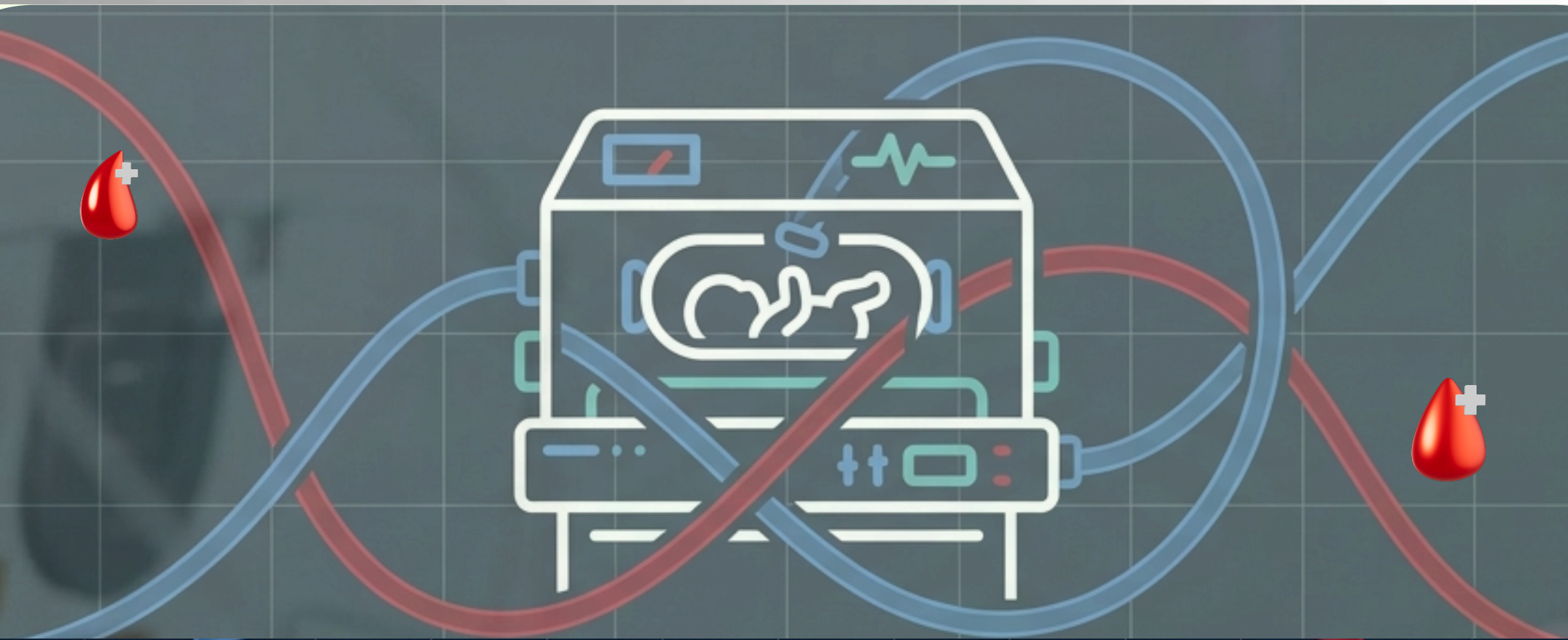




Exchange Transfusion in Neonates

Comprehensive Clinical Protocol & Execution Pathway



Indications



Severe Haemolytic Anaemia

Replaces antibody-coated red blood cells and corrects critical anaemia.



Critical Hyperbilirubinaemia

Removes intravascular bilirubin to prevent neurotoxicity (kernicterus).
Replaces 50% of available intravascular bilirubin.

Other Indications

Disseminated Intravascular Coagulation (DIC)

Chronic feto-maternal transfusion

Severe non-haemolytic anaemia

Assess Patient

Haemolytic Anaemia Thresholds (No previous IUT)

Cord Hb < 100 g/L

Urgent Exchange Transfusion
(Avoid simple packed cells)

Cord Hb 100-120 g/L

Check 6-hrly bilirubin;
consider IVIG if rapidly rising

Previous IUTs

Use top-up transfusion if
adult Hb predominates

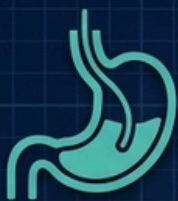
Hyperbilirubinaemia Thresholds

Plotted on NICE gestational charts

Velocity Trigger: Bilirubin rising
> 8.5 micromol/L/hr despite
intensive phototherapy

Anticipate Exchange

Precautions



Gastrointestinal Decompression

Pass NGT, empty stomach, and keep
baby nil-by-mouth (NBM).



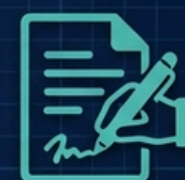
Cardiorespiratory Monitoring

Initiate continuous ECG, SpO₂, BP, and
temperature monitoring. Maintain
phototherapy if indicated.



Strict Thermoregulation

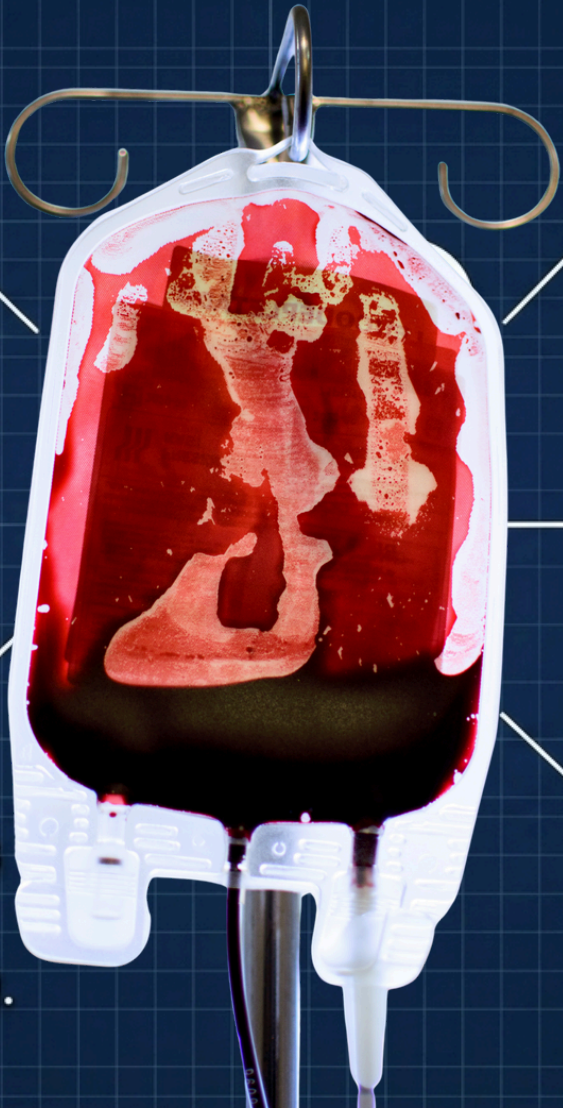
Monitor core temperature continuously.
WARNING: Use caution under radiant heaters
to prevent insensible loss/haemolysis.



Consent & Staffing

Ensure written parental consent. Allocate
1 dedicated doctor/practitioner and 1
experienced nurse to the procedure.

Characteristics of the blood to be requested



Age: < 4 days old
(as fresh as possible)

Infection Status:
CMV-negative

Irradiation: Irradiated (24 hr shelf-life) required for any baby who has had an in-utero transfusion (IUT).

Matching: Crossmatched against mother's blood group and antibody status (and baby's if requested).

Type: Plasma reduced red cells for 'exchange transfusion' (NOT SAG-M, NOT packed cells).
Haematocrit 0.5-0.6.

Double Volume Exchange (Primary standard) Removes 90% of red cells

Term Babies:

$$[W \text{ (kg)} \times 160] = \text{Total Volume (mL)}$$

Preterm Babies:

$$[W \text{ (kg)} \times 200] = \text{Total Volume (mL)}$$

Single Volume Exchange (For anaemia without antibodies / simple hyperbilirubinaemia)

Term Babies:

$$[W \text{ (kg)} \times 80] = \text{Total Volume (mL)}$$

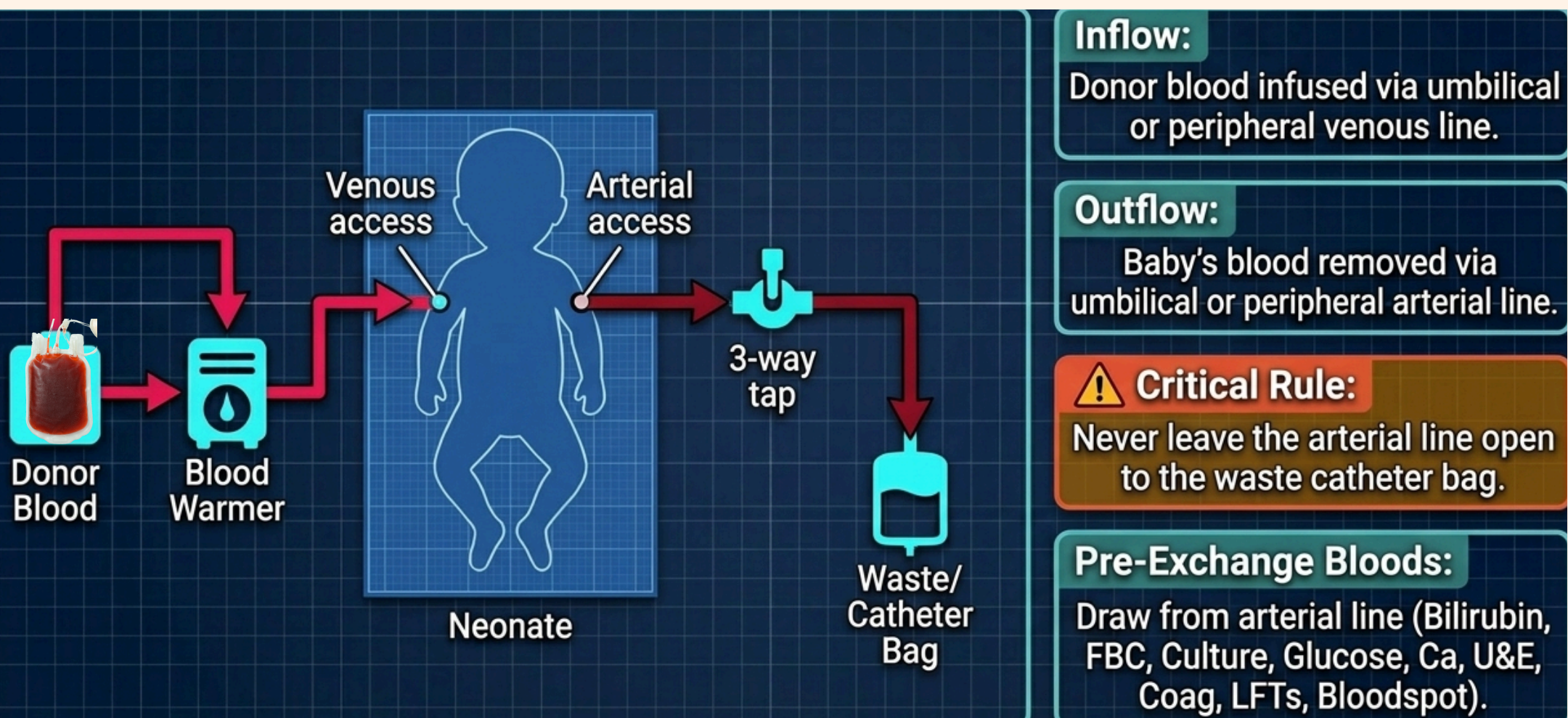
Preterm Babies:

$$[W \text{ (kg)} \times 100] = \text{Total Volume (mL)}$$

Comparison Matrix: Operative Techniques

	Isovolumetric (Continuous)	Single Catheter (Push-Pull)
Mechanics	Simultaneous, continuous in-and-out flow.	Sequential out-and-in cycles via a single line.
Vascular Access	Venous line (In) + Arterial line (Out).	Umbilical Venous Catheter (UVC) only.
Equipment	3-way tap.	4-way tap system.
Temperature Control	Blood warmer required (37°C).	Do NOT use a blood warmer.

Setup Architecture I: Isovolumetric (Continuous)



Isovolumetric Aliquots & Flow Rates

(Take aliquots from arterial line at 5 min intervals)

Weight Range	Aliquot Volume	Flow Speed
< 1500 g	Aliquot: 5 mL	Speed: 1 mL/min (60 mL/hr)
1500 - 2499 g	Aliquot: 10 mL	Speed: 2 mL/min (120 mL/hr)
2500 - 3499 g	Aliquot: 15 mL	Speed: 3 mL/min (180 mL/hr)
>= 3500 g	Aliquot: 20 mL	Speed: 4 mL/min (240 mL/hr)

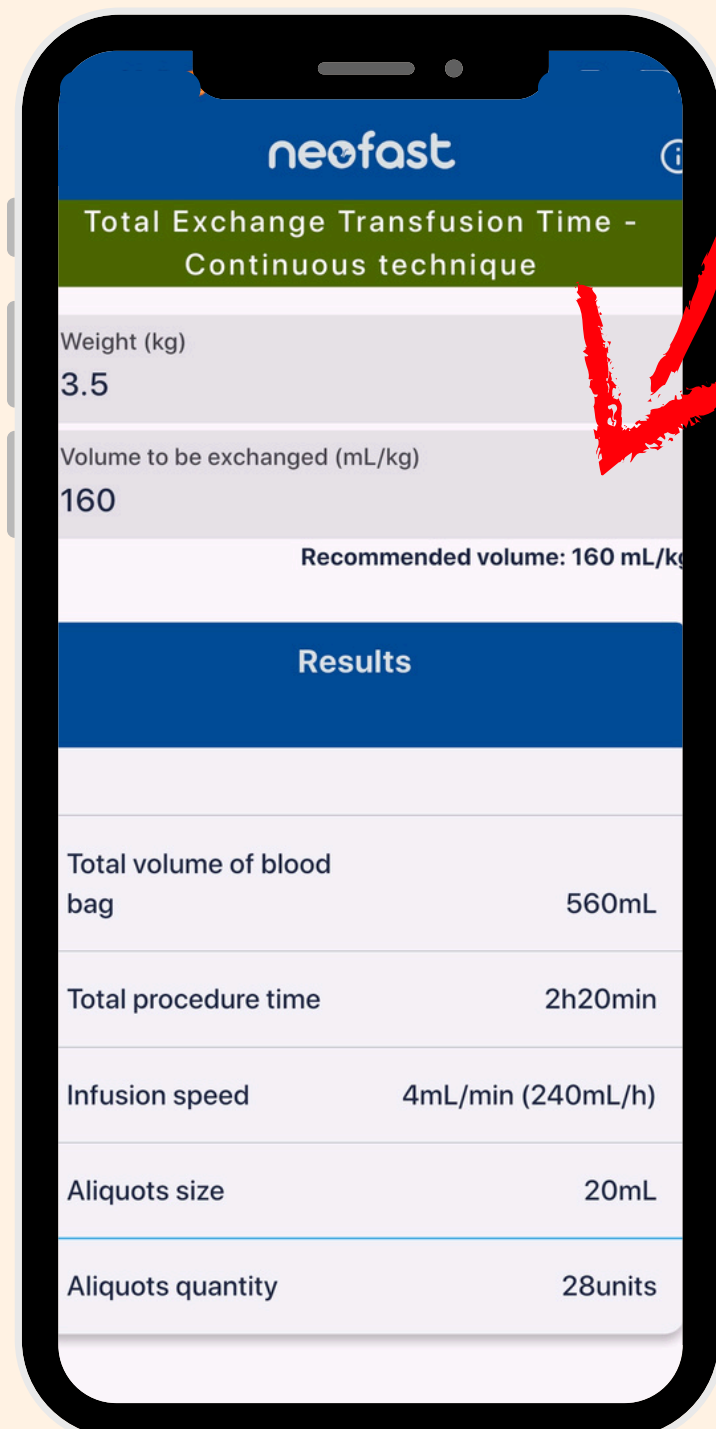
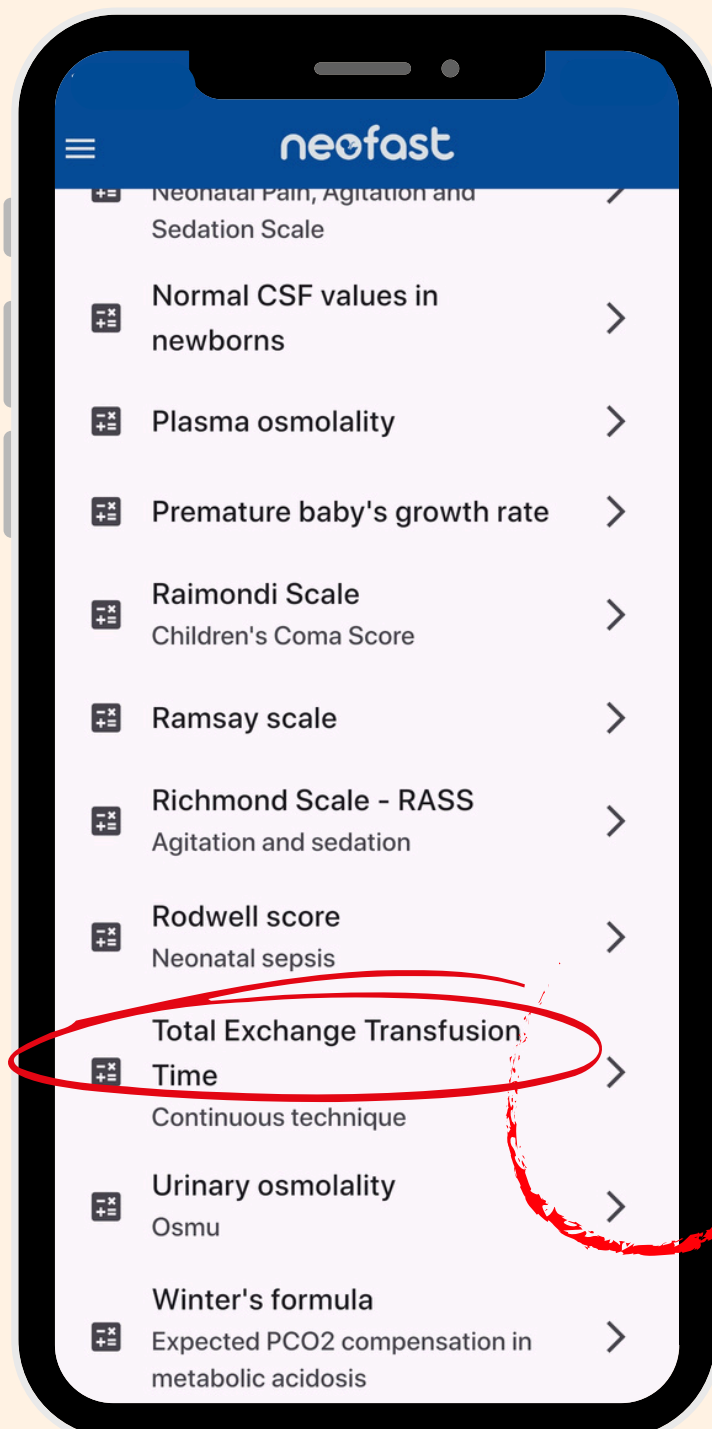
Calculation Example: 3.5 kg Term Baby

$3.5 \text{ kg} \times 160 = 560 \text{ mL Total Volume}$

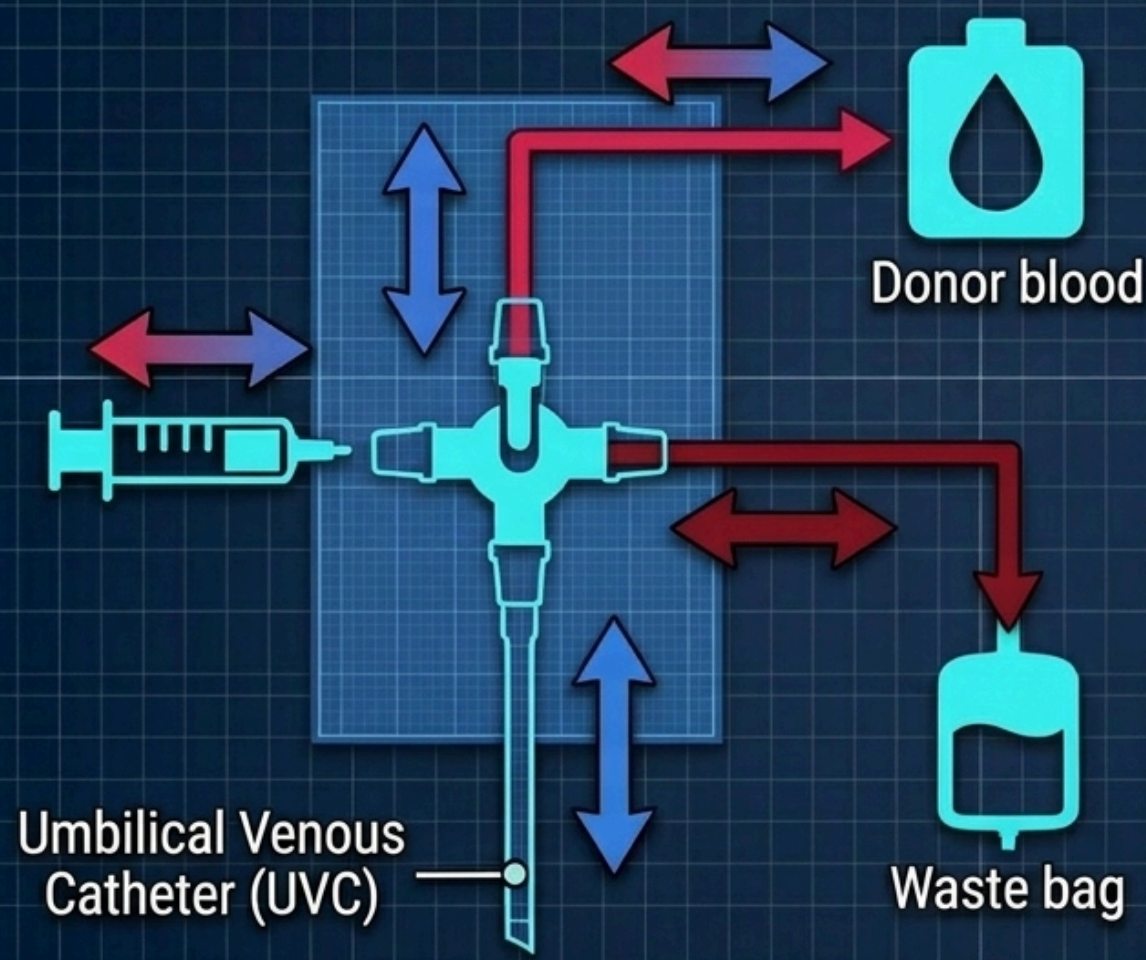
$560 \text{ mL} / 4 \text{ mL/min} = 140 \text{ minutes total time}$

$560 \text{ mL} / 20 \text{ mL aliquots} = 28 \text{ separate aliquots}$

The digital solution, NeoFast, in action



Setup Architecture II: Single Catheter Push-Pull



Access:

Relies entirely on a single Umbilical Venous Catheter (UVC).

Manifold:

Connect donor blood and waste bag to a 4-way tap, attached directly to the UVC.

⚠ Temperature Warning:

Do NOT use a blood warmer with this technique due to intermittent flow.

Pre-Exchange Bloods:

Remove blood from UVC using syringe before initiating the first replacement cycle.

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Exchange Transfusion - Single catheter push-pull technique

Single catheter push-pull technique

Blood Type Selection for Exchange Transfusion		
MATERNAL BLOOD TYPE	INFANT BLOOD TYPE	DONOR BLOOD TYPE
O	O OR A OR B OR AB	O
A, B OR AB	O OR A OR B OR AB	Baby blood type OR O
Rhesus negative	Rhesus negative OR positive	Rhesus negative

Source: NeoReviews, an official journal of the American Academy of Pediatrics. Available from: <<https://video.publications.aap.org/neovideos/detail/videos/emergent-procedures/video/61338646775001/double-volume-exchange-transfusion>>.

Three way taps

Valve for controlling flow direction

Line 1

Line 2

Output to connect: equipment, catheter and tubes

Connection

connect the blood bag to the three way line

Connect to waste bag

20 mL syringe (10 mL can be used if difficult to aspirate)

Connect to UVC or UAC

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Exchange Transfusion - Single catheter push-pull technique

Steps

Pay attention to the positions of the three ways.

1

Remove blood from UVC using syringe and send for pre-exchange bloods

Optional: remove an additional blood (e.g., 5ml) to work with Initial Negative Volume if the patient is at risk of volume overload (e.g., heart patients).

Each out-in cycle should replace ≤ 8.5 mL/kg and take ≥ 5 min; start with smaller aliquots (10 mL) and increase to 20 mL (if baby stable and weight allows) only after 30 min.

Pay attention to the positions of the three ways.

2

Discard 'out' baby blood into catheter bag.

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Exchange Transfusion - Single catheter push-pull technique

3

Aspirate the blood from the bag.

Pay attention to the positions of the three ways.

4

From the blood bag to the baby by UVC or UAC

Pay attention to the positions of the three ways.

5

- continue out-in cycles every 5 min (maximum aliquot with each cycle) until complete;
- send last 'out' baby blood sample for post-exchange bloods;
- and complete with the blood you optionally took at the beginning.

Execution: The Push-Pull Cycle

Step 1: Out (Withdraw)

Slowly remove precise volume of baby's blood into syringe. Discard into waste bag.

Step 2: In (Replace)

Draw exact equal volume of donor blood into syringe. Infuse slowly into baby.

The Golden Ratio:

Maximum volume per cycle is ≤ 8.5 mL/kg.

The Timing:

Each full Out-In cycle must take ≥ 5 minutes.

Titration: Start with small aliquots (10 mL). Increase to max 20 mL only after 30 minutes if baby is stable.

Intra-Operative Monitoring

Outer Ring
(Every 30 mins)

Inner Ring
(Every 15 mins)

15-Minute Tasks:

- Document BP, HR, RR, SpO₂, Temperature.
- Observe distal limbs (if arterial line used).
- Gently squeeze donor blood bag to prevent RBC settling.

30-Minute Tasks:

- Draw Arterial Blood Gas.
- Monitor pH, Lactate, Glucose, Calcium, Potassium.

Pause Protocol:

If cardiorespiratory status changes, pause exchange, prime catheter with non-clotting donor blood, and consult consultant. nt. Do not stop for $> 2-3$ mins without flushing lines with NaCl 0.9%.

The Complications Radar

Cardiovascular

- Cardiac arrhythmias
- Air embolism
- Apnoeas and bradycardia.

Haematological

- Thrombocytopenia
- Coagulopathy
- Late hyporegenerative anaemia.



Metabolic

- Hypoglycaemia
- Acidosis (due to non-fresh blood)
- Electrolyte shifts (hyperkalaemia, hypocalcaemia).

GI & Infectious

- Necrotising Enterocolitis (NEC)
- Sepsis

Post-Procedure Care Pathway

Immediate (0 Hours)

Draw final 'out' post-exchange bloods (Bilirubin, FBC, Culture, Glucose, Ca, U&E).

Confirm Hb/Bilirubin with consultant before removing lines.

Intermediate (4-6 Hours)

Recommence feeds 4-6 hours post-completion.

Monitor blood sugar 4-hrly until acceptable on two consecutive checks.

Administer post-procedure antibiotics if indicated.

Long-Term (Weeks)

Neurodevelopmental follow-up is mandatory.

Check FBC 1-2 weekly for ≥ 6 weeks to detect late hyporegenerative anaemia.

Care Timeline

Synthesis: The Four Pillars of Exchange Transfusion

1.

Perfect the Indication

Only proceed for precise Hb and bilirubin velocity thresholds.

Calculate double vs. single volume accurately based on weight and term status.

2.

Demand Perfect Blood

Tolerate zero deviations. Must be CMV-negative, < 4 days old, irradiated (if prior IUT), and Hct 0.5-0.6.

3.

Unyielding Math

Respect the flow rates. ≤ 8.5 mL/kg max per cycle in Push-Pull. Strict 5-minute intervals. Do not rush.

4.

Total Vigilance

The operation is a metabolic stress test. Anticipate hypocalcaemia, hyperkalaemia, and hypoglycaemia with rigorous 30-minute ABG checks. Monitor long-term for NEC and late anaemia.



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