

Proposed Treatment Guidelines for Donor Care

David J. Powner, MD, FCCP, FCCM
Professor, Departments of Neurosurgery and Medicine
Vivian L. Smith Center for Neurologic Research
University of Texas Health Science Center at Houston
Houston, TX

Joseph M. Darby, MD
Professor, Department of Critical Care Medicine
University of Pittsburgh School of Medicine
Pittsburgh, PA

John A. Kellum, MD, FCCM
Associate Professor, Department of Critical Care Medicine
University of Pittsburgh School of Medicine
Pittsburgh, PA

Recent articles¹⁻⁷ in *Progress in Transplantation* have outlined treatment issues during care of adult brain dead organ donors prior to organ removal. In general, it has been assumed that maintaining hemodynamic variables and laboratory parameters within normal ranges is the preferred goal. Although acceptance of organs from donors with deviations from normative values has been possible, none of those deviations appear to enhance organ function. Therefore, the guidelines proposed herein focus on normative hemodynamic values and laboratory parameters as therapeutic goals.

Continuing care for the donor is often complex and extends over several hours. It is recommended that the organ procurement coordinator (OPC) create a prioritized problem list as care is initiated. Items may then be deleted as problems resolve or added as new issues emerge during subsequent care. A sample flowsheet is also included below.

It is recognized that portions of these guidelines may differ from established treatment protocols from individual organ procurement organizations (OPOs). In such cases, our guidelines, based upon our experiences in donor care and standard critical care practice, are offered for consideration. Final treatment objectives and methods should be determined by local OPOs. Finally, most guidelines reach an end point when consultation between the organ procurement coordinator and a physician is recommended. This physician may be an OPO medical liaison or hospital-assigned physician, but such a physician resource must be available for discussion.

Rx Guideline – Standard Donor Care

Introduction: As the procurement coordinator assumes responsibility for continuing donor care, priorities for assessment and treatment change to assure that the best physiological support will be given to maximize the potential for successful organ transplantation. That transition is facilitated by policies that allow ongoing care orders be written by the coordinator and supported by the OPO's medical staff. Some prior treatment may no longer be appropriate for organ procurement, but many aspects of fundamental patient care should be continued.

The coordinator should write orders to initiate standard donor care:

1. Transfer care to [Name of OPO]
2. Discontinue all prior orders
3. Blood pressure, heart rate, temperature, urine output, central venous pressure (CVP) [if central venous catheter present], pulmonary artery occlusion pressure (PAOP) [if pulmonary artery (PA) catheter is present] q 1 hour
4. Reorder mechanical ventilator parameters as previously set
5. Maintain head of bed at 30-40 degrees elevation
6. Continue routine pulmonary suctioning and side-to-side body positioning.
7. Warming blanket to maintain body temp above 36.5°C
8. Maintain sequential compression devices (SCDs)
9. [If present] Continue chest tube suction or water seal as previously ordered
10. [If present] Nasogastric (orogastric) tube to low intermittent suction
11. Intravenous fluid - D5 0.45% saline plus 20 meq KCl per liter at 75cc/hour
12. Call OPO coordinator if: MAP < 70 mm Hg; systolic pressure > 170 mm Hg; Heart rate < 60 > 130 bpm; Temp < 36.5°C > 37.8°C; Urine output < 75 > 250 cc/hr; CVP or PAOP < 8 > 18 mm Hg
13. Medications: Pantoprazole 40 mgm IV q 24 hours, first dose now
Artificial tears q 1 hour and prn to prevent corneal drying
Albuteral and Atrovent unit dose per aerosol q 4 hours
Continue antibiotics previously ordered at same dose and frequency
Continue vasoactive drug infusions (dopamine, norepinephrine, etc) at previously ordered concentrations and infusion rates
[Review all medications previously ordered. Most (anticonvulsants, pain medications, laxatives, gastrointestinal motility agents, eye drops, antihypertensives, anti-nausea agents, subcutaneous heparin, osmotic agents (mannitol), and diuretics) are unnecessary during donor care and will be discontinued automatically with order #1 above.
Review any other medications in question with MD]
14. Send electrolytes, magnesium, ionized calcium, CBC, platelets, glucose, blood urea nitrogen, creatinine, phosphorous, arterial blood gas, prothrombin time (PT), partial thromboplastin time (PTT), STAT and repeat q 4 hours.
15. [If not previously done] Send blood for type and screen with above blood draw
16. Finger stick glucose q 2 hours – call glucose < 90 > 180 mgm/dL.

17. Electrocardiogram STAT
18. Chest X-ray STAT- Indication: initial donor evaluation.
19. [Add other orders for specific organ evaluation as indicated]

The above order set provides a “safety net” of call orders so that the coordinator is alerted to significant changes in donor status. It also prescribes the foundation for ongoing monitoring of physiological and laboratory variables.

Donor care is subsequently directed and “fine-tuned” through the **Rx Guidelines** that follow. These include treatment plans for hypertension, hypotension, glucose management, temperature, anemia, coagulopathy and thrombocytopenia, mechanical ventilation, fluid and electrolyte treatment, polyuria, and acid-base changes. Each may be referenced as that circumstance/problem arises. Although the guidelines are not intended to compartmentalize the complex process of overall donor care, they may be helpful in providing useful resources in methods of treatment, precautions, and points at which MD consultation is appropriate.

Rx Guideline – Hypertension

Introduction: It is unusual for hypertension to occur after brain death, although it is common during the evolution of brain death. Because donor organs are likely at more risk from hypotension than hypertension, a conservative treatment plan is recommended. The goal for mean arterial blood pressure (MAP) is <90 mm Hg when the donor is hypertensive, but always above 65-70 mm Hg. The MAP is measured via an intra-arterial catheter, non-invasive blood pressure device or calculated by: diastolic pressure + 1/3(systolic – diastolic pressures) + 5. Therapy should be started if the MAP is sustained above 95 mm Hg for 30 minutes after certification of brain death. Placement of the arterial catheter in an upper extremity is preferred.

Treatment:

- A. Reduce or discontinue inotropic or vasopressor medications or infusions.
- B. If the **difference** between the MAP recorded via an arterial catheter and non-invasive machine is > 20 mmHg – discuss which blood pressure to follow with the physician consultant (MD). Differences in measurements taken from an automatic oscillometric non-invasive device and an arterial catheter may be due to several technical factors.^{8,9}
- C. Give labetalol 20 mgm IV bolus every 20 minutes until MAP goal (65-70 mm Hg) is reached. If the MAP goal is not achieved after 2 doses begin:
- D. Nicardipine IV infusion – start infusion at 5mgm/hr and titrate up to 15 mgm/hr to achieve the MAP goal.
- E. If the MAP goal is not achieved after titration of nicardipine to 15 mgm/hr, consult MD.

Rx Guideline – Hypotension

Introduction: Hypotension commonly follows brain death and may be caused by on-going or pre-existing conditions leading to hemorrhagic, cardiogenic, distributive, or obstructive types of “shock”. In the absence of these pre-existing conditions causing shock, hypotension commonly occurs after brain death due to loss of vasomotor centers in the brain causing vasodilation, decreased contractility of the heart, or hypovolemia due to ongoing fluid loss due to diabetes insipidus. Hypotension will be defined as a mean arterial blood pressure (MAP) of < 60mmHg as measured from an indwelling arterial catheter, non-invasive blood pressure machine, or calculated by: diastolic pressure + 1/3 [systolic – diastolic pressure] + 5. Placement of an arterial line for monitoring is desirable, and insertion in an upper extremity is preferred. The treatment goal for MAP is 65-75mmHg.

I. Assessment:

- A. Review medical record for evidence of recent blood loss. Confirm that the most recent hematocrit (Hct) is > 28% and reaffirm with an immediate repeat Hct. – Refer to Rx Guidelines- Anemia and Coagulopathy and treat as indicated if Hct < 28% or a coagulation disorder is present.
- B. Review medical record for evidence of concomitant myocardial ischemia/infarction during this admission. Repeat ECG and maintain at bedside. Consult MD for ECG interpretation.
- C. Review medical record for evidence of excessive fluid losses above intake (output > intake by > 1500 cc in last 24 hrs) during current hospitalization. If polyuria is present, refer to Rx Guideline- Polyuria.
- D. Review current patient status for a central venous line and evaluate central venous pressure (CVP) or pulmonary artery (PA) catheter and evaluate pulmonary artery occlusion pressure (PAOP). The goal is to maintain both at 12-15 mm Hg. If PA catheter present, obtain information regarding cardiac output, cardiac index, systemic vascular resistance index, and left ventricular stroke work index.
- E. Review the medical record for evidence of ongoing severe infection, drug or other allergic reactions (e.g. due to transfusion), pericardial effusion, or pneumothorax. Obtain a chest radiograph and consult MD for its interpretation.

II. Treatment- Algorithm

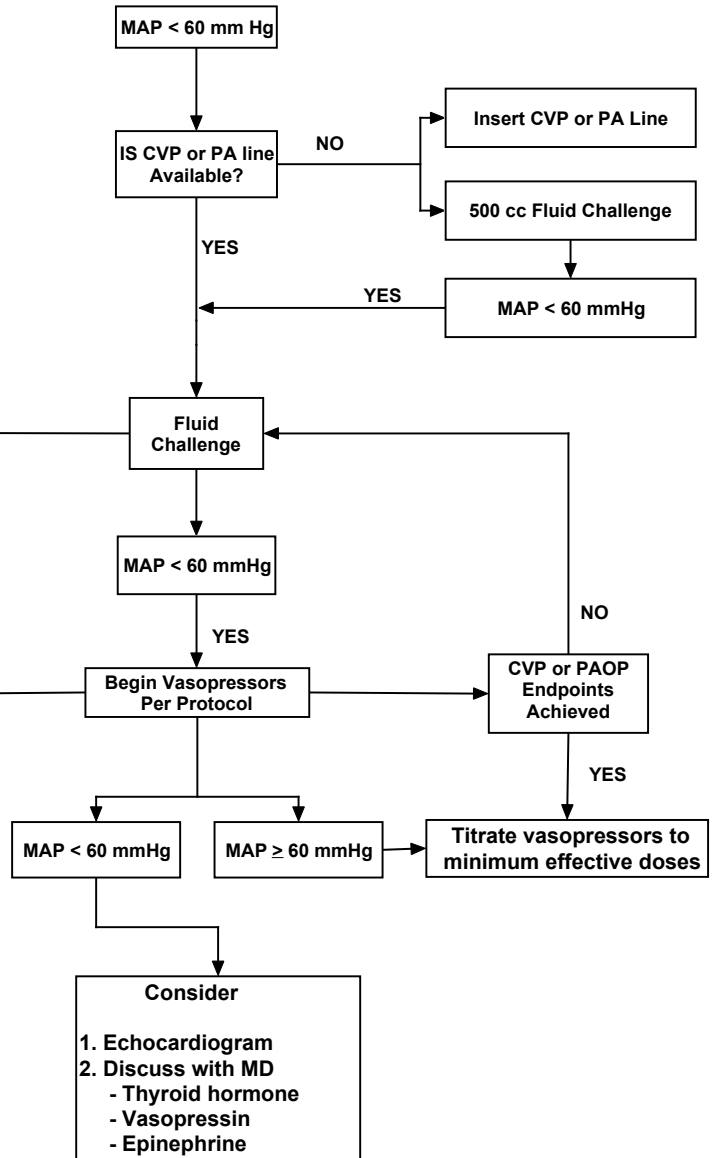
- A. Assure any signs of continuing hemorrhage (external, GI, urinary, abdominal, etc.) have been evaluated and interventions initiated.
- B. Discontinue medications that may contribute to hypotension (e.g. antihypertensives, beta-blockers)
- C. The general principle of treatment is to first, assure that adequate intravascular volume (preload) is present as evidenced by a CVP and/or PAOP greater than 12 mm Hg.
- D. Begin treatment with a crystalloid solution such as 0.9% saline (normal saline) or Ringer’s lactate. Colloid solutions may be added and may be preferable for repeated fluid challenges (5% albumin- 250 or 500 ml). Thereafter either inotropic or vasopressor medications will be infused and titrated to the MAP goal or other hemodynamic parameters. If a PA catheter is available or at any time is inserted, a cardiac/hemodynamic profile should be obtained. If the donor demonstrates a low systemic vascular resistance index (SVRI) (< 1400 dyne.sec.m²/cm⁵) a vasopressor (e.g. norepinephrine, phenylephrine) is the vasoactive drug of choice and subsequently titrated to maintain the MAP > 60 mmHg. If the left ventricular stroke work index (LVSWI) is low (< 35 gm.m/m²), a positive inotropic agent (e.g. dopamine, dobutamine) should be used. The algorithm below assumes that if the MAP, CVP, heart rate and PAOP goals are reached, vital signs will continue to be monitored. Vasoactive medications should be weaned and removed as soon as possible, while maintaining the MAP goal. Subsequent deviations from goal values may require return to the guidelines.

Hemodynamic Endpoints	
MAP	60- 70 mm Hg
CVP or PAOP	≤ 15 mm Hg

Fluid Challenge	
CVP or PAOP (mm Hg)	Volume (CC)
< 5	1000
5-10	500
11-15	250
> 15	NONE

Vasopressor Protocol

- Begin vasopressors with dopamine at 5 mcg/kg/min.
- Titrate dopamine to achieve MAP endpoints
- Maximum dopamine dose to 10 mcg/kg/min
- Add norepinephrine at 0.5 mcg/kg/min for MAP < 60 and maximum dopamine dose
- Titrate norepinephrine to maximum dose of 2.5 mcg/kg/min



Rx Guideline – Glucose Management

Introduction: Both hypoglycemia and hyperglycemia may harm donor organs. Measure serum glucose every 4 hours and obtain finger stick glucose (FSG) per glucometer every 2 hours unless as described below.

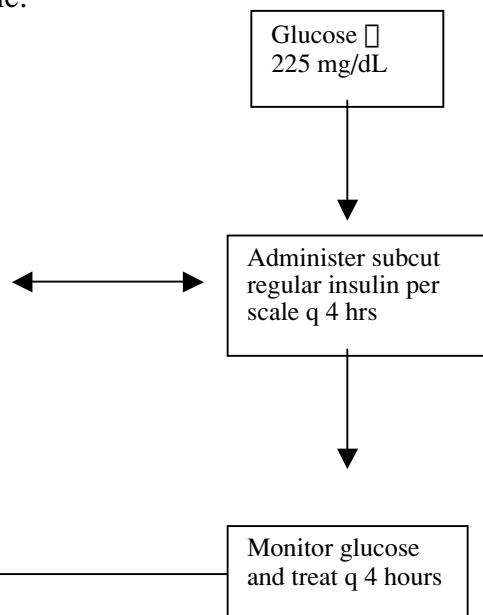
I. Hypoglycemia – treat < 75 mg/dL

- A. Give 1 pre-mixed syringe of 50% dextrose (D50).
- B. Repeat glucose or obtain finger-stick glucose in 30 minutes and repeat 50% dextrose if glucose < 75 mg/dL
- C. If laboratory or finger stick glucose remains < 75 mg/dL after 2 doses of D50, consult MD.

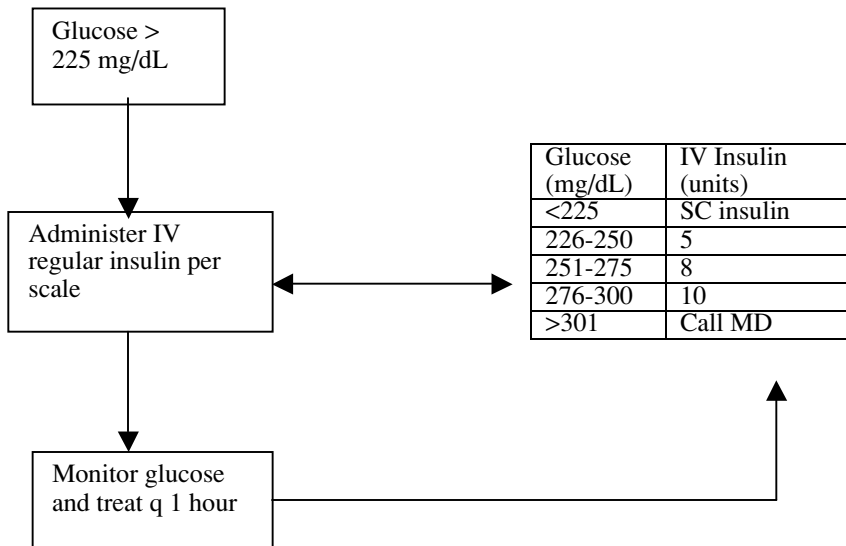
II. Hyperglycemia – treat serum glucose > 150 mg/dL

- A. Assure glucose removed from all IV fluids/infusions unless required by pharmacy.
- B. The algorithms below show a subcutaneous insulin sliding scale and a supplemental IV insulin regimen.
Note: Give subcutaneous insulin no more often than every four hours. When supplemental IV insulin is also needed, give the IV insulin bolus prescribed by the IV sliding scale every hour after the hourly FSG. Stop IV insulin when the blood sugar drops below 250 mg/dL.
- C. In summary, hyperglycemia is treated by first removing sources of exogenous glucose, followed by subcutaneous insulin per the above sliding scale every four hours. Supplemental IV insulin is given each hour thereafter only **if** the blood glucose remains above 225 mg/dL
- D. Subcutaneous insulin sliding scale:

Glucose (mg/dL)	Subcut Insulin (units)
100-150	None
151-175	7
176-200	12
201-225	16
>225	Add IV Insulin Scale



E. Supplemental intravenous insulin sliding scale. Give the q 4 hour subcutaneous insulin as prescribed above plus the hourly IV bolus prescribed below when the blood glucose or finger-stick glucose is > 225 mg/dL.



F. If glucose remains > 250 mg/dL four hours after the initial subcutaneous insulin and subsequent IV insulin therapy, consult MD to discuss an insulin infusion.

Rx Guideline – Temperature

Introduction: Brain death usually causes loss of thermal regulation in the donor, commonly resulting in hypothermia. The temperature goal is 36° C – 37.5° C (97° F – 99.5° F).

I. Hypothermia Treat < 36° C (97° F)

- A. The preferred method of body temperature measurement is from a core site, such as a pulmonary artery catheter or bladder (specialized catheter). Axillary temperatures should not be used, and oral temperatures are less accurate in hypothermia. Rectal temperatures can be used if hypothermia is not severe (>35°C).
- B. Use active surface warming with a heated-liquid or hot air warming blanket plus insulating thermal blankets.
- C. Warm the inspired gas from the ventilator to 38.5° C (101.3° F).
- D. Minimize the amount of body surface and time of exposure to environmental temperatures.
- E. If temperature remains < 36° C after 3 hours of attempted re-warming, consult MD.

II. Hyperthermia (Unusual after brain death) – treat > 37.8° C (100.1° F).

- A. Remove unnecessary blankets.
- B. Do NOT cool inspired gas.
- C. Acetaminophen 650mgm per suppository or per gastric tube q 3 hours.
- D. Use automated fluid filled cooling blanket.
- E. If temperature remains > 101° F after 3 hours of cooling, consult MD.

Rx Guideline – Anemia

Introduction: Although the differential diagnosis for anemia may be extensive, during donor care the most likely causes are continuing blood loss or excessive blood draws for laboratory testing. Hemolysis may rarely occur. The goal is to maintain the hematocrit (Hct) above 30%.

I. Assessment

- A. Review medical record for evidence of bleeding sites, prior blood transfusions and their frequencies, or other information about blood loss or hemolysis.
- B. Observe for signs of ongoing bleeding from:
 1. External wounds, IV sites, etc.
 2. GI tract via gastric tube or bowel movements; observe for abdominal distension and/or firmness and changes during repeat abdominal assessment
 3. Urinary tract by observation or laboratory assessment for blood in urine.
- B. Refer to Rx Guideline – Coagulopathy. Obtain PT, PTT, fibrinogen and platelet count and treat as indicated.
- C. If Hct 28-30% and no signs of bleeding are present begin q 4 hr Hct measurements.
- D. If Hct 28-30% and no gastric tube is in place, insert orogastric tube and lavage stomach to assess for upper GI blood.

II. Treatment

- A. If prior transfusions have been required, submit blood bank order to maintain 2-4 units of packed red blood cells (PRBC) available. Otherwise write order to type and cross-match and maintain 2 units PRBC available.
- B. If Hct < 30% transfuse 2 units PRBC rapidly.
- C. Reassess Hct 1 hour after last unit PRBC infused and repeat transfusion if Hct < 30%.
- D. Reassess Hct 1 hour after 4th unit PRBC and reconsider above assessment items. If Hct < 30% after 4 units PRBC, consult MD.

Rx Guideline – Mechanical Ventilation

Introduction: Under most circumstances volume limited controlled mechanical ventilation will be used during donor care. Pressure limited controlled mechanical ventilation is indicated when peak and plateau airway pressures are elevated, indicating high airway resistance or poor lung compliance (see below). The goals during mechanical ventilation are:

- A. Peak airway pressure (Peak AWP) < 40 cm H₂O
- B. Plateau airway pressure (Plat AWP) < 35 cm H₂O
- C. FIO₂ – lowest possible to maintain SpO₂ > 92% and PaO₂ > 70 mm Hg
- D. PEEP – minimum 5 cm H₂O, adjust to maintain PaO₂ > 70 mm Hg
- E. Auto PEEP - <5 cm H₂O
- F. Arterial blood gas (ABG) values: pH 7.35 – 7.45; PaCO₂ > 16 mm Hg, < 60 mm Hg to maintain pH within goal range; PaO₂ > 70 mm Hg; HCO₃ not independently adjusted.

I. Assessment

- A. Evaluate the medical record for cardio-pulmonary diseases prior to or during this admission. Assess related issues such as chronic oxygen use at home, ongoing pneumonia, chest radiograph results, culture results, antibiotics ordered, respiratory treatments given, etc.
- B. Assure recent ABG results available or obtain sample for testing. Compare results to the above treatment goals.
- C. Perform a physical examination with attention to abnormalities such as wheezing, rhonchi, sputum appearance/thickness/tenacity, etc.
- D. Repeat ABG's at least every 4 hours or more frequently to assess changes in respiratory status or after adjustments in ventilator settings.
- E. Consult with a respiratory care practitioner to identify if above mechanical ventilation goals are being met, i.e. auto PEEP, airway pressures, etc.

II. General Ventilator Settings

- A. Volume- limited controlled ventilation
 1. Tidal Volume (V_T) – 10 ml/kg ideal body weight (kg). If high peak airway pressures are present, reduce V_T to 6-8 ml/kg ideal body weight (kg).
Ideal body weight:
 - a. Male – 50 kg + 2.3 kg per inch > 60 inches
 - b. Female – 45 kg + 2.3 kg per inch > 60 inches
 2. Rate (f) – adjusted to maintain minute ventilation (V_T x f)(V_E) of approximately 8-10 L/min or to maintain PaCO₂ > 16 mm Hg < 60 mm Hg, so as to maintain arterial pH at 7.35 – 7.45. Downward adjustment in rate may be needed to minimize auto PEEP.
 3. Flow rate – usually about 60 L/min; adjust to minimize Peak AWP; beware of auto-PEEP as flow rate is slowed; higher flow rate may be needed to minimize auto PEEP.
 4. PEEP – minimum 5 cmH₂O – adjusted to assist in maintaining PaO₂ > 70 mm Hg.
 5. FIO₂ – adjust to maintain PaO₂ > 70 mm Hg.
 6. Use decelerating (ramp) pattern for flow delivery, when available.
- B. Pressure- limited controlled ventilation
 1. Inspiratory pressure setting – to limit peak airway pressure at 35-40 cm H₂O, consult with respiratory care practitioner for final pressure limit setting due to various ventilator types.
 2. Rate – same as A(2) above.
 3. PEEP – same as A(4) above. However, recall PEEP adjustments may change delivered V_T and V_E during pressure-limited ventilation, i.e. increased PEEP will generally decrease V_T and V_E causing PaCO₂ to rise (reverse with decreased PEEP).
 4. FIO₂ – same as A(5) above.

III. General Respiratory Treatments

- A. Assure adequate suctioning of excessive sputum.
- B. Assure bronchodilators are ordered as indicated by wheezing or a peak airway pressure – plateau airway pressure gradient of > 10 cm H₂O.
- C. Other forms of chest physiotherapy or related devices are optional but should be considered.

IV. Ventilator Adjustments – Volume-limited controlled ventilation

Note: Repeat ABG's 30 minutes after any change of ventilator settings to assess effects

Note: Combinations of adjustments listed below may be necessary as guided by arterial blood gas results and airway pressures.

- A. Acidemic pH – arterial pH < 7.35

1. Increase V_T to maximum 12 ml/kg ideal wt as long as Plat AWP remains < 35 cm H_2O , or
 2. Increase rate to maximum 22 breaths/min as long as auto PEEP remains < 5 cm H_2O .
 3. If pH remains < 7.32 after above changes, refer to Rx Guideline- Acid-Base Treatment.
- B. Alkalemic pH – arterial pH > 7.45
1. Decrease ventilator rate sequentially to minimum of 6 breaths/ min to achieve pH goal.
 2. Decrease V_T to minimum of 6 ml/kg ideal body wt.
 3. If pH remains > 7.45, consult MD.
- C. High Plat AWP > 35 cm H_2O
1. Reduce flow rate to minimum 50 L/min – as long as auto PEEP remains < 5 cm H_2O .
 2. Reduce V_T to minimum of 6 ml/kg ideal body wt – assess effect on arterial pH.
 3. Reduce PEEP to minimum 5 cm H_2O – assess effect on PaO_2 .
 4. If Plat AWP remains > 35 cm H_2O , consult MD.
- D. Auto PEEP > 5 cm H_2O
1. Increase flow rate to maximum of 90L/min – as long as Plat AWP remains < 35cm H_2O .
 2. Decrease V_T to minimum 6 ml/kg ideal body wt – assess effect on arterial pH.
 3. Decrease ventilator rate sequentially to minimum of 8 breaths/min to minimize auto PEEP - assess effect on arterial pH.
 4. If auto PEEP remains > 5 cm H_2O , consult MD.
- E. Low PaO_2 – PaO_2 < 70 mm Hg
1. Increase FIO_2 to maximum 1.0 (100%).
 2. Increase PEEP to maximum 15 cm H_2O – as long as Plat AWP remains < 35 cm H_2O .
 3. Add inspiratory pause (hold) to maximum 1.0 seconds as long as auto PEEP remains < 5 cm H_2O .
 4. If PaO_2 remains < 70 mm Hg, consult MD.

V. Ventilator Adjustments – Pressure- limited controlled mechanical ventilation

- A. Acidemic pH – arterial pH < 7.35
1. Increase ventilator rate to maximum 22 breaths/min as long as auto PEEP < 5 cm H_2O
Note: auto PEEP will decrease V_T delivered and may worsen acidemia.
 2. Increase inspiratory pressure setting to maximum Peak AWP of 45 cm H_2O .
 3. If arterial pH remains < 7.32, consult MD.
- B. Alkalemic pH – arterial pH > 7.45
1. Decrease ventilator rate sequentially to minimum of 6 breaths/min to achieve pH goals.
 2. Decrease inspiratory pressure setting but maintain V_T above 6 ml/kg ideal body wt.
 3. If arterial pH remains > 7.45, consult MD.
- C. Auto PEEP – auto PEEP > 5 cm H_2O
1. Decrease ventilator rate sequentially to minimum 8 breaths/min – assess effect on arterial pH.
 2. If > 5 cm H_2O auto PEEP persists, consult MD.
- D. Low PaO_2 – PaO_2 < 70 mm Hg
1. Increase FIO_2 to maximum 1.0 (100%).
 2. Increase ventilator PEEP to maximum of 15 cm H_2O as long as pH remains > 7.35. (increased PEEP will decrease tidal volume delivered in pressure-limited ventilation.
 3. If PaO_2 remains < 70 mm Hg, consult MD.

Rx Guideline – Fluid Electrolyte Treatment

Introduction: The treatment goal is to maintain electrolytes within the normal limits established by the clinical laboratory in each hospital. To achieve that goal, laboratory testing of Sodium (Na), Potassium (K), Chloride (Cl), Bicarbonate (HCO₃), Magnesium (Mg), Phosphorous (P), and ionized Ca (Ca⁺⁺), should be completed every 4 hours. More frequent testing may be needed to monitor/ treat critical levels. Any testing should be delayed for 30 minutes after the last dose of the electrolyte being treated. All electrolyte replacement should be by the intravenous route.

I. General Table of Normal Values:

Na 136-142 mEq/L (mmol/L)	Mg 1.5-2.3 mg/L (0.65-1.05 mmol/L)
K 3.5-5.0 mEq/L (mmol/L)	Phos 2.3-4.7 mg/dL (0.74-1.52 mmol/L)
Cl 96-106 mEq/L (mmol/L)	Ionized Ca 2.3-2.54 mEq/L (1.15-1.27mmol/L)
HCO ₃ 21-28 mEq/L (mmol/L)	

II. Electrolyte Therapy

A. Sodium (Na)

1. Hyponatremia – treat Na > 150 mEq/L
 - a. With polyuria (>250 cc's of urine above intake per hour) – see Rx Guideline – Polyuria.
 - b. Without polyuria – give 1 liter 0.2% saline (normal saline) as rapid infusion and replace urine output cc/cc/hr with 0.2% saline. Assure that all medications are mixed in 0.45% (normal saline) or 0.2% saline if pharmaceutically possible and that any maintenance IV is D5% 0.2% saline. Avoid use of diuretics.
2. Hyponatremia – treat for serum Na < 133 mEq/L
 - a. Mix all medications in 0.9% saline (normal saline) if pharmaceutically possible. Change maintenance IV to D5 0.9% saline.
 - b. If hyperglycemia is present, the serum Na may be low because of the high blood glucose. If blood sugar > 300, a “corrected” serum Na may be calculated by adding to the measured Na - 1.6 meq for each 100 gm/dl of blood glucose above 100. See Rx Guideline – Hyperglycemia and treat.
 - c. If Na < 128 mEq/L give 3% NaCl per infusion (central line preferred) at 40 cc/hr X 3 hours.
 - d. If Na remains < 133 mEq/hr after 3% NaCl infusion, consult MD.

B. Potassium (K)

1. Hyperkalemia – treat serum K ≥ 5.8 mEq/L
 - a. Note: do not treat K if laboratory reports specimen “hemolyzed” – send a new specimen for testing.
 - b. Assure all K removed from current infusions.
 - c. Repeat serum K q 1 hour
 - d. Give IV:
 1. 50cc of 50% dextrose (D50) (one pre-filled syringe)

2. 15 units regular humulin insulin
 3. 1 amp NaHCO₃ (44 or 50 meq via pre-filled syringe)
 - e. If K > 5.8 mEq/L after above intervention, consult MD
 2. Hypokalemia – treat \square 3.4 mEq/L
 - a. Delay administration of any diuretic.
 - b. Give 20 meq KCL over 1 hour (central line preferred) as:
 1. serum K < 3.4 mEq/L – 2 doses
 2. serum K < 3.1 mEq/L – 3 doses
 3. serum K < 2.9 mEq/L – 4 doses
 - c. If K remains > 2.9 < 3.8 mEq/L – repeat above
 - d. If K remains < 3.2 mEq/L thereafter, consult MD
- C. Chloride (Cl) – not independently treated.
- D. Bicarbonate (HCO₃) – not independently treated.
- E. Magnesium (Mg)
1. Hypermagnesemia – not independently treated.
 2. Hypomagnesemia – treat Mg < 1.5 mg/dL
 - a. Administer 4 grams magnesium sulfate (MgSO₄) over 2 hours – repeat as indicated by subsequent laboratory assessments to maintain above goal levels.
 - b. If Mg remains < 1.5 mg/dL after 8 gms MgSO₄, consult MD.
- F. Phosphorus (P)
1. Hyperphosphatemia – not independently treated.
 2. Hypophosphatemia- treat serum P < 2.2 mg/dL (0.71 mmol/L)
 - a. Give 30 mmol potassium or sodium phosphate over 3 hours and repeat (total 2 doses).
 - b. If P remains < 2.2 mg/dL (0.71 mmol/L) after 60 mmol sodium or potassium phosphate given, consult MD.
- G. Calcium (Ca) – **Note:** measure and treat only the ionized calcium value
1. Hyper- ionized calcemia – not separately treated. Withhold additional calcium
 2. Hypo- ionized calcemia – treat < 4.4 mg/dL or < 2.1 mEq/L or <1.1 mmol/L
 - a. Give 10cc 10% solution of calcium gluconate slow IV push.
 - b. Remeasure ionized Ca in 1 hour
 - c. Repeat if ionized Ca is low
 - d. If the ionized Ca remains low after 20cc, 10% calcium gluconate is given, consult MD.

Rx Guideline– Polyuria

Introduction: Polyuria may quickly lead to hypovolemia and hypoperfusion of donor organs. The causes of polyuria may be: 1) physiological diuresis after prior fluid administration, 2) osmotic diuresis due to previous mannitol therapy or continuing hyperglycemia, 3) diuresis from prescribed diuretics, 4) diabetes insipidus. Physiological diuresis does not lead to hypotension, but all other forms may. If the donor demonstrates hypotension and polyuria, continue in this guideline, but refer also to Rx Guideline – Hypotension. The urine output goal is 75-150cc/hour

I. Initial Assessment

- A. Evaluate blood sugar per laboratory or finger stick measurement. Glucose values > 200mg/dL may contribute to polyuria. Refer to Rx Guideline – Glucose Management.
- B. Stop any prescribed diuretic therapy.
- C. Calculate recent fluid intake/output balance and adjust intake to be 100 mls/hour less than total output. Example: You observe urine output over the last 3 hours averaged about 400 mls/hr. Adjust total IV fluid intake to equal about 300 mls/hr.
- D. Follow q 2hr measurements of serum Na and glucose.
- E. If Na > 148 mEq/L – assume excessive free H₂O loss has occurred, and proceed with treatment plan below.
- F. If serum Na 135-147 mEq/L when last measured, observe urine output and repeated serum Na measurements. Maintain fluid intake 100 mls less than urine output each hour.

II. Treatment

- A. Stop excessive intake (maintain intake 100 cc's less than output until intake and output are equal and then maintain intake = output).
- B. If urine output > 250cc above IV intake for the last 2 hours and serum Na > 145 mEq/L when last measured, give 1 microgram desmopressin (DDAVP) IV.
- C. Begin replacement of urine output each hour cc/cc with 0.2% saline (_ normal saline)(no dextrose).
- D. If urine output has not declined below 200 mls above intake (urine out > 200 mls above fluid intake) in the next 1 hour, give an additional 1 microgram of DDAVP intravenously.
- E. If urine output has not decreased to < 200 cc's above IV intake (urine output > 200 mls above fluid intake) and Na has not fallen to < 146mEq/L in 2 additional hours – consult MD.

Rx Guideline – Acid-Base Treatment

Introduction

During donor care monitoring and treating the arterial pH becomes the primary acid/base goal. Because there are few primary effects of hypocarbia or hypercarbia, the PaCO₂ will be adjusted to normalize the arterial pH (pH 7.35 – 7.45). Modifications of the mechanical ventilator to alter the PCO₂, and hence pH, are reviewed in the Rx Guideline – Mechanical Ventilation.

I. Assessment –Because hospitals may report either the Base Excess (BE) or Base Deficit (BD) with ABG results, both are included here.

- A. **Acidosis** – Review the arterial blood gas (ABG) measurement obtained prior to manipulation of the mechanical ventilator recommended in the Rx Guideline – Mechanical Ventilation. Assess the BE or BD provided as part of the ABG results. If the BE is more negative (-) than -6 or the BD is more positive (+) than +6, metabolic acidosis is likely present.
- B. **Alkalosis** – Review the ABG prior to adjustment of the mechanical ventilator as above. If the BE is more positive (+) than +6 or BD is more negative (-) than -6, metabolic alkalosis is likely present, although very unusual during donor care.

II. Treatment

- A. **Metabolic Acidosis** – If the arterial pH remains < 7.32 after the changes recommended in the Rx Guideline – Mechanical Ventilation (section IVA), administer one pre-mixed syringe (44 or 50 meq) NaHCO₃ slow IV push. However, if the Na is concurrently > 150 mEq/L, consult MD before giving NaHCO₃. If the arterial pH remains <7.32 after re-testing in 30 minutes, repeat the NaHCO₃ administration. If the arterial pH remains < 7.32 thereafter, consult MD.
- B. **Metabolic Alkalosis** – If the arterial pH remains > 7.45 after the changes recommended in the Rx Guideline – Mechanical Ventilation (Section IVB), consult MD.

References

1. Powner DJ, Darby JM. Management of variations in blood pressure during care of organ donors. *Prog Transplant*. 2000;10:25-32.
2. Powner DJ, Darby JM, Stuart SA. Recommendations for mechanical ventilation during donor care. *Prog Transplant*. 2000;10:33-40.
3. Powner DJ, Kellum JA, Darby JM. Abnormalities in fluids, electrolytes, and metabolism of organ donors. *Prog Transplant*. 2000;10:88-96.
4. Powner DJ, Kellum JA. Maintaining acid-base balance in organ donors. *Prog Transplant*. 2000;10:98-105.
5. Powner DJ, Reich HS. Regulation of coagulation abnormalities and temperature in organ donors. *Prog Transplantation*. 2000;10:146-153.
6. Powner DJ, Delgado. Using pressure-limited mechanical ventilation in caring for organ donors. *Prog Transplantation*. 2001;11:174-181.
7. Powner DJ, Crommett JW. Advanced assessment of hemodynamic parameters during donor care. *Prog Transplant*. 2003;13:249-257
8. Fessler HE, Shade D. Measurement of vascular pressures. In: Tobin MJ, ed. *Principles and Practice of Intensive Care Monitoring*. McCraw-Hill, New York, NY 1998:91-106.
9. Bur A, Herkner H, Vlcek M, et al. Factors influencing the accuracy of oscillometric blood pressure measurement in critically ill patients. *Crit Care Med*. 2003;31:793-799.

