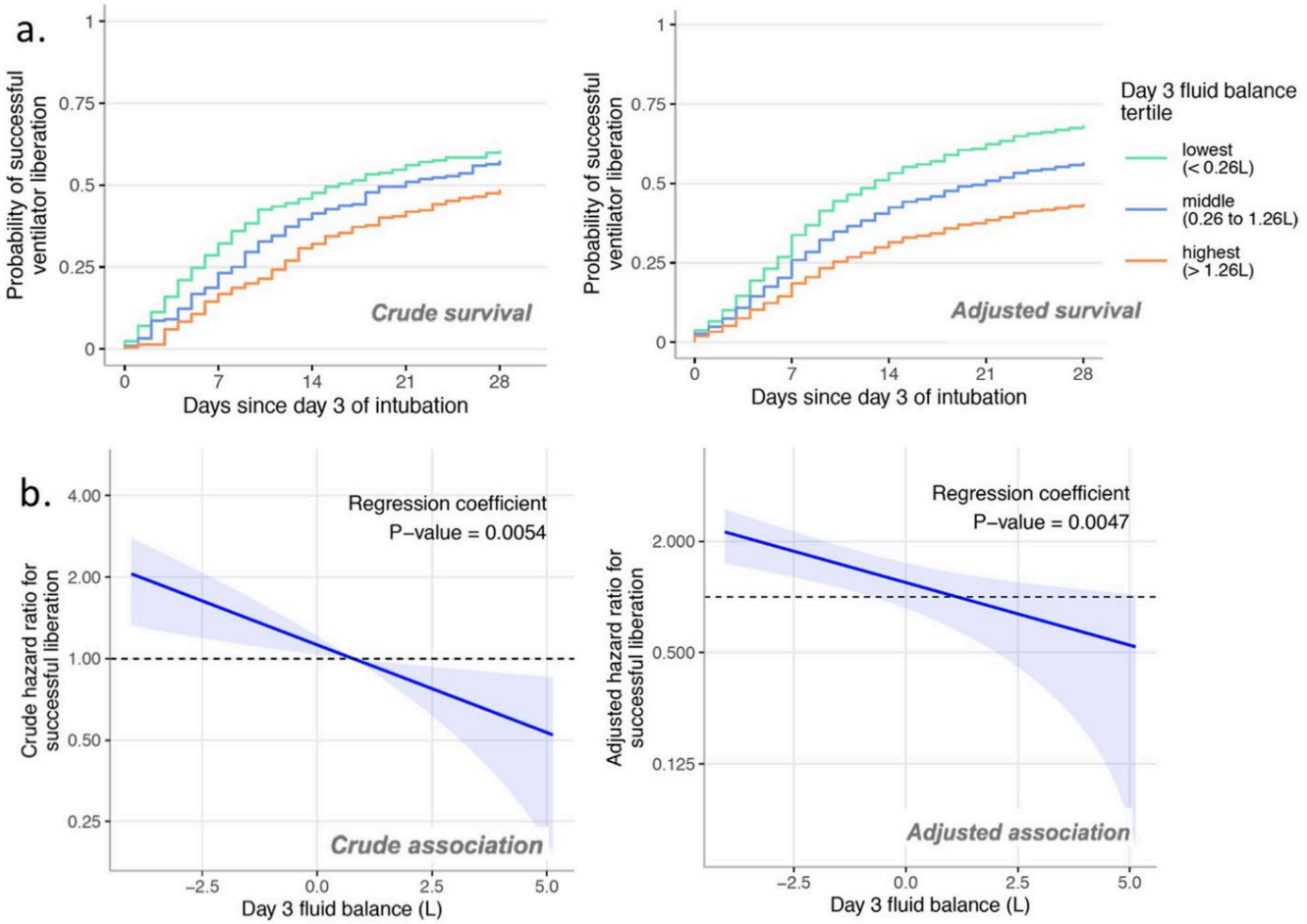
FB and Liberation of MV



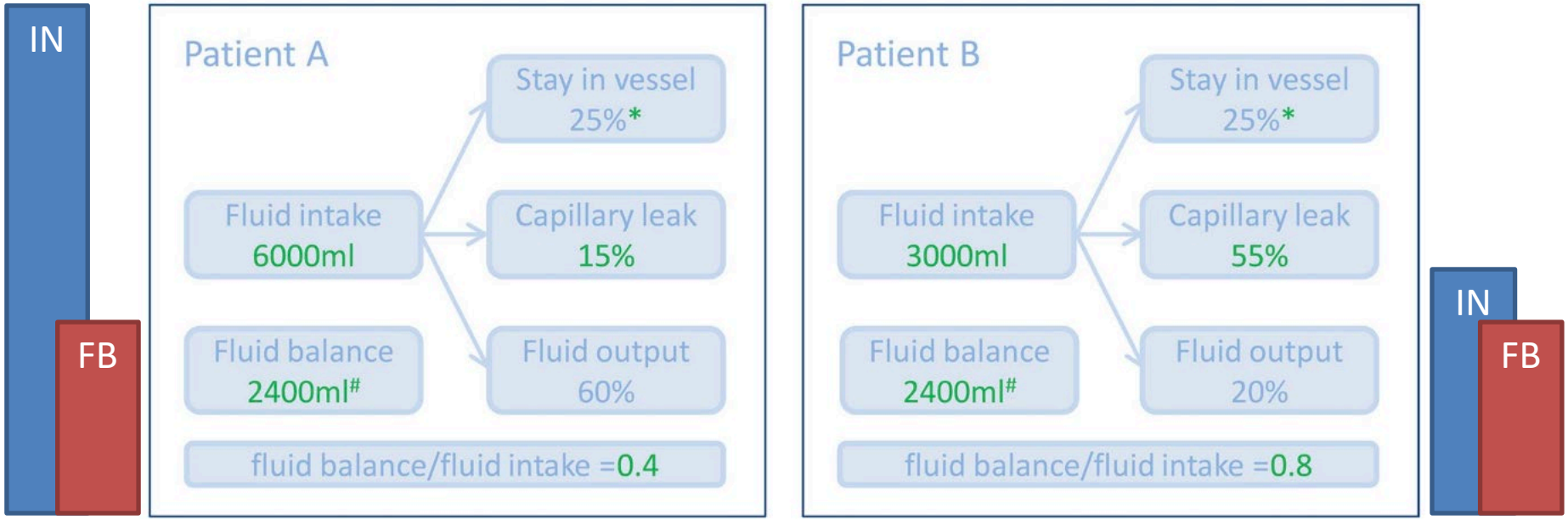
Shen et al. Critical Care (2022) 26:352
https://doi.org/10.1186/s13054-022-04188-6

Critical Care

CORRESPONDENCE Open Access

Fluid intake, fluid output or fluid balance, which one matters in ARDS

Yanfei Shen[1], Guolong Cai[1] and Jing Yan[1*]



Fluid Accumulation Index (FAI)

$$FAI = \frac{\text{Fluid balance}}{\text{Fluid intake}} = \frac{\text{Fluid intake - output}}{\text{Fluid intake}}$$

$$= \frac{\text{Fluid intake}}{\text{Fluid intake}} - \frac{\text{Fluid output}}{\text{Fluid intake}}$$

$$= 1 - \frac{\text{Fluid output}}{\text{Fluid intake}}$$

Shen et al. Critical Care (2022) 26:352
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Critical Care

Liberation MV

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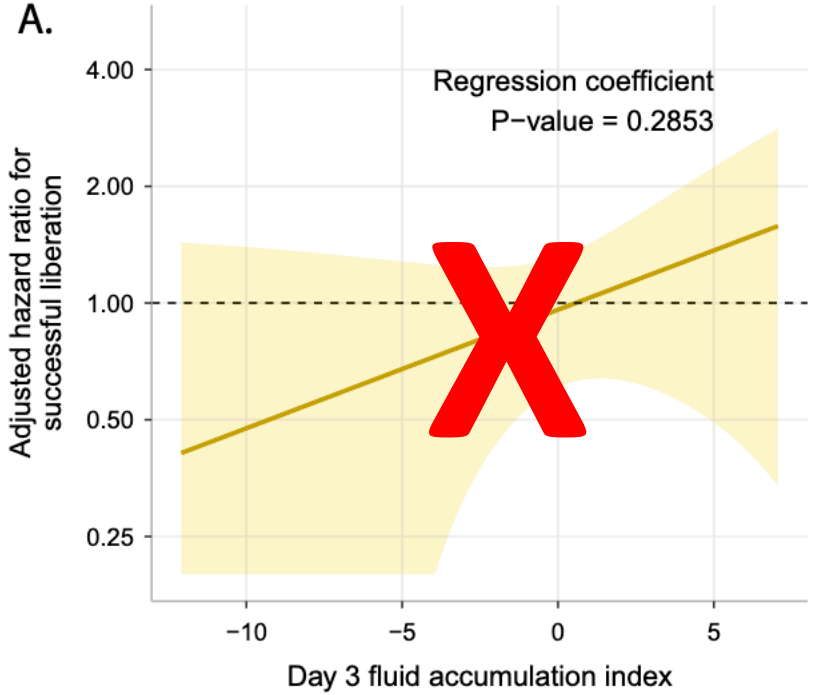
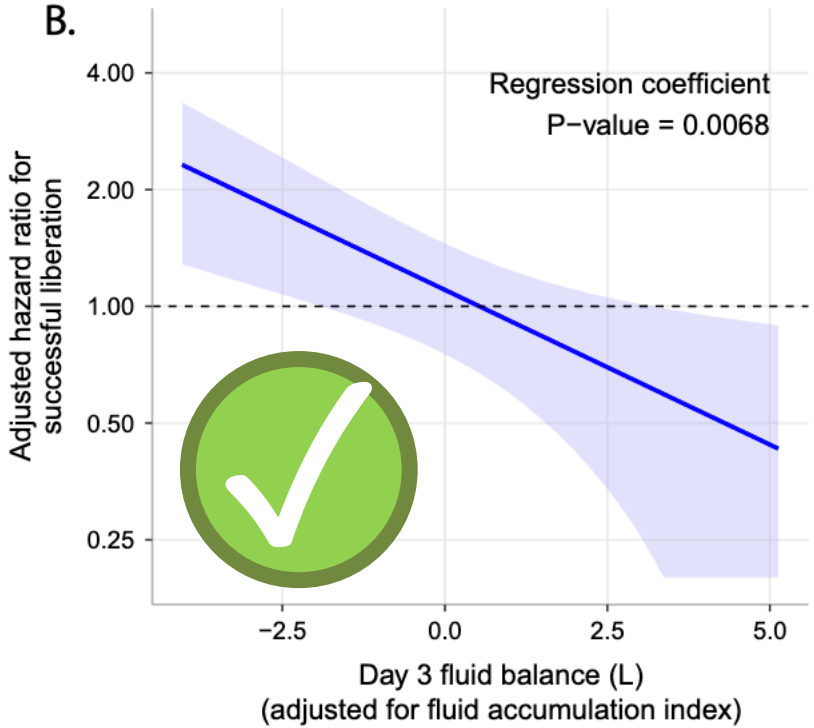
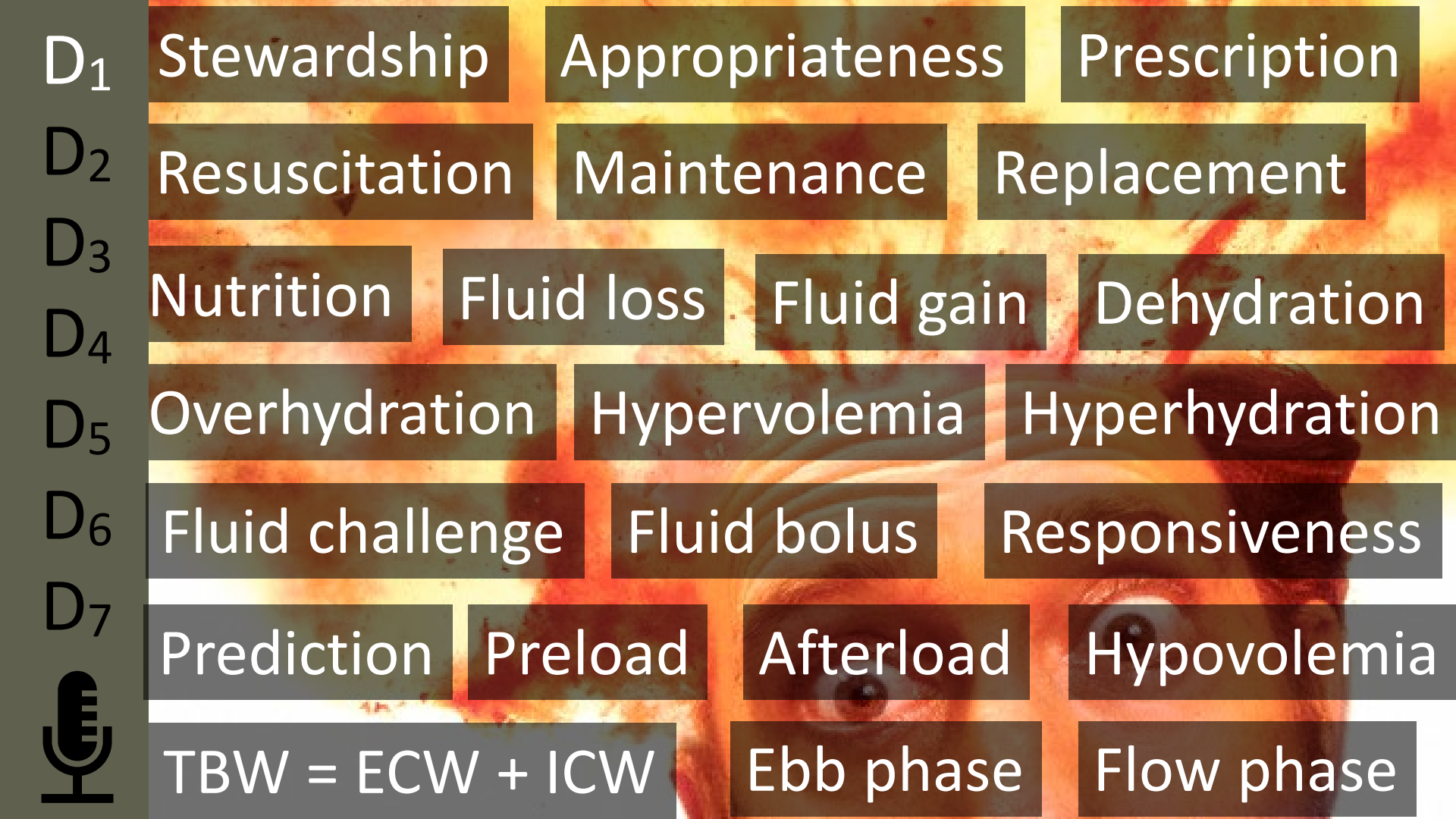


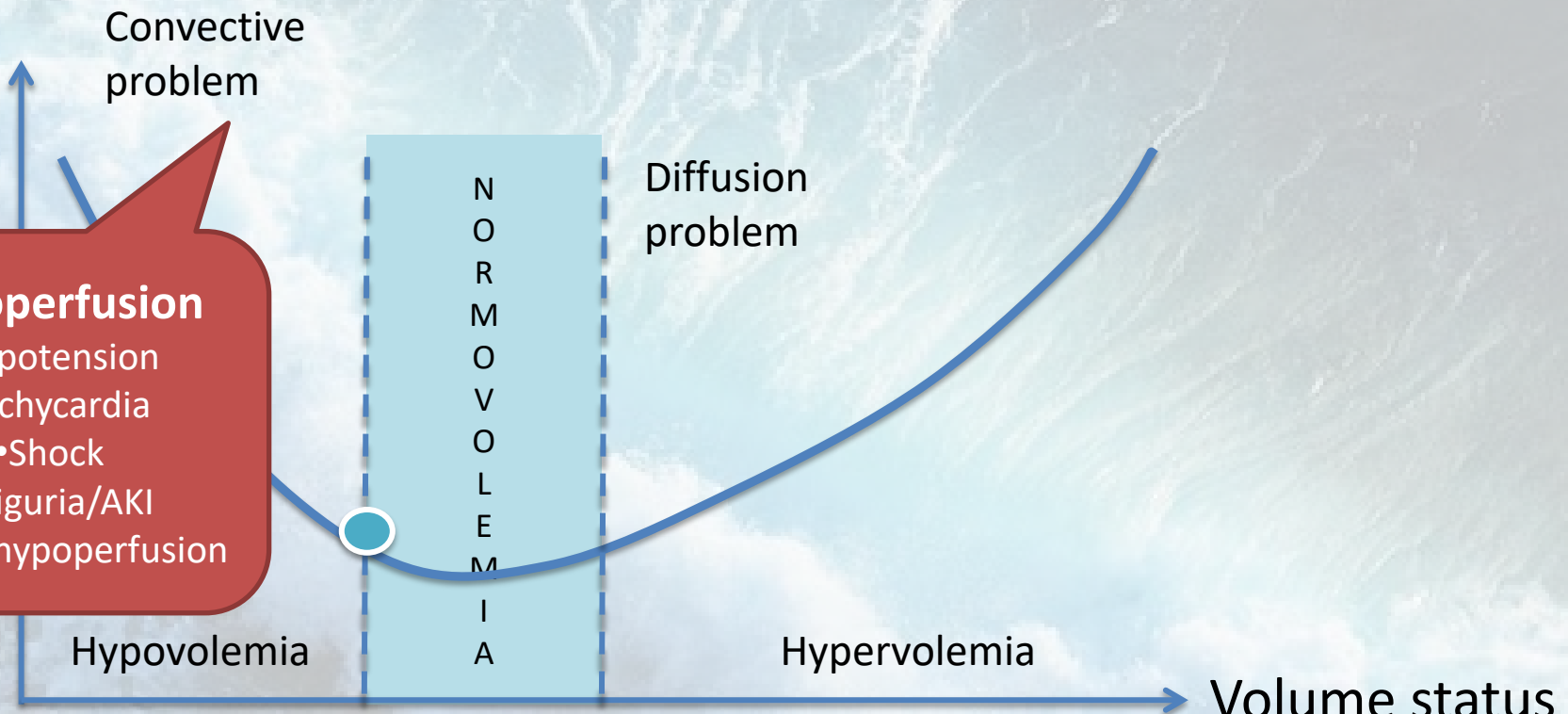



D1
Stewardship
Appropriateness
Prescription
D2
Resuscitation
Maintenance
Replacement
D3
Nutrition
Fluid loss
Fluid gain
Dehydration
D4
Overhydration
Hypervolemia
Hyperhydration
D5
Fluid challenge
Fluid bolus
Responsiveness
D6
Prediction
Preload
Afterload
Hypovolemia
D7
TBW = ECW + ICW
Ebb phase
Flow phase

D1
D2
D3
D4
D5
D6
D7

D1
D2
D3
D4

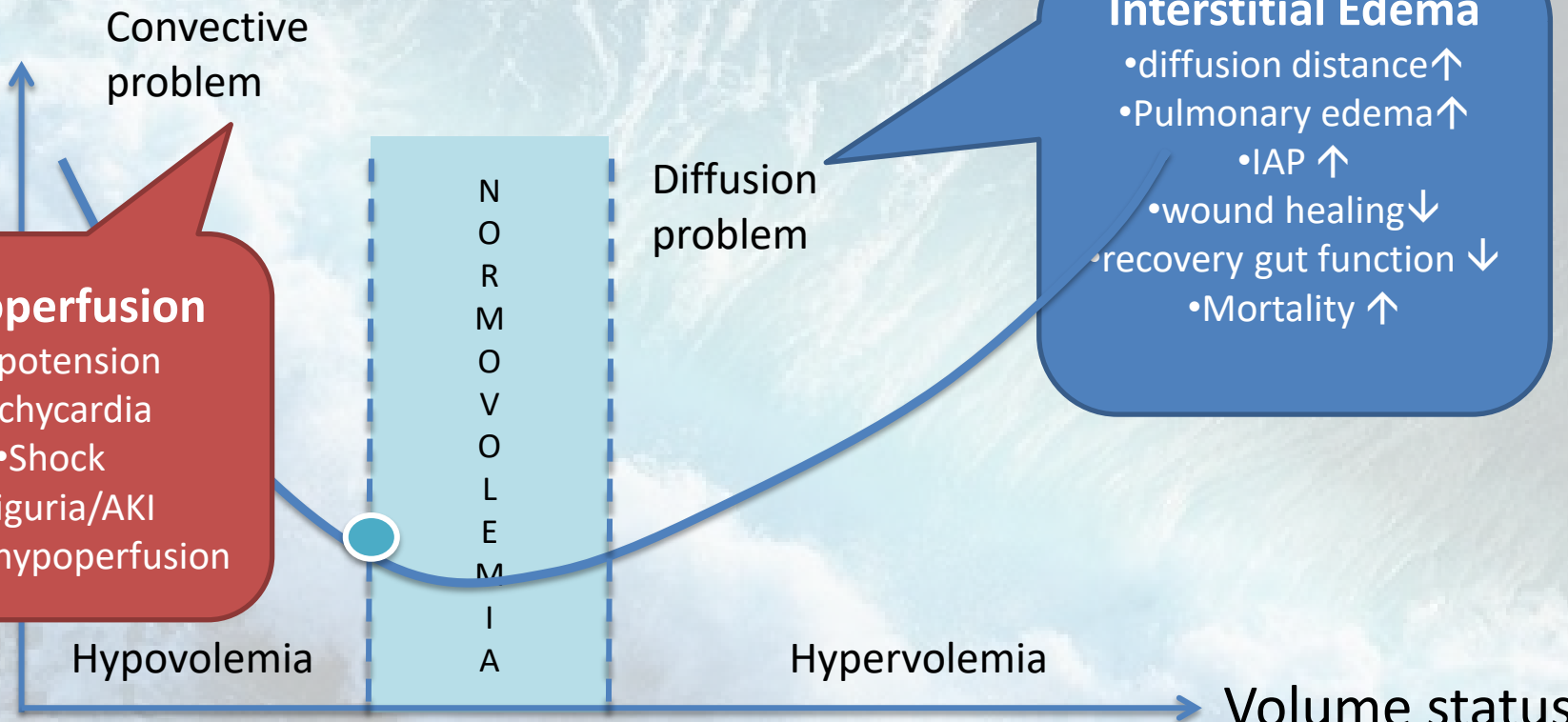
HYPOVOLEMIA IS BAD…



Bellamy MC. Br J Anaesth 2006;97:755–757

D1
D2
D3
D4

HYPERVOLEMIA IS EVEN WORSE



Bellamy MC. Br J Anaesth 2006;97:755–757

D1

D

D3

D4

D5

D6

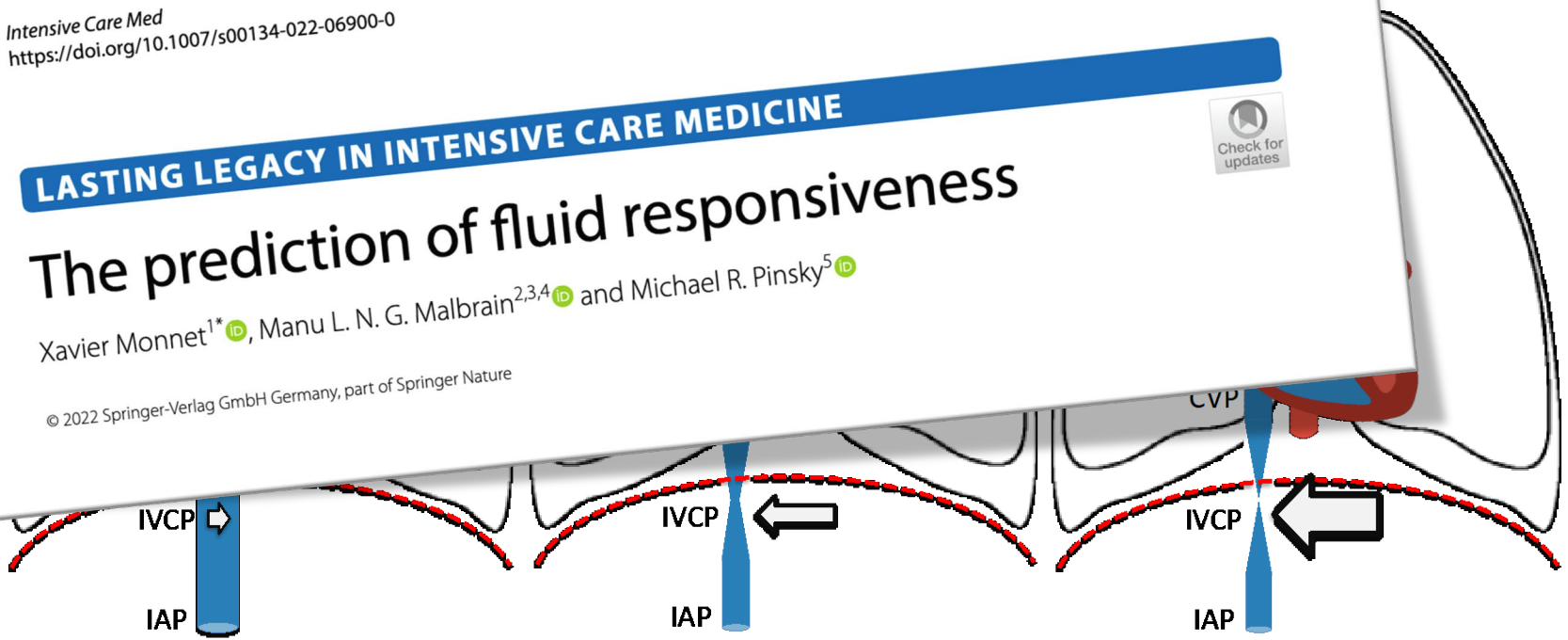
D7

Intensive Care Med
https://doi.org/10.1007/s00134-022-06900-0

LASTING LEGACY IN INTENSIVE CARE MEDICINE

The prediction of fluid responsiveness

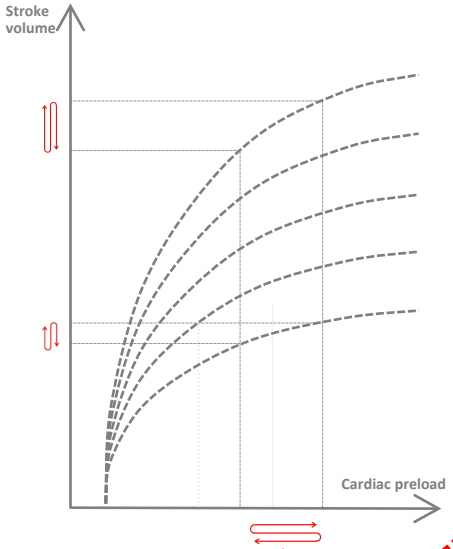
Xavier Monnet[1*], Manu L. N. G. Malbrain[2,3,4] and Michael R. Pinsky[5]

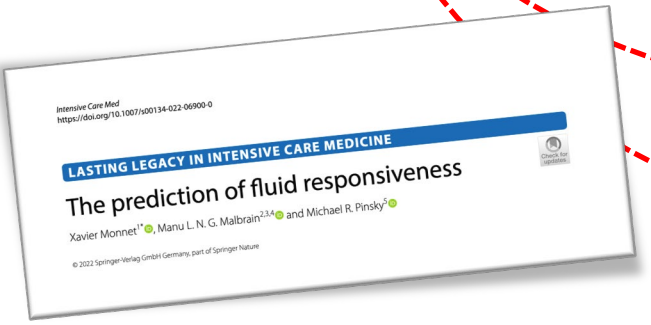


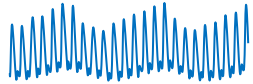
Zone 3: CVP > IVCP > IAP

Zone 2: CVP > IAP > IVCP

Zone 1: IAP > IVCP > CVP







TIMELINE

2006 Passive leg raising test ↗CO ≥10%

2011 Mini-fluid challenge ↗CO ≥5%

Mimicking a fluid challenge

2000 Pulse pressure variation ≥15%

2004 Vena cava collapsibility ≥15%

2009 End-expiratory occlusion ↗CO ≥5%

2017 Tidal volume challenge ↗PPV ≥1 to 3.5%

2017 Sigh manoeuvre ↘CO ≥30%

Using heart-lung interactions

D3

D4

D5

D6

D7

PRELOAD/VOLEMIA

Fluid Responsiveness

Fluid Unresponsiveness

FLUID TOLERANCE

Fluid Underload

Fluid Overload/Accumulation

Fluid Accumulation Syndrome

Very Low

Intermediate Low

Intermediate

Intermediate High

Very High

Very Low

Intermediate Low

Intermediate

Intermediate High

Very High

GIPS

EDEMA/CAPILLARY LEAK

D3

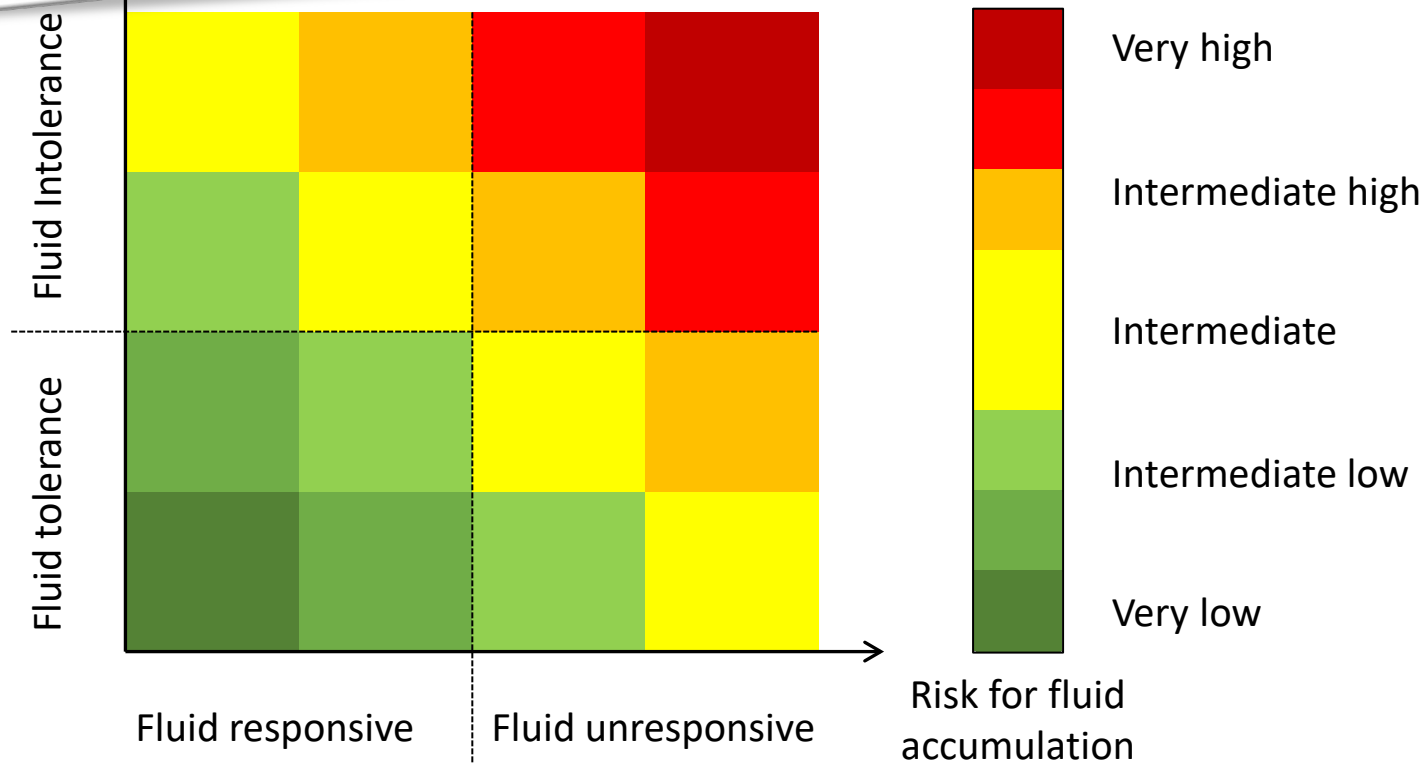
D4

D5

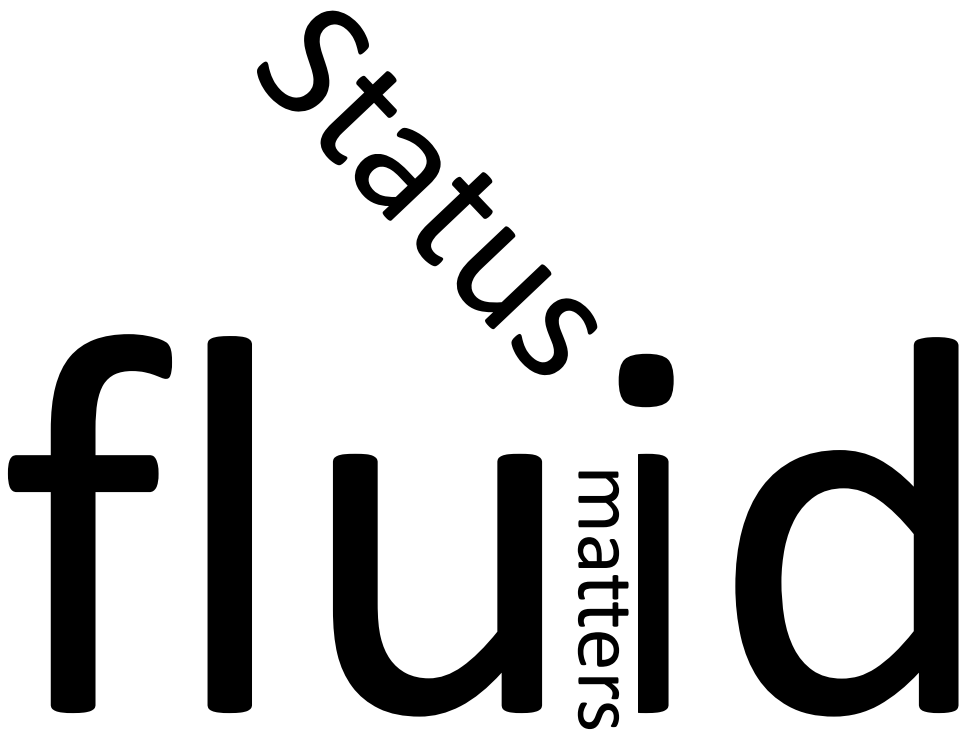
D6

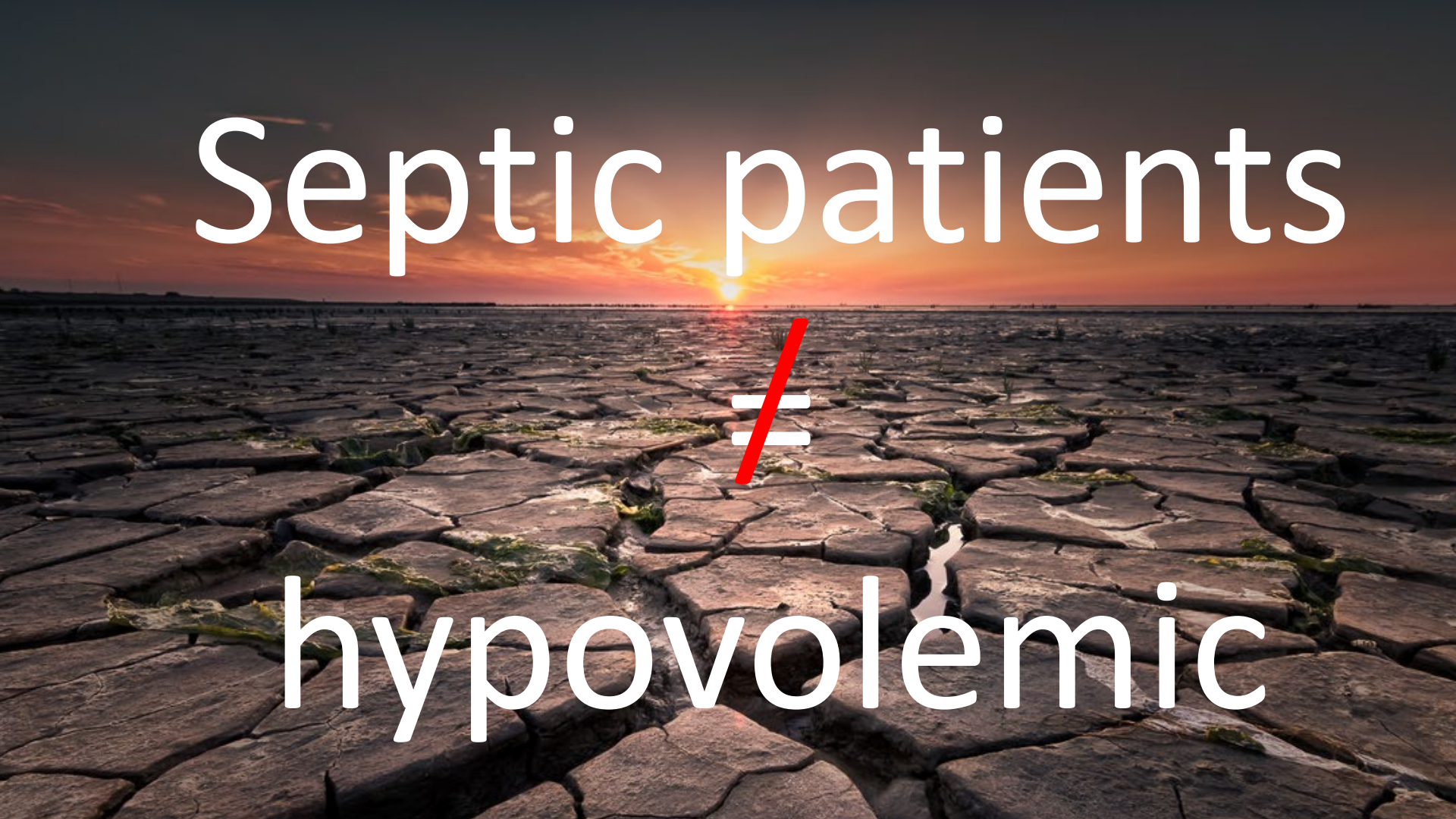
D7

Risk Fluid Accumulation



Monnet, Malbrain, Pinsky. Intensive Care Med 2022 https://doi.org/10.1007/s00134-022-06900-0


Status
fluid
matters


Septic patients
≠
hypovolemic

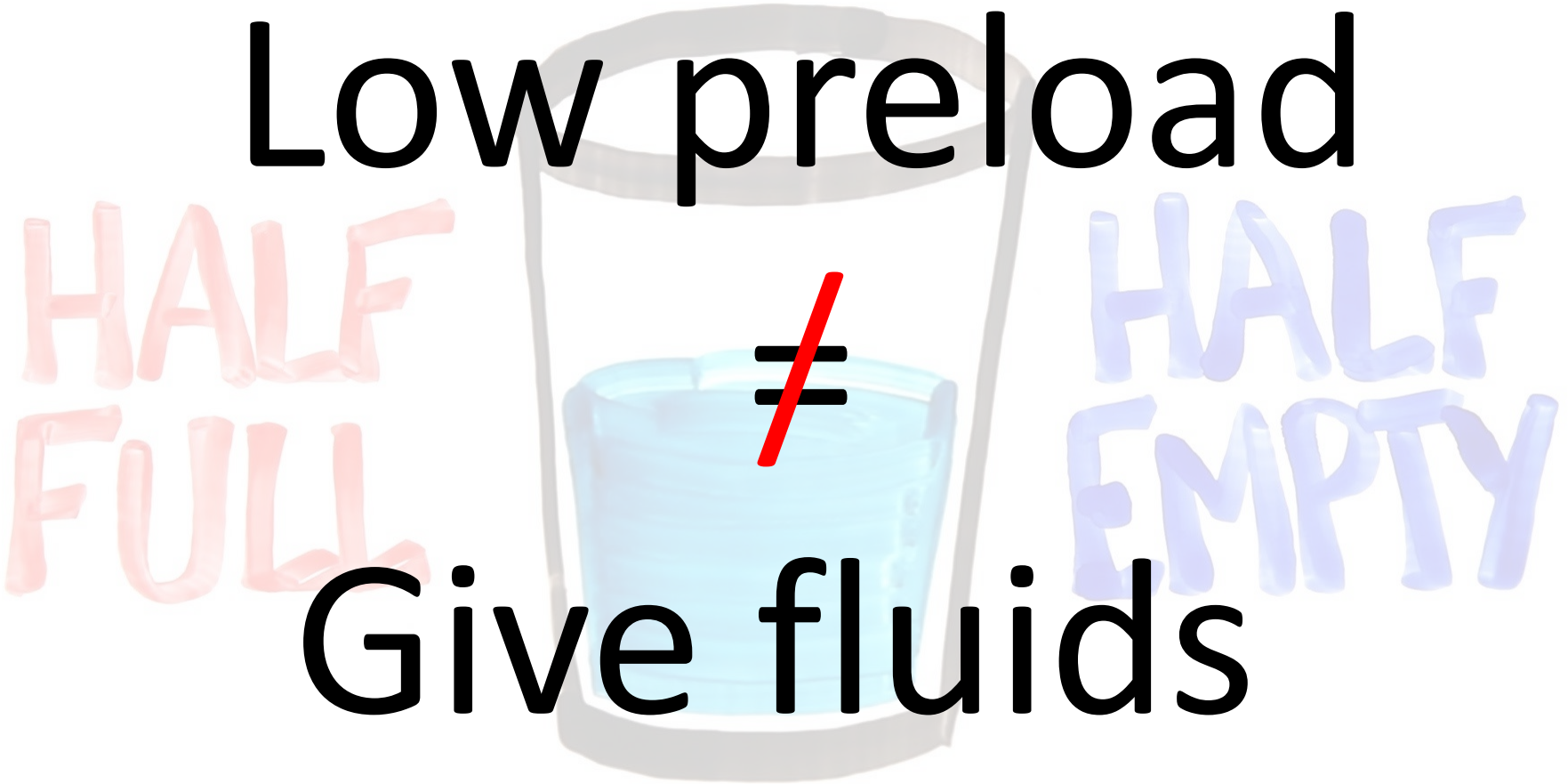

Surgical patients
≠
hypovolemic


Sepsis
≠
Insensible loss


Edema
≠
Give diuretics

HALF FULL

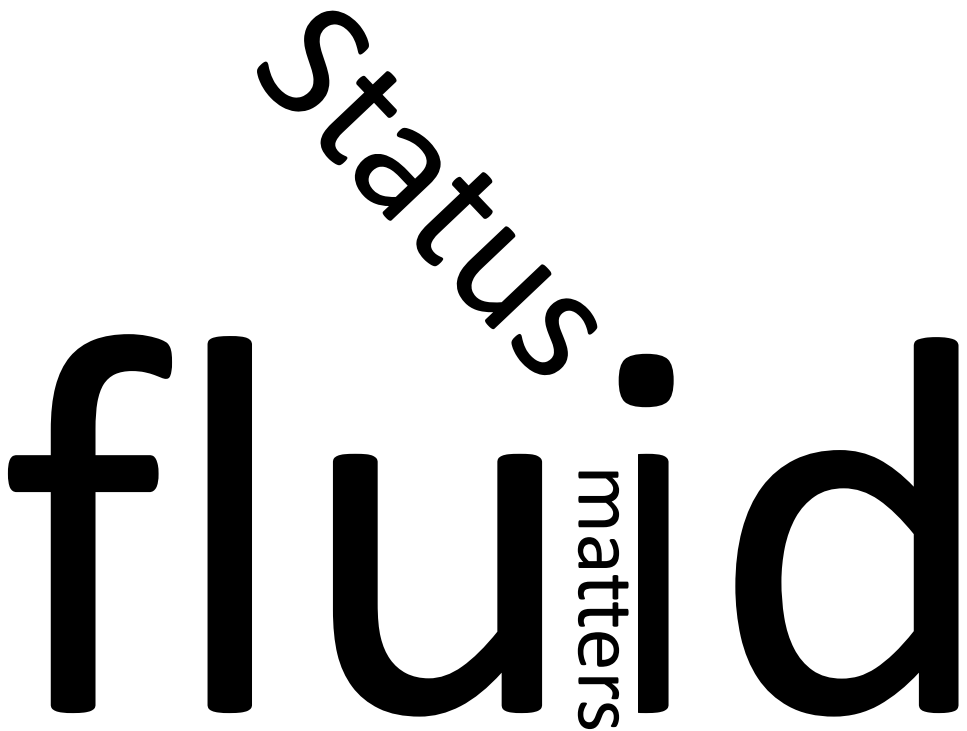
HALF EMPTY



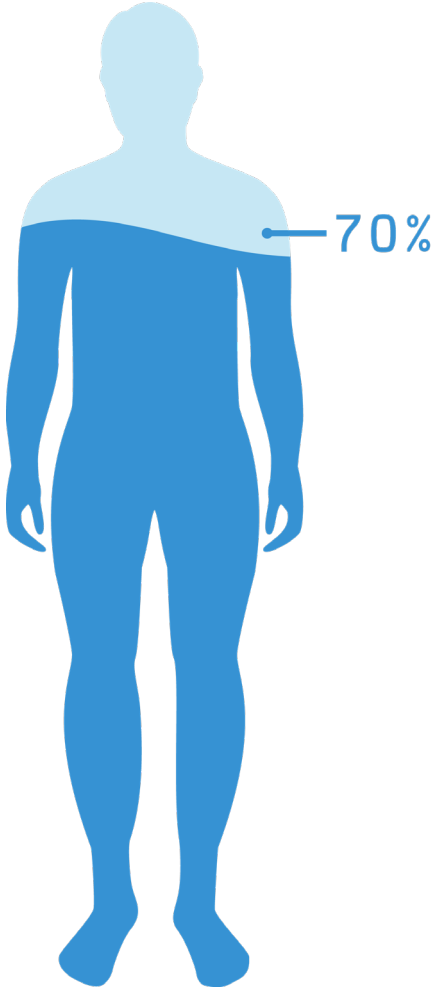
Low preload

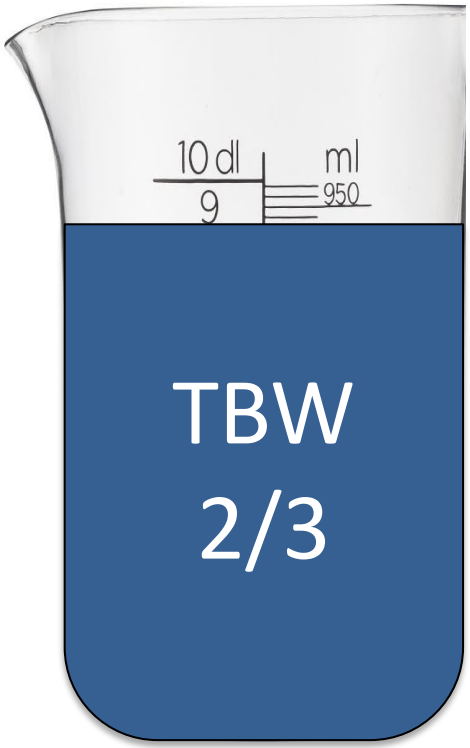
≠

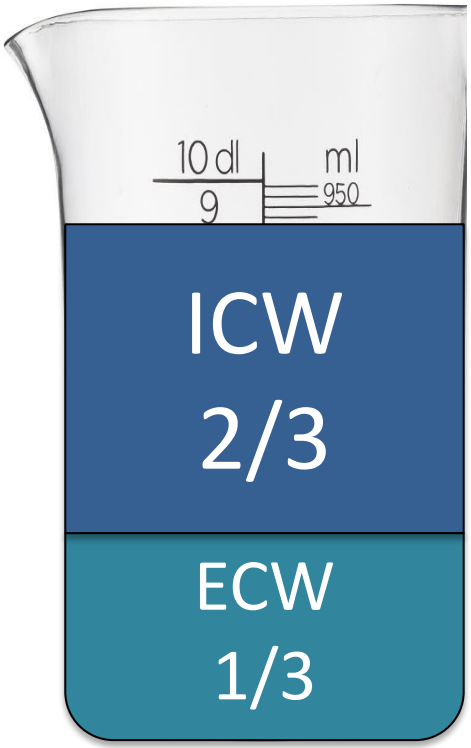
Give fluids


Status
fluid
matters

TBW = ECW + ICW


70%


10 dl
ml
9
950
TBW
2/3


10 dl
ml
9
950
ICW
2/3
ECW
1/3


10 dl
ml
9
950
8
850
7
750
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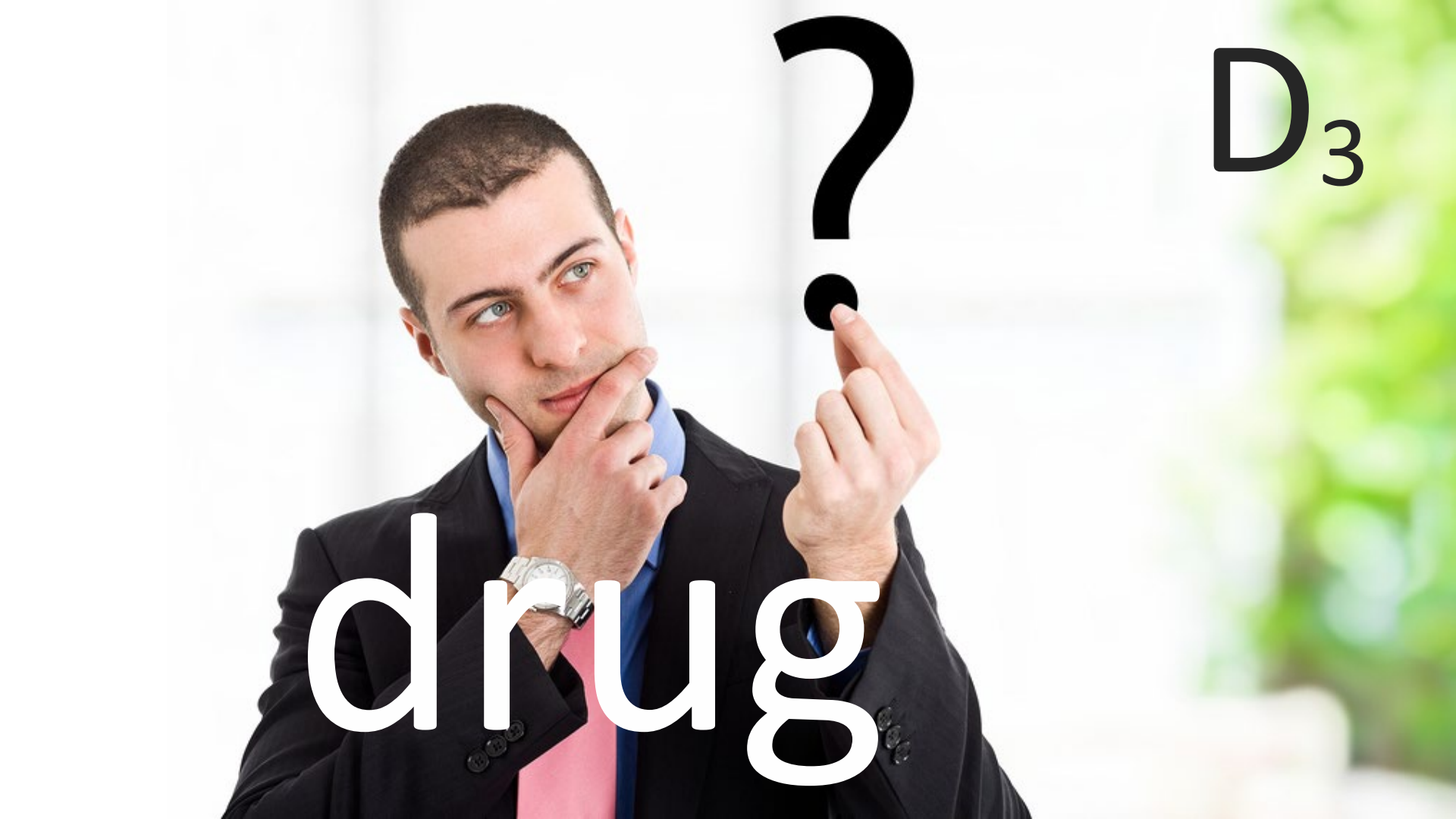
5
550
4
450
350
ISF 3/4
IVF 1/4


?
drug
D3

D1
D2
D3
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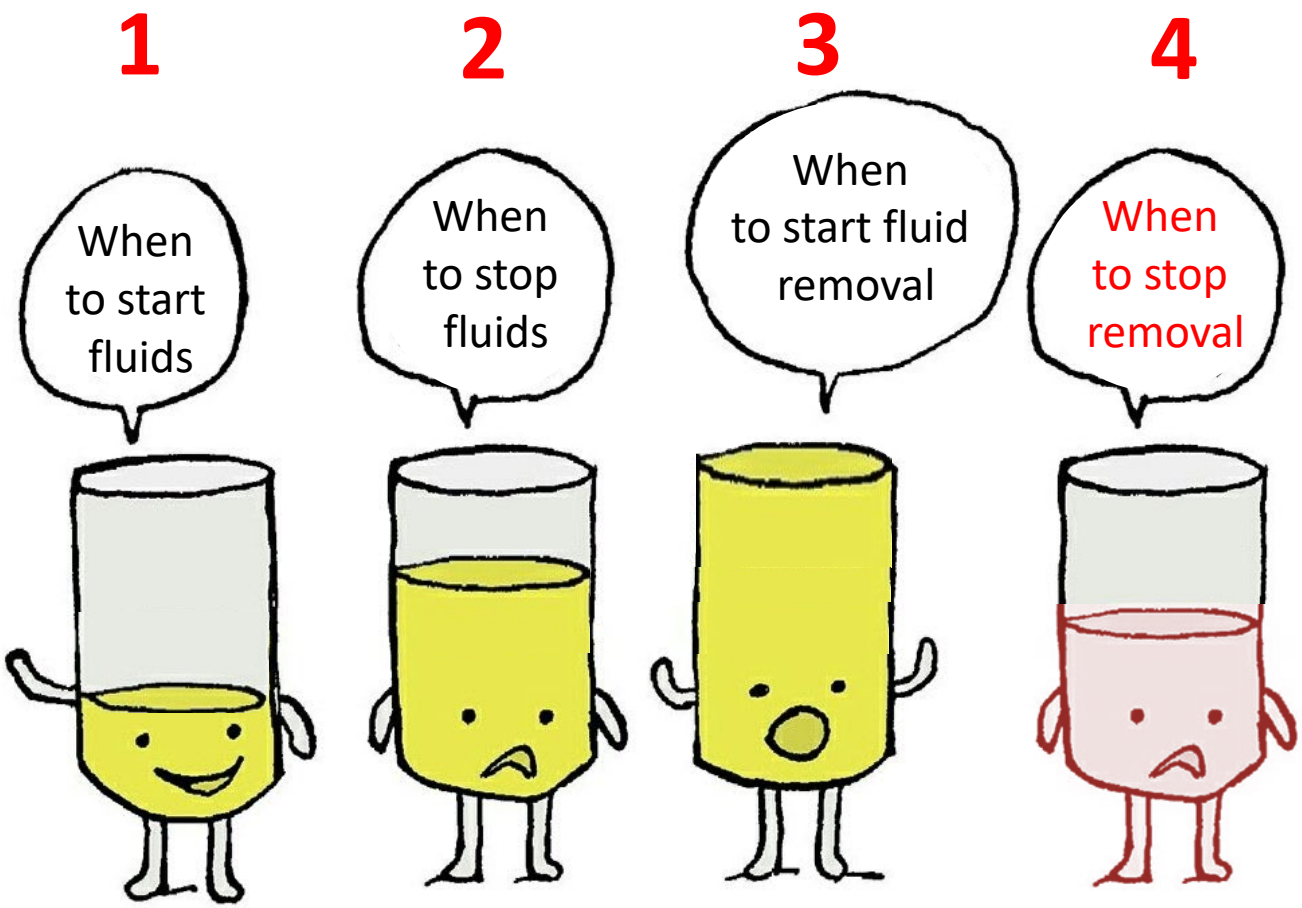
4 Questions

D1
D2
D3
D4
D5
D6
D7



D1
D2
D3
D4
D5
D6
D7

4 Indications

Resuscitation

R1

SSCG: 30ml/kg/hr
Bolus: 4ml/kg/15min
Challenge: 1ml/kg/1min

Balanced Crystalloids

Routine Maintenance

R2

1 ml/kg/hr or 25 ml/kg/d
Na: 1-1.5 mmol/kg/d
Cl/K: 1 mmol/kg/d
Gluc: 1-1.5 g/kg/d

Replacement

R3

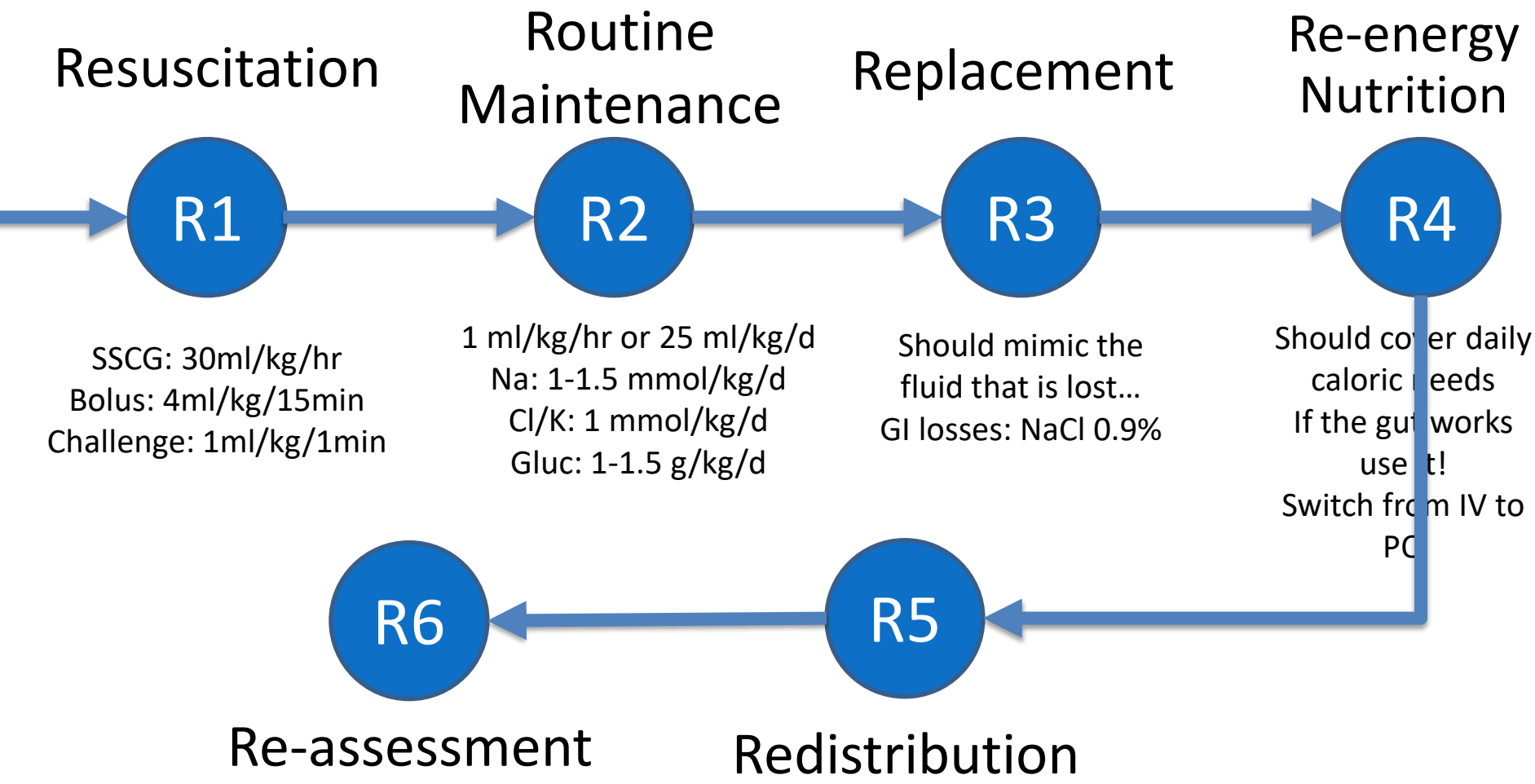
Should mimic the fluid that is lost…
GI losses: NaCl 0.9%

Saline

Re-energy Nutrition

R4

Should cover daily caloric needs
If the gut works use it!
Switch from IV to PO


Resuscitation
Routine Maintenance
Replacement
Re-energy Nutrition
R1
R2
R3
R4
SSCG: 30ml/kg/hr
Bolus: 4ml/kg/15min
Challenge: 1ml/kg/1min
1 ml/kg/hr or 25 ml/kg/d
Na: 1-1.5 mmol/kg/d
Cl/K: 1 mmol/kg/d
Gluc: 1-1.5 g/kg/d
Should mimic the fluid that is lost…
GI losses: NaCl 0.9%
Should cover daily caloric needs
If the gut works use it!
Switch from IV to PO
R6
R5
Re-assessment
Redistribution

D1
D2
D3
D4
D5
D6
D7

CRYSTALLOIDS

D1
D2
D3
D4
D5
D6
D7

Balanced Crystalloids

Saline

	Na^+	Cl^-	K^+	Ca^{2+}	Mg^{2+}	Lactate	Acetate	Gluconate
0.9% saline	154	**154**						
Lactated Ringer's	130	**109**	4.0	2.7		28		
Plasma-Lyte A®	140	**98**	5.0		3.0		27	23

The Big Fluid trials .....

Balanced Crystalloids | **Saline**

vs.

SPLIT (2015)

SALT (2017)

SALT-ED (2018)

SMART (2018)

SSC COVID (2020)

BASICS (2021)

SKOPE DKA (2021)

SSCG (2021)

PLUS (2022)

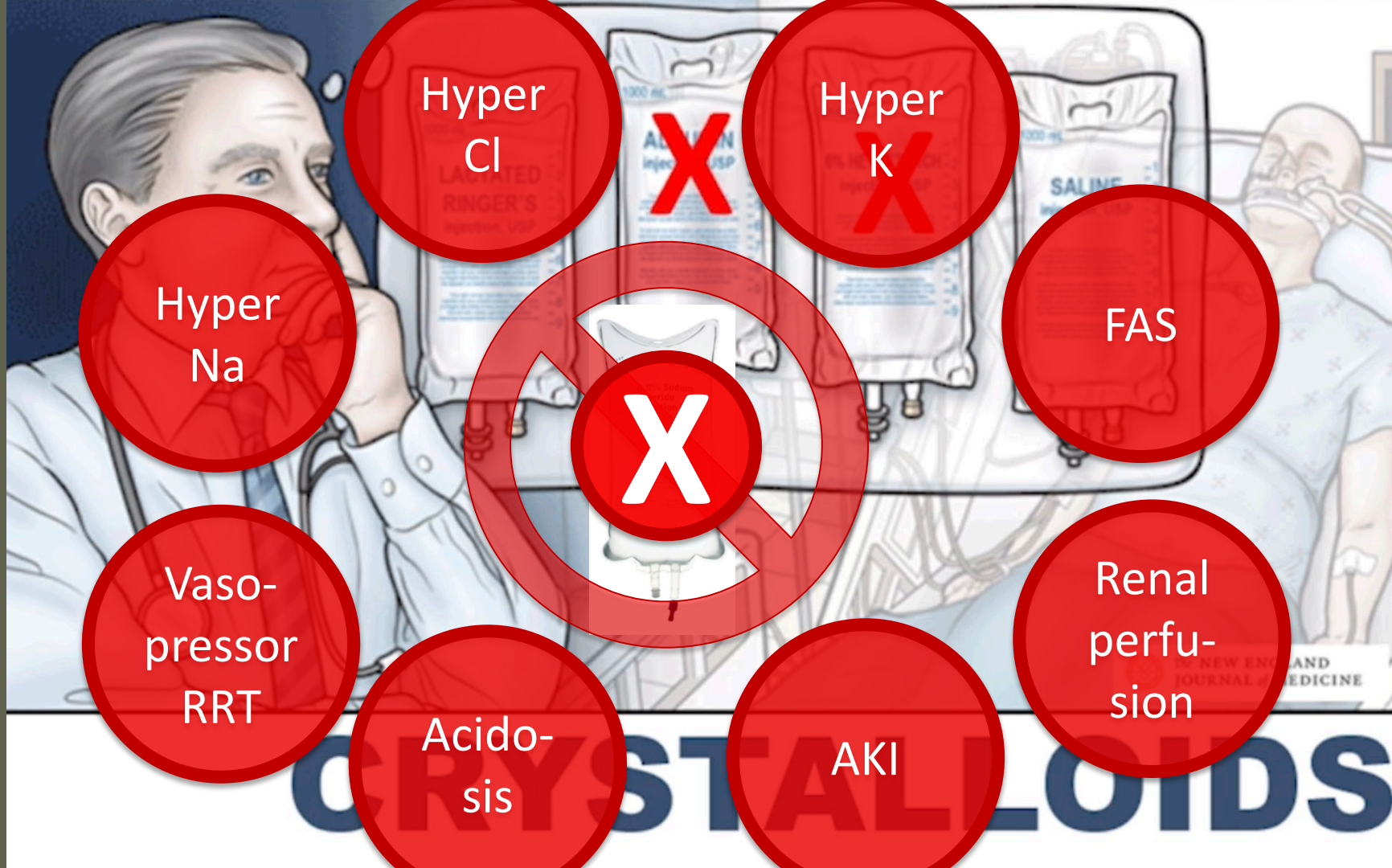
META-ANALYSIS (2022)

CRYSTALLOIDS

D1
D2
D3
D4
D5
D6
D7

STOP ABNORMAL SALINE?

D1
D2
D3
D4
D5
D6
D7



Hyper Na

Contents lists available at ScienceDirect

Journal of Critical Care

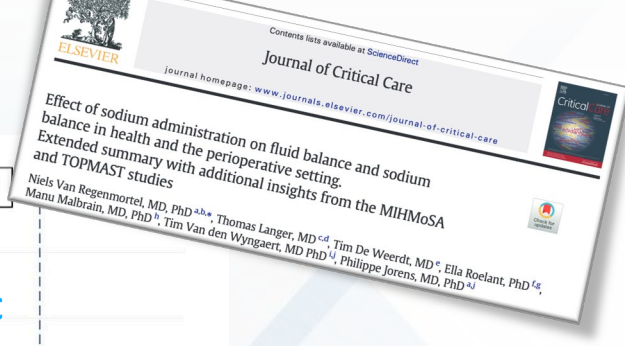
journal homepage: www.journals.elsevier.com/journal-of-critical-care

Effect of sodium administration on fluid balance and sodium balance in health and the perioperative setting. Extended summary with additional insights from the MIHMoSA and TOPMAST studies

Niels Van Regenmortel, MD, PhD [a,b,*], Thomas Langer, MD [c,d], Tim De Weerdt, MD [e], Ella Roelant, PhD [f,g], Manu Malbrain, MD, PhD [h], Tim Van den Wyngaert, MD PhD [i,j], Philippe Jorens, MD, PhD [a,j]

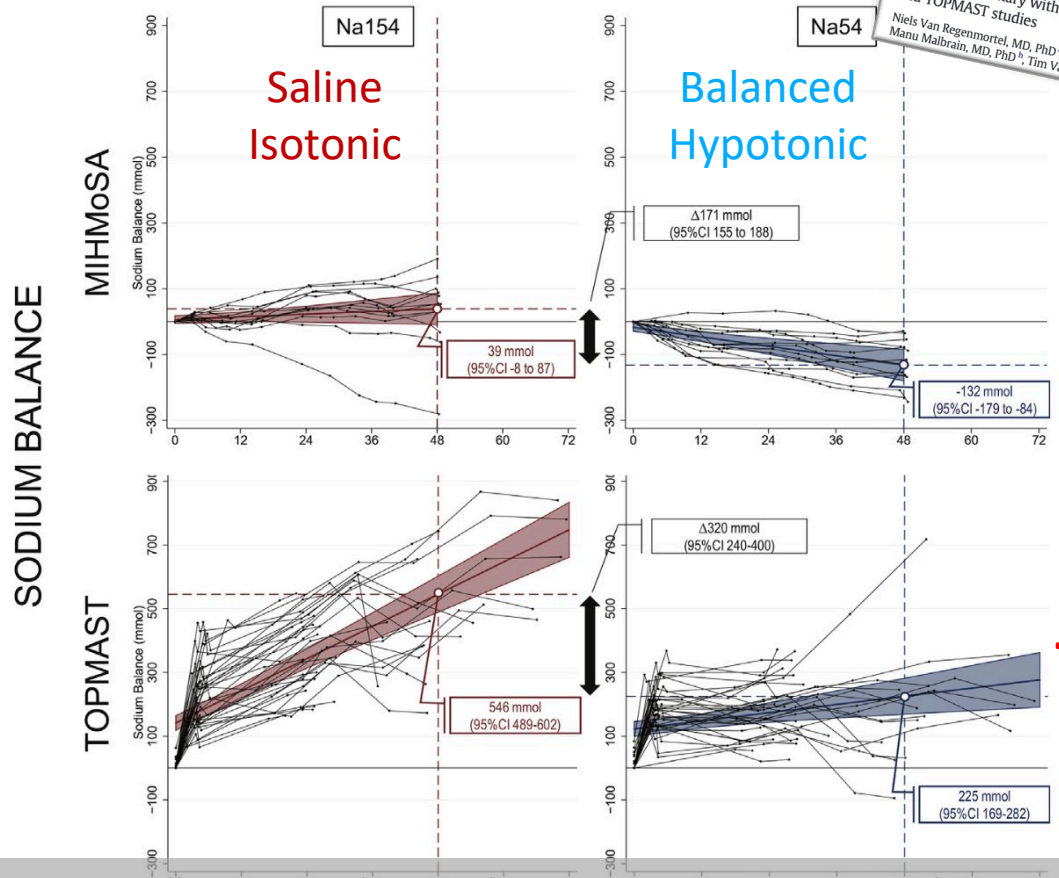
Van Regenmortel N, Langer T, Malbrain M et al. Journal Crit Care 2022;67:157-165. doi: 10.1016/j.jcrc.2021.10.022

Effect of Na load on Na Balance



healthy

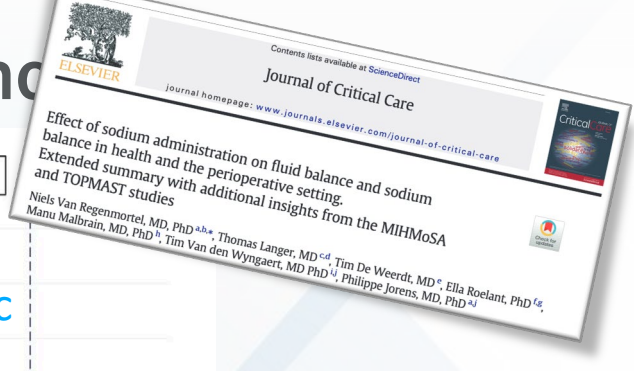
ICU



+150mmol

+300mmol

Effect of Na load on Fluid Balanc

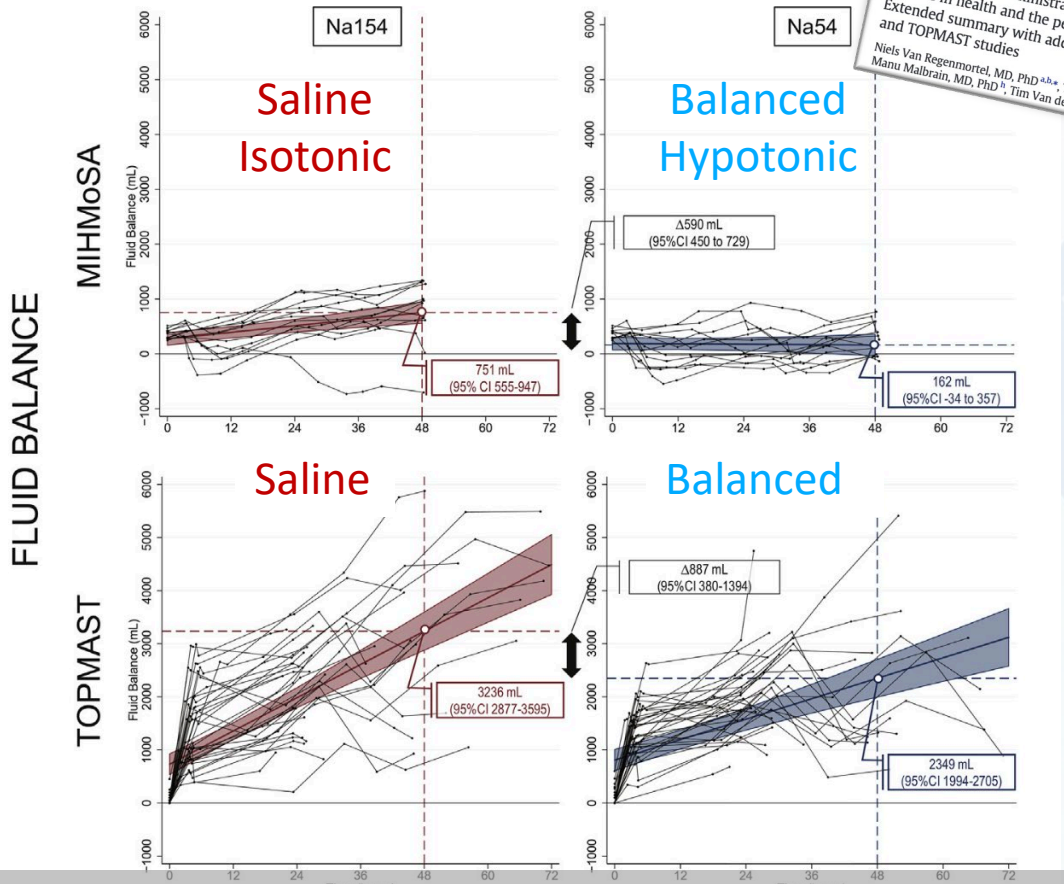

Contents lists available at ScienceDirect
Journal of Critical Care
journal homepage: www.journals.elsevier.com/journal-of-critical-care

Effect of sodium administration on fluid balance and sodium balance in health and the perioperative setting. Extended summary with additional insights from the MIHMoSA and TOPMAST studies

Niels Van Regenmortel, MD, PhD [a,b,*], Thomas Langer, MD [c,d], Tim De Weerdt, MD [e], Ella Roelant, PhD [f,g], Manu Malbrain, MD, PhD [h], Tim Van den Wyngaert, MD PhD [i,j], Philippe Jorens, MD, PhD [a,j]

healthy

ICU



+600ml

+900ml

NEJM Evidence

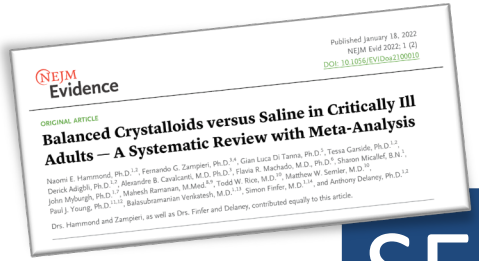
Published January 18, 2022
NEJM Evid 2022; 1 (2)
DOI: 10.1056/EVIDoa2100010

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Critically Ill Adults — A Systematic Review with Meta-Analysis

Naomi E. Hammond, Ph.D.[1,2], Fernando G. Zampieri, Ph.D.[3,4], Gian Luca Di Tanna, Ph.D.[5], Tessa Garside, Ph.D.[1,2], Derick Adigbli, Ph.D.[1,2], Alexandre B. Cavalcanti, M.D. Ph.D.[3], Flavia R. Machado, M.D., Ph.D.[6], Sharon Micallef, B.N.[1], John Myburgh, Ph.D.[1,7], Mahesh Ramanan, M.Med.[8,9], Todd W. Rice, M.D.[10], Matthew W. Semler, M.D.[10], Paul J. Young, Ph.D.[11,12], Balasubramanian Venkatesh, M.D.[1,13], Simon Finfer, M.D.[1,14], and Anthony Delaney, Ph.D.[1,2]

Drs. Hammond and Zampieri, as well as Drs. Finfer and Delaney, contributed equally to this article.



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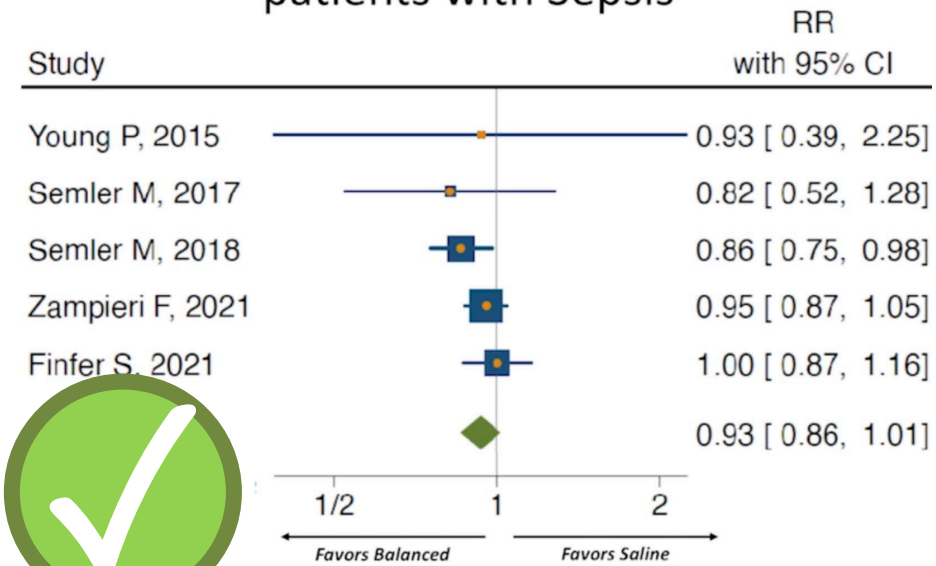
Results

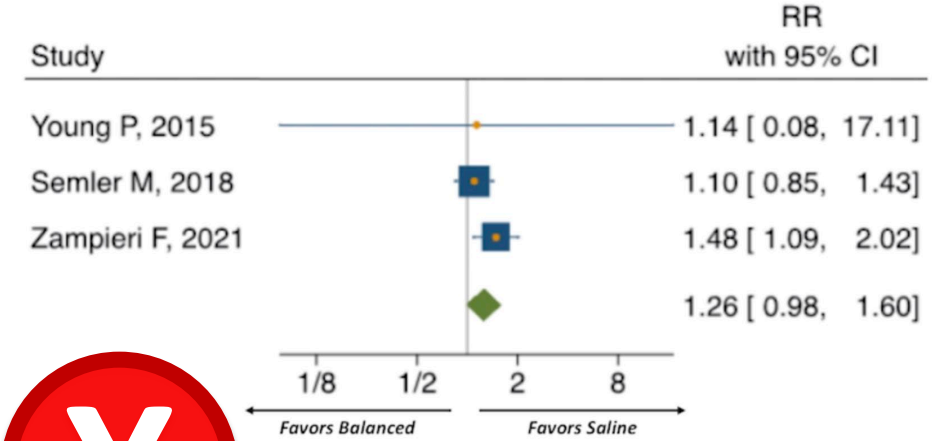
SEPSIS

Balanced Crystalloids vs Saline in 6,754 patients with Sepsis



TBI

Balanced Crystalloids vs Saline in 1,896 patients with traumatic brain injury



Published January 18, 2022
NEJM Evid 2022; 1 (2)

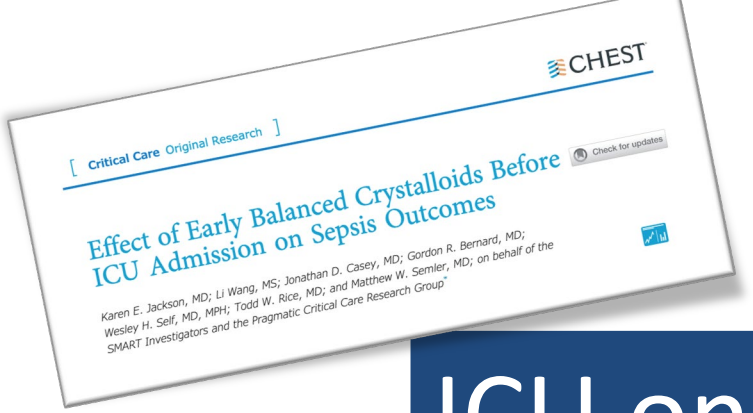
[Critical Care Original Research]

CHEST

Effect of Early Balanced Crystalloids Before ICU Admission on Sepsis Outcomes

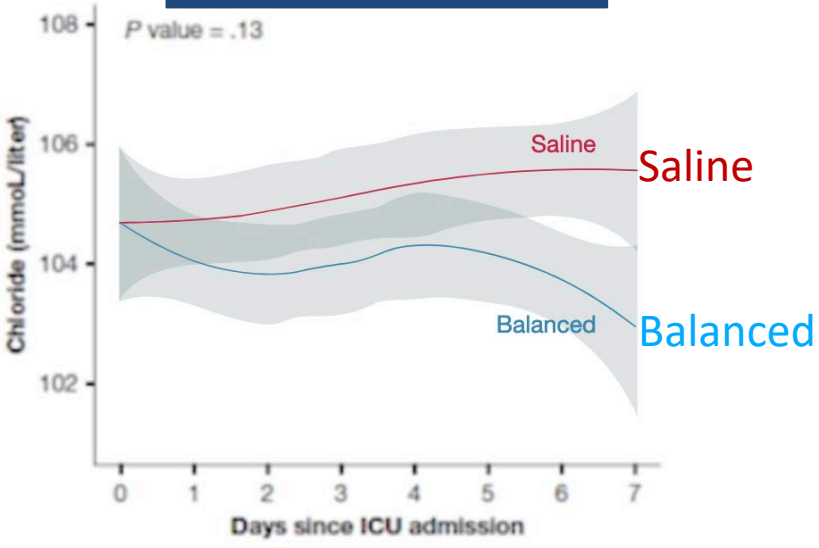
Check for updates

*Karen E. Jackson, MD; Li Wang, MS; Jonathan D. Casey, MD; Gordon R. Bernard, MD; Wesley H. Self, MD, MPH; Todd W. Rice, MD; and Matthew W. Semler, MD; on behalf of the SMART Investigators and the Pragmatic Critical Care Research Group**

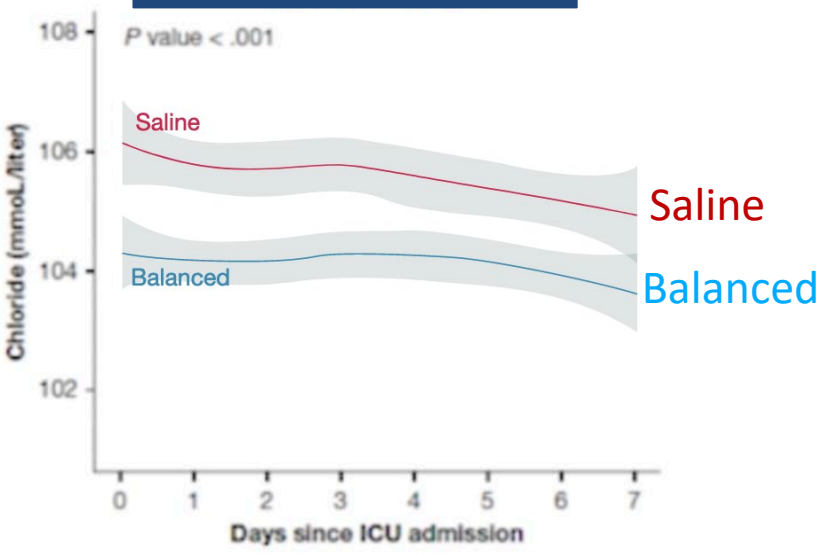


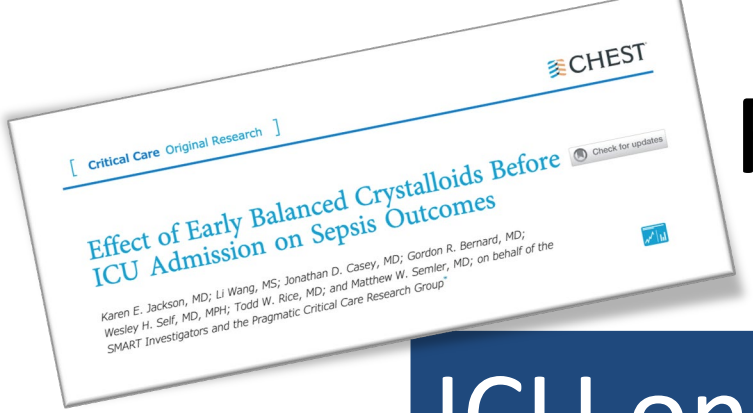
Results: Chloride

ICU only



ER + ICU




CHEST

[Critical Care Original Research]

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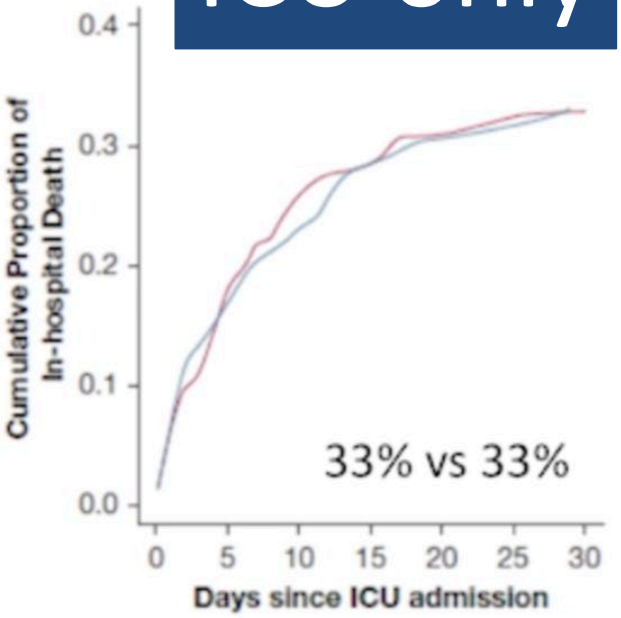
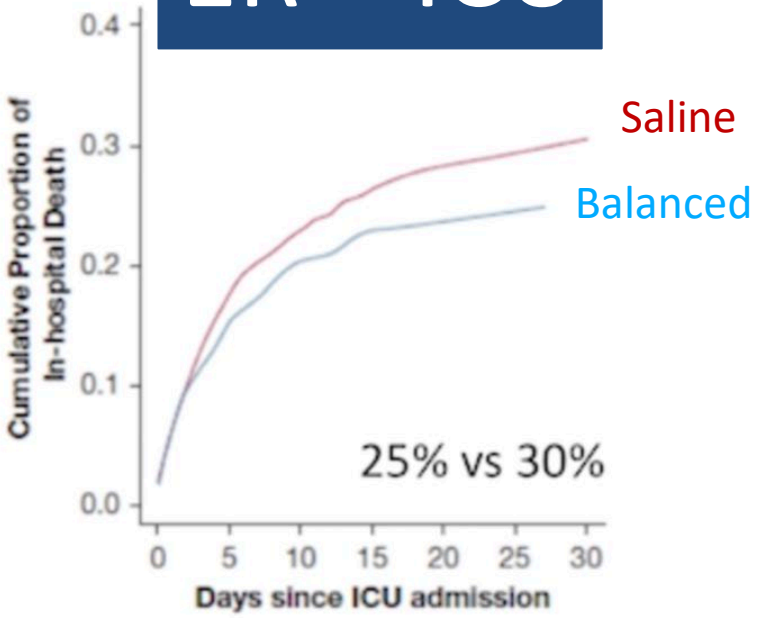
Results: HOS mortality

ICU only



ER + ICU




Published January 18, 2022
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CHEST
Randomized Controlled Trial
Am J Respir Crit Care Med. 2022 Jun 15;205(12):1419-1428.
doi: 10.1164/rccm.202111-2484OC.
Association between Type of Fluid Received Prior to Enrollment, Type of Admission, and Effect of Balanced Crystalloid in Critically Ill Adults: A Secondary Exploratory Analysis of the BaSICS Clinical Trial
Fernando G Zampieri 1 2, Flávia R Machado 2 3, Rodrigo S Biondi 2 4, Flávio G R Freitas 2 5,

Randomized Controlled Trial > Am J Respir Crit Care Med. 2022 Jun 15;205(12):1419-1428.
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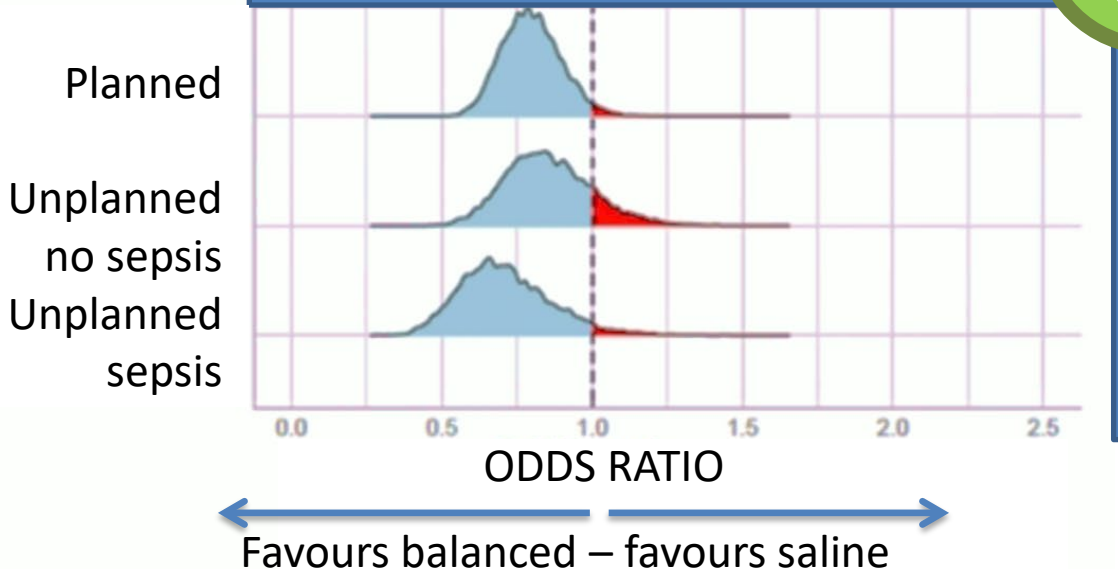
Association between Type of Fluid Received Prior to Enrollment, Type of Admission, and Effect of Balanced Crystalloid in Critically Ill Adults: A Secondary Exploratory Analysis of the BaSICS Clinical Trial

Fernando G Zampieri [1 2], Flávia R Machado [2 3], Rodrigo S Biondi [2 4], Flávio G R Freitas [2 5],

Results: HOS mortality

Balanced only (no saline)



OVERALL: 92% probability that balanced crystalloids decrease mortality

SEPSIS: 96% probability that balanced crystalloids decrease mortality

Summary Conclusions

6 randomized trials
34.450 ICU patients

~ 1% Reduction in mortality

from -9% to +1%

The probability that balanced solutions reduce mortality is high:

90%

Summary Conclusions

6 randomized trials
34.450 ICU patients

~ 1% Reduction in mortality

from -9% to +1%

The probability that balanced solutions reduce mortality is high:

90%

SMART-ICU
SALT-ED

BS associated with ↓ MAKE30

In-hospital mortality, new RRT, and persistent renal dysfunction

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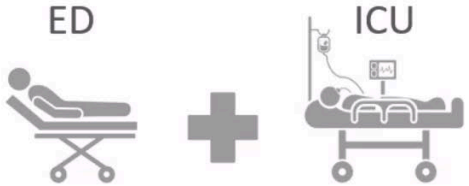
Post-hoc analysis
Jackson et al. 2021
Zampieri et al. 2022



A greater impact of balanced solutions in reducing mortality

Summary Conclusions

6 randomized trials
34.450 ICU patients

~ 1% Reduction in mortality

from -9% to +1%

The probability that balanced solutions reduce mortality is high:

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SMART-ICU
SALT-ED

BS associated with ↓ MAKE30

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Post-hoc analysis
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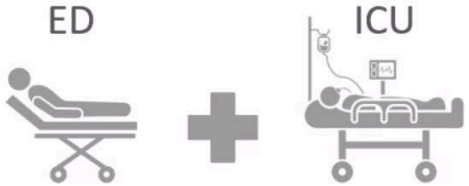


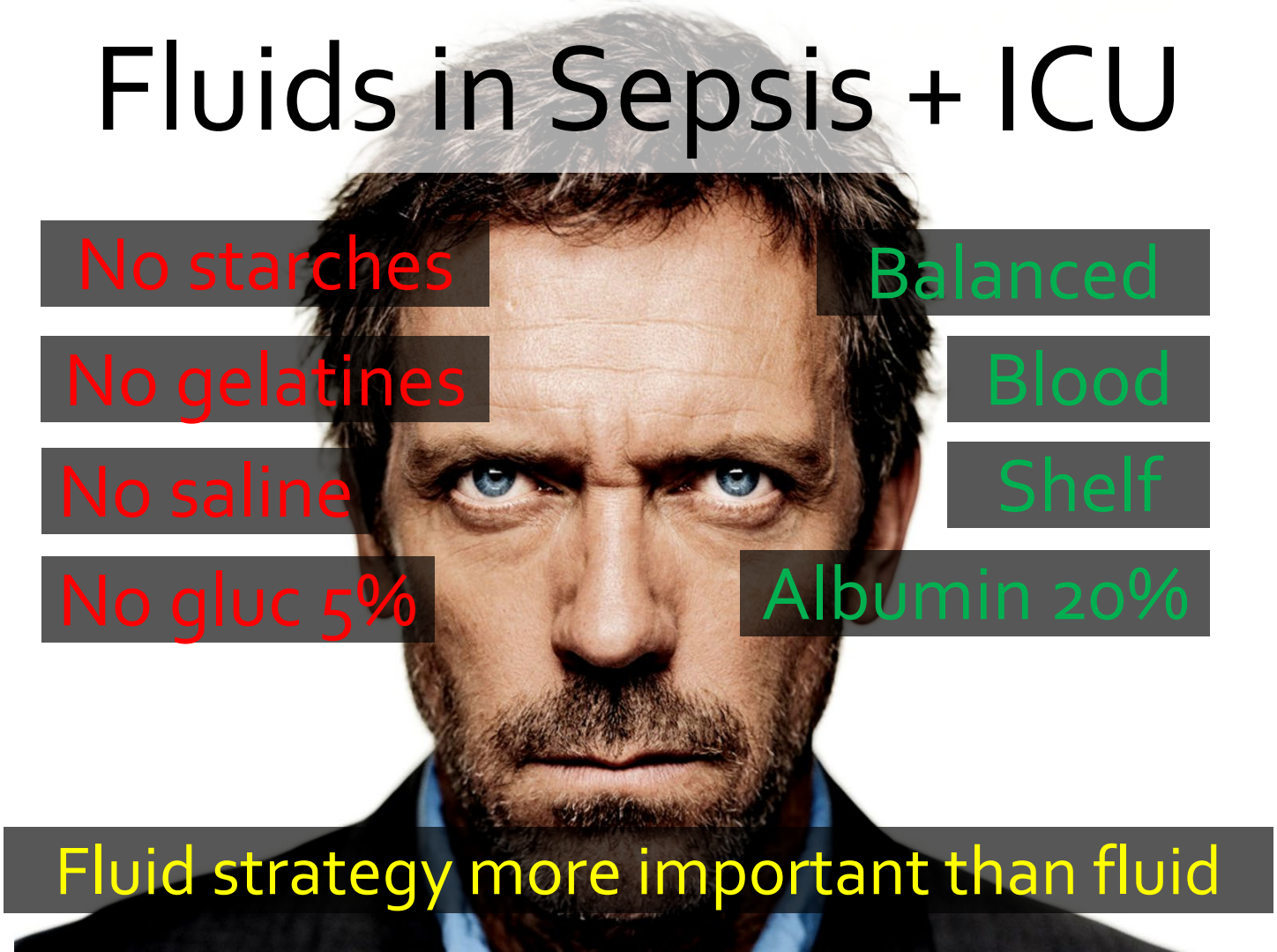
A greater impact of balanced solutions in reducing mortality

Sepsis, burns
Diabetic KA

TBI: traumatic brain injury

D1
D2
D3
D4
D5
D6
D7

Fluids in Sepsis + ICU



No starches

No gelatines

No saline

No gluc 5%

Balanced

Blood

Shelf

Albumin 20%

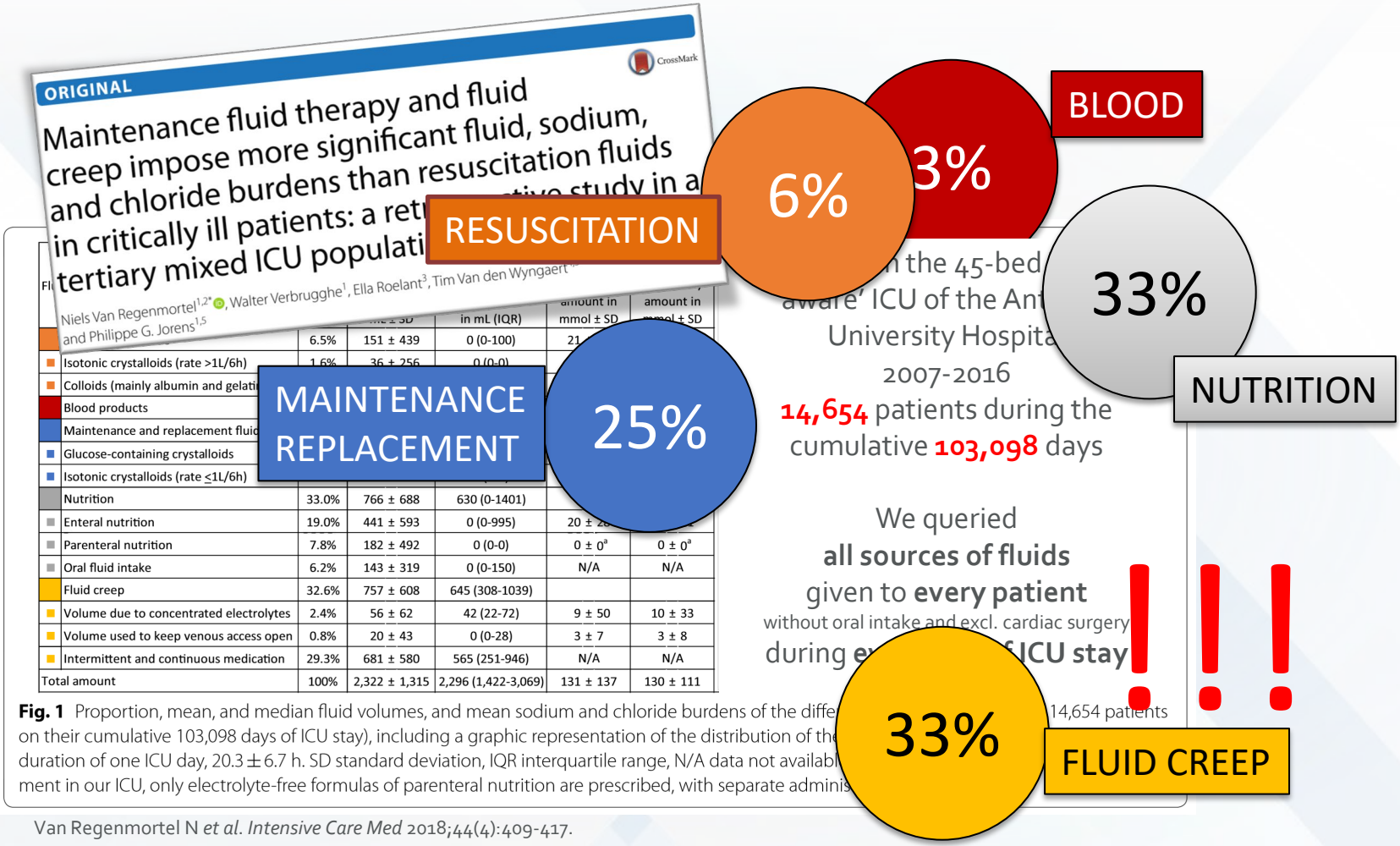
Fluid strategy more important than fluid

D1
D2
D3
D4
D5
D6
D7

Resuscitation fluids

...largest part = other type

D1
D2
D3
D4
D5
D6
D7



			in mL (IQR)	amount in mmol ± SD	amount in mmol ± SD
	6.5%	151 ± 439	0 (0-100)	21	
Isotonic crystalloids (rate >1L/6h)	1.6%	36 ± 256	0 (0-0)		
Colloids (mainly albumin and gelati					
Blood products					
Maintenance and replacement fluid					
Glucose-containing crystalloids					
Isotonic crystalloids (rate ≤1L/6h)					
Nutrition	33.0%	766 ± 688	630 (0-1401)		
Enteral nutrition	19.0%	441 ± 593	0 (0-995)	20 ± 2	
Parenteral nutrition	7.8%	182 ± 492	0 (0-0)	0 ± 0[a]	0 ± 0[a]
Oral fluid intake	6.2%	143 ± 319	0 (0-150)	N/A	N/A
Fluid creep	32.6%	757 ± 608	645 (308-1039)		
Volume due to concentrated electrolytes	2.4%	56 ± 62	42 (22-72)	9 ± 50	10 ± 33
Volume used to keep venous access open	0.8%	20 ± 43	0 (0-28)	3 ± 7	3 ± 8
Intermittent and continuous medication	29.3%	681 ± 580	565 (251-946)	N/A	N/A
Total amount	100%	2,322 ± 1,315	2,296 (1,422-3,069)	131 ± 137	130 ± 111

Fig. 1 Proportion, mean, and median fluid volumes, and mean sodium and chloride burdens of the diffe 14,654 patients on their cumulative 103,098 days of ICU stay), including a graphic representation of the distribution of th duration of one ICU day, 20.3 ± 6.7 h. SD standard deviation, IQR interquartile range, N/A data not availabl ment in our ICU, only electrolyte-free formulas of parenteral nutrition are prescribed, with separate admini

Van Regenmortel N *et al. Intensive Care Med* 2018;44(4):409-417.

D1
D2
D3
D4
D5
D6
D7

dose

D4

Alle Ding' sind Gift, und nichts ohn' Gift; allein die Dosis macht, daß ein Ding kein Gift ist

Philippus Aureolus Theophrastus Bombastus von Hohenheim, 1493 – 1541

D1
D2
D3
D4
D5
D6
D7

Key Concept: Dose (AB)

PK

Distribution volume Clearance
Albumin level
Tissue penetration …

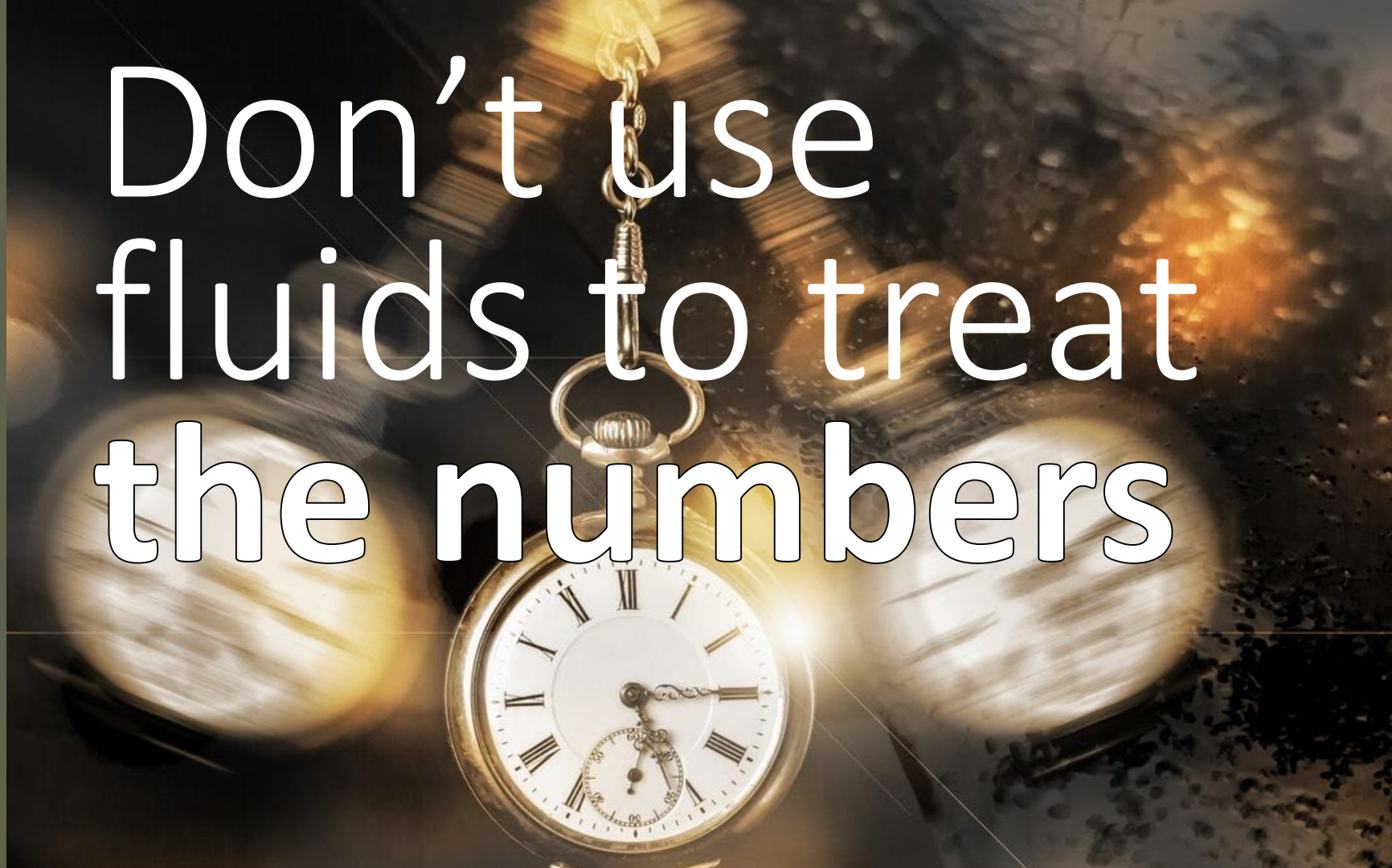
Therapeutic Drug Monitoring
Correct dosing in AKI

PD

MIC
PIC/MIC
AUIC
…
Kill characteristics
(time vs. conc dep AB)


duration
D5

D1
D2
D3
D4
D5
D6
D7



Don’t use fluids to treat **the numbers**

D1
D2
D3
D4
D5
D6
D7

Use fluids to treat shock


D6
de-escalation

D1

D2

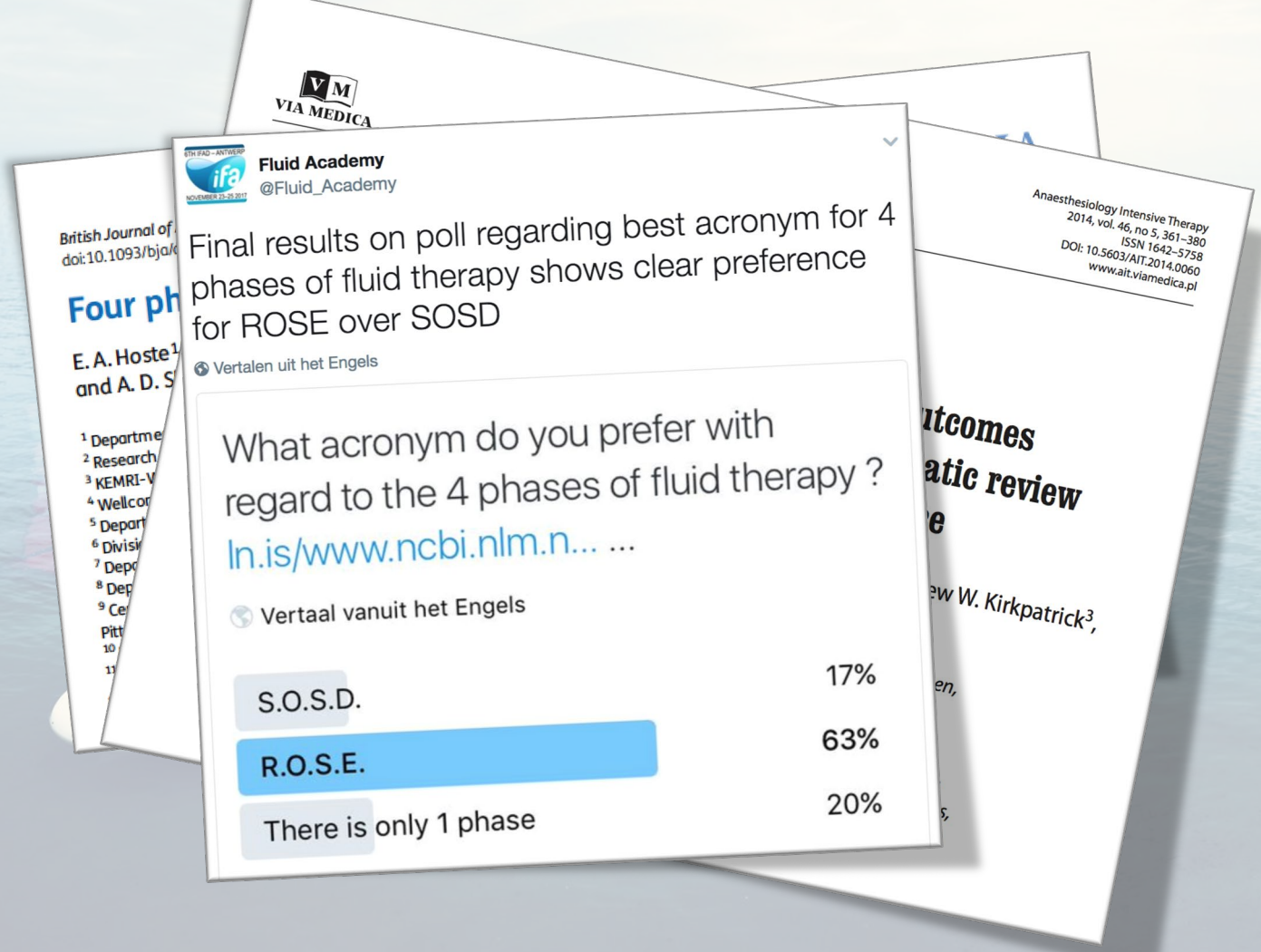
D3

D4

D5

D6

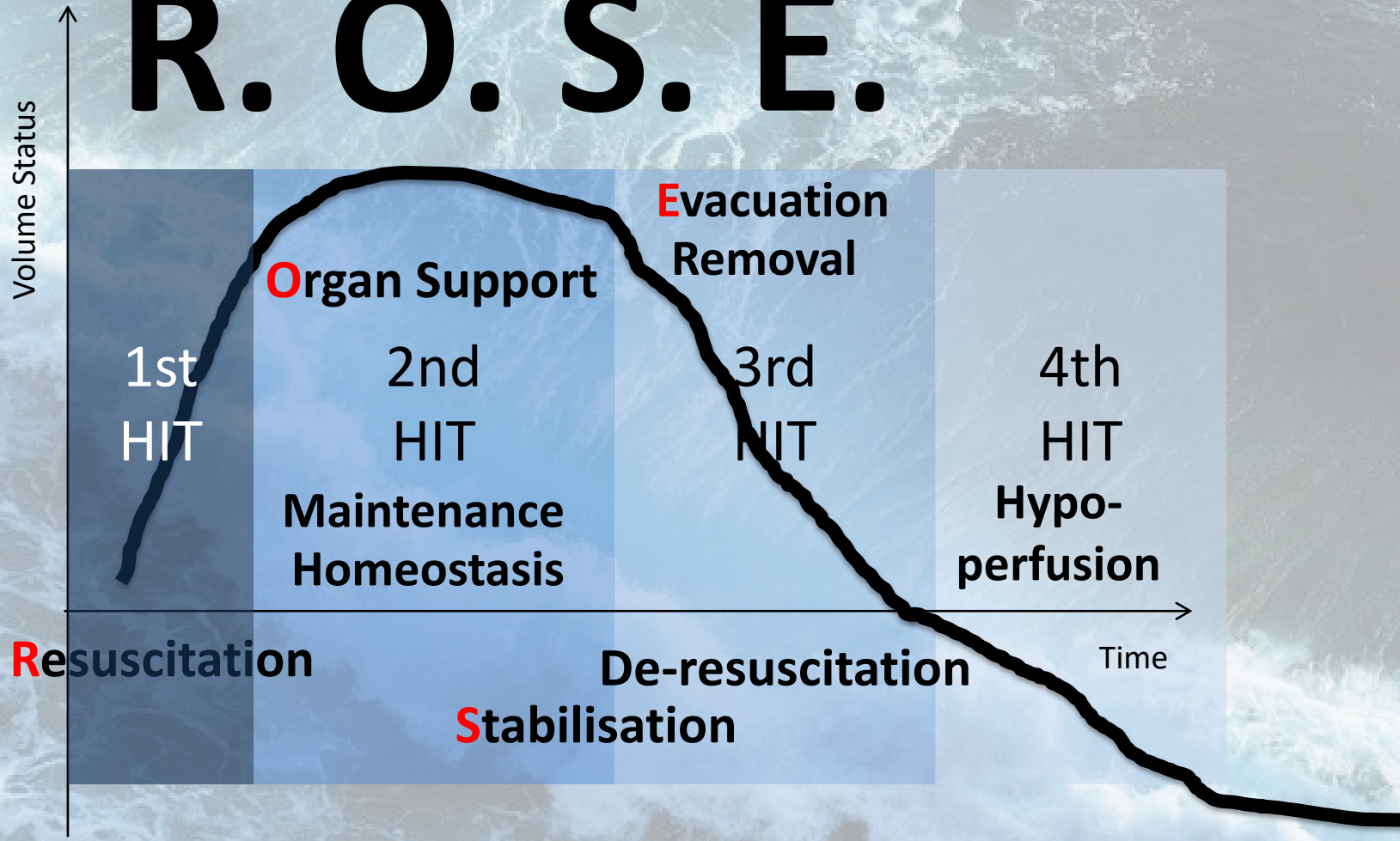
D7



The R.O.S.E.

D1
D2
D3
D4
D5
D6
D7

R. O. S. E.



D1
D2
D3
D
D
D
D7

R.O.S.E.

me Status

This is a DRY rose not a dead one

3rd

4th

Time

REVIEW ARTICLE

'ROSE concept' of fluid management: Relevance in neuroanaesthesia and neurocritical care

Joseph N. Monteiro, Shwetal U. Goraksha

Abstract

Fluid therapy in neurosurgical patients aims to restore intravascular volume, optimise haemodynamic parameters and maintain tissue perfusion, integrity and function. The goal is to minimise the risk of inadequate cerebral perfusion pressure and to maintain good neurosurgical conditions. However, fluid management in brain-injured patients has several distinctive features compared with non-brain-injured critically ill patients. The ROSE concept advocates the restriction of fluids, which is consistent with the prevention of a 'tight brain' in neurosurgery. Whether this imbalance in fluid management studies between different types of brain injuries is a reflection of differences in clinical relevance of fluid management not clear. Further randomised controlled trials in the future are essential in subarachnoid haemorrhage and traumatic brain injury patients who are critical and need long-term Intensive Care Unit stay to elucidate and define the role and relevance of the ROSE concept in neuroanaesthesia and neurocritical care.

Key words: De-resuscitation, fluid overload, resuscitation

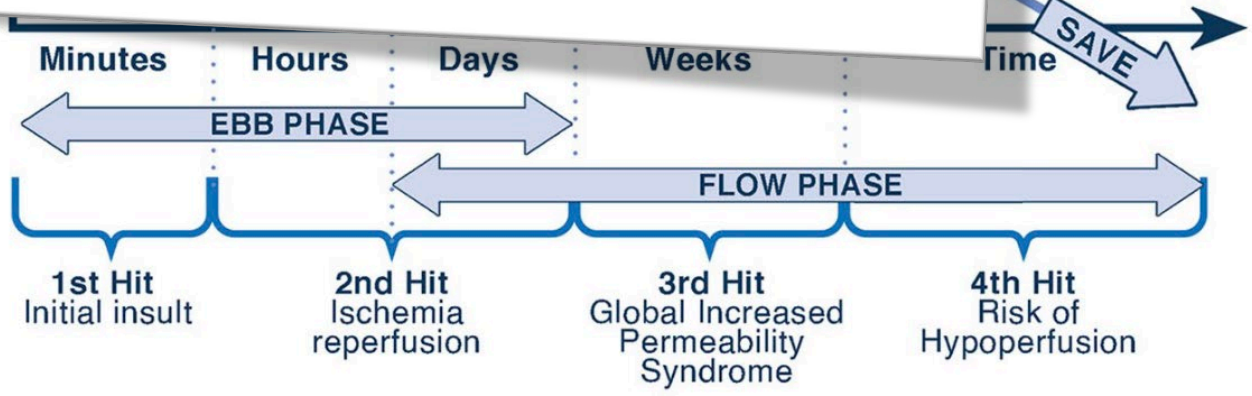
D1
D2
D3
D4
D5
D6
D7

Intensive Care Med
https://doi.org/10.1007/s00134-022-06761-7

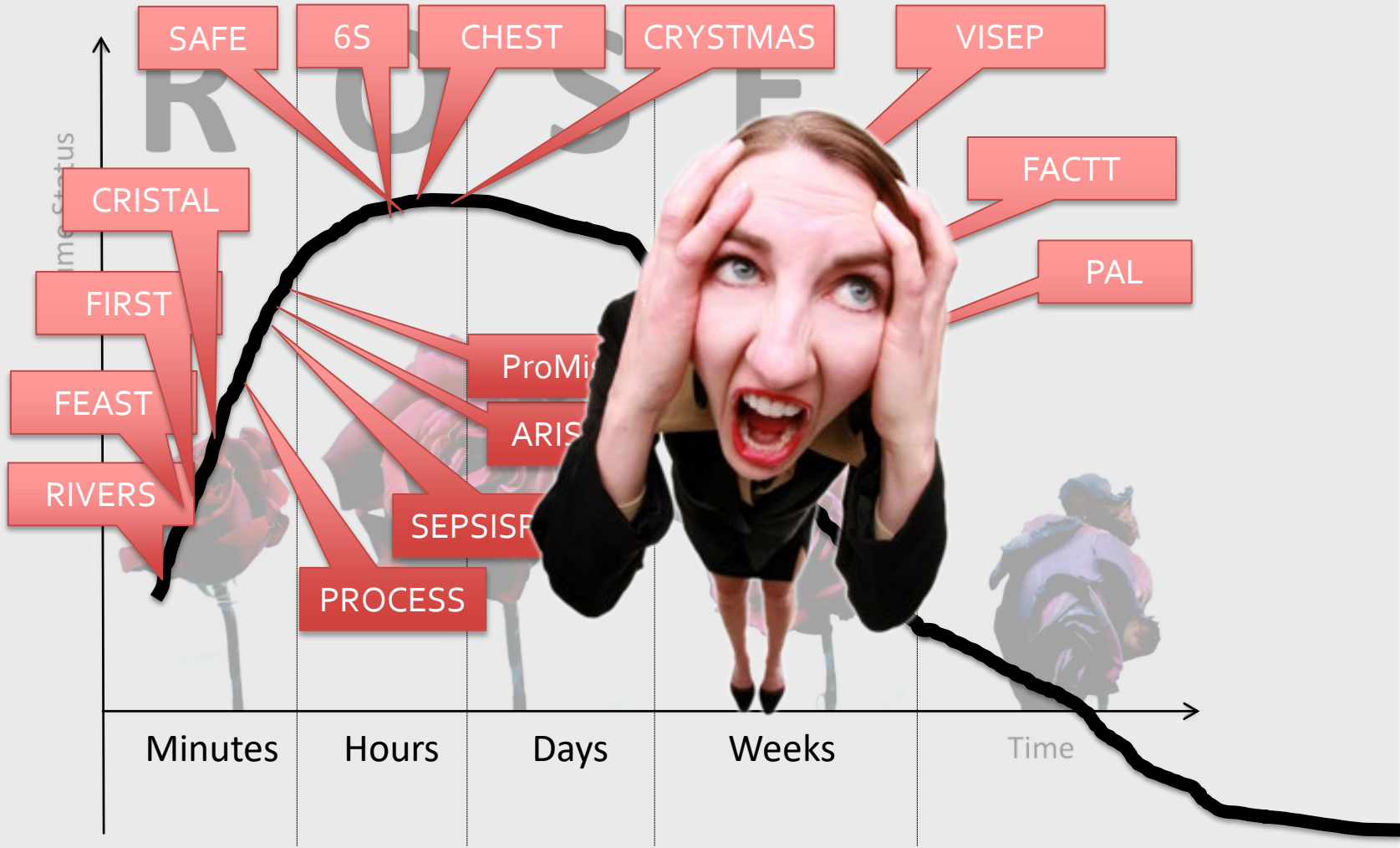
LASTING LEGACY IN INTENSIVE CARE MEDICINE

Everything you need to know about deresuscitation

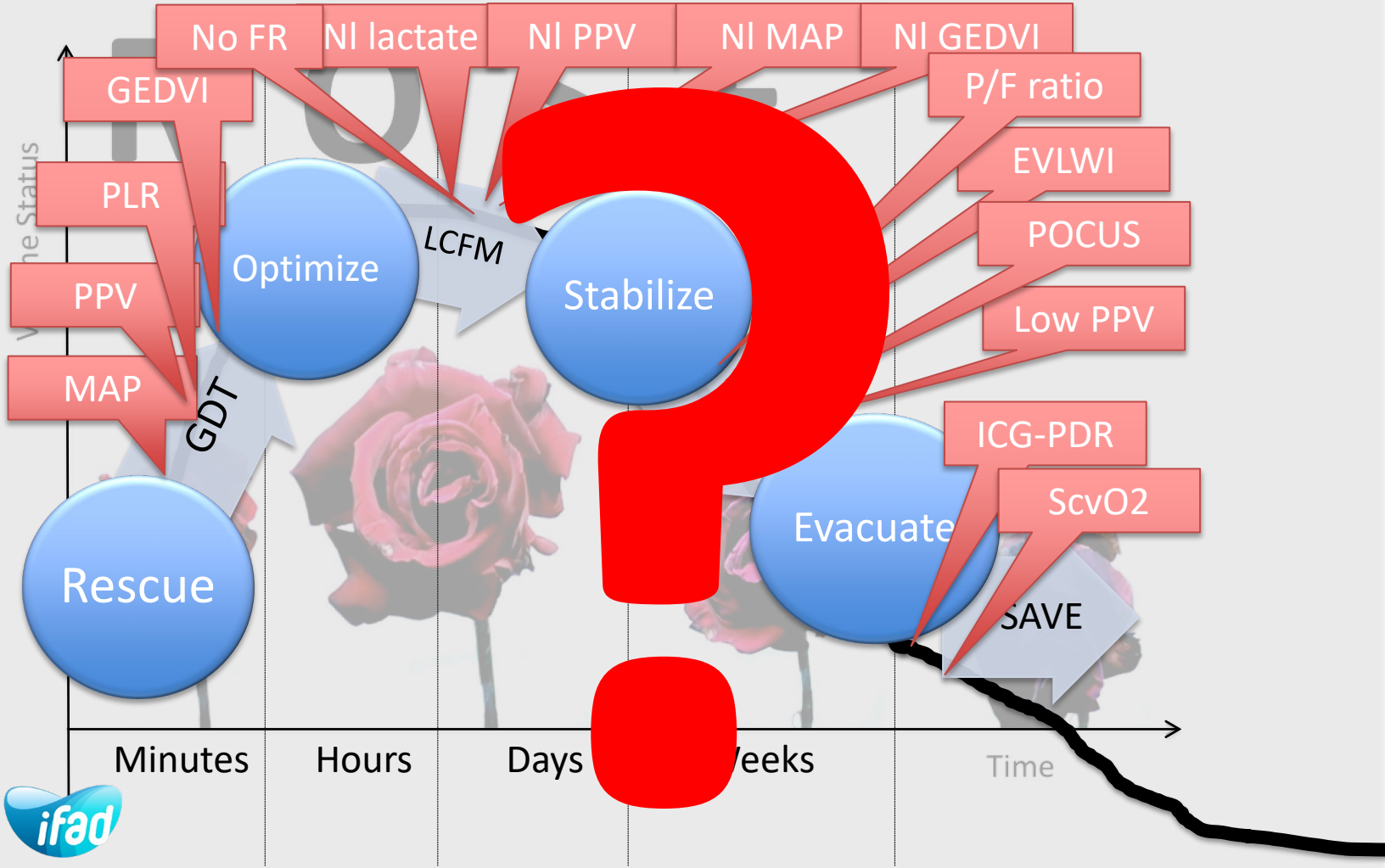
Manu L. N. G. Malbrain[1,2,3*], Greg Martin[4] and Marlies Ostermann[5]



D1
D2
D3
D4
D5
D6
D7



D1
D2
D3
D4
D5
D6
D7



D1
D2
D3
D4
D5
D6
D7

R Life saving **Resuscitation** phase with focus on **patient rescue** and early adequate fluid management (EAFM), eg 30ml/kg/1hr according to SSCG or a fluid challenge/bolus of 4ml/kg given in 5-10 minutes.

Triggers to start IV fluids: shock

- MAP < 65mmHg
- GEDVI < 640ml/m²
- (RVEDVI < 80ml/m²)#
- (CVP < 8mmHg)*
- (PAOP < 10mmHg)*
- CI < 2,5L/min/m²
- PPV or SVV > 12-15%
- PLR test positive
- Lactate > 3mmol/L (shock)
- IVCCI > 50%

O **Optimization** phase with focus on **organ rescue** (maintenance) and avoiding fluid overload (fluid creep). Aiming for neutral fluid balance.

Triggers to stop IV fluids: unresponsiveness

- MAP/APP > 65/55mmHg
- GEDVI 640-800ml/m²
- CI > 2,5 L/min/m²
- PPV or SVV < 12%
- PLR test negative
- Normal lactate < 2mmol/L
- LVEDAI 8-12cm²/m²
- IAP < 15mmHg

S **Stabilization** phase with focus on **organ support** (homeostasis). Late conservative fluid management (LCFM) is defined as two consecutive negative FB within 1st week after initial insult.

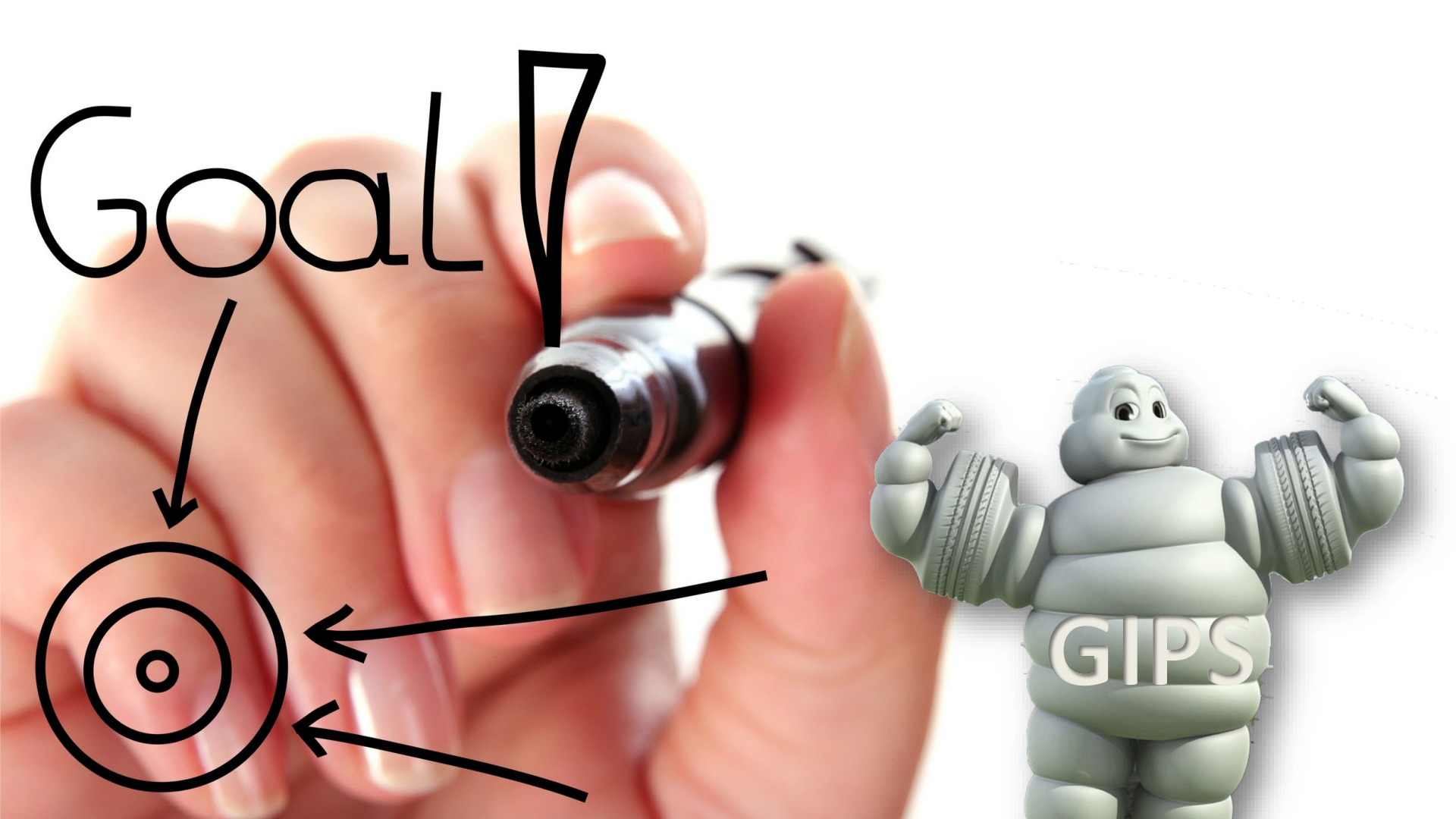
Triggers to start fluid removal: FAS/GIPS

- MAP/APP > 65/55mmHg
- GEDVI > 850ml/m²
- EVLWI > 10-12ml/kg PBW
- PVPI > 3 and PF ratio < 150
- PPV or SVV < 12%
- PLR test negative
- LVEDAI > 14cm²/m², high VExUS score
- IAP > 12-15mmHg
- COP < 16-18mmHg; CLI > 60
- BIA: ECW/ICW > 1; V_E > 5%

E **Evacuation** phase with focus on **organ recovery** and resolving fluid overload (in case of no flow state) with active late goal directed fluid removal (LGFR) and negative FB.

Triggers to stop fluid removal: hypoperfusion

- MAP/APP < 55/45mmHg**
- PPV or SVV > 15%
- PLR test positive
- Lactate > 2,5mmol/L
- S_vO_2 < 70-75%
- $S_{cv}O_2$ < 65-70%
- ICG PDR < 14-16%


Goal!
GIPS

D1
D2
D3
D4
D5
D6
D7

PERSISTENT POSITIVE CUMULATIVE FB

Volume Status

Time

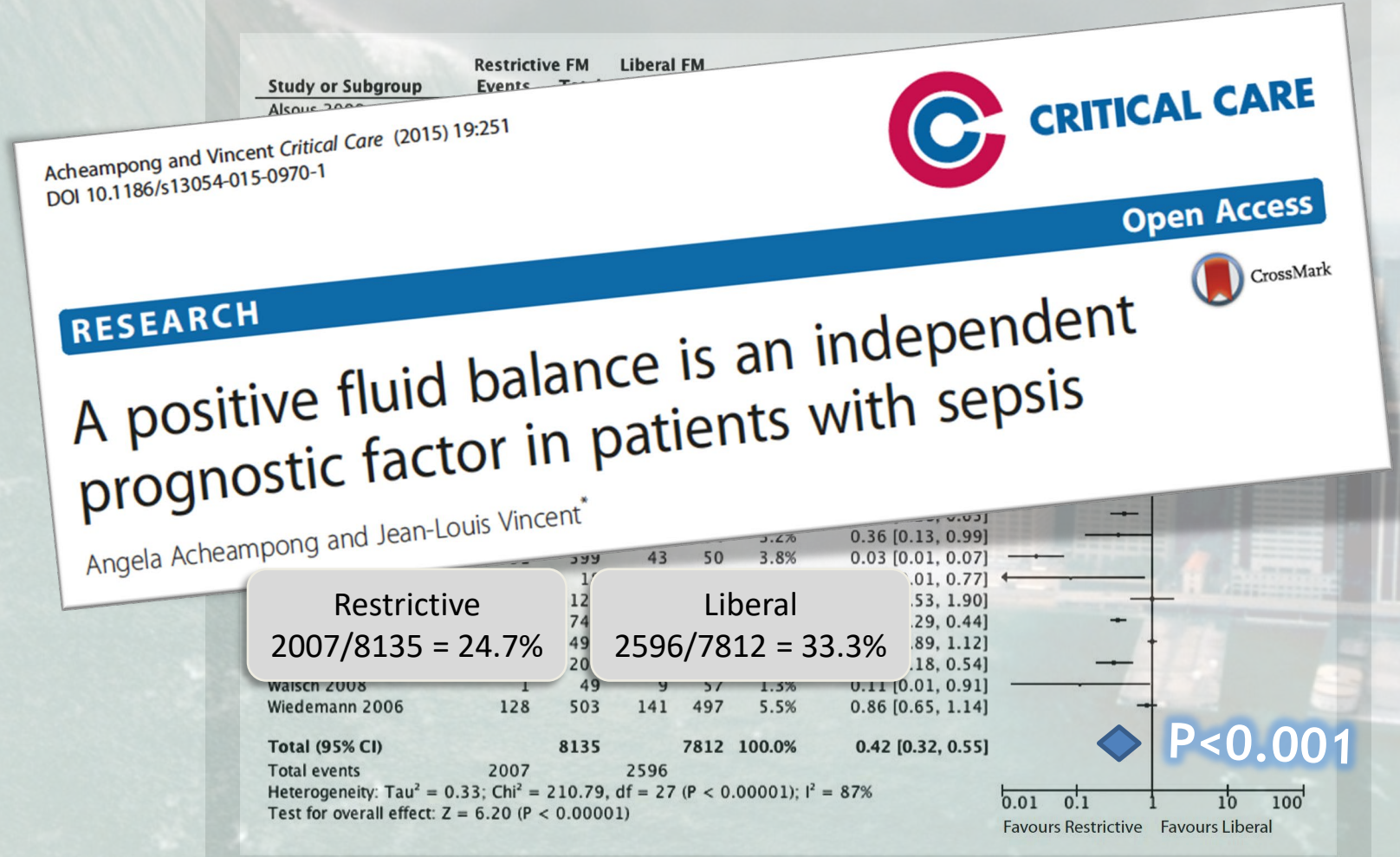
\+

ORGAN FAILURE

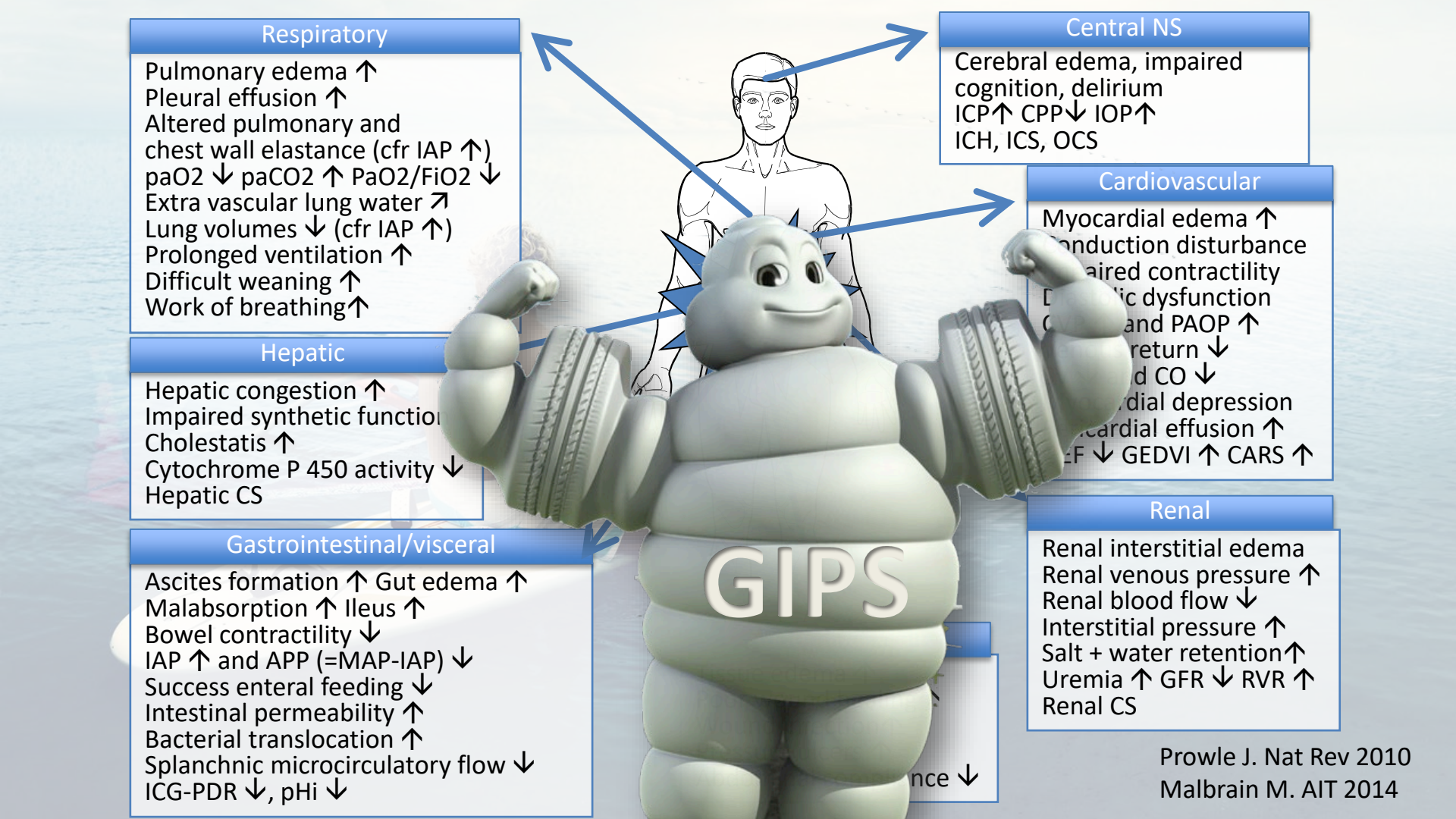
= GIPS

P/F – EVLWI – PVPI – IAP


Why?



Malbrain M., Marik P. et al. Anaesthesiol Intensive Ther 2014; 46(5): 361-380



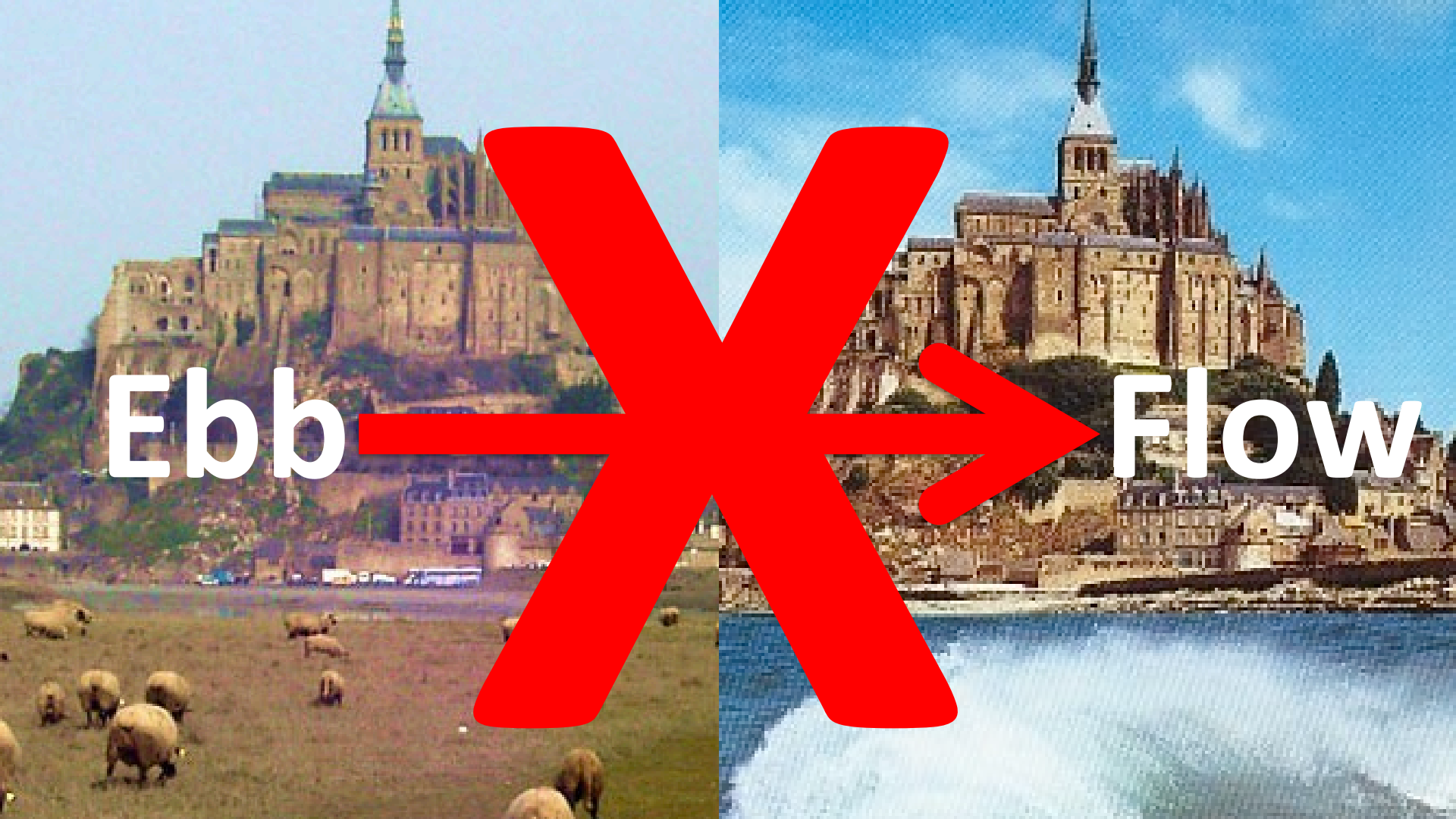
Prowle J. Nat Rev 2010
Malbrain M. AIT 2014

Anasarca is **NOT** Cosmetic

Anasarca is **BAD** medicine

D1
D2
D3
D4
D5
D6
D7

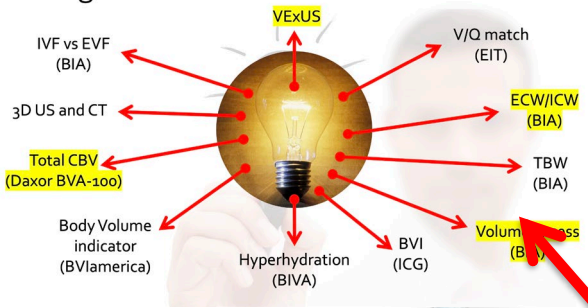
WHEN ?


Ebb
Flow

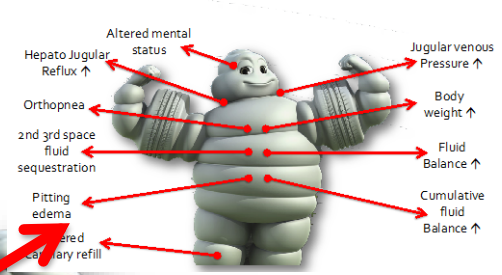

Persistent
GIPS

Assessment uid Overload

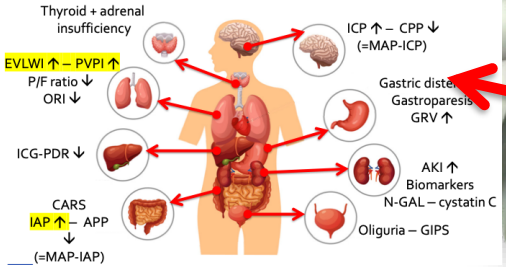
Bright Ideas Assessment Fluid Overload



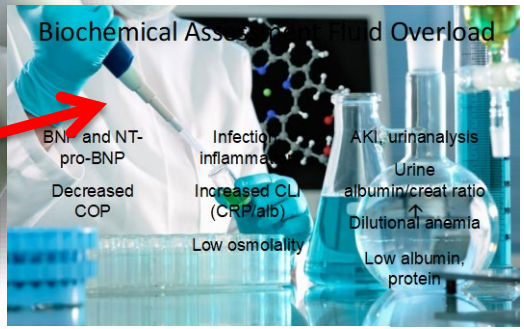
Clinical Assessment Fluid Overload



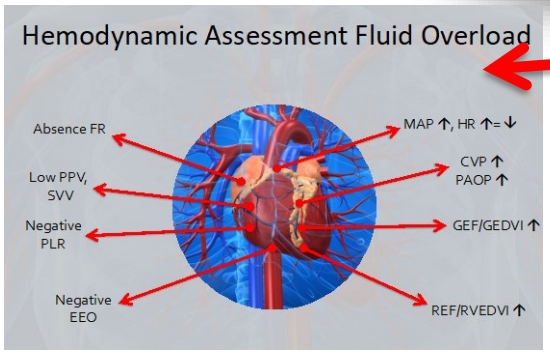
Organ Function Assessment Fluid Overload



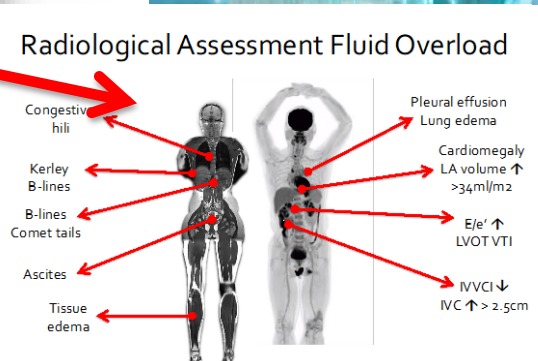
Biochemical Assessment Fluid Overload



Hemodynamic Assessment Fluid Overload

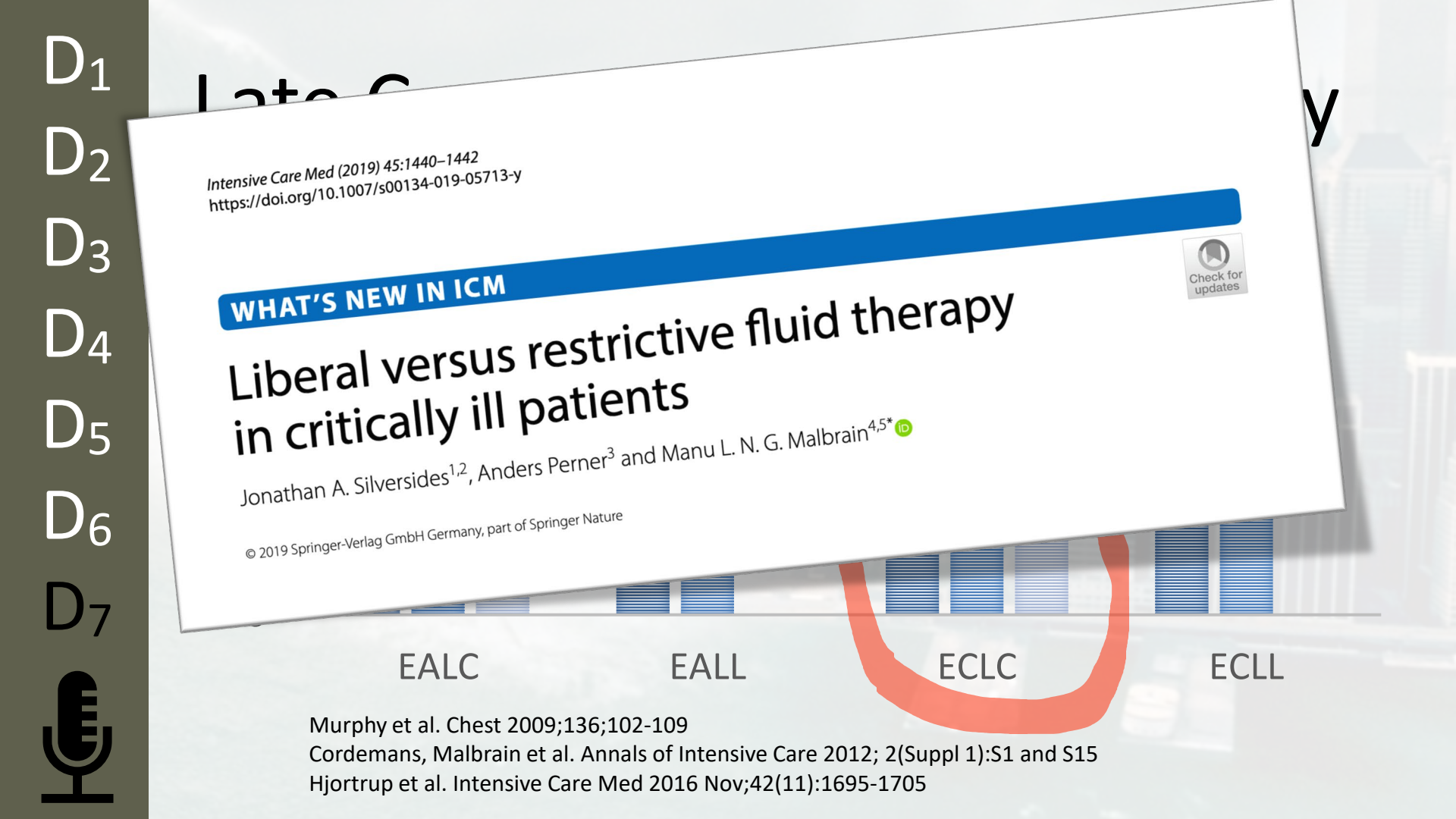


Radiological Assessment Fluid Overload




Very last
One more thing….

D1
D2
D3
D4
D5
D6
D7



Intensive Care Med (2019) 45:1440–1442
https://doi.org/10.1007/s00134-019-05713-y

WHAT'S NEW IN ICM

Liberal versus restrictive fluid therapy in critically ill patients

Jonathan A. Silversides[1,2], Anders Perner[3] and Manu L. N. G. Malbrain[4,5*]

Check for updates

EALC EALL ECLC ECLL

Murphy et al. Chest 2009;136;102-109
Cordemans, Malbrain et al. Annals of Intensive Care 2012; 2(Suppl 1):S1 and S15
Hjortrup et al. Intensive Care Med 2016 Nov;42(11):1695-1705

RELIEF: Restrictive versus Liberal Fluid Therapy for Major Abdominal Surgery

3000 patients undergoing major abdominal surgery with increased risk of complications

RANDOMISATON

Liberal arm
N=1,499

10 mL/Kg before surgery	8 mL/Kg/hr during surgery	1.5 mL/Kg after surgery

Restrictive arm
N=1,501

5mL/Kg before surgery	5 mL/Kg/hr during surgery	0.8 mL/Kg after surgery

Primary outcome

Secondary outcomes

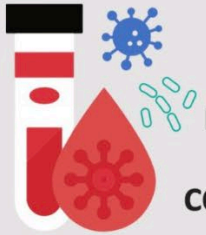
A restrictive fluid regimen did not improve disability free survival than a liberal fluid regimen and caused a higher rate of acute kidney injury.

Myles *et al* 2018 Jun 14;378(24):2263-2274

#NephJC

@Slatts_1

CLASSIC TRIAL – NEJM 2022



SEPTIC SHOCK: IN ICU PATIENTS WITH SEPTIC SHOCK, IS IV FLUID RESTRICTION ASSOCIATED WITH LESS HARM COMPARED TO STANDARD IV FLUID THERAPY?

STANDARD FLUID THERAPY

No upper limit set for amount of IV fluid administration

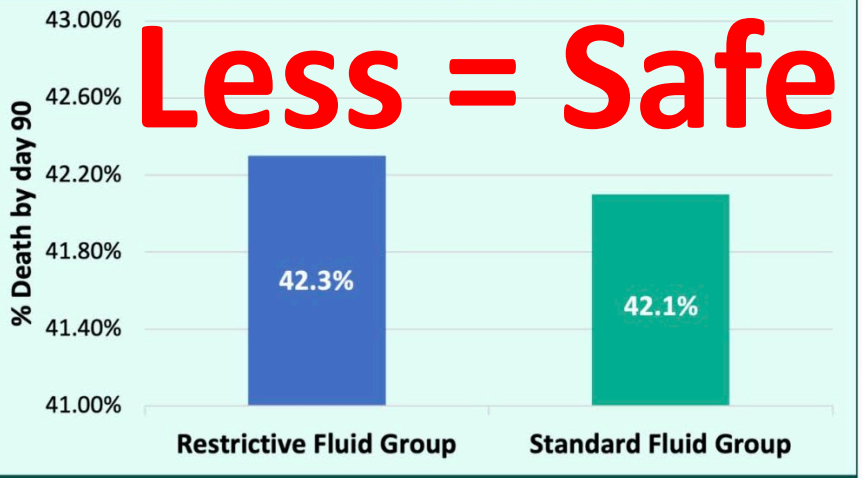
1545 patients at
to ICU with sept ck, with ons
within 12 hours prior to screeni

RESTRICTED FLUID THERAPY

IV fluid given only with lactate>4mmol, MAP<50mmHg, urine output <0.1mg/kg

PRIMARY END POINT

Death within 90 days after randomization



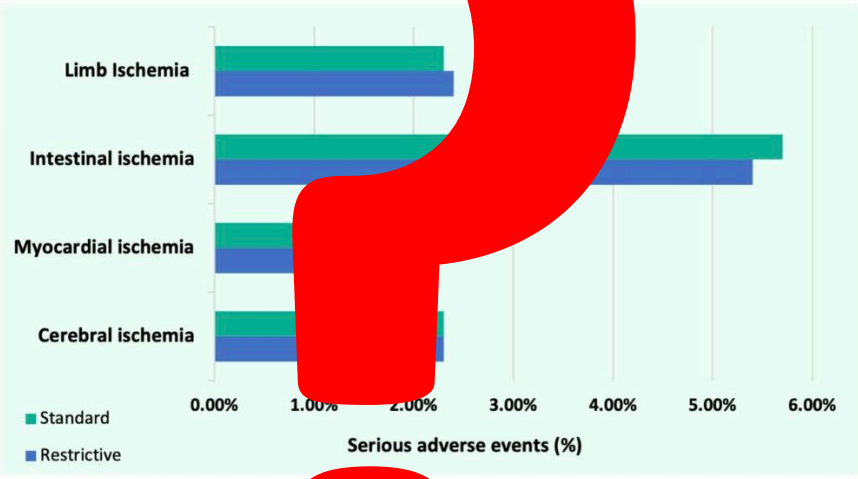
Less = Safe

Adjusted Absolute Difference

0.1

95% CI (-4.7 to 4.9)

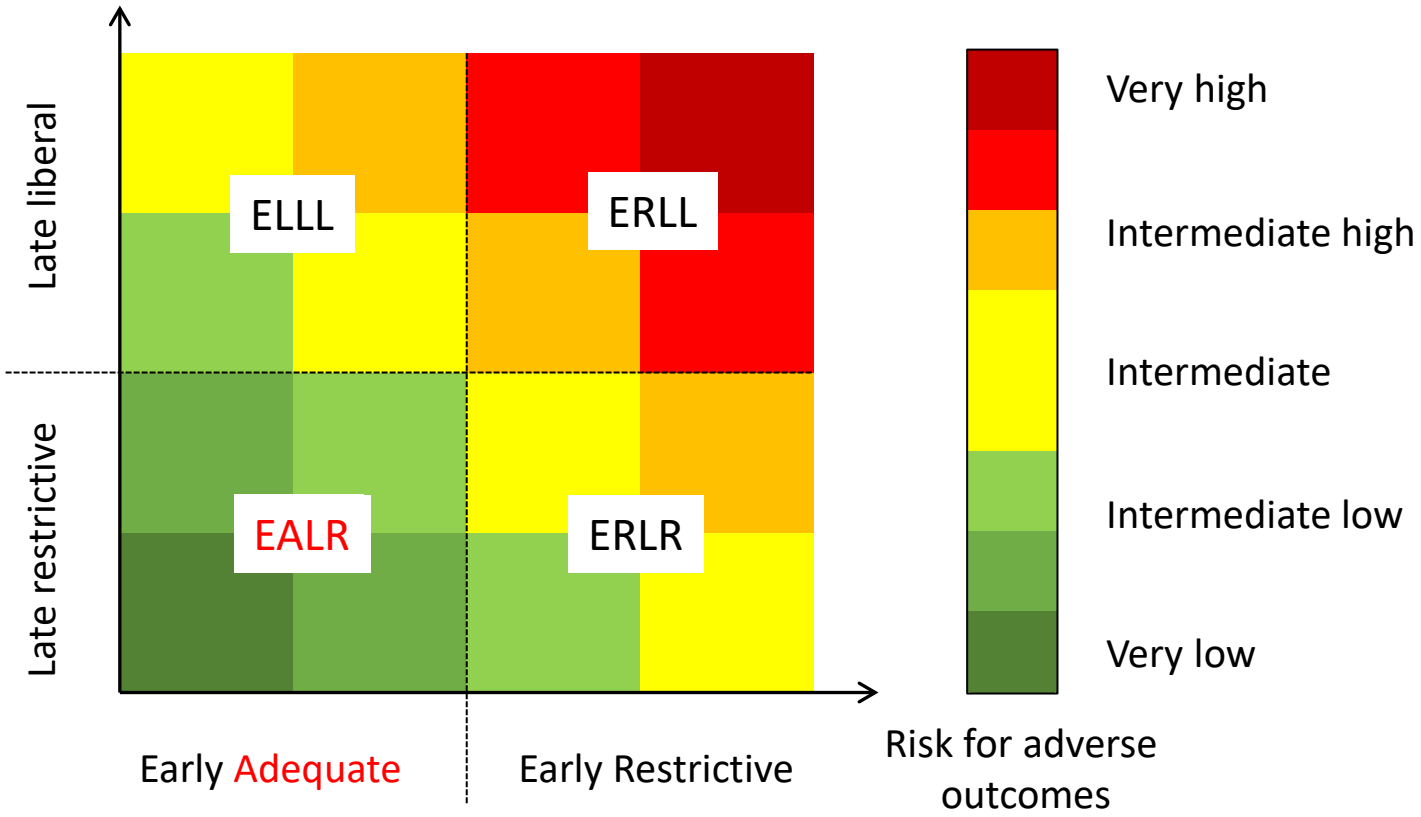
Adjusted absolute difference in percentage points between restrictive and standard fluid groups



One or more adve ccurred in **29.4%** of patients in t e-fluid group compared to **30.8%** s in the standard-fluid group, suggesting **no significant difference in outcomes** between these two groups.

D1
D2
D3
D4
D5
D6
D7

Risk for Adverse Outcomes




documentation D7

943%

Too much Na

60%

Too little K

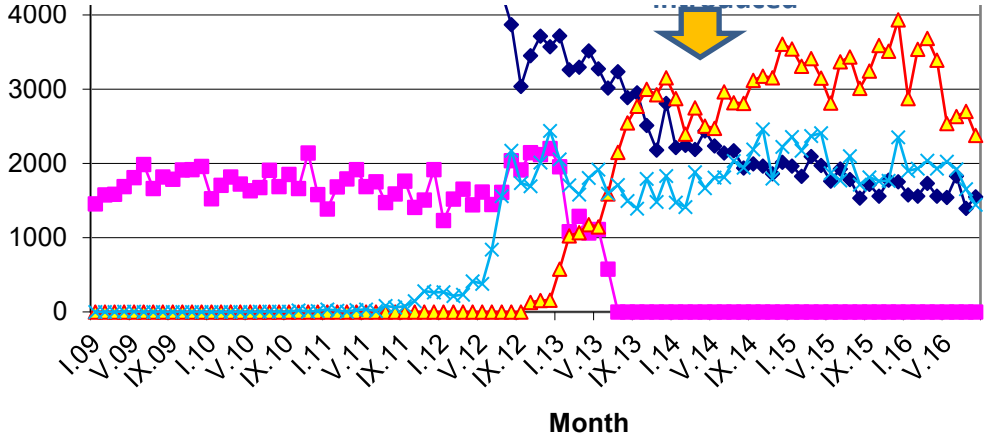

378%
32%
Too much Na
Too little K

D1
D2
D3
D4
D5
D6
D7

BMJ Open Quality

Introducing NICE guidelines for intravenous fluid therapy into a district general hospital

Marcia McDougall,[1] Bruce Guthrie ,[2] Arthur Doyle,[3] Alan Timmins,[4] Meghan Bateson,[5] Emily Ridley,[6] Gordon Drummond ,[7] Thenmalar Vadiveloo[8]



Plasmalyte substituted for Hartmanns in Jan 2013

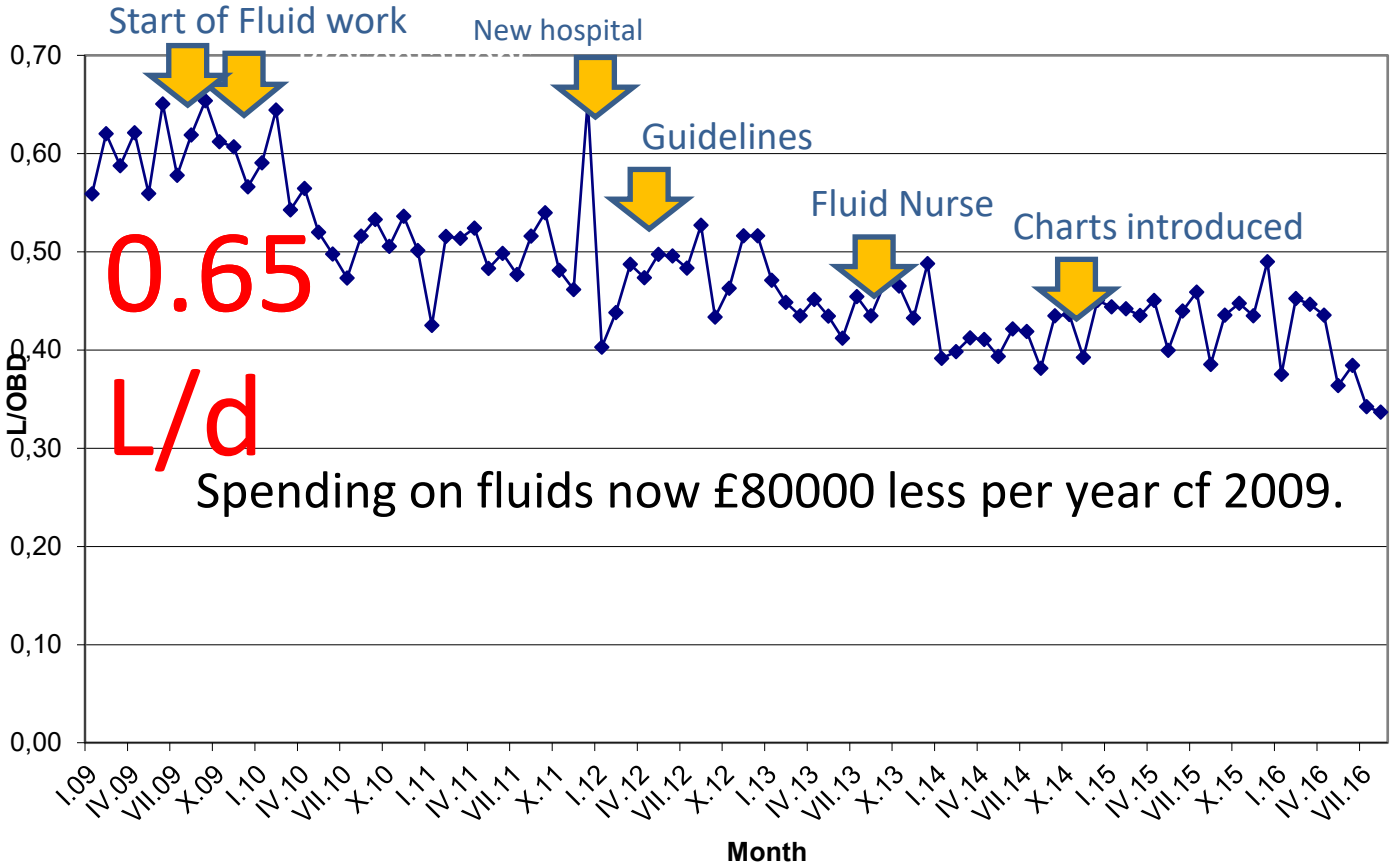
0.18%NaCl.4%Glucose with KCl is standard maintenance fluid.

Slide by courtesy of Marcia McDougall

D1
D2
D3
D4
D5
D6
D7

EXAMPLE

L/OBD = Litres/Occupied Bed Day



Slide by courtesy of Marcia McDougall

EXAMPLE

D1
D2
D3
D4
D5
D6
D7

Drop in IV Fluid use in Fife

5 L/stay → 3.7 L/stay

D1
D2
D3
D4
D5
D6
D7

Received: 30 August 2022 | Revised: 14 October 2022 | Accepted: 26 October 2022

DOI: 10.1111/aas.14176

RESEARCH ARTICLE

acta Anaesthesiologica Scandinavica

Issuing of isotonic crystalloid solutions to Danish public hospitals in 2021—A retrospective nationwide observational study

Karen Louise Ellekjaer | Anders Perner | Kathrine Bruun Svan | Morten Hylander Møller

D1
D2
D3
D4
D5
D6
D7

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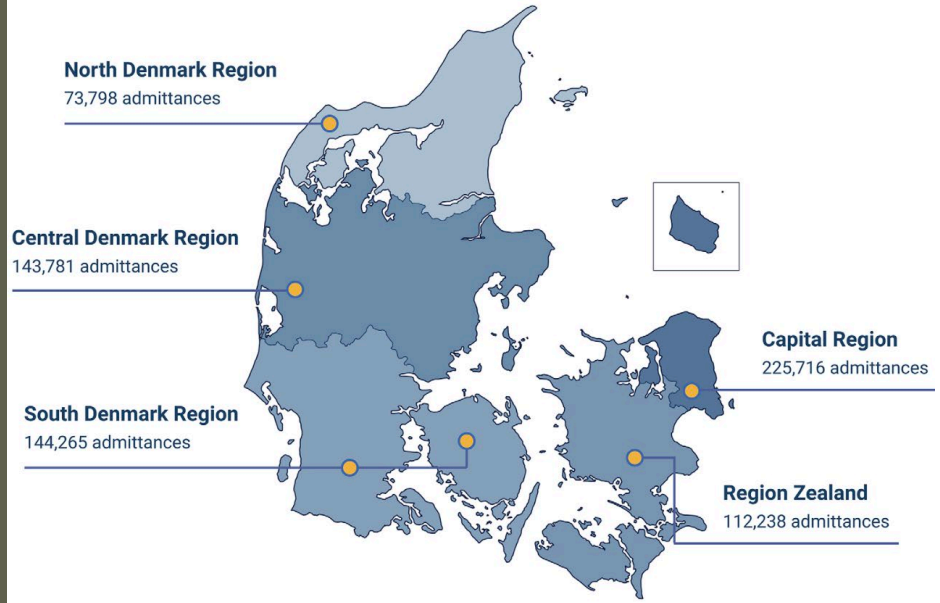
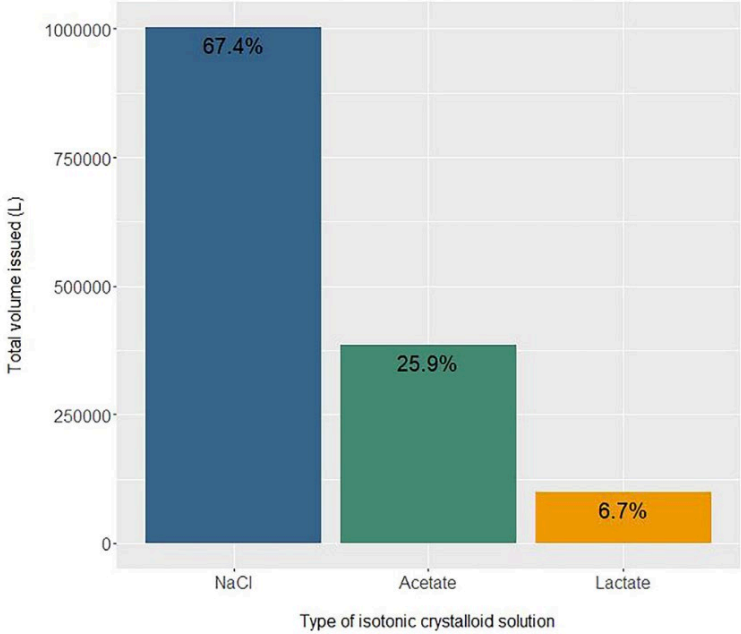
Karen Louise Ellekjaer | Anders Perner | Kathrine Bruun Svan | Morten Hylander Møller

The total amount = 1,487,144 L (67.4% saline, 25.9% acetate- and 6.7% lactate-buffered solutions)
2.1 L per hospitalised patient





D1
D2
D3
D4
D5
D6
D7

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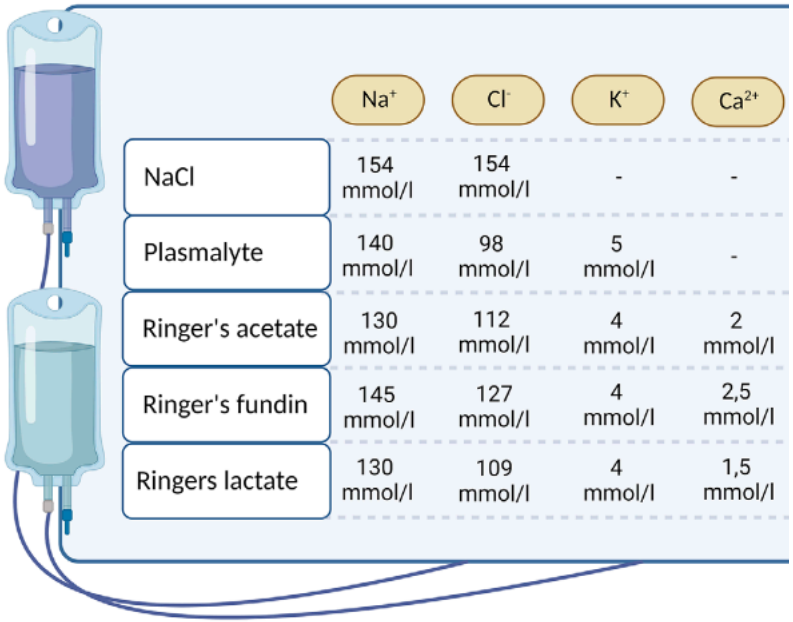
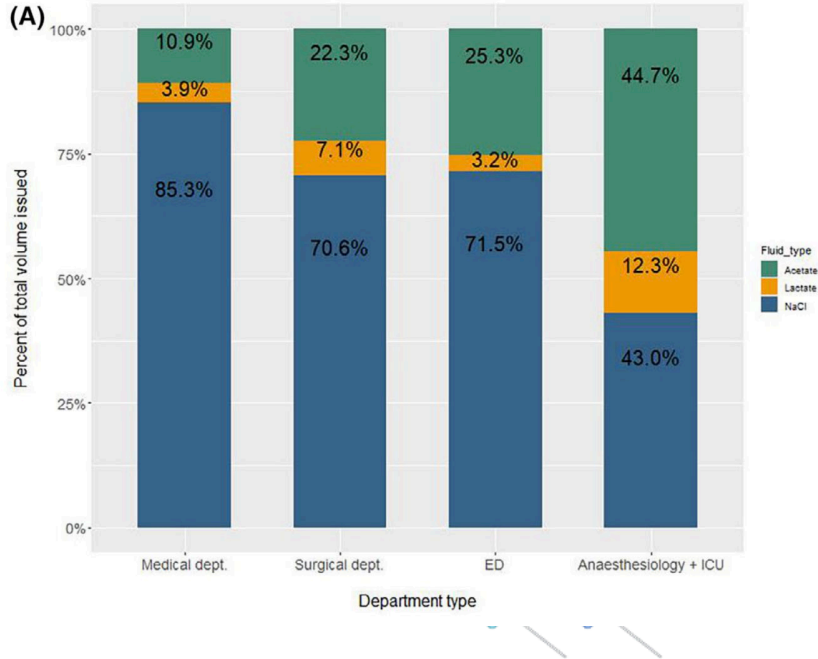
Medical departments used saline more frequently (85.3%) than emergency departments (71.5%), surgical departments (70.6%) and anaesthesiological departments including intensive care units (43.0%).



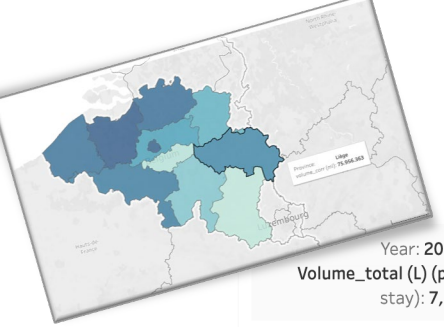
	Na^+	Cl^-	K^+	Ca^{2+}
NaCl	154 mmol/l	154 mmol/l	-	-
Plasmalyte	140 mmol/l	98 mmol/l	5 mmol/l	-
Ringer's acetate	130 mmol/l	112 mmol/l	4 mmol/l	2 mmol/l
Ringer's fundin	145 mmol/l	127 mmol/l	4 mmol/l	2,5 mmol/l
Ringers lactate	130 mmol/l	109 mmol/l	4 mmol/l	1,5 mmol/l



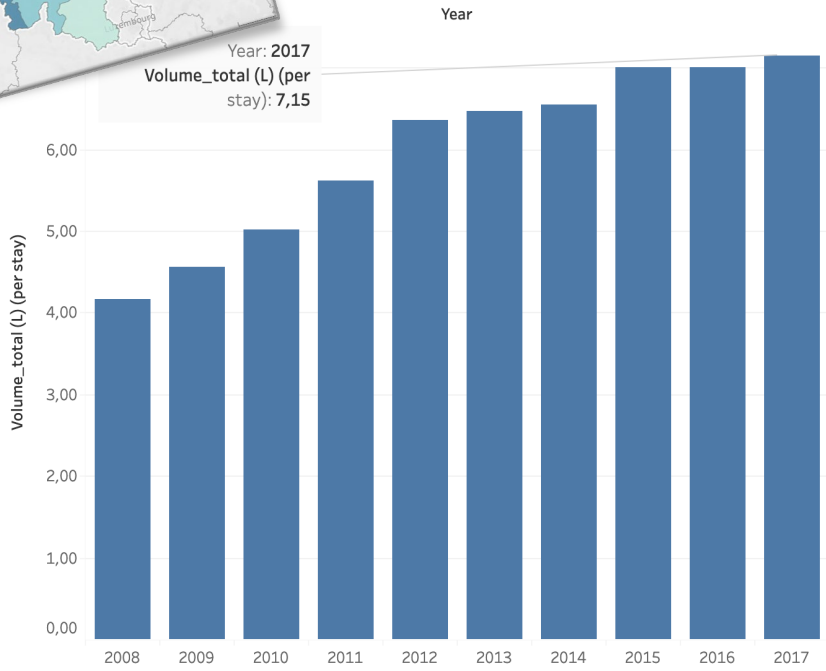
Example: Fl… …oard

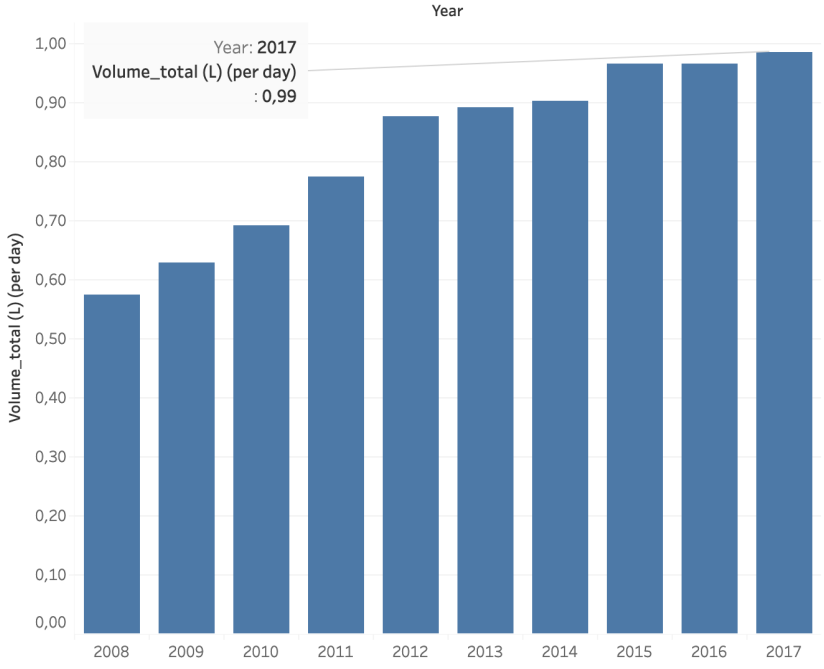
vocht_soort (maintenance, resuscit..	Volume_total (L) (per day)	Volume_total (L) (per stay)	Volume_total (ml)
Grand Total			14.272.276.784
Null	0,986	7,15	187.634.671
dilution	0,013	0,09	1.063.071.150
maintenance	0,073	0,53	3.014.702.900
medication	0,208	1,51	4.261.632.341
nutrition	0,294	2,14	553.711.365
resuscitation	0,038	0,28	5.191.524.357
	0,359	2,60	

MEDAMAN



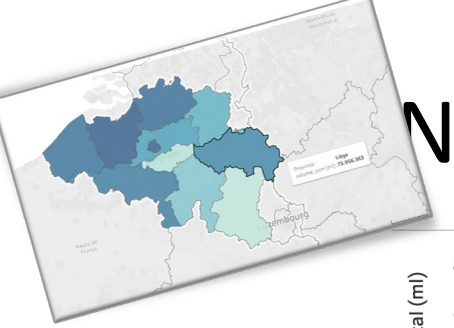
National data (Belgium)



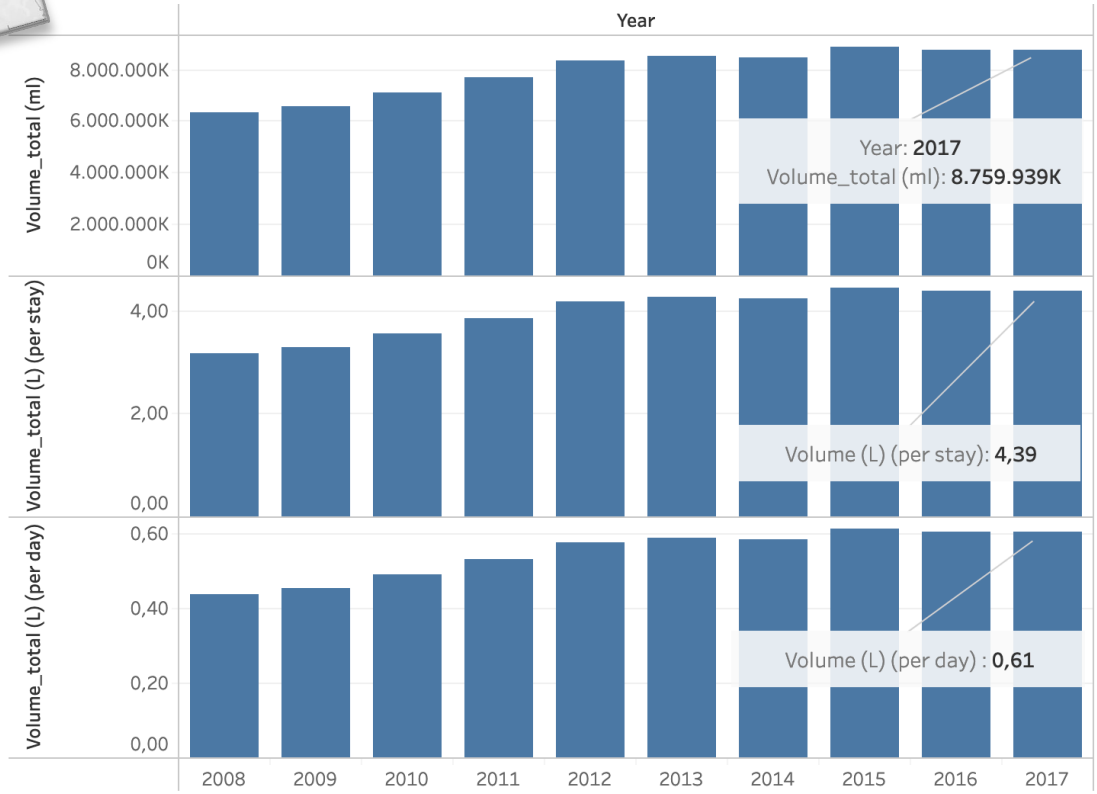


7.15 L/stay !!!

0.99 L/day !!!



National data (without medication)

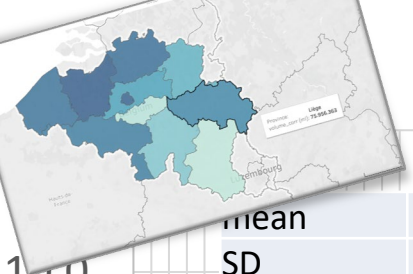


4.4 L/stay

0.6 L/day

EXAMPLE

Litres of IV infusion per hospital admission



mean	6,51
SD	1,27
median	6,31
Min	4,30
Q1	5,75
Q3	6,98
Max	11,17

MEDAMAN.

Ziekenhuis

Spec. All

Vpe All

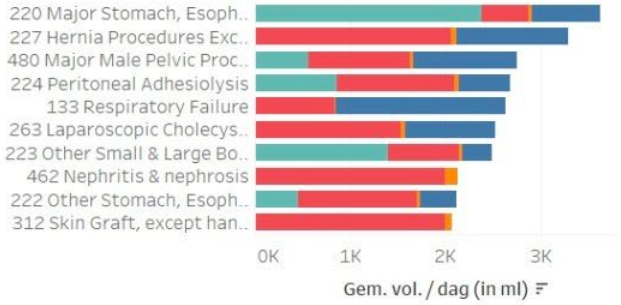
Gem. vol / verblijf (in liter) 3,6

Gem. vol / dag (in liter) 0,39

Non-glucose / other (ratio) 1,1

Glucose: isotone / hypotone (ratio) 0,8

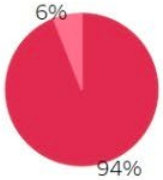
	Gem. vol. / dag	Gem. vol / verblijf
MAIN	0,975	0,9000
MED	0,468	0,4320
RES	1,209	1,1160
TPN	1,248	1,1520



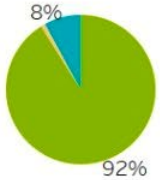
	Gem. vol / verblijf	Gem. vol. / dag
BAL	7.133	301
COLL	613	134
HYPO	3.898	864
ISO	7.500	980
NACL	1.257	352

	Gem. vol. / dag	Gem. vol / verblijf
PLASMALYTE A	1.971	5.510
GLUCOSE 5 %	1.027	3.421
SMOFKABIVEN	1.010	7.360
GLUCOSE 5 % + NA..	980	7.500
GLUCOSE 10 %	980	1.902
KABIVEN PERI	708	2.365
GLUCION 10 %	682	4.115
NACL 0,9 %	352	1.257
PARACETAMOL FR..	306	920
NATRIUMBICARBO..	168	200
TETRASPAN 6 %	138	630
CIPROFLOXACINE F..	133	233
STABIELE GEPAST..	98	1.120
GLUCOSE 20 %	76	1.750
FLUCONAZOLE B B..	65	1.450

Maintenance



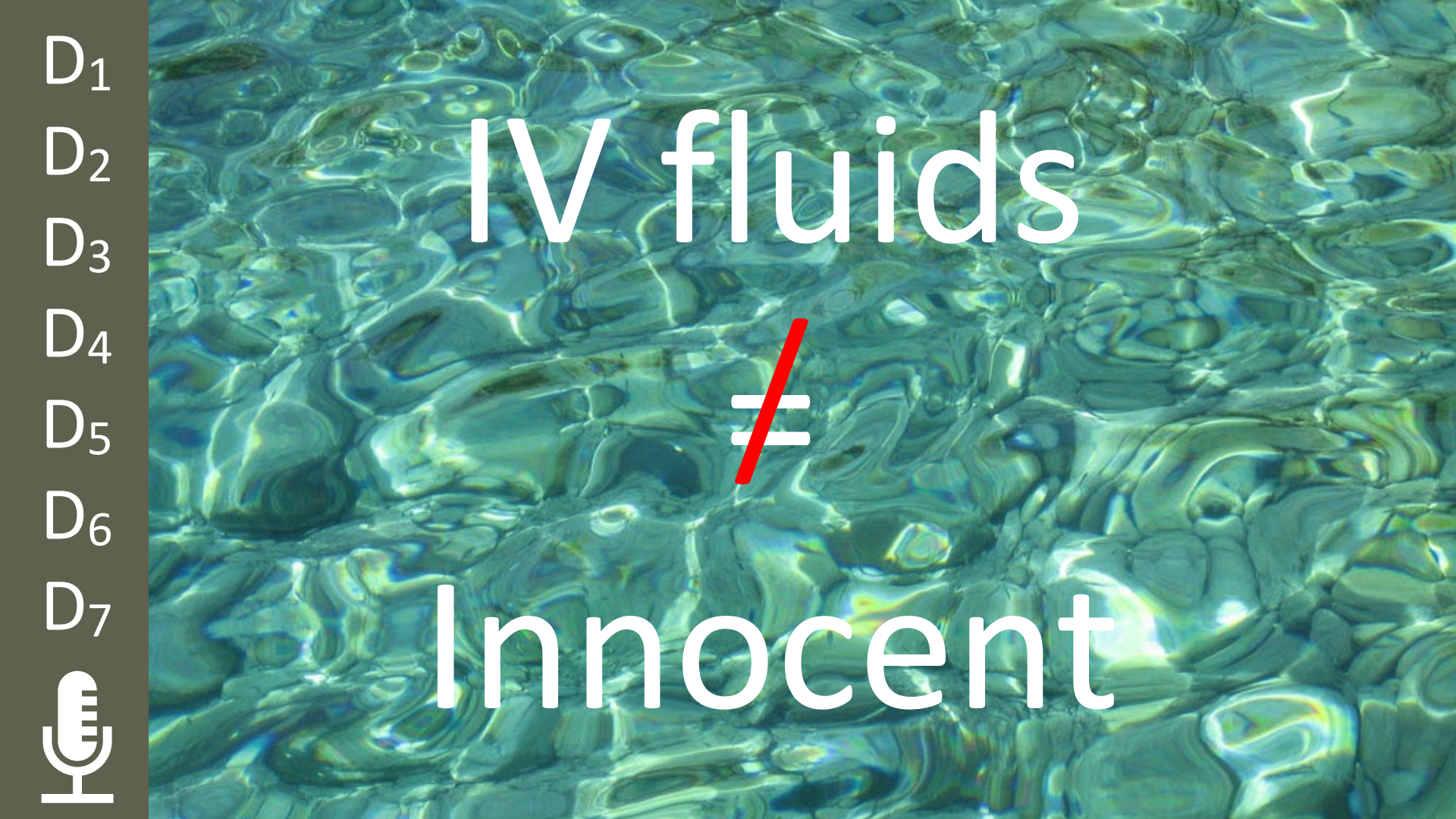
Resuscitation

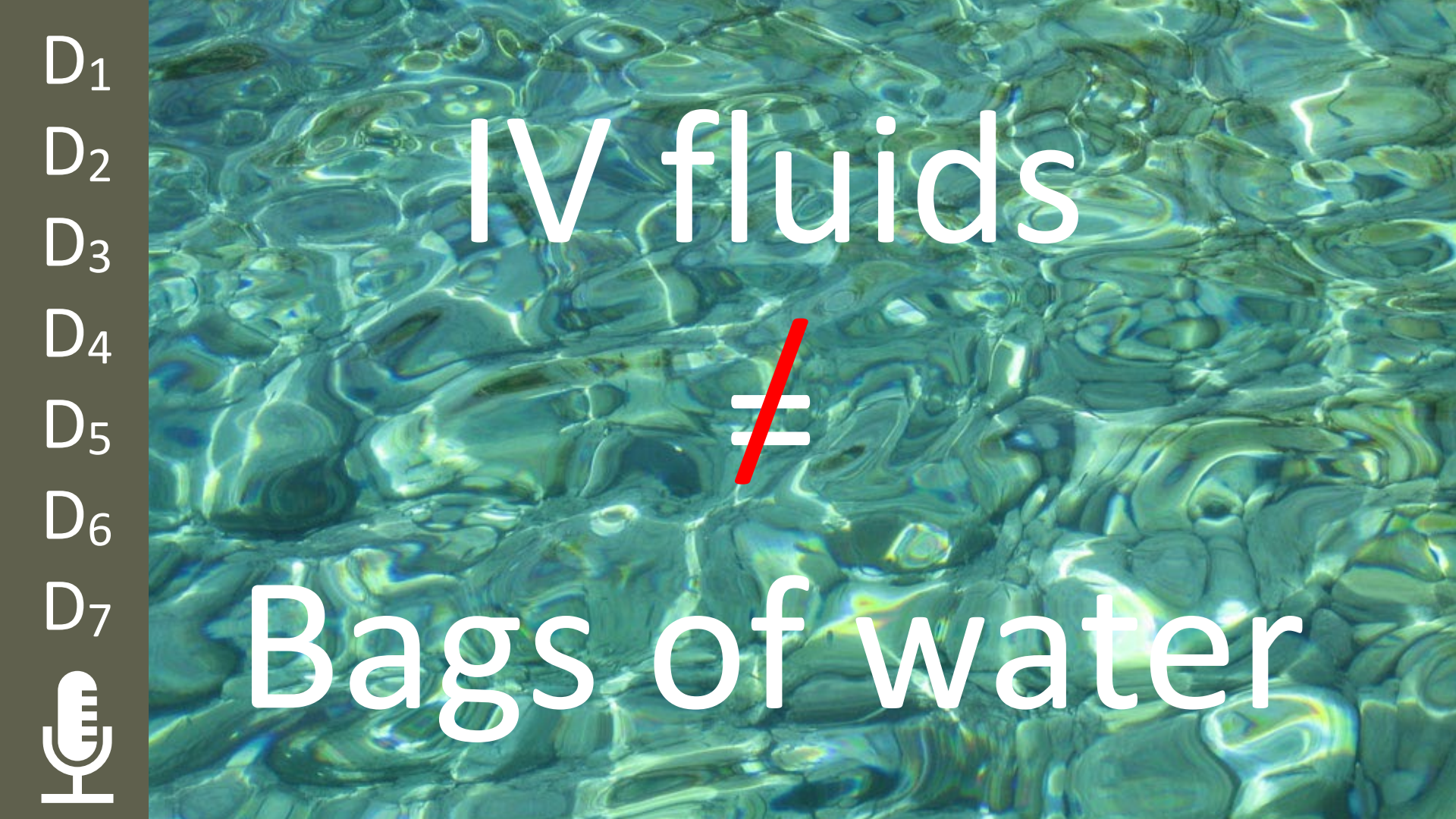


MAIN MED RES TPN

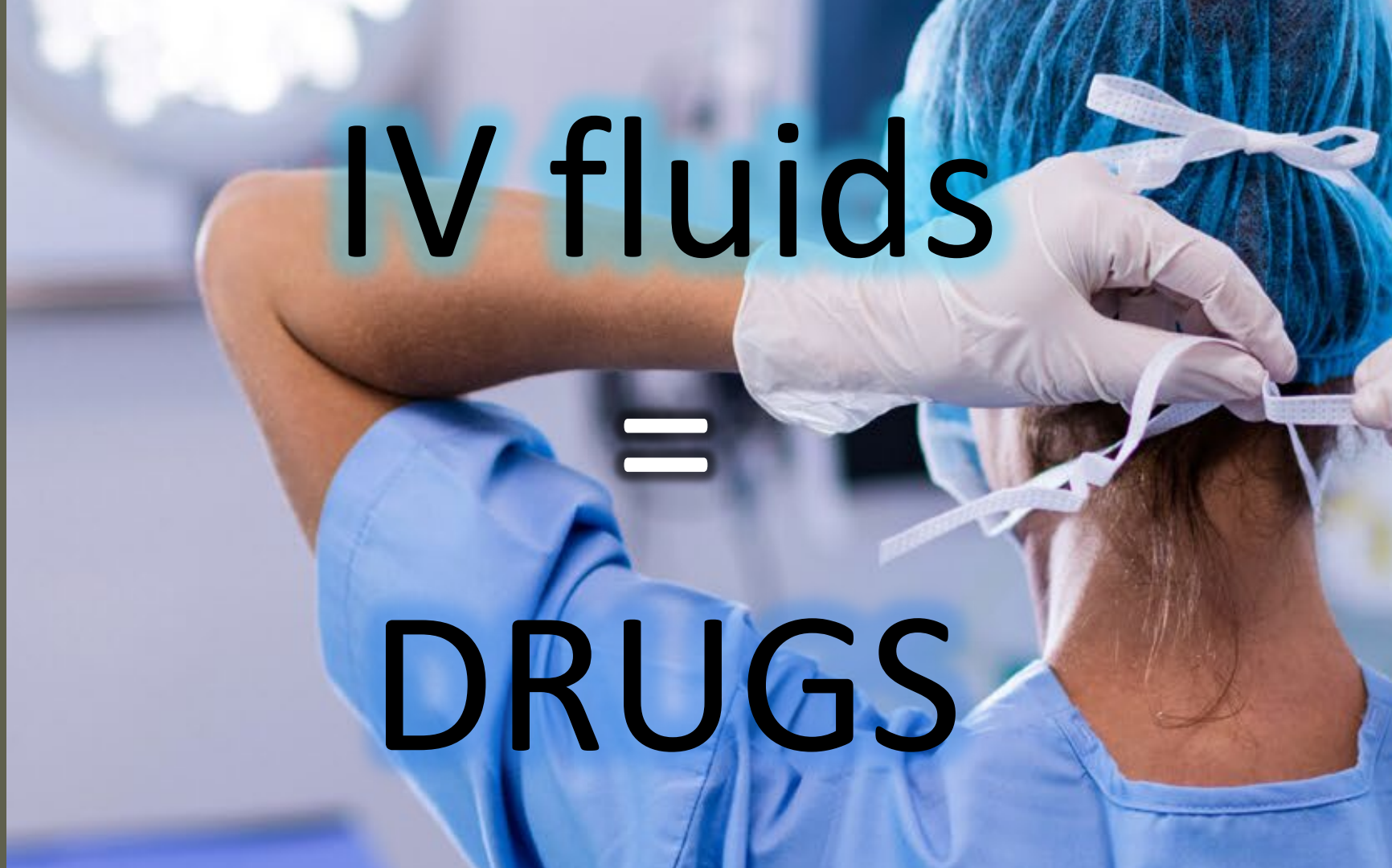
BAL COLL HYPO ISO NACL

Wrap it up


D1
D2
D3
D4
D5
D6
D7
IV fluids
≠
Innocent


D1
D2
D3
D4
D5
D6
D7
IV fluids
≠
Bags of water

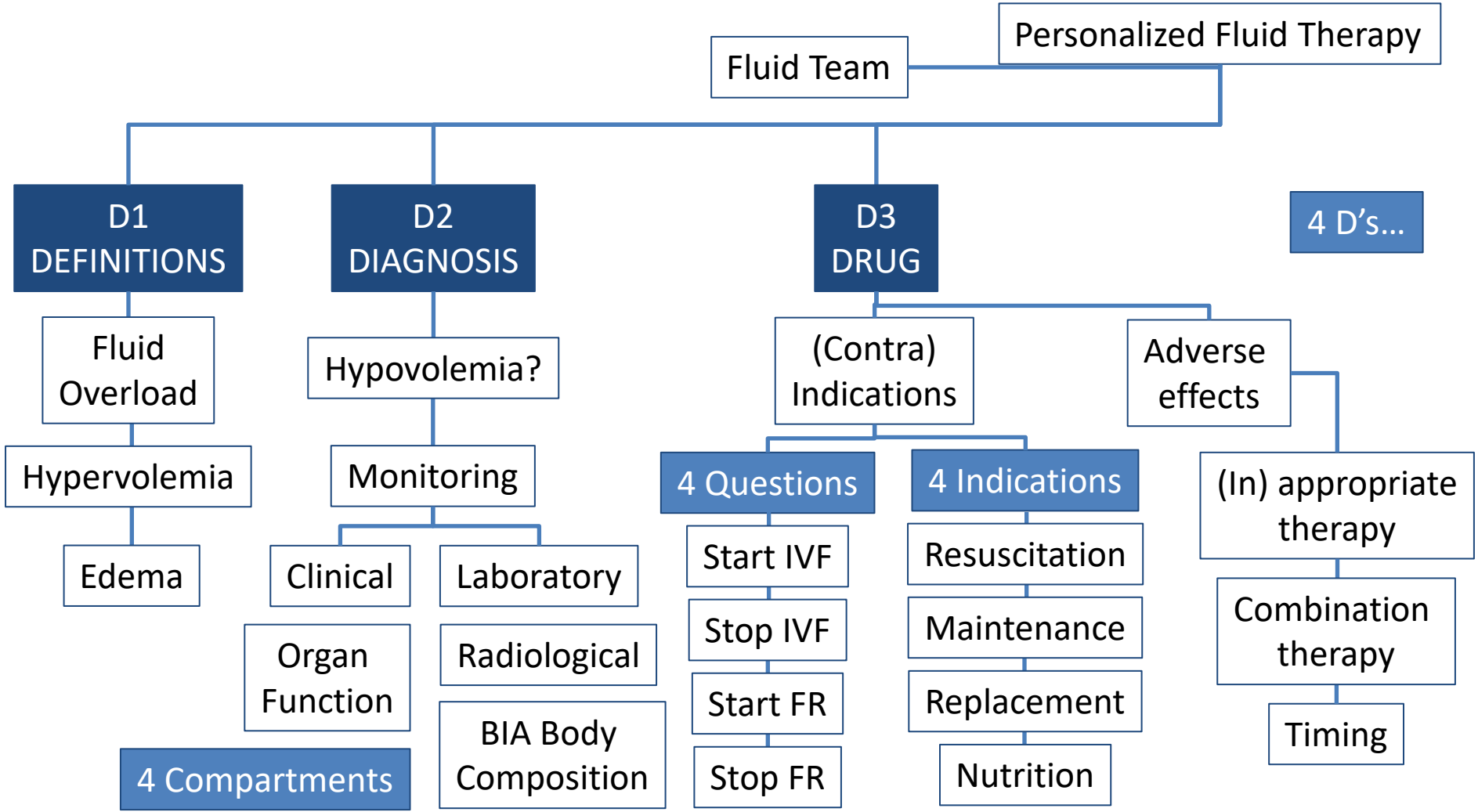
D1
D2
D3
D4
D5
D6
D7

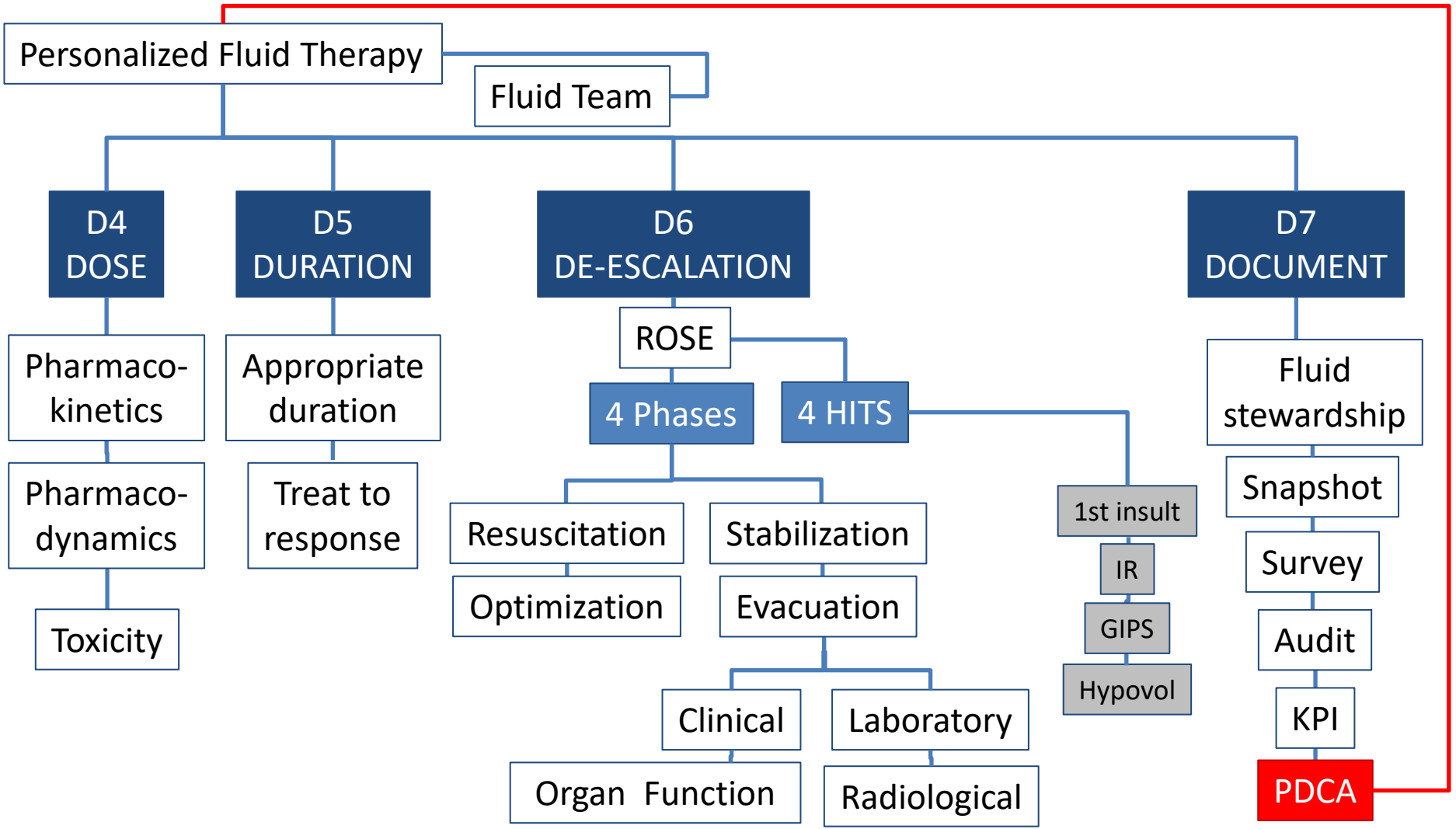


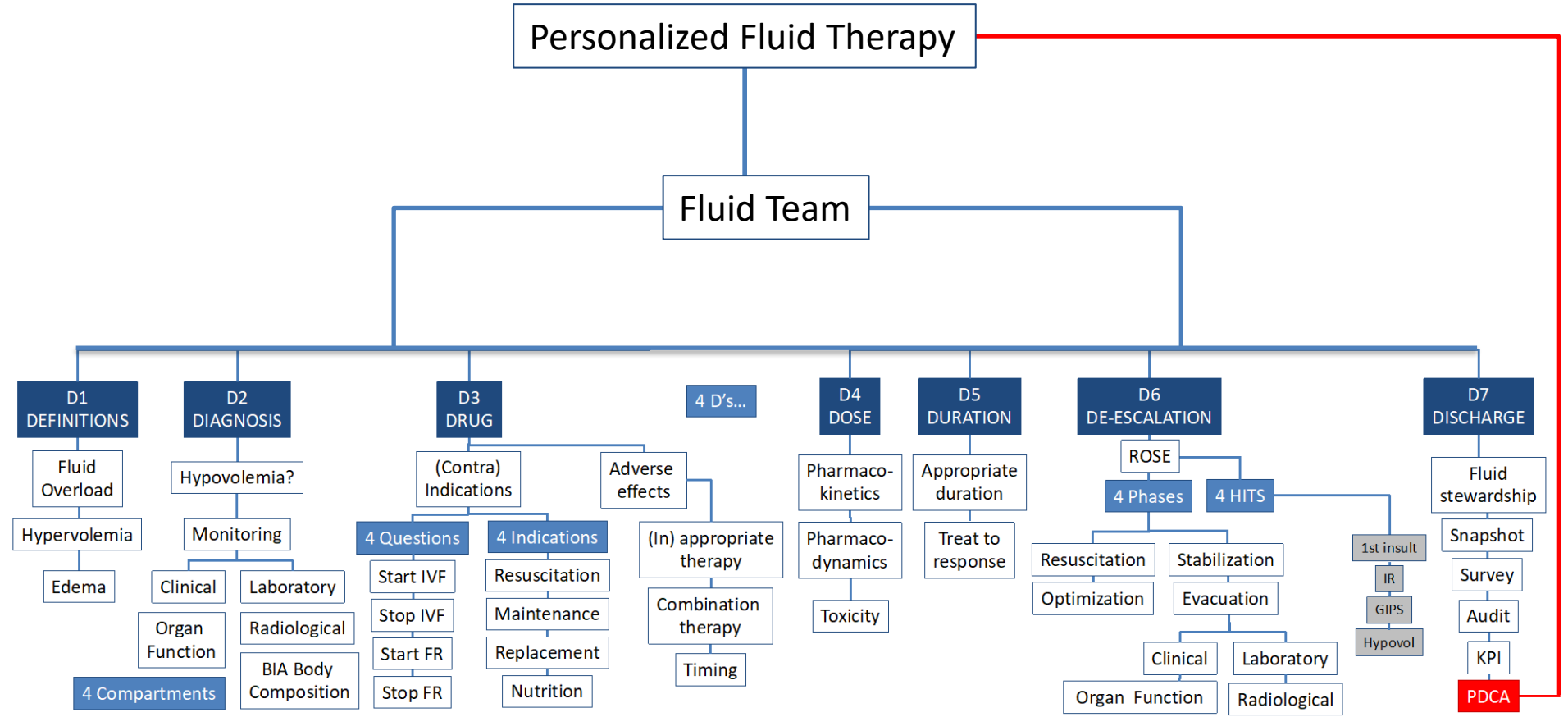
IV fluids

=

DRUGS


Personalized Fluid Therapy
Fluid Team
D1 DEFINITIONS
D2 DIAGNOSIS
D3 DRUG
4 D's…
Fluid Overload
Hypervolemia
Edema
Hypovolemia?
Monitoring
Clinical
Laboratory
Organ Function
Radiological
4 Compartments
BIA Body Composition
(Contra) Indications
Adverse effects
4 Questions
4 Indications
Start IVF
Stop IVF
Start FR
Stop FR
Resuscitation
Maintenance
Replacement
Nutrition
(In) appropriate therapy
Combination therapy
Timing


Personalized Fluid Therapy
Fluid Team
D4 DOSE
D5 DURATION
D6 DE-ESCALATION
D7 DOCUMENT
Pharmaco-kinetics
Pharmaco-dynamics
Toxicity
Appropriate duration
Treat to response
ROSE
4 Phases
4 HITS
Resuscitation
Optimization
Stabilization
Evacuation
Clinical
Laboratory
Organ Function
Radiological
1st insult
IR
GIPS
Hypovol
Fluid stewardship
Snapshot
Survey
Audit
KPI
PDCA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D1 DEFINITIONS
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4 Compartments
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Start IVF
Stop IVF
Start FR
Stop FR
4 Indications
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Maintenance
Replacement
Nutrition
Adverse effects
(In) appropriate therapy
Combination therapy
Timing
4 D's...
D4 DOSE
Pharmaco-kinetics
Pharmaco-dynamics
Toxicity
D5 DURATION
Appropriate duration
Treat to response
D6 DE-ESCALATION
ROSE
4 Phases
Resuscitation
Optimization
Stabilization
Evacuation
Clinical
Laboratory
Organ Function
Radiological
4 HITS
1st insult
IR
GIPS
Hypovol
D7 DISCHARGE
Fluid stewardship
Snapshot
Survey
Audit
KPI
PDCA

D1
D2
D3
D4
D5
D6
D7

Start Fluid STEWARDSHIP Now!

Audit

Survey nurses

Survey doctors

Snapshot of fluid consumption

Provide feed ck, define KP

Flyers, scree

Stew us

… an invitation to join the International Fluid Academy

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