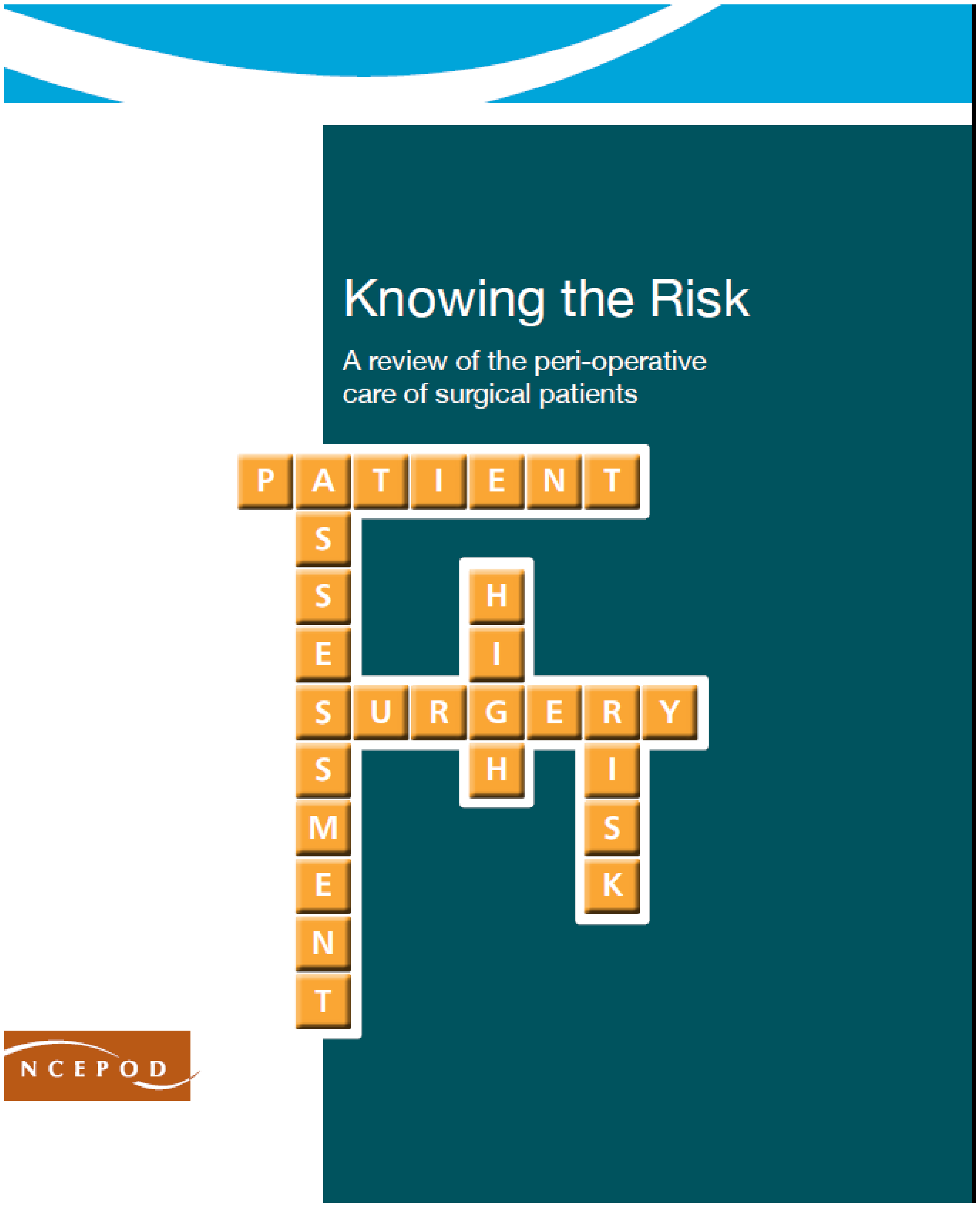
L : Line and Tube
อันตรายป้องกันได้จากการให้สารน้ำ

รศ.นพ.กวีศักดิ์ จิตตวัฒนรัตน์
ภาควิชาศัลยศาสตร์ คณะแพทยศาสตร์
มหาวิทยาลัยเชียงใหม่

3rd Mini Conference: ความปลอดภัยในผู้ป่วย ร่วมด้วย ช่วยได้ทุกคน
วันที่ 13-14 กันยายน 2558 ณ โรงแรมนารายณ์ สีลม กรุงเทพฯ

General considerations

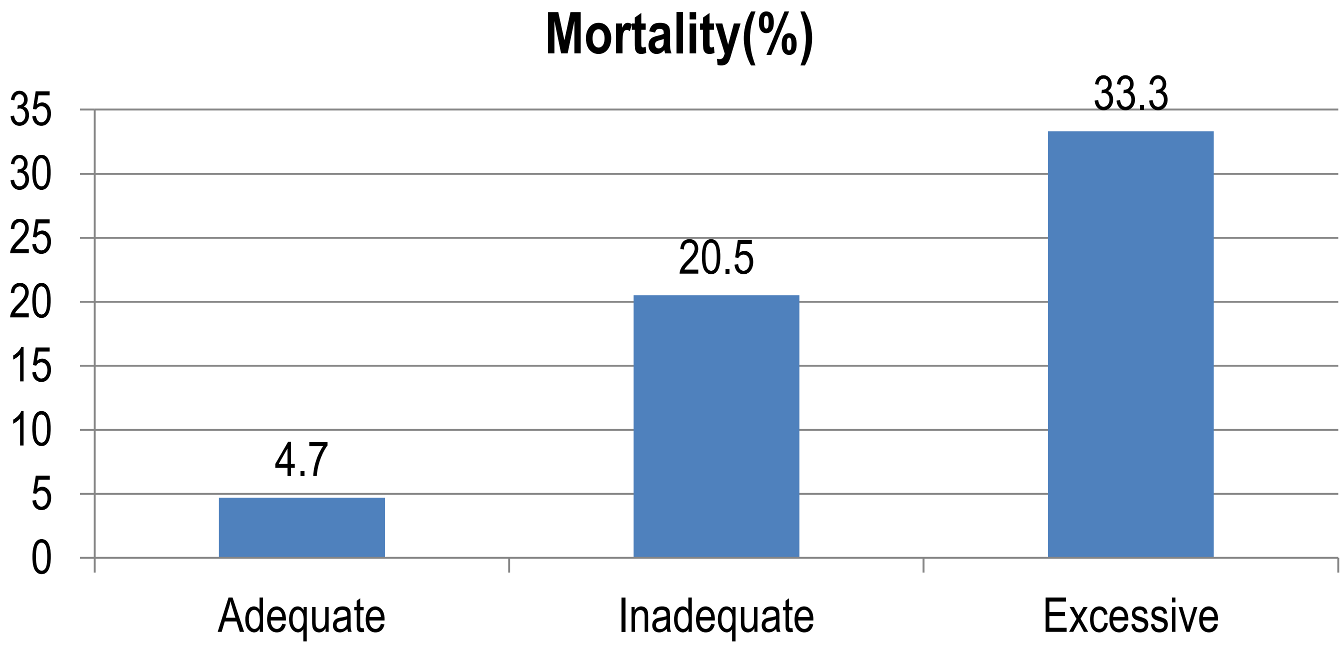
- I.V. fluid therapy plays a vital role in establishing and maintaining cellular homeostasis in hospitalized patients
- Less or over – fluid administration might be harm



(http://www.ncepod.org.uk/2011report2/downloads/POC_fullreport.pdf)

Peri-operative management : UK

- Inappropriate fluid management :
  - Pre-operative 7.4%
  - Intra-operative 8.4%



(http://www.ncepod.org.uk/2011report2/downloads/POC_fullreport.pdf)

Difference in criteria definition

Year	Author	Patient	Overload criteria	Result
1990	Lowell JA.	SICU	>10%	↑ morbidity
2009	Bouchard J	ICU with AKI	> 10%	↑ mortality
2009	Lobo DN.	Animal study	>3.3%	↑ bowel wall edema
2014	Pimanmekaporn T.	Peri-op chest	>2000 mL (4-7%)	↑ CVS complications
2014	Enger TB.	Open heart	> 90 ptile (8.04%)	↑ incidence in Homozygous UMOD gene

Therapeutics and Clinical Risk Management

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ORIGINAL RESEARCH

Fluid accumulation threshold measured by acute body weight change after admission in general surgical intensive care units: how much should be concerning?

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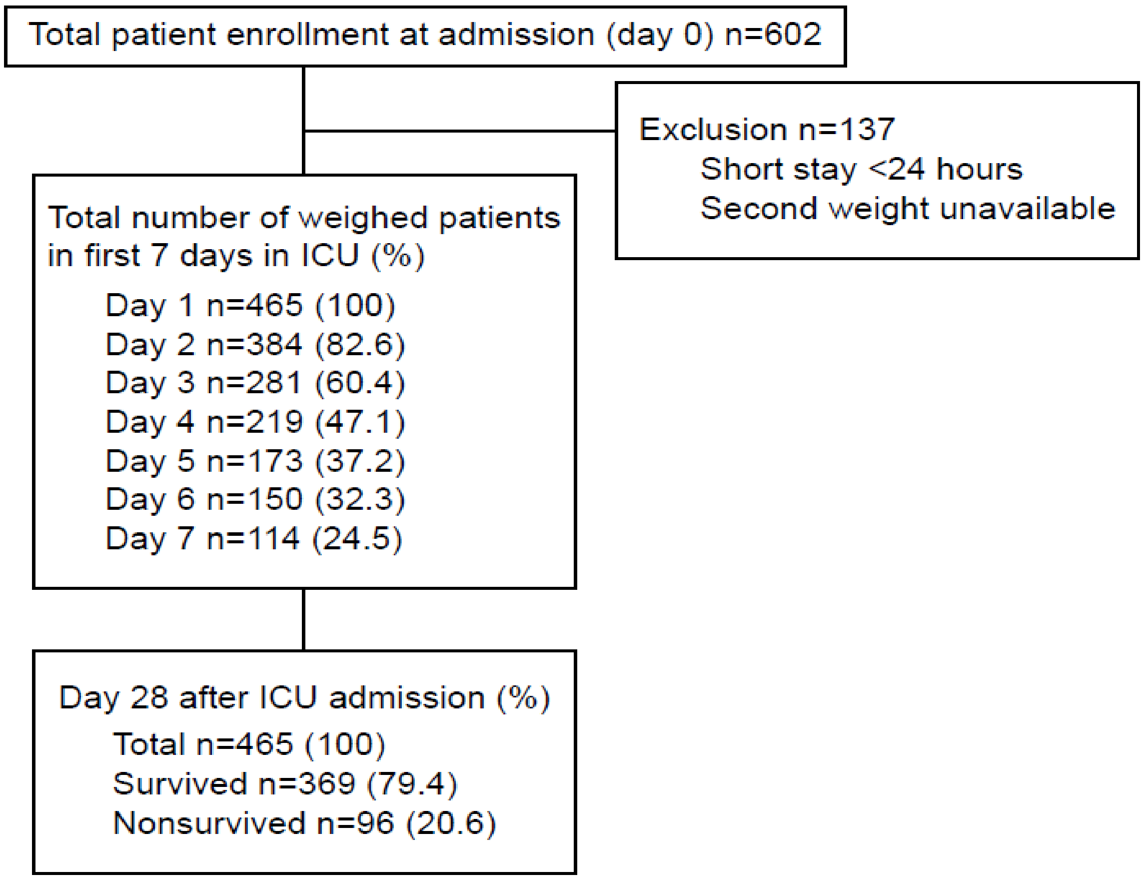
$$\%\Delta BW = \frac{\text{Each day BW} - BW0}{BW0} \times 100.$$

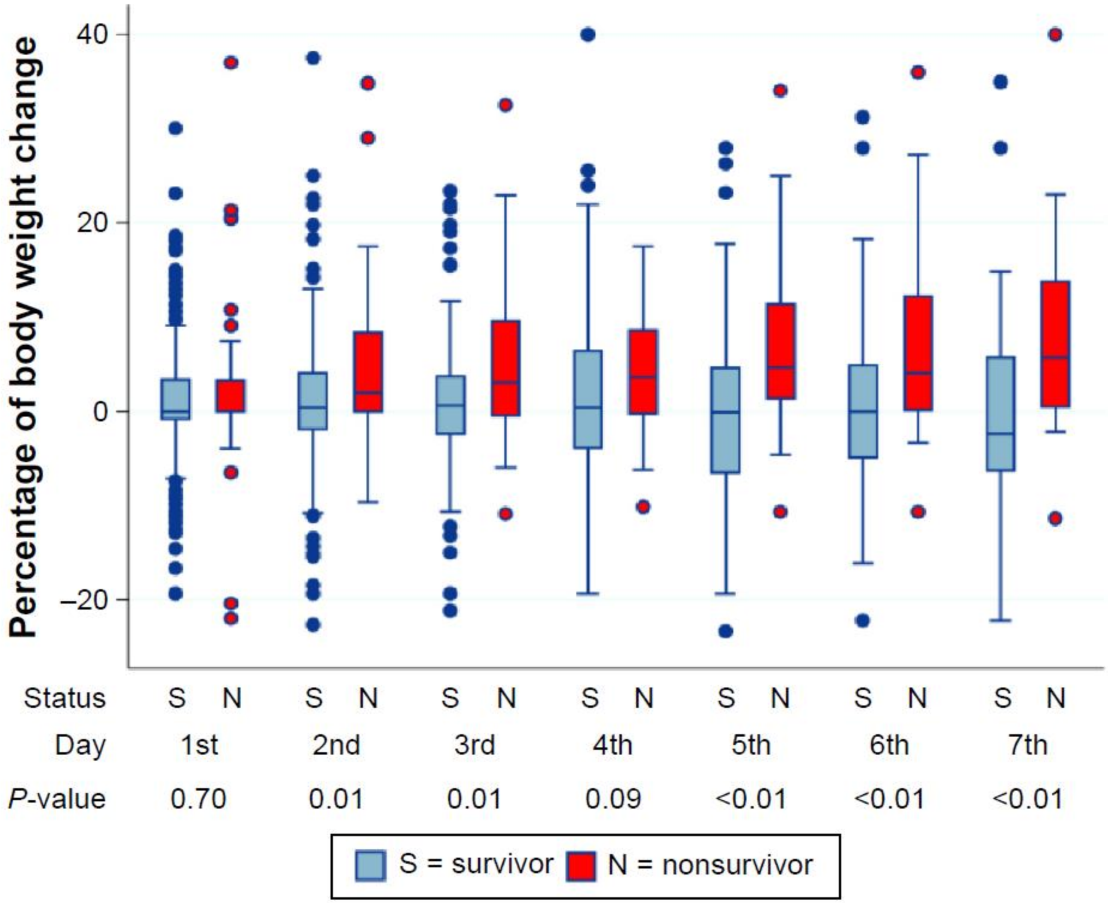
Maximum weight change

Patient enrollment



Chittawatanarat K. Therapeutics Clin Risk Manage 2015:11 1097–1106

Body weight alterations



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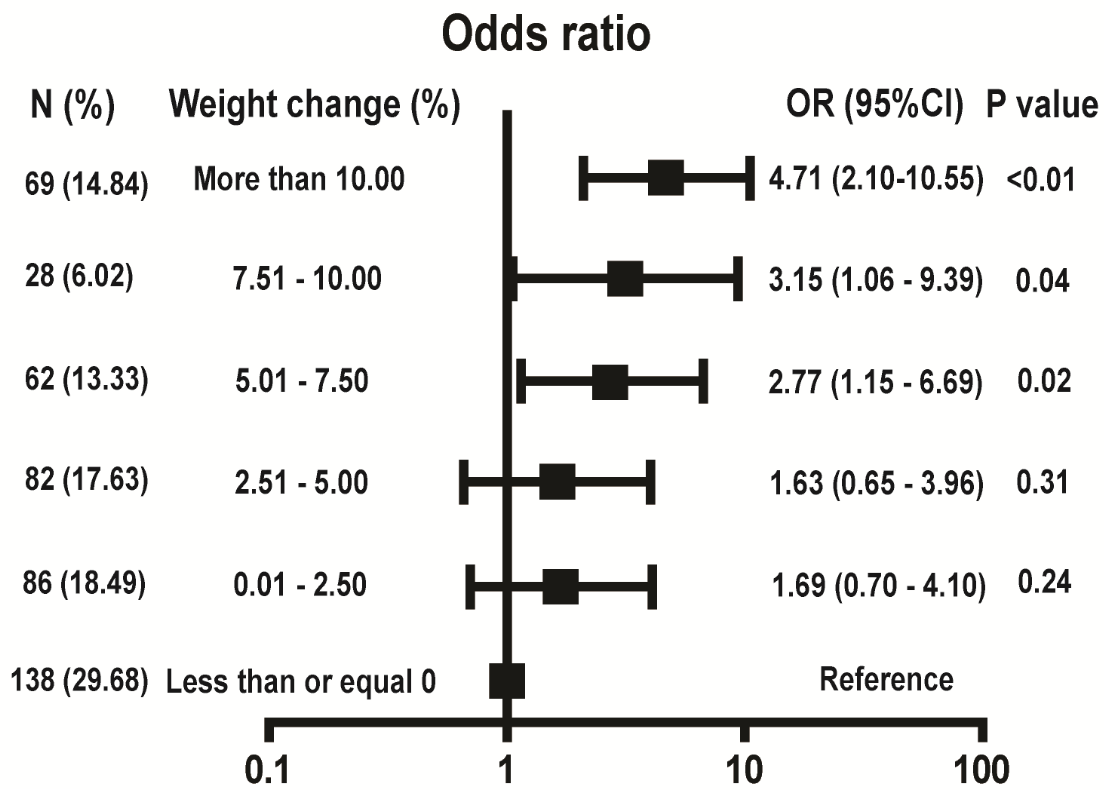
Threshold of fluid accumulation



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Type of fluid administration

Fluid (mL)	All (n=465)		≤5% (n=306)		>5% (n=159)		*P*-value**
	%‡	Median (IQR)	%‡	Median (IQR)	%‡	Median (IQR)	
Total intake per day	100	3,079 (2,127–4,185)	100	2,886 (2,000–3,947)	100	3,468 (2,497–4,903)	<0.001
Crystalloid	100	2,266 (1,632–2,985)	100	2,221 (1,590–2,865)	100	2,430 (1,646–3,210)	0.043
Albumin*	20	40 (19–73)	18	50 (18–83)	23	34 (23–62)	0.405
Gelatin*	16	250 (56–670)	16	250 (56–670)	16	285 (125–1,750)	0.106
HES*	68	350 (167–800)	63	360 (167–190)	78	340 (190–790)	0.978
Packed red cells*	66	203 (94–397)	61	198 (90–408)	78	215 (95–398)	0.538
FFP*	51	359 (167–665)	43	345 (174–625)	67	362 (164–702)	0.648
Platelets*	28	90 (40–170)	21	78 (37–153)	41	101 (40–182)	0.266
Total output per day	100	1,915 (1,320–2,543)	100	1,898 (1,340–2,500)	100	1,964 (1,245–2,654)	0.732
Fluid balance per day	100	1,013 (264–2,191)	100	859 (122–1,953)	100	1,232 (499–3,117)	<0.001
Total duration of fluid administration in day	100	3 (2–6)	100	3 (2–6)	100	4 (2–9)	0.005
Total fluid accumulation	100	3,117 (795–6,690)	100	2,552 (520–5,483)	100	4,540 (2,070–9,395)	<0.001

Chittawatanarat K. Therapeutics Clin Risk Manage 2015:11 1097–1106

Adverse events associated with overload

Adverse events and treatment outcomes	Multivariable analysis (95% CI)					
	All*	*P*-value	Nonoperated**	*P*-value	Postoperation**	*P*-value
Categorical outcomes	Adjusted odds ratio					
ICU mortality	2.38 (1.25 to 4.54)	0.008	1.54 (0.65 to 3.68)	0.329	3.87 (1.38 to 10.85)	0.010
Without RRT	2.47 (1.21 to 5.06)	0.013	1.25 (0.47 to 3.35)	0.653	6.32 (1.85 to 21.64)	0.003
28-day mortality	1.52 (0.86 to 2.67)	0.145	1.38 (0.80 to 2.39)	0.244	1.34 (0.74 to 2.42)	0.338
Reintubation within 72 hours	2.51 (1.04 to 6.00)	0.039	1.18 (0.26 to 5.27)	0.830	4.44 (1.30 to 15.16)	0.017
New acute kidney injury	1.15 (0.68 to 1.94)	0.596	1.18 (0.52 to 2.67)	0.685	1.18 (0.58 to 2.41)	0.640
Vasopressor requirement	1.49 (0.90 to 2.50)	0.120	0.98 (0.44 to 2.21)	0.969	2.04 (1.04 to 4.01)	0.037
Delirium	1.97 (1.08 to 3.57)	0.025	3.16 (1.13 to 8.78)	0.027	1.50 (0.71 to 3.20)	0.290
Renal replacement therapy	2.67 (1.13 to 6.33)	0.026	3.53 (0.93 to 13.43)	0.065	2.00 (0.59 to 6.71)	0.260
Continuous outcomes	Adjusted coefficient					
Days of mechanical ventilator use	0.85 (–0.38 to 2.08)	0.177	1.21 (–1.33 to 3.75)	0.349	0.72 (–0.64 to 2.07)	0.298
Days of required vasopressor agent	0.64 (–0.03 to 1.32)	0.061	1.07 (–0.38 to 2.52)	0.146	0.38 (–0.33 to 1.08)	0.294
Days of ICU length of stay	0.85 (–0.47 to 2.17)	0.205	1.14 (–1.47 to 3.76)	0.389	0.76 (–0.75 to 2.26)	0.322

Notes: *Models were adjusted by admission APACHE II score, albumin level, smoking status, age, and surgical status. **Models were adjusted by admission APACHE II score, albumin level, smoking status, and age.

Chittawatanarat K. Therapeutics Clin Risk Manage 2015:11 1097–1106

Questions of IV administration

- What
  - Define diagnosis/ clinical scenario and goal
- When
  - Define time and rate
- Where
  - Define patient setting (pre-hospital, ER, OR, Ward, ICU)
- How
  - Define route and monitoring

Time dependence considerations

- Resuscitation
  - Administration of fluid for immediate management of life-threatening conditions associated with impaired tissue perfusion
- Titration
  - Adjustment of fluid type, rate and amount based upon context to achieve optimization of tissue perfusion
- De-escalation
  - Minimization of fluid administration; mobilization of extra fluid to optimize fluid balance

Fluid balance……

Daily fluid balance

daily sum of all intakes and outputs

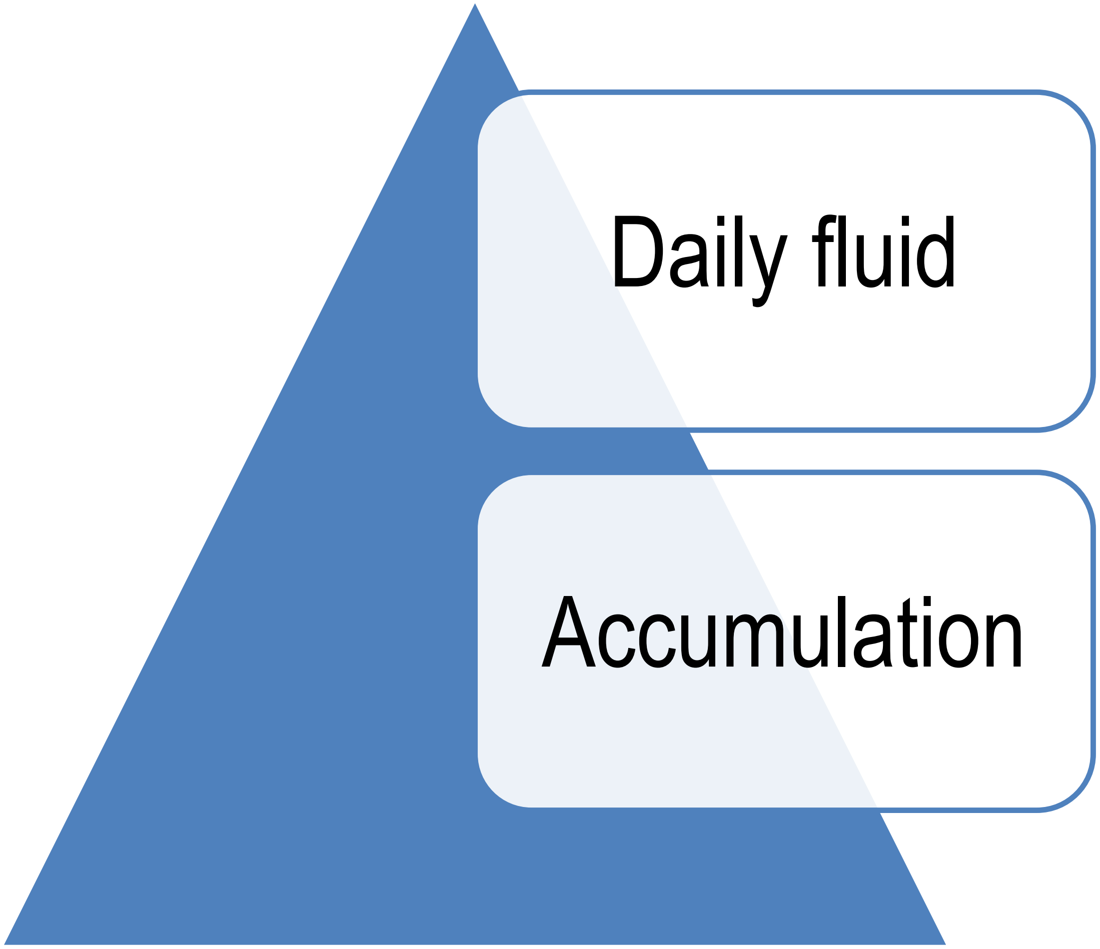
Cumulative fluid balance

sum total of fluid accumulation over a set period of time

Fluid overload

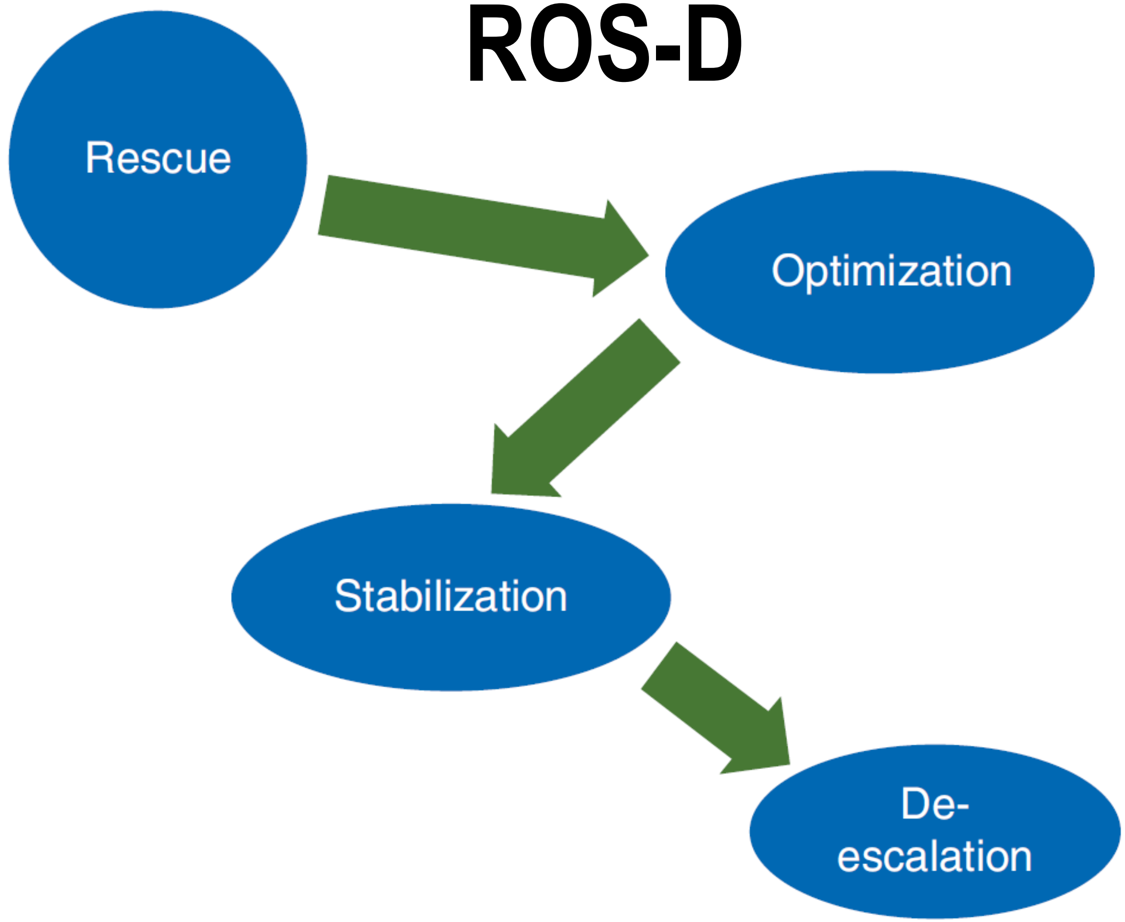
cumulative fluid balance expressed as a proportion of baseline body weight. A value of 10% is associated with adverse outcomes; 5% is after SICU admission

Fluid recorder in ward/ ICU



Four phase of fluid resuscitation

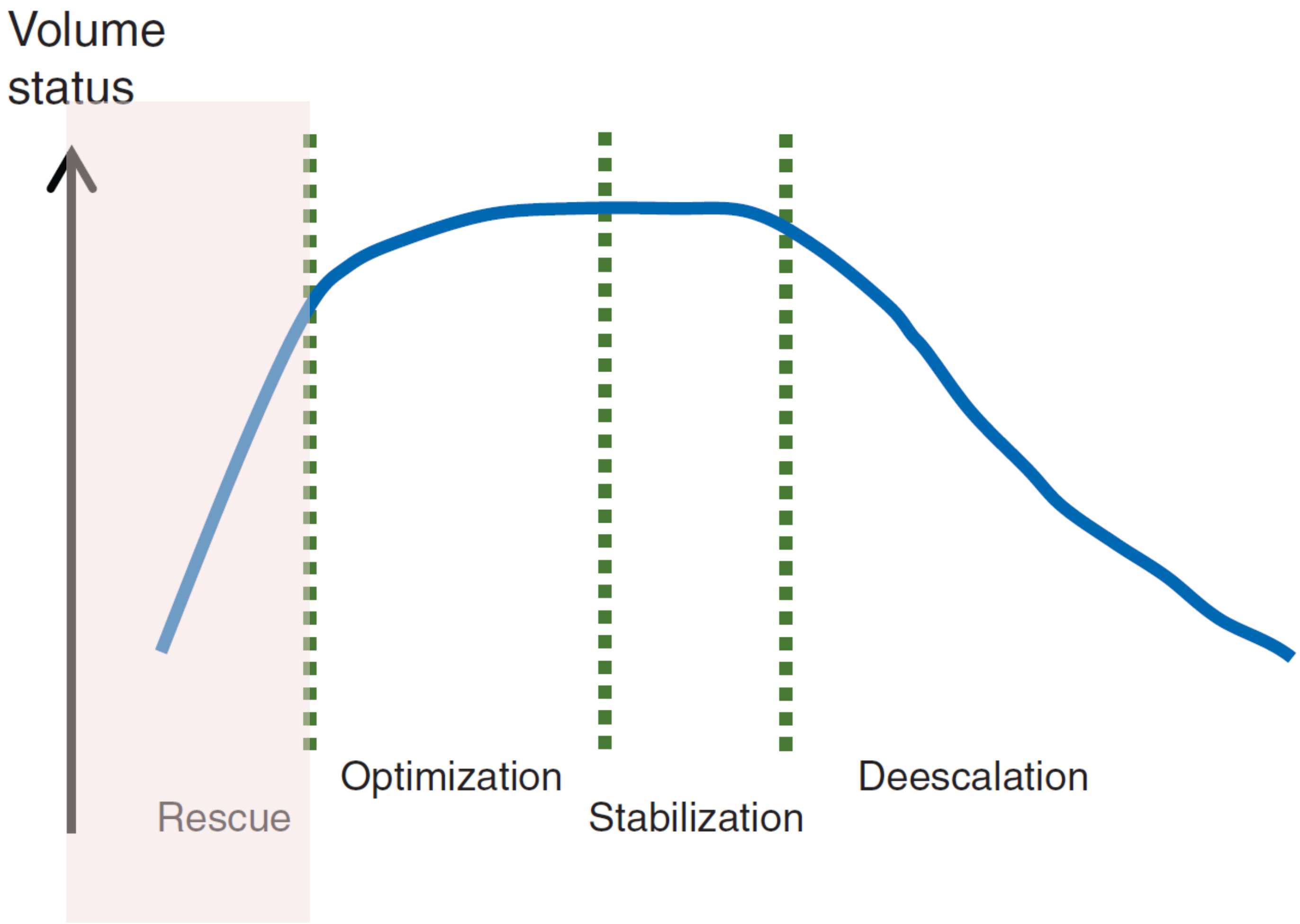
ROS-D



Patient first enrolled on difference stages

(www.ADQI.org)

Volume status of resuscitation



(www.ADQI.org)

Rescue phase

Characters	Details
Principles	Lifesaving
Goals	Correct shock
Time	Minutes
Type	Severe shock
Fluid therapy	Rapid boluses
Scenario	Septic shock, Major trauma

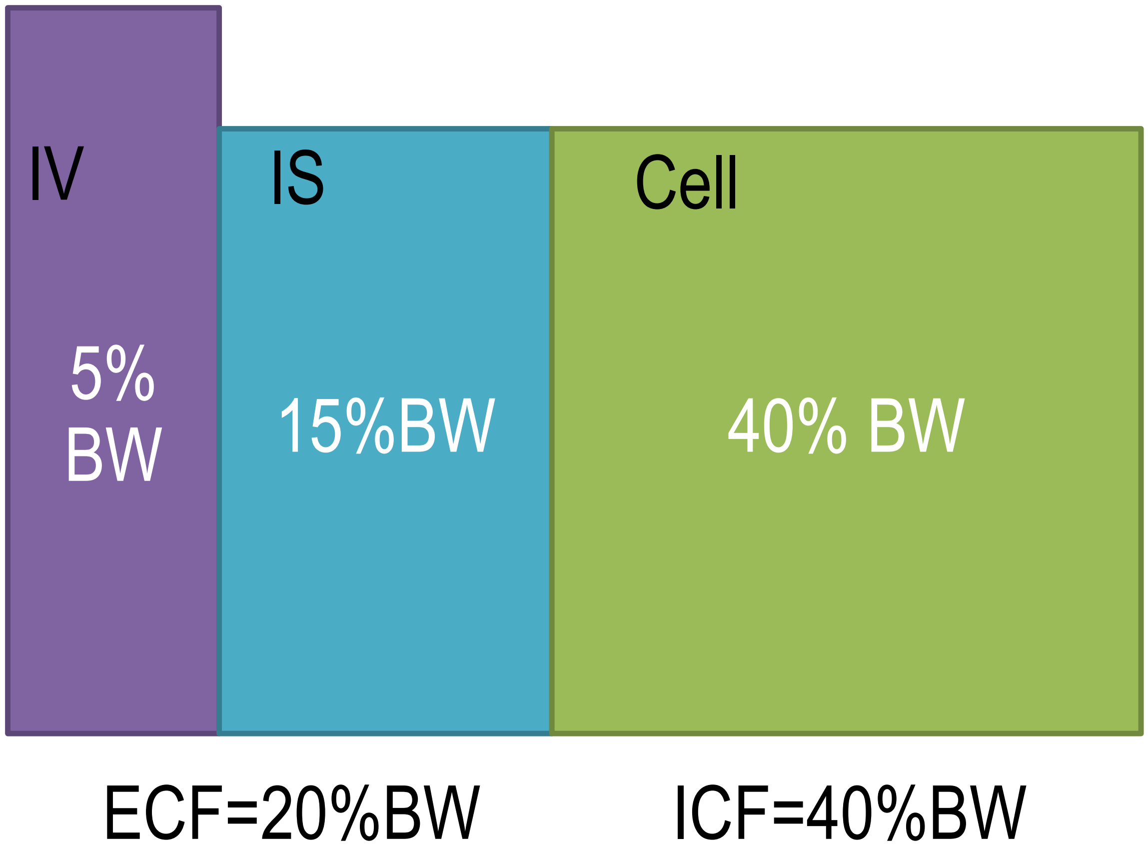
Fluid bolus

- A rapid infusion to correct hypotensive shock.
- It typically includes the infusion of at least 500 ml over a maximum of 15 min
- Monitor: (More simple)
  - Minimum : BP, HR, Lactate, ABG, Cap.refill, Urine, Mental status
  - Optimum : Echo/Doppler, CVP

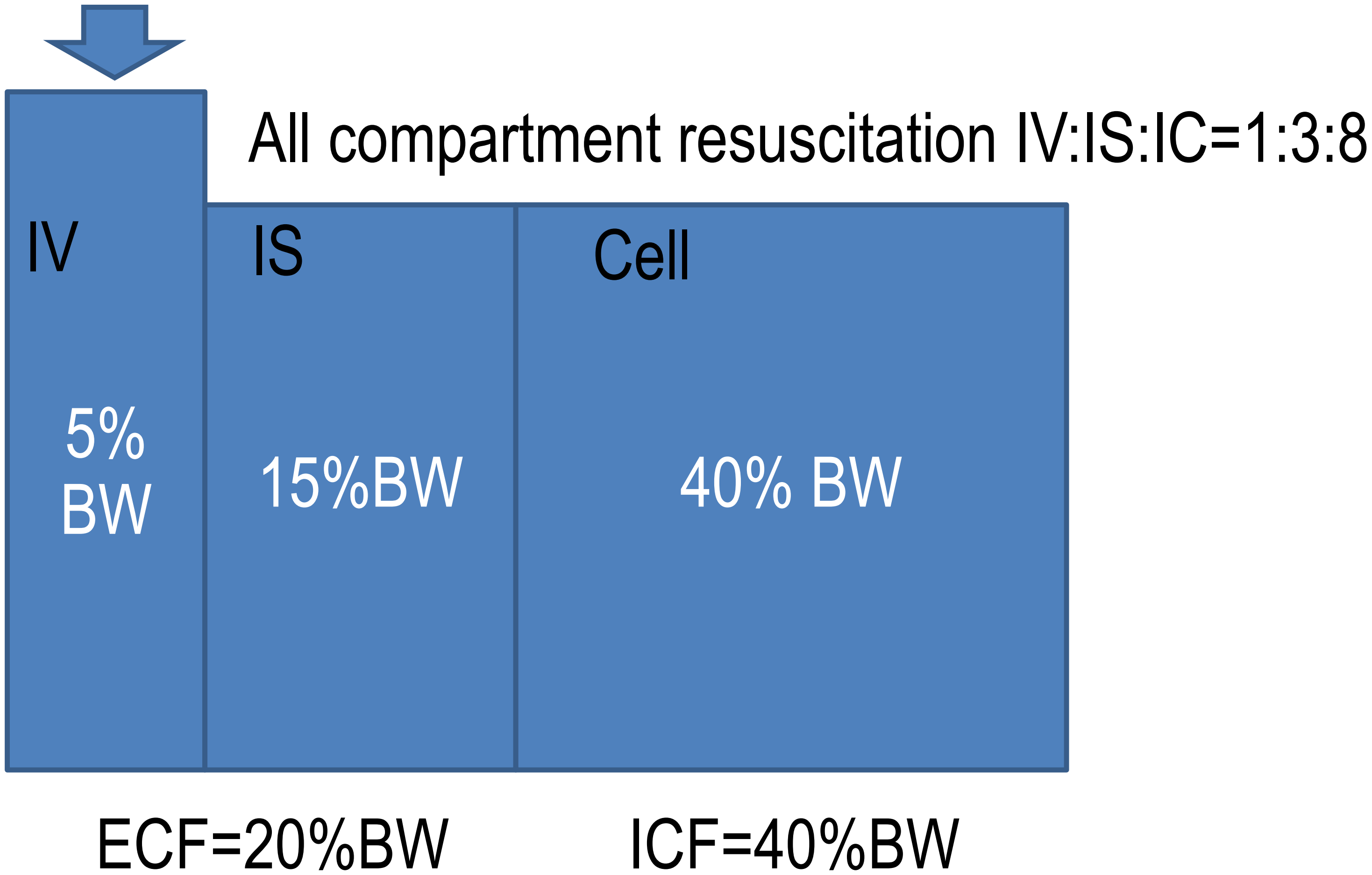
Determination of fluid choice

- Phase of fluid resuscitation
- Fluid compartment
- Patient diseases
- Complication

Fluid compartments

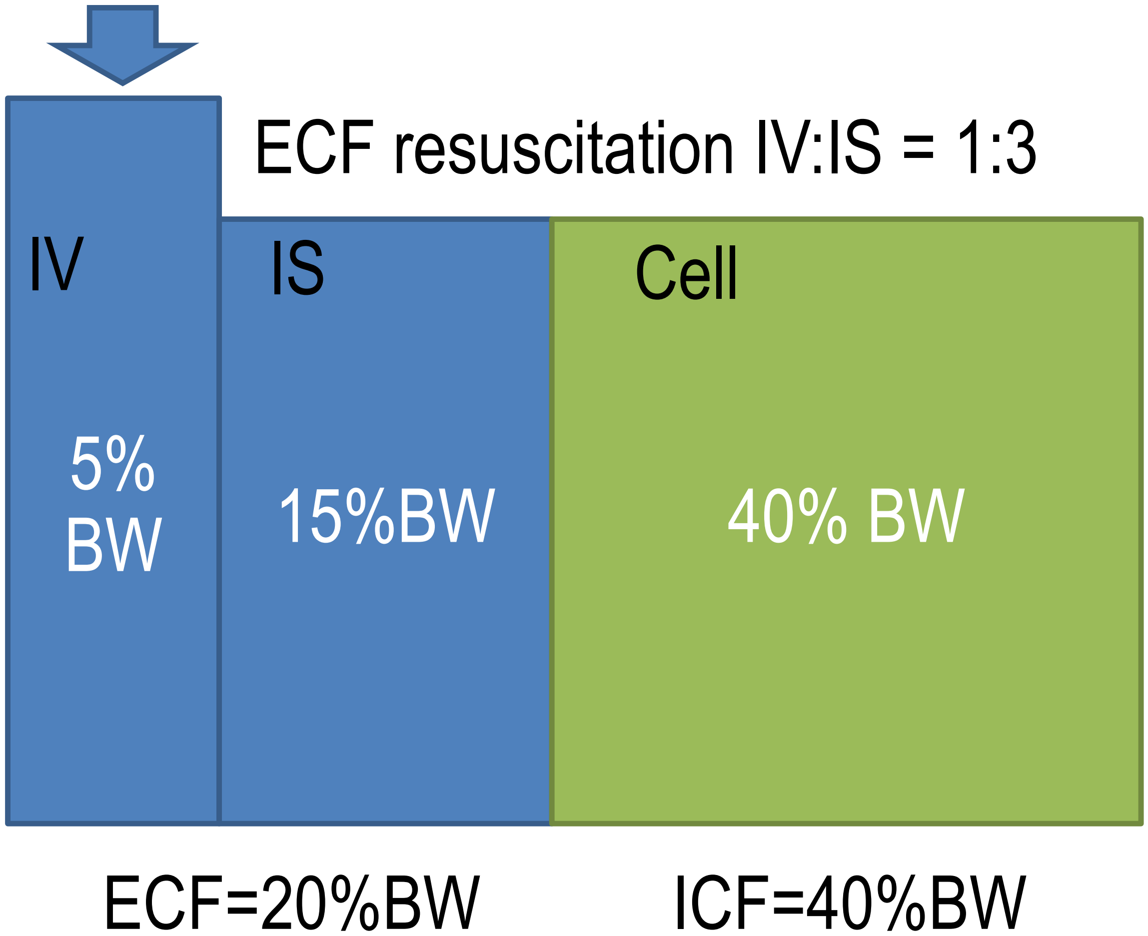


Water without Na fluid crystalloid



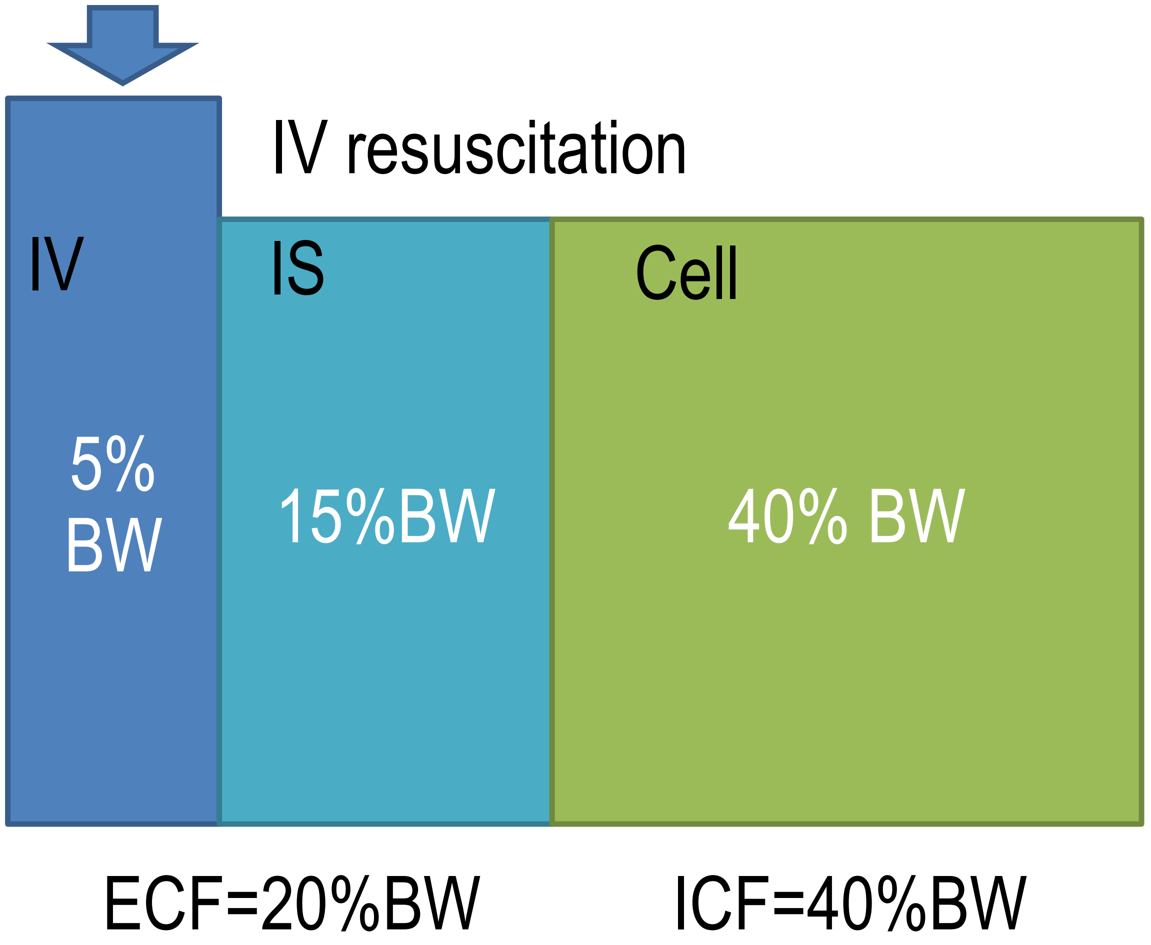
Cellular and IS edema

Isotonic Na containing fluid crystalloid



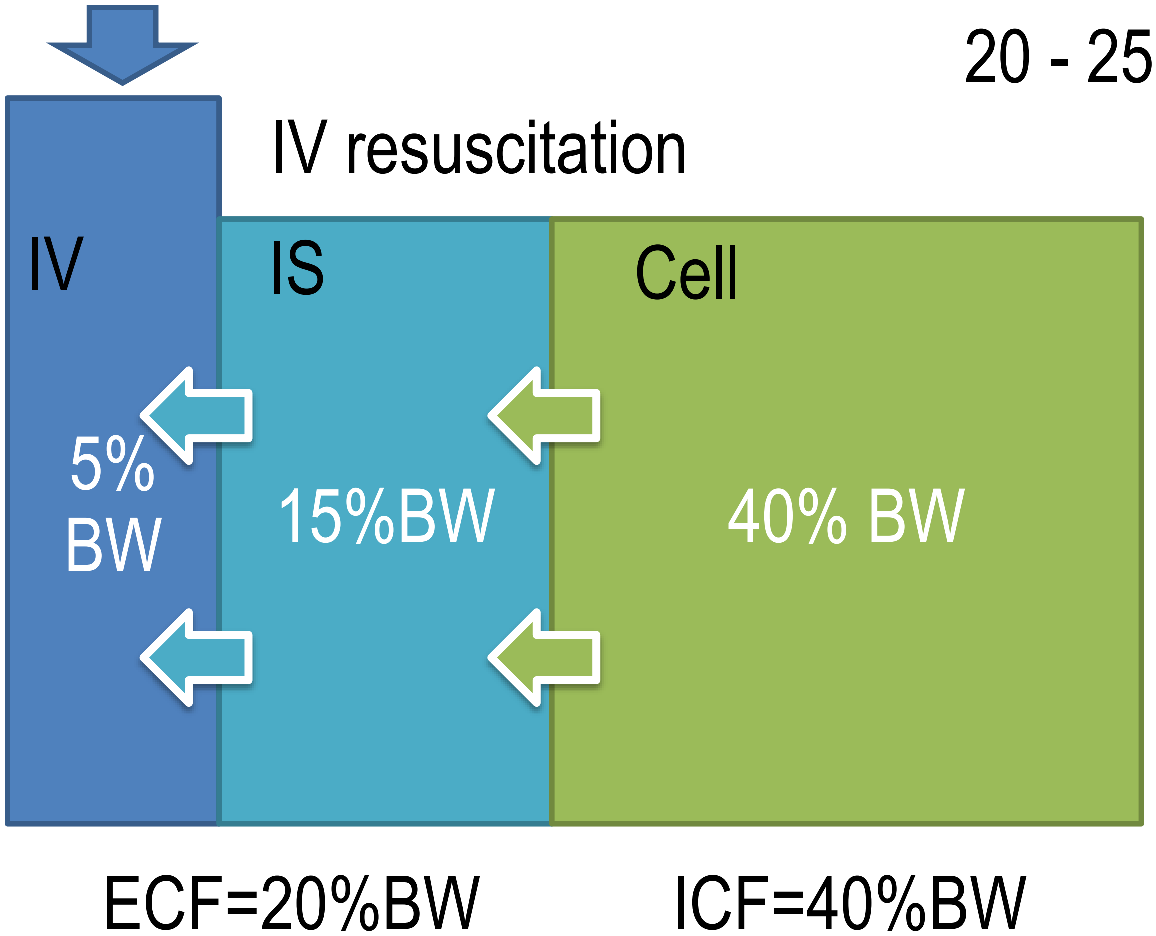
IS edema

Isotonic Na containing isotonic colloid fluid



Isotonic Na containing hypertonic colloid

20 - 25% Albumin



Cellular dehydration

Fact of cellular shock during rescue phase

- Interstitial water depletion
  - Intravascular volume compensation
  - So “ Crystalloid fluid” is first fluid choice
  - Caution
    - Failing organs
    - Interstitial edema esp. pulmonary edema
    - Low energy supply condition or cellular shock
    - Hyperchlorimic normal gap metabolic acidosis

Comparison of albumin resuscitation to other fluid regimen in sepsis

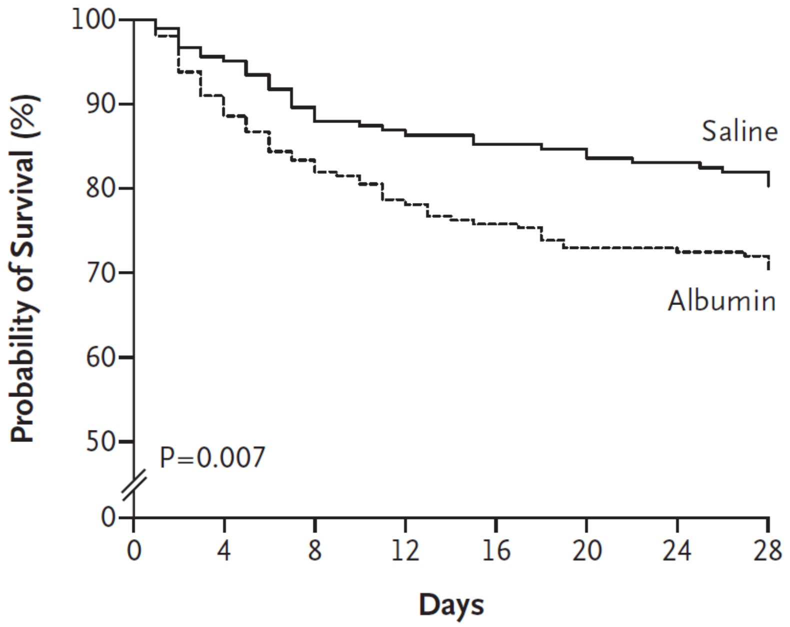
Fluid	Number of Studies	Total Participants	I^2	Estimate of Odds Ratio	95% Confidence Limits	p
Crystalloid	7	1441	0%	0.78	0.62–0.99	.04
Starch	12	463	0%	1.04	0.7–1.54	.84
Gelofusine	2	100	40.1%	0.27	0.06–1.14	.08

Guidelines currently suggest (grade2C) that albumin use should be considered as a resuscitation fluid in patients with severe sepsis, particularly if those patients are not responding to crystalloid infusion

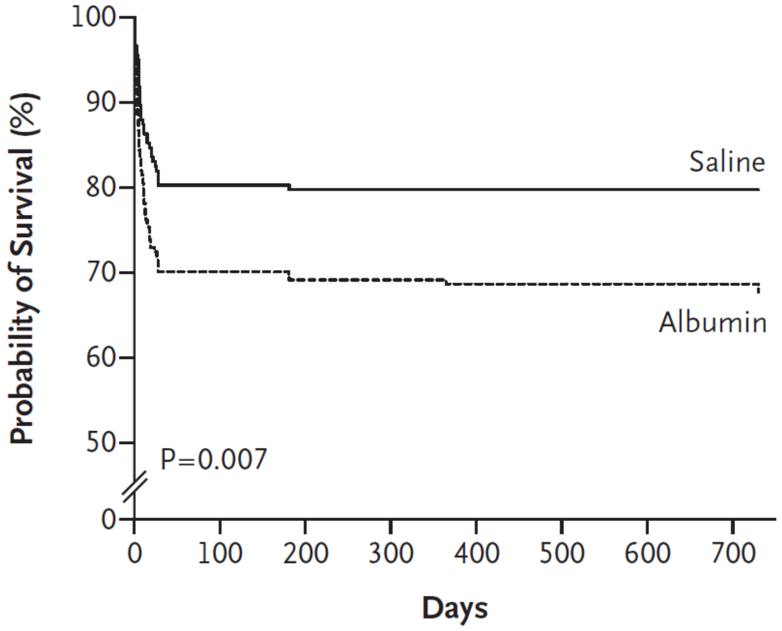
Delaney AP et al. Crit Care Med 2011;39:386-91.

Traumatic brain injury (SAFE group)

28 days mortality



24 months mortality



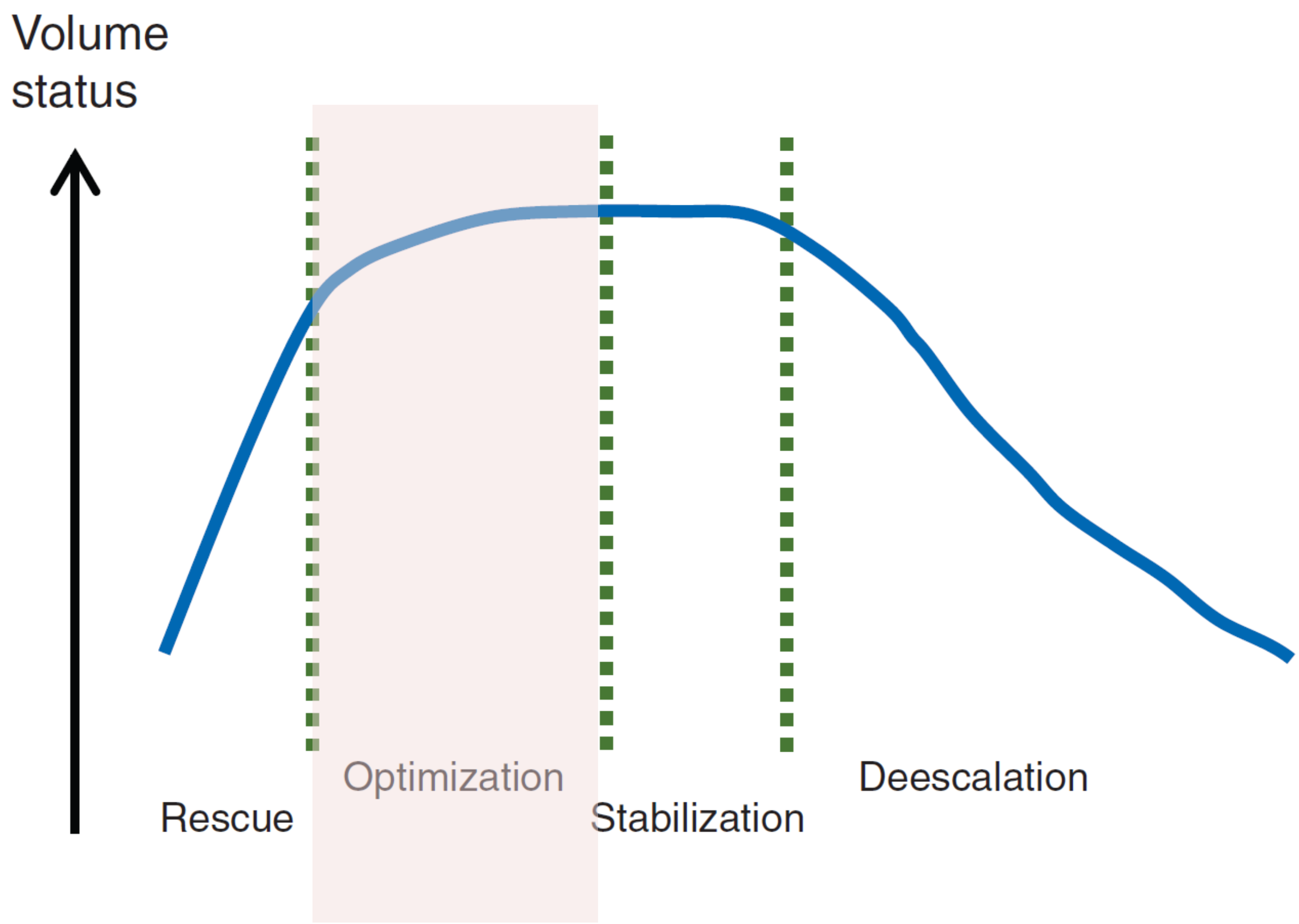
The hypotonic and hypooncotic nature of the albumin solution used may also have played a role

N Engl J Med 2007;357:874-84.

Summary of rescue phase

- Crystalloid first
- Sepsis : avoid HES, prefer albumin if crystalloid is not work
- Traumatic brain : avoid albumin
- Use basic monitoring

Volume status of resuscitation



(www.ADQI.org)

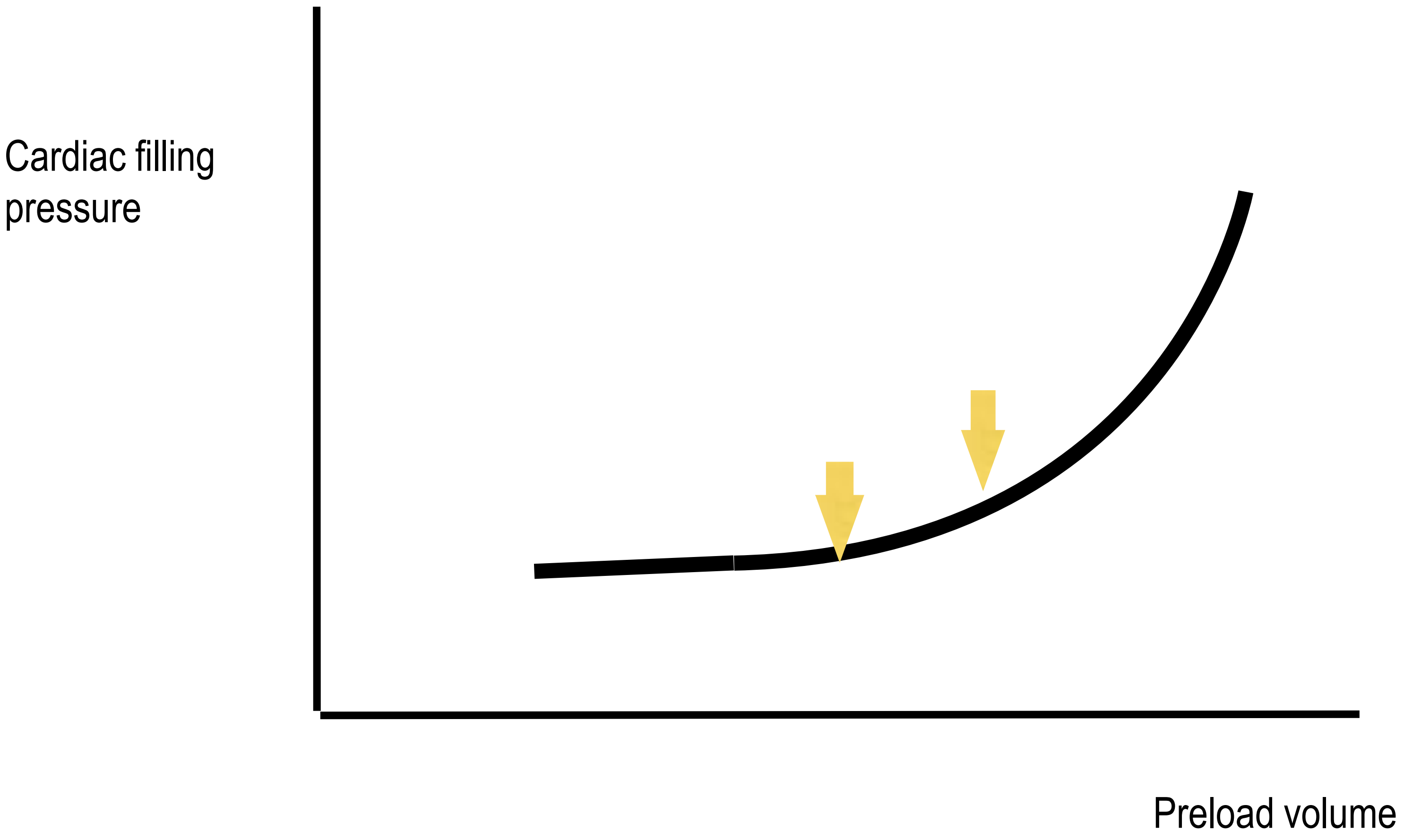
Optimization

Characters	Details
Principles	Organ rescue
Goals	Optimize and maintain tissue perfusion
Time	Hours
Type	Unstable
Fluid therapy	Titrate fluid infusion conservative use of fluid challenges
Scenario	Intra-operative goal directed therapy Burns DKA

Fluid challenge

- 100–200 ml over 5–10 min with reassessment to optimize tissue perfusion
- Monitor:
  - Minimal : BP, HR, Lactate, ABG, Cap.refill, Urine, Fluid balance
  - Optimum: Echo/Doppler, CVP, $ScvO_2$, Cardiac output, Fluid responsiveness

Optimization point



Fluid Challenge Test

Guided by	CVP	PCWP	Infusion
After bolus	⇑< 2	⇑< 3	continue
	⇑> 5	⇑> 7	stop
	2 <⇑< 5	3 <⇑< 7	Wait
After10min	⇑> 2	⇑> 3	stop
	⇑< 2	⇑< 3	continue

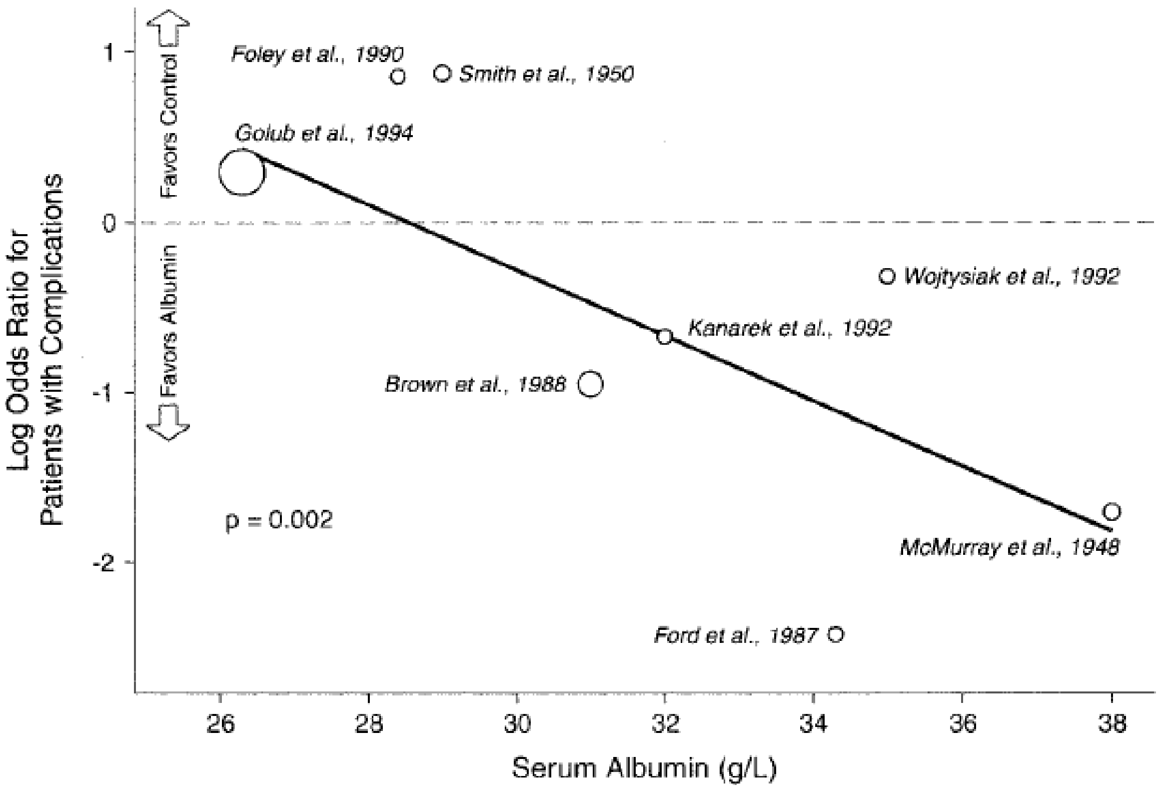
Fluid responsiveness

- Pulse pressure variation
- Systolic pressure variation
- Stroke volume variation
- IVC distensibility
- Passive leg raising test
- End expired occlusive pressure

Hypoalbuminemia in Acute Illness: Is There a Rationale for Intervention?

A Meta-Analysis of Cohort Studies and Controlled Trials

Jean-Louis Vincent, MD, PhD, FCCM,* Marc-Jacques Dubois, MD,* Roberta J. Navickis, PhD,† and Mahlon M. Wilkes, PhD†



↓1 g/dL of albumin

Mortality: OR 2.37

Morbidity: OR 1.89

↑ICU LOS: 28%

↑Hosp LOS: 71%

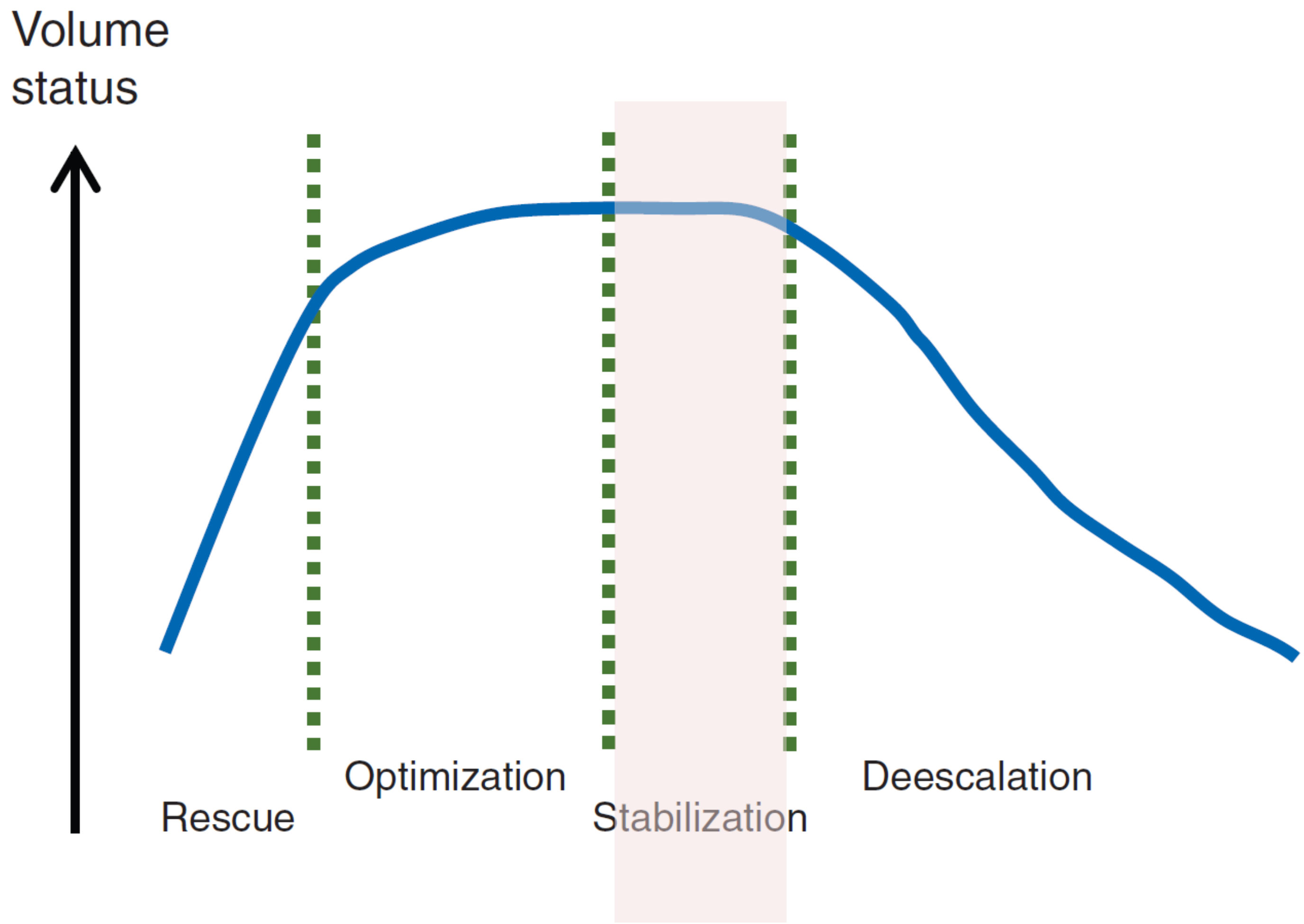
↑Resource : 66%

Vincent JL , et al. Ann Surg 2003;237:319-34.

Summary optimization phase

- Titration fluid and close monitoring
- Caution of fluid overload
- Preserve organ function and endothelial function
- +/- role of oncotic fluid

Volume status of resuscitation



(www.ADQI.org)

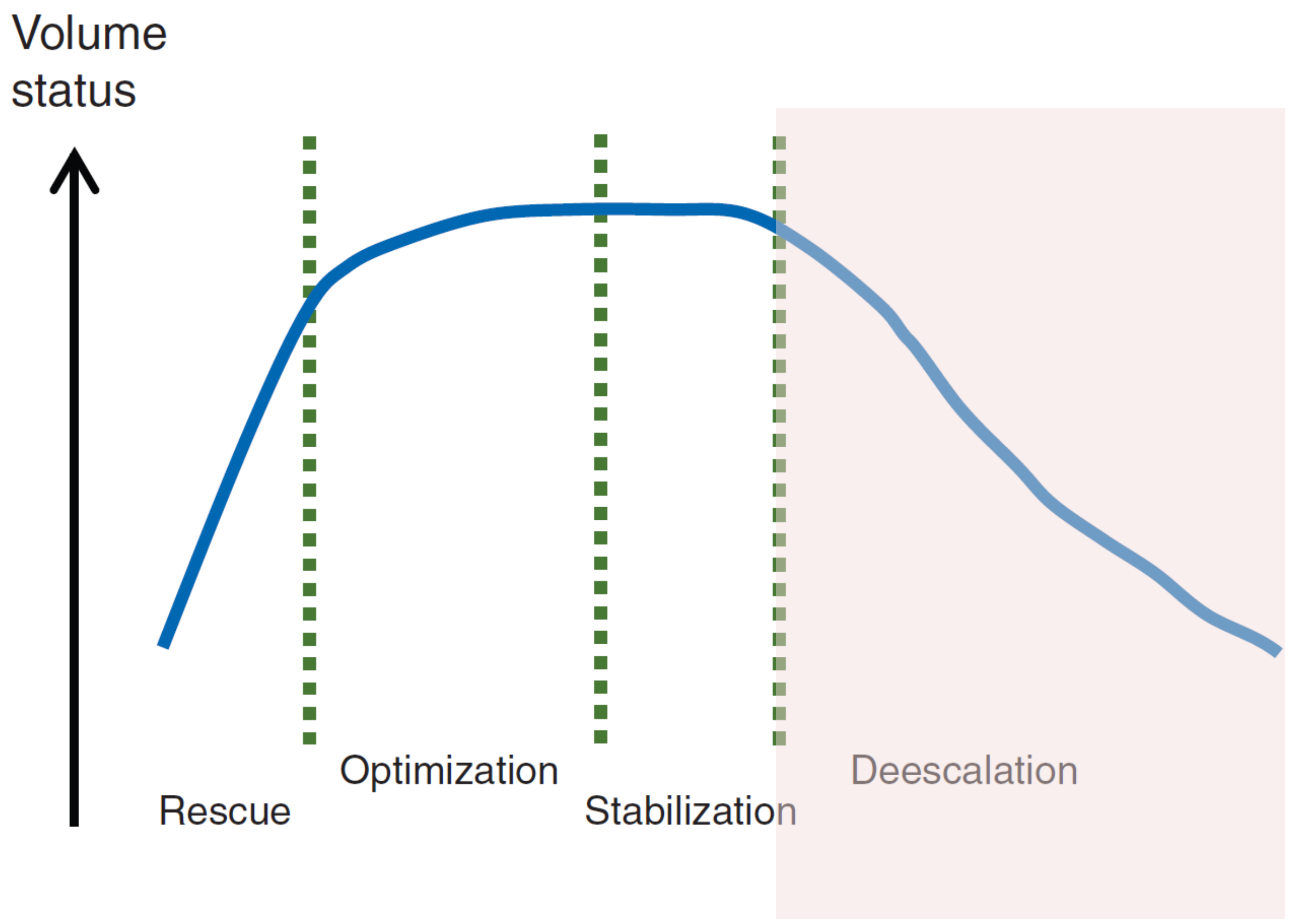
Stabilization

Characters	Details
Principles	Organ support
Goals	Aim for zero or negative fluid balance
Time	Days
Type	Stable
Fluid therapy	Minimal maintenance infusion only if oral intake inadequate
Scenario	NPO postoperative patient Drip and suck management of pancreatitis

Fluid infusion

- Continuous delivery of i.v. fluids to
  - Maintain homeostasis,
  - Replace losses, or
  - Prevent organ injury (e.g. prehydration before operation or for contrast nephropathy)
- Monitoring
  - Minimum: Same as optimization (attention on balance)
  - Optimum: +/- Echo/Doppler, CVP, $ScvO_2$, CO

Volume status of resuscitation



(www.ADQI.org)

De-escalation

Characters	Details
Principles	Organ recovery
Goals	Mobilize fluid accumulated
Time	Days to weeks
Type	Recovering
Fluid therapy	Oral intake if possible Avoid unnecessary IV fluids
Scenario	Patient on full EN in recovery phase of critical illness Recovering ATN

Maintenance

- Fluid administration for the provision of fluids for patients who cannot meet their needs by oral route.
- This should be titrated to patient need and context
  - This should include replacement of ongoing losses.
  - In a patient without ongoing losses, this should probably be no more than 1–2 ml/kg/ h
- Monitoring
  - Minimum: Same as optimization (attention on negative)
  - Optimum: +/- Echo/Doppler, CVP, $ScvO_2$, CO

Summary of fluid

- Accumulation of fluid record >> daily I/O
- Depend on phase of resuscitation
- Crystalloid first in rescue phase
- Colloid later in the others phases
- Closing of monitoring
- Avoid fluid overload
    - 10% of dry weight
    - 5% of SICU admission weight