

急診室之輸液治療概論

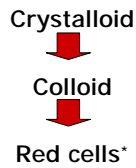


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輸液治療：目標

- n Blood volume (容量)
- n Blood composition (成份)
 - n Hemostasis
 - n Oxygen carrying capacity
 - n Oncotic pressure
 - n Biochemistry

Sequence of Components



BES (平衡電解質溶液)

- n Balanced electrolyte solutions
- n Isotonic crystalloids
 - n Ringer's lactate (林格溶液)
 - n Normal saline
- n After 1 hour,
 - n BES à 1/3 intravascular (333 cc of 1 L)
 - n D5W à 1/15 intravascular (67 cc of 1 L)

Pitfall

- n Fluid management in trauma
 - n Physicians à Inadequate or slow
 - n Surgeons à Fluid overload
- n 1:3 rule
 - n 1 L blood loss à 3~4 L RL




Classification of Hypovolemic Shock

Class	I	II	III	IV
Blood loss	< 15% (< 750cc)	15-30% (750-1500cc)	30-40% (1500-2000cc)	40% (> 2000cc)
PR	< 100 /min	100-120 /min	120-140 /min	> 140 /min
RR	14-20 /min	20-30 /min	30-40 /min	> 35 /min
Capillary refill	< 2 sec	> 2 sec	> 2 sec	> 2 sec
BP	NP	NP	Decreased	Decreased
Mental	Anxious	Irritable	Confused	Lethargic
U/O	> 30 cc/h	20-30 cc/h	5-15 cc/h	Negligible
Crystalloid (2L or 20ml/kg)	Rapid response	Transient response	Transient response	No response
Transfusion	No	Probable	Urgent	Immediate


Pitfall

- n Large amount of NS may cause hyperchloremic metabolic acidosis (non-AG)




Electrolytes

- n Normal saline
 - n Na 154 mEq/L
 - n Cl 154 mEq/L
- n Ringer's lactate
 - n Na 130 mEq/L
 - n Cl 109 mEq/L
 - n Lactate 28 mEq/L \rightleftharpoons 14 mEq/L HCO₃⁻
 - n K 4 mEq/L
 - n Ca 3 mEq/L

Always RL? 

Pitfall

- n Large amount of RL may cause severe lactic acidosis in patients with severe liver disease




Electrolytes


- n Normal saline
 - n Na 154 mEq/L
 - n Cl 154 mEq/L
- n Ringer's lactate
 - n Na 130 mEq/L
 - n Cl 109 mEq/L
 - n Lactate 28 mEq/L \rightleftharpoons 14 mEq/L HCO₃⁻
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Pitfall

- n RL should not be infused with or in the same iv tubing as bank blood

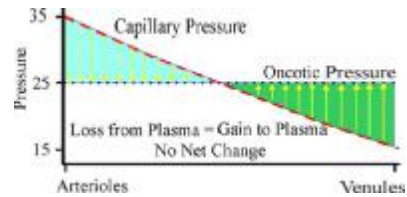
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Fluid Challenge Test

1. Check CVP
 - n If > 15 cmH₂O à No fluid challenge
2. NS 200 cc challenge (<15 min)
3. Check CVP stat and 10 min later
 - n No rise à Fluid challenge
 - n Rise > 5 cmH₂O and fall to initial à Fluid challenge
 - n Rise > 5 cmH₂O and not fall to initial à Reduce rate of infusion

Starling's Relationship



- n Hydrostatic pressure tends to cause fluid to leave the plasma
- n Oncotic pressure (血管內膠質壓力) pulls it back

Colloids

- n Plasma colloid oncotic pressure (COP)
- n Normal COP = 28 mmHg
- n Colloids
 - n ↑ Intravascular volume
 - n ↓ Interstitial edema
 - n ↑ Tissue O₂ delivery
 - n ↑ Wound healing

Dextran (葡聚糖)

- n Sucrose –(Bacteria)à Glucose polymer
- n Types
 - n D-40: MW 10,000~80,000
 - n D-70: MW 40,000~100,000
- n Beneficial effects
 - n Volume: 500 cc D-40 à 750 cc within 1h, 1,050 cc within 2h; may persist up to 8h
 - n Improves blood flow in microvasculature

Pitfall

- n Dextran – Adverse effects
 - n Increase **bleeding** from open wounds
 - ↓ Plt adhesiveness, ppt coagulation factors if > 20 cc/kg/d
 - n Difficulty with **typing** and cross-**matching** of blood
 - Should inform the blood bank
 - n **Anaphylactoid reactions**
 - Urticaria, rash, nausea, bronchospasm
 - n **Acute renal failure** in oliguric p'ts
 - Precipitate within renal tubules



Albumin (白蛋白)

- n Molecular weight 65,000
- n Accounts for 80% of plasma COP
- n Synthesis 12~14 g/day in liver
- n Adult: 4~5 g/kg
 - n 30~40% intravascular (3.5~5 g/dL)
- n Body T_{1/2} = 20~22 days
- n Plasma T_{1/2} = **12-16 hours**
- n Fractionated blood heated to 60°C x 10h
- n Preparation: 5% 500 cc; 25% 50cc

Albumin-Effects

- n Volume expansion
 - n 5% x 500 cc → Volume ↑ 250~750 cc
 - n 25% x 100 cc → Volume ↑ 300~600 cc (≈ 450 cc)
- n Other effects
 - n Binding and inactivating proteolytic enzymes
 - n Maintenance of microvascular permeability
 - n Scavenging free radicals

Pitfall

- n Infusion of albumin, especially to hypotensive patients, may rapidly reduce **iCa** levels and contribute to myocardial failure or shock

- 1 g Albumin ↔ 0.8 mg Ca
- ↓ iCa → Negative inotropic effect on myocardium



Hydroxyethyl Starch (羟乙基淀粉)

- n Hetastarch (HES, 6-10% in NS)
- n Derived from amylopectin
- n Volume expansion 100~170%
- n Retention time 12~48 h
- n Serum **amylase** levels may double
- n **>20 mL/kg/day** → Prolonged aPTT and BT
 - n ↓ Factor VIII
 - n ↑ Fibrinolysis

Pitfall

- n Hetastarch is an effective colloid for expanding blood volume, but excessive use can cause increased bleeding



FFP

- n Indication
 - n Multiple coagulation deficiencies
- n Transfusion
 - n Use filter
 - n Give within 2 hours of thawing
 - n ABO matched
 - n Compatibility testing not required

Crystalloids

Shock → Shrinkage of ECF
PE less likely due to rapid equilibration with ECF
Colloids may cross leaky pulmonary capillaries

Free from anaphylactoid reaction

Colloids (except FFP) affects coagulation

Colloids 10~100 x more expensive

Colloids

Shock → Loss of intravascular volume

Volume of crystalloids must be 3~4 x loss
Crystalloids reduces COP

< 0.05% risk

Anxiom

- n Successful resuscitation is primarily dependent on the **adequacy** of fluid replacement and not the **composition** of fluid itself



Blood Transfusion

- n $O_2 \text{ delivery} = CO \times Hb \times SaO_2 \times 1.34$
 - n Hb >10g/dl à Transfusion rarely indicated
 - n Hb <7g/dl à Transfusion usually necessary
 - n Hb 7~10 g/dl à Transfusion guided by clinical status

Hematocrit

- n Keep Hct >20~25%
 - n Young, healthy
 - n Normal blood volume and cardiac output
 - n SaO₂ >90%
- n Keep Hct >30~35%
 - n Critically ill
 - n Major/multiple trauma
- n Keep Hct >35~40%
 - n Severe sepsis
 - n Severe cardiopulmonary dysfunction

Anxiom

- n Young healthy individuals can do well with a Hb of **7.0 g/dL** if they are hemodynamically stable and their bleeding is controlled



Blood Types

- n Type O blood
 - n No cellular antigens
 - n Anti-A and Anti-B antibodies
 - n O-positive blood
 - n O-negative blood
- n Type-specific blood
 - n ABO and Rh D typing
 - n 10~15 min
- n Fully cross-matched blood
 - n ABO, Rh-D, and compatibility tests, Ab screen
 - n 30~45 min

Type O Blood

- n Un-typed, un-cross-matched type O blood in extreme emergencies
 - n O-negative for women of child-bearing age
 - n Large amount à Transfusion reactions (minor)
 - n If > 8 U à Complicate subsequent cross-matching

Pitfall



- n If physicians give type O un-cross-matched blood when it might be possible to delay infusion for **5~10 min** by using other fluids, they greatly increase the risk of complications

Extreme Emergencies

- ☒ Group O blood
 - n Women à Rhesus D negative blood
 - Type specific blood
 - n ABO and Rh D matched, available in 10~15 min
 - ☒ Cross-matched blood
 - n Use original serum sample
- n If an Ab screen -ve and more than one blood volume has been administered
- n No need for compatibility tests
 - n Should only exclude ABO mismatches

Massive Transfusion

- n Replacement of a patient's **total** blood volume in less than **24 hours**
- n Acute administration of **>50%** of the patient's estimated blood volume **per hour**

Massive Transfusion

- n Patients who require massive transfusion of **>20 U** of blood within **24 hours** à Mortality ~50%
- n Risks
 - n SBP <80 mmHg for >30 min
 - n Pre-existing disease
 - n Age >65 yr

Complication (1)

- n Dilutional thrombocytopenia
 - n Platelet function declines to zero after only a few days of storage
 - n > 1.5 x blood volume (smaller if DIC or pre-existing thrombocytopenia)
- n Coagulation Factor Depletion
 - n Supervening DIC
 - n Stored blood contains all coagulation factors except V and VIII

Tips

- n Simple test
 - n 2~3 cc blood in test tube for 5~10 min
- n Sample collection
 - n Should not be drawn from an indwelling catheter



Complication (2)

- n Oxygen Affinity Changes
 - n Not fresh blood → High O₂ affinity
 - n Fairly fresh blood (<1 week old)
 - n Fresh blood (<24 hours) not indicated
 - n 2,3 DPG levels rise rapidly following transfusion and normal oxygen affinity is usually restored in a few hours
-

Complication (3)

- n Hypocalcaemia
 - n Citrate = 1.5 g/unit
 - n Liver will metabolize 3g citrate every 5 min
 - n Citrate toxicity → Hypocalcemia (tetany, BP↓)
 - > 12-20 units at rate > 2 unit every 5 min
 - Impaired liver function
 - n Calcium supplement
 - n Only if there is biochemical, clinical or ECG evidence of hypocalcaemia
-

Complication (4)

- n Hyperkalaemia
 - n Stored blood K > 30 mEq/L
 - n Hyperkalaemia if very large amounts of blood are given quickly
 - n Hypokalaemia
 - n More common as red cells begin active metabolism and intracellular uptake of potassium restarts
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Complication (5)

- n Acid/Base Disturbances
 - n Lactic acid up to 30-40 mmol/L
 - n Citrate → HCO₃ → profound metabolic alkalosis
 - n Final acid/base status being dependent on tissue perfusion, rate of transfusion, and citrate metabolism
-

Complication (6)

- n Hypothermia (<35°C)
 - n Reduction in citrate and lactate metabolism → Hypocalcaemia and metabolic acidosis
 - n Increase in affinity of hemoglobin for oxygen
 - n Impairment of red cell deformability
 - n Platelet dysfunction
 - n Increased tendency to cardiac dysrhythmias
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Complication (7)

- n ARDS
 - n Etiology as yet not fully understood
 - n Risk factors
 - Both under- and over-transfusion are associated with an increased risk of ARDS
 - Albumin < 3 g/dL
 - Blood > 40 U and shock >30 min
 - n Microaggregate filters should be used during massive transfusion except when giving fresh whole blood or platelets
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Correcting Hemostasis

- n Platelet concentrates
 - n 2U/10kg if platelet < 50,000
 - n 2U of platelet concentrate also provides around 50ml of fresh plasma
- n Fresh frozen plasma
 - n 12 ml/kg if PT or PTT > 1.5 x control
- n Cryoprecipitate
 - n 2-3 units/10kg if fibrinogen < 0.8g/L

Pitfall

- n Massive uncontrolled hemorrhage
 - n Highest priority
 - è Definitive surgical hemostasis
 - n Lower priority
 - è Correct coagulopathy



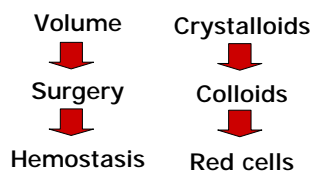
Infectious Complications

- n Risk per unit (USA)
 - n Hepatitis virus 1:5,000
 - n HTLV 1:200,000
 - n HIV 1:420,000
- n Hepatitis viruses
 - n 85~98% à HCV
 - n Incubation: HCV à 8 wk, HBV à 11 wk
 - n Chronicity: HCV à 40%, HBV à 5~10%
 - n HCV à 40~50% fulminant hepatitis

Autotransfusion

- n Benefits
 - n ↓ Blood bank needs
 - n ↓ Risk of blood-borne diseases
 - n Free of hemolytic, febrile, or allergic reactions
- n Caution
 - n Contamination (including bacteria)
 - n Excess amount à DIC
 - n Heparinization à Increased bleeding
 - n Should not > 3 L

Conclusion



Thanks



急救教室 <http://www.jack119.org>