

Therapeutic Apheresis Procedures in Patients Less than 20 Kg

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Session Goals

- Summarize what we “know for sure”
- Clarify what we know we don't know
- Provide current, evidence based references to guide practice
- Demystify the performance of therapeutic apheresis procedures in the pediatric population

Learning Objectives

- Understand population specific indications for therapeutic apheresis
- Understand the nuances of calculating total blood volume in pediatric population
- Review physiologic considerations
- Understand options for vascular access

Disclosures

No relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services.

Family Feud

- 1976-Present
- Host
- Two families competing to name the most popular responses from 100 people to a survey-type question
- Answer must have been given by a least two people survey to be on the board
- More points for the more popular answers

Pediatric Therapeutic Apheresis

- Few studies on apheresis applications in this population
- Few cases series, case reports
- Extrapolate from the adult experience
- Popular answer could be misinformation
- **WHAT DOES THE LITERATURE SAY ?**



Apheresis Family

- Pheresis Practitioners
 - Transfusion Medicine
 - Nephrology
 - Apheresis Nurses
- Progenitor Cell Transplanters
- Nephrologists
- Hematologists
- Immunologists
- Cardiologists
- Intensivists

The Hatfields vs. The McCoys



- Consensus Building
 - Shared information
 - Case Reports
 - Case Series
 - Retrospective Studies

Not Going to Discuss

- Indications (ASFA 2010 Guidelines)
- Vascular Access Options

Categories of Therapeutic Apheresis

- Peripheral blood stem cell collection (PBSC)
- Leukapheresis
- Extracorporeal photopheresis (ECP)
- Red blood cell exchange (RBCX)
- Therapeutic plasma exchange (TPE)

Survey Questions

- How does total blood volume differ in pediatric patients?
- What is the correct approach to management of fluid shifts?
- When and how should calcium be replaced?

Pediatric Periods of Growth and Development

- Neonatal (0-4 months)
- Infancy (5 – 12 months)
- Toddler (12 – 47 months)
- School age (4 – 10 years)
- Adolescent (11- 18 years)
- Young adult (18 – 21 years)

Total Blood Volume (mL/Kg)

Total Blood Volume Estimation in Pediatric Patients	
Age Group	mL/Kg
Preterm Infant	89-105
Term Infant	82-86
> 3 months- Preschool	73-82
> 30 Kg	65-75

Kim HC. Therapeutic pediatric apheresis. *J Clin Apher.* 2000;15(1-2):129-57.

Physiologic Effects of Volume Shifts

- Hypovolemic reactions:
 - Differential Diagnosis Includes:
 - Hypocalcemic reaction
 - Circulatory shock in critically ill patients
- Long term CNS Effects Unknown

To Prime or Not to Prime....

- Prime for ECV greater than 15% of TBV
 - Saline
 - Red Cells
 - Whole Blood

Know the ECV

- Cobe Spectra (ver 4.7)
 - Plasma/RBC 285 mL (Dual Needle)
 - Plasma 369 (Single Needle)
 - MNC 280 mL
- Cobe Spectra (ver 6.0)
 - Leukapheresis 282 (Dual Stage Channel)

Kim HC. Therapeutic pediatric apheresis. *J Clin Apher.* 2000;15(1-2):129-57.

Peripheral Blood Stem Cell Collection

- Indications

Stem cell rescue following high dose chemotherapy

- Solid Tumors
- Leukemia

Controversies

- Mobilization regimen
 - G-CSF, Plerixafor
- When to collect
 - Target dose, peak CD34 count, efficiencies
- Volume to process
 - Large volume vs. Ultra-large volume

WHAT DOES THE LITERATURE SAY?

- No studies on Plerixafor in pediatrics
- Gorlin et al. Pediatric Large Volume Peripheral Blood Progenitor Cell Collections From Patients under 25 Kg: A Primer. J Clin Apher 1996;11:195-203
 - 14 patients over 2 years
 - Outlines challenges
 - 7-10 Fr catheters
 - Systemic heparin and citrate 1:24-1:30
 - RBC prime (no diversion, no rinseback)
 - Good yields, no adverse events
 - Post-procedure RBC

Leukapheresis

- Clinical Indications
 - Acute lymphoblastic leukemia (ALL)
 - WBC \geq 400,000/mcL
 - Acute myelogenous leukemia (AML)
 - WBC \geq 300,000/mcL

Controversies

- Typically the smallest apheresis patients
 - Infantile or congenital leukemia
- Safety of Extracorporeal volume
 - Circuit prime
 - Whole blood reconstitution
- Sedimenting Agent
 - Hydroxyethyl starch
- Anticoagulation
 - Heparin vs. Tricitrinol

WHAT DOES THE LITERATURE SAY?

- Alizadeh L. et al. Successful Granulocytapheresis in a pediatric patient with acute myelogenous leukemia and hyperleukocytosis syndrome. J Clin Apheresis. 2011;26: 87-88.
 - Hydroxyethyl starch effectiveness in CML
 - Little published on HES in acute leukemias (Peds)

Extracorporeal Photopheresis(ECP)

- Chronic GVHD skin
- Chronic GVHD Gut

Controversies

- When to add ECP
 - Immunosuppressive chemotherapeutic agents
 - Glucocortical steroids
- Frequency, tapering, when to stop
- Instrumentation
 - ECV and fluid shifts
- Co-morbidities and long term sequelae

Survey of the Literature

- Kanold et al. Update on extracorporeal photochemotherapy for graft-versus-host disease treatment. *Bone Marrow Transplantation* (2005) 35, S69–S71
 - Minimal side effects in even the smallest
 - Required more frequent RBC Transfusions
- Kanold et al. Photopheresis in pediatric graft-versus-host disease after allogeneic marrow transplantation: Clinical practice guidelines based on field experience and review of the literature. *Transfusion* 2007;47:2276-89
 - Case by case approach
 - 27 patients (acute and chronic), 8 less than 25 Kg
 - Literature review showed 12 published studies (1 United States)
 - “Off-line” technique for patients less than 40 Kg

Red Blood Cell Exchange(RBCX)

- Sickle Cell Disease
 - Acute stroke
 - Acute chest syndrome
 - Chronic Exchange Protocol
 - Pre-op, pre-transplant
- Acute Hemolysis
 - Autoimmune HA
 - ABO incompatibility
 - HDN
 - Transfusion error

Controversies

- Donor exposure
 - Standard exchange vs. Isovolemic hemodilution
- Alloimmunization
 - Phenotypic matching (When and how)
- Manual vs. automated
- Hydroxyurea and iron chelators
- Stem cell transplantation

Therapeutic Plasma Exchange (TPE)

- Hematologic Disorders
 - Thrombotic thrombocytopenic purpura (TTP)
- Immunologic Disorders
 - Solid organ transplant rejection
- Renal Disorders
 - Wegener's granulomatosis
 - Good Pasture's Syndrome
 - Atypical Hemolytic Uremic Syndrome
- Neurologic Disorders
 - Neuromyelitis Optica
- Others
 - Familial Hypercholesterolemia

Controversies

- Frequency, tapering, stopping
- Recombinant monoclonal antibody therapies
- Critical Care Efforts of Desperation
 - Overwhelming sepsis (SIRS)
 - Hemolysis secondary to ECMO circuit

What We Know

- Pediatrics patients represent a unique population
- Paucity of studies on apheresis in pediatrics
- Red cell exchange best described

Consensus Building

- Witt V. Training courses for pediatric apheresis on site; how apheresis technology transfer can be performed. *Transfus Apher Sci.* 2010 Oct;43(2):223-5.
 - Austrian center offered 1-2 day training to interested centers
 - 13 Centers from 7 European Countries
 - Shared data
 - Predicted CD34 yield using TBV based calculations
 - Blood priming vs. saline priming
 - Lessened anxiety about procedures in small patients
 - Reproducible performance standards and quality control

One Big Happy...

