CHOICE OF FLUID, IMPACT ON RENAL FUNCTION

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Out Line OF Lecture

• Basics in fluid balance by kidney
• Types of renal failure
• Overall fluid dynamics
• Various types of fluids used and misused
• Evidence based on renal failure with type of fluid
• Evidence regarding cumulative balance and renal failure
• How to do a balancing act
• Conclusions on research and evidence
Renal Function

**EXCRETORY FUNCTION**
- Excretion product of the kidney: urine
- Remove excess fluid
- Remove waste products
- Regulate acid/base balance
- Regulate electrolyte levels

**SECRETORY FUNCTION**
- Secretion of three different hormones:
  - Renin: regulate blood pressure
  - EPO: regulate red blood cell production
  - Vitamin D: regulate calcium uptake
RIFLE CRITERIA

RIFLE defines three grades of severity of AKI on the basis of either:
- acute increase in serum creatinine
- decrease in GFR
- decreased urine output.
Classification

Pre-renal ARF  Intrinsic-renal ARF  Post-renal ARF

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Types of Acute Renal Failure

**Prerenal**, caused by transient renal hypoperfusion due to:
- Hypotension
- Decreased cardiac output
- Decreased effective arterial blood volume

**Postrenal**, due to obstruction of the urinary tract.

**Intrinsic**

- **Acute glomerulonephritis** involves inflammation and damage to the glomerular membrane.
- **Acute interstitial nephritis**, an allergic reaction, may be caused by a variety of drugs.
- **Acute tubular necrosis** accounts for more than 50% of cases of acute renal failure.
  - *Causes*: nephrotoxic agents, prolonged renal hypoperfusion.
Common causes:

- intravascular volume depletion, dehydration, hemorrhage
- decreased cardiac output, congestive heart failure, infarct
- systemic vasodilatation, (dilation of blood vessels), anaphylactic shock, sepsis

55-60% of ARF causes
causes

• Ischemic
  • prolonged prerenal azotemia
  • hypotension
  • hypovolemic shock
  • cardiopulmonary arrest
  • cardiopulmonary bypass

• Sepsis

• Nephrotoxic
  • drug-induced
    • radiocontrast agents
    • aminoglycosides
    • amphotericin B
    • cisplatinum
    • acetaminophen
  • pigment nephropathy
    • hemoglobin
    • myoglobin
Starlings Hypothesis

Fig 1 The Starling hypothesis of fluid exchange

\[
\text{art } P > \text{osm } p = \text{fluid out} \quad \text{ven } P < \text{osm } p = \text{fluid in}
\]

Principles of the Starling hypothesis
- **Fluid exchange:** fluid filtered out at the arterial end and osmotically reabsorbed at the venous end
- **Fluid balance:** fluid out = fluid in
Fluid Physiology

Water Balance and Recommended Intake

- Cellular fluids
  - Intracellular fluid
  - Extracellular fluid
    - Interstitial fluid
    - Intravascular fluid
<table>
<thead>
<tr>
<th>Intravenous fluids</th>
<th>MOsm/l&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Na&lt;sup&gt;+&lt;/sup&gt;</th>
<th>Cl&lt;sup&gt;-&lt;/sup&gt;</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Lactate</th>
<th>Dextrose (g/l)</th>
</tr>
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<tbody>
<tr>
<td>5% Dextrose in water (D5W)</td>
<td>278</td>
<td>77</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
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<tr>
<td>5% Dextrose in 0.45% NaCl</td>
<td>405</td>
<td>154</td>
<td>154</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
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<tr>
<td>5% Dextrose in 0.9% NaCl</td>
<td>561</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td>50</td>
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<tr>
<td>5% Dextrose in Ringer’s solution</td>
<td>525</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td>50</td>
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<tr>
<td>Ringer’s solution</td>
<td>309</td>
<td>147</td>
<td>156</td>
<td>4</td>
<td>4–4.5</td>
<td></td>
<td></td>
<td>50</td>
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<tr>
<td>Lactated Ringer’s solution</td>
<td>275</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td></td>
<td>28</td>
<td></td>
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<tr>
<td>5% Dextrose in Lactated Ringer’s solution</td>
<td>525</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td></td>
<td>28</td>
<td>50</td>
</tr>
<tr>
<td>Plasmalyte&lt;sup&gt;b&lt;/sup&gt;</td>
<td>298</td>
<td>140</td>
<td>98</td>
<td>5</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
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<tr>
<td>0.45% NaCl</td>
<td>154</td>
<td>77</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.9% NaCl</td>
<td>308</td>
<td>154</td>
<td>154</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3.0% Saline</td>
<td>1026</td>
<td>513</td>
<td>513</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5.0% Saline</td>
<td>1710</td>
<td>855</td>
<td>855</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7.5% Saline</td>
<td>2566</td>
<td>1283</td>
<td>1283</td>
<td></td>
<td></td>
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<tr>
<td>20% Mannitol</td>
<td>1098</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Intravenous fluids</td>
<td>Na⁺ (mEq/l)</td>
<td>Cl⁻ (mEq/l)</td>
<td>K (mEq/l)</td>
<td>Ca (mEq/l)</td>
<td>Osmolarity (mOsm/l)</td>
<td>Oncotic pressure (mm Hg)</td>
<td></td>
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<tr>
<td>----------------------------------------</td>
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<tr>
<td>Fresh-frozen plasma</td>
<td>168</td>
<td>76</td>
<td>3.2</td>
<td>8.2</td>
<td>≈ 300</td>
<td>21</td>
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<tr>
<td>5% Albumin</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dextran (10%) 40 in 0.9% saline</td>
<td>154</td>
<td>154</td>
<td></td>
<td></td>
<td>≈ 310</td>
<td>61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dextran (6%) 70 in 0.9% saline</td>
<td>154</td>
<td>154</td>
<td></td>
<td></td>
<td>≈ 310</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hetastarch (6%) in 0.9% saline</td>
<td>154</td>
<td>154</td>
<td></td>
<td></td>
<td></td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hetastarch (10%) in 0.9% saline</td>
<td>154</td>
<td>154</td>
<td></td>
<td></td>
<td>≈ 310</td>
<td>82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ISOTONIC SALINE (0.9%NaCl) Normal saline

• What is normal about it

• Composition
  1 lit of fluid contains:
  Na       154mEq,    Cl      154mEq
  Each 100 ml contains NaCl  0.9gm

• PHARMACOLOGICAL BASIS
  Present chiefly in extracellular fluid maintaining osmolality of ECF.
  Useful to correct both fluid & electrolyte deficit.
  Increase the intravascular volume substantially.
INDICATIONS

1. Water & salt depletion as in diarrhoea, vomiting, excessive diauresis or excessive perspiration.
2. Rx of hypovolemic shock.
3. In severe salt depletion
4. Miscellaneous
   Initial fluid rx in DKA
   Hypercalcemia
   Fluid challenge in prerenal ARF
   Given safely with blood
   As vehical for drugs
5. 3%NaCl(Na 513mEq) - rx of hyponatremia
Hamburger phenomenon / Chloride shift
CONTRAINDICATIONS

1. Cautious use or avoid in hypertensive or pre eclampsia pts with edema due to CHF, Renal disease & Cirrhosis.

2. Dehydration with severe hypokalemia

3. The whole process of involving transport of O2 and CO2 together with formation of alkali reserve is referred to as chloride shift or Hamburger phenomenon.
DEXTROSE SALINE (DNS)
5% Dextrose with 0.9% NaCl solution

COMPOSITION

1 liter of fluid contains:
  Glucose 50gm, Cl 154mEq, Na 154mEq
Each 100 ml contains: Glucose 5gm & NaCl 0.9gm

PHARMACOLOGICAL BASIS

To provide both energy & salt, extracellular electrolytes with fluid to correct dehydration
Increases only ECF volume so in dehydration with hypovolemic shock.

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1. Faster infusion of large volume of DNS lead to large glucose
2. Load lead to hyperglycemia induced osmotic diuresis may lead to
   increased urine output.
3. Compatible with blood transfusion.

INDICATIONS
1. Correct of salt depletion & hypovolemia with supply of energy
2. Correction of vommiting or nasogastric aspiration induced alklosis
   & hypochloremia along with supply of energy.

CONTRAINdications
1. Anasarca of cardiac, hepatic & renal disease.
2. Severe hypovolemic shock
RINGER’S LACTATE (RL)

COMPOSITION
1 liter of fluid supplies
  Na  130mEq, K  4mEq, Cl  109mEq, Ca  3mEq, Lactate  28mEq.
Each 100ml contains, Na lactate 320mg, NaCl 600mg, KCl 40mg & Calcium chloride 27mg

PHYSIOLOGIC BASIS
High Na conc so RL expands intravascular volume.
More physiological fluid similar to plasma.
Provides bicarbonate so in rx of met acidosis.

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INDICATIONS
1. Correction of severe hypovolemia.
2. For replacing fluid in postoperative patients, burns, fractures, peritonial irrigation etc.
3. Diarrhoea induced hypovolemia with hypokalemic met acidosis.
4. DKA - Correct met acidosis & supply K

CONTRAINDICATIONS
1. In severe liver disease, severe hypoxia & shock.
2. Severe CHF
3. Addison’s disease.
5. In vomiting or continuous nasogastric aspiration.
6. Along with blood transfusion
7. Certain drugs such as amphotericin, thiopental, etc.
5% DEXTROSE

COMPOSITION
1 liter of fluid contains
   Glucose 50gms

PHARMACOLOGICAL BASIS
Best agent to correct intracellular dehydration.
Provides 170Kcal/L.
Corrects dehydration & supplies energy.

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INDICATIONS
1. Prevention & treatment of dehydration due to inadequate water intake or excessive water loss.
2. Cheapest fluid to provide adequate calories to body.
3. For prevention of ketosis in starvation, diarrhoea, vomiting & high grade fever.
4. Correction of hypernatremia due to pure water loss e.g. Diabetes insipidus

CONTRAINDICATIONS
1. Cerebral oedema
2. Neurosurgical procedures
3. Acute ischemic stroke
4. Hypovolemic shock
5. Hyponatremia & water intoxication
6. Hypernatremia - rapid correction
7. Blood transfusion

PRECAUTIONS
1. May cause local pain, vein irritation & thrombophlebitis
2. Hypokalemia, hypomagnesemia, hypophosphatemia.
ISOLYTE- M
(Maintenance solution with 5% Dextrose)

• COMPOSITION

1 liter of fluid supplies
Glucose  50gms, Cl  38mEq, Na  40mEq, K  35mEq, Phosphate  15mEq, Acetate  20mEq
Each 100 ml contains
Glucose  5gm, Nacl  0.09gm, Na acetate  0.28gm, KCl  0.15gm, Dibasic K phosphate  0.13gm, Na metabisulphite  0.021gm
ISOLYTE- M
(Maintenance solution with 5% Dextrose)

• COMPOSITION

1 liter of fluid supplies
Glucose  50gms, Cl  38mEq, Na  40mEq, K  35mEq, Phosphate  15mEq, Acetate  20mEq

Each 100 ml contains
Glucose  5gm, Nacl  0.09gm, Na acetate  0.28gm, KCl  0.15gm, Dibasic K phosphate 0.13gm,
Na metabisulphite  0.021gm
PHARMACOLOGICAL BASIS

Richest source of K+.
Proportion of electrolytes is almost similar to the maintenance requirement of body.
Corrects acidosis & supplies energy.

INDICATIONS

1. Ideal fluid for maintenance fluid therapy.
2. To correct hypokalemia sec to diarrhoea, bilious vomiting, prolonged infusion of K free I.V. fluids, ulcerative colitis etc.
CONTRAINDICATIONS

1. Renal failure
2. Hyponatremia & water intoxication
3. Adrenocortical insufficiency
4. Burns
COLLOID SOLUTIONS
## Characteristics of I.V. colloid fluids per 100 ml infusion

<table>
<thead>
<tr>
<th>TYPE OF FLUID</th>
<th>Effective plasma volume expansion</th>
<th>DURATION OF EXPANSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% Albumin</td>
<td>70-130ml</td>
<td>16hrs</td>
</tr>
<tr>
<td>25% Albumin</td>
<td>400-500ml</td>
<td>16hrs</td>
</tr>
<tr>
<td>6% Hetastarch</td>
<td>100-130ml</td>
<td>24hrs</td>
</tr>
<tr>
<td>10% Pentastarch</td>
<td>150ml</td>
<td>8hrs</td>
</tr>
<tr>
<td>10% dextran-40</td>
<td>100-150ml</td>
<td>6hrs</td>
</tr>
<tr>
<td>6% Dextran-70</td>
<td>80ml</td>
<td>12hrs</td>
</tr>
</tbody>
</table>
ALBUMIN

A physiological plasma protein.
Maintain plasma oncotic pressure
Binding & transport of low molecular substances like bilirubin, hormones, certain drugs etc.
25% albumin- salt poor albumin

PHARMACOLOGICAL BASIS
5% Albumin-A colloid osmotic pressure of 20mmHg expands plasma volume to roughly the same as volume infused

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25% Albumin- colloid osmotic pressure of 70 mmHg
So expand plasma volume by 4-5 times the volume infused.
Not used for volume resuscitation in fluid deficit pt.

INDICATIONS
1. Plasma volume expansion.
2. Correction of hypoproteinemia.
3. As an exchange fluid in therapeutic plasmapheresis.

ADVERSE EFFECTS
Rarely occur & include nausea, vomiting, febrile reaction & allergic reaction, anaphylactic shock.
PRECAUTIONS & CONTRAINDICATIONS

1. Avoid fast infusion.
2. Contraindicated in pt with severe anemia or cardiac failure.
3. Caution in pt with low cardiac reserve or cardiac insufficiency.
4. Dehydrated pt require additional fluids.
5. Not used for parenteral nutrition.
DEXTRAN

Glucose polymer produced by bacteria (Leucohostoc) incubated in sucrose medium.

Available in 2 forms-
Dextran 70 (mol. Wt. 70,000)
Dextran 40 (mol. Wt. 40,000)

PHARMACOLOGICAL BASIS
1. Plasma volume expansion
   not substitute for whole blood as no O2 carrying property.
   not substitute for plasma proteins due to lack of clotting factors.

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Improvement of microcirculation & prevention of thromboembolism minimizes sludging of blood & prevent intravascular aggregation of RBC’s.

INDICATIONS
1. Correction of hypovolemia.
2. Prophylaxis of DVT.
3. To improve microcirculation & blood flow in threatened vascular gangrene.

SIDE EFFECTS
1. Acute renal failure.
2. Hypersensitivity reaction.
3. May interfere with blood grouping & cross matching.

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CONTRAINDICATIONS

• Severe oligo-anuria & renal failure.
• Known hypersensitivity to dextran.
• Severe CHF or circulatory overload.
• Bleeding disorders.
• Severe dehydration.

PRECAUTIONS

• Administered with caution in pt’s with
  a. Impaired renal functions.
  b. Active haemorrhage.
  c. Chronic liver disease.
  d. Pt’s at risk of developing pulmonary oedema or CHF.
2. Hematocrit should not be allowed to fall below 30.

3. Correct dehydration before or at least during infusion.

4. Anticoagulant effect of heparin is enhanced.

5. May require blood, coagulation factors or electrolytes.
GELATIN POLYMER
(Haemaccel)

Polymer of degraded gelatin with electrolytes.

COMPOSITION

Each 1 lit. contains; Polymer from degraded gelatin 35gm.

(mol. Wt. 30,000-35,000)

Na  145mEq  Ca  12.5mEq  Cl  145mEq
K   5.1mEq.

INDICATIONS

1. For rapid expansion of intravascular volume & correction of hypotension.
2. To reduce total volume of fluid replacement.
3. For priming of heart lung machine.

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ADVANTAGE
1. Doesn’t interfere with blood grouping, cross matching or coagulation.
2. Remain in blood for 5-6 hrs & expand plasma vol by about 50% of infused volume.

PRECAUTIONS
1. No preservative, so ensure clear sol.
2. Should not be mixed with citrated blood as calcium may cause clotting.

SIDE EFFECTS
1. Hypersensitive reaction.
2. Bronchospasm & hypotension.
HETASTARCH
(Hydroxyethyl starch)

A synthetic colloid available as 6% sol in isotonic saline. Composed of more than 90% esterified amylopectine. Molecular wt. 4,50,000.

PHARMACOLOGICAL BASIS
Low mol wt molecules are readily excreted in urine in 24 hrs. Larger mol wt fractions are metabolised & eliminated slowly. Expands circulatory plasma volume.
Calculated osmolarity of approx. 310mOsm/L. More potent than 5% albumin as colloid. Higher colloidal osmotic pressure than 5% albumin. Causes greater plasma volume expansion, which may last for 24 hrs.

ADVANTAGE
1. Nonantigenic
2. Doesn’t interfere with blood grouping & cross matching.
3. Less expensive than albumin.
4. Plama vol expansion greater than 5% albumin.
5. Expands plasma vol for a longer period, effect last for about 24hrs.

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DISADVANTAGE
1. Increase sr amylase concd during & after 3-5 days after discontinuation of Hetastarch.
2. No oxygen carrying capacity.

ADVERSE EFFECTS
Allergic & sensitive reactions.

INDICATIONS
To correct hypovolemia & shock, same as Dextran.

CONTRAINDICATIONS
Similar to Dextran, mainly bleeding disorder, CHF, Impaired renal function.
PENTASTARCH

Low mol wt derivative of hetastarch, available as 3%, 6% & 10% sol in isotonic saline.
Lower degree of esterification.
Higher colloidal osmotic pressure.
More effective as a vol expander than hetastarch.
Increase plasma vol 1.5 times of the infused vol.
Indi., contraindi., & side effects are similar to hetastarch.

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Early Goal-Directed Therapy in the Treatment of Severe Sepsis and Septic Shock

Emanuel Rivers, M.D., M.P.H., Bryant Nguyen, M.D., Suzanne Havstad, M.A., Julie Ressler, B.S., Alexandria Muzzin, B.S., Bernhard Knoblich, M.D., Edward Peterson, Ph.D., and Michael Tomlanovich, M.D., for the Early Goal-Directed Therapy Collaborative Group

SAFE STUDY
(Saline versus Albumin Fluid Evaluation)

A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit

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SAFE STUDY RESULTS

<table>
<thead>
<tr>
<th>Patients</th>
<th>Albumin Group</th>
<th>Saline Group</th>
<th>Relative Risk (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no. of deaths/total no.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>726/3473</td>
<td>729/3460</td>
<td>0.99 (0.91–1.09)</td>
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<tr>
<td>Trauma</td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>81/596</td>
<td>59/590</td>
<td>1.36 (0.99–1.86)</td>
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<tr>
<td>No</td>
<td>641/2831</td>
<td>666/2830</td>
<td>0.96 (0.88–1.06)</td>
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<td>Severe sepsis</td>
<td></td>
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<tr>
<td>Yes</td>
<td>185/603</td>
<td>217/615</td>
<td>0.87 (0.74–1.02)</td>
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<td>No</td>
<td>518/2734</td>
<td>492/2720</td>
<td>1.05 (0.94–1.17)</td>
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<tr>
<td>ARDS</td>
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<tr>
<td>Yes</td>
<td>24/61</td>
<td>28/66</td>
<td>0.93 (0.61–1.41)</td>
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<tr>
<td>No</td>
<td>697/3365</td>
<td>697/3354</td>
<td>1.00 (0.91–1.09)</td>
</tr>
</tbody>
</table>
CAPLAN MEYER CURVE OF SAFE STUDY
ALBUMIN ITALIAN OUTCOME SEPSIS STUDY
ALBIOS STUDY

90-day mortality: 41.1% vs. 43.6% (P=0.29)
ALBIOS STUDY

Pts with septic shock as defined according to the SOFA score
(3°/4°)
(pts = 1135)

Probability of Survival

P = 0.04

6.3%

Days since Randomization
CONCLUSION

• In patients with sepsis albumin vs crystalloids alone provided hemodynamic advantage and favorable fluid balance without mortality benefit.

• In subgroup of septic shock patients, hemodynamic and fluid balance advantage were greater than in general population, & had significant mortality benefit at 90 days.
STARCH vs CRYSTALLOID

THE CHEST trail
The 6S scandinavian trail
The VISEP trail

which compared various types of starches with crystalloids showed increased mortality with use of starch, and increased RENAL FAILURE as indicated by increased use of RRT in the starch group.
STARCH vs RINGER ON MORTALITY

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PROCESS trial - PROtocolised Care for Early Septic Shock

A Randomized Trial of Protocol-Based Care for Early Septic Shock

The ProCESS Investigators®
ProCESS trial

• Early goal-directed treatment (EGDT) of septic shock has been incorporated into the surviving sepsis guidelines.

• However, the findings of the original Rivers et al. study were not replicated in the recently published randomized trial of Protocol-based Care for Early Septic Shock (ProCESS).

• In this study, 1341 patients with septic shock were randomly assigned to protocol-based EGDT, protocol-based standard therapy or to usual care.

• Resuscitation strategies differed significantly with respect to the monitoring of central venous pressure and oxygen and the use of intravenous fluids, vasopressors, inotropes and blood transfusions.

• No differences in 90 day mortality, 1-year mortality or the need for organ support were observed.
### Table 2. Outcomes.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Protocol-based EGDT (N=439)</th>
<th>Protocol-based Standard Therapy (N=446)</th>
<th>Usual Care (N=456)</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Death — no./total no. (%)</strong></td>
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<td></td>
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</tr>
<tr>
<td>In-hospital death by 60 days: primary outcome</td>
<td>92/439 (21.0)</td>
<td>81/446 (18.2)</td>
<td>86/456 (18.9)</td>
<td>0.83 ‡</td>
</tr>
<tr>
<td>Death by 90 days</td>
<td>129/405 (31.9)</td>
<td>128/415 (30.8)</td>
<td>139/412 (33.7)</td>
<td>0.66</td>
</tr>
<tr>
<td><strong>New organ failure in the first week — no./total no. (%)</strong></td>
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</tr>
<tr>
<td>Cardiovascular</td>
<td>269/439 (61.3)</td>
<td>284/446 (63.7)</td>
<td>256/456 (56.1)</td>
<td>0.06</td>
</tr>
<tr>
<td>Respiratory</td>
<td>165/434 (38.0)</td>
<td>161/441 (36.5)</td>
<td>146/451 (32.4)</td>
<td>0.19</td>
</tr>
<tr>
<td><strong>Renal</strong></td>
<td>12/382 (3.1)</td>
<td>24/399 (6.0)</td>
<td>11/397 (2.8)</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Duration of organ support — days§</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>2.6±1.6</td>
<td>2.4±1.5</td>
<td>2.5±1.6</td>
<td>0.52</td>
</tr>
<tr>
<td>Respiratory</td>
<td>6.4±8.4</td>
<td>7.7±10.4</td>
<td>6.9±8.2</td>
<td>0.41</td>
</tr>
<tr>
<td>Renal</td>
<td>7.1±10.8</td>
<td>8.5±12</td>
<td>8.8±13.7</td>
<td>0.92</td>
</tr>
<tr>
<td><strong>Use of hospital resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admission to intensive care unit — no. (%)</td>
<td>401 (91.3)</td>
<td>381 (85.4)</td>
<td>393 (86.2)</td>
<td>0.01</td>
</tr>
<tr>
<td>Stay in intensive care unit among admitted patients — days</td>
<td>5.1±6.3</td>
<td>5.1±7.1</td>
<td>4.7±5.8</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>Stay in hospital — days</strong></td>
<td>11.1±10</td>
<td>12.3±12.1</td>
<td>11.3±10.9</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Discharge status at 60 days — no. (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not discharged</td>
<td>3 (0.7)</td>
<td>8 (1.8)</td>
<td>2 (0.4)</td>
<td>0.82</td>
</tr>
<tr>
<td>Discharged to a long-term acute care facility</td>
<td>16 (3.6)</td>
<td>22 (4.9)</td>
<td>22 (4.8)</td>
<td></td>
</tr>
<tr>
<td>Discharge to another acute care hospital</td>
<td>8 (1.8)</td>
<td>2 (0.4)</td>
<td>5 (1.1)</td>
<td></td>
</tr>
<tr>
<td>Discharged to nursing home</td>
<td>71 (16.2)</td>
<td>93 (20.9)</td>
<td>88 (19.3)</td>
<td></td>
</tr>
<tr>
<td>Discharged home</td>
<td>236 (53.8)</td>
<td>227 (50.9)</td>
<td>235 (51.5)</td>
<td></td>
</tr>
<tr>
<td>Other or unknown</td>
<td>13 (3.0)</td>
<td>13 (2.9)</td>
<td>18 (3.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Serious adverse events — no. (%)¶</strong></td>
<td>23 (5.2)</td>
<td>22 (4.9)</td>
<td>37 (8.1)</td>
<td>0.32</td>
</tr>
</tbody>
</table>
Goal-Directed Resuscitation for Patients with Early Septic Shock

The ARISE Investigators and the ANZICS Clinical Trials Group*
CONCLUSION OF ARISE, PROCESS and PROMISE TRIALS

- EGDT as compared with usual resuscitation practice did not decrease mortality among patients presenting to E.D with early septic shock.
- EGDT incorporation as a standard of care is questionable.
CHOICE OF CRYSTALLOID

• DEBATABLE

• BALANCED SALT SOLUTIONS BETTER THAN NORMAL SALINE

• THERE'S NOTHING NORMAL IN NORMAL SALINE, IT CAUSES HYPERCHLOREMIC METABOLIC ACIDOSIS.

• PATIENTS RESUSCITATED WITH NORMAL SALINE HAD INCREASED RENAL IMPAIRMENT {RIFLE (R), (I)} IN SOME STUDIES.
Practice points

• Fluid strategy for ICU patients should be individualized and based on the clinical scenario.

• The timing, the type and the amount of fluid given to critically ill patients have an impact on relevant patient outcomes.

• Based on best available but not high-quality evidence, early adequate resuscitation followed by a restrictive fluid strategy provides the best outcomes for critically ill patients.

• There is no clear role for the use of albumin as resuscitation fluid in ICU patients. This is based on evidence of lack of benefit, as well as because of an unfavourable pharmaco-economical balance.

• The use of colloids for resuscitation of patients in shock provides more timely shock reversal and could possibly improve outcomes.

• Modern HES can be safely used during surgery, but should be avoided in intensive care patients who have already been resuscitated, specifically in patients who have a high risk of developing acute kidney injury.

Dr S Manimala Rao
Research agenda

• More work is needed to understand the different effects and side effects (including renal effects) of different modern HES products.

• Future volume therapy studies should take into account well-defined criteria for correct indications for fluid administration, including the use of a consistent algorithm for haemodynamic stabilization and reproducible indicators of hypovolaemia.

• We need to investigate further whether the use of hypertonic fluids improves relevant patient-related outcomes in sepsis and acute lung injury.

• There is an ongoing need for relevant basic research into the physiology of fluid administration (e.g., bolus vs. continuous infusion vs. no fluid resuscitation), as well as into the in vitro and in vivo effects of different compositions of fluids (e.g., chloride level, tonicity and strong ion difference).
Our dialysis statistics at Yashoda hospital

- From January to April 2016
- Total number of patients - 41 AKI
- Dialysed - 16
- Non dialysed - 25
- 20 of them received Lasix in the form of bolus or infusion
- Mean dialysis cycles – 3.2
- No of crrt - 2
- No of shifted out - 29
- Expired - 5 (crrt-2)
- Lama - 7 (financial reason)

Dr S Manimala Rao
Fluid balance and mortality in critically ill patients with AKI Na Wang

**Critical Care** 2015, 19:371

- Among the 2526 patients included, 1172 developed AKI during the first 3 days. The mortality was 25.7% in the AKI group and 10.1% in the non-AKI group ($P < 0.001$). The daily fluid balance was higher, and the cumulative fluid balance was significantly greater, in the AKI group than in the non-AKI group. FO was an independent risk factor for the incidence of AKI (odds ratio 4.508, 95% confidence interval 2.900 to 7.008, $P < 0.001$) and increased the severity of AKI. Non-surviving patients with AKI had higher cumulative fluid balance during the first 3 days (2.77 [0.86–5.01] L versus 0.93 [−0.80 to 2.93] L, $P < 0.001$) than survivors did. Multivariate analysis revealed that the cumulative fluid balance during the first 3 days was an independent risk factor for 28-day mortality.

**Conclusions**

- In this multicenter ICU study, the fluid balance was greater in patients with AKI than in patients without AKI. FO was an independent risk factor for the incidence of AKI and increased the severity of AKI. A higher cumulative fluid balance was an important factor associated with 28-day mortality following AKI.
Cumulative fluid balance and mortality in septic patients assoc with or without AKI/CKD presence
criticalcare2016june27

• Higher cumulative balance at 72 hours of ICU admission was independently associated with increased mortality irrespective of acute or chronic kidney disease
AIM IS TO PREVENT RENAL FAILURE

What is our goal

How can we balance
Conclusions

• Fluid balancing is not easy
• Every patient requires special Attention
• Resuscitation can be adequate done with crystalloids and colloid if there is hemorrhage.
• Avoid only normal saline
• Mixing crystalloids is also helpful
• Minimum colloid 300 ml in severe shock can bring up the pressure
• Avoid more than 2L cumulative balance by end of three days

Dr S Manimala Rao
THANK YOU ALL