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Goal-Directed Fluid Therapy in Children

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About the Speaker



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- Pediatrics intensive care ,Pediatrics pain management

outline

Adequate perfusion and metabolic stability with the **minimum necessary fluid**



Why Neonates and Infants Are at Risk?

Young children have a narrow margin between dehydration and fluid overload.

Fluid Distribution

- Larger extracellular compartment per kg
- Greater insensible losses per kg
- Immature renal concentration ability
- Limitation in rapid excretion of an excess fluid load

Metabolic Risk

- Stress-induced ADH → hyponatremia risk
- Impaired free-water excretion
- Limited glycogen stores → fasting hypoglycemia

Preoperative Assessment

Establish the Clinical Context

Base the assessment on **actual intake, losses, perfusion,** and fluid tolerance _not a single measurement.

History

- Confirm true fasting duration
- Last feed timing and volume
- Vomiting, diarrhea, fever

Perfusion Signs

- Age-appropriate HR and BP
- Capillary refill, limb temperature
- Mental status and urine output

Tolerance Flags

- Cardiac or renal disease
- Edema, respiratory deterioration
- Existing positive fluid balance

A normal blood pressure does not exclude hypovolemia. Interpret findings together.

Preoperative Testing & Prescription

Laboratory Testing

- Target glucose, electrolytes, CBC, renal function when *clinically* indicated
- Routine pre-op labs unnecessary in healthy children for minor surgery
- Clear fluids permitted until 1–2 hours before surgery

Maintenance
Basal hourly needs

Deficit Correction
Measured clinical losses

Ongoing Losses
Replaced separately

Individualize ,Then Reassess Response and Tolerance

1 Balanced isotonic crystalloid for volume replacement
Typical volumes for fasting time : 20–40 mL/kg (euvolemic) · 40–80 mL/kg (dehydrated)

2 Use the 4–2–1 rule as an initial estimate of baseline maintenance.

Body Weight	Calculation Method	Total Maintenance Rate ml/h	Example
≤10 kg	4 mL/kg/h for the first 10 kg	4 × weight	8-kg child: 4 × 8 = 32 mL/h
>10–20 kg	40 mL/h + 2 mL/kg/h for each kg above 10 kg	40 + [2 × (weight − 10)]	15-kg child: 40 + (2 × 5) = 50 mL/h
>20 kg	60 mL/h + 1 mL/kg/h for each kg above 20 kg	60 + (weight − 20)	25-kg child: 60 + 5 = 65 mL/h

Case Presentation: Neuroblastoma Resection in a 1-Year-Old Child

A 1-year-old child weighing 10 kg presents for neuroblastoma resection. The child was admitted to the surgical ward the night before and has been NPO for 8 hours. The prescribed IV fluid was 1,000 mL of 5% dextrose half-normal saline over 24 hours, approximately 40 mL/h.

Serum electrolytes and renal function are normal, and hemoglobin is 10 g/dL. The child is not dehydrated on presentation, with a blood pressure of 90/60 mmHg and a heart rate of 105 beats/min.

Estimated operation time 2hours

Do you Convert Fasting Time into a Bolus ?

Traditional Calculation

40 mL/hr × 8 hrs = **320 mL** already delivered by ward maintenance

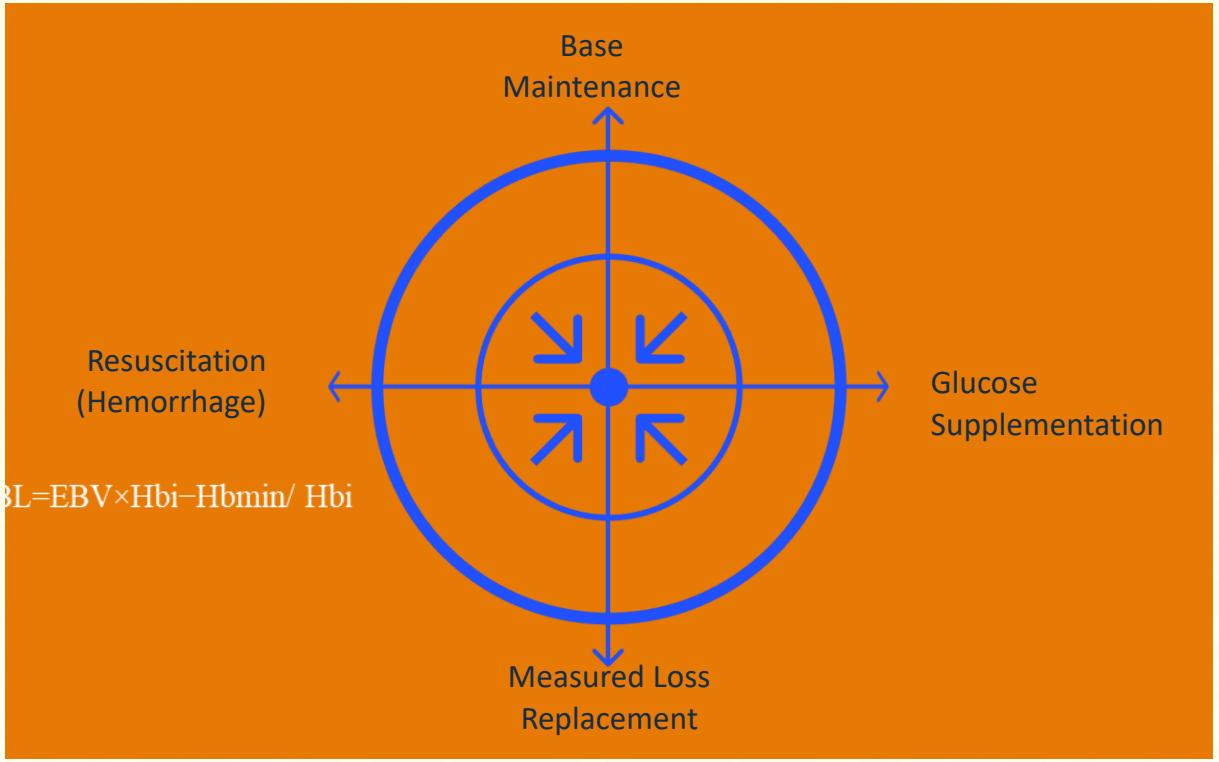
Traditional fasting-deficit calculation is matched — but this does **not** justify an additional 320 mL bolus in a clinically euvolemic child.

Intraoperative Fluid Change

- D5/0.45% saline is physiologically **hypotonic** after glucose metabolism
- Under surgical ADH stress → **hyponatremia risk**
- Stop before induction
- Replace with **isotonic balanced crystalloid** as base fluid

A calculated deficit is not, by itself, a fluid indication

Intraoperative Strategy



Case Estimate

4 mL/kg/hr × 10 kg = **40 mL/hr**

80 mL over 2 hours

Estimated blood volume=**800 cc**(70–80 mL/kg)

ABL=EBV × Hbi-Hbmin/Hbi=800 × 10-7/10=240 cc

In this case estimated blood loss is 200 cc, Bp =68/46 PR=148, Spo2=98% ,Etco2=37

- 200-mL blood loss represents approximately 25% of the estimated blood volume (800 mL).
- Automatic replacement with 600 mL of normal saline using the traditional 3:1 rule is not recommended.
- Ongoing significant bleeding or impaired perfusion favors early packed red blood cell transfusion rather than escalating crystalloid administration

Initial PRBC : 10 mL/kg = 100 mL

If BP is low and tachycardia is present ,repeat 5cc/kg

Monitor Hb/Hct, platelets, ionized Ca^{2+}, K^{+}, temperature

Restrictive threshold ~7 g/dL is supported for stable children — does not justify delay during active bleeding with impaired perfusion.

USCOM: Ultrasonic Cardiac Output Monitoring

What USCOM Provides

- **Continuous-wave Doppler: SV,SVI, CO, FTc , SVRI…**
- **Shortened FTc *may suggest* reduced preload — not diagnostic alone**
- **Long FTc , may suggest overload but low & high SVRI may happend**
- **Interpret alongside SV and clinical perfusion signs**

Key Limitation

- Adult SVV thresholds **cannot** be extrapolated to children
- FTc depends on preload, afterload, contractility, and correction method

Record Baseline

SV/SVI, CO/CI, FTc at case start

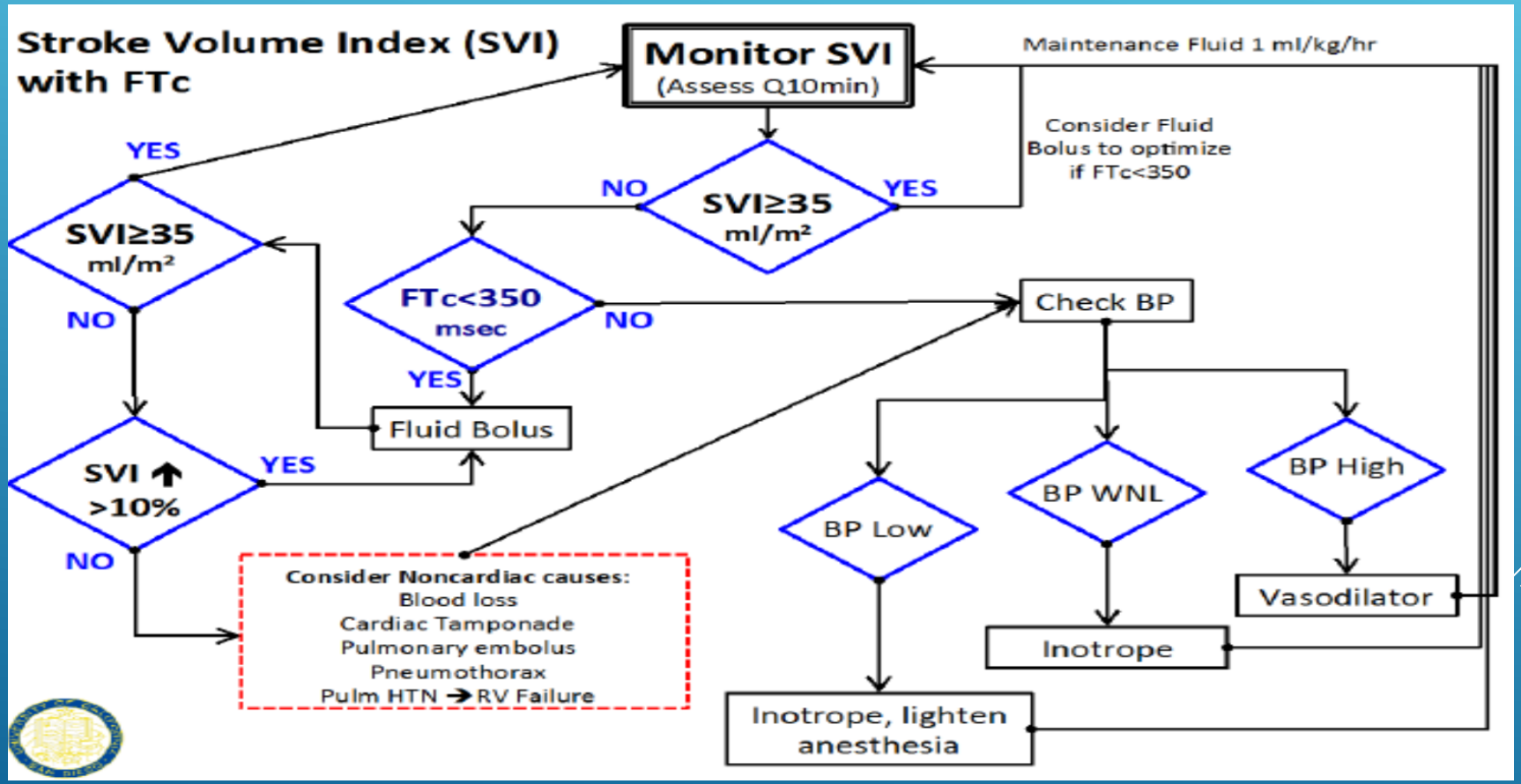
On Deterioration, Consider

Hemorrhage · Vasodilation · Reduced preload · Myocardial dysfunction

Do Not Act on FTc Alone

Low FTc in isolation is not a bolus indication

PRELOAD MONITORING



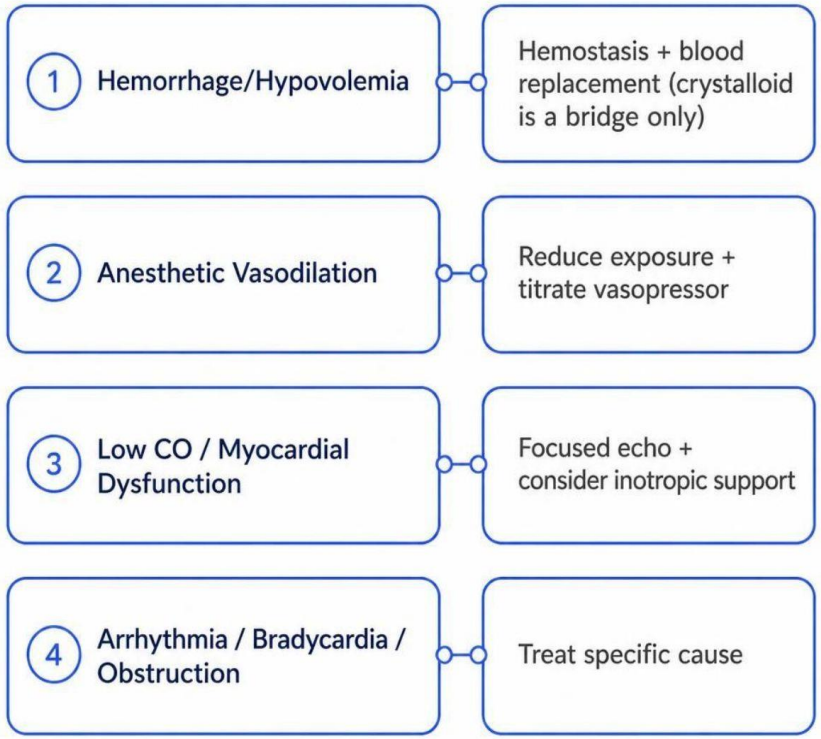
Arterial line

- A correctly zeroed and leveled arterial line provides
- Continuous MAP, systolic/diastolic pressure, pulse pressure, and access for serial blood sampling.
- Interpret pressure trends alongside peripheral perfusion, hemoglobin, lactate, and, when available, Doppler-derived stroke volume/VTI.
- Respiratory pulse pressure and systolic pressure variations are less reliable predictors of fluid responsiveness in infants and children; adult PPV thresholds should not be used as automatic fluid-bolus triggers.

PHASE 2

Intraoperative Hypotension

Identify the Mechanism Before Choosing an Intervention



First Steps

- Confirm reading and trend vs. baseline
- Assess oxygenation, ventilation, rhythm
- Evaluate anesthetic depth and surgical events

Empirical crystalloid boluses are not the stated response to anesthetic vasodilation.

Postoperative Prescription

Case Estimate

Isotonic maintenance: 4 × 10 kg = 40 mL/hr

Some references suggest 2,1,./5 cc /kg /hr for first 12 hours after OR

Calculated as 10,5,2 cc/kg /24 h

Balanced formulation with appropriate dextrose; add K^+ only after confirming serum K^+, renal function, and urine output.

Enteral Feeding

When clinically and surgically appropriate — reduce IV fluid **proportionally**. Do not add full maintenance on top of feeds or drug volumes.

Avoid Routine Hypotonic D5/0.45% Saline

- Elevated postoperative ADH increases hyponatremia risk
- Replace measurable GI or drain losses separately
- Active hemorrhage → blood products, not crystalloid
- Malignancy patients: individualize PICU fluid choice and rate

PICU Handover: Make Total Exposure Visible

Total Fluid Inputs

Crystalloid, blood products, drug carriers, flushes

Latest Labs

Hb, electrolytes, glucose, lactate, urine output ,ABG

Ongoing Losses

Drain losses, hemorrhage risk, coagulation status

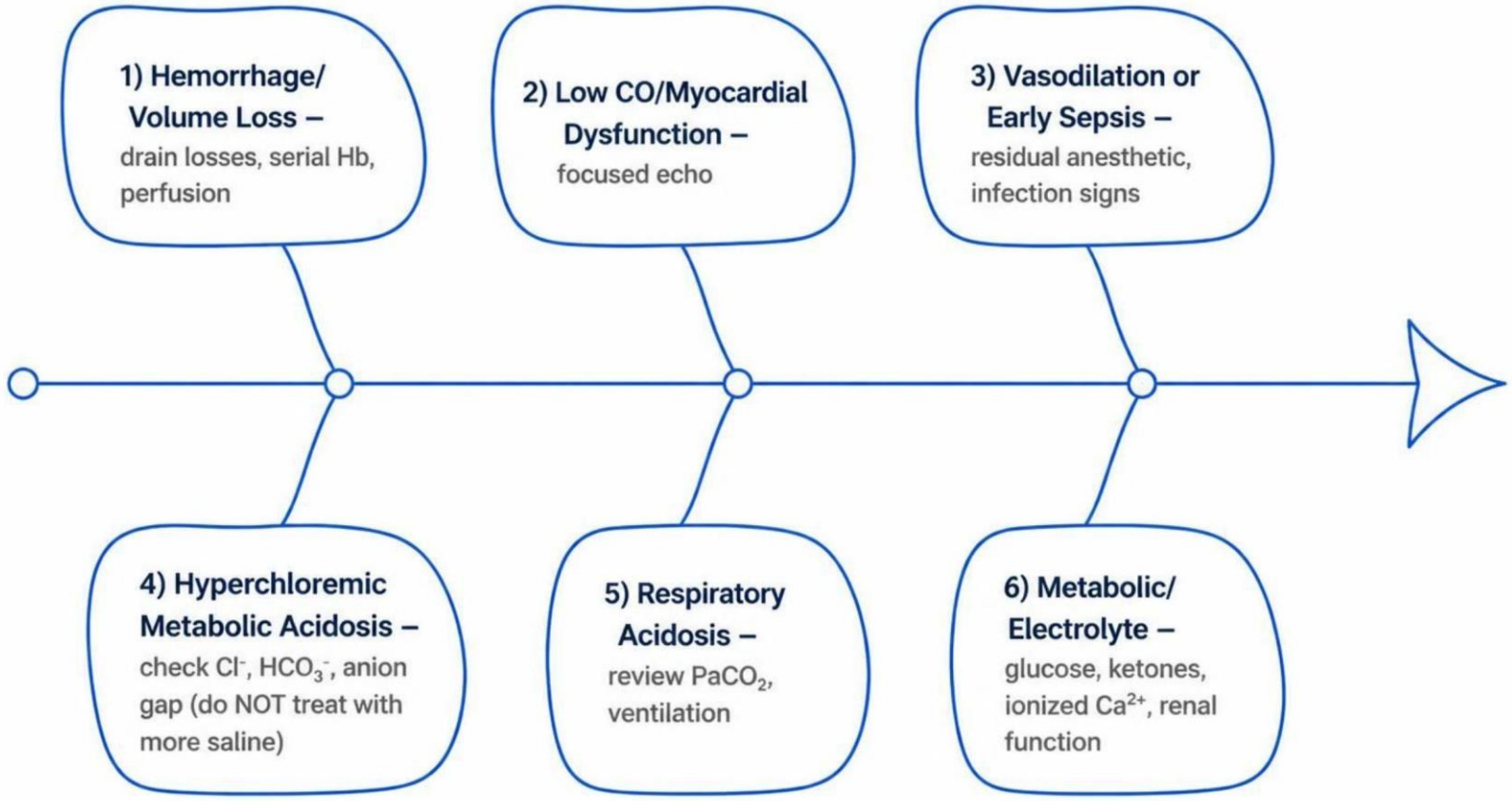
Vasoactive Support

Current agents, doses, and hemodynamic targets, Uscom ,Echo

Total fluid exposure — not crystalloid alone — must be visible so postoperative prescriptions can be interpreted against prior inputs, losses, and ongoing support.

Postoperative Acidosis & Hypotension

A Differential Diagnosis — Not an Automatic Bolus



Take-Home Framework

Adequate perfusion · minimum necessary fluid

01

Preoperative

Assess actual hydration — fasting duration alone does not define a deficit

02

Intraoperative

Separate maintenance, replacement, and resuscitation — no automatic fixed allowances

03

Postoperative / PICU

Reassess inputs, cumulative balance, electrolytes, and organ function continuously

04

Before Every Bolus — Ask Three Questions

Is fluid needed? Is it likely to help? Is it tolerable?

No single value mandates fluid. Interpret perfusion, serial labs, echo, and USCOM together.

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