Review of the Basic Principles of Autotransfusion

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Objectives

- What is autotransfusion?
- What autotransfusion devices are currently available?
- When should autotransfusion be considered?
- What are the basic operating principles for each device?
- What surgical cases are eligible for autotransfusion and how are tandem collection reservoirs utilized during relatively contraindicated surgeries?
- What are the potential complications during autotransfusion?
- What are the expiration times for the various stages of autotransfusion?
Autotransfusion

Autotransfusion is the collection of blood or blood products derived from a patient’s own circulation (autologous blood) which is collected or shed from a wound or body cavity prior to, during or following surgery for later reinfusion to the patient.

Blood Recovery

- Recovery of shed blood, its processing and re-administration
- Washed and filtered or simply filtered
- Primarily washed intraoperatively and filtered postoperatively
- Centerpiece of a blood management program in combination with other techniques and modalities

AABB Guidelines for Blood Recovery and Reinfusion in Surgery and Trauma, 2010, pg. 1
Haemonetics Elite

- Basic red cell washing (autotransfusion) and platelet-rich plasma sequestration via blood bag technique
- Automatic and manual operation
- AutoStart feature
- 70 cc, 125 cc and 225 cc bowl sizes
- SmartSuction integrated into system to reduce hemolysis
- Touch screen
- Data management and bar code scanner
- Up to 30 programmable scenarios

LivaNova XTRA

- Basic red cell washing (autotransfusion) and platelet-rich plasma sequestration via blood bag technique
- Automatic and Manual operation
- 55, 125, 175, and 225 cc bowl sizes
- Data management
- Hematocrit sensor
- Integrated printer
- Waste line color monitor
- Automatic start and stop
- Popt, Pstd, Pfat, Post-op, and PRP programs
Fresenius CATSmart – Continuous Autotransfusion System

- Continuous flow autotransfusion device
- Single volume separation container
- High fat removal capability
- Smart, Low Volume and Emergency Wash programs
- Auto-Start function
- Five comfort-set heights
- Hematocrit sensors

Medtronic autoLog

- 135 mL bowl
- Self Start at 800 mL and manual start capability
- Two stage filling sequence
- Dynamic pulse-wash mechanism with 250 mL of saline
- Abbreviated and emergency wash capabilities
- Ability to process 7 to 12 cycles in continuous mode
- Built-in vacuum pump
Unwashed Systems

- Primarily designed for postoperative use
- Blood is collected and filtered and anticoagulant is not always used
- "When adequate amounts of blood are collected, the device is typically flipped over and the blood runs through a filter" and these are frequently called "flip-n-drip" systems
- Suction levels below 100 mmHg and citrate anticoagulant is preferred
- Primarily used perioperatively outside of the U.S.

AABB Guidelines for Blood Recovery and Reinfusion in Surgery and Trauma, 2010, pp. 8-10

Ultrafiltration/Hemoconcentration ATS During CPB

2.4 Liters
Autotransfusion Triggers

- Anticipated blood loss is equal to or greater than 1000 mL
- Procedures where 20% of the patients are routinely transfused
- Emergency procedures
- Patients with rare blood types or incompatibilities
- Patients with religious objections to allogeneic blood components
- Procedures where two (2) units of blood are routinely cross-matched, that cost is equivalent to setting up a Standby Collection System (AABB Guidelines for Blood Recovery and Reinfusion in Surgery and Trauma, 2010, p. 2)

Standby Collection System

- Anticoagulant
- Suction/Anticoagulant Line
- Collection Reservoir
- Vacuum Line
- Reservoir Connector
Principles of Autotransfusion

- Density of Blood Components:
  - Plasma 1.025 - 1.029 gm/cc
  - Leukocytes 1.065 - 1.09 gm/cc
  - Erythrocytes 1.089 - 1.097 gm/cc

Centrifugal force separates these components relative to their respective densities. The higher density components will move farther from the axis of rotation than those of lower density.
Principles of Autotransfusion

- Before commencing to salvage blood:
  - Prime autotransfusion circuit with at least 100 - 200 mL of anticoagulant
  - 30,000 units of heparin per 1000mL saline (0.9% Normal) or citrate based anticoagulant (ACD-A)
  - Suction should be maintained at approximately 80 - 120 mmHg. (No more than 150 mmHg is recommended under normal circumstances)

Anticoagulation

- Heparinized saline - 30,000 units of heparin per 1000 mL 0.9% Normal saline or 15,000 units of heparin per 500 mL Normal saline. Consider a higher initial dose with the new heparin formulation
- Heparin complexes with Antithrombin III (ATIII)
- Heparin should not be used on ATIII deficient patients or patients prone to Heparin Induced Thrombocytopenia (HIT)
- ACD-A inhibits the early steps in the clotting cascade by chelating (binding) Calcium
- Do not use ACD-A on patients with impaired liver function
- ACD-A is contained in pre-mixed bags
- Do not aspirate blood mixed with Ringers Lactate irrigation solutions when using citrate based anticoagulants due to excess calcium contained in that solution
Principles of Autotransfusion

- Whenever the collection reservoir is emptied, always re-prime it with at least another 100 to 200 mL of anticoagulant.

- During collection keep the anticoagulant running at 13 - 15 mL per 100 mL of collected blood (ratio of 1:7).

“Maximizing Effectiveness”

- Appropriate suction levels, 80 to 120 torr, which can be temporarily increased “in the event of massive blood loss”

- Suction tip style and technique, appropriate size and immersion in pools of blood to minimize air aspiration

- Timely sponge rinsing with appropriate isotonic solutions

- Use of either heparin or citrate anticoagulants or a combination of both

AABB Guidelines for Blood Recovery and Reinfusion in Surgery and Trauma, 2010, pp. 2-4
Principles of Autotransfusion with Latham Bowl Devices

- Use a minimum of 3 - 4 times the bowl volume in wash solution for cardiac or vascular surgery or 7 to 10 times the bowl volume for orthopedic surgery and the line to the waste bag appears to be clear.

- The washed red blood cells are then pumped to the holding/reinfusion bag. Drain the red blood cells into a transfer bag (if available) for later patient reinfusion and remove all remaining air prior to disconnecting the bag.

Principles of Autotransfusion with Latham Bowl Devices

- Factors affecting the quality of the product:
  - Fill Rate
    - Always select the rate with the patient need in mind (i.e., a trauma patient in immediate need of fluid volume)
    - Always completely fill a bowl; if a bowl is not full, select Return or Concentrate modes.
Principles of Autotransfusion with Latham Bowl Devices

- **Wash rate**
  - Choose wash rates based upon the urgency of returning blood to the patient
  - The wash solution must be isotonic and indicated for IV use – 0.9% Normal saline is the usual wash solution
  - Always wash with a minimum of 3 - 4 times the bowl size, i.e. 750 mL for a 225 or 250 mL bowl in “clean” cases; 7 - 10 times the bowl size for orthopedic cases

Principles of Autotransfusion

- Factors affecting processing time:
  - Bowl filling volume
  - Hematocrit of the salvaged blood
  - Bowl filling rate
  - Wash volume required
  - Saline wash rate
  - Flow rate at which bowl is emptied
Principles of Autotransfusion

Contaminants such as betadine, alcohol, bleach, hydrogen peroxide, water, bone cement (both application and removal), gastric fluids, etc., should not be collected into the reservoir and should be removed to the wall suction, these agents will cause red blood cell hemolysis.

Principles of Autotransfusion

- Gelfoam is contraindicated for use with autotransfusion.
- Any antibiotics or other solutions that are NOT indicated for IV use should be aspirated to the waste collection system.
- Red cell bound antibiotics should be aspirated to the waste collection system.
Clinical Applications of Autotransfusion

- Trauma
- Thoracic and Cardiovascular surgery
- General surgery
- Vascular surgery
- Obstetric/Gynecologic surgery
- Orthopedic surgery
- Cancer surgery

Contraindications

- Absolute – inadvertent blood exposure to “solutions that cause hemolysis”: sterile water, hydrogen peroxide, alcohol, hypotonic solutions or other solutions that are “incompatible with red cells”
- Relative – “blood aspirated from contaminated or septic wounds or obstetric/surgical fields, and areas of malignancy”
- Use of a double setup of two (2) collection reservoirs and suction/anticoagulant lines minimizing contamination of the recovered blood
- Filtration of the recovered, washed blood with leukocyte reduction filters

AABB Guidelines for Blood Recovery and Reinfusion in Surgery and Trauma, 2010, pp. 6-7
Relative Contraindications to Autotransfusion

- Cesarean sections where amniotic fluid is present – tandem reservoirs and white cell reduction filters may be used and minimize aspiration of amniotic fluid
- Grossly contaminated wounds (tandem reservoirs and white cell reduction filters)
- Malignancies (cancer, sepsis, tuberculosis, etc.) – avoid blood recovery at tumor site, surgeon and medical director ATS program must discuss risks and benefits. Use leukocyte filter or irradiation
- Collagen or fibrin based hemostatic agents
- Sickle Cell Anemia – potential for cellular morphology change, surgeon and medical director of ATS program should discuss risks and benefits
- Others; cold agglutinin antibody – use a blood warmer

Tandem Collection Reservoirs

- Two (2) collection reservoirs, two (2) suction/anticoagulant lines and two (2) bags of anticoagulant solution
- Utilize individual vacuum sources for each collection reservoir, if possible
- Side by side or in series collection reservoir configurations
- Use of a waste suction system as well
- Multiple autotransfusion devices can be used simultaneously as needed
**Tandem Collection Reservoirs**

**Side by Side**

**In Series**

**Leukocyte Removal Filters**
Potential Complications of Reinfusion of Unwashed, Shed Blood

- Contaminants such as “tissue fragments; activated clotting factors; complement proteins; lymphokines; and exogenous materials, such as antibiotics and topical clotting agents”
- Recommendations to limit the amount of unwashed blood being reinfused to the patient
- Febrile reactions – “4% to 12%” and potential for hypotension
- Washing this blood is a simple solution

(AABB Guidelines for Blood Recovery and Reinfusion in Surgery and Trauma, 2010, pg. 9)

“Complications of Intraoperative Blood Recovery”

- Air embolism - use a “secondary reinfusion bag” (Blood Transfer Bag), remove air, disconnect and replace with another bag
- Air embolism is a potential cause of injury and death during autotransfusion procedures
- “Under no circumstances should a pressure cuff be used on the primary reinfusion bag when blood is being directly reinfused into the patient”
- Avoid inadvertent mixing of the recovered blood with inappropriate solutions
- The final product is washed red blood cells with a small amount of 0.9% saline solution

(AABB Guidelines for Blood Recovery and Reinfusion in Surgery and Trauma, 2010, pp. 7-8)
Prevention of Air Embolism

- Use a Transfer Bag, remove air and disconnect and exchange with a new Transfer Bag.
- “Processes and procedures for the administration of perioperative products shall prevent air embolism, including a prohibition of direct patient connection to the autotransfusion device.”
- “If a direct patient connection to the processing device is required, additional measures shall be taken to detect and prevent air embolism.”
- Recovered product must be inspected prior to release for clots, discoloration, fat, particulate, hemolysis and/or fluid interface.

AABB Standards for Perioperative Autologous Blood Collection and Administration, 7th Edition, 5.4.2-5.4.3

Expiration Times

- Hemodilution – eight (8) hours at room temperature
- Intraoperative autotransfusion with blood processing at room temperature – eight (8) hours from completion of processing
- Intraoperative autotransfusion with processing, 1 – 6 degrees C, 24 hours total if refrigerated within eight (8) hours of processing
- Intraoperative autotransfusion without processing – eight (8) hours from the start of collection
- Postoperative autotransfusion with or without processing – eight (8) hours from start of collection
- “Single-patient use materials intended to produce a postoperative product shall be used for no more than 24 hours after coming into contact with a patient’s blood at room temperature.”

AABB Standards for Perioperative Autologous Blood Collection and Administration, 7th Edition, Reference Standard 5.1.8A
Estimating Blood Loss (EBL)

- Start with the total fluid volume that arrived into the Collection Reservoir.
- Subtract the amount of anticoagulant solution delivered to the Collection Reservoir.
- Ask the surgical field how much irrigation solution was used and subtract that value from the corrected fluid volume from step 2.
- Under normal circumstances red blood cell mass recovery rates should fall into the 60 to 80% range.
- Carefully monitor EBL – at significant loss of a patient’s blood volume, coagulation factor testing may be warranted and Fresh Frozen Plasma (FFP) may be required. At larger blood volume losses, coagulation factor testing and a CBC and/or platelet function testing may be warranted and platelet transfusion may also be required.

Conclusion

- Autotransfusion can be implemented in an incremental fashion in a variety of surgical cases with devices that are available from several manufacturers.
- The principles of operation are somewhat similar for currently available autotransfusion devices.
- Relatively contraindicated surgical cases can be supported by using tandem collection reservoirs and leukocyte filtration.
- There are few complications associated with the use of autotransfusion devices and it is a safe mechanism for returning autologous blood to the patient in the perioperative setting.