# Case Studies in Therapeutic Apheresis

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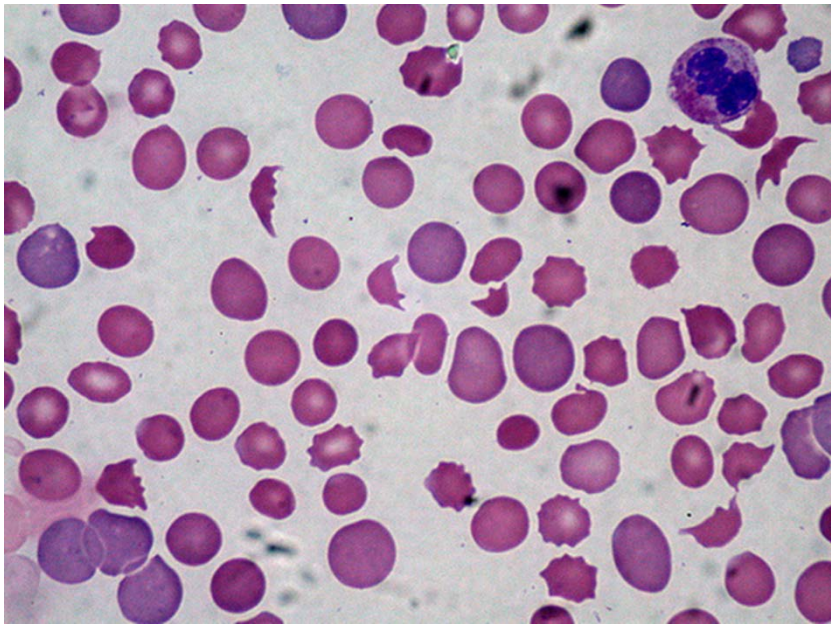
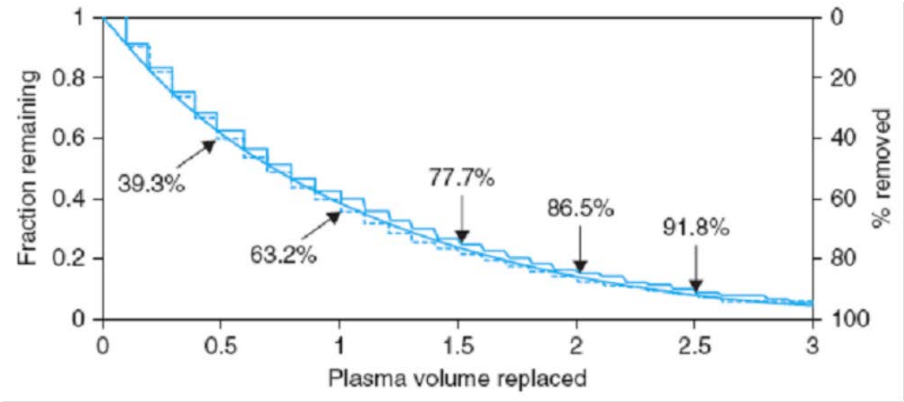
# Case #1



- 41 year old female
- Presents to ER with seizures and jaundice
- Laboratory results:
  - Hb/Hct 7/21, Plts 19K
  - LDH 845 IU/L
  - Cr 2.3 mg/dl, BUN 42 mg/dL

# Calculations

- **Weight=50 kg, thin body habitus**
- **Hct= .21**
- **TBV =50 kg x 60 mL/kg = 3000 mL**
- **Plasma % = 1-Hct = .79**
- **1 plasma volume = (1-Hct) x TBV = 0.79 x 3000 = 2370 mL**
- **# plasma units = 2370 mL/300 mL per unit ≈ 8 units**




| Gender | Normal | Obese (-10) | Thin (-5) | Muscular (+5) |
|---|---|---|---|---|
| Female | 65 | 55 | 60 | 70 |
| Male | 70 | 60 | 65 | 75 |

# Orders

- Place IJ double-lumen 10 French dialysis catheter
- Draw ADAMTS13 pre-TPE
- Perform daily 1 PV TPE with 100% plasma replacement
  - Order 8 units plasma with blood bank
  - FFP, FP24, cryopoor plasma: similar ADAMTS13 levels which are stable for 5-day storage post-thaw
- Daily CBC and LDH

Scott EA, Transfusion 2007

# Hospital course: citrate toxicity

- Patient complaints of chills and paresthesias towards end of 1st procedure, afebrile.
- Still symptomatic with pause of procedure

- Immediate corrective action
  - IV calcium gluconate
  - Apheresis nurse should decrease inlet flow rate
- Preventive corrective action
  - Calcium carbonate 1 elemental gm prior to procedure and 1 gm mid-way through procedure
  - Replete Ca, Mg, K levels pre-procedure

# Hospital course: seizures

- Patient is on carbamazepine 400 mg bid for seizure prevention, but develops recurrence of seizures towards the end of the 2nd procedure

- Carbamazepine has a high volume of distribution 1.4 L/kg but is 75% protein bound
- Morning dose was given prior to her procedure
- Dosing changed to 1 hour after each TPE

# Hospital course: allergic reaction

- **Pt develops generalized hives with 6th procedure. Also, has AB blood type and blood bank is short of AB plasma. What can be done with subsequent procedures?**

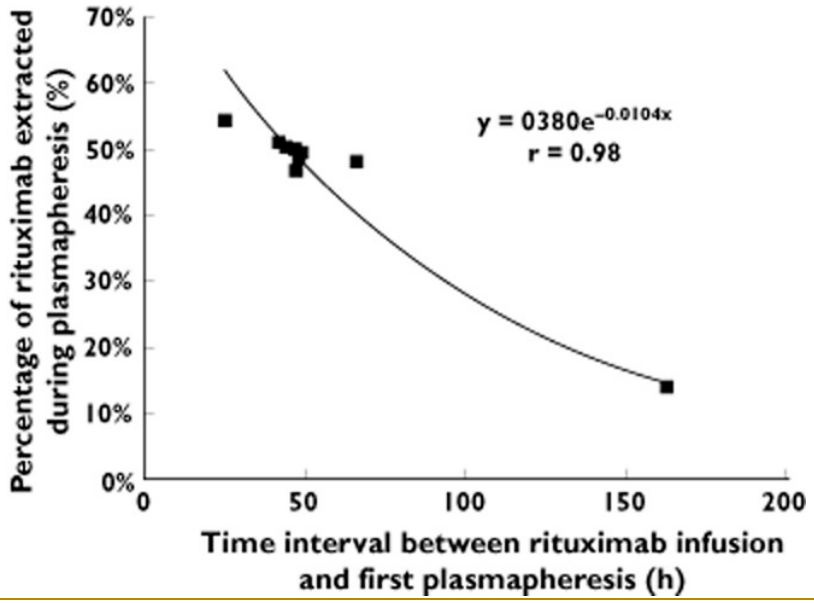
- **Premedicate**
  - **Diphenhydramine 25-50 mg IV**
  - **Hydrocortisone 100 mg IV**
  - **Add H2 blockers if more severe**
- **Reduce volume of plasma replacement**
  - **Replacing with 50% albumin, 50% plasma achieves ADAMTS13 activity of ~40% versus 65%**
  - **% response (90%), median # TPEs (11), time to response (25 days), % relapse (53%) in case series (21 patients) with ADAMTS13 ≤ 10%**
  - **Administer plasma in 2nd half of procedure**
  - **Also will help this pt's citrate toxicity sxs**

O'Brien KL, JCA 2013

# Hospital course

- **Pt discharged after 3 days of normal platelet count and LDH but re-admitted 1 month later with recurrence. In addition to resuming TPE, you decide to treat with rituximab.**

- **Although rituximab may remove > 50% B-cells by 24 hr, ~50% of rituximab removed with TPE at ~48 hr post-rituximab**
- **Separate TPE and rituximab infusion by at least 24-48 hr (stabilize counts first if possible with TPE)**






Puisset F, Br J Clin Pharm 2013
Darabi K, Am J Clin Path 2006

# Case #2

- 4 year old male
- Presents with abrupt personality change with obsessive compulsive behavior. History unremarkable except for pharyngitis 1 month ago.
- Wt 15 kg, Hct 30%, nl coags

- PANDAS (Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal infection)

# Calculations

| Variable | Formula | Example |
|---|---|---|
| TBV | Wt (kg) x 70 cc/kg | 15 x 70 = 1050 cc |
| Plasma volume | (1-Hct) * TBV | (1- 0.30) * 1050 = 735 cc |
| RCV | Hct * TBV | ( 0.30) * 1050 = 315 cc |
| % EC TBV | (Kit volume) / TBV | 185 / 1050 = 18% |
| % EC RCV | (Kit RBC volume) / RCV | 56 /315= 18% |

Device calculator (Nadler formula) not accurate for pts < 25 kg

| Spectra kit | TPE/RCE |
|---|---|
| EC TBV | 227 |
| EC RCV | 68 |

| Optia Kit | TPE/RCE |
|---|---|
| EC TBV | 185 |
| EC RCV | 56 |

# Blood prime

## Cobe Spectra

**Table 2:** Approximate change in Hct after processing an **undiluted** unit

| Theoretical Prediction Using a 300 mL Blood Prime | | | | | |
|---|---|---|---|---|---|
| **Patient TBV** | **Patient Hct** | **Prime Hct** | **TPE** | **MNC** | **Auto PBSC** |
| 600 mL | 25 | 60 | 5 | 5 | 4 |
| | 30 | 60 | 3 | 3 | 3 |
| | 35 | 60 | 2 | 2 | 2 |
| | 40 | 60 | 1 | 1 | 2 |
| | 45 | 60 | 0 | 1 | 1 |
| 1000 mL | 25 | 60 | 3 | 3 | 2 |
| | 30 | 60 | 2 | 2 | 2 |
| | 35 | 60 | 1 | 1 | 1 |
| | 40 | 60 | 1 | 1 | 1 |
| | 45 | 60 | 0 | 0 | 1 |

## Optia

Pediatrics/Low TBV Patien

### Custom Prime – RBC (60% Hct)

This table indicates the calculated estimate of the change in the patient's Hct immediately after the custom prime RBC have been delivered to the patient. This is not an indication of the patient's post-procedure Hct since it cannot predict the patient's hemodynamic response to the procedure.

| Patient | | 200 mL RBC | No blood prime | 240 mL RBC | No blood prime |
|---|---|---|---|---|---|
| | | No blood warmer | | 40 mL blood warmer | |
| TBV | Hct (%) | Change in patient Hct (%) | | | |
| 300 mL | 25 | +5 | -13 | +8 | -14 |
| | 30 | +4 | -14 | +7 | -16 |
| | 35 | +3 | -15 | +6 | -17 |
| | 40 | +2 | -16 | +4 | -18 |
| 600 mL | 25 | +3 | -7 | +5 | -8 |
| | 30 | +2 | -8 | +4 | -9 |
| | 35 | +2 | -8 | +3 | -10 |
| | 40 | +1 | -9 | +2 | -11 |
| 1000 mL | 25 | +2 | -5 | +3 | -5 |
| | 30 | +2 | -5 | +2 | -6 |
| | 35 | +1 | -5 | +2 | -6 |
| | 40 | +1 | -6 | +2 | -7 |

Note: The table indicates the approximate change in the patient's Hct after the custom prime.

If the potential increase in patient Hct is more than desired, can use less prime volume but then the device will draw from the patient

# Orders

- Perform 1 PV TPE (750 mL) with 5% albumin qd to qod for 6 treatments
  - Is it OK to use other concentrations of albumin, eg 25%?
- Prime with undiluted RBC unit with first procedure
- CBC prior to next procedure

- With a red cell prime, standard protocol is no rinseback of the blood in device at end of procedure (because Hct already maintained with prime)

# Hospital course

- Pt c/o abdominal discomfort, irritable, restless on Day 1.
- Options
  - Use blood warmer—must take into account extra 40 ml of ECV
    - What other circumstances would blood warmer be used?
  - Heparin protocol: 3000 U heparin/500 ml ACD at WB:ACD ratio of 24:1 (normal ratio 10-12:1)
  - Up to 30% saline

- Patient's fibrinogen on Day 3 of daily TPE is 90 mg/dL. No bleeding or bleeding risk.
- Options
  - Hold Day 3 procedure and change to qod procedures
  - Give 25% plasma replacement towards end of procedure
  - Give cryoprecipitate: pre- or post-procedure?

# Hospital course

- **Patient's Hct rises from 30% to 36% with 4 consecutive procedures using undiluted RBC prime.**

| Variable | Formula | Example |
|---|---|---|
| TBV | Wt (kg) x 70 cc/kg | 15 x 70 = 1050 cc |
| Plasma volume | (1-Hct) * TBV | (1- 0.36) * 1050 = 672 cc |
| RCV | Hct * TBV | ( 0.36) * 1050 = 378 cc |
| % EC TBV | (Kit volume+ blood warmer) / TBV | (185+40) / 1050 = 21% |
| % EC RCV | (Kit + blood warmer RCV) / RCV | (67 + 14)/378= 21% |
| Intra-procedure Hct | (RCV – kit RBC volume) / RCV | (378 – 82) / 1050 = 28% |

- **Perhaps less concerned about EC RCV but still concerned about EC TBV**
  - **Switch to albumin prime with partial rinseback: 60 mL rinseback returns most RBCs & expands his TBV by 6%**
  - **Recommend partial rinseback: otherwise with no rinseback, Hct will remain at intra-procedural Hct of 28%**

# Case #3

- 30 year old female with Hb SS, no transfusions in last 3 months
- Presents now with L sided weakness
- Wt= 250 lbs (114 kg), 5'5''
- Current Hb/Hct 7/21. Baseline Hct 24%.
- Do we adjust for obesity?

- Body mass index = 41.6 (BMI > 40 = morbid obesity)
- Lean body weight = 52 kg
- Corrected body weight = LBW + (0.2 x LBW) = 62 kg
- 62 x 70 ml/kg = 4340 ml

# Case #3

- **30 year old female with Hb SS, no transfusions in last 3 months**
- **Presents now with L sided weakness**
- **TBV = 4340 ml**
- **Current Hb/Hct 7/21.  Baseline  Hct 24%.**

| Variable | Formula | Example |
|---|---|---|
| TBV | Obesity-adjusted | 4340 ml |
| 1 RCV | Hct * TBV | ( 0.21)  * 4340 =  911 ml |
| # units for 1 RCV (maintaining current Hct) | (Patient RCV / unit RCV) + 1 | 911 ml / 180 ml ≈ 5 (+1) (always round up) |
| Additional units to increase Hct to 30% | Desired % Hct increase / 3% | (30- 21) / 3 = 3 units |
| Total # units to order from blood bank | # units for 1 RCV exchange + additional units | 6 + 3 = 9 units |

# Orders and subsequent course

- Perform red cell exchange with end Hct goal of 30% and FCR of 30%
- Check Hb fractionation post-procedure
  - What might be the problem if goals not achieved?

- Hb fractionation on next visit: HbS 50%, HbA 50%, starting Hct 27%
- Start monthly chronic RCE for stroke prophylaxis

# Calculating Appropriate FCR

$$\frac{\text{Desired end HbS conc}}{\text{Starting HbS conc}} \times 100 = \text{FCR\%}$$

Example:

Desired end HbS = 20%
Starting HbS = 50%

$$\frac{20}{50} \times 100 = 40\%$$

- **Orders**
  - **Isovolemic hemodilution to 21-24% (generally ≤ 30% of starting Hct and no lower than 21%)**
    - **.30 x .27 = .08  .27 - 0.08 = .19**
  - **Perform RCE with end Hct 27-33% and FCR 40%**

# Calculating Appropriate FCR%

- **Pt has SC not SS disease**
- **Hb fractionation: Hb S=30, Hb C = 30, Hb A=40%**

$$\frac{\text{Desired end HbS conc}}{\text{Starting HbS conc}} \times 100 = \text{FCR\%}$$

- **FCR = 20/60 = 0.30**

# Summary for RCE for sickle cell

- What are advantages of chronic exchange versus simple transfusion for stroke prophylaxis?
  - Less iron overload
  - Longer intervals between procedures possible
- What is your HbS goal (FCR)?
  - Use Hb fractionation to determine FCR and frequency of exchange
- What are additional requirements for RBC units for sickle cell patients?
  - Leukoreduced
  - Sickle dex negative
  - Ideally Ag matched at C, E, K if non-alloimmunized; extended matching if alloimmunized

# Case #4

- 9 yo male with T-cell ALL presents with WBC count of 500,000/uL (80% blasts) an altered consciousness.  O2 sat 90%.
- Weight 29 kg, Hct 20%, platelets 30K
- WBC depletion indicated for MNC removal not PMN removal
- Transfuse prior to apheresis vs blood prime?

# Calculations

| Variable | Formula | Example |
|---|---|---|
| TBV | Wt (kg) x 70 cc/kg | 29 x 70 = 2030 cc |
| RCV | Hct * TBV | (0.20) * 2030 = 406 cc |
| % EC TBV | (Kit volume) / TBV | 570 / 2030 = 28% |
| % EC RCV | (Kit RBC volume) / RCV | 114 / 406 = 28% |

| Kit | WBC |
|---|---|
| ECV | 570 |
| RBC volume | 114 |

# Blood Prime

- TBV = 2030 (29 kg x 70cc/kg)
- Red cell prime:
  - If increasing viscosity not so concerning, use undiluted unit
  - If viscosity concerning, use diluted unit or less volume of undiluted unit
    - Hct may decrease with unit diluted to pt's Hct
    - RBC loss in product (3-5% Hct)

**Table 2:** Approximate change in Hct after processing an **undiluted** unit

| Theoretical Prediction Using a 300 mL Blood Prime | | | | | |
|---|---|---|---|---|---|
| Patient TBV | Patient Hct | Prime Hct | TPE | MNC | Auto PBSC |
| 600 mL | 25 | 60 | 5 | 5 | 4 |
| | 30 | 60 | 3 | 3 | 3 |
| | 35 | 60 | 2 | 2 | 2 |
| | 40 | 60 | 1 | 1 | 2 |
| | 45 | 60 | 0 | 1 | 1 |
| 1000 mL | 25 | 60 | 3 | 3 | 2 |
| | 30 | 60 | 2 | 2 | 2 |
| | 35 | 60 | 1 | 1 | 1 |
| | 40 | 60 | 1 | 1 | 1 |
| | 45 | 60 | 0 | 0 | 1 |

**Table 3:** Approximate change in Hct after processing a **diluted** unit

| Theoretical Prediction Using a 300 mL* Blood Prime | | | | | |
|---|---|---|---|---|---|
| Patient TBV | Patient Hct | Prime Hct | TPE | MNC | Auto PBSC |
| 600 mL | 25 | 25 | -1 | -1 | 0 |
| | 30 | 30 | -1 | -1 | 0 |
| | 35 | 35 | -1 | -1 | 0 |
| | 40 | 40 | -1 | -1 | 0 |
| | 45 | 45 | 0 | 0 | 0 |
| 1000 mL | 25 | 25 | 0 | 0 | 0 |
| | 30 | 30 | 0 | -1 | 0 |
| | 35 | 35 | 0 | -1 | 0 |
| | 40 | 40 | 0 | -1 | 0 |
| | 45 | 45 | 0 | 0 | 0 |

*If < 300 mL is processed, the decrease in Hct will be greater.

# Orders

- Having recent WBC count is crucial
  - For both plt and WBC depletion, the collect flow rate (removal pump) is based on the plt and WBC count
- Perform WBC depletion of 2X TBV
  - Should decrease blast count from 500K to 250-350K
- Fluid balance usually negative:  order to replace with 5% albumin to isovolemia with older devices
- Check post-procedure CBC
  - To check Hct and platelet count as well as WBC count

# Thank you!

## Questions?