Transfusion Medicine
and
Apheresis

Survival Guide

2017-2018

Transfusion Medicine and Apheresis Survival Guide

Table of Contents

Dear UAB Pathology Residents:

The Division of Laboratory Medicine would like to welcome you to your rotations in Clinical Pathology. During the next few months to years you will be rotating through Microbiology, Immunology, Transfusion Medicine, Coagulation, Chemistry, Molecular Diagnostics and Cytogenetics, Flow Cytometry, and Hematology. We expect that you will enjoy all of these rotations, as well as learn from them.

These resident survival guides are designed to help you answer the more common questions that may come up during your rotations and while on call. While we have tried to include all the pertinent information, there will clearly be other information that you wish were included. Please note this information down on the blank pages provided in the back of this manual.

Towards the end of this residency year, I will be asking you for your input to improve these manuals for next year. I will also be asking for feedback on your rotations and how we may improve them every year.

Please do not hesitate to contact me with any questions or suggestions.

Lance A. Williams, III., MD
Assistant Program Director for Clinical Pathology

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SAMPLES, Jackie	4-4411	jbsamples@uabmc.edu
WHITE, Rea	4-7774	rpwhite@uabmc.edu

Departments	Phone	Location
Hospital Paging	205-934-3411	
UAB Hospital	205-934-4011	
When calling from within	4-XXXX	
Children's Hospital	205-939-9100	
When calling from within	9-XXXX	
Callahan Eye Foundation	205-325-8100	
The Kirklin Clinic	205-801-8000	
When calling from within	1-XXXX	
Laboratory Medicine	205-934-6421	West Pavilion P230
Lab Med Fax number	Fax 205-975-4468	
ARC-Ref Lab in Birmingham ARC in Charlotte for HLA matched platelets	205-994-7265 704-347-8205	
Blood Center of Wisconsin	1-800-245-3117	

Hospital Laboratories	Phone Numbers	Location
Blood Bank	4-6390 (Fax 5-9260)	SW W215
Blood Bank - Satellite Blood Bank - Highlands	4-8965; 6-7979 930-6771	7650A 3725
Chemistry Special Chemistry / Electrophoresis	4-5680 4-2854	SW S266
Coagulation	4-5385	SW S288
Diagnostic Molecular Laboratory	4-0452	SW S212
HLA Lab	4-4714	RWUH M250
Hematology	4-5625	SW S288
Bone Marrow Lab	4-7869	SW S281
Flow Cytometry	4-5615	SWW294
Immunology	4-4691	SW S234
Microbiology	4-4833	SW S218
Send-outs	4-4865	SW S299
NP Operating Room	5-5111	NP-5

UAB DEPARTMENT OF PATHOLOGY

Please visit the link below to see all weekly conferences held within the Department of Pathology.

http://www.uab.edu/medicine/pathology/images/forms-pdfs/ConferenceSeminars/05-23-2016calendar.pdf

***Note: For conferences that are mandatory under a specific rotation, please look at the specific Survival Guide that pertains to the rotation that you are on.**

CLINICAL PATHOLOGY Conferences

Division-wide Conferences - (required attendance for residents on CP rotations).

Laboratory Medicine Noon Report
Monday at 12 Noon (WP P230C)

Laboratory Medicine Seminar
Tuesday at 10:45 AM (WPCC-D, unless otherwise noted)

CHIEF RESIDENTS:

Dr. Alex Feldman - Chief Resident, Anatomic Pathology
Pager # 2039 - HSB 190
Phone # 6-2360
Phone # for Receptionist 4-4303
E-Mail: afeldman@uabmc.edu

Dr. Joseph Drwiega - Chief Resident, Clinical Pathology
Pager # 2035 - RWUH M294
Phone # 5-8171
Phone # for Receptionist 4-4303
E-Mail: jdrwiega@uabmc.edu

Rotation-Specific Conferences

Blood Bank

****Blood Bank Morning Call Report**

M, Tu, Th, F @ 8:30 AM; Wed @ 8:15 AM WP P230C

Blood Bank Didactic lectures

Monday at 12 Noon (July and August only – **Mandatory for PGY-1**), and Thursday @ 11:00 AM

Transfusion Service Quality Meeting

Quarterly

Blood Utilization Committee Meeting

4:00-5:00 PM on first Tuesday of every-other month

*****Attendance strongly encouraged for all first years and the on-call resident. Upper level residents on CP rotations strongly encouraged to attend on Wednesdays.*

Microbiology/Immunology

Infectious Disease Conferences
Thursday: 8 AM (Case Conference)
Noon (ID Grand Rounds)

Clinical Microbiology Lab Meeting
Monday at 2 PM (WP P230C)

Clinical Immunology Lab Meeting
Wednesday at 2 PM (WP P230C)

End-of-Rotation Talk
Usually on Monday at noon during final month of rotation

Chemistry

Chemistry Electrophoresis Sign-out
Daily at ~3 PM (Chemistry Lab)

Clinical Chemistry Lab Meeting
Wednesday at 9 AM WP P230C)

End-of-Rotation Talk
Usually on Monday at noon during final month of rotation

Molecular/Cytogenetics

Molecular pathology lies under both AP and CP. Please make your effort to attend AP conferences, such as APSS on Wednesday noon.

Molecular weekly QC/QA Meeting – Thursday at 10 AM
(WPCC-C)

Molecular Diagnostics Sign Out Session – Daily at 3 PM (time may be subjected to change)
(Molecular Diagnostic Laboratory)

Molecular Test Development Meeting – Monday at 11 AM
(WPCC-C)

Joint Molecular Genetic Pathology Conference –
4th Tuesday 4-5 PM, every other month (WCCC-D)

Molecular Tumor Board – Last Thursday of the month at 7:15 am (Rad Onc Conf Rm 2245)

Hematopathology

Hematology/Oncology/Pathology Case Presentation Conference
Monday at 8 AM (WPCC-Board Room)

Hematopathology Sign-out Session
Daily at 9 AM and 4 PM
(Bone Marrow Laboratory)

Hematopathology Tumor Board
Friday at 2:00 – 3:30 PM CCC Board Room

Lab Medicine Seminar

Seminar Description
This seminar series consists of two types of presentations – a Journal Club presentation and a LM Seminar format.

LM SEMINAR:

The LM Seminar format focuses on a specific question relevant to Lab Medicine. The title of the seminar should be a concise statement of the specific question to be answered. The seminar should present several key papers from the primary literature that will allow an evidence-based answer to the question posed. As much as possible, the question should be phrased in a way that the answer can be "yes or no", with appropriate qualifications as needed.

The essence of LM Seminar is **"what patient population, data, and statistical techniques did the authors use to answer the question at hand and how does that knowledge contribute to the larger question you are trying to answer?"**

The presentation should have a short focused introduction, followed by presentation of several papers with data that allow a data driven answer to the question. Although not every data figure in each paper needs to be presented, the details necessary to interpret the data presented must be shown.

At the end of the presentation, any relevant financial aspects necessary for a definitive answer to the questions should be presented. For questions involving a specific test, especially whether to bring a test in-house, the current usage data and costs should be

obtained from the hospital lab administration and presented explicitly prior to your answer to the question. The costs should include the price charged by a reference lab, the CMS reimbursement amount, and the reagent and expected labor cost for in-house testing. You need to request this information several days prior to your presentation. You can begin this request with the supervisor of the relevant hospital lab section, who may help you find further information with the lab administration.

The final segment of the presentation should be a clear answer to the question posed in the title of the seminar, along with your rationale for that answer. Also, you should acknowledge the help of the primary faculty mentor that helped you select the topic, papers, and review of the presentation.

For first and second year residents, it is required that the resident meet with
Dr. Bucy **at least one and a half to two weeks prior** to the scheduled presentation. The Lab Medicine administrative assistants will contact the residents to schedule this meeting.

In addition to question/topic selection, initial faculty instruction is provided in critical thinking, data collection and evaluation (including use of common statistical test methods), presentation and communication skills. For subsequent seminars, the resident may seek the mentorship of any LM Faculty member, but it is still required to seek guidance beginning at least one week prior to the seminar presentation.

Objectives

In preparation for their responsibility as a practicing pathologist with an integral role in laboratory and hospital management:

- Residents will learn to identify and think critically about a current laboratory issue.
- Residents will gain graduated experience in systemic analysis of laboratory methods and problems, data analysis, statistical analysis, and presentation style / effectiveness.
- Residents will learn to effectively communicate problem description, analysis, and conclusions.

Faculty Instructors

R. Pat Bucy, MD, PhD - Seminar Instructor;
Laboratory Medicine Faculty – Preceptors

Schedule

The LM Seminar and Journal Club series will begin in August and be conducted weekly through the following June. Three instructional seminars will be conducted by Dr. Bucy at the beginning of the first semester. Presentations will be assigned during the resident's core clinical pathology (CP) rotation or CP elective.*

Evaluation

All seminars will be evaluated in writing by faculty and residents for the following: clarity of presentation, knowledge of subject, presentation style/organization, slide quality, introduction, data analysis, information integration and conclusions, and response to questions. Immediately following the presentation, the residents and Dr. Bucy will conduct a short review and evaluation of the presentation with the presenter.

Journal Club:

Journal Clubs will alternate with LM seminar presentations. Residents will select a current paper to present for discussion by all LM faculty and residents. The Journal Club presentation focuses on a single substantial paper from the current literature and a detailed presentation of the data in that paper. The resident presentation should also include references to other work in the field to give an appropriate context for the selected primary paper.

The chosen paper must be a substantial publication (more than 2 or 3 data Figures or Tables and published in a high quality journal) able to support a full hour in presentation and discussion. Papers presenting a meta-analysis of other papers can be discussed in the introduction, but should not be used as the primary paper for the presentation. Residents are also required to seek guidance for the selection of papers, as for the LM Seminar format, from Dr. Bucy for 1st year residents, and any LM Faculty member for subsequent residency years. This contact will be arranged **at least 1 week prior** by the Lab Medicine administrative assistants.

Attendance for Journal Club and Laboratory Medicine Seminars

Attendance is **required** at both Journal Club and LM seminars for all residents who are current on LM rotations. Failure to maintain an 80% attendance record based on the sign-in sheet will result in a report being filed with the residency program director, which will be reflected in your annual evaluations. You can have excused absences if

you are out sick, on vacation, or away on official leave (attending a scientific meeting, etc.) that do not count in the total. You should notify the chief resident of such excused absences to communicate to LM office assistant who maintains the attendance records. You are welcome to attend these conferences when you are on an AP service and that attendance will count to increase your attendance record.

Weekly Clinical Pathology Rounds and Review

This weekly meeting at noon on Monday is attended by Laboratory Medicine faculty and all residents on Clinical Pathology rotations. At the beginning of the year, noon report consists of lectures by attending physicians to teach new residents about potential emergent or on-call issues that frequently arise. The remainder of the year consists of a mix of didactic lectures, end of rotation talks, and board review lectures.

End of Rotation Talk

Most of the CP rotations will require an end of rotation talk. These presentations are unrelated to the Laboratory Medicine Seminar lectures and have a different objective.

The primary goal of an end of rotation talk is educational and didactic in nature. The format for the talk is flexible and may vary among the

rotations. In general, the talk should be 30 minutes or more in length and review a topic(s) from the resident's current CP section in greater depth. The resident may present the material in the format they choose. Potential suggestions include:

1) Unknown case(s) report
2) Didactic on a particular topic
3) Summation of high points of a pertinent chapter in Henry
4) Presentation of a pertinent journal article of interest

For further guidance, please discuss with the faculty director of your CP rotation.

CP Pathology Resident On-Call Sign-out

Before a resident rotating on CP leaves for the day, he/she must verbally notify the on-call resident of **any** pending issues. **This discussion must take place, even if it is only to say that there are no pending issues.** The handoff should be documented in an email to the on-call resident. The on-call attending and the CP chief resident should be copied on the email. The subject of the email should be "CP signout" so the emails can be sorted quickly. This handoff must include the opportunity to ask and answer questions. Issues to be discussed include but are not limited to:

- Ongoing apheresis procedures or potential apheresis procedures which are expected to take place after hours.
- If an apheresis consult is received before 7 pm, but will not be initiated until after 7 pm, the day resident is expected to begin and complete as much
of the consult and preparation as possible. Any preparation not completed prior to 7 pm should be verbally signed off to the call resident.

- Apheresis consults received during on-call hours should be initiated and completed dependent upon the time the consult was received.
- Anticipated critical shortage (imminent triage status) of any blood product.
- Any patient requiring cross-matched platelets (i.e., CCI pending, expected arrival of cross-matched platelets, okay to give stock platelets in the meantime).
- Any issue regarding the administration of recombinant factor VIIa, PCC/KCentra, or any of the other coagulation factors. These orders, whether the product was administered already or not, usually print out again at around 2 am and result in a call to the on-call resident for approval. To prevent unnecessary phone calls in the middle of the night, the on-call resident should check with the clinical team and the blood bank early in the evening to ensure that the orders are clearly communicated to the night shift staff.

- Any issue regarding patients with clotting disorders requiring replacement, even if the patient is not anticipated to require a dose overnight. Please convey the patient's weight, the calculated dose, and the discussed dosing schedule. Please also convey to the on-call resident the type of replacement factor to be issued and the status of in-house stock for that factor.
- Any potential transfusion reaction(s) which occurred during the day that is/are still being investigated.
- Any issue where an exception is being made to an established lab protocol (i.e. washing red blood cells for non-standard reasons, administration of coagulation factors without a confirmed diagnosis of a clotting disorder, etc.)

Hematology Lab (UAB) / Hematopathology

Evening and Weekend Call Issues

Following is the list of the potential evening and weekend resident calls from hematology / BM lab (UAB).

On all of these calls, attending/on call pathologist should be consulted first, and if needed, contact Dr. Reddy or designated pathologist / hematopathology fellows.

Type of Call	Standard Operating Procedures
1. New patients with blasts > 5% or organisms in CSF	Main laboratory / Hem lab technologists will page and notify Lab Medicine resident on call on all "new" patients with blasts > 5%, resident should contact the clinical team (ER, main hospital, TKC and Highlands etc.) and inform / discuss the increase of blasts on smear review. Residents do not have to come to the lab for smear review, however, should inform and document discussion with the clinical team. Similar process applies to CSF organisms. Only exception is where the confirmation/ or diagnosis is needed for immediate treatment. Resident may escalate the call to faculty backup and or page Drs. Reddy (pager # 0331), Peker or Bucy.
2. Evening and weekend bone marrows	***Not offered.*** Rare exceptions are for the patients requiring immediate treatment. Page Dr. Reddy or designated pathologist for instructions/approval.

3. Specimen for flow cytometry analysis and cytogenetics	Holding media (Hanks/RMPI-1640) media is available in bone marrow lab (281B – Spain). Blood or bone marrow sample (1-2cc) are preserved in media in the refrigerator (4^{o}C). Check with Hempath fellows or Dr. Reddy.
4. Intracellular organisms	Residents are paged by hem-lab for confirmation / clinical correlation. **Note**: Slides are usually reviewed during day-time, however, if immediate confirmation is needed, the resident will review and confirm the findings with backup by senior resident, on call pathologist or Dr. Reddy. Resident must notify house staff / primary physician for appropriate additional tests (Gram's stain or cultures etc.). *Notification of the primary physician is documented in Hematology Section Log book and in Lab Med Consult form.*

Type of Call	Standard Operating Procedures
5. Atypical cells, blasts/tumor cells in body fluids or in peripheral blood.	Residents are paged by hem-lab for confirmation / clinical correlation. **Note**: In most cases, telephonic notification of the house staff / primary physician is sufficient. *In rare cases,* if the situation warrants, the resident will review and confirm the findings along with backup by senior resident, pathologist on call and or Dr. Reddy. *Notification of the primary physician is documented in Hematology section Log book and in Lab Med Consult form.*
6. Crystal identification (urine or body fluid)	Residents are paged by hem-lab for confirmation. Note: Clinical correlation is needed in most cases and actual review of the smear is done during day time "slide review" session by hematology residents and Dr. Reddy.

Laboratory Room Numbers	Contact Information and Hours
Labs	**Telephone or Pager Numbers**
Bone marrow lab (SW S281	934-7869 7:00 am – 4:00 pm (M-F)
Routine Hematology Lab (UAB) SW S288	934-5625 - 24 hrs
Flow Cytometry Lab SW S294	934-5615 8:00 am – 4:30 pm (M-F)
Hematopathology Fellows	UAB Paging operator
Dr. Reddy	UAB pager # 0331 - 24hrs

Microbiology

1) Consults

Microbiology residents are occasionally consulted by the VA microbiology laboratory. As for consults from the UAB microbiology laboratory, please respond promptly and consult your attending as necessary. Maintain a record of the consult on the routine resident consult sheet.

How to handle a page alerting you that Cerner is down and is expected to be down for a prolonged time:

1) Ask if there is a need for resident intervention:
   A. Triaging phone calls from clinical staff, so the technologists can focus on operational details
   B. Help with paperwork

2) Notify the attending on call.

3) If the Cerner downtime persists into the normal work day, then notify the Chief Resident. The Chief Resident will notify all residents of the problem with Cerner. After notification, each resident should contact the laboratories they are rotating through and offer assistance. The Chief Resident will also be responsible for notifying all of the laboratory section heads of the Cerner downtime. This can be done via e-mail, page, or phone.

Dress Code:

Use good judgment at all times regarding your personal appearance. You are expected to dress appropriately, to be neat, to wear clean clothing, and to be careful with your personal hygiene. While in the laboratories you should wear a white coat over your street clothes.

For safety reasons, we have a very strict dress code for shoes worn in the labs. Part of that policy requires that toes be covered.

The policy applies across the board to everyone in the lab area: employees, visitors, etc., and is dictated by NCCLS nationwide for all laboratories.

Transfusion Medicine And Apheresis

Survival Guide

2017-2018

INTRODUCTION TO TRANSFUSION MEDICINE AND APHERESIS

Our Transfusion Medicine Service (aka Blood Bank) is very large, providing over 46,000 blood products (including 30,000 RBC units, 10,000 plasma, and 6,000 apheresis platelet units) each year. In addition, the same team of physicians oversees approximately 2,500 therapeutic apheresis procedures per year, performed by a group of nurses under the UAB Apheresis Service. In Transfusion Services, residents are actively involved in all areas, including blood product release, coagulation factor dosing, transfusion reactions investigation, and blood product utilization review, among others. An essential part of this rotation is to spend time in the Blood Bank to learn the techniques and intricacies of that laboratory.

This guide provides basic requirements and duties expected of you as well as detailed background information and instructions on how to perform various tasks. Familiarize yourself with the contents and reference often as you progress through the rotation.

Under the guidance and supervision of the attending physicians (and transfusion medicine fellow) you will be responsible for the day to day operations of the transfusion medicine and coagulation services. This year there will be three residents on the service each rotation. Responsibilities alternate weekly and are divided into Blood Bank Consult and Therapeutic Apheresis. <u>However, it is expected that you will work as a true team player and help out in whatever is needed</u>.

Faculty and Contact Information:

- Robin Lorenz, MD, PhD (Associate Dean, MSTP program) 934-0676
  or UAB Pager #6296
- Marisa B. Marques, MD (Section Head of Blood Bank) 934-5990
  or UAB Pager #3981
- Huy P. Pham, MD, MPH (Section Head of Apheresis) 996-9920
  or UAB Pager #5671
- Lance A. Williams, MD (Section Head of Coagulation) 934-9529
  or UAB Pager #7425
- X. Long Zheng, MD, PhD (LM Division Director) 975-8161
  or UAB Pager #5615
- Rea White (Administrative Associate)
  934-7774

TRANSFUSION MEDICINE
GOALS & OBJECTIVES

The overall goals of the training program are the following:

1. To give the trainee a comprehensive experience in blood banking, transfusion medicine, and apheresis.

2. To instill a sense of lifelong learning.

3. To facilitate the resident's acquisition of essential knowledge and familiarity with issues in transfusion practice, from the collection of blood to the proper monitoring of patients following transfusion.

4. To expose the trainee to the skills necessary to optimally direct the management of a transfusion / apheresis services.

5. To demonstrate the role of research, in its broadest definition, in clinical decision-making, testing development, knowledge generation, and continuing education.

Objectives for this rotation are as follows:

The trainee is expected:

1. To show caring and respectful behavior when interacting with patients, and understand the principles of confidentiality.
2. To gather essential and accurate information about patients using all relevant available sources.
3. To consult effectively on the use of blood transfusion and apheresis techniques for patients with special needs.
4. To understand the principles of patient/unit identification and pre-transfusion testing, including ABO/Rh testing, RBC antibody screen and identification.
5. To recognize the basics of triaging and screening blood product orders during inventory shortages.
6. To be able to choose appropriate blood components and derivatives based on a thorough knowledge of the indications for transfusion (including for patients with autoimmune hemolytic anemia).
7. To become familiar with the evaluation and appropriate transfusion therapy of thrombocytopenic patients (both adult and pediatric), including issues related to platelet response (CCI, refractoriness, etc.).
8. To apply the principles of a massive transfusion protocol.
9. To correctly classify transfusion reactions and give appropriate treatment recommendations based on understanding of pathophysiology.

10. To be aware of measures to ensure prevention of transfusion reactions.
11. To learn the pathophysiology, prevention, and treatment of hemolytic disease of the fetus and newborn.
12. To have a working knowledge of the principles of hemostasis and to be able to advise on the initial treatment of patients with bleeding disorders.
13. To evaluate and present findings from recent peer-reviewed journal articles related to transfusion medicine.
14. To be aware of the role of the transfusion service in the health care system.
15. To recognize the logistics used to determine the appropriate blood inventory for a geographic region, and the process of meeting daily, weekly and monthly collection goals.
16. To be skillful in performing blood utilization reviews, audits, lookbacks and product recalls.
17. To understand proficiency programs, such as those provided by CAP and to recognize the requirements of regulatory and accrediting agencies.
18. To have a working knowledge of alternative blood products such as autologous units and blood substitutes.
19. To understand the importance of positive donor identification, self-deferral, "high risk groups", health history evaluation, and donor eligibility.
20. To recognize donor reactions and learn their proper management.
21. To summarize the steps in blood component and blood derivative preparation.
22. To summarize the methodology of screening and confirmatory tests employed in donor infectious disease testing.

23. To outline the necessary steps in donor notification and counseling associated with positive infectious disease testing results, and the donor look-back process.
24. To identify the major infectious complications of blood transfusions and their risk, and explain how these infections can be prevented.
25. To learn the issues unique to directed and autologous donations.
26. To compare and contrast the eligibility requirements for allogeneic and autologous blood donations.
27. To gain knowledge of apheresis donor collections including platelets and red cells.
28. To demonstrate knowledge concerning the requirements of all applicable regulatory and accrediting agencies.
29. To be aware of the Rare Donor Registry.
30. To be familiar with specialized serologic testing only available in reference laboratories, such as platelet crossmatching.

BASIC ROTATION SCHEDULE

Morning Report: M, Tu, Th, F 8:30 am;

Wed 8:15 am – WP P230C

TM Didactic Lectures: Thursdays 11:00 am; mostly in WP P230C but sometimes in WP P210F; other didactic lectures may be scheduled for other days/times.

Journal Club: Bi-monthly

TRANSFUSION MEDICINE (aka BLOOD BANK or BB) RESIDENTS' RESPONSIBILITIES

It is extremely important that you are responsible and organized on this rotation. Many tasks require follow-up. If you forget to do something, it can have serious consequences for the patient. See Apheresis Section for further responsibilities.

Consult Resident:

- Answer all pages from the Blood Bank and Coagulation labs promptly, as well as clinicians in general.
- Complete activities on the Blood Bank Bench Work Checklist **Appendix 1**.
- When hemophiliacs are inpatients, approve and monitor their coagulation factor dosing.
- Be present and on time for scheduled didactic lectures. Didactics are protected time unless an emergency occurs. BB attendings or fellow will try to hold pagers during lecture.
- Turn Pathology consult forms into attending for completion within
  24 hours.
- Investigate transfusion reactions and discuss with attending on call as soon as possible. Enter transfusion reaction reports into Cerner for verification by the attending within 24 hours.
- Manage the HLA-matched and crossmatched platelet inventory.

Bench Work with the Lab Tech

- Arrange with the BB supervisor, Danielle Sylvester, to observe bench work in the appropriate areas.
- Complete the Blood Bank/ Bench Work Checklist (**Appendix 1**) **by the end of the first month on service.**
- Throughout the rotation, make similar arrangements to observe/learn the less common activities in the list.

- Return the completed checklist to the TM attending's administrative assistant by the end of the rotation.

Required Reading

- TM Survival Guide (Red Book given to all residents in our program)
- Blaney, KD, Howard, PR. Basic and Applied Concepts of Blood Banking and Transfusion Practices. 3rd or 4th ed. St. Louis, MO: Elsevier, 2013 or 2016 (please make an effort to purchase this book).

Highly Recommended Reading

- Williams, LA, Fritsma, MG, Marques, MB. *A Quick Guide to Transfusion Medicine*. 2nd ed. - AACC Press, 2014.
- Transfusion Medicine chapters in Henry's textbook

Suggested Reading

- Roback J (ed). *Technical Manual*. 18th Ed. Bethesda, MD: American Association of Blood Banks, 2014. (This may be purchased online at www.aabb.org or by phone (301) 215-6499.
- *Standards for blood banks and transfusion services*. 30th Ed. Bethesda, MD AABB 2016.

GENERAL CONSULT DOCUMENTATION

For all consults (paperwork sent to Morning Report by BB medical technologists ("Tech") for when they call you with a patient's question)
you must document the following:

BB Tech's name
Date and time Tech called
Patient's name and medical record number
Physician's name
Brief patient history, including diagnosis
Problem (why you are being consulted)
Name of MD and/or nurse with whom you spoke and the date/time (if applicable; if not, please write NA)
Resolution
Name of the BB Tech notified about the resolution and date/time

It is important to keep this documentation and be prepared to present
the information at Morning Report. See Apheresis section for information regarding new patient consults.

COMMON BLOOD BANK TESTS and CONSULTS

Type and Screen (T&S)
Crossmatching
- Electronic
- Immediate spin
- Extended

DAT
Elution
Autoadsorption
Antibody identification panel
Antibody Titer
Phenotype matching request

TEST DESCRIPTIONS

Introduction:

Specimen Requirements: Samples for Blood Bank tests are the strictest compared with the requirements for any of other tests available because if the sample of blood does not belong to the right person, subsequent transfusion of the wrong blood type can be fatal.

Improperly labeled samples cannot be accepted. They should never be relabeled or corrected. Another sample must be collected, properly labeled and sent to the blood bank. If in doubt, consult with your attending physician.

According to the AABB: "Before leaving the bedside, the phlebotomist must label the blood sample tubes with the patient's first and last names, identification number, and the date of collection. Printed labels may be used if the information on the label is identical to that on the wristband and request form. There must be a mechanism to identify the phlebotomist; this certification may go on the label of the tube or on the requisition."

Regarding the age of the blood sample, AABB also dictates that: "If the patient has been pregnant or transfused within the preceding 3 months or if the history is uncertain or unavailable, compatibility tests ("crossmatching") must be performed on a blood sample collected within 3 days of the RBC transfusion." In addition, patients with antibodies to RBC antigens (see Type & Screen below), need to have a sample that is less than 3 days old to be used for crossmatching (for surgery, for example).

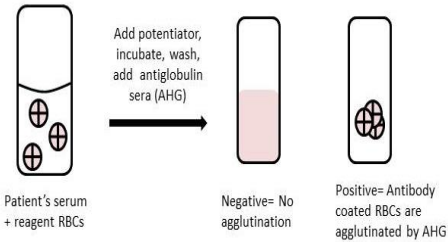
Additional AABB requirements that must be fulfilled by the Blood Bank before components are issued for transfusion are:

1) Positive identification of recipient and recipient's blood sample (proper patient identification is one of the most important aspects of transfusion and patient safety, in general, is a focus of the Joint Commission to ensure patient safety).
2) ABO and Rh typing of recipient.
3) Red cell antibody detection tests using recipient's plasma or serum.
4) Comparison of current findings on the recipient's sample with records of previous results.
5) Tests on donor blood (done at the Blood Center).
6) Selection of components of ABO and Rh types appropriate for the recipient.

7) Performance of a serologic ("extended") or computer crossmatch.
8) Labeling of components with the recipient's identifying information.

Sample tubes for common tests – see Appendix 3

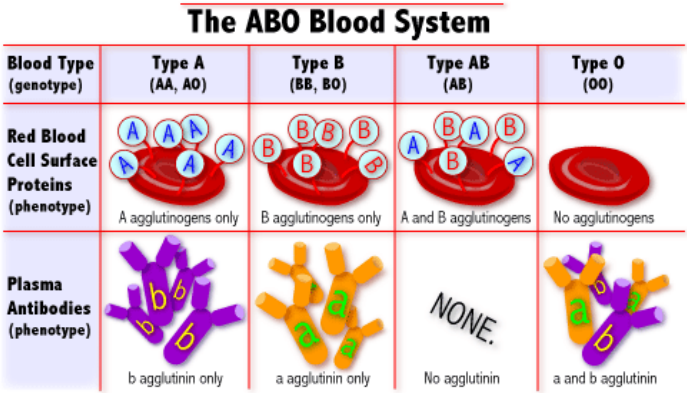
A. Type and Screen (T&S):



This is by far the most commonly performed test. It involves several steps and can be done by different methods. At UAB, when T&S is ordered as a routine test (as opposed to STAT) it is performed in an automated instrument named "ProVue" or "Vision". These machines use the gel methodology to do T&S. If the result of the T&S is needed STAT, the test is performed manually, using the same gel methodology.

"Type" is the part that determines which of the A, B, and D (Rh) antigens are present on the patient's red cells. In order to do this, red cells from a sample collected in an EDTA-tube (purple top) are mixed with anti-A, anti-B, and anti-D. If the antigen is present, there will be agglutination, which is a positive reaction. This part of T&S is called "forward" or "front" type. The second part of "type" is the "reverse" or "back" type. In this step, we determine which antibody(ies) are in the patient's plasma. People that lack the A or the B antigens are expected to have naturally occurring anti-A or anti-B, respectively. Thus, group O individuals have both antibodies. A blood type is assigned when both

"forward and reverse" types have been completed. If it is a patient's first type, a second T&S (confirmatory) is done before blood can be issued.



The "screen" part of T&S (also known as Indirect Coombs) involves checking for the possibility of antibodies to other red cell antigens besides anti-A and anti-B. Anyone that has been pregnant or transfused has a chance to have developed antibodies to antigens such as D (also known as the Rh factor). For example, if an Rh negative person (who lacks D) receives a unit of Rh positive red cells, he/she has an approximately 30-50% chance of becoming immunized against D. That is why all units are typed for the D antigen and only in cases of shortage or emergency; such patients will be given Rh positive transfusions. However, while red cells have >400 other antigens (like E, e, C, c, K, k, etc.), all others are much less immunogenic than D. Indeed, the chance of sensitization is lower than 5% for each antigen that the patient lacks, but is present in the unit transfused. For this reason, we do not routinely type the patient for additional antigens and provide units that are phenotypically matched with the patient. This

practice is mainly used for sickle cell disease patients expected to require chronic transfusions.

The “screen” is performed by incubating the patient’s plasma in glass tubes in the “manual” method, in gel microtubes or in an automated gel instrument (ProVue or Vision) with 3 commercially supplied type O red cells that have been phenotyped for all clinically significant antigens (except A and B). These are the antigens that elicit antibodies that could cause a hemolytic transfusion reaction or hemolytic disease of the fetus or newborn. Thus, their presence in the patient’s plasma must be excluded prior to transfusion. Only in life-threatening situations, is a unit issued before the T&S is ready. A negative “screen” means the patient’s plasma does not agglutinate any of the 3 reagent cells in this test. In such cases, blood can be issued without any additional testing (see table below). In fact, if there are no antibodies in the current sample and no history of antibodies in our system, the units are only crossmatched electronically (computer system checks the patient’s history and blood type, compares with the blood type of the red cell unit, and allows the unit to be assigned to that patient.

If the “screen” is positive, it is necessary that the specificity of the antibody be identified by what is called an “antibody panel”. In the panel, the patient’s plasma is added to 10-20 tubes (or gel microtubes) containing suspensions of type O reagent cells with different combinations of antigens. At this point, there is also a tube called “auto control”, where the patient’s cells and his/her plasma are mixed together. Depending on the combination of cells that agglutinate and those that do not, the specificity of the antibody is determined. For example, if all cells that have the D antigen are agglutinated by the patient’s plasma, and none of the Rh negative ones (lacking the D), then the patient has anti-D. The

more antibody that is present, (i.e. titer), the stronger the degree of agglutination, which is graded from negative to 4+.

Blood Group Systems and Antigen Frequencies:

Chart on next page indicates Caucasian frequencies in the United States, except where noted. Frequencies may differ in African-Americans, Hispanics, Asian-Americans, and other groups.

Determine Frequency of Compatible Units

When a patient has multiple alloantibodies, the expected antigen frequencies in the donors are used to determine what percentage of units are likely to be compatible. This determination can be useful as it indicates how easy or difficult it may be to obtain blood for a particular patient.

Example: Patient has anti-c, anti-Fya and anti-S

Among random donors:

20% are c negative

34% are Fya negative

45% are S negative

Frequency of compatible units = 0.20 x 0.34 x 0.45 = 0.03 or 3% (we should write in the AB consult in Impact – "Only 3% of donors are expected to be compatible with this patient. It may take several hours for units to be available for this patient.")

Blood Group Systems and Antigen Frequencies

Blood Group System	Antigen	Antigen Frequency %	% Donor Blood Compatible (Antigen-Negative)
Rh	D	85	15
	C	70	30
	E	30	70
	c	80	20
	e	98	2
Kell	K	9	91
	Kp^a	2	98
	Js^a	0.1 Caucasian 19.5 African-American	99.9 Caucasian 80 African-American
	k, Kp^b, Js^b	99.9	0.1
Duffy	Fy^a	*66	34
	Fy^b	*85	15 *Note: 68% of African-Americans are Fy(a-b-)
Kidd	Jk^a	77	23
	Jk^b	72	28
MNS	M	78	22
	N	72	28
	S	55	45
	s	89	11
P	P_1	80	20
Lewis	Le^a	22	78
	Le^b	72	28 *Note: 22% of African-Americans are Le(a-b-)
Lutheran	Lu^a	8	92
	Lu^b	99.9	0.1

Immunogenicity of blood group antigens

Antigen (blood group system)	Antigenic sites per RBC	% Immunogenicity
D (Rh)	10,000-35,000	50
K (Kell)	6,000	5
c (Rh)	37,000-85,000	2
E (Rh)	450-25,600	1.7
k (Kell)	3,500	1.5

Scott MD, Murad KL. Cellular camouflage: fooling the immune system with polymers.
Curr Pharm Des. 1998 Dec;4(6):423-38.

Resident preparation of daily antibody consults (AB consults in Impact):

1. Review antibody work-ups. If you have questions about the work-up or interpretation, ask an antibody specialist, TM fellow or attending.
2. Check if patient is scheduled for surgery. If so, make sure your interpretation starts with **"The blood bank needs a new sample within 3 days of surgery…"**
if the sample is from more than 3 days from the planned surgery date.
3. Make sure to note other findings (antibody titer, DAT, etc.) and estimate frequency/time required to prepare units for the patient.
4. Enter interpretation into "BB results entry" using the accession number. See example templates in the TM folder on the P drive. Read for errors before "performing".
5. Write your interpretation on the face-sheet, initial and date. Bring work-ups to the TM attending as soon as you have entered and "performed" your interpretation.

C. Crossmatching:
Several types are used depending on the case, as seen on this table:

Type of crossmatch	Electronic	Immediate spin	Extended
How it is done	Computer checks if ABO and Rh of patient and unit match and approves issuing it	Patients' plasma mixed with cells of unit, tube centrifuged, agglutination checked visually	Tube method: Patients' plasma mixed with cells of unit plus PEG, 37 C incubation, tube centrifuged, agglutination and/or hemolysis checked visually, anti-human globulin added (Coombs reagent), incubation, tube centrifuged, checked for agglutination Gel method: Patients' plasma mixed with cells of unit, 37 C incubation, microtube centrifuged, agglutination checked visually
Sensitive to	ABO and Rh errors	ABO and Rh errors	Incompatibility due to alloantibodies
When it is used	When antibody screen is negative (current and historical)	When antibody screen is negative (rarely used)	When antibody screen is positive, even when unit is negative for the antigen recognized by the antibody

D. Direct Antiglobulin Test (DAT):

Also known as Direct Coombs test. When the "autocontrol" is positive in the "antibody panel", it suggests that the patient has

an antibody to his or her red blood cells (autoantibody). This antibody may be clinically significant and cause hemolysis, in which case the patient is diagnosed with autoimmune hemolytic anemia (AIHA) or be weak and not cause any disease. In order to determine if antibody has bound to the patient's red cells *in vivo,* we need to perform a DAT. In some cases, physicians order a DAT during the workup of a patient with hemolysis or unexplained anemia. If only the auto control is positive, it should be called a cold autoantibody. When the DAT is also positive, it is a warm autoantibody (bound at body temperature).

For the DAT, the patient's washed red cells from an EDTA-anticoagulated blood sample are incubated with a polyspecific antibody ("antiserum") that recognizes both human IgG and C3 (Coombs reagent) attached to the patient's cells in vivo. Agglutination (positive test) will occur with as few as 200 to 500 molecules of IgG per patient cell. If the polyspecific DAT is positive, the "split" DAT follows: patient's cells are incubated with an antiserum specific for either IgG or C3. If the DAT is positive for IgG, the patient has a "warm" autoantibody and may have autoimmune hemolytic anemia (WAIHA), because it proves that IgG bound at body temperature or 37º C. Not all patients (probably the minority) with a positive DAT have hemolysis. Most often in WAIHA, the DAT is positive for IgG only. That is because IgG is not as efficient as IgM at activating complement. Hence, IgG is also called an "incomplete" antibody. The stronger the DAT (agglutination), such as 4+, the more likely there is also C3 attached to the cell and *in vivo* hemolysis.

A DAT is ordered on all umbilical cord workups (soon after birth). Positive DATs in this scenario are most commonly due to passively acquired antibodies which may cause hemolysis in the newborn:

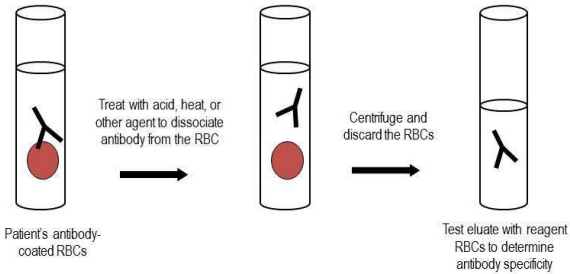
Anti-A,B from O mothers

Anti-D due to RhIg
Anti-D due to sensitization
Other alloantibodies from mother's sensitization (usually present in her T&S at the time of delivery).

Clinicians may at times order a DAT to look for autoimmune hemolysis. If there is not a current T&S, the blood bank will consult you to evaluate whether further workup is indicated. When the DAT positive and there is a recent history of transfusion and no subsequent antibody screen, advise the blood bank to perform an
eluate and potentially an antibody screen on the sample. This is to evaluate whether the positive DAT is the result of a newly formed alloantibody in response to the recent transfusion. If the eluate and/or antibody screen is positive with a new antibody, notify the attending pathologist and the patient's physician. Workups of isolated DAT ordered without a T&S also have an associated AB consult to be entered in Impact.

Resident preparation of DAT consults:
1. Review DAT work-ups. If you have questions about the work-up ask an antibody specialist, TM fellow or attending.
2. Enter interpretation into "BB results entry" using the accession number. See example templates in the TM folder on the P drive. Read for errors before "performing".
3. Write your interpretation on the worksheet, initial and date. Bring work-ups to the TM attending as soon as you have entered and "performed" your interpretation.

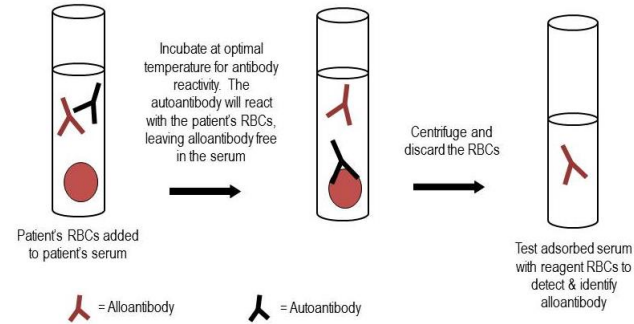
E. Elution:



In order to confirm that the positive DAT is due to an autoantibody, an elution of the bound IgG is performed unless it had been done in the last 30 days. The elution results in what is called the "eluate", concentrated IgG removed from the cells. The eluate is subsequently incubated with the same reagent red cells used in the "antibody screen or panel" to check for the specificity of the antibody. A true autoantibody will react with all reagent cells with similar agglutination strengths (i.e. panagglutination), because it is directed at an antigen present in all cells (pan antigen). Rarely, the antibody may show a relative specificity within the Rh system such as the *e* antigen. If the DAT is only weakly positive, the eluate may not react with the reagent cells. An elution is particularly important if the patient has a history of recent transfusions within the last month. In this case, the DAT may be due to an alloantibody bound to the still circulating transfused red cells, instead of an autoantibody attached to the patient's own cells. In such cases, the eluate should react only with selected reagent cells containing the antigen recognized by the antibody.

This is the classic finding in a patient with delayed hemolytic transfusion reaction.

F. Autoadsorption:



When the antibody "screen" and "panel" are positive with all cells tested and
the DAT is also positive, an autoantibody is the most likely explanation. Since autoantibodies are directed at a pan antigen, the crossmatches are expected to be incompatible. However, it is imperative that the presence of a concurrent clinically significant alloantibody in the patient's plasma be excluded, for units for transfusion should lack the appropriate antigen. An autoadsorption is performed to remove the excess autoantibody from the plasma and allow detection of possible alloantibodies. Following incubation of a concentrated sample of patient's cells with his/her own plasma, from 1 to 3 times, the adsorbed plasma is then tested with the reagent cells
of the antibody "screen" and/or "panel". If no more agglutination occurs, an underlying alloantibody is ruled out. The adsorbed plasma is then used for the crossmatch. If the patient has been transfused in the last 30 days, adsorption may also remove an

alloantibody. In this instance, an allo adsorption using phenotypically matched allogeneic cells may be performed at the Red Cross.

When discussing transfusion risks of patients with autoimmune hemolytic anemia, many people call crossmatched units that are compatible with the adsorbed plasma as "least incompatible". Instead, in such cases, we should

explain to the clinicians that "We have attempted to exclude alloantibodies to minimize the possibility of an alloantibody-induced hemolytic transfusion reaction. Red cell survival will not be normal because the autoantibodies will cause survival to be about that of the patient's own cells, but acute and severe reactions are not likely (Dr. Lawrence D. Petz, Los Angeles, CA)" Note: Alloadsorptions are performed at the local Red Cross Reference Laboratory and usually require the approval of the resident or attending Pathologist.

G. Antibody Titer:

If a pregnant patient has an alloantibody, such as anti-E, its semi-quantitation is needed to help determine the possible deleterious effect on the fetus. In other words, if the fetus is positive for the antigen the mother has an antibody against, he/she can boost the mother's immune response, IgG can cross the placenta, and cause hemolysis of the fetus' cells. Thus, a titration of the mother's antibody is performed by incubating her plasma serially diluted in saline with reagent red cells that are positive for the antigen in question. The titer is the reciprocal of the plasma dilution that gives a 1+ agglutination of the reagent red cell. Every time a sample is titered, leftover plasma should be frozen to be run in parallel with a subsequent sample. That is because quantitation

of agglutination is subjective, and running both samples at the same time allows a comparison and a better sense for what the fetus' risk is. Depending on the absolute titer, especially if it is 16 or greater (or 8 and greater for anti-Kell), the fetus will be monitored and, in the case of anemia, may receive an intrauterine transfusion. In such cases, the Blood Bank prepares the desired volume of blood ordered by the obstetrician from a fresh unit (less than 7 days) of red blood cells that is CMV-negative, and irradiates the unit just before issuing it. Obviously, the donor cells must also lack the antigen for which the mother has the antibody. Titers are also performed for ABOi renal transplant patients in the peri-transplant period.

H. Kleihauer-Betke Testing and Rh Immunoglobulin (RhIg) Administration

The Kleihauer-Betke (K-B) test determines the amount of red cells containing fetal hemoglobin in the maternal circulation. It should follow a positive Fetal Screen, which is done on every Rh negative mother who has delivered an Rh positive baby. The K-B stain is performed to determine the amount of **Rh Immunoglobulin** needed for a D-antigen negative mother carrying a D-positive fetus. The K-B stain may be used in pregnant women after trauma to identify whether there has been fetal significant bleeding. The test is not indicated for pregnancy less than 14-20 weeks, since the volume of the fetal blood is too small for even a significant bleed to be detected. An attending and a resident must review the slide prior to result.

300ug (1 syringe) of **Rh Immunoglobulin (Rhophylac is the brand name we have in the Blood Bank, that can be used IM or IV)** will protect against 30 ml of D-positive fetal whole blood OR 15 ml of packed red cells. For Rh incompatible platelet transfusions, Rhophylac is thought to be capable of protecting

against anti-D formation for up to 6 units of apheresis platelets within a conservatively established 14-day time span (the half-life of Rhophylac is approximately 23 days (Tiblad et al. Pharmacokinetics of 250 ug anti-D IgG. Acta Obstet Gynecol Scand. 2012;91(5):587).

Determine required # Rh Immunoglobulin (RhIg or Rhophylac) doses, as follows:

1. Calculate the maternal blood volume by using the chart based on Nadler's formula in the back of this book.

Example: for a 95kg woman, 1.68m tall = 5018mL

2. Multiply the K-B result in % x the maternal blood volume

Example (1.3/100) x 5,018 mL (maternal blood volume*)

= 65 mL fetal blood

3. Divide the maternal blood volume by the amount of whole blood covered by a single vial of Rhophylac.

Example 65/(30 mL per dose) = 2.2 doses

4. Use the following rounding rules:

When number to the right of the decimal point is < 5, round down
When number to the right of the decimal point is ≥ 5 round up

Example – Round down to 2 in this case.

5. Add one dose to your final number from step 4

Example: 2+1 = Final dose of 3 RhIg vials in this patient

The blood bank techs will enter the following comments based on your final interpretation and calculation:

"Based on the mother's estimated blood volume of __ml, this percentage of fetal red cells corresponds to _ ml of fetal blood in her circulation. Thus, we calculate that she needs _ doses of Rh Immunoglobulin."

--A Rhogam / Rhophylac calculator is available in "CP Tools" on the Google drive

--A shortcut method for boards is as follows:

5/3 x KB% +1

Example
5/3 x 1.3 +1 = 3 Vials

Note: This shortcut should not be used in clinical practice, since we try to provide much more accurate info to the OB team in real-time.

BLOOD PRODUCTS and CONSULTS

Patient Blood Management (PBM): Defined as the scientific use of safe and effective medical and surgical techniques designed to prevent anemia and decrease bleeding in an effort to improve patient outcome (www.sabm.org).

The best available evidence for the proper use of red cell units (RBCs) came from the TRICC trial published in 1999 (N Engl J Med 1999;340:409–17).

TRICC trial: multicenter, randomized, controlled clinical trial of transfusion requirements in critical care

Randomized, controlled trial conducted 1994–1997

- 418 patients assigned to restrictive strategy of transfusion when hemoglobin <7 g/dL to maintain at 7–9 g/dL
- 420 patients assigned to liberal strategy of transfusion when hemoglobin <10 g/dL to maintain at 10–12 g/dL
- 30-day mortality similar in two groups (18.7% vs. 23.3%, p = 0.11)
- 30-day mortality was significantly lower in the restrictive transfusion strategy among patient who were less acutely ill; APACHE II score < 20 (8.7% in vs. 16.1%, p = 0.03)
- 30-day mortality lower in the restrictive group among patients < 55 years of age (5.7% vs. 13%, p = 0.02)
- Mortality among patients with cardiac disease did not differ at 30 days (20.5% vs. 22.9%, p = 0.69)
- Mortality rate during hospitalization was lower in the restrictive strategy group (22.2% vs. 28.1%, p = 0.05)
- Liberal group received a mean of 5.6 units of RBCs compared to 2.6 units in the restrictive group (p <0.01)

The UAB Transfusion Guidelines last updated in December of 2014 are based on the findings of the TRICC trial, other studies, and consensus among the Blood Utilization and Management Committee members.

Remember:

Every indication for the use of blood products cannot be anticipated. These guidelines will not override physician judgment and blood products will be released in response to physician orders. However, transfusions outside these guidelines shall be carefully peer- reviewed to assure appropriate use.

Red Blood Cells (RBCs) for Adults:

1. Non-bleeding hemodynamically stable inpatients (including post-operative) should be transfused RBCs only if the hemoglobin falls to 7 g/dL to keep it between 7-9 g/dL (restrictive transfusion approach). Exceptions include active coronary ischemia, evidence of hypoperfusion, severe sepsis or septic shock, or failure to meet ScvO2 goals on sepsis protocol despite having a CVP of 8-12 and MAP > 65 mmHg, and patients with high-risk placental abnormalities and/or history of obstetrical bleeding.

2. Patients with active coronary ischemia should be transfused only if the hemoglobin falls to 8 g/dL. Maintenance of hemoglobin above 9 g/dL through transfusion is discouraged.

3. RBCs should be ordered as single units for most inpatients (transfuse and reassess strategy), with the exception of ongoing blood loss with hemodynamic instability.

4. Patients undergoing ECMO or photopheresis will require higher hemoglobin thresholds as determined by patient-specific parameters.

5. Active bleeding with loss of >30% of blood volume (1500 – 2000 mL) along with plasma and platelets (Massive Transfusion Protocol or MTP).

6. Symptomatic chronic anemia: 1. Irreversible transfusion-dependent bone marrow syndromes; 2.Unexplained ongoing resting tachycardia (110/minute) in a patient with hemoglobin <10 g/dL).

7. Transfusion or exchange transfusion for sickle cell disease.

Apheresis Platelets (PLTs) for Adults:

1. Platelet count of ≤10,000/μL for bleeding prophylaxis

2. Platelet count of ≤50,000/μL in the presence of bleeding

3. Platelet count of ≤100,000/μL *and* 12 hours pre or post-surgery

a. Platelet count of ≤50,000/μL prior to a Cesarean-section or ≤20,000/μL for vaginal delivery

4. Massive transfusion (including autologous blood salvaged intra-operatively)

5. Open heart surgery with bleeding episode

6. ECMO as determined by patient-specific parameters

7. Bleeding due to dysfunctional platelets from antiplatelet therapy

8. Platelet count of ≤100,000/μL and intracranial hemorrhage

9. *Pre-procedure prophylaxis:*

a. Lumbar puncture (elective): ≤50,000/μL or lower

b. Lumbar puncture (emergency, eg:suspected meningitis): ≤20,000/μL

c. Transjugular liver puncture: ≤50,000/μL

d. Gastrointestinal endoscopy with biopsy: ≤20,000/μL

e. Bronchoscopy: ≤10,000/μL

f. Bronchoscopy with biopsy: ≤50,000/μL

g. Central venous catheter insertion: ≤10,000/μL

h. Epidural anesthesia: ≤80,000/μL

i. Spinal anesthesia: ≤50,000/μL

Plasma Indications (AKA as FFP) for Adults:

1. Bleeding due to multiple factor deficiencies such as that of liver failure or Disseminated Intravascular Coagulation (DIC)

2. Massive transfusion (See MTP policy)

3. Treatment of congenital immunodeficiency

4. Therapeutic plasma exchange (TPE) for TTP

5. Replacement fluid during TPE and high risk of bleeding

6. Treatment of coagulation factor deficiencies for which there is no concentrate available such as factor V or XI

7. Plasma should not be used as a colloid volume expander in the absence of other indications

8. Plasma replacement should not be guided solely by Prothrombin Time (PT) and Partial Thromboplastin Time (PTT) results

Abnormal PT and/or PTT should be followed up by tests to determine the specific cause of the prolonged tests.

Non-indications for plasma:

a) Prophylactic administration prior to paracentesis, thoracentesis or central venous cannulation in patients with liver dysfunction and coagulopathy

b) Prophylactic administration in acute liver failure without bleeding with the objective of improving the outcome

c) Burns in the absence of bleeding and without coagulopathy

Cryoprecipitate Indications for Adults:

1. Fibrinogen concentration < 100 mg/dL and bleeding.

2. Trauma scenarios and OB hemorrhage when fibrinogen is <200mg/dL.

2. Factor XIII deficiency.

Critical Blood Shortages (Triage of Products)

- Notify the attending Pathologist.
- Due to short expiration time, PLTs are the most common product we must triage. For these requests, check the patient's platelet count, identify the reason for thrombocytopenia, know if

acute or chronic and consult with the ordering physician regarding shortage and delaying the transfusion, if possible.
    - If orders are from the OR, it is rarely appropriate to ask if they truly need the unit (in doubt, check with Attending).
- For requests of RBCs when the patient's hematocrit (Hct) is <24%, check to see if the decrease has been gradual or rapid and consult with the ordering physician regarding the blood shortage to request for delay/defer of transfusion, if possible.
- For requests of multiple RBC units at once (except for an OR patient), consult with the ordering physician to issue one unit at a time, if possible, rather than dispensing multiple units at once. Also, have the physician check a Hct after each transfusion unless there is ongoing bleeding such as in the OR.

I. Red Blood Cells (RBCs)

1. Giving Rh(+) RBCs to Rh(-) patients: During blood shortages, we may have to switch patients from Rh(-) to Rh(+) products. These patients will most likely develop anti-D from the exposure to the D-antigen (50% chance with a unit of RBCs). With this in mind, the patients who would be least affected by development of an anti-D are those unable to bear children: (1) Males, and (2) females older than 50 (beyond childbearing potential). If transfusion is absolutely indicated and no Rh(-) blood is available, notify the patient's physician and explain the reason for switching to Rh(+) and the possibility of developing anti-D. RBC units in the Massive Transfusion Protocol (MTP) are all O positive unless there is time to prepare O negative units for females younger than 50 or any patient with a known anti-D. Once a patient has received a unit of Rh(+) RBCs, there is no need to revert to Rh(-) and there is nothing to be done to prevent Rh sensitization (RhIg will not protect due to the large number of cells with the D antigen). However, the anti-D will only appear weeks to months later when the transfused Rh(+) cells will have been cleared from the circulation.

2. ABO group selection order for red cell transfusion when patient's type is unavailable:

Recipient ABO	1st Choice	2nd Choice	3rd Choice	4th Choice
AB	AB	A	B	O
A	A	O		
B	B	O		
O	O			

3. Release of least incompatible RBC Units:

- The presence of a warm autoantibody (WAA) in the plasma may cause all crossmatches to be incompatible.
- Review the patient's labs for signs of hemolysis (decreasing Hct, increased LDH, presence of spherocytes, etc.)
- Review the work-up and antibody panels.
- Call the patient's clinician and discuss the following issues:
  - The RBC unit(s) will be accompanied by an emergency release form, which requires their signature because of the risk of hemolysis.
  - Explain in detail what a WAA is, the risk of an underlying alloantibody, the risk of in vivo hemolysis if signs of hemolysis are present, and the risk of increasing autoantibody formation with transfusion.

II. Platelets (PLTs)

1. Apheresis (pre-storage leukoreduced) PLTs.

- Contents: $\geq 3 \times 10^{11}$ platelets; $<5 \times 10^{6}$ WBC; 150 mg fibrinogen in 100-200 ml of plasma.
- Storage: 5 days at 20-24^{o} C with agitation.
- Dose: 10 units (2 pools of 5)/adult or 10-15 ml/kg for neonates.
- Expected platelet count increase; CCI (Corrected Count Increment) at least 7,500/μL in 1 hour. (Or an increase in platelet count of approximately 30,000-60,000/μL).

- Anti-A and anti-B titers checked if ABO mismatched units are the only ones available. Low titer means anti-A and/or anti-B are not reactive when the plasma from the unit is not reacting with the respective A and B reagent red cells at a dilution of 1:50 in saline.

2. Selection of PLTs for transfusion.

Depends on several factors: current inventory, types available, shelf-life of the units, CMV status of the patient, etc. The supply of PLTs is limited at times, requiring use of out of group units. In general, since apheresis PLTs have a small amount of plasma, transfusing out of group units is permissible, though it should be monitored (see item #5 below). Refer to the following table for compatible products that may be used:

Patient	***PLTs and Plasma*** ***1st 2nd 3rd 4th***
A	A AB B O
B	B AB A O
AB	AB A B O
O	O AB A B
***Remember to use low titer (below 50) for 2nd-4th choices for platelets.**	

- There is an additional chart for BMT patients in the *Special Patient Population Section.*
- Always consult with your attending if you have a question before making a decision to give a patient an out of group PLT.
- When out of group PLTs are short-dated (due to expire within the next several hours) it is permissible to switch ABO types, after notifying the ordering physician.

3. Requests for a second PLT dose within 24 hours for any patient, except for the following units / situations:

a. Outpatients, HOSU, MICU or BMT patients which should be consulted on the **third** unit requested within 24 hours.

b. CICU, OR, CVOR, or UED patients which should be consulted on the **fourth** unit requested within 24 hours.

c. Patients receiving MTP may receive a PLT with each cooler. During platelet triage, consult to give the **third** unit.

Use the following guidelines when deciding about the clinical need for a PLTs request:

- Approval depends on: (1) the type of bleeding, (2) platelet count, and (3) inventory.
- Oozing (as opposed to arterial bleeding) is characteristic of a low platelet count or qualitative platelet defect.
- Ask to check the platelet count before approving a second unit. For surgical procedures, the desired platelet count is between 50-100,000/μl. If the second unit is approved, ask the primary team to check the platelet count within 60 minutes after the unit is finished.
- Remember that patients currently on bypass or patients immediately following surgery requiring bypass may need a PLT transfusion even when their platelet count is normal. These patients may have a platelet function (qualitative) defect due to the bypass circuit.

4. Transfusion of Rh(+) PLTs to Rh(-) patients:
Follow the same guidelines for RBCs. In the rare case in which females <50 years old have to receive Rh(+) platelets, call the patient's physician and discuss the possibility of Rh immunoglobulin (RhIg), which can be given IV (Rhophylac). A full dose of RhIg, 300μg (1 syringe) will protect against at least 6 units of Rh(+) apheresis PLTs, given to an Rh(-) patient within a 14-day period. This is usually not necessary for BMT patients.

5. Requests for a third unit of ABO-mismatched PLTs within 24 hours: Need to inform ordering physician of risk of hemolysis from ABO alloantibodies (even though all products have been titered and should have a titer less than 50 of anti-A or anti-B). Check DAT and for signs of hemolysis, if DAT positive.

6. Inappropriate doses:

- Sometimes multiple units of PLTs will be ordered at once because the ordering physician thinks that he is ordering random donor units, which are usually used as a pool of about 6 units, and are equal to one

single donor (apheresis) unit. We do not stock random-donor platelets at UAB. Neonates receive aliquots of an apheresis single donor unit (10 ml/kg).

- Request for release of multiple units of apheresis at once. Please only release one unit at a time, as there is potential for wastage if the second unit is not used. Only the Blood Bank is equipped to store platelets under specified conditions and products are released for immediate transfusion. The second unit may be "set up" for the patient, but only one unit at a time should be released (this rule may be different for certain surgical procedures and the technologists know about it). Again, recommend and follow-up platelet counts within 60 minutes following each transfusion.

7. Platelet Refractoriness – Requests for HLA Matched or Crossmatched

Platelets (PLTs):

Patients may become refractory to platelet transfusions if they are: frequently transfused, transfused at other hospitals that do not provide leukoreduced products, or females with previous pregnancies. Immune platelet refractoriness is a result of HLA antibodies; clinical refractoriness is when the patient does not respond to the transfusion due to various factors such as splenomegaly, fever, profound bone marrow suppression, infections, etc. Should the clinical team request crossmatched platelets, the following steps should be performed (may combine steps for efficiency):

a. Order a platelet count within 15-60 minutes of the end of a PLT transfusion. You will need to request this from the team and monitor to make sure it happens.
b. Calculate a Corrected Count Increment (CCI- formula below). If less than 5,000/μL then patient might be refractory.
c. Order platelet crossmatching from the American Red Cross (ARC) reference lab, where the patient's serum will be incubated with aliquots from various PLT units to determine which ones are compatible. The method utilized for platelet crossmatching is called hemagglutination and it does not attempt to identify the specificity of the antibodies causing the incompatibility.

- For platelet crossmatching, ask the nurse for **two red-top tubes to be sent to the Blood Bank before noon**. The UAB Blood Bank Tech will fill out the paperwork to send to ARC. Be sure a comment is placed in Cerner under PTC regarding the samples sent for crossmatching.
- The result of the platelet crossmatching is usually available in the evening and will reflect the number of crossmatch-compatible PLT units out of the 13-14 units tested with the patient's plasma. The results should be documented in Cerner under PTC, including when and how many of the crossmatch-compatible units are expected to arrive at UAB. The Blood Bank Tech will help you with this.
- Ideally, you will be told of the number of compatible units and in conjunction with the primary team, decide how many units are needed. **(Remember: Once the platelets arrive, their shelf life is approximately 3 days.)** If all are incompatible, you will need to order HLA-matched PLTs. Be sure to discuss this with your attending.
- The patient sample sent to ARC is only good for a week; if the patient requires more PLTs, let the clinician know we will need two additional, red-top, tubes. Optimally, samples should be sent 2 days prior to need.
- Matched platelets incur significant costs and should be used judiciously. All matched units, which are transfused, require a one-hour post-transfusion platelet count to check the patient's response (calculate another CCI).
- The consult resident is in charge of checking which patients are receiving matched platelets. The number of available units, their expiration date, and plan for future use. THIS MUST BE DONE DAILY.

d. If crossmatch-compatible PLTs are not increasing the patient's platelet count appropriately, it may be necessary to order HLA-matched PLTs (which take longer and cost more).

e. To order a work-up for HLA antibodies at UAB, order the "HLA Specimen" powerplan. At the bottom is a heading entitled: ***HLA TESTING FOR MATCHED PLATELETS***. Check the box for "HLA Class I SAB (Ab Ident.)" at the very bottom. The very top box "HLA Patient Type/Analysis Reason" will be automatically checked and should stay checked. In the comment section please add: "Draw 2

yellow top and 1 red top tubes," and call the primary team to let them know. The 2 yellow top tubes are for the HLA typing and the red top tube is for the HLA antibody work-up.

f. The UAB HLA lab can be reached at 205-934-4714 to find out when they can run this test (sometimes it's not until the following day). They do the tests in batches so it helps to find out when they predict the next batch will be run. If this is on the weekend, they don't have an on-call number, but the hospital operator has their information and can get you in touch with the on-call person, if needed.

g. If the patient has HLA antibodies, coordinate HLA typing and HLA antibody determination with the HLA lab. You should order these using the HLA power plan, then call the nurse to send appropriate samples to the BB. Once everything arrives to the BB notify the HLA lab that you are sending them samples for a patient who needs HLA matched PLTs. Tube samples and transmittals to station 409.

h. Discuss platelet transfusion needs with the physician. HLA-matched platelets cannot be ordered until results are back from HLA lab. It takes several days to arrange for delivery and so close communication is required with the primary team. **Residents are responsible for monitoring needs and inventory for all patients receiving HLA matched platelets on their rotation.**

i. Orders for HLA-matched platelets must be faxed and called to the ARC.

$$\text{CCI at 1 hour} = \frac{(\text{platelet count}_{post} - \text{platelet count}_{pre}) \times \text{BSA}\ (m^2) \times 10^{11}}{\text{Number of platelets} \times 10^{11}\ \text{in unit}}$$

$$\text{Body Surface Area (BSA)} = \left[\frac{\text{Ht(cm)} \times \text{Wt(kg)}}{3600}\right]^{1/2}$$

or

$$\text{Body Surface Area (BSA)} = \left[\frac{\text{Ht(in)} \times \text{Wt(lb)}}{3131}\right]^{1/2}$$

PROCESS FOR ORDERING HLA-MATCHED PLATELETS:

If a patient requires HLA-matched platelets, here are the steps to initiate the process:

Under reports and documents (one of the tabs on the left of the screen), search "by type" and find the HLA folder under "Laboratory Reports" --> "HLA Lab" and print out the report for the Blood Bank. You should at least find the HLA antigen report but perhaps you won't find the HLA antibody report if they didn't test for that yet.

You can work with the Blood Bank to get a request form filled out for the patient (usually the BB does this). The Red Cross asked that you clarify on the request form if you want a specific ABO type for the PLTs, because if not, their default is to send whichever ABO-type PLTs they have. The request form and HLA antigen results from above will be faxed by the BB to the ARC, Carolinas Region, in Charlotte, NC. Phone: 704-347-8205 (M-F); Fax: 704-335-6384. 1-800-532-0025 (weekend line). 1-800-708-2623 (alternate fax number).

You can ask their HLA lab to contact you once they know if there are any HLA-matched PLTS available in stock. If there is a 100% match, then you won't need to check for HLA antibodies, but if you want to get this HLA-antibody work-up started, you can either send a sample to Charlotte and request they do the work-up, or ask the UAB HLA lab to do it.

Ordering HLA antibody testing at UAB:

Order the "HLA Specimen" powerplan. At the bottom is a heading entitled: ***HLA TESTING FOR MATCHED PLATELETS***. Check the box for "HLA Class I SAB (Ab Ident.)" at the very bottom. The very top box "HLA Patient Type/Analysis Reason" will be automatically checked and should stay checked. In the comment section please add: "Draw 2 yellow top and 1 red top tubes," and call the primary team to let them know. The 2 yellow top tubes are for the HLA typing and the red top tube is for the HLA antibody work-up.

The UAB HLA lab can be reached at 205-934-4714 to find out when they can run this test (sometimes it's not until the following day). They do the tests in batches so it helps to find out when they predict the next batch will be run. If this is on the weekend, they don't have an on-call number, but the hospital operator has their information and can get you in touch with the on-call person, if needed.

8. Release of Platelets without BDS Testing Result:

All apheresis platelets are checked for bacterial contamination by Bacterial Detection Systems (BDS) 24hrs after collection. On the next day, the result is read at the collection facility prior to shipment. Under normal circumstances, we do not accept any units for which a negative BDS result is not available. In rare occasions of severe shortage, we may have to accept them. However, prior to issuing, the resident contacts the ordering physician to explain that 1:5,000 units may be contaminated with bacteria that could lead to a septic transfusion reaction. The patient's physician will have to sign a form to attest that the risk of not transfusing is higher than that of bacterial contamination.

III. FFP/FP24/Thawed Plasma

1. Indications:
   - To replace clotting factors in a patient undergoing massive transfusion (replacement of $\geq$1 blood volume within 24 hours)
   - Bleeding patients with clotting factor deficiencies, when factor concentrates are not available (XI is the most common example).
   - Patients taking Warfarin who are bleeding **(ONLY if Kcentra is not available)**
   - DIC
2. Composition: all coagulation factors (F), 1 IU of each F/ml of plasma.
3. Volume: FFP is 220ml (range is 180-300ml).
4. Ideally, ABO compatible with patient.
5. Dose is 10-20 ml/kg body weight (a standard dose would be 4-6 units in an adult). At this dose, expect an increase of each coagulation factor level by 20%.
6. **Note:** For renal transplant patients that received ABO incompatible (ABOi) organ, any unit of plasma in the peri-operative period should be compatible with both the donor and the recipient to avoid acute transplant

rejection (see chart for guidance on selecting the right blood type for these patients).

IV. Cryoprecipitate

1. Indications: Hypofibrinogenemia, FXIII deficiency and hypofibronectinemia (burn and traumatic shock patients).
2. Composition: 80-120 U of FVIII, 50% of vWF and 25% of FXIII from original unit, 150 mg of fibrinogen, and fibronectin. Most units in stock are pools of 5 units.
3. Volume: 10-25 ml, thawed at 37°C and used up to 6 hrs; thawed pools expire in 4 hrs.
4. May not be ABO compatible with patient.
5. Dose is 10-20 units/adult: 1 unit/10 kg will increase fibrinogen by 7-10 mg/dl (for fibrinogen replacement).
6. How to calculate the dose of cryoprecipitate to raise fibrinogen:
   - Weight (kg) x 70 ml/kg = blood volume (BV) (ml)
   - BV (ml) x (1-Hct) = plasma volume (PV)(ml)/100 = (dl)
   - Mg of fibrinogen required = (desired level in mg/dl – initial level in mg/dl) x PV(dl)
   - # units of cryo = mg fibrinogen required/250 mg per unit of cryo
   - Note: Though 150 mg of fibrinogen is required by the FDA to be in the unit of cryo, we assume that there is approximately 250 mg/single unit and use this value in the calculation of cryo units needed.

V. Granulocytes(very rarely used – less than once a year at UAB)

1. Indications:
   - Neutropenia ($<0.5 \times 10^9$ /L) and infection for $\geq$ 24-48 hours, lack of response to appropriate antibiotics or other modes of therapy, myeloid hypoplasia, BUT a reasonable chance for recovery of marrow function in a few days.
   - Neonatal sepsis with neutropenia.

2. Dose: 1×10^9 cells/kg.
3. Stored at 20-24°C and transfused ASAP (within 8 hours); must be completed within 24 hours from collection.
4. RBC crossmatching must be performed: For BMT patients, need to have a current sample for forward and reverse typing (during engraftment period) to determine the "best" ABO match since product cannot be washed and product must be ABO-compatible.
5. Products should also be irradiated.

6. Arrange for collection by calling the Medical Director of the American Red Cross, Dr. Kenneth McMilin (205-613-1783).
***Please have product specifications, including CMV status of the patient, and ordering physician's pager number, before calling.*

PRODUCT MODIFICATION REQUESTS and CONSULTS

1. Requests for Leukocyte-Reduced Products

All our cellular products (RBCs and PLTs) are **pre-storage leukoreduced** ($<5x10^6$ leukocytes per unit);therefore, leukocyte filters are not necessary. If, on a rare instance, the product is not leukocyte-reduced, it will automatically be issued with a leukocyte filter.

2. Requests for Washed Products

Washed RBCs must be transfused within 24 hours, as it is an "open system".
** Note, most requests for washed products are ordered in error. Discuss indication with ordering physician prior to approval. When in doubt, contact the TM attending.*

Indications:

- For neonatal or intrauterine transfusion of irradiated products when more than 5 hours have elapsed between the time of irradiation and transfusion (this delay does not usually happen at UAB). This is to remove extracellular K+ (potassium) to prevent hyperkalemia. Potassium reference range for newborns is 3.5-5.0 mol/L. Be aware that heel stick samples may have hemolysis that elevates K+.
- For patients with IgA deficiency, if products from an IgA-deficient donor are not available.
- For patients with plasma allergy or severe allergic response not controllable with antihistamines.
- For patients with repeated / severe allergic or febrile non-hemolytic transfusion reactions to RBCs.
- PLTs are considered plasma products and cannot be washed.
- There are no “STAT” orders for washed products as it can take up to one hour to prepare these units. If the patient is critical and needs blood immediately, ask the BB Tech to release the freshest units in our inventory.

- Washing should not be made a permanent requirement in the patient's BB record unless first discussed with the TM attending.

3. Requests for Irradiated Products

Irradiation is used to prevent graft versus host disease (GVHD) in populations at risk for this complication of transfusion. Only cellular blood components should be irradiated (RBCs, PLTs, and granulocytes).
Indications:

- All Heme/Onc patients
- All HLA- or crossmatched PLTs for intended recipients
- Current or past treatment withfludarabine, nelarabine, or clofarabine
- All infants up to four (4) months of age
- All intrauterine transfusions
- All directed donations from first-degree relatives
- Congenital immunodeficiencies Confirmed or suspected DiGeorge's Syndrome (if you need to determine DiGeorge test results or whether a sample was sent for testing, call Cytogenetics at 934-4968)
- As needed, per discussion with primary team and TM attending

Irradiation decreases the shelf life of the RBCs to 28 days or the original expiration date, whichever is shorter.

Examples:
--Unit with 35 days until expiration will now expire in 28 days.
--Unit with 23 days until expiration will still expire in 23 days.

4. Requests for CMV Seronegative Products:

CMV seronegative products are used to prevent the transmission of CMV, when the patient is at risk for significant morbidity or mortality from CMV infections. We encourage the use of "CMV safe", which are pre-storage leukoreduced products ($<5x10^6$ leukocytes) over CMV negative products because the former are considered to be equally effective in preventing CMV transmission. **All products issued from the UAB BB are "CMV safe".** We will issue CMV negative products, if available, for the following indications at UAB:

- All intrauterine transfusions
- All neonatal exchange transfusions
- All infants up to 4 months old

- All lung transplant patients*
- All heart-lung transplant patients*
- Upon request, for CMV negative immunocompromised patients

**May issue CMV-safe without physician consultation in case CMV negative units are unavailable.*

SPECIAL PATIENT POPULATION CONSULTS

Stem Cell - Bone Marrow Transplant (BMT) Patients

1. Need Patient's historical blood type, donor's blood type, and date of transplant.
2. Current forward and reverse type - Provue printout.
3. See table below for recommended transfusion for ABO mismatched BMT immediately following the transplant. Depending on the situation, we may select alternative types for transfusion in order to monitor engraftment.

Table for Transfusion Options with History of ABO Mismatched BMT

Recipient	***Donor***	***RBCs***	***Plasma & Platelets 1st, 2nd, 3rd, 4th****
O	A	O	A, AB, B, O
O	B	O	B, AB, A, O
O	AB	O	AB, A, B, O
A	O	O	A, AB, B, O
B	O	O	B, AB, A, O
AB	O	O	AB, A, B, O
A	B	O	AB, A, B, O
B	A	O	AB, B, A, O
A	AB	A	AB, A, B, O
B	AB	B	AB, B, A, O
AB	A	A	AB, A, B, O
AB	B	B	AB, B, A, O

Remember to use low titer (< 50) for 2nd-4th choices of platelets*

4. For Rh mismatch, first preferences are Rh-negative products. Consult with Heme Fellow or BMT attending if switching to Rh-positive products for an Rh-negative patient (per Dr. Salzman).

5. In order to approve 2nd-4th choices of PLTs or plasma, you must consult the Heme Fellow or BMT attending (per Dr. Salzman).

6. If called regarding verification of BMT status for a patient admitted to a BMT attending and the BMT floor, but not identified as a BMT patient in the computer system, the Pathology resident MUST speak to the BMT fellow or a BMT attending, NOT to a nurse or cross-cover resident.

7. Following the patient's BMT you will be paged by the BB to verify the patient's blood type for each time that is ordered. The Tech will give you a print out of the Provue results. If blood is needed urgently, go ahead and verify the historical type. If there is no urgent need to verify the type, take the time to review recent transfusions and maybe ask the BB Tech to perform a DAT (this is something you will learn doing it – it is difficult to explain).

Stem Cell Collection through Peripheral Blood Apheresis

The great majority of BM transplants at UAB use either autologous or allogeneic peripheral blood collection (apheresis) of stem cells (after mobilization) and for those, orders for RBC units to wash/prepare the product for infusion are extremely rare, since the Hct of the product is typically low (2-5%). Thus, even if there is major ABO incompatibility there is no need to process the product with recipient compatible ABO units.

Allogeneic Stem Cell Collection through BM Aspiration

When there is major ABO incompatibility, since the Hct of the product is typically higher (20-50%) when collected from the bone marrow (BM), there is concern for hemolysis and in order to avoid that, the stem cell product may be diluted with recipient ABO-compatible RBC units:

Donor	Recipient	Processing required
A	O	RBC depleted
A	B	RBC and plasma depleted
B	O	RBC depleted
B	A	RBC and plasma depleted
AB	O	RBC depleted
AB	A	RBC depleted
AB	B	RBC depleted
Rh+	Rh-	RBC depleted (ask M.D.)

Typically, the CRNP in the BMT unit will put an order for 1 unit of ABO recipient matched irradiated leukoreduced RBCs after the request of the stem
cell processing lab is originated. The BB resident should double check if there is a major ABO discrepancy and approves the order.

Intrauterine transfusions (IUTs) of babies whose mothers have red cell alloantibodies:

Units for use in IUTs have the following requirements:

- Fresh (5-7 days old, if possible)
- Type O negative, regardless of maternal blood type
- Antigen-negative corresponding to maternal antibodies
- Irradiated
- Leukoreduced
- Titered for isohemagglutinin levels to less than 50
- CMV negative, if possible
- Hemoglobin S negative
- Final Hct of 74-77% **OR** as requested by the clinical team

NOTE: Getting the correct Hct may require mixing the RBCs with donor plasma. The donor plasma should always be type AB.

Neonates

1. Neonates 0-4 months requiring exchange transfusion, receive CMV negative, group O RBCs, which are $\leq$ 14-days old. If CMV negative units are unavailable, discuss with clinician that leukoreduced products are "CMV safe".

2. Simple transfusions use the “dedicated unit protocol” where a single RBC with the shortest possible shelf-life is assigned to the baby, and aliquots are removed as needed until the expiration day of the unit. This practice limits donor exposures and potential transfusion-transmitted infections.

3. Irradiate for neonates 0-4 months old and any patient with of the following:

- Possible DiGeorge's Syndrome. (If you need to determine DiGeorge test results or whether sample sent for testing call Cytogenetics at 934-4968.)
- Undergoing ECMO (extracorporeal membrane oxygenation).
- Undergoing exchange transfusion.

Surgery patients with alloantibodies:

Every evening, a BB technologist will review the surgery schedule for the following day in order to identify patients who have known alloantibodies. Some pre-surgical patients may have a positive antibody screen at their pre-surgical anesthesia clinic visit; others may have histories of antibodies. The technologist will notify you of these patients if we do not have a blood sample in the lab and crossmatch units may be indicated. You will need to decide if the surgeon needs to be contacted about these patients and the challenges that the BB may face when crossmatching units for them.

Resident preparation of pre-surgery antibody consults:

1. Find out what alloantibodies the patient has, and the last time he/she had a type&screen performed. Make sure you know date, time, and type of surgery that is scheduled. Use the pre-surgical form to help guide your collection of information. The pre-surgical form is located in the Transfusion Medicine folder in the P: drive.

2. Theguidelines for blood use in surgery (called MSBOS)is also located in this folder and should be used along with the patient’s Hct to guide the decision-making regarding the likelihood of a surgery requiring units.

3. Discuss the case with the BB attending to determine whether or not the surgeon and/or anesthesiologist need to be contacted.

Example: --A patient is pre-surgery for a colonoscopy; Hct is 37%, patient has anti-E. This **does not** require contact because of the near normalHct, the low risk of bleeding during the procedure, and the ease of finding E-negative units, if transfusion is required.

Patients receiving ABO incompatible (ABOi) kidneys:

Due to the chronic shortage of kidneys available for transplant, the Renal Transplant service is now performing ABOi transplants from living donors depending on the recipient's anti-A and/or anti-B titers

We often perform a series of TPEs before and after transplant to lower the isohemaglutinin titer (anti-A or anti-B) from the patient's plasma, when indicated. When you are notified of a patient receiving ABOi transplant, ask a BB Tech to put a special transfusion requirement in the patient's BB records based on the table below.

- **Plasma and platelets for these patients should be compatible with both**
the donor and recipient, much like transfusing a patient that received an
ABO incompatible bone marrow transplant. This is extremely important because anti-A and anti-B may cause hyperacute rejection of the donor
kidney.

Table for Transfusion Options with ABOi Renal Transplant

Recipient	***Donor***	***RBCs***	***Plasma & Platelets*** 1^{st}, 2^{nd},
O	A	O	A, AB
O	B	O	B, AB
O	AB	O	AB
A	O	O	A, AB
B	O	O	B, AB
AB	O	O	AB
A	B	O	AB
B	A	O	AB
A	AB	A	AB
B	AB	B	AB
AB	A	A	AB
AB	B	B	AB

TRANSFUSION REACTIONS

Symptom	Possible Reaction Type	Pertinent Differential Diagnostic Information
Hypertension	TACO	1. What has BP and HR been in hours/days prior to transfusion? 2. Fluid status: volume of fluid in & out for 8-24 hrs prior 3. Pulmonary wedge pressure (n=6-12, > 25 cardiogenic edema) 4. Chest radiograph results 5. BNP level?
Hypotension	Hemolytic TRALI Anaphylactic Bacterial sepsis	1. Pulse: Slow - suggests vasovagal reaction Fast - suggests volume depletion or sepsis 2. Is patient on an ACE inhibitor 3. Was patient already on vasopressor medications 4. Was anti-hypertensive medication given prior to transfusion
Dyspnea	Anaphylactic TRALI TACO Sepsis Hemolytic Allergic	1. Did patient have rales versus wheezing on lung exam 2. Did patient have coughing or bronchospasm 3. What was O2 saturation and O2 requirement 4. What was rate of blood product infusion 5. Fluid status: volume of fluid in & out for 8-24 hrs prior 6. What was pulmonary wedge pressure (n=6-12, > 25 cardiogenic edema) or central venous pressure (CVP) 7. Were there abnormal chest radiograph findings 8. Did symptoms improve with diuresis 9. Did white blood cell count decrease following symptoms

Temperature increase	Hemolytic Febrile Non- hemolytic Sepsis	1. Greater than 1°C or 1.8 F change and temp greater than 38°C 2. What has temperature been in hours/days prior to transfusion 3. Were there signs of sepsis – hypotension, tachycardia, positive blood or urine cultures 4. Was patient post-op with lung atelectasis 5. Was patient pre-medicated with Tylenol 6. What happened to temp since stopping the transfusion
Hive/rash	Allergic Anaphylactic	1. What was extent and location of hives, rash or swelling 2. Was patient premedication with anti-histamine or steroids 3. Does patient have any other known allergies 4. What other medications did patient receive

Background

A. See *Transfusion Reaction Work-up Documentation form*. Appendix 4
(You may want to use this as a template for calls received at home.)

B. Collection information about the reaction: Contact the patient's clinician or nurse or review the patient's chart in Impact. You will need history regarding what happened during the transfusion (see above), including:

- Patient's diagnosis and brief clinical history.
- Changes in vital signs (HR, BP, Temp, Pulse).
- Be sure to check historical vital signs from previous 24-48 hours (i.e. the patient developed fever during transfusion, but also had a fever within the past 24 hours).
- Check post transfusion vital signs for 24-48 hours following transfusion.
- Changes in symptomatology.
- Signs, which indicated the possible reaction.

- Pre- and post-transfusion medications provided to the patient (especially antihistamines such as Benadryl and antipyretics such as Tylenol).
- Discuss and determine the need for additional transfusions.

C. Steps taken in the event of an Acute Transfusion Reaction (taught to all nurses):

1. Discontinue the transfusion.
1. Continue IV fluids (0.9%) NaCl.
2. Check & document vital signs and the amount of blood transfused.
3. Perform a clerical check (make sure the patient identity and blood product identity match).
4. Notify the physician caring for the patient.
5. Notify the Blood Bank.
6. Collect & label a red top tube of blood, purple top tube of blood and a urine sample.
7. Send the samples collected and the remainder of the blood product (or the empty blood product) with the tubing, but without the needle, to the Blood Bank to check for clerical errors and hemolysis.
8. In the Blood Bank:
   - Perform the clerical checkCompare pre- and post-transfusion testing of the following:
   - ABO/ Rh
   - Antibody screen
   - DAT
   - Crossmatch
   - Plasma color
   - Plasma hemoglobin
   - Urine hemoglobin (when positive, most likely it is hematuria – intact red cells, rather than hemoglobinuria due to hemolysis)
   - Urine free red cells
   - Urine red cell casts

D. In the event of the following types of transfusion reactions, additional testing must be performed and the TM attending should be notified immediately.

- If you suspect a septic transfusion reaction (from contaminated PLTs, for example), the remaining portion of the transfused unit must be cultured (BB Tech will take unit to Microbiology for this to happen) and blood cultures from the patient must be sent.
- If you suspect an acute hemolytic transfusion reaction, remind patient's physician to keep patient well-hydrated to avoid acute renal failure.
- If you suspect an anaphylactic transfusion reaction, an IgA level may need to be ordered.If you suspect TRALI, advise supportive care, and order a CBC to check for transient leukopenia. Avoid diuretics!

E. Finalize reaction investigation:

1. When the BB completes workup and calls you with the results, contact the patient's clinician, nurse practitioner or physician assistant to discuss the final disposition of the reaction. This must be discussed with a practitioner responsible for the patient's care, not the patient's nurse. Explain that the workup may have been negative for hemolysis because the other types of reactions are based on clinical signs and symptoms.

2. Inform BB of interpretation of reaction and whether it is OK to transfuse, if additional products are required.

Resident preparation of Transfusion Reaction consults:

1. Review transfusion reaction work-up. If you have questions about the work-up ask an antibody specialist, TM fellow or attending.
2. Enter interpretation into "BB results entry" using the accession number. See example templates in the TM folder on the P drive. Read for errors before "performing".
3. It is very important that you read through the portion filled out by the Tech and correct any errors you find. Also, you must make sure the formatting is lined up appropriately. Remove extra dashes

and “prompts”. If the consult is messy, you will be asked to fix it before the attending signs it out.

4. Fill out the resident sections of the transfusion reaction worksheet, sign and date. Bring work-ups to the TM attending as soon as you have entered and “performed” your interpretation.

Sample Transfusion Reaction Write-ups

1. No Transfusion Reaction:

This patient is a 74yo woman admitted for intractable headache and vision changes. While receiving a unit of RBCs she developed chills and experienced "leg jerking". Her vital signs had remained stable during the transfusion and were consistent with vital signs 4 hours prior to the transfusion through 12 hours following the transfusion.

There is no laboratory evidence of incompatibility between the donor and the recipient of the RBCs. The clinical findings of chills (without fever) and "leg jerking" are somewhat obscure and do not fit with any category of a transfusion reaction. Other medical conditions should be considered.

2. Febrile Transfusion Reaction:

This patient is a 19yo white man s/p BM transplant. He developed chills and fever during a platelet transfusion this afternoon. His temperature increased from 98.1F to 100.7F (2.6 F change) with his BP and HR remaining stable. During the week prior to this transfusion, his temperature was relatively stable fluctuating from 97.8F to 99.9F, although, he had two spikes in temperature of 100.4F and 102.0F on two recent occasions.

There is no evidence of incompatibility between the donor and the recipient. The clinical findings of chills and an increase in temperature greater than 1.8F fit best with a febrile, nonhemolytic transfusion reaction due to anti-leukocyte antibodies and/or transfused cytokines. Clinical correlation of the patient's underlying disease process is recommended. Blood cultures were drawn at the

time of the reaction and the patient is currently on multiple antibiotics.

Should the patient need further transfusions, blood products may be provided as indicated. Pre-transfusion medication with an antipyretic, such as acetaminophen, is recommended.

3. Allergic Transfusion Reaction:

This patient is a 73 yo man in the SICU. He developed a rash on his abdomen and legs immediately following the transfusion of one unit of plasma (or PLTs). His BP (123/52 – 158/63), HR (104) and temperature (99.5F – 100.0F), remained relatively stable.

There is no evidence of incompatibility between the donor and the patient. The observed clinical findings fit best with an allergic, nonhemolytic transfusion reaction due to transfused plasma proteins.

Should the patient need further transfusions, blood products may be provided as indicated. Pre-transfusion medication with an antihistamine, such as Benadryl, is suggested to treat or prevent allergic transfusion reactions.

4. Transfusion Related Acute Lung Injury (TRALI):

This patient is a 58yo female, status post renal transplant. Prior to transfusion, her post-operative course was unremarkable. During transfusion of a second unit of RBCs on (date), she became acutely dyspneic and developed fever. Intubation was required following the reaction.
Comparison of pre- and post- transfusion chest radiograph reveals the development of bilateral pulmonary infiltrates post-transfusion. These findings, along with negative blood bank laboratory testing, are most consistent with transfusion related acute lung injury (TRALI).
TRALI is usually due to the transfusion of a donor's anti-leukocyte antibody acting against the recipient's leukocytes. Treatment is supportive and TRALI typically resolves within several days. Because TRALI is donor-related and there is a low risk of transfusing

a second product from the same donor, further transfusions may be provided as indicated.

ACUTE TRANSFUSION REACTIONS

Type: Mild to Moderate Allergic
Causes: Donor antibody to recipient plasma protein; recipient antibody to donor plasma protein (both lead to release of histamine).
Signs and Symptoms: Localized itching (pruritus) and/or hives (urticaria); no fever.
Action: Follow Steps 1-9; administer the following as clinically indicated: *Antihistamine* (e.g. diphenhydramine 25-50mg PO/IM/IV q6h) and monitor for improvement of the signs and symptoms.
Prevention: Premedicate with Antihistamine 30-60 minutes prior to transfusion.

Type: Severe Allergic
Causes: Donor antibody to recipient plasma protein; recipient antibody to donor plasma protein.
Signs and Symptoms: Hives, shortness of breath, wheezing, hypotension, and/or anaphylaxis; no fever.
Action: Follow Steps 1-9; administer the following as clinically indicated: *Antihistamine* (e.g. diphenhydramine 25-50mg PO/IM/IV q6h), *Epinephrine* (e.g. 0.3-0.5 ml of 1:1000 solution SQ q20min), *Vasopressor* (e.g. dopamine 400mg in 250ml D5 @2-20 ug/kg/min), *Corticosteroids* (e.g. methylprednisolone 125mg IV q6h).
Prevention: Pre-medicate with Antihistamine H1 and H2 blockers (cimetidine etc.); use washed products.

Type: Anaphylactic
Causes: Recipient antibody to donor plasma protein (most commonly anti-IgA).
Signs and Symptoms: After transfusing only a few mL of plasma, rapid development of hives, erythema, anxiety, respiratory distress, laryngeal/pharyngeal edema, bronchospasm, and/or hypotension; no fever.
Action: Follow Steps 1-9; administer the following as clinically indicated: *Antihistamine* (e.g. diphenhydramine 25-50mg PO/IM/IV q6h), *Epinephrine* (e.g. 0.3-0.5 ml of 1:1000 solution SQ q20min), *Vasopressor* (e.g. dopamine 400mg in 250ml D5 @2-20 ug/kg/min), *Corticosteroids* (e.g. methylprednisolone 125mg IV q6h).
Prevention: For IgA deficient patients, use products from IgA deficient donors or use washed products; pre-medicate with Antihistamine H1 and H2 blockers.

Type: Febrile, non-hemolytic
Causes: Recipient antibody to donor WBC or plasma protein leads to IL-1 production; accumulation of cytokines (IL-1) from donor's WBCs in blood product; underlying condition.

Signs and Symptoms: Increase of temperature ≥1.8°F (1°C) with or without chills (Rarely may cause hypotension).
Action: Follow Steps 1-9; administer the following as clinically indicated: *Antipyretic* (e.g. acetaminophen 325-650mg PO/PR q4h).
Prevention: Premedicate with antipyretic; use leukocyte reduced products if repeat febrile reaction.

Type: Volume Overload (TACO)
Causes: Rapid transfusion rate; excessive volume; congestive heart failure.
Signs and Symptoms: Shortness of breath, pulmonary edema, productive cough (pink, frothy sputum), tachycardia, headache, and/or hypertension.
Action: Follow Steps 1-9; Administer the following as clinically indicated: *Diuretic* (e.g. furosemide 1mg/kg body weight or 20-80mg IV); check the chest radiograph; recommend NT-Pro-BNP level.
Prevention: Decrease transfusion rate to 100ml/hr (normal is 200ml/hr); decrease volume.

Type: Septic
Causes: Contaminated blood product (almost exclusively PLTs, which are stored at room temperature).**Signs and Symptoms:** Chills, fever, hypotension, and/or nausea and vomiting.
Action: Follow Steps 1-9; administer the following as clinically indicated: *Antibiotic* (review gram stain and culture results of blood product to determine which antibiotic to administer).
Prevention: Proper handling of products.

Type: Acute Hemolysis
Causes: Incompatible RBC transfusion. Most commonly ABO incompatible, but other frequently incited antibodies are anti-Kell, -Jk^a, -Fy^a. All of these strongly bind complement and cause intravascular hemolysis. Extravascular hemolysis may also occur if antigen-antibody complexes activate complement to C5-9 complex.
Signs and Symptoms: Shortness of breath, anxiety, chills, fever, pain at infusion site, chest and flank pain, shock, renal failure, hemoglobinuria, DIC hypotension and/or bleeding.
Action: Follow Steps 1-9; administer the following as clinically indicated: Maintain blood pressure with *Vasopressor* (e.g. dopamine 400mg in 250ml D5% at 2-ug/kg/min) renal sparing dose. Maintain renal output >100mL/hour with fluid replacement and diuresis; *Diuretic* (e.g. furosemide 1mg/kg body weight or 20-80mg IV). Maintain airway. Monitor coagulation and watch for *DIC*. Request appropriate labs which may include: CBC (complete blood count), coagulation studies: PT (Prothrombin Time), PTT (Partial Thromboplastin Time), Fibrinogen, D-Dimer; Renal function studies: BUN and Creatinine; Hemolysis studies: bilirubin, haptoglobin, urinalysis.

Prevention: Perform pre-transfusion Type&Screen and give crossmatch-compatible RBCs.

Type: Transfusion Related Acute Lung Injury (TRALI)
Causes: Typically donor antibody versus recipient HLA or WBC antigens.
Signs and Symptoms: Chills, fever, shortness of breath, respiratory failure, hypotension, and/or non-cardiogenic pulmonary edema.
Action: Follow Steps 1-9; Administer oxygen, Intubate (mechanical ventilation) if necessary. Supportive care. Check leukocyte count (CBC), chest radiograph, and NT-Pro-BNP level.
Prevention: Do not use product from the same donor (donor deferred for future donation). After consulting with the TM attending, notify the donor center so the donor can be tested for HLA antibodies.

What to look for based on transfusion reaction symptoms:

1. **Hypertension**
   a. What has BP been running in hours/days prior to transfusion
   b. Back or other type pain
   c. Fluid status: I & O's for 8-24 hrs prior, pulmonary wedge pressure (n=6-12, > 25 cardiogenic edema)
2. **Hypotension**
   a. Pulse – slow: vasovagal reaction; fast: volume depletion, sepsis
   b. ACE inhibitor
   c. Vasopressor support
   d. Anti-hypertensive given prior to transfusion
3. **Temperature increase**
   a. Greater than 1^{o}C or 1.8F change and greater than 38^{o}C
   b. What has temperature been in hrs/days before transfusion (spiking temps?)
   c. Signs of sepsis – hypotension, tachycardia, positive cultures
   d. Atelectasis, post-op
   e. Premedicated with Tylenol
4. **Hives/rash**
   a. Wheals, erythema, and or rash – extent and location
   b. Premedication with anti-histamine or steroids
   c. Swelling – extent, location

5. Dyspnea

a. Rales versus wheezing
b. Coughing/bronchospasm
c. O2 saturation, O2 requirement
d. Rate of blood product infusion
e. I & O's for last 8 to 24 hrs.
f. Wedge or central venous pressure
g. CXR findings
h. Symptoms responsive to diuresis
i. BNP levels
j. WBC count

LOOKBACKS AND RECALLS

The FDA has detailed regulations mandating what must occur when a blood donor center such as the ARC determines that a blood component did not meet all of the requirements for safety, quality, purity, potency, and identification. Some of these regulations are applicable to the hospital TM service as well.

Two types of retrievals occur, a "Market Withdrawal" which involves a minor violation that would not be subject to legal action by the FDA and "Recall" which indicates a more significant violation of the law.

When the BB is notified by a blood supplier that a particular product is being retrieved, they must document the disposition of that unit and/or destroy the product if instructed. Additionally, the Director of the hospital TM service determines if the retrieval warrants notification of the recipient.

Additionally, when a donor tests positive for infectious disease and has donated previously with negative test results, the FDA requires a "Look-back" at all prior donations and transfusion be conducted. The hospital BB and medical director must respond with the disposition of the blood product recipient and in some cases must notify the recipient's physician of the results.

Residents on the TM service will be given several examples of look-backs and recall cases for review and discussion with the BB attending and the rest of the team.

COAGULATION FACTOR REPLACEMENT

I. BACKGROUND

The coagulation factor inventory is managed in the BB rather than the pharmacy as in many other institutions. All orders must be reviewed and approved by the BB resident prior to issuing the factor from the lab.

Obtain the basic patient information including:

- Name and medical record number
- Location in hospital
- Attending and resident names
- Determine whether this is a new patient to UAB or returning patient
- HIV, HCV, HBV status

Please come to morning report (MR) with the following information for patients that have received or are about to receive factors such as those going to the OR for a procedure:
What dose does he take at home and what is the frequency?
(Click on orders then "Document Meds by Hx" to check)

- When in the last week did he last take his home dose?
- Is the patient bringing his/her own factor replacement to the hospital or will we dispense ours from the blood bank?
- What is the patient's plasma volume? (used for estimating the correct doses needed)
- Is the patient actively bleeding?
- Things to consider for monitoring outcomes during the hospital stay:
- Is he hypotensive or tachycardic?
- Did his Hg/HCT drop from the prior day? If so, by how much?
- Was he transfused in the last 24 hours? If so, with how many units of RBCs?
- If he had a diagnostic study (EGD, angiogram, other imaging) to assess bleeding, what are the results?
- What is his trough level and how many hours elapsed from the last dose to the time the trough was drawn?

- What is his peak level and how much time elapsed from the last dose being given to the peak?
- What is the dose and frequency of the factor he is receiving in the hospital?
- What is the total daily dose?
- What is the total dose for the next five days?
- When is the patient being discharged and does that shorten the total dose for the next five days?

Instructions for the primary team or Hematology:

- Please ask them to order the factor and give them our recommended dose, frequency, and recommended time of administration (roughly)
- Either ask them to enter the trough in 12 hours (FVIII) or 24 (FIX) hours after the last dose but before the next dose (this varies on the type of factor deficiency and clinical scenario, so please check with the TM team on this) and if needed, a peak 15 to 30 minutes after the factor was infused. Remind them they need to enter a nursing transfusion order along with the factor product if they ask
- Call the BB (934-6390) and approve the recommended doses discussed (with # of units, frequency, # of doses, and time of administration)
- Consider sharing the trough and peak plan with the coag lab (934-5385) so they can anticipate the specimens. They leave by 4 pm each weekday, so we cannot get values back that are drawn near or after that time.

II. ORDERING FACTOR PRODUCTS

Coag Factor Orders through IMPACT

To order coagulation factors in IMPACT, the word "coag" is typed in the search box. A Power Plan called "Coag Factor Administration" will be the first option to appear in the list and is the one that should be chosen.

When the options under that Power Plan open, a list of different factors will appear such as "antihemophilic factor (factor 8 concentrate)" in 3 different lines because each one has a different dose frequency.

For example, the first line says “Every 8 hr”, the second is “Every 12 hr” and the third line is for “Once”.

If the patient needs factor VIII, the physician should click on the correct line and subsequently add the details of the order such as dose and type of product (plasma-derived or recombinant).

Below the options for factor VIII concentrate are 3 lines for “coagulation factor 9 (factor IX concentrate)”, which can be ordered for every 24 hr, 12 hr or once. Factor IX concentrate is the product of choice for a patient with hemophilia B (factor IX deficiency), in which case we can issue plasma-derived or recombinant according to

what the Path resident decides is more appropriate.

This Power Plan also has NovoSeven, FEIBA, von Willebrand factor concentrate (Humate-P), antithrombin, and prothrombin complex concentrate (KCentra) as options for ordering.

It is essential that the Impact order be for the exact dose of factor that is released from the Blood Bank. Thus, if the resident approves a different dose after discussing the case with the ordering team, the latter must discontinue the wrong order and place a new one with the appropriate dose. This step ensures that there is documentation of the exact physician’s order for the nurses to check prior to administering the product.

It is also necessary that a transfusion order for nursing be entered at the end. If you get asked how to administer the product, refer them to the package insert or the pharmacist on their floor.

III. HEMOPHILIA

A. You will need to answer the following questions:
   1. Does the patient have hemophilia A or B (factor VIII or IX deficiency respectively)?
   2. What product does the patient take at home?
      - Remember that most patients use recombinant factors because this type is the one provided by the state. However, if they have already been exposed to plasma products and/or are serologically positive for hepatitis B or C or HIV, we

should use a plasma-derived product (heat/detergent treated to minimize risk of virus transmission).

- If they are newly diagnosed and always used a recombinant factor, we should continue using these products.

3. Does the patient have a history of an inhibitor (alloantibody to the factor)? You can find this information by calling the Special Coag lab during the day at 934-8650.
   - Frequency of Factor VIII inhibitor > frequency of Factor IX inhibitor.
   - Up to 30% of patients with severe Hemophilia A have a factor eight (VIII) inhibitor that usually develops early in life.
   - For patients with inhibitors, we use FEIBA, AKA, anti-inhibitor complex (AIC) or activated prothrombin complex concentrate (aPCC).
4. Does the patient have HIV, Hepatitis C, or Hepatitis B?
   - If so, he does not need recombinant products.
5. Did the patient bring factor replacement products from home, which he/she is going to use in the hospital?
6. Is the patient bleeding or going to surgery/procedure?
   - This will help determine desired activity levels.
7. What is the current factor VIII/IX activity level?
   - Baseline activity level < 1% is considered severe deficiency.
   - If no factor VIII/IX activity level is readily obtainable (e.g. in the middle of the night), and the patient has a known factor VIII/IX deficiency, get a PTT. The factor VIII/IX activity level can be estimated from the PTT with the following tables.

USE THE FOLLOWING TABLES **ONLY IF THE PT IS NORMAL!**

VIII/IX Activity Level Estimated Using PTT

PTT (UAB)	**FACTOR VIII** ACTIVITY (%)
31	100
37	50
42	30
44	25
52	12.5
79	6.25

PTT (UAB)	**FACTOR IX** ACTIVITY (%)
30	100
34	50
37	30
38	25
44	12.5
61	6.25

***These tables are examples. Values change slightly with every lot number.**

Dosing for Factor VIII

The normal activity level of all factors ranges from 50% to 150% (or 0.5-1.5 units/mL of plasma), and >30% is required for hemostasis. ***Refer to http://www.uab.edu/medicine/coag/*** for additional information.

A. Activity Level Goals (Peak):

- For most surgery/procedure prophylaxis/minor bleeding: 75%
- For neurosurgery: 100%
- For major bleeding and spontaneous retroperitoneal bleeding: at least 100%

B. Calculate the dose based on Plasma Volume (PV)

a. PV = BV x (1-PCV)
b. BV = Blood Volume = pt's wt.(kg) x 70ml/kg (slim)60ml/kg (mildly obese) or 50ml/kg (morbidly obese)
c. PCV = Packed Cell Volume = Hematocrit
d. Dose (in units) =

(Desired Activity Level – Current Activity Level) x PV

Example: Desired activity level = 75%
Current activity level = 5%
PV = 3500ml
Dose = (0.75 - 0.05) x 3500 = 0.70 x 3500 = 2500 units

If you are called in the middle of the night and no activity level is available, get a PTT, dose a recombinant product, and request a pre-treatment sample be drawn for a factor level in the a.m. If you assume 0% factor level, please note that the initial 100% replacement dose is a LOADING dose. Another factor level should be drawn before the second dose (8-12hr later and typically 50% of the loading dose), particularly if the initial factor level is unknown. Always get the pre-treatment sample, even in the middle of the night, as the plasma may be kept frozen till the a.m.

Factor VIII Concentrate Products

Plasma-derived:

- Indicated for patients who have previously received plasma products or who have HBV, HCV, or HIV infection or positive serology.
- Safe: after millions of units used, no evidence of viral transmission per CDC long-term surveillance.
- Equivalent choices include: Monarc-M®, Hemofil-M®, Monoclate-P® or Koate-HP®; all are labeled with factor VIII units per vial.Products prepared using recombinant technology
- Indicated for previously untreated patients (PUPs), those who have never been exposed to plasma products or whose previous treatment or serology status is unknown.
- Equivalent choices include: Kogenate®, Helixate®, Recombinate® or Bioclate®; all are labeled with factor VIII units per vial.

Dosing for Factor IX

Calculate the dose based on the desired activity level as for the factor VIII dosing equations described above. Then multiply the result from the calculated dose by 2 (in other words, double the dose calculated).

This value is doubled because half the infused dose disappears after infusion (tissue distribution). Factor IX has more extravascular distribution than Factor VIII. Next dose is due in 24 hours. Some patients may require doses every 12 hours (dose is typically 50% of the loading dose). Decision will depend on peak and trough factor IX levels after the initial doses, as well as clinical response to treatment. Achieving an activity level of about 50% is generally sufficient.

Factor IX Concentrate Products

Plasma-derived products

- Safe, indicated for patients who have previously received plasma products or who have HBV, HCV, or HIV infection or positive serology.
- Equivalent choices include: Alpha Nine SD® or Mononine®; labeled with factor IX units per vial.

Recombinant Factor IX

- Indicated for previously untreated patients (PUPs), those who have never been exposed to plasma products, or whose previous treatment is unknown
- BeneFIX®

IV. WARFARIN REVERSAL / PRE-SURGERY INRs

Prothrombin Complex Concentrates or PCC

Dosing for Warfarin reversal is based on the patient's INR: Dosing decision takes into account the patient's clinical condition (bleeding, how much, etc.), degree of emergency to reverse INR, history of receiving vitamin K, liver function, number of units per PCC (KCentra) vial (product should not be wasted after it is reconstituted). Discuss these issues with patient's clinical team and the TM attending. Let the BB know which dose should be released to the patient. Dosing is based on a current INR. If the patient has not had an INR measured in the previous 2-3 hours ask the team to order the test STAT.

INR 2-4: 25 units of factor IX/Kg of body weight
INR 4-6: 35 units of factor IX/Kg of body weight
INR > 6: 50 units of factor IX/Kg of body weight

Note: Max body weight for any dose per package insert is 100kg. For example, the maximum dose for a patient with an INR of 3.7 is 2500 units.

- Note that patients with left ventricular assist devices (LVAD) who have prolonged INR should receive a smaller dose than the ones above because they must remain anticoagulated to avoid clotting in the instrument.
- One dose is all that is needed by most patients.
- NOTE: Doses for patients not on Warfarin (i.e. liver patients that need a pre-procedure dose) may be lower than those given above and are at the discretion of the TM attending based on the clinical circumstances of the patient. The dose should only be released right before the procedure and the clinical team should be instructed to not recheck the INR.

Prothrombin Complex Concentrate Products.

Kcentra

Contains procoagulant factors IX, VII, X, prothrombin; and natural anticoagulants Protein C and Protein S. Concomitant transfusion with plasma is not necessary.

Important note about checking INR after PCC infusion:
The *in vitro* PT/INR assay used in the lab is not an accurate reflection of the *in vivo* clotting ability after infusion of PCC. Tell clinical team not to order a post INR.

Important note about approving PCC:
This is a very expensive product that should only be approved, released and administered if the patient needs it immediately. You may get requests for use prior to a procedure. Do not approve unless procedure is absolutely going to occur at the time of dispensing. Always check with the fellow or Attending if you have any questions about its appropriateness.

V. ANTITHROMBIN DEFICIENCY

Antithrombin Concentrate (AT)

Antithrombin concentrate **(Thrombate or ATryn)** is used to treat patients with congenital or acquired deficiency of this natural anticoagulant. The most common use of AT at UAB is for patients on cardiopulmonary bypass (CPB) or extracorporeal membrane oxygenation (ECMO) receiving heparin. In order for heparin to mediate anticoagulation, it must bind to AT and, thus, after or during treatment with large doses of heparin (i.e. CPB or ECMO) AT may become deficient and heparin will be less effective. These patients are monitored with the activated clotting time (ACT), which shows results below the desired therapeutic range when AT is decreased. If this happens between 7 am and 3 pm (7 days a week), we may measure the AT activity if time permits.

Calculate the dose based on the desired activity level as for the factor VIII dosing equations described above. These calculations are very patient and situation specific.

- If the patient is on CPB or ECMO the patient's plasma volume (PV) plus the extracorporeal circuit volume must be considered.
- Adults may receive from 2-6 vials depending on their size and degree of AT deficiency.
- During cardiac surgery, we often give AT concentrate after estimating how much is needed and do not wait for the level. These cases may be emergent and consulting with the TM attending early is warranted.
- In emergency situations when AT levels are not available (e.g. heparin resistance for patient on ECMO) provide enough factor to increase AT to 75-125%.
- For babies undergoing heart surgery, one vial is more than enough, since vials come with approximately 500-600 units of AT, depending on the lot number.
-

VI. VON WILLEBRAND DISEASE

Dosing for von Willebrand factor (vWF)

Patients with type 3 (severe) von Willebrand disease sometimes need to be treated with factor concentrate. For such patients, the product of choice is Humate-P®, which is stored in the Blood Bank refrigerator. This product is plasma-derived from donors that have been repeatedly tested negative for infectious agents such as HIV, HBV, and HCV. Thus, the risk of transmission of these infections is practically zero. Each vial of Humate-P® is labeled with the number of units of both factor VIII and vWF, since the two molecules are bound together in the plasma. In order to calculate the dose of vWF, use the same formulas as for calculating the dose of factor VIII. Unlike factors VIII and IX, vWF is not measured by the PTT. The only way to estimate the current activity level is based on history. When in doubt, we may have to wait for the determination of vWF antigen and activity prior to issuing the factor. When the dose has been calculated, **the vials should be chosen based on the labeled number of units of vWF** and not the units of factor VIII. The first dose is the loading one, and subsequent doses given every 12 hours are usually half of it. It is always useful to measure a peak vWF antigen level and a trough prior to the second dose, in order to adjust the amount to be given. Clinical monitoring of the patient in terms of bleeding or hemoglobin level is quite helpful in the determination of the optimal treatment regimen.

INHIBITORS

Dosing for FEIBA **(Activated prothrombin complex concentrates, aPCC)**

- Use for patients with a known inhibitor to Factor VIII.
- Current factor level unnecessary to check.
- Dose in units/kg body weight (See package insert for details).
    - **A common dose is 50 units/kg every 12 hours.**
    - **FEIBA may be dosed as high as 100 units /kg every 12 hours or 70 units/kg every 8 hours (if difficult to control patient's bleeding use this more frequent dosing).**
    - **BUT may not exceed 200 units/kg/24 hours (risk of DIC).**

- **Maximum infusion/injection rate must not exceed 2 units/kg of body weight/minute. (For a 75-kg patient, approximately 2.5-7.5 ml/minute, depending on the # of units/vial).**

- There is no test to monitor FEIBA therapy; the patient's clinical response is the only guide (i.e. monitor patient's hematoma, Hct, etc.).

Dosing for NovoSeven

Although this product was prepared originally for hemophiliacs with inhibitor, it is much more expensive than FEIBA and has a half-life of less than 3 hours. Thus, it is not the first choice at UAB.

Currently, it is used mainly for life-threatening bleeding, most commonly after trauma or during cardiovascular surgery. Since these are off-label uses, orders should come from the patient's attending physician. Unless the patient is in the operating room, prior to release the product, the pathology resident should contact the ordering team and discuss the risks, benefits, and alternatives of NovoSeven. In particular, there have been reports of thrombosis in the subsequent days that were attributed to the drug.

Dose adults and children over 12 Kg:
Calculate the dose as 30 micrograms/Kg, and plan for just one dose.

- Round it up or down to the closest whole number to use the full vial(s), which contain 1, 2 or 5 mg, depending on what is available in the inventory at the time.

Dosing for children less than 12 Kg undergoing CV surgery:

- **Calculate the dose as 100 micrograms/Kg, and plan for just one dose.**
- Since the vials of NovoSeven have a final concentration of 1 mg/ml after reconstitution with the sterile water provided with the product, the volume is now easier to calculate, i.e., 0.4 ml for a 4 Kg baby to receive 0.4 mg of the product. For children weighing 11 or 12 Kg, use 1 mg.

Remember that all product must be infused within 3 hours after reconstitution.

Coagulation Factor Concentrates and Treatment Indications

Disorder	Product	Brand names	Indication	Vial label
Hemophilia A	Recombinant factor VIII	Advate rAHF®, Helixate®, Kogenate®, Recombinate®, Refacto®	"PUPS" – previously untreated patients	Number of units of factor VIII
	High-purity factor VIII concentrate, plasma-derived	Hemofil-M®, Koate-HP®, Monoclate-P®, Monarc-M®	Patients previously exposed to plasma and/or with hepatitis B, hepatitis C or HIV infection	Number of units of factor VIII
	Intermediate purity factor VIII concentrate, plasma-derived	Alphanate®, Humate-P®	von Willebrand disease or hemophilia A (only to be used if recombinant or high-purity concentrates not available)	Number of units of von Willebrand factor and factor VIII
Hemophilia A with inhibitor (up to 30% of severe hemophiliacs) or Acquired hemophilia*	Activated prothrombin complex concentrate (APCC)	Factor Eight Inhibitor Bypass Activity (FEIBA VH®),	Bleeding or prophylactic prior to surgical procedure	Number of units of concentrate (not a specific factor)
	Recombinant activated factor VII	NovoSeven®	"PUPS" – previously untreated patients	Number of mg (1, 2 or 5). We usually only have the 1 and 2 mg vials

Hemophilia B	Recombinant factor IX	BeneFIX®	"PUPS" – previously untreated patients	Number of units of factor IX
	High-purity factor IX concentrate, plasma-derived	Alphanine SD®, Mononine®	Patients previously exposed to plasma and/or with hepatitis B, hepatitis C or HIV infection	Number of units of factor IX
Hemophilia B with inhibitor (very rare)	Activated prothrombin complex concentrate (APCC)	Factor Eight Inhibitor Bypass Activity (FEIBA FH®)	Patients previously exposed to plasma and/or with hepatitis B, hepatitis C or HIV infection	Number of units of concentrate (not a specific factor)
Von Willebrand disease	Intermediate purity concentrate, plasma-derived	Humate-P® (first choice) Alphanate® (if Humate-P® not available)	Prophylactic use prior to surgery or active bleeding, mainly in types 2B and 3 von Willebrand disease	Number of units of von Willebrand factor and factor VIII

Other factor deficiencies (X II, Vitamin K def, liver disease, warfarin therapy)	Activated Prothrombin complex concentrate (PCC)	KCentra	Deficiencies of factors X or prothrombin. Hemophilia B patients are treated with the purified factor IX concentrates listed above	Number of factor IX Units. For every 100 units of factor IX, there are 148 units of prothrombin, 64 units of factor X and only 11 units of factor VII
Antithrombin (AT) deficiency	Antithrombin concentrate Plasma derived Recombinant	Thrombate ATryn	Congenital AT deficiency (very rare) or AT deficiency due to heparin (post-CV surgery and/or during ECMO) causing heparin resistance	Number of AT units. Calculate dose based on PV, baseline AT, target AT and units in vial (similar to calculation for factor VIII)

MANAGEMENT OF BLEEDING CAUSED BY DIRECT ORAL ANTICOAGULANTS:

Use this table created by a group of UAB physicians (trauma, neurosurgery, ER, TM) to help clinicians order the appropriate product for treatment of bleeding with these drugs. Remember to ask when the last dose of the drug was taken to help estimate how much drug is in the patient's circulation. The second table has information on drug clearance that can be very helpful.

Generic Drug (Brand)	Elimination Half-life	Removal by HD	Reversal Strategy
Alteplase (tissue plasminogen activator) Class: Thrombolytic	2 – 12 minutes	No	• Discontinue thrombolytic agent when intracranial hemorrhage is suspected or confirmed • Consider cryoprecipitate (10 units initial dose) to a goal fibrinogen >150 mg/dL in patients with thrombolytic agent-related symptomatic intracranial hemorrhage who have received thrombolytic agent in the previous 24 hours • If cryoprecipitate is contraindicated, consider aminocaproic acid 4-5 g IV over 1 hour or tranexamic acid 10-15 mg/kg IV over 20 mins
Apixaban (Eliquis) Class: Factor Xa inhibitor	8-15 hours (longer in renal impairment)	No	Drug activity can be assessed with an anti-Xa activity assay (only qualitative – negative or positive for drug). • If ingested within 2 hours, administer activated charcoal • Consider aPCC (FEIBA) 50 units/kg **NOTE**: aPCC may partially correct PT/PTT but will not affect anti-factor Xa activity and will not increase drug clearance; correlation of shortening PT/PTT with reduction in bleeding risk is unknown and should not be used since it does not correlate with clinical response.

Argatroban Class: Direct Thrombin Inhibitor	40-50 minutes	~20%	• Turn off infusion • Degree of anticoagulation can be assessed with PTT
Bivalirudin (Angiomax) Class: Direct Thrombin Inhibitor	25 minutes (up to 1 hour in severe renal impairment)	~25%	• Turn off infusion • Degree of anticoagulation can be assessed with PTT
Dabigatran (Pradaxa) Class: Direct Thrombin Inhibitor	14-17 hours (up to 34 hours in severe renal impairment)	~65%	• Drug activity can be assessed with thrombin time. UAB's thrombin time is very sensitive to the presence of drug in the circulation. • If ingested within 2 hours, administer activated charcoal • Administer **idarucizumab (Praxbind) 5 g IV once** o For assistance in obtaining this reversal agent please contact the pharmacist. The dose will be dispensed in two 2.5 g/50 mL vials. • Consider HD or idarucizumab re-dosing for refractory bleeding after initial administration. • No factors should be administered

<table>
<tr>
<td>Dalteparin
(Fragmin)

Class:
Indirect
Thrombin
Inhibitor:
Low
Molecular
Weight
Heparin</td>
<td>3-5 hours
(longer in renal
impairment)</td>
<td>~20%</td>
<td>

Use protamine for partial neutralization (~60%)
Degree of reversal can be assessed with anti-Xa activity

<table>
<tr><th>Time since last dose of dalteparin</th><th>Dose of PROTAMINE for each 100 units of dalteparin administered</th></tr>
<tr><td>< 8 hours</td><td>1 mg (alternative [alt]: 50 mg fixed dose)</td></tr>
<tr><td>8-12 hours</td><td>0.5 mg (alt: 25 mg fixed dose)</td></tr>
<tr><td>>12 hours</td><td>Not likely to be useful (alt 25 mg fixed dose)</td></tr>
</table>
</td>
</tr>
<tr>
<td>Enoxaparin
(Lovenox)

Class:
Indirect
Thrombin
Inhibitor:
Low
Molecular
Weight
Heparin</td>
<td>3-5 hours
(longer in renal
impairment)</td>
<td>~20%</td>
<td>

Use protamine for partial neutralization (~60%)
Degree of reversal can be assessed with anti-Xa activity

<table>
<tr><th>Time since last dose of enoxaparin</th><th>Dose of PROTAMINE for each 1mg of enoxaparin administered</th></tr>
<tr><td>< 8 hours</td><td>1 mg (alt: 50 mg fixed dose)</td></tr>
<tr><td>8-12 hours</td><td>0.5 mg (alt: 25 mg fixed dose)</td></tr>
<tr><td>>12 hours</td><td>Not likely to be useful (alt 25 mg fixed dose)</td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr>
<td>Fondaparinux
(Arixtra)

Class:
Factor Xa Inhibitor</td>
<td>17-21 hours (significantly longer in renal impairment)</td>
<td>No</td>
<td>

Fondaparinux levels can be assessed by anti-Xa activity for fondaparinux (different than the other anti-Xa test offered).
Consider aPCC (FEIBA) 20 units/kg or rFVIIa (Novoseven) 30 mcg/kg

NOTE: aPCC may partially correct PT/PTT but will not affect anti-factor Xa activity and will not increase drug clearance; correlation of shortening PT/PTT with reduction in bleeding risk is unknown and should not be used since it does not correlate with clinical response.
</td>
</tr>
<tr>
<td>Heparin

Class:
Indirect Thrombin Inhibitor</td>
<td>30-90 minutes (dose dependent)</td>
<td>Partial</td>
<td>

Use protamine for heparin neutralization (100%)
Degree of reversal can be assessed with anti-Xa activity

<table>
<tr><th>Time since last dose of heparin</th><th>Dose of PROTAMINE for each 100 units of heparin administered</th></tr>
<tr><td>Immediate</td><td>1 mg (alt: 50 mg fixed dose)</td></tr>
<tr><td>30 min – 2 hours</td><td>0.5 mg (alt: 25 mg fixed dose)</td></tr>
<tr><td>>2 hours</td><td>0.25 mg (alt 10 mg fixed dose)</td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr>
<td>Rivaroxaban
(Xarelto)

Class: Factor Xa Inhibitor</td>
<td>Healthy: 5-9 hours
Elderly: 11-13 hours
(longer in renal impairment)</td>
<td>No</td>
<td>

Drug activity can be assessed with anti-Xa activity (only qualitative – negative or positive for drug).
If ingested within 2 hours, administer activated charcoal
Consider aPCC (FEIBA) 50 units/kg

NOTE: aPCC may partially correct PT/PTT but will not affect anti-factor Xa activity and will not increase drug clearance; correlation of shortening PT/PTT with reduction in bleeding risk is unknown and should not be used since it does not correlate with clinical response.
</td>
</tr>
<tr>
<td>Warfarin
(Coumadin)

Class: Vitamin K antagonist</td>
<td colspan="3">
<table>
<tr><th>INR</th><th>Clinical Scenario</th><th>Management</th></tr>
<tr>
<td>Any INR</td>
<td>Life-threatening bleeding (eg, intracranial hemorrhage)</td>
<td>

Hold warfarin
Give phytonadione (vitamin K) 10 IV over 10-30 minutes (repeated if necessary depending on the INR)
Consider 4-factor PCC (KCentra) f all life threatening bleeding

INR 1.5 – 3.9; 25 units/kg; not to exceed 2500 units
INR 4.0 – 6.0; 35 units/kg; not to exceed 3500 units
INR >6.0; 50 units/kg not to exceed 5000 un

If PCC is not available or contraindicated, Treat with FFP 10 mL/kg IV along with vitamin K 10 mg IV over 10-30 minutes

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</table>
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</table>

	4.5-10	No significant bleeding	• Lower the warfarin dose and monitor more frequently or hold warfarin and resume therapy at an appropriately adjusted dose when INR is in the therapeutic range • PCC and/or Vitamin K is not recommended
	>10	No significant bleeding	• Hold warfarin and administer vitamin K 2.5-5 mg PO x 1 with the expectation that the INR will be reduced substantially in 24 to 48 hrs.

Table 5. The pharmacological properties of warfarin and novel oral anticoagulants[a,b]

	Dabigatran	Rivaroxaban	Apixaban	Edoxaban
Target	Thrombin	FXa	FXa	FXa
Pro-drug	Yes	No	No	No
Dose regimen	BID (150 mg or 110 mg, or 75 mg dose daily for patients with CrCl <30 ml/min)	OD/BID (15 mg or 20 mg)	BID (5 mg or 2.5 mg)	OD (60 mg with adjustment to 30 mg if required)
Bioavailability (%)	6.5	80–100 (10 mg dose) 60% (20 mg dose)	66	50
Half-life (h)	12–14	5–13	8–15	5–11
Protein binding	35	>90	87	55
Time to full effect (h)	1–3	2–4	1–2	1–2
Linear PK	Yes	Up to 15 mg daily	Yes	Yes
Interaction with diet	NA	Affects pharmacological activity. In elderly subjects with dietary vitamin K deficiency the PT is prolonged compared to subjects with healthy diets	NA	NA
Metabolism by CYP	No	3A4, 2J2 (60%)	3A4/5 (15%)	3A4 (<4%)
P-gp substrate	Yes	Yes	Yes	Yes
Renal clearance as unchanged active drug (%)	80	50	25	50
Elimination half-life (h) with CrCl >80 ml/min	13.8	8.3	15.1	NA
Elimination half-life (h) with CrCl >50–79 ml/min	16.6	8.7	14.6	NA
Elimination half-life (h) with CrCl >30–49 ml/min	18.7	9.0	17.3	NA
Elimination half-life (h) with CrCl <30 ml/min	27.5	9.5	17.3	NA

[a]Data derived from [95–98].

[b]Abbreviations: BID, twice daily; CrCl, creatininine clearance; NA, not available; OD, once daily; P-gp, P-glycoprotein; PK, pharmacokinetics; PT, prothrombin time.

PLATELET ANTIBODY TESTS

* Heparin Platelet Antibody (HIT antibody)
* Platelet Antibody Specificity (No longer performed at UAB, must be ordered from a reference laboratory, such as QUEST)

HIT testing is only offered Monday through Friday, 7:00am to 3:30pm. To ensure a same-day result, specimens for these assays should be IN-LAB by 12:00 noon. A summary of the important points regarding each assay is below - call lab with any questions BEFORE collecting blood:

Heparin-Induced Thrombocytopenia Antibody (HIT Ab)

- Identifies antibody in patient's plasma or serum specific for complexes of platelet factor 4 (PF4) associated with HIT.
- Assay can be added-on to blood already in lab, plasma or serum.
- Positive result DOES NOT make diagnosis of HIT. Clinical correlation is required.
- A Serotonin-Release Assay is sent each day following a positive HIT Ab in-house. It is performed M-Sat at the Blood Center of Wisconsin, in the coagulation laboratory.

THERAPEUTIC APHERESIS GOALS & OBJECTIVES

Stem cell collection and processing:
The trainee is expected:

1. To become familiar with the principles of stem cell transplantation including collection, processing, and storage of stem cell products, and the indications for use (e.g. bone marrow, peripheral blood, and cord blood).

Apheresis Resident:

Apheresis resident is expected to read and follow the protocols outlined in the following pages. In general:

a. Every morning, prior to Blood Bank Morning Report, check the Apheresis schedule book and become familiar with the patients'

histories and pertinent labs to bring to morning report. Identify which staff are assigned to apheresis for the day and discuss with each nurse the orders and plan for their patient.

b. Needs to be available to assist with procedures as planned. Nurses have been advised to only call if an emergency during TM didactic lectures.
c. Evaluate the patient prior to starting the procedure. In doubt, check with the Attending on call.
d. Must let the nurses know who to call if any problems arise during the treatment and be available by pager and in the hospital at all times a patient is being treated.
e. When it is time to end the treatment, the nurse will page the resident to let him/her know of any complications and the important information regarding the procedure.
f. Review and plan patient care prior to morning report i.e. note fibrinogen or hemoglobin levels and whether plasma or red cells should be infused before, during, or after the procedure. See patient, discuss with primary team, write consults and procedure notes, review with Attending, and get consent for new apheresis patient.

Make sure all orders are placed for the following day BEFORE leaving the hospital. Order labs, albumin, calcium and other medications as needed for each patient. If plasma is necessary, write the information on the white-board in the blood bank and notify a nurse working at the front desk.

Please read the following pages for details in each protocol. Protocol may change throughout the year. When this happens, the chief resident will send out the email to inform about the updates and revisions. The resident and fellow are expected to read and understand the email and follow the most updated protocol. If unsure, please check with the attending on-service regarding the treatment plan and/or technical details of the procedure.

Background

1. When you receive a call for a new patient requiring apheresis you will first need the following general information:

- Patient's name and MR#
- Location and service
- Attending physician and contact person (i.e. fellow or resident)
- Diagnosis and urgency
- Whether the patient has a double or triple-lumen catheter (the same used for dialysis, i.e.:vascath or traumacath). Make sure the person you are talking to understand which line we must use. If the patient does not have one, let the resident/fellow know that we will need one and always ask for a trialysis catheter, if possible.
- Patient's height and weight
- Patients labs including:
  - Hematocrit,PT, PTT, fibrinogen
  - For TTP: platelet count, LDH, peripheral blood smear including number of schistocytes, reticulocytes, haptoglobin, bilirubin
  - For Leukopheresis: WBC including number of blasts
  - For Plateletpheresis: Platelet count
  - For Red Cell Exchange: Percent of abnormal hemoglobin (if known; assume 100% if unknown), current hematocrit
  - Residents and fellows are required to review and sign lab results that go to their message center within 7 days of the lab draw.

- If blood products (i.e. plasma, RBCs) will be used for the exchange, check if the patient has a specimen in the Blood Bank. If not be sure a red top and purple top are sent to the Blood Bank as soon as possible to order type and antibody screen (and crossmatching if RBCs will be used). You must put the order for the Blood Bank to prepare the blood product for the patient.

Catheters:

- Trialysis catheter is now available in apheresis unit (in JT6).
  a. The apheresis unit in JT6 is now stocking trialysis catheter kits (3 kits for IJ and 3 kits for femoral line). The code to clinic is 13579#. They are located in the clinic (please familiarize yourself with location of the kit before your CP calls by coming to the unit and talk with Nick, our nurse coordinator). Several floors, such as HOSU, may not have these in their inventory stocks. Therefore, you may actually be able to facilitate line placement if you actively deliver the catheter kit to the line placement team.

     Starting March 23, 2017, there is an option of utilizing the UAB CVAT service for emergent Vascath placement for emergent apheresis procedure. There may be a couple nights at the beginning when there is no attending on to place the line but the service will tell us if this is the case so we can move to our next option. However, it seems that after March 27, 2017, there will always be an attending on-call for the service days and nights (24/7) for vascath placement (until the state of AL allows NP/PA to do so). We should consider this option when the primary team cannot place access for us to initiate apheresis procedure. This will be a great help to our service in order to avoid delay patient care. To request this, order the powerplan: "Comprehensive Vascular Access Team (CVAT) Follow-up."

  b. The following are information you may need in order to pick the appropriate kit for your patient
     1. Per the ICU fellow: the 15cm/13 French are typically used for IJ access, while the 24cm/13French is for femoral access; although these lengths can be adapted based on the size of your patient. Please check with the line placement team regarding the size of the catheter.
     2. If you use the kit in the apheresis unit for your patients, then please email Trevor Lever (tlever@uabmc.edu) and me (hpham@uabmc.edu) the name of the patient and the kit you used for this patient so the patient can be billed appropriately.

c. This information can be especially important for emergent procedures. Anything we can do to facilitate line placement could directly benefit patient outcome.

- **Subcutaneous Ports**

To order a port:

For anyone ordering a port, please include the following product number "Vortex port: CT96STSD" in the clinical concerns/special instructions and special considerations/instructions boxes (there is a box in each of the IR Port Placement and IR PORT PLACEMENT orders). You will also need to order 2 ports, since our new approach is to ask for 2, single-lumen (instead of a 1, double-lumen) ports. This product number along with the number of ports are critical to alert the Interventional Radiologist to the type (that is a 9.6-French size compared to one with a smaller lumen) and number for the procedure. The rest you can fill out as you see fit--remember anything in yellow has to be filled out. Don't forget to activate or initiate the order if it is for an inpatient. Call Kyle at 6-6029 for inpatient requests. An outpatient order must be placed under the DOCUMENTATION encounter and will be activated by IR. Call Cheryl 4-0152 or Christi 4-0153 for outpatient requests.

An outpatient order must be placed under the DOCUMENTATION encounter and will be activated by IR.

To order a port check:

2 groups do port checks:
a. interventional radiology
b. diagnostic radiology

To place the order:

Choose "IR port change" if:
…a port is not flushing at all or
…you want a port change regardless
Note: they will message or call you to verify this is what you want before proceeding. You can call IR to notify them of your plans.

Choose "Rf cathetogram" in diagnostic Radiology if:
…a port is flushing slowly and you want to check the function
Note: You will need to call Radiology scheduling at 1-9380 & they will put you on hold while they call the Radiologists to confirm that they are agreeable with this (they likely will be).
Know the following before calling:

1. Does the pt have a contrast allergy?
2. Talk to Nick ahead of time to pick a day the patient will be in our apheresis clinic to have the port study, because Radiology asks that our nurses access and de-access the port before and after the study if they are still around. If it's an early morning port check, Radiology MAY have nurses that can access the port.

Tips: Ask the scheduler to call the patient while I'm on the phone (as a conference call) to confirm that they can come in at the chosen time. If they don't answer, then we just pick a time.

To speak to the physicians in Diagnostic Radiology, call 1-8793.

2. Contact and inform the Attending Pathologist about the new patient and current status.

3. Contact and inform the apheresis nurse (on call if it is after hours) about the new patient and current status.
Nurse availability for **emergent apheresis procedures**

a. There will always be a back-up nurse available for the chance that you have 2 or more emergent procedures (discuss below) that are ready to begin simultaneously. The decision to call in the back-up nurse is an **attending-level decision**, and should only be made in the setting of true medical emergencies (such as, TTP, acute chest/stroke for sickle cell disease, severe hemolysis in cold agglutinin disease, leukapheresis in patients with leukostasis symptoms) and not simply because multiple (urgent) procedures happen to be occurring in one night - in those settings, the cases should be triaged by accordingly after discussing with your attending on-call.
b. If there are 2 or more emergent procedures that are ready to begin simultaneously, after you obtain attending approval for calling in the back-up nurse, then please contact Nick Boshell (at 205-739-

9068) so he can assign a second nurse to come in for the procedures. If he cannot be reached within 10 minutes from the initial call, then please page Ashley Lovingood (pager #7016) so staff mobilization can begin as soon as possible.

c. Please email me (hpham@uabmc.edu) the names of the patients and the situation so we can plan the apheresis call schedule appropriately.

Nursing notification for **emergent or urgent procedures**

a. In the setting of medical emergency, such as in TTP, acute chest/stroke for sickle cell disease, severe hemolysis in cold agglutinin disease, heart rejection in unstable patients, leukapheresis in patients with leukostasis symptoms), it is important that our team not delay patient care. Thus, you should call in the nurse as soon as you believe the line is in the process of placement.

b. For urgent procedures that need to happen that night, but not medical emergent procedures, such as myasthenia gravis exacerbation, organ transplant rejection, Wegener's or Goodpasture's with alveolar bleeding, etc…, the on-call nurse needs not be called until the line is placed and is in the process of X-ray confirmation.

c. The decision whether to call in the nurse when line is being placed (emergent procedure) vs. when line is in and in the process of being X-ray confirmed (urgent procedure) is an attending-level decision. Please discuss with your attending regarding the classification between emergency and urgency (if you are unsure) after you receive the initial page regarding the incoming patient.

4. You will use the patient's height and weight to estimate the Predicted Normal Blood Volume for Men/Women from the Normal Predicted Blood Volume tables.

(**Appendices 10, 11**). Use the specific table for a male or a female patient accordingly, and then calculate the plasma volume. The volume to be exchanged will usually be 1 plasma volume.

Blood Volume x (1.0 – Hct) = Plasma Volume

Ex: 4838mL x (1.0 – 0.38) = 2,999 mL (3.0L)

5. Consent: The consent for an apheresis process should be obtained by the pathology resident and/or Transfusion Medicine fellow/attending. Even if the primary care team or other team has obtained the consent, it is best to re-obtain the consent for the apheresis procedure because pathology is the one who performs the procedure and knows best about the procedure and its adverse reactions. Apheresis nurse should check to ensure that the consent is signed and is in the chart prior to perform the procedure.

In general:

a. When a patient switches location from inpatient to outpatient or vice versa, a new consent should be obtained.
b. For inpatient consent:
    - The consent is good for the entire admission
c. For outpatient consent:
    - The outpatient consent should not be signed more than 30 days prior to the procedure
    - For both inpatient and outpatient procedures, when completing the consent, it must clearly state the intended number of treatments/procedures that has been consented for (for example: therapeutic plasma exchange for up to 30 days or 30 procedures)
    - The nurse needs to be present in the room during the consent to sign as a witness. The family member should not be the witness
    - The outpatient consent is good for 1 year (if it does not exceed the number of procedures/treatments that was consented for)
    - Apheresis nurse will help to keep track of the number of procedures and will notify the resident/attending physician when to re-consent the patient

- Please obtain two consents for each procedure: one for the procedure itself (e.g. TPE) and the other for the possible use of blood products during the procedure (e.g plasma for TTP patients)

d. "Consider adding the following sentence, if pertinent, to the end of the note: Note: We recommend against the use of ACE inhibitors within 24 hours of plasma exchange as they can lead to severe hypotension during the procedure. ARBs and other anti-hypertensives are acceptablealternatives if clinically indicated."

6. Transfusion reaction initiation: If the patient experiences adverse reaction(s) while receiving blood product(s) during an apheresis procedure and the pathology resident, fellow, and/or attending decides that the reaction may relate to the blood products, then a Transfusion reaction work-up should be initiated. All the blood product(s) that have been giving during that procedure should be sent to the Blood Bank (not just the current product that is running) for the transfusion reaction work-up. Apheresis nurse is responsible to send the necessary specimen(s)/paperwork(s) for the reaction. The resident/fellow is responsible for follow-up with the transfusion reaction work-up to ensure proper documentation.

7. New patients will require completion of a consult with the following information obtained (as appropriate) from the patient's medical record, the patient and the clinician.
   - Chief Complaint (CC)
   - History of Present Illness (HPI)
   - Past Medical History (PMH)
   - Past Surgical History (PSH)
   - Medications (home and current in the hospital – **NO ACE inhibitors**)
   - Transfusion history (helpful for the blood bank work-up)

- Allergies (if heparin allergy, must use 4% citrate to lock line)
- Social History (SHx)
- Family History (FHx)
- Physical Exam (PE) – vital signs and other pertinent findings.
- Current Lab Values including: CBC, fibrinogen, K, Ca and Mg
- Assessment and Plan
- ***Get the consent form signed*** by the patient and/or responsible relative. This is very important!

Explain/describe the procedure including risks, benefits, and alternatives, and ask for and answer any of their questions. A statement should be written regarding the consent form. "The consent form was discussed, signed, and placed in the patient's medical record." Never start a procedure without signed/ completed consent in the patient's medical record.

Resident preparation of initial consult note:

Entering consult notes into Powerchart

The consulting team must order a consult to blood bank for inpatient apheresis procedures. The transfusion medicine resident will enter an initial consult note in Powerchart as well as place necessary orders. Apheresis consult note templates can be found in the Transfusion Medicine folder located in the P: drive. Screen shots can be found in the Survival Guide Supplemental Material in the Transfusion Medicine folder if needed to augment the following directions for entering the notes into Powerchart:

a. Open Powernotes and click “Add”.

b. “Consult Note” for type – “Transfusion Medicine Consult Note”

c. “<procedure> Initial Consult” for title; click ok.

d. Click which components you want in the note (usually medications, family history, procedure history, social history).

e. Follow the structure headings to complete the note.

f. Click "Save"; then "Forward" will become available so the note can be forwarded to the attending for signature.

g. Close the document.

The consult is reviewed and electronically signed by the attending.

Please make sure your consult note contains the following essential items in order to qualify for a level 2 consult.

LEVEL 2 CONSULT

Reason for consult: "[procedure name] for [disease]"
Consult requesting MD: [clinician]
Consult provider: [pathologist]
HPI: At least 3 out of the list [location] [severity] [duration] [context of disease] [quality] [associated signs/symptoms] [timing] [modifying factor]
Plus at least 2 [Review of system 2-9 or Allergy]
Plus 1 out of [PMH/Meds] [FH] or [SH]
Physical exam: At least 3 from [Vital signs] [Heart] [Lungs] [Abdomen] [Musculoskeletal] [Skin]
Labs: At least 1 [lab values]
Radiology: [Confirmation of line] [CT]
Diagnosis: [disease]
Impression: [Plan of care]
Attestation statement
Prolong care code: Regular level 2: 35-40 minutes
If more than 50% then use prolong code 99356 (inpatient only) in Patient Keeper

8. Once the procedure schedule for the patient has been decided upon, be sure to contact the apheresis nurses (5-4026) or call Nick to schedule the patient's treatment.

- **Check for conflicting procedures (i.e. dialysis) or tests (i.e. MRI) by talking to the nurse or residents taking care of the patient. When TPE and dialysis need to be done on the same day, dialysis should be done after apheresis to avoid hypotension during the latter.**

9. Replacement fluids:

Albumin is used as replacement fluid when risk of bleeding is low, no coagulopathy is present and the diagnosis is not TTP. **1mEq Ca-gluconate and 2mEq K Cl are added to each 500mL bottle.**

For patient's at increased risk of citrate toxicity (e.g. renal dysfunction), a calcium gluconate drip is ordered via the apheresis powerplan (13.95mEq in 250mL of NS or D5W)

Fibrinogen is checked on each day of treatment. If fibrinogen <120 mg/dl discuss with the attending whether use a combination of plasma plus albumin for the replacement fluid.

Order the albumin as soon as possible for a new patient or the day prior to the procedure for a current patient. See below for ordering instructions.

Plasma is used if the diagnosis is TTP and if the patient is immediately pre- or post- surgery/invasive procedure. There are other clinical situations when plasma may be used in full or at the end of the procedure to prevent coagulopathy (e.g. patient on ECMO).

Resident guide to ordering in Impact:

- Log onto Impact Citrix.
- Select "**Power Chart Organizer**" and log onto Cerner Millennium.

- At first screen click on "**Patient"** from top menu bar and pull down menu to select "**Search**"
- A new search window will open: Enter patient name or MRN then "**OK**"
- Select the patient from the results by double-clicking on the patient name. **NOTE:** If there is more than one admission, click on the current admission in the bottom window pane.
- A new window will open with the patient's information (current orders etc.)
- Select the "**+ Add**" button located just below the Power Orders tab.
- A new search window will open: In the "Find" field, type in "**plasmapheresis**"
- Select the "**plasmapheresis / photopheresis**" powerplan. Close window by clicking "**done**".
- Check box for "**albumin for plasmapheresis**", click corresponding boxes if premedication (diphenhydramine) or calcium needs to be ordered. Click boxes for additional labs (you will usually only need to order fibrinogen).
- Change the **start time** to correspond with morning of treatment. Change **duration** to 1 day.
- If ordering on outpatients, you will need to click the **Initiate** button. A light-bulb will appear next to your orders.
- Click once on the albumin order. In the bottom window, under the continuous details tab, type in the number of 500 ml bottles needed for the treatment.
- Click on any other orders to ensure they are correct.
- When you are finished, click "**Orders for Signature**", click the "**Sign**" button, refresh the screen.
- The order(s) should now be listed under medications.
- To exit, do **NOT** click the "X" in the upper right corner. You must select the "**Exit**" tab (has a picture of a door with a blue arrow) from the tool bar.

After exiting cerner, log off citrix.

Note: *After July, 2017, all apheresis orders will change. The powerplan is called "JT6 Therapeutic Apheresis" Residents will be able to select the type of procedure, planned and prn medications (including the anticoagulant), labs needed, and blood products needed for both in- and outpatients. Once one order is signed, it can be "copy forwarded" for*

subsequent days when the patient requires the same order set for additional procedures. There will be more training to come on this.

10. Patient evaluation: Apheresis resident on-service and on-call now will see and evaluate all patients (both inpatients and outpatients) prior to the initiation of any apheresis procedures.

a. To facilitate the outpatient process, Stephanie will page the resident when the outpatients come so that they all can be seen and evaluated before the procedures.

b. The apheresis resident will see and evaluate all the inpatients prior to the procedures. At minimum, the resident should see and evaluate all the inpatients undergoing morning procedures before 7:30AM. They may see and evaluate the rest of the inpatients later as long as that occurs prior to the procedures. Other evaluation steps regarding

notes and laboratory results as described in the previous policy (attachment) remain unchanged.

There is now an apheresis communication board in the break room. Since the resident will see and evaluate outpatients as well as inpatients prior to the procedures, to facilitate the communication, the resident and Nick will meet and together write the special needs for each patient on the board. At minimum, this writing should be done for any patients undergoing morning procedures by 7:30AM the latest (instead of calling to the unit before 7:30AM). This process of communicating special needs for patients between resident and Nick may be repeated for patients undergoing procedures later in the day.

The apheresis nurses will not start the inpatient apheresis procedure before the apheresis resident tells them that it is ok to start that day.

The apheresis nurses will continue checking the labs prior to starting the procedure. Additionally, the apheresis nurses will read the recent clinical notes in the electronic medical charts as well as communicate with the nurses on the floor regarding the status of the patient and if there is any change in the status recently prior to going to start the procedure. The apheresis nurse will communicate with the apheresis resident if there is any concerns regarding the current clinical status and/or laboratory results of the patient. The resident will then re-evaluate the patient, discuss with the attending (if necessary), and then if needed, modify and promptly communicate the apheresis decision (either Yes for apheresis today, Yes for apheresis today but need modification to the procedure (specify the modifications), Hold on apheresis today, or No to apheresis today) to Nick.

For emergent procedures or procedures that happen during weekends and holidays, the resident and/or fellow will evaluate the patients and communicate the plan directly to the on-call apheresis nurse (instead of Nick).

11. Always be prepared for Morning Report with the following information regarding each day's apheresis:

- Name of patient
- Type of procedure
- Number of procedure (i.e. Procedure #3 of 5 or for Photopheresis patients #1 of 2 in series #8)
- Brief patient history (i.e. Patient with history of lung transplant in 1998 secondary to emphysema or patient with myasthenia gravis who presented with shortness of breath refractory to steroids and IVIG) and special patient needs (i.e. premedication with Benadryl).
- Pertinent labs, including:
  - CBC: WBC, Hgb, Hct, and platelets (If Hct < 21% or platelets < 30,000/uL, discuss with the Attending. Make sure the patient has a specimen in the Blood Bank.)
  - PT/PTT/Fibrinogen when albumin is being used as the replacement fluid (not necessary for photopheresis patients). If Fibrinogen is less than <120 mg/dl, and albumin is being used,

discuss the addition of plasma with the Attending. Make sure a blood sample is in the Blood Bank. Be aware that heparin will elevate the PTT.

- Absolute lymphocyte count for photopheresis patients (WBC x % lymphs = absolute). If decreased <200 we may delay the procedure.
- Electrolytes: Ca, K, Mg.
- There may be other labs to report specific to the patient's disease process (e.g. TTP: LDH, bilirubin, haptoglobin (if ordered), BUN and Cr).

12. Patient scheduling

a. Resident (both on-call and/or day-covered resident) is responsible for telling Nick, Stephanie, and the on-call nurse the tentative apheresis schedule for any new patient that were consulted when that resident is on. If the consult occurs during the night or weekend, then the resident is responsible to email Nick (mboshell@uabmc.edu) and Stephanie (slisby@uabmc.edu) the name, MRN, Indication, type of apheresis procedure, and the tentative schedule as soon as possible in addition to telling the on-call nurse the tentative schedule for that patient.

b. On-call nurse is responsible to write down the name of the patient, apheresis procedure, and his/her tentative apheresis schedule in the schedule book.

c. Nick (or his designee) and Stephanie are responsible for checking emails for the communication emails from the residents.

d. For example, if Resident A is on Saturday and was consulted to perform TPE for patient Y who has MG exacerbation, then Resident A is responsible to tell on-call nurse Z that patient A will tentatively have TPE on Sat, Mon , Wed, Fri, and Sunday. At the same time, resident A should send Nick and Stephanie an email describing such schedule for patient A. On-call nurse Z is responsible to write down the patient and the schedule in the schedule book. Nick and Stephanie are responsible to ensure that patient A's apheresis schedule is in the schedule book.

13. Adverse event(s)

a. The on-call resident should notify the attending on-call promptly when the patient dies, has a cardiac arrest, and/or significant adverse events during apheresis procedure.

b. We will now have morbidity and mortality discussion during each apheresis quarterly meeting in order to improve patient care. Thus, when the patient experiences cardiac arrest, death, and/or any significant adverse event during apheresis that either the resident and/or the attending on-service feels that it should be discussed at M&M, then the resident is responsible to let me know in person (either drop by my office P230E or call x69920) so I can put the case on the agenda for the next meeting. Per risk management, email is not the preferred method. The resident is also responsible to present the case at the apheresis meeting. Of note, all cases with death or cardiac arrest during apheresis procedure are required to present at M&M.

Therapeutic Plasma Exchange (TPE)

TPE is performed in a wide variety of patients including the following diagnoses: TTP, Guillain-Barre, Myasthenia Gravis, Chronic Inflammatory Demyelinating Polyneuropathy (CIDP) Acute Heart Transplant Rejection, etc. See American Society for Apheresis (ASFA) guidelines and Apheresis Indication table in the TM folder on the P-drive. The following are general guidelines only. Please check with the attending on-service for the exact schedule and technical issues for each patient.

Typical Therapeutic TPE (TPE) Protocols

Thrombotic thrombocytopenic purpura (TTP)

- For the first 3 days, exchange 1.5 plasma volume. Exchange 1 plasma volume from day 4 on until platelet count >150 x 10^9/L for 3 consecutive day and the LDH is normalizing.
- Replacement fluid is plasma
  - Resident should order the plasma and write the order on the white board in the Blood Bank.
- Order and draw ADAMTS-13 level **before** first TPE. Requires **two** blue top tubes.
- Consent the patient for both procedure and Dr. Zheng's research protocol.
- Collect samples longitudinally and bring to the coagulation labs for frozen per Dr. Zheng's research protocol (see below for TTP check list). Dr. Zheng's research protocol consent can be found at J:\CPResidency\Rotation Guides\Transfusion Medicine\Apheresis service & Calculators\TTP.
  - ADAMTS13 is a send-out test that requires a Path resident consult (i.e. you) prior to being sent.
  - Call Blood Center of Wisconsin 1.800.245.3117 x6129 with pt name and DOB for results. Usually available in the late afternoon one to two days after sample went out.

TTP check list:

Please use this checklist for all TTP patients

Patient Name: _____ MRN: _____
Day of First TPE: _____

Resident/Fellow	Nurse
[ ] Consent for TTP Research Study	
[ ] Ensure 4 blue top tubes are drawn, fully filled, and labeled appropriately to be given to the Special Coagulation Lab to be processed	[ ] Collect 4 blue top tubes. Ensure they are fully filled, and labeled appropriately to be given to the resident to bring to the Special Coagulation Lab to be processed
[ ] Email Wendy Kocher /Nicole(Wenjing) Cao, Sheila Gray as soon as possible to pick up first sample for DNA extraction	
[ ] Ensure 2 blue top tubes are drawn, fully filled, and labeled appropriately on: o Day 3 o Day 6 o Day 9 o Day 12 o Day 15 o Day 18 o Day 21 o Day 24 o Day 27 o Day 30	[ ] Collect 2 blue top tubes Ensure they are fully filled, and labeled appropriately to be given to the resident to bring to the Special Coagulation Lab to be processed on: o Day 3 o Day 6 o Day 9 o Day 12 o Day 15 o Day 18 o Day 21 o Day 24 o Day 27 o Day 30
[ ] Obtain and give Laura the sample (2 blue top tubes) from the Special Coagulation Lab on the first day TPE is skipped	
[ ] If TPE is re-started, obtain and give Laura Taylor (in the Special Coagulation Lab) the samples (2 tubes) when TPE is first re-initiated	
[ ] Continue to follow the patient. Obtain and give Laura (in the Special Coagulation Lab) 4 blue top tubes at the day the patient is discharged	

Most neurologic disorders (CIDP, GBS, MG, MS, NMO, etc.)

- 1 PV every other day x 5 TPE
- Replacement fluid is 5% Albumin
    - Order day before each procedure
- Order fibrinogen level day before each TPE to be drawn early the day of TPE
    - Lower acceptable limit around 110 mg/dl

Transplant FSGS and occasionally renal-pulmonary disorders

- 1 PV daily x 3, then every other day x 6 for a total of 9 TPE
- Replacement fluid is 5% Albumin
    - Order day before each procedure
- Order fibrinogen level day before each TPE to be drawn early the day of TPE
    - Lower acceptable limit around 110 mg/dl

Acute Humoral Kidney Transplant Rejection

- 1 PV every other day x 5 TPE
- Replacement fluid is 5% Albumin
    - Order day before each procedure
- Order fibrinogen level day before each TPE to be drawn early the day of TPE
    - Lower acceptable limit around 110
- This disorder is frequently treated with TPE and IVIg concurrently. Therefore we must coordinate timing of TPE with the transplant nephrology team. Goal is for IVIg to be given just after TPE so that the very expensive IVIg can remain in the circulation for as long as possible since TPE will remove it.
- Some patients may be undergoing dialysis as well. It is safer to perform TPE prior to dialysis because the latter usually leave them with decreased intravascular volume and hypotension often occurs during TPE. Coordination with the Renal transplant team is key.
- Some nephrology patients may have a fistula that can be a used for TPE access. Coordination with the Dialysis nurses to access will be needed.

Idiopathic Pulmonary Fibrosis (the "Duncan" protocol)

Day 01 - IV solumedrol 1g - TPE X 1 -
Day 02 - IV solumedrol 1g - TPE X 2 -
Day 03 - Prednisone 40mg - TPE X 3 -
Day 04 - Prednisone 40mg - Break -
Day 05 - Prednisone 40mg - TPE X 4 -
Day 06 - Prednisone 40mg - TPE X 5 - Rituximab (+premeds)
Day 07 - Prednisone 40mg - Break -
Day 08 - Prednisone 40mg - Break -
Day 09 - Prednisone 40mg - TPE X 6
Day 10 - Prednisone 40mg - Break
Day 11 - Prednisone 40mg - TPE X 7
Day 12 - Prednisone 40mg - Break
Day 13 - Prednisone 40mg - TPE X 8
Day 14 - Prednisone 20mg - Break -
Day 15 - Prednisone 20mg - TPE X 9 - Rituximab (+premeds)
Day 16 - Prednisone 20mg - IVIG -
Day 17 - Prednisone 20mg - IVIG -
Day 18 - Prednisone 20mg - IVIG -
Day 19 - Prednisone 20mg - IVIG

To contact Dr. Duncan and his lab to pick up the first plasma bag for a patient receiving the Duncan protocol: The apheresis nurse will page him and call 4-5017. If he/she does not reach anyone, the resident can try the following numbers:

- Dr. Duncan's cell: 412-215-6977
- Other lab numbers: 6-9187 or 4-5018
- Melissa's cell: 850-509-2738
- Kaiyu's cell: 205-413-0812

Acute heart transplant rejection

- 1 PV every day x 3 TPE
- Replacement fluid is 5% Albumin
  - Order day before each procedure
- Order fibrinogen level day before each TPE to be drawn early the day of TPE
  - Lower acceptable limit around 110 mg/dl (Warning: since these patients are in heart failure, their fibrinogen level tends to stay low for several days). The third TPE may have to be done 2 days after the second)

For patients with most other diseases we exchange 1 plasma volume with albumin (see instructions for ordering albumin in Apheresis: Background). These patients are scheduled for 5 procedures occurring every other day.

Red Blood Cell Exchange

1. Indications:
   - Sickle Cell crisis (acute chest syndrome), acute stroke, bone marrow necrosis or cholestasis: the patients usually require only 1 procedure. For acute patients, the goals are HgbS $\leq$ 30% and Hct ~ 30% (target hct will depend on patient's baseline hct). For cholestasis, your HgbS target is closer to <10%.
   - For chronic stroke patients the goals are different, such as target HgbS is < 20% and hematocrit ~30% (target hct will depend on patient's baseline hct).

2. Find out if the patient has been exchanged in the past and gather the following information:

   - History of antibodies.
   - Volume exchanged (number of RBC units).
   - The starting and finishing hematocrits.
   - The final percentage of hemoglobin S that was used.

3. Contact the Attending Pathologist to discuss:

- The status of the patient and work-up.
- The end hematocrit and goal Hgb S.
- Whether the patient needs depletion RBC exchange.

4. Contact the nurse on-call if it is after hours. You need to inform them of what is happening and discuss with them what needs to be done. You will need to give them the following information:

- Patient's height and weight
- Current hct and desired end hct, and desired end percentage of hemoglobin A (this is called "FCR" – fraction of cells remaining). The **FCR = goal %HgbS / initial %HgbS**.
  If the initial %HgbS is unknown use 100%.
- For patients with SC disease, you should add the S and C percentage together to get your starting percentage for use in the above calculation

5. If the patient has multiple antibodies, blood must be ordered STAT from the Red Cross. Units must be tested and negative for sickle trait using the Sickledex test (done by hematology lab). The nurse will use the instrument to calculate how many units of RBCs will be required for the exchange. Discuss with the attending on-service regarding how many units RBCs to order.

Therapeutic Leukopheresis and Plateletpheresis

1. Leukopheresis is indicated for acute blast crisis (blast count usually >100,000/µl); and plateletpheresis for platelet count usually >1,000,000µl. These patients frequently present with signs and symptoms of hyperviscosity
(i.e. headache and blurred vision).

2. The procedure involves 2 blood volumes, which generally removes 30-50% of the WBC and 50% of the platelets. Please check with the attending

on-service regarding the fluid replacement, priming of the machine and/or other technical details prior to the procedure. Typically 1 procedure is necessary.

3. If the patient has altered mental status when you are called, please ask the primary team to complete a STAT head CT while you are setting up the leukopheresis procedure to rule out an intracranial bleed.

Extracorporeal Photopheresis (ECP)

1. Photopheresis is indicated for cutaneous T-cell lymphoma (CTCL), graft-vs-host disease (GVHD and the prevention of chronic heart/lung transplant rejection.

2. Unlike TPE, photopheresis can be performed using one or two access sites because discontinuous flow is employed.

3. Many patients have internal, semi-permanent Vortex ports (1 chamber). These ports reduce the risk of infection and are more comfortable than permanent external catheters. For various reasons some patients have one-lumen or two-lumen (either semi-permanent or temporary) external.

4. In patients with semi-permanent two-lumen catheter, you should alternate the lumens used during the 2-day series. By flushing each lumen during the cycle, you reduce the risk of clotting-related access problems at the next visit.

Apheresis Procedure Notes:

Every apheresis procedure requires a note to be entered into Impact once the procedure is completed. The note should document who the patient is, why we are treating them, any pertinent pre-procedure clinical findings and labs, type and amount of replacement fluid, any adverse reactions, plan (next procedure, etc.), and time of completion. See sample notes in Apheresis Procedure Notes section here. Notify the attending that the procedure has been completed.

Resident guide to preparing a procedure note:

Entering Procedure Notes into Powerchart

- A procedure note is required for each procedure completed. The notes should be entered the same day as the procedure.
- Templates can be found in the Transfusion Medicine folder on the P drive.
- Screen shots can be found in the Survival Guide Supplemental Material folder found in the Transfusion Medicine folder on the P: drive.
- Follow directions for opening a note as described for the initial consult.
- Indicate "Procedure Note" as type and procedure for title; click ok. Click "Freetext" icon to type note into Powerchart.
- Click "Save"; then "Forward" to attending for signature.

Additional Notes from Dr. Pham:

1) If labs are ordered for an outpatient, then an apheresis resident and/or attending physician must review all the results prior to the patient being released from the clinic. An apheresis nurse cannot release the patient from the clinic without clearance/approval from an apheresis resident and/or attending physician.

> The criteria for release will depend on each physician's clinical judgment based on the patient's medical history, current and previous clinical status, and/or previous laboratory results; however, it is recommended that the patient shall not be released from the clinic if there are any critical values in the lab results and/or significant changes from the previous results. If there is any question, the apheresis resident must discuss with the attending physician prior to release the patient.

2) If there is any concern about the patient's laboratory results and/or clinical status, the apheresis nurse and the patient shall be notified and the patient must remain in the clinic until further notice. The apheresis resident will discuss the results with the attending and the referral physician must be notified. Together, the referral physician and/or apheresis attending/resident will decide on appropriate action(s) and it will be communicated to the apheresis nurse and the patient.

3) Of note, it is recommended that an outpatient apheresis patient shall have pre-procedural lab every 2 weeks at minimum. However, it is at the discretion of the apheresis attending physician to have pre-procedural labs performed on a patient based on the clinical judgment and/or on the patient's medical history, current and previous clinical status, and/or previous laboratory results. If there are no pre-procedural labs done, then the apheresis nurse must notify the apheresis resident and/or attending if there is any change in the patient's clinical status and/or procedure complications before release the patient from the apheresis clinic.

2016 ASFA Categories for Therapeutic Apheresis

TABLE IV. Category and Grade Recommendations for Therapeutic Apheresis

Disease name	TA Modality	Indication	Category	Grade	Page
Acute disseminated encephalomyelitis	TPE	Steroid Refractory	II	2C	163
Acute inflammatory demyelinating polyradiculoneuropathy/ Guillain-Barre syndrome	TPE TPE	Primary Treatment After IVIG	I III	1A 2C	165
Acute liver failure	TPE TPE-HV		III I	2B 1A	167
Age related macular degeneration, dry	Rheopheresis		I	1B	169
Amyloidosis, systemic	β_2 microglobulin column TPE		II IV	2B 2C	171
ANCA-associated rapidly progressive glomerulonephritis (Granulomatosis with polyangiitis; and Microscopic Polyangiitis)	TPE TPE TPE	Dialysis dependence DAH Dialysis independence	I I III	1A 1C 2C	173
Anti-glomerular basement membrane disease (Goodpasture's syndrome)	TPE TPE TPE	Dialysis dependence, no DAH DAH Dialysis independence	III I I	2B 1C 1B	175
Aplastic anemia, pure red cell aplasia	TPE TPE	Aplastic anemia Pure red cell aplasia	III III	2C 2C	177
Atopic (neuro-) dermatitis (atopic eczema), recalcitrant	ECP IA TPE		III III III	2C 2C 2C	179
Autoimmune hemolytic anemia; WAIHA; cold agglutinin disease	TPE TPE	Severe WAIHA Severe cold agglutinin disease	III II	2C 2C	181
Babesiosis	RBC exchange	Severe	II	2C	183
Burn shock resuscitation	TPE		III	2B	185
Cardiac neonatal lupus	TPE		III	2C	187
Cardiac transplantation	ECP ECP TPE TPE	Cellular/recurrent rejection Rejection prophylaxis Desensitization Antibody mediated rejection	II II II III	1B 2A 1C 2C	189
Catastrophic antiphospholipid syndrome	TPE		II	2C	191
Chronic focal encephalitis (Rasmussen Encephalitis)	TPE		III	2C	193
Chronic inflammatory demyelinating polyradiculoneuropathy	TPE		I	1B	195
Coagulation factor inhibitors	TPE TPE IA IA	Alloantibody Autoantibody Alloantibody Autoantibody	IV III III III	2C 2C 2B 1C	197
Complex regional pain syndrome	TPE	Chronic	III	2C	199
Cryoglobulinemia	TPE IA	Symptomatic/severe Symptomatic/severe	II II	2A 2B	201
Cutaneous T-cell lymphoma; mycosis fungoides; Sezary syndrome	ECP ECP	Erythrodermic Non-erythrodermic	I III	1B 2C	203
Dermatomyositis/polymyositis	TPE ECP		IV IV	2B 2C	205
Dilated cardiomyopathy, idiopathic	IA TPE	NYHA II-IV NYHA II-IV	II III	1B 2C	207
Erythropoietic porphyria, liver disease	TPE RBC Exchange		III III	2C 2C	209

TABLE IV. *Continued*

Disease name	TA Modality	Indication	Category	Grade	Page
Familial hypercholesterolemia	LDL apheresis	Homozygotes	I	1A	211
	LDL apheresis	Heterozygotes	II	1A	
	TPE	Homozygotes with small blood volume	II	1C	
Focal segmental glomerulosclerosis	TPE	Recurrent in transplanted kidney	I	1B	213
	LDL apheresis	Steroid resistant in native kidney	III	2C	
Graft-versus-host disease	ECP	Skin (chronic)	II	1B	216
	ECP	Non-skin (chronic)	II	1B	
	ECP	Skin (acute)	II	1C	
	ECP	Non-skin(acute)	II	1C	
Hashimoto's encephalopathy: Steroid-responsive encephalopathy associated with autoimmune thyroiditis	TPE		II	2C	219
HELLP syndrome	TPE	Postpartum	III	2C	221
	TPE	Antepartum	IV	2C	
Hematopoietic stem cell transplantation, ABO Incompatible	TPE	Major HPC, Marrow	II	1B	223
	TPE	Major HPC, Apheresis	II	2B	
	RBC exchange	Minor HPC, Apheresis	III	2C	
Hematopoietic stem cell transplantation, HLA desensitization	TPE		III	2C	225
Hemophagocytic lymphohistiocytosis; Hemophagocytic syndrome; Macrophage activating syndrome	TPE		III	2C	227
Henoch-Schönlein purpura	TPE	Crescentic	III	2C	229
	TPE	Severe extrarenal disease	III	2C	
Heparin induced thrombocytopenia & thrombosis	TPE	Pre-cardiopulmonary bypass	III	2C	231
	TPE	Thrombosis	III	2C	
Hereditary hemachromatosis	Erythrocytapheresis		I	1B	233
Hyperleukocytosis	Leukocytapheresis	Symptomatic	II	1B	235
	Leukocytapheresis	Prophylactic or secondary	III	2C	
Hypertriglyceridemic pancreatitis	TPE		III	2C	237
Hyperviscosity in monoclonal gammopathies	TPE	Symptomatic	I	1B	239
	TPE	Prophylaxis for rituximab	I	1C	
Immune thrombocytopenia	TPE	Refractory	III	2C	241
	IA	Refractory	III	2C	
Immunoglobulin A nephropathy	TPE	Crescentic	III	2B	243
	TPE	Chronic progressive	III	2C	
Inflammatory bowel disease	Adsorptive cytapheresis	Ulcerative colitis	III/II	1B/2B	245
	Adsorptive cytapheresis	Crohn's Disease	III	1B	
	ECP	Crohn's Disease	III	2C	
Lambert-Eaton myasthenic syndrome	TPE		II	2C	247
Lipoprotein (a) hyperlipoproteinemia	LDL apheresis		II	1B	249
Liver transplantation	TPE	Desensitization, ABOi LD	I	1C	251
	TPE	Desensitization, ABOi DD	III	2C	
	TPE	Antibody mediated rejection (ABOi & HLA)	III	2C	
Lung transplantation	ECP	Bronchiolitis obliterans syndrome	II	1C	253
	TPE	Antibody mediated rejection	III	2C	
	TPE	Desensitization	III	2C	
Malaria	RBC exchange	Severe	III	2B	255
Multiple sclerosis	TPE	Acute CNS inflammatory demyelinating	II	1B	257
	IA	Acute CNS inflammatory demyelinating	III	2C	
	TPE	Chronic progressive	III	2B	

TABLE IV. *Continued*

Disease name	TA Modality	Indication	Category	Grade	Page
Myasthenia gravis	TPE	Moderate-severe	I	1B	259
	TPE	Pre-thymectomy	I	1C	
Myeloma cast nephropathy	TPE		II	2B	261
Nephrogenic systemic fibrosis	ECP		III	2C	263
	TPE		III	2C	
Neuromyelitis optica spectrum disorders	TPE	Acute	II	1B	265
	TPE	Maintenance	III	2C	
N-methyl D-aspartate receptor antibody encephalitis	TPE		I	1C	267
Overdose, envenomation and poisoning	TPE	Mushroom poisoning	II	2C	269
	TPE	Envenomation	III	2C	
	TPE	Drug overdose/poisoning	III	2C	
Paraneoplastic neurological syndromes	TPE		III	2C	271
	IA		III	2C	
Paraproteinemic demyelinating neuropathies/chronic acquired demyelinating polyneuropathies	TPE	Anti-MAG neuropathy	III	1C	273
	TPE	Multifocal Motor Neuropathy	IV	1C	
	TPE	IgG/IgA	I	1B	
	TPE	IgM	I	1C	
	TPE	Multiple myeloma	III	2C	
	IA	IgG/IgA/IgM	III	2C	
Pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections; Sydenham's chorea	TPE	PANDAS exacerbation	II	1B	275
	TPE	Sydenham's chorea, severe	III	2B	
Pemphigus vulgaris	TPE	Severe	III	2B	277
	ECP	Severe	III	2C	
	IA	Severe	III	2C	
Peripheral vascular diseases	LDL apheresis		II	1B	279
Phytanic acid storage disease (Refsum's disease)	TPE		II	2C	281
	LDL apheresis		II	2C	
Polycythemia vera; erythrocytosis	Erythrocytapheresis	Polycythemia vera	I	1B	283
	Erythrocytapheresis	Secondary erythrocytosis	III	1C	
Post transfusion purpura	TPE		III	2C	285
Prevention of RhD allloimmunization after RBC exposure	RBC exchange	Exposure to RhD(+) RBCs	III	2C	287
Progressive multifocal leukoenchephalopathy associated with natalizumab	TPE		I	1C	289
Pruritus due to hepatobiliary diseases	TPE	Treatment resistant	III	1C	291
Psoriasis	ECP		III	2B	293
	Adsorptive cytapheresis	Disseminated pustular	III	2C	
	Lymphocytapheresis		III	2C	
	TPE		IV	2C	
Red cell alloimmunization in pregnancy	TPE	Prior to IUT availability	III	2C	295
Renal transplantation, ABO compatible	TPE/IA	Antibody mediated rejection	I	1B	297
	TPE/IA	Desensitization, LD	I	1B	
	TPE/IA	Desensitization, DD	III	2C	
Renal transplantation, ABO incompatible	TPE/IA	Desensitization, LD	I	1B	299
	TPE/IA	Antibody medicated rejection	II	1B	
	TPE/IA	A_2/A_2B into B, DD	IV	1B	
Scleroderma (systemic sclerosis)	TPE		III	2C	301
	ECP		III	2A	
Sepsis with multi-organ failure	TPE		III	2B	303

TABLE IV. *Continued*

Disease name	TA Modality	Indication	Category	Grade	Page
Sickle cell disease, acute	RBC Exchange	Acute stroke	I	1C	305
	RBC Exchange	Acute chest syndrome, severe	II	1C	
	RBC Exchange	Priapism	III	2C	
	RBC Exchange	Multiorgan failure	III	2C	
	RBC Exchange	Splenic/ hepatic sequestration; intrahepatic cholestasis	III	2C	
Sickle cell disease, non-acute	RBC exchange	Stroke prophylaxis/iron overload prevention	I	1A	307
	RBC exchange	Recurrent vaso-occlusive pain crisis	III	2C	
	RBC exchange	Pre- operative management	III	2A	
	RBC exchange	Pregnancy	III	2C	
Stiff-person syndrome	TPE		III	2C	309
Sudden sensorineural hearing loss	LDL apheresis		III	2A	311
	Rheopheresis		III	2A	
	TPE		III	2C	
Systemic lupus erythematosus	TPE	Severe	II	2C	313
	TPE	Nephritis	IV	1B	
Thrombocytosis	Thrombocytapheresis	Symptomatic	II	2C	315
	Thrombocytapheresis	Prophylactic or secondary	III	2C	
Thrombotic microangiopathy, coagulation mediated	TPE	*THBD* mutation	III	2C	317
Thrombotic microangiopathy, complement mediated	TPE	Complement factor gene mutations	III	2C	319
	TPE	Factor H autoantibodies	I	2C	
	TPE	MCP mutations	III	1C	
Thrombotic microangiopathy, drug associated	TPE	Ticlopidine	I	2B	321
	TPE	Clopidogrel	III	2B	
	TPE	Calcineurin inhibitors	III	2C	
	TPE	Gemcitabine	IV	2C	
	TPE	Quinine	IV	2C	
Thrombotic microangiopathy, hematopoietic stem cell transplantation associated	TPE		III	2C	323
Thrombotic microangiopathy, Shiga toxin mediated	TPE/IA	Severe neurological symptoms	III	2C	325
	TPE	Streptococcus pneumoniae	III	2C	
	TPE	Absence of severe neurological symptoms	IV	1C	
Thrombotic thrombocytopenic purpura	TPE		I	1A	327
Thyroid storm	TPE		III	2C	329
Toxic epidermal necrolysis	TPE	Refractory	III	2B	331
Vasculitis	TPE	HBV-PAN	II	2C	333
	TPE	Idiopathic PAN	IV	1B	
	TPE	EGPA	III	1B	
	Adsorption granulocytapheresis	Behcet's disease	II	1C	
	TPE	Behcet's disease	III	2C	
Voltage-gated potassium channel antibodies	TPE		II	2C	335
Wilson's disease, fulminant	TPE	Fulminant	I	1C	337

DAH = diffuse alveolar hemorrhage; DD = deceased donor; EGPA = eosinophilic granulomatosis with polyangiitis; LD = living donor; PAN = polyarteritis nodasa; WAIHA = warm autoimmune hemolytic anemia.

References:
ASFA guidelines for Therapeutic Apheresis indications:
Schwartz J et al, Guidelines on the use of therapeutic apheresis in clinical practice-evidence-based approach from the Writing Committee of the American Society for Apheresis: the seventh special issue.
J Clin Apher 2016;31:149.

Starting and Finishing Apheresis Procedures Using Catheters or Ports

Background

These are general guidelines. TPE procedures require 2 vascular access sites because they utilize continuous flow (blood is removed from the patient at the same time that processed blood is being returned). There are several methods to obtain access at 2 sites. Typically, double lumen "hemodialysis" (vascath) catheters or triple lumen (traumacath catheters) are used leading to a central vein. For some outpatients a peripheral catheter is placed in an antecubital vein in each arm. In patients with AV fistulas for chronic hemodialysis, the removal line (also referred to as access or draw line) can be inserted into the artery, and the return line can be placed in the vein. No matter what method is used, in order to ensure adequate flow during the procedure, one of the lumens should be no smaller than 16 gauge for access and 18 gauge for return. Procedures are the same for semi-permanent and temporary catheters regardless of catheter site.

Observe a procedure before flying solo (particularly if you have not been on the blood bank rotation). Remember residents, attendings, and apheresis nurses work together as a team to take care of the patient.

Starting and finishing procedures are semi-sterile processes. Chlorhexidine swabs are used frequently as a means of decreasing possible contamination by removing blood at connection sites. The finishing process is essentially the reverse of the starting process with some differences.

Do not start any procedures without consent. The consent should be immediately placed in the patient's medical record. Additionally, in

your consult and/or first procedure note comment that the consent form has been discussed, signed and placed in the patient's medical record.

Additionally, single or double access vortex ports, located under the patient's skin, are used for procedures.

The apheresis nurses are responsible for connecting patients to the machine and for accessing ports.

Troubleshooting for Slow Access Problems

Vascular access problems are fairly common during procedures. The two primary causes of access problems are clotting and anatomical issues (i.e. the catheter tip can become lodged against the vein wall). Anatomical problems usually present as minimal to slow flow during the initial aspiration of samples or early in the apheresis procedure. They are more likely to affect the access (removal) line since it has negative pressure. First, make sure there are no kinks in the line. Next, try to reposition the catheter in relationship to the patient's body. For IJ and femoral catheters, lines often work better if they are flat against the patient's skin and running parallel to the vein. If the line still is not running well, have the patient create negative thoracic pressure by coughing or breathing deeply. Another potential cure without risk is to change the body position of the patient. This includes turning the head to the other side, laying the patient flat, laying the patient on either side, and/or raising the patient's arm above their head.

If these methods do not improve the flow adequately, the patient may have a clot in the line. If you don't have much experience or don't feel comfortable, call the attending at this point. Otherwise, the next step is to try to aspirate using an empty syringe (or a syringe with few ml of saline). If you are unable to aspirate then very GENTLY and CAREFULLY flush the line with saline. You should press on the syringe GENTLY at first. If there is little resistance, the problem is likely to be anatomical. In that case you should gently flush the line with a few ml of saline and then try to aspirate again. If it is the access (removal) line and it still doesn't work when connected to the red port, you can try changing it to the blue catheter port.

If there is considerable resistance when you try to gently flush the line, there is a greater risk of having a clot. In that case flushing can dislodge the thrombus into the circulation. A clot also should be suspected

if you couldn't aspirate any blood during the hook-up. In that case you can't try to flush the line because it would infuse the highly concentrated heparin (3,750units) that is used to maintain potency between procedures.

Once a clot is suspected, the attending should be notified. If the attending is unable to get adequate flow, there are 3 options. Usually we will try declotting with a fibrinolytic agent, if that fails then the clinical team will need to put in a new catheter. Occasionally the clinicians will decide to stop the treatments.

Port Occlusion Activase protocol

Activase (Alteplase) 2mg/2ml

- Add 2.2 ml of sterile water/saline to vial.
- Slowly instill Activase solution into cannula.
- Slowly push about 2-3 ml of air until Activase solution is at level of needle inserted into Vortex catheter.
- Wait 30 minutes.
- Aspirate Activase solution/blood.
- Re-start procedure.
- If Activase is to remain in the port overnight.
    - Flush the port with 10 ml of saline before following steps described above.

Line flushing:

When the interval is $\geq$5 weeks, the patient must come to have their access port or catheter flushed 3 weeks following the procedure.

Hematology Lab (UAB)
Hematopathology Evening and Weekend Calls Issues

Routine hematology lab performs 450-600 CBC/day and 150--200 differential counts, 15-40/day body fluid analysis (pleural, peritoneal, CSF and synovial etc.) and approximately 150 urine examinations in a single day. Majority of these are reported by lab and some require review by residents/pathologist (9am & 4pm, M-F review sessions in the Bone Marrow Lab 281B-SW). Following is the list of the potential evening and weekend calls from UAB hematology/BM lab services. *On call attending pathologist should be contacted first, and if needed contact Dr. Reddy or the designated pathologist or hematopathology fellow.*

Type of Call	Standard Operating Procedures
1. Evening and weekend bone marrows	***Not offered.*** Rare exceptions are patients requiring immediate treatment. Page Dr. Reddy or designated pathologist for instructions / approval.
2. Specimen for flow cytometry analysis and cytogenetics	Holding media (Hanks/RMPI-1640) media is available in bone marrow lab (281B – Spain). Blood or bone marrow sample (1-2cc/tube) in media, kept in the refrigerator (4^0C). Samples are good for at least 48 hours. Check with hematopathology fellows or Dr. Reddy.
3. Atypical cells, blasts/tumor cells in body fluids or in peripheral blood and abnormal CBC/panic values	Residents are paged by hem-lab for confirmation / clinical correlation. **Note**: In most cases telephonic notification of the house staff / primary physician is sufficient. *In rare cases*, if the situation warrants actual onsite review of the smear is done by the resident with backup by senior resident, designated pathologist or Dr. Reddy
4.Intracellular organisms	Residents are paged by hem-lab for confirmation / clinical correlation. **Note**: Resident notifies the house staff / primary physician and microbiology lab for appropriate additional tests (Gram's stain or cultures etc.). Slides are usually reviewed during day-time. However, if immediate confirmation is needed check with on call attending pathologist.
5. Crystal identification (urine or body fluid)	Residents are paged by hem-lab for confirmation. **Note**: Clinical correlation is needed in most cases and actual review of the smear is done during day time "slide review" session by hematology residents and Dr. Reddy.

Flow Cytometry Submission / Storage Requirements			
Test	**Specimen**	**Storage**	**Specimen Requirement**
CD3/CD4 Assay	Peripheral Blood	Rm. Temp	Lavender-top tube (liquid EDTA)
CD4/CD8	Peripheral Blood	Rm. Temp	Lavender-top tube (liquid EDTA)
Cell Markers	Peripheral Blood	Rm. Temp	Green-top tube (freeze-dried heparin)
Cell Markers	Bone Marrow	Rm. Temp*	Sodium heparin / RPMI / Hanks Media
Cell Markers	Tissue biopsies	Refrigerator	RPMI or Hanks Media
Cell Markers	Body Fluid (CSF, etc.)	Refrigerator	RPMI or Hanks Media

***Note:** For all cell marker analysis specimens (peripheral blood, bone marrow, tissue biopsy, body fluid / CSF) held for more than 12 hours, add nutrient media (RMPI / Hanks). This is very critical for the survival of the cells especially in acute leukemias and high-grade lymphomas (e.g. Burkitt's). Add 2-3 mL of media to a 10 mL tube. Refrigerate all weekend specimens or any specimen held for me than 24 hours.

For CD3/CD4/CD8 assays: Refrigeration is recommend for weekend specimens (do not add media).

Telephone and Pager Numbers

Labs	Telephone #
Bone marrow lab (SW – S281)	934-7869 8:00 am – 4:00 pm (M-F)
Routine Hematology Lab (UAB)	934-5625 - **24 hours**
Routine Hematology LAB (VA)	12-6478 or 12-6460 – **24 hours**
Flow Cytometry Lab (SW-W294)	934-5615 8:00 am – 4:30 pm (M-F)
Hematopathology Fellows	UAB Paging operator
Dr. Vishnu V. B Reddy	**UAB pager # 0331, 24 Hours**

BLOOD BANK BENCH WORK CHECKLIST

During the time you are covering the Blood Bank, observe and learn how to perform and interpret the following tests. This checklist should be completed and returned to TM administrative assistant by the end of the second month of your rotation. Please make arrangements with the BB supervisor. Xerox this form and complete it.

Your Name:_____
Dates of Rotation:_____

Test Observed	Date	Tech Observed
ABO/Rh Testing		
Manual Method	_____	_____
Autocontrol Test	_____	_____
Newborn ABO/Rh	_____	_____
Gel Method (Provue)	_____	_____
Antibody Screen		
Tube technique	_____	_____
Prewarm technique (for screen and/or panel)	_____	_____
Gel Method (Provue)	_____	_____
Antibody Panel		
Tube technique	_____	_____
Selected Cells	_____	_____
Lewis Substance Neutral.	_____	_____
Additional Antibody Workup Testing		
Phenotype RBCs	_____	_____
Antibody Titer	_____	_____
Autoadsorption	_____	_____
Crossmatching		
Electronic	_____	_____
PEG technique	_____	_____
Prewarm technique	_____	_____
Other Testing		
Elution & Eluate	_____	_____
Direct Antiglobulin Test (DAT)	_____	_____
Fetal Screen	_____	_____

Kleihauer-Betke
- Positive Test & determination of Rhlg Dose _____ _____
- Negative Test _____ _____

Transfusion Reaction Workup _____ _____

Receipt of Patient Specimens
- Accepted specimen _____ _____
- Rejected specimen _____ _____

Issuing Blood Products for Patients
- Follow workflow of issuing _____ _____
- Emergency Release of RBCs, _____ _____
- Plasma, and plateletsReceiving Blood Products

Follow workflow of processing
Products into the BB computer system
- RBCs _____ _____
- Platelets _____ _____
- FFP &/or Cryo _____ _____

Blood Product Preparation
- Aliquoting _____ _____
- Irradiating _____ _____
- Thawing _____ _____
- Washing _____ _____
- Platelet Titer _____ _____
- Follow workflow in Satellite Blood Bank _____ _____

Coagulation / Immunocytopenia

PT/PTT _____ _____
vWD profile _____ _____
D-Dimer _____ _____
HIT assay _____ _____
Factor VIII _____ _____
Platelet Aggregation _____ _____
Anti-Xa _____ _____
Mixing Study _____ _____

Common test tubes with examples of tests

Cap Color	Additive/ anticoagulant	Volume (ml)	Common Use(s)
Lavender or Pink	K_2EDTA	2, 4, 6	Type & screen, CBC, cyclosporin, FK506,
Red	None	3, 10	Toxicology (alcohol, drugs, therapeutic drug monitoring), may be used for Type & screen
Gold or Red/Gray (SST, Corvac)	Silicone Gel	3.5, 8.5	Most serum chemistry and immunology assays. TRALI testing at ARC Not for drugs, alcohol, or Blood Bank tests
Green	Sodium Heparin	4	B12, folate, ammonia
Pale Green	Lithium Heparin plus Gel	3	STAT plasma chemistry assays in emergency room laboratory
Light Blue	3.2% Sodium Citrate	2.7	Coagulation: PT, PTT, fibrinogen, D-dimer, clotting factors
Gray	4 mg Potassium Oxalate and 5 mg Sodium Fluoride	2	Lactic acid, glucose tolerance test (GTT)
Black	Buffered Sodium Citrate	2.4	Sedimentation rate
Yellow	ACD-A	8.5	Platelet antibody assays
Pearl	K_2EDTA plus Gel	4.5	Viral load
Royal Blue	None Red Stripe on Label	7	Antimony, copper

Affix label indicating physician name and patient location.

University Hospital
University of Alabama at Birmingham
Transfusion Service
Birmingham, Alabama 35249

Transfusion Reaction Investigation Documentation

Reaction Date: _____ Specimen Received Date/Time: _____
Blood Product: _____ Donor Number: _____
Blood Warmer Used: Y N Infusion Pump Used: Y N
Amount Infused: ¼ ½ ¾ all cc: _____
Attending Physician: _____ Resident Physician: _____
Pre-transfusion Diagnosis: _____
TM Resident Notified: _____ Date/Time: _____

VITAL SIGNS

Start of transfusion: Time: _____ BP: _____ P: _____ T: _____
Reaction Noted: Time: _____ BP: _____ P: _____ T: _____

SYMPTOMS (Circle all that apply)

Fever Urticaria Hypotension Chills Pruritus Low Back Pain
Hematuria Dyspnea Oozing Nausea Other, describe: _____

BLOOD BANK CLERICAL CHECK

Do the name, medical record number, and transfusion requirements on transmittal and in computer match the name, medical record number, and transfusion requirements on the unit bag tag?	Y	N
Do the unit number and ABORh on the unit match the unit number and ABORh on the unit bag tag?	Y	N
Does the name and medical record number on the transmittal match the name and medical record number on the pre- and post-transfusion specimens?	Y	N
Tech Performing Workup: _____ Pre Transfusion Crossmatch:	I	C

POST-TRANSFUSION REACTION LABORATORY TESTING

	PRE	POST		PRE	POST
ABO/RH:			Plasma color:		
DAT:	P N	P N	Urine HGB:	N T S M L	N T S M L
Antibody Screen:	P N	P N	Urine RBCs @ 40x:	____ /Field	____ /Field
Crossmatch:	I C	I C			

(PRE = testing on pre-transfusion samples, POST = testing on post-transfusion samples)
(I=incompatible; C=compatible; P=positive; N=negative; T=trace=1+; S=small=2+; M=moderate=3+; L=large=4+)

PATHOLOGIST INTERPRETATION (Circle all that apply)

Hemolytic Anaphylactic Febrile Allergic TRALI TACO No Reaction
Other describe: _____
OK to transfuse? Y N
Supplemental Testing Required? Y N If yes, describe: _____

Patient Chart / Bag Tag Review

1. Compare the number of units dispensed to the number of charted bag tags reviewed: _____
2. Number of charted bags tags documented correctly: _____

Incomplete information (indicate # of bagtags):
Vital Signs (pre &/or post) missing: _____
"ABC" transfusionist's checks (1-7): _____
Are both certification signatures present?: _____
Transfusion Reaction? Is (Y/N) box checked: _____

BRIEF HISTORY & ASSESSMENT (May be found in the Cerner or PIN systems):

Dr. _____ discussed all of the above with Dr. _____ on _____ (Date) at _____ (Time)

RESIDENT: _____, MD **DATE:** _____

ATTENDING PATHOLOGIST: _____, MD **DATE:** _____

Table of Predicted "Normal" Blood Volumes for Women
(from Nadler et al 1962)

Weight		Height							
		1.52	**1.58**	**1.63**	**1.68**	**1.73**	**1.78**	**1.83**	**1.88(m)**
(kg)	**(lb)**	**60**	**62**	**64**	**66**	**68**	**70**	**72**	**74(in.)**
36.2	80	2646	2776	2915	3036	3220	3387	3564	3750
40.8	90	2796	2927	3066	3214	3371	3537	3714	3901
45.4	100	2947	3077	3216	3364	3521	3688	3864	4052
49.9	110	3097	3227	3366	3514	3671	3838	4015	4201
54.5	120	3247	3378	3517	3665	3822	3989	4165	4352
59.0	130	3398	3528	3667	3815	3972	4139	4315	4502
63.5	140	3548	3678	3817	3965	4123	4289	4466	4652
68.0	150	3698	3829	3968	4116	4273	4440	4616	4803
72.5	160	3849	3979	4118	4266	4423	4590	4766	4953
77.0	170	3999	4129	4268	4416	4571	4740	4917	5103
81.6	180	4150	4280	4410	4567	4724	4891	5067	5254
86.2	190	4300	4430	4560	4717	4874	5041	5217	5404
90.7	200	4450	4581	4719	4867	5025	5191	5368	5554
95.3	210	4601	4731	4870	5018	5175	5342	5518	5705
99.8	220	4751	4881	5020	5168	5325	5492	5669	5855
103.4	230	4901	5032	5171	5318	5476	5642	5819	6005
108.9	240	5052	5182	5321	5469	5626	5793	5969	6156
113.4	250	5202	5332	5471	5619	5776	5943	6120	6306
118.0	260	5352	5483	5622	5770	5927	6093	6270	6457
122.5	270	5503	5633	5772	5920	6077	6244	6420	6607
127.0	280	5653	5783	5922	6070	6227	6394	6571	6757
131.6	290	5803	5934	6073	6221	6378	6544	6721	6908

Table of Predicted "Normal" Blood Volumes for Men
(from Nadler et al 1962)

Weight		Height							
		1.52	**1.58**	**1.63**	**1.68**	**1.73**	**1.78**	**1.83**	**1.88(m)**
(kg)	**(lb)**	**60**	**62**	**64**	**66**	**68**	**70**	**72**	**74(in.)**
45.4	100	3365	3500	3643	3795	3957	4129	4311	4503
49.9	110	3512	3646	3789	3941	4103	4275	4457	4649
54.5	120	3658	3792	3935	4088	4250	4422	4604	4796
59	130	3804	3938	4082	4234	4396	4658	4750	4942
63.5	140	3951	4085	4228	4380	4542	4714	4896	5088
68	150	4097	4231	4374	4527	4689	4860	5040	5235
72.5	160	4243	4377	4521	4678	4835	5007	5189	5381
77	170	4389	4524	4667	4819	4981	5153	5335	5527
81.6	180	4530	4670	4813	4966	5128	5299	5481	5633
86.2	190	4682	4816	4959	5112	5274	5446	5627	5820
90.7	200	4828	4963	5106	5258	5420	5593	5774	5966
95.3	210	4975	5109	5252	5405	5566	5738	5920	6112
99.8	220	5121	5255	5398	5551	5713	5885	6066	6295
103.4	230	5267	5402	5545	5697	5859	6031	6213	6405
108.9	240	5414	5548	5691	5843	6005	6177	6359	6551
113.4	250	5560	5694	5837	5990	6152	6323	6505	6698
118	260	5706	5840	5984	6136	6298	6470	6652	6844
122.5	270	5852	5987	6130	6282	6444	6616	6798	6990
127	280	599	6133	6276	6429	6591	6762	6944	7136
131.6	290	6145	6279	6423	6575	6737	6909	7091	7283
136.1	300	6291	6426	6569	6721	6883	7055	7237	7429
140.6	310	6428	6572	6715	6868	7030	7201	7383	7575