Clinical Strategies for Avoiding and Controlling Hemorrhage and Anemia Without Blood Transfusion in Surgical Patients*

GENERAL NONBLOOD MANAGEMENT PRINCIPLES

1. **Formulate a detailed and individualized clinical management plan** to minimize blood loss and treat anemia. Comprehensive prospective planning should make optimal use of a combination of modalities to prevent or respond to hemorrhage or anemia. A blood conservation program cannot depend on a single modality.
2. Obtain informed **consent for anticipated or potential procedures.** Discuss the risks and benefits (both short- and long-term) of proposed interventions with the patient/family.
3. Considering the risk of transfusion and available blood management options, refer patient to another institution if better resources are available elsewhere.
4. Employ **a multidisciplinary team approach.** Collaborate with other disciplines to develop the most appropriate blood management strategy. Communicate management plan to all team members, assigning clear roles and responsibilities. Maintain ongoing communication regarding patient management, especially where there are multiple conditions treated by multiple physicians.
5. Maintain **surveillance for blood loss or physiological deterioration.** Early recognition and involvement of appropriate senior staff and prompt action to prevent/control abnormal bleeding are essential. The threshold for intervention should be lower than for patients who will accept allogeneic blood transfusion.
6. Prompt action to **secure hemostasis in the actively bleeding patient** who refuses blood transfusion is lifesaving. Use diagnostic tests that will provide rapid results, minimize delays, and thus reduce blood loss. In general, avoid a "watch and wait" approach to the bleeding patient.
7. Exercising **clinical judgment,** be prepared to modify routine practice when conditions change.
8. Consult promptly with senior specialists with experience in managing patients without allogeneic transfusion at an early stage if complications arise.
9. Transfer a stabilized patient, if necessary, to a major center before the patient's condition deteriorates.

GENERAL THERAPEUTIC PRINCIPLES

1. Adopt a **proactive approach including anticipation,** preparation, and management steps to prevent uncontrolled blood loss, utilizing a combination of interventions.
2. Perform a thorough preoperative workup. **Methodical history taking, physical examination, and judicious diagnostic tests** should be part of an integrated assessment approach to facilitate perioperative planning. Identify abnormalities of coagulation and previous treatments that may increase the risk of blood loss.
3. Identify appropriate **management strategies** to optimize the patient's condition before surgery. Interventions applied prospectively to create a favorable physiological environment are more likely to result in a favorable outcome than those applied retroactively as treatment.
4. Restrict diagnostic phlebotomy. **Perform essential tests** only and use less blood for analysis.
5. Combine surgical and anesthetic **blood conservation techniques:** meticulous surgical hemostasis and minimization of blood loss, and rigorous intraoperative blood management using appropriate autologous blood procurement strategies.
6. **Optimize oxygen delivery and consider measures to minimize oxygen consumption.**
7. In trauma or postoperative patients with active bleeding, **perform immediate concomitant investigation and diagnosis and early intervention** aimed at rapidly controlling hemorrhage. Consider moderate fluid underresuscitation in the presence of uncontrolled hemorrhage.

CONTENTS PAGE

1. CLINICAL EVALUATION/PREOPERATIVE PLANNING
- *A.* Medical History and Physical Examination 2
- *B.* Selective Laboratory Assessment 2
- *C.* Management of Medications and Coagulation Status 2
- *D.* Management of Anemia 2
- *E.* Optimize Preoperative Red Blood Cell Production 3
- *F.* Additional Preoperative Planning 3

2. MINIMIZATION OF PERIOPERATIVE BLOOD LOSS
- *A.* Restrict Diagnostic Phlebotomy 3
- *B.* Minimize Nondiagnostic Iatrogenic Blood Loss 3
- *C.* Prevent Gastrointestinal Bleeding 3

3. MAINTENANCE OF OXYGEN DELIVERY
- *A.* Optimize Cardiac Output/Volume Status 3
- *B.* Optimize Ventilation and Oxygenation 4
- *C.* Minimize Oxygen Demand 4

4. INTRAOPERATIVE BLOOD CONSERVATION AND AUTOLOGOUS BLOOD MANAGEMENT
- *A.* Multimodality Approach 4
- *B.* Surgical Techniques to Minimize Blood Loss 4
- *C.* Prophylactic Angiographic Embolization 4
- *D.* Hemostatic Surgical Instruments 4
- *E.* Minimally Invasive Approaches 4
- *F.* Pharmacological Enhancement of Hemostasis 4
- *G.* Normothermia/Preservation of Coagulation 5
- *H.* Controlled Hypotensive Anesthesia 5
- *I.* Other Anesthetic Considerations 5
- *J.* Cell Salvage/Autotransfusion 5
- *K.* Component Sequestration 6
- *L.* Intraoperative Hemodilution 6
- *M.* Hemofiltration/Hemoconcentration 6

5. POSTOPERATIVE MANAGEMENT
- *A.* Close Surveillance for Blood Loss 6
- *B.* Prompt Arrest of Bleeding 6
- *C.* Postoperative Blood Salvage 7
- *D.* Hemostasis/Coagulation Management 7
- *E.* Judicious Fluid Therapy 7
- *F.* Control of Blood Pressure/Avoidance of Hypertension 7
- *G.* Erythropoietin Therapy (See 1.D.3.) 7
- *H.* Judicious Prophylaxis of Thromboembolism 7
- *I.* Judicious Use of Analgesics 7
- *J.* Prophylaxis of Infection 7
- *K.* Prophylaxis of Upper Gastrointestinal Hemorrhage (See 2.C.) 7
- *L.* Nutritional Support 7

6. MANAGEMENT OF ACUTE BLEEDING AND SHOCK
- *A.* Stop the Blood Loss 7
- *B.* Treat Shock 7
- *C.* Maximize Oxygenation of Circulating Blood 8
- *D.* Maintain Normothermia 8
- *E.* Early Initiation of Erythropoietin Therapy 8
- *F.* Management of Severe Acute Anemia 8
- *G.* Antibiotic Prophylaxis 8
- *H.* Prevention of Thromboembolism 8
- *I.* Early Transfer When Necessary 8

7. PHYSIOLOGICAL RESPONSE TO ANEMIA
- *A.* Compensatory Mechanisms 8
- *B.* Tolerance of Normovolemic Anemia 8
- *C.* Effects of Storage on Red Cells 8

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

1. CLINICAL EVALUATION/PREOPERATIVE PLANNING

A. Medical History and Physical Examination[1]

1. History of anemia
2. History of abnormal bleeding (personal and family history)[2]
   a. Congenital/acquired bleeding disorders[3,4] (known from birth; spontaneous or easy bruising; prolonged bleeding with epistaxis or minor trauma; obstetric or gynecologic history, e.g., menometrorrhagia, pregnancy)
3. Coexisting disease/injury (renal, hepatic, cardiac, or pulmonary)
4. Medical/surgical history
   a. Types of procedures and amount of blood loss (e.g., circumcision; tonsillectomy; dental extraction, especially molar)
   b. Previous treatments or factors that may increase the risk of blood loss (e.g., repeat surgery at proposed operative site, known or suspected significant adhesions, radiation therapy)
5. Identify current medications that may adversely affect hemostasis[5-7]
   a. ASA, NSAIDs, anticoagulants, platelet aggregation inhibitors (e.g., abciximab, ticlopidine), antibiotics (e.g., beta-lactams such as penicillin, ticarcillin)
   b. Prescription and nonprescription drugs containing ASA or NSAIDs[8,9]
   c. Dietary or herbal supplements that may affect coagulation[10-14]
6. Physical exam (e.g., hepatomegaly, splenomegaly, petechiae, purpura, ecchymoses, hemarthrosis, evidence of collagen-vascular defects, telangiectases, evidence of other disease associated with hemostatic dysfunction)

B. Selective Laboratory Assessment

1. Diagnosis of anemia[15-17]
   a. Complete blood count (CBC)
   b. Serum ferritin
   c. Serum vitamin B_{12}[18]
   d. Serum folate
   e. Peripheral blood smear examination
2. Judicious additional tests (if indicated by medical history, abnormal clinical data, current medications, and degree of hemostatic challenge)[19]
   a. Coagulation tests
      (1) PT, PTT, template bleeding time
      (2) Platelet function, adhesion, aggregation tests
      (3) Fibrinogen concentration
      (4) Fibrin degradation products (FDP)/D-Dimer
      (5) Specific coagulation factor assays
      (6) Assay for ristocetin cofactor activity
   b. Liver function tests
   c. Renal function tests

Notes:

1. A detailed workup may be advisable if a procedure is associated with significant blood loss.
2. If the preoperative laboratory investigation is abnormal, consider postponement of surgery until correctable abnormalities are treated.
3. In the presence of a history of abnormal or excessive bleeding or suspected platelet dysfunction, consider consulting a hematologist.

C. Management of Medications and Coagulation Status[20]

1. Avoid drug-induced coagulopathies
   a. Analgesics. Consider discontinuing drugs associated with increased bleeding complications (from 3 to 14 days preoperatively) and temporary substitution with alternate therapy (e.g., NSAIDs with short half-lives):
      (1) Aspirin/ASA and aspirin-containing compounds (discontinue at least 7 days before surgery)
      (2) NSAIDs with long half-lives (e.g., tenoxicam, phenylbutazone) (discontinue 3 to 14 days or longer before surgery)

      Note: Half-lives of NSAIDs may be increased in the elderly.
   b. Antibiotics (e.g., beta-lactams such as high-dose penicillin, ticarcillin)
2. Management of Anticoagulants
   a. Consider discontinuation or substitution (e.g., heparin instead of warfarin) of anticoagulants or antiplatelet agents before surgery. Consider medical indication for the anticoagulant, emergency nature of surgery, type of surgical procedure planned, and type of anesthetic planned
   b. Postpone nonurgent surgery for patients on anticoagulant/antiplatelet medications (some may irreversibly inhibit platelet function for up to 14 days)
   c. For urgent surgery, normalize coagulation with appropriate agents[21-24] (e.g., vitamin K, recombinant or concentrated clotting factors VIIa and IX)
   d. Consider appropriate clotting factor replacement therapy (See ***4.F.***)
3. Review other current medications
   a. Identify and discontinue dietary or herbal supplements that may affect coagulation or platelet function (See ***1.A.***5.)
   b. Review adverse reactions and drug interactions (e.g., platelet dysfunction, thrombocytopenia, bleeding, suppression of erythropoiesis, anemia)
4. Treatment for congenital/acquired hemorrhagic disorders[25]
   (See ***4.F.*** Pharmacological Enhancement of Hemostasis)

D. Management of Anemia

1. Identify and address possible causes of anemia[26]
   a. Control significant gynecological hemorrhage with preoperative hormone manipulation
2. Address iron deficiency[27] (oral/parenteral)
   a. Intravenous iron may replenish iron stores more quickly and efficiently than oral or intramuscular iron therapy.[28,29] Consider administration by saline infusion[30]
   b. Intravenous iron should be considered for patients with low iron stores, intolerance to oral iron, inadequate absorption, or noncompliance or for patients with chronic or severe blood loss.[31,32] Administer a test dose[33]
   c. Bioavailability of oral iron may be improved with concomitant administration of ascorbic acid[34]

Note: The parenteral administration of a drug or an agent (e.g., iron dextran) bears the potential for an allergic or anaphylactic reaction and should be administered with appropriate precautions. Prompt recognition of signs and symptoms of adverse drug reactions and timely management are required.

3. Recombinant erythropoietin (r-HuEPO) therapy[35,36]
   a. Response to r-HuEPO is dose dependent and varies among patients.[37] Increase dosage or change route of administration to improve response[38]

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

b. Virtually all patients will eventually require supplemental iron to increase or maintain transferrin saturation to levels that will adequately support erythropoiesis stimulated by r-HuEPO[39-41]

c. r-HuEPO has been reported used in infants and children with no significant adverse reactions[42-44]

d. Identify and treat factors associated with a diminished response to r-HuEPO:

(1) Iron deficiency. Consider a trial of IV iron

(2) Hematinic deficiencies. Consider supplementary folate and vitamin B_{12}[45] (especially in the elderly and patients who have had gastric surgery[46])

(3) Hyperparathyroidism

(4) Presence of an infectious, inflammatory, or malignant process

4. Consider androgen therapy if there is a poor response to r-HuEPO despite increase to high dose or if r-HuEPO is unavailable[47]

Note: Use androgenic therapy with caution in patients with cardiac, renal, or hepatic disease.

5. Nutritional support

E. Optimize Preoperative Red Blood Cell Production

1. Administer supplementary iron to support postoperative erythropoiesis, even in patients with normal iron stores[48,49]
2. Use r-HuEPO to increase the hematocrit in marginally anemic patients undergoing procedures associated with substantial blood loss to facilitate intraoperative autologous blood procurement and/or minimize postoperative anemia[50-56]
3. Consider using r-HuEPO to raise preoperative hemoglobin concentrations in patients with ischemic heart disease to reduce risks related to myocardial ischemia[57,58]

F. Additional Preoperative Planning[59-63]

1. Estimate the postoperative hematocrit by calculating the patient's blood volume and the expected blood loss (considering the patient's condition, diagnosis, type of surgery, as well as the skill of the surgeon and anesthesiologist)
2. If hemodilution is being considered, the blood volume to be removed (V) or the optimal initial hematocrit (Hct_i) can be determined using the formula: $V = EBV \times (Hct_i - Hct_f) / Hct_{av}$ (where EBV is the estimated blood volume, Hct_f is the minimum hematocrit, and Hct_{av} is the average hematocrit $[(Hct_i + Hct_f)/2]$)
3. If the anticipated blood loss will have a serious adverse effect on the patient's hematocrit:
   a. Consider a modified surgical approach. Technical factors and operative approach are important determinants of blood loss[64]
   b. Identify appropriate combinations of preoperative strategies to optimize perioperative hemoglobin level, coagulation status, and the patient's condition[65]
   c. Select appropriate combinations of intra- and postoperative blood conservation and autologous blood management methods
4. Therapy for coexisting disease (e.g., treatment of cardiopulmonary disease[66,67])
5. Optimize weight and/or physiological condition. Consider postponement of elective surgery to optimize condition of patient

2. MINIMIZATION OF PERIOPERATIVE BLOOD LOSS

A. Restrict Diagnostic Phlebotomy[68-70]

1. Limit phlebotomy to necessary diagnostic testing
2. Decrease volume drawn for laboratory tests (use pediatric-size tubes for adults)
3. Perform multiple tests per sample
4. Microsampling/microanalysis techniques
5. Consider noninvasive blood gas monitoring and instrumentation

B. Minimize Nondiagnostic Iatrogenic Blood Loss[71,72]

C. Prevent Gastrointestinal Bleeding

1. Consider prophylaxis of stress ulcers in at-risk patients[73,74]
   a. Enteral nutrition
   b. Sucralfate
   c. H_2-receptor antagonists
   d. Proton pump inhibitors

3. MAINTENANCE OF OXYGEN DELIVERY

A. Optimize Cardiac Output/Volume Status

1. Maintain circulating volume
   a. Crystalloids
      (1) Ringer's lactate
      (2) Normal saline
      (3) Hypertonic saline[75-81]
   b. Colloids
      (1) Pentastarch (and low-molecular-weight starches)
      (2) Hydroxyethyl starch[82,83] (may adversely affect coagulation—see Note 4)
      (3) Dextran[84] (affects coagulation—see Note 4)
      (4) Gelatin[85,86]

Notes:

1. Volume replacement should be prompt and judicious in terms of choice of solution and the volume, rate, and timing of its administration.[87-89]
2. In the bleeding patient, aggressive restoration of blood pressure to the normal range before control of hemorrhage may increase blood loss.[90] Consider moderate underresuscitation and permissive hypotension and concomitant measures to stop the bleeding.[91-93]
3. Avoid fluid overload.[94] Avoid unnecessary dilution of red cell mass and coagulation factors. Consider use of pulmonary artery catheter or CVP line to monitor volume replacement. Alternatively, consider noninvasive monitoring.[95]
4. Avoid negative interference with hemostasis and coagulation, i.e., dextrans and high-molecular-weight hetastarches.[96-101] Consider use of low-molecular-weight hetastarches or pentastarch.[102-104]
5. Desmopressin may partially reverse the antithrombotic effects of hydroxyethyl starches[105,106] and dextrans.[107,108] (See also ***4.F.***)
6. Hemoglobin level determinations can be misleading and are affected by sampling techniques and in vivo and in vitro variables.[109]
   (1) Hematocrits may be artificially decreased due to transient alterations of intravascular volume due to administration of colloids and crystalloids, impaired renal function, etc.

c. Oxygen-carrying red cell substitutes (when available for clinical use)

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

(1) Perfluorochemicals
(2) Hemoglobin-based oxygen carriers
2. Inotropic agents
3. Vasoactive agents

B. Optimize Ventilation and Oxygenation

1. Increase the fraction of inspired oxygen (FiO_2)[110,111]
   a. Consider high FiO_2 and concomitant interventions to treat anemia[112,113]
      (1) Hypoxemia poses greater risks than oxygen toxicity
      (2) Consider concomitant antioxidant therapy
   b. Consider controlling factors responsible for hemoglobin affinity for oxygen (pH, PCO_2, temperature)
2. Individualize ventilator management to minimize ventilator-induced lung injury[114] (e.g., ventilation mode, prone position,[115] inhaled nitric oxide[116])
   Note: Use of nitric oxide to improve oxygenation may have a clinically significant effect on bleeding due to transient inhibition of platelet aggregation.
3. Hyperbaric oxygen therapy[117-122]

C. Minimize Oxygen Demand

1. Controlled hypothermia (See ***4.G.2.***)
2. Sedation
3. Muscle relaxation
4. Mechanical ventilation
5. Adequate and appropriate analgesia

4. INTRAOPERATIVE BLOOD CONSERVATION AND AUTOLOGOUS BLOOD MANAGEMENT

A. Multimodality Approach

1. The greater the expected blood loss, the greater the indication for the use of multiple blood conservation modalities tailored to the clinical circumstances[123-129]
2. Use of appropriate combinations of techniques has a synergistic effect on reduction of blood loss[130-133]

B. Surgical Techniques to Minimize Blood Loss

1. Meticulous hemostasis and operative technique
   a. Rigorous hemostasis using combination of techniques[134-142]
      (1) Least traumatic surgical approach (e.g., consider an approach that avoids operating through known or suspected adhesions). Well-planned operative exposure through avascular tissue planes[143,144]
      (2) Atraumatic tissue handling
      (3) Knowledge of common aberrant vasculature
      (4) Expeditious and fastidious control of hemorrhage
      (5) Mechanical occlusion (ligation, vascular clips, clamps, tacks, balloons)[145-151]
      (6) Vascular isolation[152-156] (e.g., Pringle maneuver)
      (7) Venovenous bypass[157]
   b. Intraoperative positioning of patient[158,159]
      (1) Avoid venous compression
   c. Tourniquets[160,161]
2. Minimize duration of surgery
   a. Reduced operating time may decrease intraoperative blood loss[162,163]
   b. Consider enlarged surgical team
   c. Review and rehearse procedures[164]
   d. Ensure availability of equipment and instruments necessary to perform the procedure expeditiously and to manage contingencies
3. Staged surgery for complex procedures[165-169]
   a. Planned reoperation (e.g., high blood loss surgery, trauma)[170]
   b. Consider temporary packing and wound closure for nonsurgical bleeding

C. Prophylactic Angiographic Embolization

1. Preoperative embolization[171-179]

D. Hemostatic Surgical Instruments

1. Electrocautery/electrosurgery[180,181]
2. Ultrasonic scalpel[182,183]
3. Argon beam coagulator[184-188]
4. Radiofrequency thermal ablation[189-191]
5. Water-jet dissector[192-194]
6. Microwave devices[195-197]
7. Laser[198,199]

E. Minimally Invasive Approaches

1. Endoscopic/laparoscopic surgery[200-204]
2. Endoluminal techniques[205-207]
3. Cryosurgery[208-210]
4. Precision radiation therapy
   a. Stereotactic radiosurgery[211] (e.g., linear accelerator)
   b. Conformal and Intensity Modulated Radiation Therapy (IMRT)[212]
   c. Brachytherapy[213]

F. Pharmacological Enhancement of Hemostasis[214,215]

1. Systemic hemostatic agents
   a. Tranexamic acid[216-223]
   b. Aprotinin[224-231] (when available for clinical use)
      Note: Administer a test dose[232]
   c. Epsilon-aminocaproic acid[233]
   d. Vasopressin[234,235]
   e. Conjugated estrogens (IV)[236-238]
   f. Octreotide (somatostatin)[239-241]

Notes:

1. Antifibrinolytics may be administered prophylactically in patients at high risk of bleeding or to patients with excessive postoperative bleeding.[242]
2. Aprotinin has been reported to decrease bleeding in patients treated with aspirin before surgery.[243-245]
3. In postoperative or trauma patients, pharmacological hemostatic agents should be considered when bleeding is generalized or the bleeding site is not accessible. Do not defer surgery if active bleeding cannot be controlled medically.

2. Augment clotting factor activity
   a. Desmopressin[246-252]
      Notes:
      1. Desmopressin has been reported to decrease bleeding in patients treated with aspirin or NSAIDs before surgery.[253,254]
      2. Intra- or postoperative desmopressin may decrease blood loss *in patients with otherwise normal hemostatic function* by increasing serum levels of factor VIII and von Willebrand factor and increasing platelet adhesion in a dose-dependent manner.[255-258]
      3. Desmopressin is also used to treat the prolonged bleeding time and platelet dysfunction associated with uremia to assist in the maintenance of hemostasis during surgical procedures and postoperatively.[259]

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

4. Desmopressin causes a transient dose-dependent increase in plasminogen activator activity. Avoid excessive dose. Also, there is a tendency toward lessening of response with repeat administration within 48 hours.
5. Desmopressin has been used with epsilon-aminocaproic acid or tranexamic acid without adverse effects.[260]

b. Vitamin K[261,262] (prophylactic)

Notes:

1. Preoperative prophylactic administration of vitamin K increases levels of vitamin K-dependent coagulation factors.
2. Consider postoperative parenteral vitamin K.[263]
3. Administration of antibiotics may adversely affect absorption of oral vitamin K.

c. Recombinant factor VIIa (r-FVIIa)[264-269]

Notes:

1. Consider use of r-FVIIa in patients with congenital bleeding disorders or abnormal platelet function.[270-272]
2. Consider use of r-FVIIa in patients with thrombocytopenia or acquired platelet defects *with otherwise normal coagulation mechanisms* who are bleeding at sites with limited possibilities for mechanical hemostasis.[273-279]
3. Consider use of r-FVIIa in patients with bleeding due to DIC.[280]

d. Clotting factor replacement therapy

(1) Clotting factors VIIa, VIII, IX are available as recombinant products

e. Cryoprecipitate[281]

3. Topical/Local hemostatic agents

a. Tissue adhesives[282-284]

b. Fibrin glue[285-293]

c. Fibrin gel or platelet gel[294,295] (See also ***4.K.***)

d. Collagen hemostat (Avitene®, Instat®)[296,297]

e. Topical thrombin or thrombin-soaked packing[298,299]

f. Oxidized cellulose hemostat (Surgicel®, Oxycel®)

g. Gelatin foam/sponges (Gelfoam®, Surgifoam®)

h. Calcium alginate[300-303] (Algosteril®, Kaltostat®)

Note: Topical hemostatic agents can stop or reduce capillary bleeding when the bleeding site is identifiable and accessible.

4. Topical/Local vasoconstrictors

a. Induce local vasoconstriction by infiltration with epinephrine[304,305] or sympathomimetic amines

b. Phenylephrine[306]

c. Topical cocaine[307,308]

G. Normothermia/Preservation of Coagulation

1. Maintain normothermia

a. Hypothermia may increase blood loss due to platelet dysfunction and impairment of coagulation protein function[309-314]

b. Maintain a high ambient room temperature. Employ preinduction, intraoperative, and postoperative patient warming. Keep covered as much as possible. Consider monitoring core temperature[315]

c. Consider forced-air warming (applied to head, neck, shoulders) to maintain core temperature and decrease vasodilator requirements[316,317]

d. Warm all intravenous fluids and blood returned from autotransfusion unit[318]

e. Hypothermia may predispose to coagulopathy and bleeding and is associated with vasoconstriction and hypertension, impaired immune response to infections, dehiscence, hemodynamic instability, and shivering (associated with increased oxygen consumption)[319-323]

2. Consider controlled therapeutic hypothermia in certain clinical settings (e.g., cardiac surgery, neurosurgery) to decrease tissue oxygen requirements and protect against cerebral or myocardial ischemia[324-326]

3. Individualize and optimize heparinization and protamine reversal for cardiac procedures; avoid standard dosing[327,328]

a. Weight-based dosing protocols for heparin are often unreliable due to patients' widely variable response to heparin, variable clearance rates during surgery, and drug interactions

b. Consider use of heparin-bonded circuits for CPB[329-333]

H. Controlled Hypotensive Anesthesia

1. Induce and control optimum level of deliberate hypotension[334-338] (e.g., hepatic surgery,[339,340] orthopedic,[341] pediatric,[342,343] spinal,[344] urologic[345])

2. The higher the expected blood loss, the greater the indications for use of controlled hypotension in combination with other blood conservation techniques (e.g., erythropoietin, blood salvage)[346-350]

3. Individualize approach according to the type of surgery being performed and the presence of any preexisting medical conditions

a. Relative contraindications to controlled hypotension include uncontrolled hypertension, coronary artery disease, cerebral vascular disease, severe pulmonary disease, renal disease, hepatic disease, pregnancy, hypovolemia

4. Hypotensive epidural anesthesia has been safely used in elderly patients with comorbid conditions, including low cardiac output due to ventricular dysfunction[351,352]

5. Some agents used to induce hypotension (e.g., nitroglycerine, sodium nitroprusside) may transiently inhibit platelet aggregation,[353,354] but the clinical consequences may not be significant in patients with normal platelet function

I. Other Anesthetic Considerations

1. Normovolemic anemia is generally well tolerated (See **7.**)

2. Consider continuous high FiO_2 in patients with oxygen transport limitations

3. Regional/epidural anesthesia[355-360]

Note: Consistent reduction of blood loss has not been observed with the use of regional or general anesthesia. Regardless of the choice of anesthesia (regional, narcotic, etc.), the anesthetic technique must be well-planned and executed so as to minimize blood loss (e.g., positioning, ventilation, controlled hypotension).

4. Control intraoperative blood pressure and avoid intraoperative hypertension, especially in vascular operations[361,362]

a. Cardiovascularly compromised patients may tolerate a moderate reduction in blood pressure. Maintain coronary flow by ensuring adequate volume support

J. Cell Salvage/Autotransfusion

1. Intraoperative blood salvage[363-374]

a. Blood cell salvage can provide autologous blood that is immediately available in the event of rapid blood loss[375,376]

b. In oncologic surgery with use of blood salvage,[377] consider leukocyte depletion filters[378-380] alone or in combination with irradiation[381,382]

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

c. If there is risk of bacterial contamination (e.g., bowel injury), consider preoperative and/or postoperative systemic antibiotic prophylaxis. Consider addition of antibiotic to anticoagulant/saline solution[383]

d. With precautions, risk of amniotic fluid embolism is rare when blood salvage is employed in obstetric surgery[384]

K. Component Sequestration

1. Autologous single- or multicomponent intraoperative pheresis/sequestration[385-388]
2. Platelet-rich plasma[389,390]
3. Plateletpheresis[391,392]

L. Intraoperative Hemodilution

1. Acute Normovolemic (Isovolemic) Hemodilution (ANH)[393-399]
   a. The efficacy of ANH is proportional to the amount of blood withdrawn. ANH may be more effective when 1000 mL or more of autologous blood is withdrawn at the commencement of surgery (See ***1.F.2.***)
   b. If intravascular volume is maintained, blood pressure and heart rate may remain nearly unchanged[400,401]
   c. Blood withdrawn at the commencement of surgery is reinfused during or after surgery, as needed, to maintain the desired post-ANH hemoglobin concentration
   d. ANH has been used in selected patients with cardiac disease[402-405] but should be used with caution in conjunction with anesthetic agents having a negative inotropic effect.[406,407] Additional vigilance and monitoring may be necessary in patients with hepatic or renal dysfunction or cardiovascular, cerebrovascular, or pulmonary disease
   e. ANH is safe and effective in small children[408-410]
2. Acute Hypervolemic Hemodilution (AHH)[411-415]
   a. During AHH, asanguineous fluid is infused at the beginning of surgery to achieve a reduction in the hematocrit
   b. Compared to ANH, AHH has higher oxygen transport capacity and peripheral oxygen delivery and is well tolerated[416]
   c. Although AHH may be less effective than ANH for blood conservation, it may provide a greater margin of safety in older surgical patients[417-419]

Notes:

1. Hemodilution may be employed alone or in conjunction with other blood conservation methods such as preoperative erythropoietin, controlled hypotension, or cell salvage.[420,421] To optimize blood conservation, hemodilution should be a component of an integrated surgical blood management program.[422]
2. During surgical hemodilution, moderate anemia is generally well tolerated due to control of blood volume. Recommendations regarding minimum hemoglobin levels in the literature are generally in the context of acute blood loss.
3. In cardiac surgery, there is evidence that limited bypass prime volume, reduced-caliber tubing, and limited hemodilution can significantly decrease allogeneic blood transfusion.[423,424] Consider "primeless pump" to maintain higher intraoperative hematocrit.[425] Alternatively, consider use of ultrafiltration. (See ***4.M.***)

M. Hemofiltration/Hemoconcentration

1. Consider use of ultrafiltration devices instead of centrifugation to conserve platelets, coagulation factors, and plasma proteins[426-428]
   a. Consider use of ultrafiltration in addition to cell salvage to avoid the discard of plasma from cell salvage equipment[429]
2. After cardiopulmonary bypass, concentrate residual oxygenator contents and reinfuse to patient
3. In cardiac surgery for infants and children, consider a combination of smaller bypass circuits, intraoperative blood salvage, antifibrinolytic agents, greater tolerance of anemia, and modified ultrafiltration[430]

5. POSTOPERATIVE MANAGEMENT

A. Close Surveillance for Blood Loss

1. Monitor patient frequently to identify and quantify any bleeding or changes in coagulation status to facilitate prompt intervention
2. Signs/symptoms of blood loss include:[431]
   a. Pain, wound swelling, or firmness at surgical site and surrounding areas
   b. Hemodynamic instability
   c. Fluid status

   Note: A common cause of poor response to fluid therapy is continued hemorrhage. Maintain a high index of suspicion of bleeding when a patient shows evidence of hypovolemia despite reasonable hydration.
   d. Vital signs and clinical examination (e.g., dizziness, nausea, thirst, dyspnea, tachycardia, tachypnea, diaphoresis, change in mental status, shock)
   e. Decreasing serial hemoglobin/hematocrit (individualize tests according to clinical circumstances; minimal blood samples)
   f. Decreasing serial CVP measurements
   g. Tube drainage
3. Diagnosis of bleeding[432,433]
   a. Consider site(s) of bleeding:
      (1) Bleeding from only one site (e.g., the operative wound) is likely a localized defect in surgical hemostasis
      (2) Diffuse bleeding may suggest a generalized problem of hemostasis (e.g., oozing from mucosal membranes, IV sites, widespread petechiae, purpura, large ecchymosis, hematuria)

   Notes:

   1. Relatively normal hemostasis test results in the setting of excessive bleeding would indicate a surgical source rather than coagulopathy.
   2. Oozing may be caused by a hemostatic plug formation problem (e.g., due to platelet dysfunction or dilutional thrombocytopenia).

   b. Review history of recent drug ingestion (e.g., aspirin and aspirin-containing compounds, NSAIDs, anticoagulants/antiplatelet agents, some antibiotics, self-medication)
4. Continuous low-level blood loss (e.g., oozing) could become significant if permitted for a prolonged period of time

B. Prompt Arrest of Bleeding

1. Hemostatic pharmacological interventions
   a. Systemic hemostatic agents[434-436] (See ***4.F.1.***)
   b. Clotting factor augmentation (See ***4.F.2.***)
   c. Topical/Local hemostatic agents (See ***4.F.3.***)
2. Angiographic embolization[437] (See ***6.A.8.***)
3. Immediate return to OR to control hemorrhage
   a. Clinical experience and consideration of clinical circumstances allow the anesthesiologist, in consultation with the surgeon, to assess and diagnose whether postoperative bleeding is excessive and requires immediate reoperation

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

C. Postoperative Blood Salvage[438-446]

Note: For the rapidly bleeding patient, consider cell salvage as a temporary measure until the patient can be promptly returned to the operating room for surgical hemostasis.

D. Hemostasis/Coagulation Management[447]

1. Individualized neutralization of heparin[448-450]
2. Consider monitoring coagulation and platelet function using point-of-care viscoelastic analysis (e.g., thromboelastogram, Sonoclot) to optimize hemostasis management, assess platelet function, differentiate mechanical versus hemostatic bleeding, identify hypercoagulable and heparin-resistant patients, and screen for hyperfibrinolysis
3. Maintain normothermia (See ***4.G.***)

E. Judicious Fluid Therapy

1. Active rigorous fluid management in the immediate postoperative period to minimize hemodilution, sustain adequate perfusion and vital organ function; avoid hypertension[451-453] (See ***3.A.***)
   a. Tissue perfusion may be assessed by blood gas measurements, patient alertness, urine output
2. Maintain normovolemia in the hemodynamically stable patient[454]

F. Control of Blood Pressure/Avoidance of Hypertension

1. Consider tolerating moderate hypotension in a bleeding patient (e.g., mean arterial pressure (MAP) of 60-70 mm Hg in a normotensive patient) while taking measures to arrest bleeding
2. Use appropriate positioning and optimum ventilation techniques

G. Erythropoietin Therapy (See ***1.D.***3.)

H. Judicious Prophylaxis of Thromboembolism

1. Using clinical judgment, individualize timing, dosage, and duration of anticoagulation according to risk of bleeding and thromboembolism.[455,456] Avoid routine prophylaxis
   a. Maintain close clinical and laboratory monitoring for any anticoagulated patient to reduce bleeding risk
   b. Consider use of low-dose, low-molecular-weight heparin
   c. Patients at high risk for bleeding as well as for thrombosis and who may also require emergency surgery require treatment with short-acting anticoagulants that can be monitored with conventional methods (e.g., heparin, lepirudin)
2. If there is evidence of ongoing bleeding, discontinue, substitute, or reduce dosage of anticoagulant or antiplatelet agent
3. Consider use of compression devices, foot pumps, or vena cava filters in patients at increased risk of bleeding and thrombosis where use of heparin is contraindicated[457-459]

I. Judicious Use of Analgesics

1. Consider adverse effects of medications and drug interactions (e.g., platelet dysfunction, thrombocytopenia)
2. Some NSAIDs may be more likely to increase postoperative bleeding after certain procedures[460]

J. Prophylaxis of Infection

K. Prophylaxis of Upper Gastrointestinal Hemorrhage (See ***2.C.***)

L. Nutritional Support[461]

6. MANAGEMENT OF ACUTE BLEEDING AND SHOCK

In an actively bleeding trauma patient, arrest of external and internal hemorrhage must be the first management priority. Secondarily, employ moderate fluid underresuscitation in the presence of uncontrolled hemorrhage. Minimize time at the scene and in the emergency department. Appropriate resources (e.g., surgical personnel, autotransfusion devices) should be mobilized expeditiously. With multiple personnel, it is possible to perform assessment, control of hemorrhage, and fluid resuscitation simultaneously. Consider using a combination of measures to arrest blood loss (e.g., pharmacological and mechanical). Avoid treatment delays through advance planning, good organization, and well-rehearsed systematic management protocols.

A. Stop the Blood Loss

1. Direct pressure, elevation, pressure points, pressure dressings
2. Consider tourniquets
3. Pharmacological hemostatic agents[462-464] (See ***4.F.***)
4. Employ diagnostic methods that yield rapid results (e.g., ultrasound)[465-470] and facilitate timely decision-making
5. Tolerate hypotension (See ***6.B.***)
6. Prompt surgery for patients with active bleeding[471,472] (See ***4.B.***3.)
   a. Modified operative approach for rapid control of bleeding[473-478]
   b. "Damage control" strategy[479-486] (See notes below.)
   c. For pelvic fractures, consider early stabilization (e.g., external fixation)[487-489] or use of anti-shock garment (tamponade effect)[490]
   d. Minimally invasive devices (e.g., endoscopy for GI bleeding)[491-493]
7. Autotransfusion/blood salvage[494-500] (See ***4.J.***)
   a. Blood that collects in the thoracic or abdominal cavity following blunt or penetrating trauma can be autotransfused using drainage devices
   b. With appropriate precautions, autotransfusion of enteric-contaminated blood has been performed without sequelae[501,502]
8. Emergency arterial embolization[503-510]
   a. Consider prompt angiographic embolization for bleeding patients where surgical repair may release the tamponade effect and possibly result in severe blood loss[511]
   b. Consider angiographic embolization as part of nonoperative management for bleeding patients who are hemodynamically stable

Notes:

1. Avoid delay. Prompt control of hemorrhage should be the first objective.[512]
2. Consider "damage control" strategy for multiple injuries associated with hemodynamic compromise: Brief initial laparotomy and rapid control of major vascular injuries, control of contamination, use of temporizing measures (e.g., packing) to restore a survivable physiology, and planned reoperation for staged definitive surgical repair. This requires early recognition of a patient's physiological limits and prompt modification of the duration and scope of surgery.
3. Consider precautions to avoid bleeding sequelae related to removal of packing.[513,514]

B. Treat Shock

1. Trendelenburg/shock position (patient supine with head lower than legs)

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

2. Judicious fluid resuscitation/individualized volume replacement (See ***3.A.***)
   a. In the presence of uncontrolled hemorrhage, consider moderate underresuscitation (MAP of 55-70 mm Hg) sufficient to sustain tissue perfusion until hemostasis is secured[515-525] (not for patients with head injuries)
      (1) In the presence of uncontrolled hemorrhage, aggressive fluid resuscitation or use of anti-shock garments to elevate arterial or venous blood pressure to the normal range may increase the rate of bleeding and dislodge an effective thrombus[526-530]
      (2) Colloid resuscitation may provide more rapid and effective correction of intravascular volume deficits and avoid peripheral edema
   b. Avoid rapid infusion rates[531]
   c. Use warmed fluids
      (1) Infusion of unwarmed fluids may cause hypothermia and coagulopathy
   d. Consider intraosseous (IO) route for pediatric or adult patients if difficulty is encountered in promptly establishing adequate intravenous access[532,533]

C. Maximize Oxygenation of Circulating Blood

1. Airway management, administration of oxygen, treatment of pulmonary injuries (See ***3.***)

D. Maintain Normothermia

1. Active patient warming[534-537] (See ***4.G.***)
2. Warming of intravenous fluids, body-cavity lavage, and airway

Note: Therapeutic hypothermia may be indicated in rare cases.[538]

E. Early Initiation of Erythropoietin Therapy

1. High-dose recombinant erythropoietin (r-HuEPO) to decrease duration of anemia[539-543]
   a. Critically ill patients may be unable to mount an erythropoietic response to acute anemia or respond to endogenous EPO[544,545]
2. Supplementary IV iron[546-549]

F. Management of Severe Acute Anemia[550]

1. Maximize oxygen delivery (See ***3.***)
   a. Maintain normovolemia (See ***7.B.***)
   b. Ensure adequate cardiac output
2. Minimize iatrogenic blood loss (See ***2.A.***)
3. Minimize oxygen demand (See ***3.C.***)

G. Antibiotic Prophylaxis

1. Decisions regarding prophylactic antibiotic administration should take into consideration the number of organs injured, the degree of contamination, and the presence of colon injury[551,552]
2. Prompt and appropriate wound management to prevent infection[553] (especially fecal contamination)

H. Prevention of Thromboembolism

1. For multiple trauma patients at high risk of thromboembolism (for whom anticoagulants are contraindicated due to bleeding and mechanical prophylaxis is not possible because of their injuries), consider inferior vena cava filters and close surveillance for evidence of bleeding

I. Early Transfer When Necessary

1. Consider making transfer arrangements in advance if appropriate skills and facilities are not available locally

7. PHYSIOLOGICAL RESPONSE TO ANEMIA

A. Compensatory Mechanisms[554]

1. Increased cardiac output (heart rate and stroke volume)
2. Redistribution of blood flow to augment the coronary and cerebral (vital organ) perfusion
3. Increased tissue oxygen extraction[555,556]
4. Decreased oxygen affinity of hemoglobin
   a. Oxygen delivery to tissues is increased due to a rightward shift of the oxyhemoglobin dissociation curve as a result of a rise in 2,3-DPG levels

Notes:

1. Adaptive mechanisms in chronic and acute anemia differ.
2. Under conditions of normovolemic anemia, decreased blood viscosity results in decreased vascular resistance and increased venous return and cardiac output.
3. Decreased blood viscosity may lower the risk of thrombosis.

B. Tolerance of Normovolemic Anemia

1. Moderate levels of normovolemic anemia are well tolerated by critically ill patients with coexisting disease[557-560]
2. Profound intraoperative normovolemic hemodilution has been reported to be well tolerated in children[561]
3. Hemodilution to a hematocrit of 15% has been reported to be well tolerated in anesthetized adult patients[562-564]
4. Studies in healthy resting adults show good oxygen delivery and tolerance of normovolemic anemia to hemoglobin levels of 45 g/L[565,566]

Notes:

1. In a study of 8,787 elderly hip fracture patients undergoing surgical repair, anemia of 80 g/L appeared to have no effect on mortality even among those with cardiovascular disease.[567]
2. The "10/30" transfusion threshold is arbitrary and outdated. The efficacy of RBC transfusion has not been demonstrated in an appropriately controlled, prospective study.[568-570] The data preclude any scientific conclusion in support of a safe hemoglobin concentration or transfusion trigger.[571,572]
3. The compensatory mechanisms permitting tolerance of normovolemic anemia may be affected by several factors necessitating other measures to ensure adequate oxygen delivery:
   (1) left ventricular dysfunction and drug therapy (e.g., beta-adrenergic or calcium channel blockade),
   (2) certain pharmacological agents, such as anesthetics, hypnotics, and neuromuscular blocking drugs,
   (3) intraoperative conditions (e.g., hypothermia).

C. Effects of Storage on Red Cells

1. Impaired oxygen-carrying capacity of hemoglobin due to lower levels of 2,3-DPG in red blood cells. This may be reversible within 24-48 hours[573,574]
2. Decreased deformability of RBCs. This may adversely affect tissue oxygen delivery in sepsis and septic shock[575,576]
3. Decreased oxygen delivery due to impaired microvascular flow and/or formation of microaggregates in stored blood. This may impair microcirculatory oxygenation in sepsis and shock[577]

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

References

Database Abbreviations:
PMID: Medline®/PubMed® Unique Identifier (Index Medicus)
EMBASE: Embase® Accession Number (Excerpta Medica)
ISI: Institute for Scientific Information IDS Number

Preoperative Assessment

1. McIntyre AJ. Blood transfusion and haemostatic management in the perioperative period. *Can J Anaesth* 1992;39(5 Pt 2): R101-14. [PMID: 1600567]
2. Colon-Otero G, Cockerill KJ, Bowie EJ. How to diagnose bleeding disorders. *Postgrad Med* 1991;90(3):145-50. [PMID: 1881848]
3. Hampton KK, Preston FE. Bleeding disorders, thrombosis, and anticoagulation. *BMJ* 1997;314(7086):1026-9. [PMID: 9112850]
4. Rapaport SI. Preoperative hemostatic evaluation: which tests, if any? *Blood* 1983;61(2):229-31. [PMID: 6821695]
5. Spiess BD. Coagulation function in the operating room. *Anesthesiol Clin North Am* 1990;8(3):481-99. [EMBASE: 1990303633]
6. Szto GY, Linnemeier TJ, Ball MW. Fatal neutropenia and thrombocytopenia associated with ticlopidine after stenting. *Am J Cardiol* 1999;83(1):138-9. [PMID: 10073806]
7. Love BB, Biller J, Gent M. Adverse haematological effects of ticlopidine: prevention, recognition and management. *Drug Safety* 1998;19(2):89-98. [PMID: 9704247]
8. Brigden M, Smith RE. Acetylsalicylic-acid-containing drugs and nonsteroidal anti-inflammatory drugs available in Canada. *CMAJ* 1997;156(7):1025-8. [PMID: 9099173]
9. Hylek EM, Heiman H, Skates SJ, et al. Acetaminophen and other risk factors for excessive warfarin anticoagulation. *JAMA* 1998;279(9):657-62. [PMID: 9496982]
10. Koneti Rao A, Carvalho AC. Acquired qualitative platelet defects. In: Colman RW, Hirsh J, Marder VJ, Salzman EW, editors. *Hemostasis and Thrombosis: Basic Principles and Clinical Practice*. 3rd ed. Philadelphia: Lippincott; 1994. p. 685-704. [ISBN: 978-0-397-51059-7]
11. Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990-1997. *JAMA* 1998;280(18):1569-75. [PMID: 9820257]
12. Fugh-Berman A. Herb-drug interactions. *Lancet* 2000;355(9198):134-8. [PMID: 10675182]
13. Petry JJ. Garlic and postoperative bleeding. *Plast Reconstr Surg* 1995;96(2):483-4. [PMID: 7662027]
14. Steiner M. Vitamin E, a modifier of platelet function: rationale and use in cardiovascular and cerebrovascular disease. *Nutr Rev* 1999;57(10):306-9. [PMID: 10575906]
15. Carmel R. A focused approach to anemia. *Hosp Pract* (*Off Ed*) 1999;34(2):71-8, 81-5, 89-91. [PMID: 10047761]
16. Hash RB, Sargent MA, Katner H. Anemia secondary to combined deficiencies of iron and cobalamin. *Arch Fam Med* 1996;5(10):585-8. [PMID: 8930231]
17. Faris PM, Spence RK, Larholt KM, et al. The predictive power of baseline hemoglobin for transfusion risk in surgery patients. *Orthopedics* 1999;22(1 Suppl): S135-40. [PMID: 9927114]
18. Snow CF. Laboratory diagnosis of vitamin B_{12} and folate deficiency: a guide for the primary care physician. *Arch Intern Med* 1999;159(12):1289-98. [PMID: 10386505]
19. Czinn EA, Chediak JR. Coagulation and hemostasis. In: Salem MR, editor. *Blood Conservation in the Surgical Patient*. Baltimore: Williams & Wilkins; 1996. p. 45-78. [ISBN: 978-0-683-07531-1]

Medication Management

20. Perioperative management of medications. *Compendium of Pharmaceuticals and Specialties*. 35th ed. Ottawa: Canadian Pharmacists Association; 2000. p. L31-4. [ISBN: 0-919-11576-4]
21. Baglin T. Management of warfarin (coumarin) overdose. *Blood Reviews* 1998;12(2):91-8. [PMID: 9661797]
22. Muleo G, Santoro R, Iannaccaro PG, et al. Small doses of recombinant factor VIIa in acquired deficiencies of vitamin K dependent factors. *Blood Coagul Fibrinolysis* 1999;10(8):521-2. [PMID: 10636464]
23. Boulis NM, Bobek MP, Schmaier A, Hoff JT. Use of factor IX complex in warfarin-related intracranial hemorrhage. *Neurosurgery* 1999;45(5):1113-9. [PMID: 10549927]
24. Makris M, Greaves M, Phillips WS, et al. Emergency oral anticoagulant reversal: the relative efficacy of infusions of fresh frozen plasma and clotting factor concentrate on correction of the coagulopathy. *Thromb Haemost* 1997;77(3):477-80. [PMID: 9065997]
25. Spence RK. Management of surgical patients with special problems. In: Petz LD, Swisher SN, Kleinman S, et al, editors. *Clinical Practice of Transfusion Medicine*. 3rd ed. New York: Churchill Livingstone; 1996. p. 595-606. [ISBN: 0-443-08981-7]

Anemia Management

26. Dierdorf SF. Anesthesia for patients with rare and coexisting diseases. In: Barash PG, Cullen BF, Stoelting RK, editors. *Clinical Anesthesia*. 3rd ed. Philadelphia: Lippincott-Raven; 1996. p. 472-4. [ISBN: 978-0-397-51482-3]
27. Brugnara C, Zurakowski D, DiCanzio J, et al. Reticulocyte hemoglobin content to diagnose iron deficiency in children. *JAMA* 1999;281(23):2225-30. [PMID: 10376576]
28. Auerbach M, Winchester J, Wahab A, et al. A randomized trial of three iron dextran infusion methods for anemia in EPO-treated dialysis patients. *Am J Kidney Dis* 1998;31(1):81-6. [PMID: 9428456]
29. Auerbach M, Witt D, Toler W, et al. Clinical use of the total dose intravenous infusion of iron dextran. *J Lab Clin Med* 1988;111(5):566-70. [PMID: 3361236]
30. Mays T, Mays T. Intravenous iron-dextran therapy in the treatment of anemia occurring in surgical, gynecologic and obstetric patients. *Surg Gynecol Obstet* 1976;143(3):381-4. [PMID: 959957]
31. Swain RA, Kaplan B, Montgomery E. Iron deficiency anemia. When is parenteral therapy warranted? *Postgrad Med* 1996;100(5):181-93. [PMID: 8917332]
32. Burns DL, Mascioli EA, Bistrian BR. Parenteral iron dextran therapy: a review. *Nutrition* 1995;11(2):163-8. [PMID: 7647482]
33. Monaghan MS, Glasco G, St. John G, et al. Safe administration of iron dextran to a patient who reacted to the test dose. *South Med J* 1994;87(10):1010-2. [PMID: 7939912]
34. Hallberg L. Prevention of iron deficiency. *Baillières Clin Haematol* 1994;7(4):805-14. [PMID: 7881155]
35. Cazzola M, Mercuriali F, Brugnara C. Use of recombinant human erythropoietin outside the setting of uremia. *Blood* 1997;89(12):4248-67. [PMID: 9192747]
36. Snook NJ, O'Beirne HA, Enright S, et al. Use of recombinant human erythropoietin to facilitate liver transplantation in a Jehovah's Witness. *Br J Anaesth* 1996;76(5):740-3. [PMID: 8688281]

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

37. Mercuriali F, Inghilleri G, Biffi E, et al. Epoetin alfa in low hematocrit patients to facilitate autologous blood donation in total hip replacement: a randomized, double-blind, placebo-controlled, dose-ranging study. *Acta Haematologica* 1998;100(2):69-76. [PMID: 9792935]

38. Law EJ, Still JM, Gattis CS. The use of erythropoietin in two burned patients who are Jehovah's Witnesses. *Burns* 1991;17(1):75-7. [PMID: 2031685]

39. Goodnough LT, Marcus RE. Erythropoiesis in patients stimulated with erythropoietin: the relevance of storage iron. *Vox Sang* 1998;75(2):128-33. [PMID: 9784666]

40. Rutherford CJ, Schneider TJ, Dempsey H, et al. Efficacy of different dosing regimens for recombinant human erythropoietin in a simulated perisurgical setting: the importance of iron availability in optimizing response. *Am J Med* 1994;96(2):139-45. [PMID: 8109598]

41. Nyvad O, Danielsen H, Madsen S. Intravenous iron-sucrose complex to reduce epoetin demand in dialysis patients. *Lancet* 1994;344(8932):1305-6. [PMID: 7968018]

42. Shimpo H, Mizumoto T, Onoda K, et al. Erythropoietin in pediatric cardiac surgery: clinical efficacy and effective dose. *Chest* 1997;111(6):1565-70. [PMID: 9187175]

43. Shaddy RE, Bullock EA, Tani LY, et al. Epoetin alfa therapy in infants awaiting heart transplantation. *Arch Pediatr Adolesc Med* 1995;149(3):322-5. [PMID: 7858695]

44. Maier RF, Obladen M, Kattner E, et al. The European Multicenter rhEPO Study Group. High-versus low-dose erythropoietin in extremely low birth weight infants. *J Pediatr* 1998;132(5):866-70. [PMID: 9602202]

45. Breen CP, Macdougall IC. Correction of epoetin-resistant megaloblastic anaemia following vitamin B_{12} and folate administration. *Nephron* 1999;83(4):374-5. [PMID: 10575307]

46. Sumner AE, Chin MM, Abrahm JL, et al. Elevated methylmalonic acid and total homocysteine levels show high prevalence of vitamin B_{12} deficiency after gastric surgery. *Ann Intern Med* 1996;124(5):469-76. [PMID: 8602704]

47. Jockenhövel F, Vogel E, Reinhardt W, Reinwein D. Effects of various modes of androgen substitution therapy on erythropoiesis. *Eur J Med Res* 1997;2(7):293-8. [PMID: 9233903]

48. Andrews CM, Lane DW, Bradley JG. Iron pre-load for major joint replacement. *Transfus Med* 1997;7(4):281-6. [PMID: 9510925]

49. Macdougall IC, Tucker B, Thompson J, et al. A randomized controlled study of iron supplementation in patients treated with erythropoietin. *Kidney Int* 1996;50(5):1694-9. [PMID: 8914038]

50. Meyers MO, Heinrich S, Kline R, Levine EA. Extended hemipelvectomy in a Jehovah's Witness with erythropoietin support. *Am Surg* 1998;64(11):1074-6. [PMID: 9798772]

51. D'Ambra MN, Gray RJ, Hillman R, et al. Effect of recombinant human erythropoietin on transfusion risk in coronary bypass patients. *Ann Thorac Surg* 1997;64(6):1686-93. [PMID: 9436556]

52. Goodnough LT, Despotis GJ, Parvin CA. Erythropoietin therapy in patients undergoing cardiac operations. *Ann Thorac Surg* 1997;64(6):1579-80. [PMID: 9436537]

53. Rosenblum N, Levine MA, Handler T, Lepor H. The role of preoperative epoetin alfa in men undergoing radical retropubic prostatectomy. *J Urol* 2000;163(3):829-33. [PMID: 10687987]

54. Sowade O, Warnke H, Scigalla P, et al. Avoidance of allogeneic blood transfusions by treatment with epoetin beta (recombinant human erythropoietin) in patients undergoing open-heart surgery. *Blood* 1997;89(2):411-8. [PMID: 9002942]

55. Stowell CP, Chandler H, Jové M, et al. An open-label, randomized study to compare the safety and efficacy of perioperative epoetin alfa with preoperative autologous blood donation in total joint arthroplasty. *Orthopedics* 1999;22(1 Suppl): S105-12. [PMID: 9927110]

56. Monk TG, Goodnough LT, Brecher ME, et al. A prospective randomized comparison of three blood conservation strategies for radical prostatectomy. *Anesthesiology* 1999;91(1):24-33. [PMID: 10422925]

57. Hogue CW Jr, Goodnough LT, Monk TG. Perioperative myocardial ischemic episodes are related to hematocrit level in patients undergoing radical prostatectomy. *Transfusion* 1998;38(10):924-31. [PMID: 9767742]

58. Sowade O, Gross J, Sowade B, et al. Evaluation of oxygen availability with oxygen status algorithm in patients undergoing open heart surgery treated with epoetin beta. *J Lab Clin Med* 1997;129(1):97-105. [PMID: 9011596]

Additional Preoperative Planning

59. Nelson CL, Stewart JG. Primary and revision total hip replacement in patients who are Jehovah's Witnesses. *Clin Orthop* 1999;(369):251-61. [PMID: 10611880]

60. Ashley E. Anaesthesia for Jehovah's Witnesses. *Br J Hosp Med* 1997;58(8):375-80. [PMID: 9509037]

61. Nelson CL, Fontenot HJ, Flahiff C, Stewart J. An algorithm to optimize perioperative blood management in surgery. *Clin Orthop* 1998;(357):36-42. [PMID: 9917698]

62. Dupuis JF, Nguyen DT. Anesthetic management of the patient who refuses blood transfusions. *Int Anesthesiol Clin* 1998;36(3):117-31. [PMID: 10812420]

63. Goodnough LT. Alternatives to allogeneic transfusion in patients with surgical anemia. In: Mintz PD, editor. *Transfusion Therapy: Clinical Principles and Practice*. Bethesda (MD): AABB Press; 1999. p. 379-98. [ISBN: 1-563-95099-5]

64. Wong DH, Jenkins LC. Surgery in Jehovah's Witnesses. *Can J Anaesth* 1989;36(5):578-85. [PMID: 2639668]

65. Ereth MH, Oliver WC, Santrach PJ. Perioperative interventions to decrease transfusion of allogeneic blood products. *Mayo Clin Proc* 1994;69(6):575-86. [PMID: 8189764]

66. Dougherty JE, Gallagher RC, Hirst JA, et al. Coronary stent placement as a bridge to coronary artery bypass surgery in an unstable, anemic Jehovah's Witness patient: a case report and review of bloodless surgery techniques. *Conn Med* 1997;61(4):195-9. [PMID: 9149480]

67. Poldermans D, Boersma E, Bax JJ, et al. The effect of bisoprolol on perioperative mortality and myocardial infarction in high-risk patients undergoing vascular surgery. *N Engl J Med* 1999;341(24):1789-94. [PMID: 10588963]

Minimize Perioperative Blood Loss

68. Corwin HL, Parsonnet KC, Gettinger A. RBC transfusion in the ICU. Is there a reason? *Chest* 1995;108(3):767-71. [PMID: 7656631]

69. Dale JC, Pruett SK. Phlebotomy—a minimalist approach. *Mayo Clin Proc* 1993;68(3):249-55. [PMID: 8474266]

70. Rehmani R, Amanullah S. Analysis of blood tests in the emergency department of a tertiary care hospital. *Postgrad Med J* 1999;75(889):662-6. [PMID: 10621876]

71. Karski JM, Mathieu M, Cheng D, et al. Etiology of preoperative anemia in patients undergoing scheduled cardiac surgery. *Can J Anesth* 1999;46(10):979-82. [PMID: 10522587]

72. Silber S. Rapid hemostasis of arterial puncture sites with collagen in patients undergoing diagnostic and interventional cardiac catheterization. *Clin Cardiol* 1997;20(12):981-92. [PMID: 9422835]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

73. Cook D, Heyland D, Griffith L, et al. Risk factors for clinically important upper gastrointestinal bleeding in patients requiring mechanical ventilation. *Crit Care Med* 1999;27(12):2812-7. [PMID: 10628631]

74. MacLean LD. Prophylactic treatment of stress ulcers: first do no harm. *Can J Surg* 1988;31(2):76-7. [PMID: 3349379]

Maintain Oxygen Delivery/Volume Status

75. Wade CE, Kramer GC, Grady JJ, et al. Efficacy of hypertonic 7.5% saline and 6% dextran-70 in treating trauma: a meta-analysis of controlled clinical studies. *Surgery* 1997;122(3):609-16. [PMID: 9308620]

76. Simma B, Burger R, Falk M, et al. A prospective, randomized, and controlled study of fluid management in children with severe head injury: lactated Ringer's solution versus hypertonic saline. *Crit Care Med* 1998;26(7):1265-70. [PMID: 9671379]

77. Younes RN, Aun F, Accioly CQ, et al. Hypertonic solutions in the treatment of hypovolemic shock: a prospective, randomized study in patients admitted to the emergency room. *Surgery* 1992;111(4):380-5. [PMID: 1373007]

78. Cross JS, Gruber DP, Burchard KW, et al. Hypertonic saline fluid therapy following surgery: a prospective study. *J Trauma* 1989;29(6):817-26. [PMID: 2661843]

79. Christ F, Niklas M, Kreimeier U, et al. Hyperosmotic-hyperoncotic solutions during abdominal aortic aneurysm (AAA) resection. *Acta Anaesthesiol Scand* 1997;41(1 Pt 1):62-70. [PMID: 9061116]

80. Tølløfsrud S, Noddeland H. Hypertonic saline and dextran after coronary artery surgery mobilises fluid excess and improves cardiorespiratory functions. *Acta Anaesthesiol Scand* 1998;42(2):154-61. [PMID: 9509195]

81. Murphy JT, Horton JW, Purdue GF, Hunt JL. Cardiovascular effect of 7.5% sodium chloride-dextran infusion after thermal injury. *Arch Surg* 1999;134(10):1091-7. [PMID: 10522853]

82. Treib J, Baron JF, Grauer MT, Strauss RG. An international view of hydroxyethyl starches. *Intensive Care Med* 1999;25(3):258-68. [PMID: 10229159]

83. Kozek-Langenecker SA. Effects of hydroxyethyl starch solutions on hemostasis. *Anesthesiology* 2005;103(3):654-60. [PMID: 16129993]

84. Dung NM, Day NP, Tam DT, et al. Fluid replacement in Dengue shock syndrome: a randomized, double-blind comparison of four intravenous-fluid regimens. *Clin Infect Dis* 1999;29(4):787-94. [PMID: 10589889]

85. Edwards JD. Use of gelatins as volume expanders in shock and trauma. In: Baron JF, Treib J, editors. *Volume Replacement*. Berlin: Springer-Verlag; 1998. p. 23-46. [ISBN: 978-3-540-64187-2]

86. Evans PA, Glenn JR, Heptinstall S, Madira W. Effects of gelatin-based resuscitation fluids on platelet aggregation. *Br J Anaesth* 1998;81(2):198-202. [PMID: 9813523]

87. von Roten I, Madjdpour C, Frascarolo P, et al. Molar substitution and C2/C6 ratio of hydroxyethyl starch: influence on blood coagulation. *Br J Anaesth* 2006;96(4):455-63. [PMID: 16464978]

88. Lichtenstein A, Eckhart WF, Swanson KJ. Unplanned intraoperative and postoperative hemodilution: oxygen transport and consumption during severe anemia. *Anesthesiology* 1988;69(1):119-22. [PMID: 3389548]

89. Bundgaard-Nielsen M, Secher NH, Kehlet H. 'Liberal' vs. 'restrictive' perioperative fluid therapy—a critical assessment of the evidence. *Acta Anaesthesiol Scand* 2009;53(7):843-51. [PMID: 19519723]

90. Stern SA, Dronen SC, Wang X. Multiple resuscitation regimens in a near-fatal porcine aortic injury hemorrhage model. *Acad Emerg Med* 1995;2(2):89-97. [PMID: 7621231]

91. Riddez L, Johnson L, Hahn RG. Central and regional hemodynamics during crystalloid fluid therapy after uncontrolled intra-abdominal bleeding. *J Trauma* 1998;44(3):433-9. [PMID: 9529168]

92. Capone AC, Safar P, Stezoski W, et al. Improved outcome with fluid restriction in treatment of uncontrolled hemorrhagic shock. *J Am Coll Surg* 1995;180(1):49-56. [PMID: 8000655]

93. Krausz MM, Bashenko Y, Hirsh M. Crystalloid or colloid resuscitation of uncontrolled hemorrhagic shock after moderate splenic injury. *Shock* 2000;13(3):230-5. [PMID: 10718381]

94. Lowell JA, Schifferdecker C, Driscoll DF, et al. Postoperative fluid overload: not a benign problem. *Crit Care Med* 1990;18(7):728-33. [PMID: 2364713]

95. Shoemaker WC, Belzberg H, Wo CC, et al. Multicenter study of noninvasive monitoring systems as alternatives to invasive monitoring of acutely ill emergency patients. *Chest* 1998;114(6):1643-52. [PMID: 9872201]

96. Lisander B, Jacobsson SA, Ivarsson I, et al. Giving both enoxaparin and dextran increases the need for transfusion in revision hip arthroplasty. *Eur J Surg* 1996;162(11):861-6. [PMID: 8956954]

97. Baldassarre S, Vincent JL. Coagulopathy induced by hydroxyethyl starch. *Anesth Analg* 1997;84(2):451-3. [PMID: 9024047]

98. Ruttmann TG, James MF, Aronson I. In vivo investigation into the effects of haemodilution with hydroxyethyl starch (200/0.5) and normal saline on coagulation. *Br J Anaesth* 1998;80(5):612-6. [PMID: 9691864]

99. Fenger-Eriksen C, Anker-Møller E, Heslop J, Ingerslev J, Sørensen B. Thrombelastographic whole blood clot formation after ex vivo addition of plasma substitutes: improvements of the induced coagulopathy with fibrinogen concentrate. *Br J Anaesth* 2005;94(3):324-9. [PMID: 15608046]

100. Knutson JE, Deering JA, Hall FW, et al. Does intraoperative hetastarch administration increase blood loss and transfusion requirements after cardiac surgery? *Anesth Analg* 2000:90(4):801-7. [PMID: 10735779]

101. Treib J, Haass A, Pindur G. Coagulation disorders caused by hydroxyethyl starch. *Thromb Haemost* 1997;78(3):974-83. [PMID: 9308738]

102. Treib J, Haass A, Schimrigk K. European hydroxyethyl starch: a safe and inexpensive alternative to albumin [letter]. *Anesth Analg* 1997;85(3):709. [PMID: 9296444]

103. Stoll M, Treib J, Schenk JF, et al. No coagulation disorders under high-dose volume therapy with low-molecular-weight hydroxyethyl starch. *Haemostasis* 1997;27(5):251-8. [PMID: 9690484]

104. Treib J, Grauer MT, Haass A. Efficacy of Plasma Substitutes for Volume Therapy. In: Treib J, editor. *Volume Therapy*. Berlin: Springer-Verlag; 2000. p. 78-122. [ISBN: 978-3-642-59621-6]

105. Conroy JM, Fishman RL, Reeves ST, et al. The effects of desmopressin and 6% hydroxyethyl starch on factor VIII:C. *Anesth Analg* 1996;83(4):804-7. [PMID: 8831325]

106. Lazarchick J, Conroy JM. The effect of 6% hydroxyethyl starch and desmopressin infusion on von Willebrand factor: ristocetin cofactor activity. *Ann Clin Lab Sci* 1995;25(4):306-9. [PMID: 7545380]

107. Flordal PA, Svensson J, Ljungström KG. Effects of desmopressin and dextran on coagulation and fibrinolysis in healthy volunteers. *Thromb Res* 1991;62(5):355-64. [PMID: 1716790]

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

108. Flordal PA, Ljungström KG, Svensson J, et al. Effects on coagulation and fibrinolysis of desmopressin in patients undergoing total hip replacement. *Thromb Haemost* 1991;66(6):652-6. [PMID: 1796409]

109. Waterbury L. Anemia: introduction and approach to diagnosis. In: *Hematology for the House Officer*. 3rd ed. Baltimore: Williams & Wilkins; 1988. p. 1-8. [ISBN: 0-683-08853-X]

110. Chaney MA, Aasen MK. Severe acute normovolemic hemodilution and survival [letter]. *Anesth Analg* 1993;76(6):1371-2. [PMID: 8498684]

111. Akça O, Podolsky A, Eisenhuber E, et al. Comparable postoperative pulmonary atelectasis in patients given 30% or 80% oxygen during and 2 hours after colon resection. *Anesthesiology* 1999;91(4):991-8. [PMID: 10519502]

112. Tinits P. Oxygen therapy and oxygen toxicity. *Ann Emerg Med* 1983;12(5):321-8. [PMID: 6414343]

113. Leach RM, Bateman NT. Acute oxygen therapy. *Br J Hosp Med* 1993;49(9):637-44. [PMID: 8508257]

114. Slutsky AS. Lung injury caused by mechanical ventilation. *Chest* 1999;116(1 Suppl):9S-15S. [PMID: 10424561]

115. Mure M, Martling CR, Lindahl SGE. Dramatic effect on oxygenation in patients with severe acute lung insufficiency treated in the prone position. *Crit Care Med* 1997;25(9):1539-44. [PMID: 9295829]

116. Germann P, Pöschl G, Leitner C, et al. Additive effect of nitric oxide inhalation on the oxygenation benefit of the prone position in the adult respiratory distress syndrome. *Anesthesiology* 1998;89(6):1401-6. [PMID: 9856714]

117. McLoughlin PL, Cope TM, Harrison JC. Hyperbaric oxygen therapy in the management of severe acute anaemia in a Jehovah's Witness. *Anaesthesia* 1999;54(9):891-5. [PMID: 10460565]

118. Cope T, Harrison J. The use of hyperbaric oxygen in the management of severe anaemia in a Jehovah's Witness [letter]. *Anaesthesia* 2000;55(3):293-4. [PMID: 10744564]

119. Tibbles PM, Edelsberg JS. Hyperbaric-oxygen therapy. *N Engl J Med* 1996;334(25):1642-8. [PMID: 8628361]

120. Hart GB, Lennon PA, Strauss MB. Hyperbaric oxygen in exceptional acute blood-loss anemia. *J Hyperbaric Med* 1987;2(4):205-10. [ISSN: 0884-1225]

121. Plafki C, Peters P, Almeling M, et al. Complications and side effects of hyperbaric oxygen therapy. *Aviat Space Environ Med* 2000;71(2):119-24. [PMID: 10685584]

122. Camporesi EM. Hyperbaric oxygen therapy: applications in the trauma patient. *Anesthesiol Clin North Am* 1999;17(1):311-23. [EMBASE: 1999111558]

Intraoperative Blood Conservation/ Autologous Blood Management

123. Schmied H, Schiferer A, Sessler DI, Meznik C. The effects of red-cell scavenging, hemodilution, and active warming on allogenic blood requirements in patients undergoing hip or knee arthroplasty. *Anesth Analg* 1998;86(2):387-91. [PMID: 9459254]

124. Oishi CS, D'Lima DD, Morris BA, et al. Hemodilution with other blood reinfusion techniques in total hip arthroplasty. *Clin Orthop* 1997;(339):132-9. [PMID: 9186211]

125. Pivalizza EG, Tjia IM, Juneja HS, et al. Elective splenectomy in an anemic Jehovah's Witness patient with cirrhosis. *Anesth Analg* 1998;87(3):529-30. [PMID: 9728821]

126. Helm RE, Rosengart TK, Gomez M, et al. Comprehensive multimodality blood conservation: 100 consecutive CABG operations without transfusion. *Ann Thorac Surg* 1998;65(1):125-36. [PMID: 9456106]

127. Estioko MR, Litwak RS, Rand JH. Reoperation, emergency and urgent open cardiac surgery in Jehovah's Witnesses. *Chest* 1992;102(1):50-3. [PMID: 1623795]

128. Øvrum E, Åm Holen E, Tangen G. Consistent non-pharmacologic blood conservation in primary and reoperative coronary artery bypass grafting. *Eur J Cardiothorac Surg* 1995;9(1):30-5. [PMID: 7727143]

129. Polley JW, Berkowitz RA, McDonald TB, et al. Craniomaxillofacial surgery in the Jehovah's Witness patient. *Plast Reconstr Surg* 1994;93(6):1258-63. [PMID: 8171147]

130. Shander A, Perelman S. Acute normovolemic hemodilution and cell salvage as symbiotic strategies to avoid allogeneic transfusions in aortic surgery [abstract]. *Br J Anaesth* 1999;82(Suppl 1):81. [ISI: 211KG]

131. Levack ID, Gillon J. Intraoperative conservation of red cell mass: controlled hypotension or haemodilution—not necessarily mutually exclusive? [editorial] *Br J Anaesth* 1999;82(2):161-3. [PMID: 10364985]

132. Cutler BS. Avoidance of homologous transfusion in aortic operations: the role of autotransfusion, hemodilution, and surgical technique. *Surgery* 1984;95(6):717-23. [PMID: 6427961]

133. Krieger KH, Isom OW, editors. *Blood Conservation in Cardiac Surgery*. New York: Springer-Verlag; 1998. [ISBN: 0-387-94908-9]

Surgical Techniques and Devices

134. Torzilli G, Makuuchi M, Inoue K, et al. No-mortality liver resection for hepatocellular carcinoma in cirrhotic and noncirrhotic patients: is there a way? A prospective analysis of our approach. *Arch Surg* 1999;134(9):984-92. [PMID: 10487594]

135. Atabek U, Spence RK, Pello M, et al. Pancreaticoduodenectomy without homologous blood transfusion in an anemic Jehovah's Witness. *Arch Surg* 1992;127(3):349-51. [PMID: 1347993]

136. Miyaji K, Hannan RL, Ojito JW, et al. The Ross operation in a Jehovah's Witness: a paradigm for heart surgery in children without transfusion. *Ann Thorac Surg* 2000;69(3):935-7. [PMID: 10750791]

137. Viñuela F, Canalis RF, Hartz RS, et al. Surgical hemostasis and blood conservation. In: Salem MR, editor. *Blood Conservation in the Surgical Patient*. Baltimore: Williams & Wilkins; 1996. p. 386-424. [ISBN: 978-0-683-07531-1]

138. Shah DM, Chang BB, Paty PS, et al. Treatment of abdominal aortic aneurysm by exclusion and bypass: an analysis of outcome. *J Vasc Surg* 1991;13(1):15-20. [PMID: 1987386]

139. Crawford ED. Radical retropubic prostatectomy: the anatomic antegrade approach. In: Crawford ED, Das S. *Current Genitourinary Cancer Surgery*. 2nd ed. Baltimore: Williams & Wilkins; 1997. p. 240-57. [ISBN: 978-0-683-02185-1]

140. Singer AJ, Starr A, Schlossberg IR. Suture ligation of the dorsal vein complex during radical retropubic prostatectomy. *Infect Urol* 1999;12(3):77-8, 83. [ISI: 206XX]

141. Hochberg J, Murray GF. Principles of operative surgery: antisepsis, technique, sutures, and drains. In: Sabiston DC Jr, editor. *Textbook of Surgery: The Biological Basis of Modern Surgical Practice*. 15th ed. Philadelphia: WB Saunders; 1997. p. 253-63. [ISBN: 978-0-721-65887-2]

142. Edgerton MT. *The Art of Surgical Technique*. Baltimore: Williams & Wilkins; 1988. [ISBN: 978-0-683-02750-1]

143. Lemos MJ, Healy WL. Blood transfusion in orthopaedic operations. *J Bone Joint Surg* 1996;78-A(8):1260-70. [PMID: 8753721]

144. Spence RK, Cernaianu AC, Carson J, DelRossi AJ. Transfusion and surgery. *Curr Probl Surg* 1993;30(12):1101-80. [PMID: 8261799]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

145. Sweeney MS, Young DJ, Frazier OH, et al. Traumatic aortic transections: eight-year experience with the "clamp-sew" technique. *Ann Thorac Surg* 1997;64(2):384-7. [PMID: 9262580]

146. Ngo GH, Pham VB, Nguyen NT. Haemostasis prior to retropubic prostatectomy by temporary clamping of the genitovesical arteries. [French] *Prog Urol* 1997;7(1):126-7. [PMID: 9116730]

147. Yokota T, Iwamoto K, Kunii Y, Yamauchi H. Malignant fibrous histiocytoma: a method to control intraoperative hemorrhage by clamping the feeding arteries. *Upsala J Med Sci* 1999;104(3):231-6. [PMID: 10680956]

148. Malassagne B, Cherqui D, Alon R, et al. Safety of selective vascular clamping for major hepatectomies. *J Am Coll Surg* 1998;187(5):482-6. [PMID: 9809563]

149. Ishiwata Y, Inomori S, Fujitsu K, et al. A new intracranial silastic encircling clip for hemostasis. *J Neurosurg* 1990;73(4):638-9. [PMID: 2398397]

150. Selikowitz SM, Curtis MR. Hemostatic control with flexible compression tape used during partial nephrectomy and organ salvage. *J Urol* 1999;162(2):458-9. [PMID: 10411056]

151. Timmons MC, Kohler MF, Addison WA. Thumbtack use for control of presacral bleeding, with description of an instrument for thumbtack application. *Obstet Gynecol* 1991;78(2):313-5. [PMID: 2067780]

152. So SK, Monge H, Esquivel CO. Major hepatic resection without blood transfusion: experience with total vascular exclusion. *J Gastroenterol Hepatol* 1999;14(Suppl):S28-31. [PMID: 10382635]

153. Cherqui D, Malassagne B, Colau PI, et al. Hepatic vascular exclusion with preservation of the caval flow for liver resections. *Ann Surg* 1999;230(1):24-30. [PMID: 10400032]

154. Arnoletti JP, Brodsky J. Reduction of transfusion requirements during major hepatic resection for metastatic disease. *Surgery* 1999;125(2):166-71. [PMID: 10026750]

155. Man K, Fan ST, Ng IO, et al. Prospective evaluation of Pringle maneuver in hepatectomy for liver tumors by a randomized study. *Ann Surg* 1997;226(6):704-11. [PMID: 9409569]

156. Terblanche J, Krige JE, Bornman PC. Simplified hepatic resection with the use of prolonged vascular inflow occlusion. *Arch Surg* 1991;126(3):298-301. [PMID: 1998469]

157. Seu P, Neelankanta G, Csete M, et al. Liver transplantation for fulminant hepatic failure in a Jehovah's Witness. *Clin Transplant* 1996;10(5):404-7. [PMID: 8930452]

158. Lee TC, Yang LC, Chen HJ. Effect of patient position and hypotensive anesthesia on inferior vena caval pressure. *Spine* 1998;23(8):941-7. [PMID: 9580963]

159. Schneeberger AG, Schulz RF, Ganz R. Blood loss in total hip arthroplasty. Lateral position combined with preservation of the capsule versus supine position combined with capsulectomy. *Arch Orthop Trauma Surg* 1998;117(1-2):47-9. [PMID: 9457336]

160. Snyder SO Jr. The pneumatic tourniquet: a useful adjunct in lower extremity distal bypass. *Semin Vasc Surg* 1997;10(1):31-3. [PMID: 9068074]

161. Mathru M, Dries DJ, Barnes L, et al. Tourniquet-induced exsanguination in patients requiring lower limb surgery. An ischemia-reperfusion model of oxidant and antioxidant metabolism. *Anesthesiology* 1996;84(1):14-22. [PMID: 8572327]

162. Brodsky JW, Dickson JH, Erwin WD, et al. Hypotensive anesthesia for scoliosis surgery in Jehovah's Witnesses. *Spine* 1991;16(3):304-6. [PMID: 2028301]

163. Flordal PA, Neander G. Blood loss in total hip replacement. A retrospective study. *Arch Orthop Trauma Surg* 1991;111(1):34-8. [PMID: 1772723]

164. Nelson CL, Fontenot HJ. Ten strategies to reduce blood loss in orthopedic surgery. *Am J Surg* 1995;170(6A Suppl):64S-68S. [PMID: 8546251]

165. Safi HJ, Miller CC 3rd, Iliopoulos DC, et al. Staged repair of extensive aortic aneurysm: improved neurologic outcome. *Ann Surg* 1997;226(5):599-605. [PMID: 9389393]

166. Kantrowitz AB, Spallone A, Taylor W, et al. Erythropoietin-augmented isovolemic hemodilution in skull-base surgery. *J Neurosurg* 1994;80(4):740-4. [PMID: 8151356]

167. Bowen JR, Angus PD, Huxster RR, MacEwen GD. Posterior spinal fusion without blood replacement in Jehovah's Witnesses. *Clin Orthop* 1985;4(198):284-8. [PMID: 4028561]

168. Genden EM, Haughey BH. Head and neck surgery in the Jehovah's Witness patient. *Otolaryngol Head Neck Surg* 1996;114(4):669-72. [PMID: 8643286]

169. Eton D, Terramani TT, Katz M. Staged thoracic and abdominal aortic aneurysm repair using stent graft technology and surgery in a patient with acute renal failure. *Ann Vasc Surg* 2000;14(2):114-7. [PMID: 10742424]

170. Hirshberg A, Mattox KL. Planned reoperation for severe trauma. *Ann Surg* 1995;222(1):3-8. [PMID: 7618965]

171. Takayama T, Makuuchi M, Kosuge T, et al. Preoperative portal embolization. *Ann Ital Chir* 1997;68(6):745-50. [PMID: 9646534]

172. Takada T, Ammori BJ, Yoshida M, et al. Combined preoperative embolization of the right portal vein and hepatic artery for hepatic resection in a high-risk patient. *Am J Roentgenol* 1999;173(1):165-7. [PMID: 10397120]

173. Detry O, Honoré P, Delwaide J, et al. Liver transplantation in a Jehovah's Witness [letter]. *Lancet* 1999;353(9165):1680. [PMID: 10335797]

174. Hess T, Kramann B, Schmidt E, Rupp S. Use of preoperative vascular embolisation in spinal metastasis resection. *Arch Orthop Trauma Surg* 1997;116(5):279-82. [PMID: 9177804]

175. Shi HB, Suh DC, Lee HK, et al. Preoperative transarterial embolization of spinal tumor: embolization techniques and results. *Am J Neuroradiol* 1999;20(10):2009-15. [PMID: 10588136]

176. Mitty HA, Sterling KM, Alvarez M, Gendler R. Obstetric hemorrhage: prophylactic and emergency arterial catheterization and embolotherapy. *Radiology* 1993;188(1):183-7. [PMID: 8511294]

177. Hiatt JR, Gomes AS, Machleder HI. Massive splenomegaly. Superior results with a combined endovascular and operative approach. *Arch Surg* 1990;125(10):1363-7. [PMID: 2222177]

178. Salai M, Garniek A, Rubinstein Z, et al. Preoperative angiography and embolization of large pelvic tumors. *J Surg Oncol* 1999;70(1):41-4. [PMID: 9989419]

179. Morandi U, Stefani A, De Santis M, et al. Preoperative embolization in surgical treatment of mediastinal hemangiopericytoma. *Ann Thorac Surg* 2000;69(3):937-9. [PMID: 10750792]

180. Jaramillo JL, Carmona C, Gálvez C, et al. Efficacy of the heater probe in peptic ulcer with a non-bleeding visible vessel. A controlled, randomised study. *Gut* 1993;34(11):1502-6. [PMID: 8244132]

181. Sajjadian A, Isaacson G. Electrosurgery in the head and neck. *Ann Otol Rhinol Laryngol* 1998;107(3):254-61. [PMID: 9525249]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

182. Hoenig DM, Chrostek CA, Amaral JF. Laparosonic coagulating shears: alternative method of hemostatic control of unsupported tissue. *J Endourol* 1996;10(5):431-3. [PMID: 8905489]

183. Epstein MR, Mayer JE Jr, Duncan BW. Use of an ultrasonic scalpel as an alternative to electrocautery in patients with pacemakers. *Ann Thorac Surg* 1998;65(6):1802-4. [PMID: 9647117]

184. Gombotz H, Metzler H, List WF. Methods for reduction of perioperative bleeding. *Br J Anaesth* 1998;81 Suppl 1: 62-6. [PMID: 10318991]

185. Ross JH, Kay R, Alexander F. Management of bilateral Wilms' tumors in the daughter of Jehovah's Witnesses. *J Pediatr Surg* 1997;32(12):1759-60. [PMID: 9434021]

186. Idowu O. Hayes-Jordan A. Partial splenectomy in children under 4 years of age with hemoglobinopathy. *J Pediatr Surg* 1998;33(8):1251-3. [PMID: 9721997]

187. Rees M, Plant G, Wells J, Bygrave S. One hundred fifty hepatic resections: evolution of technique towards bloodless surgery. *Br J Surg* 1996;83(11):1526-9. [PMID: 9014666]

188. Cipolletta L, Bianco MA, Rotondano G, et al. Prospective comparison of argon plasma coagulator and heater probe in the endoscopic treatment of major peptic ulcer bleeding. *Gastrointest Endosc* 1998;48(2):191-5. [PMID: 9717787]

189. McGovern FJ, Wood BJ, Goldberg SN, Mueller PR. Radio frequency ablation of renal cell carcinoma via image guided needle electrodes. *J Urol* 1999;161(2):599-600. [PMID: 9915457]

190. Zlotta AR, Djavan B, Matos C, et al. Percutaneous transperineal radiofrequency ablation of prostate tumour: safety, feasibility and pathological effects on human prostate cancer. *Br J Urol* 1998;81(2):265-75. [PMID: 9488071]

191. Curley SA, Izzo F, Delrio P, et al. Radiofrequency ablation of unresectable primary and metastatic hepatic malignancies. *Ann Surg* 1999;230(1):1-8. [PMID: 10400029]

192. Rau HG, Meyer G, Cohnert TU, et al. Laparoscopic liver resection with the water-jet dissector. *Surg Endosc* 1995;9(9):1009-12. [PMID: 7482205]

193. Shekarriz B, Shekarriz H, Upadhyay J, et al. Hydro-jet dissection for laparoscopic nephrectomy: a new technique. *Urology* 1999;54(6):964-7. [PMID: 10604690]

194. Piek J, Wille C, Warzok R, Gaab MR. Waterjet dissection of the brain: experimental and first clinical results. *J Neurosurg* 1998;89(5):861-4. [PMID: 9817429]

195. Amar D, Fogel DH, Shah JP. The Shaw Hemostatic Scalpel as an alternative to electrocautery in patients with pacemakers [letter]. *Anesthesiology* 1996;85(1):223. [PMID: 8694374]

196. Naito S, Nakashima M, Kimoto Y, et al. Application of microwave tissue coagulator in partial nephrectomy for renal cell carcinoma. *J Urol* 1998;159(3):960-2. [PMID: 9474192]

197. Shibata T, Murakami T, Ogata N. Percutaneous microwave coagulation therapy for patients with primary and metastatic hepatic tumors during interruption of hepatic blood flow. *Cancer* 2000;88(2):302-11. [PMID: 10640961]

198. Wyman A, Rogers K. Randomized trial of laser scalpel for modified radical mastectomy. *Br J Surg* 1993;80(7):871-3. [PMID: 8155115]

199. Cornford PA, Biyani CS, Brough SJ, Powell CS. Daycase transurethral incision of the prostate using the holmium: YAG laser: initial experience. *Br J Urol* 1997;79(3):383-4. [PMID: 9117218]

200. Ferzli GS, Hurwitz JB, Fiorillo MA, et al. Laparoscopic splenectomy in a Jehovah's Witness with profound anemia. *Surg Endosc* 1997;11(8):850-1. [PMID: 9266651]

201. Laine L, Stein C, Sharma V. Randomized comparison of ligation versus ligation plus sclerotherapy in patients with bleeding esophageal varices. *Gastroenterology* 1996;110(2):529-33. [PMID: 8566601]

202. O'Reilly MJ, Saye WB, Mullins SG, et al. Technique of hand-assisted laparoscopic surgery. *J Laparoendosc Surg* 1996;6(4):239-44. [PMID: 8877742]

203. Caprotti R, Porta G, Franciosi C, et al. Laparoscopic splenectomy for hematological disorders. Our experience in adult and pediatric patients. *Int Surg* 1998;83(4):303-7. [PMID: 10096747]

204. Kerbl K, Clayman RV. Acute hemostasis during laparoscopic procedures: method for intraoperative application of hemostatic material. *J Urol* 1994;151(1):109-10. [PMID: 8254784]

205. White RA, Donayre CE, Walot I, et al. Preliminary clinical outcome and imaging criterion for endovascular prosthesis development in high-risk patients who have aortoiliac and traumatic arterial lesions. *J Vasc Surg* 1996;24(4):556-71. [PMID: 8911404]

206. Simionato F, Righi C, Silvani P, et al. Emergency endovascular treatment of a life-threatening hemorrhage from traumatic rupture of the left extracranial vertebral artery. *Intensive Care Med* 1999;25(10):1177-9. [PMID: 10551980]

207. Morrissey DD, Andersen PE, Nesbit GM, et al. Endovascular management of hemorrhage in patients with head and neck cancer. *Arch Otolaryngol Head Neck Surg* 1997;123(1):15-9. [PMID: 9006498]

208. Pergolizzi JV Jr, Auster M, Conaway GL, Sardi A. Cryosurgery for unresectable primary hepatocellular carcinoma: a case report and review of literature. *Am Surg* 1999;65(5):402-5. [PMID: 10231204]

209. Lee F, Bahn DK, Badalament RA, et al. Cryosurgery for prostate cancer: improved glandular ablation by use of 6 to 8 cryoprobes. *Urology* 1999;54(1):135-40. [PMID: 10414740]

210. Saliken JC, Donnelly BJ, Brasher P, et al. Outcome and safety of transrectal US-guided percutaneous cryotherapy for localized prostate cancer. *J Vasc Interv Radiol* 1999;10(2 Pt 1):199-208. [PMID: 10082109]

211. Kondziolka D, Lunsford LD, McLaughlin MR, Flickinger JC. Long-term outcomes after radiosurgery for acoustic neuromas. *N Engl J Med* 1998;339(20):1426-33. [PMID: 9811917]

212. Fraass BA, Kessler ML, McShan DL, et al. Optimization and clinical use of multisegment intensity-modulated radiation therapy for high-dose conformal therapy. *Semin Radiat Oncol* 1999;9(1):60-77. [PMID: 10196399]

213. Ragde H, Elgamal AA, Snow PB, et al. Ten-year disease free survival after transperineal sonography-guided iodine-125 brachytherapy with or without 45-gray external beam irradiation in the treatment of patients with clinically localized, low to high Gleason grade prostate carcinoma. *Cancer* 1998;83(5):989-1001. [PMID: 9731904]

Pharmacological Enhancement of Hemostasis

214. Verstraete M. Haemostatic drugs. In: Bloom AL, Forbes CD, Thomas DP, Tuddenham EGD, editors. *Haemostasis and Thrombosis*. 3rd ed. Edinburgh: Churchill Livingstone; 1994. p. 1057-73. [ISBN: 978-0-443-04521-9]

215. Green D, Wong CA, Twardowski P. Efficacy of hemostatic agents in improving surgical hemostasis. *Transfus Med Rev* 1996;10(3):171-82. [PMID: 8809968]

216. Dunn CJ, Goa KL. Tranexamic acid: a review of its use in surgery and other indications. *Drugs* 1999;57(6):1005-32. [PMID: 10400410]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

217. Zohar E, Fredman B, Ellis M, et al. A comparative study of the postoperative allogeneic blood-sparing effect of tranexamic acid versus acute normovolemic hemodilution after total knee replacement. *Anesth Analg* 1999;89(6):1382-7. [PMID: 10589612]

218. Boylan JF, Klinck JR, Sandler AN, et al. Tranexamic acid reduces blood loss, transfusion requirements, and coagulation factor use in primary orthotopic liver transplantation. *Anesthesiology* 1996;85(5):1043-8. [PMID: 8916821]

219. Hiippala ST, Strid LJ, Wennerstrand MI, et al. Tranexamic acid radically decreases blood loss and transfusions associated with total knee arthroplasty. *Anesth Analg* 1997;84(4):839-44. [PMID: 9085968]

220. Karski JM, Teasdale SJ, Norman P, et al. Prevention of bleeding after cardiopulmonary bypass with high-dose tranexamic acid. *J Thorac Cardiovasc Surg* 1995;110(3):835-42. [PMID: 7564453]

221. Brown RS, Thwaites BK, Mongan PD. Tranexamic acid is effective in decreasing postoperative bleeding and transfusions in primary coronary artery bypass operations: a double-blind, randomized, placebo-controlled trial. *Anesth Analg* 1997;85(5):963-70. [PMID: 9356085]

222. Isacson S. Tranexamic acid in acute upper gastrointestinal bleeding. *Scand J Gastroenterol* 1987;22 (Suppl 137):64-6. [PMID: 3321407]

223. Barer D. Drug treatment for acute upper gastrointestinal bleeding [letter]. *BMJ* 1992;304(6823):383. [PMID: 1540747]

224. Levy JH, Pifarre R, Schaff HV, et al. A multicenter, double-blind, placebo-controlled trial of aprotinin for reducing blood loss and the requirement for donor-blood transfusion in patients undergoing repeat coronary artery bypass grafting. *Circulation* 1995;92(8):2236-44. [PMID: 7554207]

225. Penkoske PA, Entwistle LM, Marchak E, et al. Aprotinin in children undergoing repair of congenital heart defects. *Ann Thorac Surg* 1995;60(6 Suppl):S529-32. [PMID: 8604927]

226. Peters DC, Noble S. Aprotinin: an update of its pharmacology and therapeutic use in open heart surgery and coronary artery bypass surgery. *Drugs* 1999;57(2):233-60. [PMID: 10188764]

227. Murkin JM, Shannon NA, Bourne RB, et al. Aprotinin decreases blood loss in patients undergoing revision or bilateral total hip arthroplasty. *Anesth Analg* 1995;80(2):343-8. [PMID: 7529467]

228. Porte RJ, Molenaar IQ, Begliomini B, et al. Aprotinin and transfusion requirements in orthotopic liver transplantation: a multicentre randomised double-blind study. *Lancet* 2000;355(9212):1303-9. [PMID: 10776742]

229. Lentschener C, Benhamou D, Mercier FJ, et al. Aprotinin reduces blood loss in patients undergoing elective liver resection. *Anesth Analg* 1997;84(4):875-81. [PMID: 9085974]

230. Lentschener C, Cottin P, Bouaziz H, et al. Reduction of blood loss and transfusion requirement by aprotinin in posterior lumbar spine fusion. *Anesth Analg* 1999;89(3):590-7. [PMID: 10475286]

231. Kesten S, de Hoyas A, Chaparro C, et al. Aprotinin reduces blood loss in lung transplant recipients. *Ann Thorac Surg* 1995;59(4):877-9. [PMID: 7535041]

232. Llau JV, Garciá-Pérez ML. Increased safety in the administration of aprotinin: need for a test-dose [letter]. *Anesth Analg* 2000;90(3):770-1. [PMID: 10702481]

233. Royston D. Blood-sparing drugs: aprotinin, tranexamic acid, and epsilon-aminocaproic acid. *Int Anesthesiol Clin* 1995;33(1):155-79. [PMID: 7543455]

234. Garner WL, Thomson PD, Moore NP, et al. Effect of triglycyl-lysine-vasopressin on skin blood flow and blood loss during wound excision in patients with burns. *J Burn Care Rehab* 1993;14(4):458-60. [PMID: 8408173]

235. Onarheim H, Aanderud L, Røttingen JT. Triglycyl-lysine-vasopressin for reduction of blood loss during wound excision in patients with burns [letter]. *J Burn Care Rehabil* 1994;15(4):392. [PMID: 7929525]

236. Frenette L, Cox J, McArdle P, et al. Conjugated estrogen reduces transfusion and coagulation factor requirements in orthotopic liver transplantation. *Anesth Analg* 1998;86(6):1183-6. [PMID: 9620500]

237. Heunisch C, Resnick DJ, Vitello JM, Martin SJ. Conjugated estrogens for the management of gastrointestinal bleeding secondary to uremia of acute renal failure. *Pharmacotherapy* 1998;18(1):210-7. [PMID: 9469696]

238. van Cutsem E, Rutgeerts P, Vantrappen G. Treatment of bleeding gastrointestinal vascular malformations with oestrogen-progesterone. *Lancet* 1990;335(8695):953-5. [PMID: 1970032]

239. Imperiale TF, Birgisson S. Somatostatin or octreotide compared with H_2 antagonists and placebo in the management of acute nonvariceal upper gastrointestinal hemorrhage: a meta-analysis. *Ann Intern Med* 1997;127(12):1062-71. [PMID: 9412308]

240. Jenkins SA. Drug therapy for non-variceal upper gastrointestinal bleeding. Assessment of options. *Digestion* 1999;60 Suppl 3: 39-49. [PMID: 10567788]

241. Chen HM, Jan YY, Chen MF. Intra-arterial infusion of octreotide to stop gastrointestinal tract bleeding that is difficult to manage surgically: a case report. *Hepatogastroenterology* 1998;45(19):128-32. [PMID: 9496501]

242. Kallis P, Tooze JA, Talbot S, et al. Aprotinin inhibits fibrinolysis, improves platelet adhesion and reduces blood loss. *Eur J Cardiothorac Surg* 1994;8(6):315-23. [PMID: 7522018]

243. Bidstrup BP, Hunt BJ, Sheikh S, et al. Amelioration of the bleeding tendency of preoperative aspirin after aortocoronary bypass grafting. *Ann Thorac Surg* 2000;69(2):541-7. [PMID: 10735695]

244. Klein M, Keith PR, Dauben HP, et al. Aprotinin counterbalances an increased risk of peri-operative hemorrhage in CABG patients pre-treated with Aspirin. *Eur J Cardiothorac Surg* 1998;14(4):360-6. [PMID: 9845139]

245. Murkin JM, Lux J, Shannon NA, et al. Aprotinin significantly decreases bleeding and transfusion requirements in patients receiving aspirin and undergoing cardiac operations. *J Thorac Cardiovasc Surg* 1994;107(2):554-61. [PMID: 7508071]

246. Lethagen S. Desmopressin—a haemostatic drug: state-of-the-art review. *Eur J Anaesthesiol* 1997;14 Suppl:1-9. [PMID: 9088828]

247. Flordal PA. Use of desmopressin to prevent bleeding in surgery. *Eur J Surg* 1998;164(1):5-11. [PMID: 9537702]

248. Cattaneo M, Harris AS, Strömberg U, Mannucci PM. The effect of desmopressin on reducing blood loss in cardiac surgery—a meta-analysis of double-blind, placebo-controlled trials. *Thromb Haemost* 1995;74(4):1064-70. [PMID: 8560415]

249. Letts M, Pang E, D'Astous J, et al. The influence of desmopressin on blood loss during spinal fusion surgery in neuromuscular patients. *Spine* 1998;23(4):475-8. [PMID: 9516704]

250. Waldenström E, Holmberg L, Axelsson U, et al. Bernard-Soulier syndrome in two Swedish families: effect of DDAVP on bleeding time. *Eur J Haematol* 1991;46(3):182-7. [PMID: 1901273]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

251. Castaman G, Di Bona E, Schiavotto C, et al. Pilot study on the safety and efficacy of desmopressin for the treatment or prevention of bleeding in patients with hematologic malignancies. *Haematologica* 1997;82(5):584-7. [PMID: 9407726]

252. Jobes DR, Ellison N. Pharmacology of hemostasis in the surgical patient. *Anesth Analg* 1992;75(3):317-8. [PMID: 1510250]

253. Flordal PA. Pharmacological prophylaxis of bleeding in surgical patients treated with aspirin. *Eur J Anaesthesiol* 1997;14 Suppl:38-41. [PMID: 9088834]

254. Sheridan DP, Card RT, Pinilla JC, et al. Use of desmopressin acetate to reduce blood transfusion requirements during cardiac surgery in patients with acetylsalicylic-acid-induced platelet dysfunction. *Can J Surg* 1994;37(1):33-6. [PMID: 8306217]

255. Johnson RG, Murphy JM. The role of desmopressin in reducing blood loss during lumbar fusions. *Surg Gynecol Obstet* 1990;171(3):223-6. [PMID: 2385815]

256. Despotis GJ, Levine V, Saleem R, et al. Use of point-of-care test in identification of patients who can benefit from desmopressin during cardiac surgery: a randomised controlled trial. *Lancet* 1999;354(9173):106-10. [PMID: 10408485]

257. Kobrinsky NL, Letts RM, Patel LR, et al. 1-Desamino-8-D-arginine vasopressin (desmopressin) decreases operative blood loss in patients having Harrington rod spinal fusion surgery. A randomized, double-blinded, controlled trial. *Ann Intern Med* 1987;107(4):446-50. [PMID: 3631784]

258. Jy W, Horstman LL, Park H, et al. Platelet aggregates as markers of platelet activation: characterization of flow cytometric method suitable for clinical applications. *Am J Hematol* 1998;57(1):33-42. [PMID: 9423814]

259. Mannucci PM. Desmopressin (DDAVP) in the treatment of bleeding disorders: the first 20 years. *Blood* 1997;90(7):2515-21. [PMID: 9326215]

260. Desmopressin acetate product monograph. *Compendium of Pharmaceuticals and Specialties*. 35th ed. Ottawa: Canadian Pharmacists Association; 2000. p. 427-9. [ISBN: 0-919-11576-4]

261. Chakraverty R, Davidson S, Peggs K, et al. The incidence and cause of coagulopathies in an intensive care population. *Br J Haematol* 1996;93(2):460-3. [PMID: 8639449]

262. Alperin JB. Coagulopathy caused by vitamin K deficiency in critically ill, hospitalized patients. *JAMA* 1987;258(14):1916-9. [PMID: 3656602]

263. Prasad GVR, Abidi SM, McCauley J, Johnston JR. Vitamin K deficiency with hemorrhage after kidney and combined kidney-pancreas transplantation. *Am J Kidney Dis* 1999;33(5):963-5. [PMID: 10213656]

264. Ingerslev J, Sneppen O, Hvid I, et al. Treatment of acute bleeding episodes with rFVIIa. *Vox Sang* 1999; 77 Suppl 1:42-6. [PMID: 10529687]

265. Roberts HR. Clinical experience with activated factor VII: focus on safety aspects. *Blood Coagul Fibrinolysis* 1998;9(Suppl 1):S115-8. [PMID: 9819041]

266. Liebman HA, Chediak J, Fink KI, et al. Activated recombinant human coagulation factor VII (rFVIIa) therapy for abdominal bleeding in patients with inhibitory antibodies to factor VIII. *Am J Hematol* 2000;63(3):109-13. [PMID: 10679799]

267. Schmidt ML, Gamerman S, Smith HE, et al. Recombinant activated factor VII (rFVIIa) therapy for intracranial hemorrhage in hemophilia A patients with inhibitors. *Am J Hematol* 1994;47(1):36-40. [PMID: 8042614]

268. Lusher JM. Recombinant factor VIIa (NovoSeven®) in the treatment of internal bleeding in patients with factor VIII and IX inhibitors. *Haemostasis* 1996;26(Suppl 1):124-30. [PMID: 8904186]

269. Majumdar G, Savidge GF. Recombinant factor VIIa for intracranial haemorrhage in a Jehovah's Witness with severe haemophilia A and factor VIII inhibitors. *Blood Coagul Fibrinolysis* 1993;4(6):1031-3. [PMID: 8148476]

270. Mariani G, Testa MG, Di Paolantonio T, et al. Use of recombinant, activated factor VII in the treatment of congenital factor VII deficiencies. *Vox Sang* 1999;77(3):131-6. [PMID: 10545848]

271. Peters M, Heijboer H. Treatment of a patient with Bernard-Soulier syndrome and recurrent nosebleeds with recombinant factor VIIa [letter]. *Thromb Haemost* 1998;80(2):352. [PMID: 9716174]

272. Révész T, Arets B, Bierings M, et al. Recombinant factor VIIa in severe uremic bleeding [letter]. *Thromb Haemost* 1998;80(2):353. [PMID: 9716175]

273. White B, McHale J, Ravi N, et al. Successful use of recombinant FVIIa (Novoseven®) in the management of intractable post-surgical intra-abdominal haemorrhage. *Br J Haematol* 1999;107(3):677-8. [PMID: 10583276]

274. Martinowitz U, Kenet G, Luboshitz J, et al. Recombinant FVIIa (rFVIIa) for salvage of surgical patients suffering uncontrolled bleeding [abstract]. *Blood* 1999;94(10 Suppl 1 Pt 1):461a. [ISI: 257PH]

275. Vlot AJ, Ton E, Mackaay AJ, Kramer MH, Gaillard CA. Treatment of a severely bleeding patient without preexisting coagulopathy with activated recombinant factor VII. *Am J Surg* 2000;108(5):421-3. [PMID: 10759100]

276. Hedner U. Recombinant activated factor VII as a universal haemostatic agent. *Blood Coagul Fibrinolysis* 1998;9(Suppl 1):S147-52. [PMID: 9819047]

277. Kristensen J, Killander A, Hippe E, et al. Clinical experience with recombinant factor VIIa in patients with thrombocytopenia. *Haemostasis* 1996;26(Suppl 1):159-64. [PMID: 8904193]

278. Papatheodoridis GV, Chung S, Keshav S, et al. Correction of both prothrombin time and primary haemostasis by recombinant factor VII during therapeutic alcohol injection of hepatocellular cancer in liver cirrhosis. *J Hepatol* 1999;31(4):747-50. [PMID: 10551401]

279. de Wolf JT, Hendriks HG, Meijer K, et al. Impressive reduction of blood requirements in orthotopic liver transplantation due to recombinant factor VIIa (RFVIIA, NovoSeven) [abstract]. *Transfusion* 1999;39(10 Suppl):87S. [ISI: 247EK]

280. Kenet G, Walden R, Eldad A, Martinowitz U. Treatment of traumatic bleeding with recombinant factor VIIa. *Lancet* 1999;354(9193):1879. [PMID: 10584732]

281. Shiono N, Koyama N, Watanabe Y, et al. Application of cryoprecipitate as a hematostatic glue. *J Cardiovasc Surg (Torino)* 1998;39(5):609-12. [PMID: 9833720]

282. Bhatti T, Ashley S, Cosgrove C, et al. Cyanoacrylate glue improves haemostasis of PTFE vascular anastomoses: a randomized prospective trial [abstract]. *Br J Surg* 1998; 85 Supp 1:41. [ISI: ZZ633]

283. Quinn J, Wells G, Sutcliffe T, et al. Tissue adhesive versus suture wound repair at 1 year: randomized clinical trial correlating early, 3-month, and 1-year cosmetic outcome. *Ann Emerg Med* 1998;32(6):645-9. [PMID: 9832658]

284. Bachet J, Goudot B, Dreyfus G, et al. The proper use of glue: a 20-year experience with the GRF [gelatin-resorcinol-formaline] glue in acute aortic dissection. *J Card Surg* 1997;12 Suppl 2: 243-53. [PMID: 9271753]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

285. Levy O, Martinowitz U, Oran A, et al. The use of fibrin tissue adhesive to reduce blood loss and the need for blood transfusion after total knee arthroplasty. A prospective, randomized, multicentre study. *J Bone Joint Surg Am* 1999;81-A(11):1580-8. [PMID: 10565650]

286. Cohn SM, Cross JH, Ivy ME, et al. Fibrin glue terminates massive bleeding after complex hepatic injury. *J Trauma* 1998;45(4):666-72. [PMID: 9783602]

287. Kram HB, Shoemaker WC, Clark SR, et al. Spraying of aerosolized fibrin glue in the treatment of nonsuturable hemorrhage. *Am Surg* 1991;57(6):381-4. [PMID: 2048851]

288. Ochsner MG. Fibrin solutions to control hemorrhage in the trauma patient. *J Long Term Eff Med Implants* 1998;8(2):161-73. [PMID: 10181374]

289. Kram HB, Nathan RC, Stafford FJ, et al. Fibrin glue achieves hemostasis in patients with coagulation disorders. *Arch Surg* 1989;124(3):385-8. [PMID: 2465752]

290. McCarthy PM. Fibrin glue in cardiothoracic surgery. *Transfus Med Rev* 1993;7(3):173-9. [PMID: 8347983]

291. Cohn SM, Feinstein AJ, Nicholas JM, et al. Recipe for poor man's fibrin glue. *J Trauma* 1998;44(5):907. [PMID: 9603097]

292. Stechison MT. Rapid polymerizing fibrin glue from autologous or single-donor blood: preparation and indications. *J Neurosurg* 1992;76(4):626-8. [PMID: 1545256]

293. Komatsu F, Yoshida S. Utility and quality of autologous fresh frozen plasma and autologous fibrin glue for surgical patients. *Transfus Sci* 1999;21(2):105-9. [PMID: 10747517]

294. Hartman AR, Galanakis DK, Honig MP, et al. Autologous whole plasma fibrin gel: intraoperative procurement. *Arch Surg* 1992;127(3):357-9. [PMID: 1550487]

295. Whitman DH, Berry RL, Green DM. Platelet gel: an autologous alternative to fibrin glue with applications in oral and maxillofacial surgery. *J Oral Maxillofac Surg* 1997;55(11):1294-9. [PMID: 9371122]

296. Takeuchi H, Konaga E, Kashitani M, et al. The usefulness of Avitene for the control of oozing in laparoscopic cholecystectomy. *Surg Gynecol Obstet* 1993;176(6):495-6. [PMID: 8480276]

297. Hill RC, Kalantarian B, Jones DR. Use of microfibrillar collagen hemostat (Avitene) and thrombin to achieve hemostasis after median sternotomy [letter]. *J Thorac Cardiovasc Surg* 1994;108(6):1151-2. [PMID: 7983888]

298. McGill V, Kowal-Vern A, Gamelli RL. A conservative thermal injury treatment protocol for the appropriate Jehovah's Witness candidate. *J Burn Care Rehab* 1997;18(2):133-8. [PMID: 9095422]

299. Bobrowski RA, Jones TB. A thrombogenic uterine pack for postpartum hemorrhage. *Obstet Gynecol* 1995;85(5 Pt 2):836-7. [PMID: 7724130]

300. Davies MS, Flannery MC, McCollum CN. Calcium alginate as haemostatic swabs in hip fracture surgery. *J R Coll Surg Edinb* 1997;42(1):31-2. [PMID: 9046141]

301. Kneafsey B, O'Shaughnessy M, Condon KC. The use of calcium alginate dressings in deep hand burns. *Burns* 1996;22(1):40-3. [PMID: 8719315]

302. Blair SD, Jarvis P, Salmon M, McCollum C. Clinical trial of calcium alginate haemostatic swabs. *Br J Surg* 1990;77(5):568-70. [PMID: 2191753]

303. Nishiya M, Hareyama H, Makinoda S, Fujimoto S. A study on the hemostatic effect of sodium alginate on uterocervical hemorrhage. *Asia-Oceania J Obstet Gynaecol* 1994;20(2):203-8. [PMID: 8092969]

304. Kuster GG, Fischer B. Pharmacologic hemostasis in laparoscopy: topical epinephrine facilitates cholecystectomy. *Am Surg* 1993;59(5):281-4. [PMID: 8489094]

305. Sheridan RL, Szyfelbein SK. Staged high-dose epinephrine clysis is safe and effective in extensive tangential burn excisions in children. *Burns* 1999;25(8):745-8. [PMID: 10630857]

306. Moghtader JC, Edlich RF, Mintz PD, et al. The use of recombinant human erythropoietin and cultured epithelial autografts in a Jehovah's Witness with a major thermal injury. *Burns* 1994;20(2):176-7. [PMID: 8198726]

307. Berde CB, Strichartz GR. Local anesthetics. In: Miller RD, editor. *Anesthesia*. 5th ed. New York: Churchill Livingstone; 2000. p. 491-521. [ISBN: 978-0-443-07988-7]

308. Riegle EV, Gunter JB, Lusk RP, et al. Comparison of vasoconstrictors for functional endoscopic sinus surgery in children. *Laryngoscope* 1992;102(7):820-3. [PMID: 1614253]

Normothermia and Coagulation

309. Schmied H, Kurz A, Sessler DI, et al. Mild hypothermia increases blood loss and transfusion requirements during total hip arthroplasty. *Lancet* 1996;347(8997):289-92. [PMID: 8569362]

310. Rohrer MJ, Natale AM. Effect of hypothermia on the coagulation cascade. *Crit Care Med* 1992;20(10):1402-5. [PMID: 1395660]

311. Michelson AD, MacGregor H, Barnard MR, et al. Reversible inhibition of human platelet activation by hypothermia in vivo and in vitro. *Thromb Haemost* 1994;71(5):633-40. [PMID: 7522354]

312. Valeri CR, Feingold H, Cassidy G, et al. Hypothermia-induced reversible platelet dysfunction. *Ann Surg* 1987;205(2):175-81. [PMID: 3813688]

313. Tönz M, Mihaljevic T, von Segesser LK, et al. Normothermia versus hypothermia during cardiopulmonary bypass: a randomized, controlled trial. *Ann Thorac Surg* 1995;59(1):137-43. [PMID: 7818312]

314. Douning LK, Ramsay MA, Swygert TH, et al. Temperature corrected thrombelastography in hypothermic patients. *Anesth Analg* 1995;81(3):608-11. [PMID: 7653831]

315. Frank SM, Nguyen JM, Garcia CM, Barnes RA. Temperature monitoring practices during regional anesthesia. *Anesth Analg* 1999;88(2):373-7. [PMID: 9972759]

316. El-Rahmany HK, Frank SM, Schneider GM, et al. Forced-air warming decreases vasodilator requirement after coronary artery bypass surgery. *Anesth Analg* 2000;90(2):286-91. [PMID: 10648308]

317. Bock M, Müller J, Bach A, et al. Effects of preinduction and intraoperative warming during major laparotomy. *Br J Anaesth* 1998;80(2):159-63. [PMID: 9602578]

318. Kurz A, Sessler DI, Lenhardt R. Study of Wound Infections and Temperature Group. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. *N Engl J Med* 1996;334(19):1209-15. [PMID: 8606715]

319. Bush HL Jr, Hydo LJ, Fischer E, et al. Hypothermia during elective abdominal aortic aneurysm repair: the high price of avoidable morbidity. *J Vasc Surg* 1995;21(3):392-402. [PMID: 7877221]

320. Gubler KD, Gentilello LM, Hassantash SA, et al. The impact of hypothermia on dilutional coagulopathy. *J Trauma* 1994;36(6):847-51. [PMID: 8015007]

321. Sessler DI. Mild perioperative hypothermia. *N Engl J Med* 1997;336(24):1730-7. [PMID: 9180091]

322. Sessler DI. Deliberate mild hypothermia. *J Neurosurg Anesthesiol* 1995;7(1):38-46. [PMID: 7881239]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

323. Frank SM, Fleisher LA, Breslow MJ, et al. Perioperative maintenance of normothermia reduces the incidence of morbid cardiac events. *JAMA* 1997;277(14):1127-34. [PMID: 9087467]

324. Koehntop DE, Belani KG. Acute severe hemodilution to a hemoglobin of 1.3 g/dl tolerated in the presence of mild hypothermia [letter]. *Anesthesiology* 1999;90(6):1798-9. [PMID: 10360891]

325. Akingbola OA, Custer JR, Bunchman TE, Sedman AB. Management of severe anemia without transfusion in a pediatric Jehovah's Witness patient. *Crit Care Med* 1994;22(3):524-8. [PMID: 8125005]

326. Cooley DA, Boyer JW. Selective hypothermia in repair of aneurysms of the descending aorta. *Tex Heart Inst J* 1999;26(2):103-6. [PMID: 10397431]

327. Jobes DR, Aitken GL, Shaffer GW. Increased accuracy and precision of heparin and protamine dosing reduces blood loss and transfusion in patients undergoing primary cardiac operations. *J Thorac Cardiovasc Surg* 1995;110(1):36-45. [PMID: 7609566]

328. Despotis GJ, Joist JH, Hogue CW Jr, et al. The impact of heparin concentration and activated clotting time monitoring on blood conservation. A prospective, randomized evaluation in patients undergoing cardiac operation. *J Thorac Cardiovasc Surg* 1995;110(1):46-54. [PMID: 7609568]

329. van Son JA, Hovaguimian H, Rao IM, et al. Strategies for repair of congenital heart defects in infants without the use of blood. *Ann Thorac Surg* 1995;59(2):384-8. [PMID: 7531422]

330. Mahoney CB, Lemole GM. Transfusion after coronary artery bypass surgery: the impact of heparin-bonded circuits. *Eur J Cardiothorac Surg* 1999;16(2):206-10. [PMID: 10485422]

331. Aldea GS, O'Gara P, Shapira OM, et al. Effect of anticoagulation protocol on outcome in patients undergoing CABG with heparin -bonded cardiopulmonary bypass circuits. *Ann Thorac Surg* 1998;65(2):425-33. [PMID: 9485240]

332. Shore-Lesserson L. Pro: heparin-bonded circuits represent a desirable option for cardiopulmonary bypass. *J Cardiothorac Vasc Anesth* 1998;12(6):705-9. [PMID: 9854673]

333. von Segesser LK. Heparin-bonded surfaces in extracorporeal membrane oxygenation for cardiac support. *Ann Thorac Surg* 1996;61(1):330-5. [PMID: 8561600]

Controlled Hypotension

334. Ullrich PF Jr, Keene JS, Hogan KJ, Roecker EB. Results of hypotensive anesthesia in operative treatment of thoracolumbar fractures. *J Spinal Disord* 1990;3(4):329-33. [PMID: 2134446]

335. Precious DS, Splinter W, Bosco D. Induced hypotensive anesthesia for adolescent orthognathic surgery patients. *J Oral Maxillofac Surg* 1996;54(6):680-4. [PMID: 8648471]

336. Klowden AJ, Salem MR, Fahmy NR, Crystal JG. Deliberate hypotension. In: Salem MR, editor. *Blood Conservation in the Surgical Patient*. Baltimore: Williams & Wilkins; 1996. p. 189-251. [ISBN: 978-0-683-07531-1]

337. Shapira Y, Gurman G, Artru AA, et al. Combined hemodilution and hypotension monitored with jugular bulb oxygen saturation, EEG, and ECG decreases transfusion volume and length of ICU stay for major orthopedic surgery. *J Clin Anesth* 1997;9(8):643-9. [PMID: 9438892]

338. Testa LD, Tobias JD. Pharmacologic drugs for controlled hypotension. *J Clin Anesth* 1995;7(4):326-37. [PMID: 7546762]

339. Melendez JA, Arslan V, Fischer ME, et al. Perioperative outcomes of major hepatic resections under low central venous pressure anesthesia: blood loss, blood transfusion, and the risk of postoperative renal dysfunction. *J Am Coll Surg* 1998;187(6):620-5. [PMID: 9849736]

340. Jones RM, Moulton CE, Hardy KJ. Central venous pressure and its effect on blood loss during liver resection. *Br J Surg* 1998;85(8):1058-60. [PMID: 9717995]

341. Sharrock NE, Salvati EA. Hypotensive epidural anesthesia for total hip arthroplasty: a review. *Acta Orthop Scand* 1996;67(1):91-107. [PMID: 8615115]

342. Lerman J. Special techniques: acute normovolemic hemodilution, controlled hypotension and hypothermia, ECMO. In: Gregory GA, editor. *Pediatric Anesthesia.* 3rd ed. New York: Churchill Livingstone; 1994. p. 319-47. [ISBN: 978-0-443-08904-6]

343. Coté CJ. Strategies to reduce blood transfusions: controlled hypotension and hemodilution. In: Coté CJ, Ryan JF, Todres ID, Goudsouzian NG, editors. *A Practice of Anesthesia for Infants and Children*. 2nd ed. Philadelphia: WB Saunders; 1993. p. 201-10. [ISBN: 978-0-7216-3198-1]

344. Sum DC, Chung PC, Chen WC. Deliberate hypotensive anesthesia with labetalol in reconstructive surgery for scoliosis. *Acta Anaesthesiol Sin* 1996;34(4):203-7. [PMID: 9084548]

345. Ahlering TE, Henderson JB, Skinner DG. Controlled hypotensive anesthesia to reduce blood loss in radical cystectomy for bladder cancer. *J Urol* 1983;129(5):953-4. [PMID: 6854766]

346. Hack H, Mitchell V. Hypotensive anaesthesia. *Br J Hosp Med* 1996;55(8):482-5. [PMID: 8732218]

347. Hur SR, Huizenga BA, Major M. Acute normovolemic hemodilution combined with hypotensive anesthesia and other techniques to avoid homologous transfusion in spinal fusion surgery. *Spine* 1992;17(8):867-73. [PMID: 1523488]

348. Van Hemelen G, Avery CM, Venn PJ, et al. Management of Jehovah's Witness patients undergoing major head and neck surgery. *Head Neck* 1999;21(1):80-4. [PMID: 9890356]

349. Purdham RS. Reduced blood loss with hemodynamic stability during controlled hypotensive anesthesia for Lefort I maxillary osteotomy using high-dose fentanyl: a retrospective study. *CRNA* 1996;7(1):33-46. [PMID: 8680354]

350. Lisander B, Jonsson R, Nordwall A. Combination of blood-saving methods decreases homologous blood requirements in scoliosis surgery. *Anaesth Intensive Care* 1996;24(5):555-8. [PMID: 8909665]

351. Sharrock NE, Bading B, Mineo R, Blumenfeld JD. Deliberate hypotensive epidural anesthesia for patients with normal and low cardiac output. *Anesth Analg* 1994;79(5):899-904. [PMID: 7978407]

352. Williams-Russo P, Sharrock NE, Mattis S, et al. Randomized trial of hypotensive epidural anesthesia in older adults. *Anesthesiology* 1999;91(4):926-35. [PMID: 10519494]

353. Aoki H, Inoue M, Mizobe T, et al. Platelet function is inhibited by nitric oxide liberation during nitroglycerin-induced hypotension anaesthesia. *Br J Anaesth* 1997;79(4):476-81. [PMID: 9389267]

354. Harris SN, Rinder CS, Rinder HM, et al. Nitroprusside inhibition of platelet function is transient and reversible by catecholamine priming. *Anesthesiology* 1995;83(6):1145-52. [PMID: 8533905]

355. D'Ambrosio A, Borghi B, Damato A, et al. Reducing perioperative blood loss in patients undergoing total hip arthroplasty. *Int J Artif Organs* 1999;22(1):47-51. [PMID: 10098585]

356. Grass JA. Surgical outcome: regional anesthesia and analgesia versus general anesthesia. *Anesthesiol Rev* 1993;20(4):117-25. [EMBASE: 1993263766]

357. Kehlet H. General versus regional anesthesia. In: Longnecker DE, Tinker JH, Morgan GE Jr, editors. *Principles and Practice of Anesthesiology*. 2nd ed. St. Louis: Mosby; 1998. p. 1317-29. [ISBN: 978-0-815-15479-2]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

358. Scott NB, Kehlet H. Regional anaesthesia and surgical morbidity. *Br J Surg* 1988;75(4):299-304. [PMID: 3282596]

359. Modig J. Regional anaesthesia and blood loss. *Acta Anaesthesiol Scand* 1988;32(Suppl 89):44-8. [PMID: 3067490]

360. Horlocker TT, Wedel DJ. Spinal and epidural blockade and perioperative low molecular weight heparin: smooth sailing on the Titanic. *Anesth Analg* 1998;86(6):1153-6. [PMID: 9620494]

361. Ramsay JG. Methods of reducing blood loss and non-blood substitutes. *Can J Anaesth* 1991;38(5):595-9. [PMID: 1934208]

362. Cooper JR Jr. Perioperative considerations in Jehovah's Witnesses. *Int Anesthesiol Clin* 1990;28(1):210-5. [PMID: 2228276]

Intraoperative Cell Salvage/Autotransfusion

363. Joseph NJ, Kamaryt J, Paulissian R. Blood Salvage Techniques. In: Salem MR, editor. *Blood Conservation in the Surgical Patient*. Baltimore: Williams & Wilkins; 1996. p. 252-304. [ISBN: 978-0-683-07531-1]

364. Tawes RL Jr, editor. *Autotransfusion: Therapeutic Principles and Trends*. Detroit: Appleton; 1997. [ISBN: 978-1-567-57061-8]

365. Jeng JC, Boyd TM, Jablonski KA, et al. Intraoperative blood salvage in excisional burn surgery: an analysis of yield, bacteriology, and inflammatory mediators. *J Burn Care Rehabil* 1998;19(4):305-11. [PMID: 9710727]

366. Samuelsson A, Björnsson A, Nettelblad H, Sjöberg F. Autotransfusion techniques in burn surgery [letter]. *Burns* 1997;23(2):188-9. [PMID: 9177893]

367. Park KI, Kojima O, Tomoyoshi T. Assessment of the availability of intraoperative autotransfusion in urological operations. *J Urol* 1997;157(5):1777-80. [PMID: 9112526]

368. Szalay D, Wong D, Lindsay T. Impact of red cell salvage on transfusion requirements during elective abdominal aortic aneurysm repair. *Ann Vasc Surg* 1999;13(6):576-81. [PMID: 10541609]

369. Glazier DB, Ciocca RG, Gosin JS, et al. Elective aortic surgery with minimal banked blood. *Am Surg* 1998;64(2):171-4. [PMID: 9486892]

370. Goodnough LT, Monk TG, Sicard G, et al. Intraoperative salvage in patients undergoing elective abdominal aortic aneurysm repair: an analysis of cost and benefit. *J Vasc Surg* 1996;24(2):213-8. [PMID: 8752031]

371. Booke M, Schmidt C, Van Aken H, et al. Continuous autotransfusion in a Jehovah's Witness undergoing coronary artery bypass grafting [letter]. *Anesth Analg* 1999;89(1):262-3. [PMID: 10389828]

372. Cataldi S, Bruder N, Dufour H, et al. Intraoperative autologous blood transfusion in intracranial surgery. *Neurosurgery* 1997;40(4):765-71. [PMID: 9092850]

373. Ray JM, Flynn JC, Bierman AH. Erythrocyte survival following intraoperative autotransfusion in spinal surgery: an in vivo comparative study and 5-year update. *Spine* (Phila Pa 1976) 1986;11(9):879-82. [PMID: 3824064]

374. Benli IT, Akalin S, Duman E, et al. The results of intraoperative autotransfusion in orthopaedic surgery. *Bull Hosp Jt Dis* 1999;58(4):184-7. [PMID: 10711365]

375. Potter PS, Waters JH, Burger GA, Mraović B. Application of cell-salvage during cesarean section. *Anesthesiology* 1999;90(2):619-21. [PMID: 9952170]

376. Heimbecker RO. Blood recycling eliminates need for blood [letter]. *CMAJ* 1996;155(3):275-6. [PMID: 8705904]

377. Karczewski DM, Lema MJ, Glaves D. The efficiency of an autotransfusion system for tumor cell removal from blood salvaged during cancer surgery. *Anesth Analg* 1994;78(6):1131-5. [PMID: 8198270]

378. Perseghin P, Vigano M, Rocco G, et al. Effectiveness of leukocyte filters in reducing tumor cell contamination after intraoperative blood salvage in lung cancer patients. *Vox Sang* 1997;72(4):221-4. [PMID: 9228711]

379. Torre GC, Ferrari M, Favre A, et al. A new technique for intraoperative blood recovery in the cancer patient. *Eur J Surg Oncol* 1994;20(5):565-70. [PMID: 7926061]

380. Miller GV, Ramsden CW, Primrose JN. Autologous transfusion: an alternative to transfusion with banked blood during surgery for cancer. *Br J Surg* 1991;78(6)713-5. [PMID: 2070241]

381. Hansen E, Knuechel R, Altmeppen J, Taeger K. Blood irradiation for intraoperative autotransfusion in cancer surgery: demonstration of efficient elimination of contaminating tumor cells. *Transfusion* 1999;39(6):608-15. [PMID: 10378841]

382. Thomas MJ. Infected and malignant fields are an absolute contraindication to intraoperative cell salvage: fact or fiction? *Transfus Med* 1999;9(3):269-78. [PMID: 10555821]

383. Yamada T, Ikeda A, Okamoto Y, et al. Intraoperative blood salvage in abdominal simple total hysterectomy for uterine myoma. *Int J Gynecol Obstet* 1997;59(3):233-6. [PMID: 9486513]

384. Rainaldi MP, Tazzari PL, Scagliarini G, et al. Blood salvage during caesarean section. *Br J Anaesth* 1998;80(2):195-8. [PMID: 9602584]

Intraoperative Pheresis/Component Sequestration

385. Safwat AM, Reitan JA, Benson D. Management of Jehovah's Witness patients for scoliosis surgery: the use of platelet and plasmapheresis. *J Clin Anesth* 1997;9(6):510-3. [PMID: 9278843]

386. Scott WJ, Rode R, Castlemain B, et al. Efficacy, complications, and cost of a comprehensive blood conservation program for cardiac operations. *J Thorac Cardiovasc Surg* 1992;103(5):1001-6. [PMID: 1569752]

387. Svensson LG, Sun J, Nadolny E, Kimmel WA. Prospective evaluation of minimal blood use for ascending aorta and aortic arch operations. *Ann Thorac Surg* 1995;59(6):1501-8. [PMID: 7771831]

388. Zhou SF, Estrera AL, Loubser P, et al. Autologous platelet-rich plasma reduces transfusions during ascending aortic arch repair: a prospective, randomized, controlled trial. *Ann Thorac Surg* 2015;99(4):1282-90. [PMID: 25661906]

389. Stover EP, Siegel LC, Hood PA, et al. Platelet-rich plasma sequestration, with therapeutic platelet yields, reduces allogeneic transfusion in complex cardiac surgery. *Anesth Analg* 2000;90(3):509-16. [PMID: 10702428]

390. Davies GG, Wells DG, Mabee TM, et al. Platelet-leukocyte plasmapheresis attenuates the deleterious effects of cardiopulmonary bypass. *Ann Thorac Surg* 1992;53(2):274-7. [PMID: 1731668]

391. Christenson JT, Reuse J, Badel P, et al. Plateletpheresis before redo CABG diminishes excessive blood transfusion. *Ann Thorac Surg* 1996;62(5):1373-9. [PMID: 8893571]

392. Shulman G, Solanki DR, Nicodemus CL, et al. Audit of autotransfusion in spine surgery. *Int Orthop* 1998;22(5):303-7. [PMID: 9914933]

Intraoperative Hemodilution

393. Johnson LB, Plotkin JS, Kuo PC. Reduced transfusion requirements during major hepatic resection with use of intraoperative isovolemic hemodilution. *Am J Surg* 1998;176(6):608-11. [PMID: 9926799]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

394. Goldberg J, Paugh TA, Dickinson TA, et al; PERFform Registry and the Michigan Society of Thoracic and Cardiovascular Surgeons Quality Collaborative. Greater volume of acute normovolemic hemodilution may aid in reducing blood transfusions after cardiac surgery. *Ann Thorac Surg* 2015;100(5):1581-7. [PMID: 26206721]

395. Monk TG, Goodnough LT, Brecher ME, et al. Acute normovolemic hemodilution can replace preoperative autologous blood donation as a standard of care for autologous blood procurement in radical prostatectomy. *Anesth Analg* 1997;85(5):953-8. [PMID: 9356083]

396. Ochani TD, Shander A, Ozawa S. Pancreaticoduodenectomy using bloodless management in a pediatric Jehovah's Witness patient. *Am J Anesthesiol* 1999;26(2):81-5. [ISSN: 1078-4500]

397. Copley LA, Richards BS, Safavi FZ, Newton PO. Hemodilution as a method to reduce transfusion requirements in adolescent spine fusion surgery. *Spine* 1999;24(3):219-24. [PMID: 10025016]

398. Stehling L, Zauder HL. Acute normovolemic hemodilution. *Transfusion* 1991;31(9):857-68. [PMID: 1755091]

399. Crystal GJ, Salem MR. Acute normovolemic hemodilution. In: Salem MR, editor. *Blood Conservation in the Surgical Patient*. Baltimore: Williams & Wilkins; 1996. p. 168-88. [ISBN: 978-0-683-07531-1]

400. Monk TG, Goodnough LT, Birkmeyer JD, et al. Acute normovolemic hemodilution is a cost-effective alternative to preoperative autologous blood donation by patients undergoing radical retropubic prostatectomy. *Transfusion* 1995:35(7):559-65. [PMID: 7631387]

401. Stehling L, Zauder HL. How low can we go? Is there a way to know? *Transfusion* 1990;30(1):1-3. [PMID: 2296783]

402. Spahn DR, Seifert B, Pasch T, Schmid ER. Haemodilution tolerance in patients with mitral regurgitation. *Anaesthesia* 1998;53(1):20-4. [PMID: 9505737]

403. Spahn DR, Schmid ER, Seifert B, et al. Hemodilution tolerance in patients with coronary artery disease who are receiving chronic beta-adrenergic blocker therapy. *Anesth Analg* 1996;82(4):687-94. [PMID: 8615482]

404. Hobisch-Hagen P, Schobersberger W, Innerhofer P, et al. Normovolemic hemodilution does not lead to myocardial injury during major orthopaedic surgery [abstract]. *Acta Anaesthesiol Scand* 1996;40 Suppl 109:252. [ISSN: 0001-5172]

405. Herregods L, Foubert L, Moerman A, et al. Comparative study of limited intentional normovolaemic haemodilution in patients with left main coronary artery stenosis. *Anaesthesia* 1995;50(11):950-3. [PMID: 8678250]

406. Van der Linden P, Wathieu M, Gilbart E, et al. Cardiovascular effects of moderate normovolaemic haemodilution during enflurane-nitrous oxide anaesthesia in man. *Acta Anesthesiologica Scand* 1994;38(5):490-8. [PMID: 7524256]

407. Fukusaki M, Maekawa T, Kobayashi I, et al. Catecholamine and renin-angiotensin response during controlled hypotension induced by prostaglandin E_1 combined with hemodilution during isoflurane anesthesia. *J Clin Anesth* 1997;9(4):321-7. [PMID: 9195357]

408. Aly Hassan A, Lochbuehler H, Frey L, Messmer K. Global tissue oxygenation during normovolaemic haemodilution in young children. *Paediatr Anaesth* 1997;7(3):197-204. [PMID: 9189964]

409. Innerhofer P, Luz G. Systemic haemodynamics and oxygenation during haemodilution in children [letter]. *Lancet* 1996;347(8998):398-9. [PMID: 8598721]

410. van Iterson M, van der Waart FJM, Erdmann W, Trouwborst A. Systemic haemodynamics and oxygenation during haemodilution in children. *Lancet* 1995;346(8983):1127-9. [PMID: 7475603]

411. Singbartl K, Schleinzer W, Singbartl G. Hypervolemic hemodilution: an alternative to acute normovolemic hemodilution? A mathematical analysis. *J Surg Res* 1999;86(2):206-12. [PMID: 10534425]

412. Trouwborst A, van Woerkens EC, van Daele M, Tenbrinck R. Acute hypervolaemic haemodilution to avoid blood transfusion during major surgery. *Lancet* 1990;336(8726):1295-7. [PMID: 1978123]

413. Trouwborst A, Hagenouw RR, Jeekel J, Ong GL. Hypervolaemic haemodilution in an anaemic Jehovah's Witness. *Br J Anaesth* 1990;64(5):646-8. [PMID: 2354105]

414. Sugita M, Ushijima K, Ichinose K, Terasaki H. Preoperative acute hypervolemic hemodilution with hydroxyethylstarch in a Jehovah's Witness: effects on hemodynamics and coagulation systems. *J Anesth* 1998;12(3):164-7. [EMBASE: 1998339286]

415. Entholzner E, Mielke L, Plötz W, et al. Hypervolemic hemodilution as a means of preventing homologous blood transfusion. A simple alternative to acute normovolemic hemodilution [German]. *Fortschr Med* 1994;112(29):410-4. [PMID: 7528160]

416. van Daele M, Trouwborst A, van Woerkens L, et al. Transesophageal echocardiographic monitoring of preoperative acute hypervolemic hemodilution. *Anesthesiology* 1994;81(3):602-9. [PMID: 8092505]

417. Mielke LL, Entholzner EK, Kling M, et al. Preoperative acute hypervolemic hemodilution with hydroxyethylstarch: an alternative to acute normovolemic hemodilution? *Anesth Analg* 1997;84(1):26-30. [PMID: 8988994]

418. Kreimeier U, Finsterer U. Preoperative acute normovolemic hemodilution is an alternative to hypervolemic hemodilution—in case of proper use [letter]. *Anesth Analg* 1997;85(6):1412-3. [PMID: 9390623]

419. Smetannikov Y, Hopkins D. Intraoperative bleeding: a mathematical model for minimizing hemoglobin loss. *Transfusion* 1996;36(9):832-5. [PMID: 8823461]

420. Rohling RG, Haers PE, Zimmerman AP, et al. Multimodal strategy for reduction of homologous transfusions in cranio-maxillofacial surgery. *Int J Oral Maxillofac Surg* 1999;28(2):137-42. [PMID: 10102398]

421. Monk T. Improving the outcome of acute normovolemic hemodilution with epoetin alfa. *Semin Hematol* 1996;33(2 Suppl 2):48-52. [EMBASE: 1996134931] [PMID: 8999552]

422. Goodnough LT, Monk TG, Brecher ME. Acute normovolemic hemodilution should replace the preoperative donation of autologous blood as a method of autologous-blood procurement. *Transfusion* 1998;38(5):473-6. [PMID: 9633561]

423. Shapira OM, Aldea GS, Treanor PR, et al. Reduction of allogeneic blood transfusions after open heart operations by lowering cardiopulmonary bypass prime volume. *Ann Thorac Surg* 1998;65(3):724-30. [PMID: 9527202]

424. Montiglio F, Dor V, Quaegebeur J, et al. Cardiac surgery in adults and children without use of blood. *Ann Thorac Cardiovasc Surg* 1998;4(1):3-11. [PMID: 9495902]

425. Rousou JA, Engelman RM, Flack JE 3rd, et al. The 'primeless pump': a novel technique for intraoperative blood conservation. *Cardiovasc Surg* 1999;7(2):228-35. [PMID: 10353677]

Hemofiltration/Hemoconcentration

426. Duffy CM, Manninen PH, Chung F, et al. Assessment of a new ultrafiltration blood processing system. *Can J Anaesth* 1997;44(11):1204-7. [PMID: 9398963]

427. Sutton RG, Kratz JM, Spinale FG, Crawford FA Jr. Comparison of three blood-processing techniques during and after cardiopulmonary bypass. *Ann Thorac Surg* 1993;56(4):938-43. [PMID: 8215672]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

428. Christenson JT, Reuse J, Badel P, et al. Plateletpheresis before redo CABG diminishes excessive blood transfusion. *Ann Thorac Surg* 1996;62(5):1373-8. [PMID: 8893571]

429. Dekkers RJ, Rizzo RJ, Body SC, et al. Shed whole blood autotransfusion during aortic aneurysm operation with a modified collection infusion system. *Ann Thorac Surg* 1995;59(1):184-6. [PMID: 7818319]

430. Bando K, Turentine MW, Vijay P, et al. Effect of modified ultrafiltration in high-risk patients undergoing operations for congenital heart disease. *Ann Thorac Surg* 1998;66(3):821-8. [PMID: 9768937]

Postoperative Management

431. Griffin KB. Postoperative bleeding. Current nursing management. *Crit Care Nurs Clin North Am* 1990;2(4):549-57. [PMID: 2096860]

432. Waterbury L. Bleeding disorders: approach to diagnosis. In: *Hematology for the House Officer*. 3rd ed. Baltimore: Williams & Wilkins; 1988. p. 69-75. [ISBN: 0-683-08853-X]

433. Despotis GJ, Skubas NJ, Goodnough LT. Optimal management of bleeding and transfusion in patients undergoing cardiac surgery. *Semin Thorac Cardiovasc Surg* 1999;11(2):84-104. [PMID: 10378853]

434. Çiçek S, Demirkiliç U, Özal E, et al. Postoperative use of aprotinin in cardiac operations: an alternative to its prophylactic use. *J Thorac Cardiovasc Surg* 1996;112(6):1462-7. [PMID: 8975837]

435. Katoh J, Tsuchiya K, Sato W, et al. Additional postbypass administration of tranexamic acid reduces blood loss after cardiac operations. *J Thorac Cardiovasc Surg* 1997;113(4):802-4. [PMID: 9104995]

436. Fremes SE, Wong BI, Lee E, et al. Metaanalysis of prophylactic drug treatment in the prevention of postoperative bleeding. *Ann Thorac Surg* 1994;58(6):1580-8. [PMID: 7526811]

437. Bulakbaşi N, Kurtaran K, Üstünsöz B, Somuncu I. Massive lower gastrointestinal hemorrhage from the surgical anastomosis in patients with multiorgan trauma: treatment by subselective embolization with polyvinyl alcohol particles. *Cardiovasc Intervent Radiol* 1999;22(6):461-7. [PMID: 10556404]

438. Shenolikar A, Wareham K, Newington D, et al. Cell salvage auto transfusion in total knee replacement surgery. *Transfus Med* 1997;7(4):277-80. [PMID: 9510924]

439. Berman AT, Levenberg RJ, Tropiano MT, et al. Postoperative autotransfusion after total knee arthroplasty. *Orthopedics* 1996;19(1):15-22. [PMID: 8771109]

440. Pasquinelli FM, Binazzi R, Borghi B, Gargioni G. Autotransfusion with intra- and postoperative blood recovery in prosthetic hip surgery. A study conducted on 1368 cementless prostheses. *Chir Organi Mov* 1997;82(3):249-61. [PMID: 9494242]

441. Han CD, Shin DE. Postoperative blood salvage and reinfusion after total joint arthroplasty. *J Arthroplasty* 1997;12(5):511-6. [PMID: 9268790]

442. Healy WL, Pfeifer BA, Kurtz SR, et al. Evaluation of autologous shed blood for autotransfusion after orthopaedic surgery. *Clin Orthop* 1994;(299):53-9. [PMID: 8119037]

443. Huët C, Salmi LR, Fergusson D, et al. A meta-analysis of the effectiveness of cell salvage to minimize perioperative allogeneic blood transfusion in cardiac and orthopedic surgery. *Anesth Analg* 1999;89(4):861-9. [PMID: 10512256]

444. Tawes RL Jr, Sydorak GR, DuVall TB. Postoperative salvage: technological advance in the "washed versus unwashed" blood controversy. In: Tawes RL Jr, editor. *Autotransfusion. Therapeutic Principles and Trends*. Detroit: Appleton; 1997. p. 188-95. [ISBN: 978-1-567-57061-8]

445. De Rai P, Biffi R, Rebulla P. Postsplenectomy blood salvage in anemic patients [letter]. *JAMA* 1987;258(10):1332. [PMID: 3625928]

446. Schmidt H, Mortensen PE, Følsgaard SL, Jensen EA. Autotransfusion after coronary artery bypass grafting halves the number of patients needing blood transfusion. *Ann Thorac Surg* 1996;61(4):1177-81. [PMID: 8607679]

447. Dorman BH, Spinale FG, Bailey MK, et al. Identification of patients at risk for excessive blood loss during coronary artery bypass surgery: thromboelastograph versus coagulation screen. *Anesth Analg* 1993;76(1):694-700. [PMID: 8466003]

448. Despotis GJ, Joist JH. Anticoagulation and anticoagulation reversal with cardiac surgery involving cardiopulmonary bypass: an update. *J Cardiothorac Vasc Anesth* 1999;13(4 Suppl 1): 18-29. [PMID: 10468245]

449. Martin P, Bannan S, Ashraf SS. Individualized patient heparinization and protamine reversal [letter]. *J Thorac Cardiovasc Surg* 1996;111(2):493-4. [PMID: 8583830]

450. Despotis GJ, Joist JH, Goodnough LT. Monitoring of hemostasis in cardiac surgical patients: impact of point-of-care testing on blood loss and transfusion outcomes. *Clin Chem* 1997;43(9):1684-96. [PMID: 9299961]

451. Cooley DA. Conservation of blood during cardiovascular surgery. *Am J Surg* 1995;170(6A Suppl):53S-59S. [PMID: 8546249]

452. Oliveira SA, Bueno RM, Souza JM, et al. Effects of hypertonic saline dextran on the postoperative evolution of Jehovah's Witness patients submitted to cardiac surgery with cardiopulmonary bypass. *Shock* 1995;3(6):391-4. [PMID: 7544684]

453. Simpson P. Perioperative blood loss and its reduction: the role of the anaesthetist. *Br J Anaesth* 1992;69(5):498-507. [PMID: 1467083]

454. Neff TA, Stocker R, Wight E, Spahn DR. Extreme intraoperative blood loss and hemodilution in a Jehovah's Witness: new aspects in postoperative management. *Anesthesiology* 1999;91(6):1949-51. [PMID: 10598641]

455. Goldhaber SZ. Pulmonary embolism. *N Engl J Med* 1998;339(2):93-104. [PMID: 9654541]

456. Kearon C. Perioperative management of long-term anticoagulation. *Semin Thromb Hemost* 1998; 24 Suppl 1:77-83. [PMID: 9840696]

457. Spain DA, Bergamini TM, Hoffmann JF, et al. Comparison of sequential compression devices and foot pumps for prophylaxis of deep venous thrombosis in high-risk trauma patients. *Am Surg* 1998;64(6):522-5. [PMID: 9619172]

458. Rogers FB, Strindberg G, Shackford SR, et al. Five-year follow-up of prophylactic vena cava filters in high-risk trauma patients. *Arch Surg* 1998;133(4):406-11. [PMID: 9565121]

459. Greenfield LJ, Proctor MC. Twenty-year clinical experience with the Greenfield filter. *Cardiovasc Surg* 1995;3(2):199-205. [PMID: 7606407]

460. Fragen RJ, Stulberg SD, Wixson R, et al. Effect of ketorolac tromethamine on bleeding and on requirements for analgesia after total knee arthroplasty. *J Bone Joint Surg Am* 1995;77-A(7):998-1002. [PMID: 7608243]

461. Dudrick SJ, O'Donnell JJ, Matheny RG, et al. Stimulation of hematopoiesis as an alternative to transfusion. *South Med J* 1986;79(6):669-73. [PMID: 3086983]

Management of Acute Bleeding and Shock

462. Henry DA, O'Connell DL. Effects of fibrinolytic inhibitors on mortality from upper gastrointestinal haemorrhage. *BMJ* 1989;298(6681):1142-6. [PMID: 2500167]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

463. Holcomb JB, Pusateri AE, Harris RA, et al. Dry fibrin sealant dressings reduce blood loss, resuscitation volume, and improve survival in hypothermic coagulopathic swine with grade V liver injuries. *J Trauma* 1999;47(2):233-42. [PMID: 10452456]

464. Holcomb JB, Pusateri AE, MacPhee MJ, Hess JR. New technologies for hemorrhage control. *Curr Opin Crit Care* 1997;3(6):488-93. [ISSN: 1070-5295]

465. Branney SW, Moore EE, Cantrill SV, et al. Ultrasound based key clinical pathway reduces the use of hospital resources for the evaluation of blunt abdominal trauma. *J Trauma* 1997;42(6):1086-90. [PMID: 9210546]

466. Partrick DA, Bensard DD, Moore EE, et al. Ultrasound is an effective triage tool to evaluate blunt abdominal trauma in the pediatric population. *J Trauma* 1998;45(1):57-63. [PMID: 9680013]

467. Boulanger BR, McLellan BA, Brenneman FD, et al. Prospective evidence of the superiority of a sonography-based algorithm in the assessment of blunt abdominal injury. *J Trauma* 1999;47(4):632-7. [PMID: 10528595]

468. Poole GV, Thomae KR, Hauser CJ. Laparoscopy in trauma. *Surg Clin North Am* 1996;76(3):547-56. [PMID: 8669014]

469. Stephen DJ, Kreder HJ, Day AC, et al. Early detection of arterial bleeding in acute pelvic trauma. *J Trauma* 1999;47(4):638-42. [PMID: 10528596]

470. Cerva DS Jr, Mirvis SE, Shanmuganathan K, et al. Detection of bleeding in patients with major pelvic fractures: value of contrast-enhanced CT. *Am J Roentgenol* 1996;166(1):131-5. [PMID: 8571861]

471. Kitchens CS. Approach to the bleeding patient. *Hematol Oncol Clin North Am* 1992;6(5):983-9. [PMID: 1400082]

472. Bragg LE, Thompson JS. Management strategies in the Jehovah's Witness patient. *Contemp Surg* 1990;36:45-9. [ISSN: 0045-8341]

473. Aucar JA, Hirshberg A. Damage control for vascular injuries. *Surg Clin North Am* 1997;77(4):853-62. [PMID: 9291986]

Prompt Surgery to Arrest Hemorrhage

474. Asensio JA, Demetriades D, Berne JD, et al. Stapled pulmonary tractotomy: a rapid way to control hemorrhage in penetrating pulmonary injuries. *J Am Coll Surg* 1997;185(5):486-7. [PMID: 9358095]

475. Carrillo EH, Bergamini TM, Miller FB, Richardson JD. Abdominal vascular injuries. *J Trauma* 1997;43(1):164-71. [PMID: 9253935]

476. Macho JR, Markison RE, Schecter WP. Cardiac stapling in the management of penetrating injuries of the heart: rapid control of hemorrhage and decreased risk of personal contamination. *J Trauma* 1993;34(5):711-6. [PMID: 8497006]

477. Loftus IM, Thompson MM, Fishwick G, et al. Technique for rapid control of bleeding from an aortoenteric fistula. *Br J Surg* 1997;84(8):1114. [PMID: 9278655]

478. Uranüs S, Mischinger HJ, Pfeifer J, et al. Hemostatic methods for the management of spleen and liver injuries. *World J Surg* 1996;20(8):1107-2. [PMID: 8798373]

479. Moore EE, Burch JM, Franciose RJ, et al. Staged physiologic restoration and damage control surgery. *World J Surg* 1998;22(12):1184-91. [PMID: 9841741]

480. Ham AA, Coveler LA. Anesthetic considerations in damage control surgery. *Surg Clin North Am* 1997;77(4):909-20. [PMID: 9291990]

481. Wall MJ Jr, Soltero E. Damage control for thoracic injuries. *Surg Clin North Am* 1997;77(4):863-78. [PMID: 9291987]

482. Krige JE, Bornman PC, Terblanche J. Liver trauma in 446 patients. *S Afr J Surg* 1997;35(1):10-5. [PMID: 9164149]

483. Stylianos S. Abdominal packing for severe hemorrhage. *J Pediatr Surg* 1998;33(2):339-42. [PMID: 9498413]

484. Scalea TM, Mann R, Austin R, Hirschowitz M. Staged procedures for exsanguinating lower extremity trauma: an extension of a technique—case report. *J Trauma* 1994;36(2):291-3. [PMID: 8114158]

485. Garrison JR, Richardson JD, Hilakos AS, et al. Predicting the need to pack early for severe intra-abdominal hemorrhage. *J Trauma* 1996;40(6):923-7. [PMID: 8656478]

486. Carrillo C, Fogler RJ, Shaftan GW. Delayed gastrointestinal reconstruction following massive abdominal trauma. *J Trauma* 1993;34(2):233-5 [PMID: 8459461]

487. Rosenberg AD, Bernstein RL. Perioperative anesthetic management of orthopedic injuries. *Anesthesiol Clin North Am* 1999;17(1):171-82. [EMBASE: 1999111549]

488. Routt ML Jr, Simonian PT, Ballmer F. A rational approach to pelvic trauma. Resuscitation and early definitive stabilization. *Clin Orthop* 1995;(318):61-74. [PMID: 7671533]

489. Ben-Menachem Y. Exploratory and interventional angiography in severe trauma: present and future procedure of choice. *Radiographics* 1996;16(4):963-70. [PMID: 8835986]

490. Clarke G, Mardel S. Use of MAST to control massive bleeding from pelvic injuries. *Injury* 1993;24(9):628-9. [PMID: 8288388]

491. Lee JG, Turnipseed S, Romano PS, et al. Endoscopy-based triage significantly reduces hospitalization rates and costs of treating upper GI bleeding: a randomized controlled trial. *Gastrointest Endosc* 1999;50(6):755-61. [PMID: 10570332]

492. Jensen DM, Machicado GA, Jutabha R, Kovacs TO. Urgent colonoscopy for the diagnosis and treatment of severe diverticular hemorrhage. *N Engl J Med* 2000;342(2):78-82. [PMID: 10631275]

493. Tait IS, Krige JE, Terblanche J. Endoscopic band ligation of oesophageal varices. *Br J Surg* 1999;86(4):437-46. [PMID: 10215811]

Emergency Autotransfusion

494. Smith LA, Barker DE, Burns RP. Autotransfusion utilization in abdominal trauma. *Am Surg* 1997;63(1):47-9. [PMID: 8985070]

495. Reinhorn M, Kaufman HL, Hirsch EF, Millham FH. Penetrating thoracic trauma in a pediatric population. *Ann Thorac Surg* 1996;61(5):1501-5. [PMID: 8633966]

496. Reiner DS, Tortolani AJ. Postoperative peritoneal blood salvage with autotransfusion after hepatic trauma. *Surg Gynecol Obstet* 1991;173(1):501-4. [PMID: 1948613]

497. Collin GR, Bianchi JD. Laparoscopic examination of the traumatized spleen with blood salvage for autotransfusion. *Am Surg* 1997;63(6):478-80. [PMID: 9168756]

498. Smith RS, Meister RK, Tsoi EKM, Bohman HR. Laparoscopically guided blood salvage and autotransfusion in splenic trauma: a case report. *J Trauma* 1993;34(2):313-4. [PMID: 8459481]

499. Cavallieri S, Riou B, Roche S, et al. Intraoperative autologous transfusion in emergency surgery for spine trauma. *J Trauma* 1994;36(5):639-43. [PMID: 8189463]

500. Silva PD, Beguin EA Jr. Intraoperative rapid autologous blood transfusion. *Am J Obstet Gynecol* 1989;160(5 Pt 1):1226-7. [PMID: 2729398]

501. Timberlake GA, McSwain NE Jr. Autotransfusion of blood contaminated by enteric contents: a potentially life-saving measure in the massively hemorrhaging trauma patient? *J Trauma* 1988;28(6):855-7. [PMID: 3385834]

502. Ozmen V, McSwain NE, Nichols RL, et al. Autotransfusion of potentially culture-positive blood (CPB) in abdominal trauma: preliminary data from a prospective study. *J Trauma* 1992;32(1):36-9. [PMID: 1732572]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

Emergency Angiographic Embolization

503. Velmahos GC, Chahwan S, Falabella A, et al. Angiographic embolization for intraperitoneal and retroperitoneal injuries. *World J Surg* 2000;24(5):539-45. [PMID: 10787073]
504. Velmahos GC, Demetriades D, Chahwan S, et al. Angiographic embolization for arrest of bleeding after penetrating trauma to the abdomen. *Am J Surg* 1999;178(5):367-73. [PMID: 10612529]
505. Hansen ME, Kadir S. Elective and emergency embolotherapy in children and adolescents. Efficacy and safety. *Radiologe* 1990;30(7):331-6. [PMID: 2402545]
506. Denton JR, Moore EE, Coldwell DM. Multimodality treatment for grade V hepatic injuries: perihepatic packing, arterial embolization, and venous stenting. *J Trauma* 1997;42(5):964-8. [PMID: 9191682]
507. Agolini SF, Shah K, Jaffe J, et al. Arterial embolization is a rapid and effective technique for controlling pelvic fracture hemorrhage. *J Trauma* 1997;43(3):395-9. [PMID: 9314298]
508. Henry SM, Tornetta P 3rd, Scalea TM. Damage control for devastating pelvic and extremity injuries. *Surg Clin North Am* 1997;77(4):879-95. [PMID: 9291988]
509. Sclafani SJ, Shaftan GW, Scalea TM, et al. Nonoperative salvage of computed tomography-diagnosed splenic injuries: utilization of angiography for triage and embolization for hemostasis. *J Trauma* 1995;39(5):818-27. [PMID: 7473996]
510. Reber PU, Patel AG, Baer HU, et al. Acute hemorrhage in chronic pancreatitis: diagnosis and treatment options including superselective microcoil embolization. *Pancreas* 1999;18(4):399-402. [PMID: 10231846]
511. Panetta T, Sclafani SJ, Goldstein AS, et al. Percutaneous transcatheter embolization for massive bleeding from pelvic fractures. *J Trauma* 1985;25(11):1021-9. [PMID: 4057290]
512. Pourmoghadam KK, Fogler RJ, Shaftan GW. Ligation: an alternative for control of exsanguination in major vascular injuries. *J Trauma* 1997;43(1):126-30. [PMID: 9253922]
513. McHenry CR, Fedele GM, Malangoni MA. A refinement in the technique of perihepatic packing. *Am J Surg* 1994;168(3):280-2. [PMID: 8080068]
514. Urschel JD, Bertsch DJ, Takita H. Thoracic packing for postoperative hemorrhage. *J Cardiovasc Surg* 1997;38(6): 673-5. [PMID: 9461278]

Fluid Resuscitation

515. Elliott DC. An evaluation of the end points of resuscitation. *J Am Coll Surg* 1998;187(5):536-47. [PMID: 9809573]
516. Tisherman SA, Peitzman AB. Restriction of fluid resuscitation in posttraumatic hypotension. *Curr Opin Crit Care* 1997;3(6):448-54. [ISSN: 1070-5295]
517. Bickell WH, Wall MJ Jr, Pepe PE, et al. Immediate versus delayed fluid resuscitation for hypotensive patients with penetrating torso injuries. *N Engl J Med* 1994;331(17):1105-9. [PMID: 7935634]
518. McCunn M, Karlin A. Nonblood fluid resuscitation. More questions than answers. *Anesthesiol Clin North Am* 1999;17(1):107-23. [EMBASE: 1999111545]
519. Stern SA, Dronen SC, Birrer P, Wang X. Effect of blood pressure on hemorrhage volume and survival in a near-fatal hemorrhage model incorporating a vascular injury. *Ann Emerg Med* 1993;22(2):155-63. [PMID: 8427424]
520. Burris D, Rhee P, Kaufmann C, et al. Controlled resuscitation for uncontrolled hemorrhagic shock. *J Trauma* 1999;46(2):216-23. [PMID: 10029024]
521. Silbergleit R, Satz W, McNamara RM, et al. Effect of permissive hypotension in continuous uncontrolled intra-abdominal hemorrhage. *Acad Emerg Med* 1996;3(10):922-6. [PMID: 8891037]
522. Owens TM, Watson WC, Prough DS, et al. Limiting initial resuscitation of uncontrolled hemorrhage reduces internal bleeding and subsequent volume requirements. *J Trauma* 1995;39(2):200-9. [PMID: 7674386]
523. Herlevsen P, Lund O, Hansen PA, Knudsen F. Deliberate hypotension and prophylactic cerebral protection in a case of combined severe neurotrauma and aortic rupture. *J Cardiothorac Vasc Anesth* 1996;10(4):513-5. [PMID: 8776648]
524. Pepe PE. Acidosis in acute hemorrhage: detrimental or elemental? [editorial] *Acad Emerg Med* 1995;2(2):81-2. [PMID: 7621227]
525. Stoelting RK, Dierdorf SF. Diseases of the nervous system. In: *Anesthesia and Co-existing Disease.* 3rd ed. New York: Churchill Livingstone; 1993. p. 204-7. [ISBN: 978-0-443-08813-1]
526. Nolan J. Fluid replacement. *Br Med Bull* 1999;55(4):821-43. [PMID: 10746333]
527. Lilly MP, Gala GJ, Carlson DE, et al. Saline resuscitation after fixed-volume hemorrhage. Role of resuscitation volume and rate of infusion. *Ann Surg* 1992;216(2):161-71. [PMID: 1503518]
528. Solomonov E, Hirsh M, Yahiya A, Krausz MM. The effect of vigourous fluid resuscitation in uncontrolled hemorrhagic shock after massive splenic injury. *Crit Care Med* 2000;28(3):749-54. [PMID: 10752825]
529. Bickell WH, Stern S. Fluid replacement for hypotensive injury victims: how, when and what risks? *Curr Opin Anaesthesiol* 1998;11(1):177-80. [PMID: 17013216]
530. Pepe PE. Resuscitation of the patient with major trauma. *Curr Opin Crit Care* 1995;1(6):479-86. [ISSN: 1070-5295]
531. Dries DJ. Hypotensive resuscitation. *Shock* 1996;6(5):311-6. [PMID: 8946643]
532. Sawyer RW, Bodai BI, Blaisdell FW, McCourt MM. The current status of intraosseous infusion. *J Am Coll Surg* 1994;179(3):353-60. [PMID: 8069439]
533. Chávez-Negrete A, Majluf Cruz S, Frati Munari A, et al. Treatment of hemorrhagic shock with intraosseous or intravenous infusion of hypertonic saline dextran solution. *Eur Surg Res* 1991;23(2):123-9. [PMID: 1718756]
534. Kirkpatrick AW, Chun R, Brown R, Simmons RK. Hypothermia and the trauma patient. *Can J Surg* 1999;42(5):333-43. [PMID: 10526517]
535. Gentilello LM, Jurkovich GJ, Stark MS, et al. Is hypothermia in the victim of major trauma protective or harmful? A randomized, prospective study. *Ann Surg* 1997;226(4):439-49. [PMID: 9351712]
536. Peng RY, Bongard FS. Hypothermia in trauma patients. *J Am Coll Surg* 1999;188(6):685-96. [PMID: 10359364]
537. Bräuer A, Wrigge H, Kersten J, et al. Severe accidental hypothermia: rewarming strategy using a veno-venous bypass system and a convective air warmer. *Intensive Care Med* 1999;25(5):520-3. [PMID: 10401949]
538. Bernard SA, Jones BM, Buist M. Experience with prolonged induced hypothermia in severe head injury. *Crit Care* 1999;3(6):167-72. [PMID: 11056742]

Early Erythropoietin Therapy

539. Corwin HL, Gettinger A, Rodriguez RM, et al. Efficacy of recombinant human erythropoietin in the critically ill patient: a randomized, double-blind, placebo-controlled trial. *Crit Care Med* 1999;27(11):2346-50. [PMID: 10579246]
540. Gabriel A, Kozek S, Chiari A, et al. High-dose recombinant human erythropoietin stimulates reticulocyte production in patients with multiple organ dysfunction syndrome. *J Trauma* 1998;44(2):361-7. [PMID: 9498512]

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.

541. DeMeester SR, Marsh EE, Gerkin TM, Rodriguez JL. Immediate use of recombinant erythropoietin in a Jehovah's Witness following major blunt trauma. *Contemp Surg* 1994;45(4):228-32. [ISSN: 0045-8341]

542. Kraus P, Lipman J. Erythropoietin in a patient following multiple trauma. *Anaesthesia* 1992;47(11):962-4. [PMID: 1466437]

543. Koestner JA, Nelson LD, Morris JA Jr, Safcsak K. Use of recombinant human erythropoietin (r-HuEPO) in a Jehovah's Witness refusing transfusion of blood products: case report. *J Trauma* 1990;30(11):1406-8. [PMID: 2231810]

544. Levine EA, Rosen AL, Sehgal LR, et al. Erythropoietin deficiency after coronary artery bypass procedures. *Ann Thorac Surg* 1991;51(5):764-6. [PMID: 2025080]

545. Goodnough LT, Brittenham GM. Limitations of the erythropoietic response to serial phlebotomy: implications for autologous blood donor programs. *J Lab Clin Med* 1990;115(1):28-35. [PMID: 2299254]

546. Walsh DS, Pattanapanyasat K, Lamchiagdhase P, et al. Iron status following trauma, excluding burns. *Br J Surg* 1996;83(7):982-5. [PMID: 8813793]

547. Collins SL, Timberlake GA. Severe anemia in the Jehovah's Witness: case report and discussion. *Am J Crit Care* 1993;2(3):256-9. [PMID: 8364678]

548. Koenig HM, Levine EA, Resnick DJ, Meyer WJ. Use of recombinant human erythropoietin in a Jehovah's Witness. *J Clin Anesth* 1993;5(3):244-7. [PMID: 8318245]

549. Howell PJ, Bamber PA. Severe acute anaemia in a Jehovah's Witness. Survival without blood transfusion. *Anaesthesia* 1987;42(1):44-8. [PMID: 3548474]

550. Thomas JM, Wong CJ, Scheuermann KW, et al. Clinical strategies for managing hemorrhage and anemia without blood transfusion in the ICU. Poster presented at the 7th World Congress of Intensive and Critical Care Medicine; 1997 Jun 29–Jul 3; Ottawa, Canada.

551. Nichols RL, Smith JW, Muzik AC, et al. Preventive antibiotic usage in traumatic thoracic injuries requiring closed tube thoracostomy. *Chest* 1994;106(5):1493-8. [PMID: 7956409]

552. Sarmiento JM, Aristizabal G, Rubiano J, Ferrada R. Prophylactic antibiotics in abdominal trauma. *J Trauma* 1994;37(5):803-6. [PMID: 7966479]

553. Hunt TK, Hopf HW. Wound healing and wound infection. What surgeons and anesthesiologists can do. *Surg Clin North Am* 1997;77(3):587-606. [PMID: 9194882]

Physiological Response to Anemia

554. Tuman KJ. Tissue oxygen delivery: the physiology of anemia. *Anesthesiol Clin North Am* 1990;8(3):451-69. [EMBASE: 1990303631]

555. Bush RL, Pevec WC, Holcroft JW. A prospective, randomized trial limiting perioperative red blood cell transfusions in vascular patients. *Am J Surg* 1997;174(2):143-8. [PMID: 9293831]

556. Landow L. Perioperative hemodilution. *Can J Surg* 1987;30(5):321-5. [PMID: 3311328]

557. Hébert PC, Wells G, Blajchman MA, for the Transfusion Requirements in Critical Care Investigators and the Canadian Critical Care Trials Group. A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. *N Engl J Med* 1999;340(6):409-17. [PMID: 9971864]

558. Spiess BD, Ley C, Body SC, et al. Hematocrit value on intensive care unit entry influences the frequency of Q-wave myocardial infarction after coronary artery bypass grafting. *J Thorac Cardiovasc Surg* 1998;116(3):460-7. [PMID: 9731788]

559. Bracey AW, Radovancevic R, Riggs SA, et al. Lowering the hemoglobin threshold for transfusion in coronary artery bypass procedures: effect on patient outcome. *Transfusion* 1999;39(10):1070-7. [PMID: 10532600]

560. Spence RK. Preoperative packed cell volume necessary for patients undergoing elective surgery. *Br J Anaesth* 1998;81 Suppl 1:50-5. [PMID: 10318989]

561. Fontana JL, Welborn L, Mongan PD, et al. Oxygen consumption and cardiovascular function in children during profound intraoperative normovolemic hemodilution. *Anesth Analg* 1995;80(2):219-25. [PMID: 7818103]

562. Mathru M, Kleinman B, Blakeman B, et al. Myocardial metabolism and adaptation during extreme hemodilution in humans after coronary revascularization. *Crit Care Med* 1992;20(10):1420-5. [PMID: 1395663]

563. McLoughlin TM Jr, Fontana JL, Alving B, et al. Profound normovolemic hemodilution: hemostatic effects in patients and in a porcine model. *Anesth Analg* 1996;83(3):459-65. [PMID: 8780263]

564. Kreimeier U, Messmer K. Hemodilution in clinical surgery: state of the art 1996. *World J Surg* 1996;20(9):1208-17. [PMID: 8864083]

565. Lieberman JA, Weiskopf RB, Kelley SD, et al. Critical oxygen delivery in conscious humans is less than 7.3 ml O_2·kg^{-1}·min^{-1}. *Anesthesiology* 2000;92(2):407-13. [PMID: 10691227]

566. Weiskopf RB, Viele MK, Feiner J, et al. Human cardiovascular and metabolic response to acute, severe isovolemic anemia. *JAMA* 1998;279(3):217-21. [PMID: 9438742]

567. Carson JL, Duff A, Berlin JA, et al. Perioperative blood transfusion and postoperative mortality. *JAMA* 1998;279(3):199-205. [PMID: 9438739]

568. Stehling, L, Doherty DC, Faust RJ, et al. Practice guidelines for blood component therapy. A report by the American Society of Anesthesiologists Task Force on blood component therapy. *Anesthesiology* 1996;84(3):732-47. [PMID: 8659805]

569. Goodnough LT, Vizmeg K, Riddell J 4th, Soegiarso RW. Discharge haematocrit as clinical indicator for blood transfusion audit in surgery patients. *Transfus Med* 1994;4(1):35-44. [PMID: 8012491]

570. Lum G. Should the transfusion trigger and hemoglobin low critical limit be identical? *Ann Clin Lab Sci* 1997;27(2):130-4. [PMID: 9098512]

571. Viele MK, Weiskopf RB. What can we learn about the need for transfusion from patients who refuse blood? The experience with Jehovah's Witnesses. *Transfusion* 1994;34(5):396-401. [PMID: 8191563]

572. Beyens T. Management of profound postoperative anemia in a Jehovah's Witness [letter]. *J Cardiovasc Vasc Anesth* 1998;12(1):130. [PMID: 9509374]

573. Hebert PC, Hu LQ, Biro GP. Review of physiologic mechanisms in response to anemia. *CMAJ* 1997; 156(11):S27-S40. [ISI:XC077]

574. Högman CF, Meryman HT. Storage parameters affecting red blood cell survival and function after transfusion. *Transfus Med Rev* 1999;13(4):275-96. [PMID: 10553271]

575. Purdy FR, Tweeddale MG, Merrick PM. Association of mortality with age of blood transfused in septic ICU patients. *Can J Anaesth* 1997;44(12):1256-61. [PMID: 9429042]

576. Marik PE, Sibbald WJ. Effect of stored-blood transfusion on oxygen delivery in patients with sepsis. *JAMA* 1993;269(23):3024-9. [PMID: 8501845]

577. Ince C, Sinaasappel M. Microcirculatory oxygenation and shunting in sepsis and shock. *Crit Care Med* 1999;27(7):1369-77. [PMID: 10446833]

---

* This *Clinical Strategies* document is an informational resource and reference for medical practitioners only. It provides neither medical advice nor treatment recommendations and does not substitute for an appropriately qualified health-care professional. The editor does not recommend or endorse any test, physician, product, or procedure, and has endeavored to include accurate, timely information. However, not all listed strategies are appropriate or acceptable to all patients. It is the responsibility of each provider to maintain awareness of new information, discuss options for care, and assist patients in making choices in accord with their wishes, values, and beliefs. Patients should always seek the advice of a qualified health-care professional regarding a medical condition or treatment.



cha-E 200827

© 2001, 2017 Watch Tower Bible and Tract Society of Pennsylvania. E-mail: HIS@jw.org