

Liver Transplant Program

POST-OPERATIVE INPATIENT MANAGEMENT

I. Purpose

To outline post-operative inpatient management and address specific issues of post-operative care. Recognizing that medical care is an ever-changing field, this portion of the protocol is meant as a guideline for the management of post-operative patients. In no way should it supersede current standard of care. As standard of care changes, the protocol will be updated.

II. Policy

A. Overview.

The routine liver transplant patient will be placed on the abbreviated liver transplant clinical pathway as long as outcome criteria are met. The patient will evolve through two phases of care: Intensive Care Unit (MSICU) and the General Practice Unit (routine transplant floor, 3N). A standard pathway should lead to discharge within 7-10 days after liver transplantation. Specific outcomes and concerns should be addressed as outlined below. The care of the liver transplant patient is a team effort at its best. The cooperation and dedication of all team members (surgeons, hepatologist, coordinators, nurse practitioners, pharmacists, physical therapist, nurses and other support personnel) is key to assuring the best quality care to our patients and achieving long-term success and satisfaction with our services.

B. MSICU Phase

1. Personnel

- a. *Transplant Team.* The Transplant Service is the primary participant in the immediate post-operative care of these patients. The Team consists of transplant surgery attendings, general surgery residents, the transplant hepatologists, the transplant nurse practitioner, and transplant coordinators. Consulting Services are contacted as the need arises.
- b. *MSICU Nursing Staff.* Initially, a 1-to-1 nurse to patient ratio is provided. As the patient becomes more stable, this ratio is decreased. All nurses working with the liver transplant patients have had special "in-house" training.

- c. *Respiratory Therapist Staff.* The respiratory therapist coordinates equipment needed for ventilation and respiratory monitoring. The therapists assist the nursing staff with post-op pulmonary treatments.
- d. *Hospital Personnel.* It is imperative that all medical, nursing, and paramedical personnel receive a hepatitis B vaccination prior to their participation in the post-operative management of liver transplant patients. Any person with a communicable disease (upper respiratory infection, open sores, active herpes, diarrhea, fever, etc.) is excluded from caring for these patients. Routine body substance precautions should be used by all personnel at all times to protect from communicable disease.

2. **Patient Arrival in the MSICU**

- a. *MSICU Post-Operative Orders.* see Appendix A
- b. *Transport.* Before the completion of the surgical procedure, the anesthesiologist supervising the transplant anesthetic contacts the MSICU, to give them a one hour warning. The case will have been discussed with the Transplant Team prior to transport, if the patient is unstable. Nursing staff needs to be aware of patient's temperature and blood requirements so that blood warmers can be set up. All blood components are transferred to the MSICU from the OR. Blood is not returned immediately to the blood bank, but stored in the MSICU blood refrigerator.

The patient is monitored while transported to the MSICU by the responsible anesthesia personnel. The monitored cart provides continuous assessment of arterial pressure, pulmonary artery pressure, and EKG. It also provides a portable oxygen source and a means of positive pressure ventilation. Continuous arterial pressure monitoring is maintained during transfer of the patient. The arterial transducer is not disconnected until after the patient has been moved from the cart to the hospital bed. Report is given to the assigned MSICU nurse by the anesthesia personnel accompanying the patient.

- b. *Environment.* Liver transplant recipients have private rooms. Other patient rooms are utilized as the need arises. Room temperature is individually controlled via thermostat. Room temperature of 75°F is achieved unless otherwise indicated. Visiting privileges are left to the discretion of the nursing staff. Young children do not visit while the patient is in the MSICU.

3. **Lines & Catheters.**

When the patient arrives to the MSICU, they will be on the ventilator with full support and will have several lines including 1 arterial lines, a Swan-Ganz catheter, 1 or 2 peripheral IV lines, NG tube, Foley catheter, possible T-tube (or roux-tube), and 2-3 Jackson-Pratt (JP) drains attached to bulb suction. All of these lines will have to be carefully monitored and secured in order to avoid inadvertent removal which can be disastrous.

4. **Monitoring & Management.**

- a. *Wound Drainage & JP Output.* JP drains will be placed to bulb suction. Usually the fluid is serosanguinous in nature, and clears within 1-2 days. Drain output should be measured every 4 hours and recorded. If bleeding from surgical sites occurs early, the JP fluid usually becomes quite bloody and the Transplant Surgical staff should be informed immediately. JP #2 is usually placed in Morrison's pouch; hence we would look for bilious drainage which suggests bile leak or disruption.
- b. *Temperature / Hypothermia.* Patients are frequently rather cold from the duration of the procedure, exposure of the open abdomen, and administration of cold blood products. Although our anesthesia colleagues have been carefully monitoring and treating this parameter with elevated room temperature, use of blood warmers, and the patient "bair-hugger" or "K-thermia" blanket, a small number of patients may be hypothermic. This will affect their recovery and the recovery of their coagulopathy.

Temperature is monitored continuously via a thermistor incorporated in the pulmonary artery catheter. Temperature is first charted hourly until the patient is normothermic and then every 4 hours. Devices used to achieve and maintain normothermia are heating blankets, ventilator humidifier, and "blood warmers" for rapid infusion of blood and crystalloid. Nondepolarizing muscle relaxants can be used during the rewarming process in order to avoid the catabolic effects of shivering if necessary. Patients should also be monitored for the presence of fever. The physician should be notified if the temperature falls below 36°C or rises above 38°C.

- c. *Ventilation.* Because of the significance of the surgical procedure, its location, and associated fluid shifts, the post-operative liver transplant patient usually requires mechanical ventilation for 12 hours or more after arrival in the MSICU. An arterial blood gas (ABG) measurement should be made 30 minutes after arrival to the MSICU. ABGs are then determined at least every 6 hours in the immediate post-operative period or more often as the patient's condition dictates or with changes in ventilator settings. A pulse oximeter may be placed for continuous assessment of arterial oxygen saturation. A chest X-ray should be taken upon patient arrival to the MSICU and then in the morning of the first post-operative day.

Right diaphragm elevation and right lower lobe collapse is relatively common. This collapse is tolerated without fiberoptic intervention. Bronchoscopy is performed to re-expand lung lobes only if conservative means have consistently failed or oxygenation is severely impaired. Right pleural effusion, also a common event, is usually tolerated without thoracentesis unless the effusion becomes so large that it results in respiratory compromise or if the composition of the effusion fluid is in question. To avoid lobar atelectasis, chest physiotherapy is performed every 4 hours unless the patient is hemodynamically unstable. Endotracheal suctioning is performed on a prn basis. An incentive spirometer is provided for

patient use following extubation, and should be used hourly. High levels of PEEP are avoided if possible since they can potentially reduce liver blood flow.

These patients should start waking up within 1-2 hours after the procedure is completed. Delayed recovery is a concern and the Transplant Surgical Team should be alert to problems with liver function, over-sedation, or intracranial catastrophes such as intracranial bleeding or herniation (especially in patients with preoperative stage III-IV encephalopathy). Six hours after the procedure weaning efforts should begin. Depending on the patient's condition, patient should be extubated within the 24 hours of the procedure. The MSICU care team will assist in the ventilation management and hour to hour weaning efforts as needed.

- d. *Hemodynamics.* Hemodynamically, euvolemia is the goal. Blood pressure is monitored by "Dinamap" pressure cuff and by arterial catheter tracings. Blood pressure is charted every 15 minutes until the patient is deemed stable by the Transplant Team, then hourly. The on-call Transplant Surgeon should be notified if the blood pressure rises above 180 mmHg systolic or drops below 100 systolic. Site changes for the arterial catheters are not made routinely; however, peripheral arterial monitoring is discontinued as soon as the patient's condition permits.

Pulmonary artery pressures are continuously monitored with the pulmonary artery catheter. After the patient arrives from the operating room, SaO₂ and central venous pressures (CVP) are taken every 15 minutes x 4, every 30 minutes x 2 and then hourly for the first 24 hours, then every 8 hours (if the catheter is still in place). A CVP of 5-10 mmHg is adequate. Pulmonary artery pressures, cardiac output, and SaO₂ are charted every 4 hours for 24 hours, then every 8 hours (if the catheter is still in place). Pulmonary capillary wedge pressures (PCWP) are done as needed at the request of the Transplant Surgeon. Routine central line site care is provided per UTSW protocol. Site changes for all central catheters (including pulmonary artery catheters) are not made routinely; however, central catheters are discontinued as the patient's condition permits.

The Swan-Ganz catheter should be removed at 24 hours and replaced with a simple CVP line unless hemodynamic instability is present.

Dopamine is the inotrope of choice. Epinephrine and CaCl₂ are also available for the treatment of hypotensive episodes. Hypertension is treated with IV nitroglycerin, sodium nitroprusside, or hydralazine. Caution is required with the use of sodium nitroprusside. Frequent assessment of ABGs and occasional determination of cyanide levels are required. Any evidence of tachyphylaxis to sodium nitroprusside results in the discontinuation of the drug.

In the event of a cardiopulmonary arrest, the existing "Code 3333" system is used to alert the resuscitative services of the hospital. However, when a Transplant Surgery Team member is present, he or she will ultimately be responsible for directing the resuscitative measures.

- e. *Fluid Balance.* Intake and output are determined every hour until the patient is stable. The Transplant Surgeon on-call should be notified if the urine output drops to less than 50 mL in a 2-hour period. Most patients have excess body sodium because of their disease and various amounts of excess fluid from the procedure. In addition, because of the associated nephrotoxicity of immunosuppression and the surgical insult, their diuretic response is blunted. Hence, fluid mobilization will push fluid into the lungs rather than a spontaneous diuresis. Therefore, diuretics will be needed by day 1 after the procedure. Fluid resuscitation is usually with 5% albumin in 1/2NS since these patient are always hypoalbuminemic. Crystalloids are kept to a minimum (e.g. 50 mL/hour) and adjusted based on overall fluid status.
- f. *Cardiac.* A 12-lead EKG is obtained immediately upon admission to the MSICU and repeated if needed. An EKG should be performed upon arrival to the MSICU. The cardiac rhythm is continuously monitored. Pulse rate is charted every 15 minutes until the patient is deemed stable, then hourly. Nurses should notify the physician if the pulse rate rises above 120 or drops below 60 beats per minute on admission. On admission and every 8 hours thereafter, the nurse "runs-a-strip" to evaluate any alteration of "T-waves" or "Q-T interval."
- g. *Blood Products.* Administration of blood products should be conservative.

- 1) Coagulopathy. Most liver disease patients have some degree of coagulopathy. In addition, blood loss during the transplant procedure, the anhepatic phase during the implantation phase, and the potential preservation damage in the allograft may result in additional coagulation defects. The anesthesiologist monitors coagulation during the procedure using frequent coagulation profiles and thromboelastograms (TEGs). These patients will often have a prothrombin time (PT) of ~15-18 seconds (INR 1.5-1.8) with good liver function. Postoperatively, PT/INR/PTT are checked every 6 hours for 24 hours and daily thereafter unless otherwise indicated. The PT should be kept <20 seconds (INR <2.0). If oozing or bleeding are present (detected in JP drains), PT should be corrected to <16 seconds (INR <1.6) with FFP. Avoiding overcorrection is important and clinical judgment should be exercised when deciding to transfuse these patients. Cryoprecipitate should not be given unless bleeding is encountered with a fibrinogen <125 or with PT >20 not corrected with FFP alone.

Coagulation profiles usually improve daily with good liver function. If bleeding persists in the presence of corrected coagulation profiles, surgical bleeding should be suspected and consideration given for re-exploration. With improvements in operative techniques and perioperative management this is an infrequent complication.

- 2) Platelets. Platelets counts >20,000 are acceptable if no bleeding is present. If bleeding occurs transfusion will be given to maintain a platelet count of >50,000. For invasive procedures, the PT should be <16 seconds (INR <1.6) and the platelet count >50,000.

- 3) Red Blood Cells. Postoperatively, the hemoglobin is checked every 6 hours for 24 hours and then daily thereafter unless otherwise indicated. Hemoglobin counts >7 are acceptable unless the patient is hemodynamically compromised, is hypoxic, or suffers from CAD in which situations a hemoglobin of >10 is preferred. All blood products for liver transplant recipients should be leucopoor and irradiated in order to reduce the likelihood of CMV transmission and graft-versus-host disease. Vitamin K is not given without staff instruction because of the associated risks for hypercoagulability and development of clots. Overcorrection of coagulation profiles is hazardous in the post-transplant setting because of the higher risk of hepatic artery thrombosis. Adherence to the above criteria is paramount and the transplant surgery staff should be involved if any exceptions arise.
- h. *Nasogastric Tube*. An NG tube is left to low-intermittent suction, and should be flushed with 30 mL of normal saline every 4 hours. The NG tube is generally removed by postoperative day #2 unless otherwise instructed by the physicians (i.e., in the setting of a Roux-n-Y anastomosis).
- i. *Mental Status*. The patient's mental status should be continuously monitored. Documentation is done as per MSICU protocol and frequency is increased prn for adverse mental status changes. Five major factors can adversely alter the patient's level of consciousness: hepatic encephalopathy, drug toxicity (cyclosporine), embolus (air, other), intracranial bleeding, and hypoglycemia. Any abrupt change in mental status or any seizure activity results in the administration of a 50 cc ampule of D50W, while simultaneously a serum glucose and chemstrip sample is being obtained. In the immediate post-operative period, any abrupt mental status change that does not respond to IV glucose administration will result in the patient being placed on a left lateral decubitus – head down position. Central lines are aspirated for air. If an altered mental status persists, a CT scan is performed to rule out intracranial bleeding. Tacrolimus levels and serum lipid levels are determined and tacrolimus dosage is adjusted if necessary. A neurological observation record is available to document trends. This record is used when an altered neurologic status is expected or already observed.
- j. *Post-operative Bleeding & Transfusion*. Wound drain accumulation is measured every hour initially and then every 6 hours. Hematocrit is measured at least every 6 hours in the immediate post-operative period. For the first 48 hours post-operatively, "one-half batch" of red blood cells are located in the Blood Bank and immediately available if needed. ("One-half batch" is 10 to 20 units depending on the patient). Two blood pumps are available in the MSICU for rapid transfusion. CMV negative patients who receive a CMV negative donor liver receive CMV negative blood products unless the patient's transfusion requirements have already exceeded "one batch" of RBC units. Hematocrit is measured at least every 6 hours in the immediate post-operative period.
- k. *Hyper- & Hypoglycemia*. Hyperglycemia is very common and etiology is multifactorial. Operative stress, steroid boluses, cyclosporine, and tacrolimus are contributing factors. Serum glucose levels are determined at least every 6 hours

in the immediate post-operative period. Chemstrips are performed and charted every 2 hours initially and then every 6 hours. Chemstrip samples are taken from the arterial line, not from finger sticks.

As hyperglycemia has been a common occurrence in the post-operative period, no fluids contain dextrose initially. However, with any change in mental status or with any seizure activity, hypoglycemia must be suspected and the administration of D50W is appropriate with simultaneous serum glucose and chemstrip determination. Any deterioration of liver function should alert the clinician to the possibility of ensuing hypoglycemia and chemstrips should be checked every 2 hours.

- 1) Hyperglycemia. – Use the insulin drip protocol, with the goal blood glucose (BG) of 80 to 150 mg/dL.
 - a) Standard Drip – 100 Units/100 mL 0.9% NaCl via an infusion device.
 - b) Oral Medications – Surgical patients who have received an oral diabetes medication within 24 hours should start the drip when the BG>120. All other patients can start the drip when the BG>70.
 - c) Discontinuation – Insulin infusions should be discontinued when a patient is eating AND has received their first dose of subcutaneous insulin.
 - d) Intravenous Fluids – Most patients will need 5-10 grams of glucose per hour (e.g., D5W at 100-200 mL/hour or equivalent (TPN, enteral feeds, etc.)
 - e) Initiating the Infusion – Most patients will start at the first level of the UTSW algorithm. This should be followed closely. At times, depending on the state-of-the-art of glucose management, the algorithms may change. These algorithms are posted in the MSICU.
 - f) Moving from Algorithm to Algorithm
 - i) Moving Up: An algorithm failure is defined as blood glucose outside the goal range (see above goal), and the blood glucose does not decrease by at least 60mg/dL within 1 hour
 - ii) Moving Down: When blood glucose is <70 mg/dL x 2 or if BG decreases by greater than 100 mg/dL in an hour
 - g) Patient Monitoring
 - i) Check capillary or chemstick BG every hour until it is within goal range for 4 hours, and then decrease to every 2 hours for 4 hrs, and if remains stable may decrease to every 4 hours. If patient's BG is within target for 4 hrs, there is no need to adjust rate, unless the BG falls out of target.

ii) Hourly monitoring may be indicated for critically ill patients even if they have stable blood glucose. In addition if a patient is eating, hourly blood glucose monitoring is necessary for at least 3 hours after eating.

iii) **Decrease insulin infusion rate by 50% if nutritional therapy (e.g. TPN or tube feeds) are discontinued or significantly reduced. Reinstigate hourly BG checks X 4 hrs.**

2) Hypoglycemia. – (BG <60 mg/dL)

a) Turn off the insulin drip.

b) Give D50W IV

i) patient is awake – give 25 mL (1/2 amp)

ii) patient is not awake (i.e., sedated) – give **50 mL** (1 amp)

c) Recheck BG every 20 minutes and repeat 25 mL of D50W if <60 mg/dL. Restart the insulin drip once blood glucose is >70 mg/dL x 2 checks. Restart the insulin drip using a lower algorithm (see “moving down” above)

3) Notifying the Physician – The algorithms can be run by the nursing staff who have been trained to do so. The Transplant Surgeons caring for the patient should be notified:

a) For any blood glucose change >100 mg/dL within one hour;

b) For any blood glucose >360 mg/dL; or

c) For hypoglycemia which has not resolved within 20 minutes of administering 50 mL of D50W IV and discontinued the insulin drip.

1. *Metabolic Issues*. Liver transplant recipients will experience many metabolic derangements and electrolyte imbalances.

1) Sodium. Perioperative hyponatremia resolves gradually with improvement in liver function and restriction of free water intake.

2) Potassium. Hypo- or hyperkalemia can occur resulting from diuretic use, renal insufficiency, or even cyclosporine toxicity. A definitive etiology is determined and treated accordingly. Because of unpredictable post-operative potassium (K^+) shifts, K^+ level is determined at least every 6 hours in the immediate post-operative period unless the patient's condition dictates more frequent determinations. On admission to the MSICU, the nurse will "run a strip" to evaluate for any alteration of "T-waves" or "Q-T interval." The practice is repeated every 12 hours or more often if required. Regular insulin, D50W, $NaHCO_3$, $CaCl_2$ are immediately available in the emergency stock drawers of the MSICU for the treatment of hyperkalemia. KCl is immediately available for the treatment of hypokalemia.

3) Alkalosis-Acidosis. Metabolic alkalosis is not uncommon. Shifts in hydrogen ions (H^+) occur in the post-operative period. The new healthy liver metabolizes the citrate used to preserve blood into bicarbonate. This causes a

metabolic alkalosis. An ABG is determined at least every 6 hours in the immediate post-operative period unless the patient's condition dictates more frequent determinations. Lactated Ringer's is avoided post-operatively as this solution can contribute to the alkalosis. HCl and NaHCO₃ are both immediately available in the emergency stock drawers for the treatment of alkalosis-acidosis. Acetazolamide can be used to treat metabolic alkalosis in a patient with adequate intravascular volume and renal function. Severe metabolic alkalosis is treated with 0.1N or 0.2N HCl, at approximately 1 ml/kg/hr. An abnormality is never completely corrected so as to avoid "overshoot" and the development of the opposite acid-base abnormality. Metabolic acidosis in the absence of renal failure is of concern because it may suggest poor liver function. With improved operative and anesthetic techniques, acid-base imbalance (in the absence of primary nonfunction or severe bleeding) is frequently self-limited.

- 4) Calcium. Hypocalcemia is almost uniform. "Citrate toxicity" from rapid blood transfusion can also result in hypocalcemia. Because of acid-base shifts and low serum albumin, ionized calcium should be measured in the early post-operative period, at least every 6 hours. Hypocalcemia can have detrimental effects on both hemodynamics and coagulation. CaCl₂ should be immediately available if needed. CaCl₂ is routinely administered if serum ionized calcium falls below 2.0 mg/dL.
 - 5) Phosphate. Severe hypophosphatemia sometimes occurs in post-operative liver transplantation patients. In order to alert the medical staff to a low serum phosphate level and avoid any possible consequences (altered myocardial performance, hemolytic anemia, respiratory muscle weakness, etc.), phosphate levels are determined with each morning phlebotomy sample.
 - 6) Magnesium. Hypomagnesemia is also very common and frequently results from urine wasting associated with nephrotoxicity of cyclosporine and tacrolimus. Appropriate replacements are given in order to avoid muscle spasms and potentially seizures.
- m. *Infection Control*. The patient is admitted to a private room. A "modified protective isolation" is implemented. The door to the patient's room is kept closed at all times. All people entering and leaving the room scrupulously wash hands or use the hand sanitizers provided at the entry to the room.

Invasive monitoring lines are not changed on a routine basis. However, the dates of catheter placement are documented and the length of catheter occupancy should be noted on a daily basis. These lines are discontinued as the improved condition permits. Tubing and CL hubs are to be changed on Tuesday and Friday. Dressings are changed every 7 days if Biopatch is used – more often if they become soiled or wet, etc. The Infectious Disease Service provides consultation on request.

- n. *Nutrition.* As hyperglycemia has been the rule in all liver transplant patients thus far, dextrose containing solutions are avoided in the first 24 hours after transplant. The Transplant dietician evaluates caloric requirements on the first post-operative day and makes suggestions for nutritional support. Also on the first or second post-operative day, bowel function is evaluated (bowel sounds, flatus, NG output, etc.) and PO intake is considered and advanced as tolerated.
5. **Laboratory**
All laboratory samples are drawn through a stopcock on the arterial line. Laboratory studies usually include electrolyte and liver profiles, coagulation profiles, and drug levels (cyclosporine or tacrolimus).
6. **Radiology**
A chest x-ray is obtained immediately following admission to the Unit. It is checked for any evident of hemothorax, adequate endotracheal tube placement, and the presence of lobar collapse. If present, these should be treated as appropriate. All patients will have a right pleural effusion; this will resolve spontaneously and should not be removed unless respiratory compromise is suspected. A doppler ultrasound of the hepatic vessels is performed within 24 hours of the procedure and hepatic artery resistive indices are recorded. A chest x-ray is repeated on a 24-hour basis until extubation and then as required.
7. **Special Equipment**
- a. 4-chamber drug pumps
 - b. 2 pressure bags for rapid infusion of blood (do not prime unless needed)
 - c. 2 blood warmers
 - d. 2 warming blankets
 - e. "Accucheck" to accurately assess chemstrip serum glucose determinations
 - f. ETCO₂ monitor
 - g. Pulse oximeter
 - h. Bed scale
8. **Routine Medications** (See Post-operative Orders)
The medication protocols are quite elaborate. These are described in Section 20. Medications & Pharmacy. The transplant surgeon should discuss the appropriate course of management and medications with the house officer and transplant pharmacist in order to clarify the plan for the rest of the team. The pre-printed post-operative orders allow for the described options, and appropriate sections are checked off. Please remember that such medications should be adjusted for renal and liver function. Always consult with the transplant pharmacist on the team for more details and guidance.
- a. *Immunosuppression.* Immunosuppressive therapy orders are written daily and consist of methylprednisolone, ATG, mycophenolate, and tacrolimus, when renal function permits (see immunosuppression protocol). When a patient is on tacrolimus, levels are drawn each morning at 8 am. The drug is administered through an NG tube or PO. A blood level of 10-15 ng/ml is the goal for drug therapy pending normal renal and central nervous system functioning.

- b. *Antifungal Therapy.* Following extubation, Nystatin swish and swallow or Mycelex troches are used every 6 hours.
 - c. *Antibacterial Therapy.* Cefotaxime is given at 1 gram every 8 hours for 48 hours.
 - d. *Antiviral Therapy.* Depending on the CMV status of the patient and liver donor, Ganciclovir will be used prophylactically (see immunoprophylaxis protocol).
 - e. *IV Fluids.* D5 1/2 normal saline is the routine IV maintenance fluid. 5% albumin is used for volume expansion.
 - f. *Antacids.* Nexium is used for stress ulcer prophylaxis. 30 cc of Maalox every two hours may be used for break through hyperacidity.
 - g. *Pain Control.* Analgesia is provided with patient controlled analgesia (PCA), titrated on a PRN basis.
 - h. *Dextran.* Patients who require vascular conduit reconstruction (venous or arterial) or portal vein thrombectomy may be placed on Dextran 40 for 72 hours and then switched to aspirin for 3-6 months. If platelet count is <50,000, antiplatelet therapy should be temporarily on hold until recovery if noted spontaneously.
9. **Preparing for Transfer to the Floor**
The MSICU phase of transplantation is considered to be a transitional phase. The patient usually requires 1-2 days in the unit, during which time many of the monitoring lines have been removed, hemodynamic stability is assured, patient starts assisting with his care, physical therapy has been initiated, and usually an oral liquid diet also has been given. The nasogastric tube is removed post-operative day #2, unless stated otherwise by Transplant Surgeon, particularly in patients with Roux-Y reconstruction.

The patient is then transferred to the general unit (3N) which is the last phase of this hospitalization. Transfer orders are preprinted and appropriate sections should be checked. Transfer orders (*see* Appendix B) must be completed prior to transfer of the patient to the floor.

C. Floor Management

1. **Location.**
At University Hospital – St. Paul, 3-north (3N) is the designated transplant floor for the transplant surgery service.
2. **Personnel.**
Nurses will receive periodic training in the administration of immunosuppressive medications, care of the liver, kidney, and diabetic disease patients. The nurses will assist in the implementation of the clinical pathway for liver transplantation.

3. **Floor Care “Fine Tuning”**.

The routine floor phase is considered the "fine-tuning" phase following transplantation. All intravenous medications are converted to oral. Oral diet is adjusted to daily caloric need. Physical therapy has progressed to allow the patient to ambulate without assistance. Patient education will be completed by the transplant coordinator; which will focus on important issues such as signs and symptoms of infection, liver dysfunction, and "do's and don'ts" after liver transplantation. The transplant pharmacist will complete the medication checklist and discuss the final drug program with the patient and family. Stable liver function is assured and if elevated liver enzymes are encountered, these are investigated as appropriate. Elevated liver studies warrant a liver biopsy which is performed by the transplant hepatology staff according to the guidelines outlined below. In the absence of a T-tube, ERCP or PTC is the only means of evaluating the biliary tree. If indicated, a doppler ultrasound will be repeated; any worsening in the arterial resistive indices or other flow parameters will be further investigated with a hepatic arteriogram (with portal venous phase).

4. **Discharge Planning**.

Discharge planning is coordinated by the transplant coordinator and home care needs are assessed early in the course of treatment. Patients needing additional physical therapy will have home PT; those needing more intensive therapy will be transferred to the University Hospital/Zale Lipshy rehabilitation unit. Those needing dressing changes for open wounds or additional intravenous medications will have homecare visits with reports given regarding the outcomes of these visits.

D. **Immunosuppression Protocol** – see Section 21. Immunosuppressive Management

E. **Rejection** – see Section 22. Rejection: Diagnosis & Treatment

F. **Post-Operative Issues & Complications**

1. **Technical Complications**.

- a. *Hepatic Artery Thrombosis & Stenosis*. Early hepatic artery thrombosis (HAT) is more common in the pediatric population, especially when arterial reconstruction is required. The rate of early HAT in children is as high as 10%, although with recent popular application of microsurgical techniques, this incidence is decreasing. In the adult population this occurrence is found in <2-3 % of all cases. Acute HAT is associated with marked and sudden elevation in aminotransferases (usually in the order 100s to 1000s), possibly fevers, and reduction or cessation in bile formation. Severe preservation injury can also present like this. Therefore, hepatic duplex color flow ultrasound should be used liberally when this diagnosis is considered, especially in the setting of worsening aminotransferases. Abnormal ultrasound findings are confirmed with a hepatic arteriogram or CT angiogram.

Early HAT (<7 days post-operative) is an indication for urgent re-transplantation since the liver will develop massive or submassive necrosis, bile duct necrosis/leak, or bilomas with potential for sepsis. There have been some case

reports of early thrombectomy for early HAT; long-term success is dismal, although this offers a temporizing option until a new suitable liver is available. Late HAT (>6-8 weeks) is not as dramatic in presentation. This is usually detected with the development of biliary strictures or bilomas, but some patients have tolerated the event because of the development of arterial collaterals. However, elective re-transplantation will frequently be necessary.

Hepatic artery stenosis is general more insidious, occurring later after transplant and often presents with a more cholestatic picture with minimal to mild elevations in serum aminotransferases. It may be suggested by doppler ultrasound, but must be confirmed by arteriogram.

- b. *Biliary Complications.* The biliary tree is considered by many to be the Achilles heel of liver transplantation, with a complication rate (major and minor) as high as 40% in some series. In patients with a duct-duct anastomosis, usually an ERCP is performed for evaluation. In patients with a Roux-en-Y anastomosis, percutaneous cholangiography is necessary

Biliary complications can be classified as early (perioperative and <4-6 weeks post-operatively) or late (>6 weeks post-operatively). In the early period, anastomotic leaks are most common. If pain develops in the right upper quadrant, bile leak must be ruled out. Within 1-2 weeks of the transplant procedure, surgical exploration and suture closure of the leak site is most appropriate. Beyond 2 weeks, ERCP with internal biliary stenting will result in immediate relief. The stent will be removed endoscopically in 4-6 weeks.

Early postoperative leaks can be of great significance. Major leaks are associated with bile duct necrosis and frequently hepatic artery thrombosis, which should be managed as above. Enteric diversion may also be needed in that setting. A persistent leak on follow-up ERCP requires enteric diversion with a Roux-en-Y choledochojejunostomy.

Late biliary strictures can be anastomotic, hilar, or diffuse. Anastomotic strictures, when focal, can be managed with balloon dilatation and a period of internal stenting rarely needing enteric diversion. If a long stricture is detected in the common duct, this usually associated with duct wall ischemia and requires a more definitive treatment with a Roux-en-Y. Hilar strictures usually develop very late and can be caused by a chronic rejection process, although duct wall ischemia has been implicated. Management involves PTC drainage and stenting. If strictures recur, internal metallic stents (Wallstent) are placed as appropriate. Such patients will probably require additional procedures at a later time. Diffuse strictures are more difficult to deal with because of difficulty in access and their clinical significance. Such strictures could be ischemic in nature and should raise the suspicion for hepatic artery stenosis or thrombosis and evaluation should proceed accordingly. In the absence of proven ischemia, this finding can reflect chronic rejection or recurrence of primary sclerosing cholangitis. In any event, percutaneous stenting is frequently necessary with placement of intrahepatic

Wallstents. However, the long-term success is limited and these patients will frequently need elective re-transplantation unless contraindications arise.

2. **Liver Graft Complications**

- a. *Primary Non-Function.* Approximately 1-5% of transplanted livers will not function to any significant extent. This event, identified as primary nonfunction (PNF) is suspected when the liver has poor reperfusion after implantation and shows no evidence of bile formation with intraoperative acidosis and coagulopathy. Many factors can be associated with PNF, most importantly donor factors (donor hepatitis, hemodynamic instability, old age, severe steatosis, cardiac arrest with ischemia) and recipient factors (hemodynamic instability).

In the post-operative period, patients with PNF will not wake up as described above. They remain intubated with monitoring line in place. There is no or minimal bile production, PT is usually >20 seconds (INR >2.0) and rising, serum aminotransferases and LDH are >5,000 and rising. Immediate re-listing and urgent re-transplantation are needed. Patients with true PNF usually become unstable within 72 hours when re-transplantation may no longer be possible. An FFP drip is started to keep PT <25 seconds (INR <2.0). If renal failure or oliguria develop, the patient will be started on CVVH-D after consultation with the nephrology service. These patients are hemodynamically unstable and will not tolerate regular hemodialysis. Renal dose dopamine may be used if found to be effective in establishing diuresis; diuretics and dopamine are usually ineffective at this point. Close monitoring of the patient's neurologic is essential on a minute-by-minute basis. The family should be informed of the gravity of this situation and supported for their needs. Spontaneous recovery is rare. If performed in a timely fashion, re-transplantation is associated with good outcomes.

- b. *Acute Cellular Rejection.* Hyperacute rejection (antibody mediated) has not been clearly described in liver transplant recipients. However, accelerated acute rejection has been described. The typical scenario is that of good initial liver function with bile production, followed in 24-48 hours with severe liver dysfunction suspicious for ischemia, reduced to no bile formation, and established vascular patency. Moderate response to steroid boluses is observed but urgent re-transplantation is necessary since recovery is the exception. Early biopsy shows mixed infiltrate and positive immune complex deposits by immunofluorescence.

Classic acute cellular rejection (cell mediated) is more common and occurs in 2/3 of patients on cyclosporine induction and 1/2 of patients on tacrolimus induction. This usually occurs 5-10 days after transplantation; although rejection can occur anytime after transplantation, this is much less likely beyond 2 months after transplantation. Diagnosis is made with a percutaneous liver biopsy. Typical findings include mixed infiltrates in the portal tracts, including lymphocytes, plasma cells and eosinophils, with bile ductular damage (lymphocytic cholangitis). Endothelialitis may also be present (particularly in the central veins). The severity of rejection may be rated based on the number of tracts involved and the extent of damage, especially in the presence of endothelialitis.

Therapy for acute rejection is detailed in Section 21. Immunosuppressive Management. Treatment with Solumedrol boluses as outlined in the protocol is the first line therapy. For steroid resistant rejection, Thymoglobulin will be given according to protocol. Typical duration of therapy will be 3-7 days, tailored to patient response and tolerance to the drug.

- c. *Ductopenic (Chronic) Rejection.* Chronic rejection usually occurs beyond 3 months after liver transplantation. The diagnosis is more difficult to establish. On biopsy, there is paucity of cellular infiltrates; there may be intimal thickening and loss of bile ducts ("vanishing bile duct syndrome"). This form of rejection is difficult to treat and rescue therapy with tacrolimus should be attempted if the patient is on cyclosporine. While helpful in some patients, many progress to chronic liver dysfunction and subsequent liver failure requiring re-transplantation.

3. **Systemic Complications**

- a. *Renal Complications.* Patients with liver failure may have renal insufficiency, described as the "hepatorenal syndrome." With liver replacement, good liver function is usually associated with improved renal function. However, because of operative stress, potential hemodynamic instability, and the use of nephrotoxic drugs (antibiotics, cyclosporine, tacrolimus, ganciclovir, etc.) some degree of renal insufficiency is frequently encountered. Management should begin with an evaluation of the patient's hemodynamic status and thorough examination of all medications being administered and their dosages. Appropriate changes in regimen should be made accordingly and dosages adjusted based on renal function.

In an attempt to reduce the degree of renal dysfunction, drug levels should be monitored and dosages always adjusted to renal function. Oliguria should be systematically evaluated. The nurse and physician should examine the foley drainage system and eliminate simple causes such as kinking or dislodgement of the foley catheter. Hemodynamic stability should be confirmed with absence of bleeding assured. When filling pressures are low, euvolemia and normotension should be achieved with fluid resuscitation. The fluid of choice is 5% albumin in 1/2NSS especially when serum albumin is <3 gm/dl. If filling pressures are adequate (by CVP and PCWP) oliguria should be managed with judicious use of diuretics and reduction of nephrotoxic drugs. Patients with significant renal insufficiency are switched to renal-sparing immunosuppressive protocol.

- b. *Pulmonary Complications.* Pulmonary complications can be very common after liver transplantation and prevention is the key. Patients who smoke are instructed to stop smoking before transplantation. Patients are enrolled in a smoking cessation program in conjunction with the use of Nicoderm patches or Nicorette chewing gum. This is emphasized with every clinic visit by all members of the transplant team.

Post-operatively, if possible, patients are extubated within 24 hours and transferred out of MSICU7 within 48 hours in order to minimize the likelihood of nosocomial pneumonia. Aggressive chest physical therapy, incentive spirometry

and early ambulation have kept pulmonary infection in our patients to a minimum. Right pleural effusions are very common after liver transplantation, but usually self-limited and resolve spontaneously; thoracentesis is indicated only when infection or respiratory compromise is suspected. Pulmonary edema can occur especially in the setting of oliguria due to renal insufficiency. While fluid administration can be kept to a minimum, fluid mobilization on post-operative day #3 in the setting of blunted diuretic response will result in severe pulmonary edema requiring mechanical ventilation. Treatment is anticipation with early forced diuresis using appropriate doses of Lasix tailored to individual need and response.

A paralyzed right hemidiaphragm may contribute to pulmonary insufficiency. This usually occurs from the crushing injury to the phrenic nerve by the suprahepatic vena cava clamp. This can be avoided by accurate clamp positioning without diaphragmatic clamping and almost never occurs with the piggyback technique currently used at University Hospital/St. Paul. Spontaneous recovery is the rule, usually within 4-6 weeks. In the workup of pulmonary infections, bronchoscopy should be used early with any infiltrate that is not accounted for or persistent after appropriate therapy. The pulmonary service is consulted for this procedure.

- c. *Infection.* Infectious complications can cause severe morbidity and death of these immunocompromised patients. Again, prevention is the most effective therapy. Antibacterial, antifungal, and antiviral prophylaxis is administered as described in the infection protocol (*See* Section 20. Medications & Pharmacy). In addition, patients are placed in private MSICU rooms with positive pressure ventilation and 95% efficient ventilation systems. On 3N, patients are placed in private rooms. Universal precautions with frequent hand washing and gloving are standard practice. Line changes and other invasive procedures should be performed using gown and mask and standard sterile procedures. Lines and catheters are changed every 3 days in MSICU and every 5 days on 3N. Central lines are removed when only peripheral access is needed.

Postoperative fevers are re-evaluated with cultures of blood and urine, sputum if indicated, a chest-X-ray to rule out infiltrates, and close examination of all lines and tubes with removal and cultures of any potential source.

Viral infections are very common in liver transplant recipients. Cytomegalovirus infections are most common and can occur in as many as 25% of patients. The usual time frame is 4-6 weeks after the transplant procedure. Viral prophylaxis, consisting of ganciclovir has reduced the incidence of significant CMV infection in our patients. Various types of CMV infection can be encountered and these are described in the infection protocol. High risk groups include patients who are seronegative and receive an organ from a seropositive donor, those who require high dose steroid and ATG for recurring rejection and those who require multiple transfusions intra- and perioperatively. Cytomegalovirus infection frequently is detected in the blood or the liver allograft in the form of hepatitis. More virulent forms are CMV pneumonitis and gastroenteritis. Therapy is aimed at reduction of

immunosuppression and intravenous ganciclovir; intravenous cytochrome b5 hyperimmune globulin is added in the therapy of invasive or life-threatening CMV.

- d. *Graft-vs.-Host Disease*. This is a rare complication that may occur after liver transplant in about 1-5% of patients, depending on heightened awareness and immunosuppression. The constellation of signs and symptoms included diarrhea without clear etiology, leukopenia and thrombocytopenia, and a skin rash. Severity can vary and in severe cases, the rash results in depigmentation and bullous changes and a septic picture sets in. A flexible sigmoidoscopy typically shows normal mucosa which on microscopy shows loss of crypts. Bone marrow biopsy shows reduced cellularity and a skin biopsy also shows typical changes with apoptosis at the germinal level. Therapy would be most successful with early diagnosis and treatment with steroid boluses if real early or ATG. Antibiotic prophylaxis and reverse precautions should be standard. Peripheral blood is also sent to HLA to evaluate for chimerism.

G. Abbreviated Pathway for the Liver Transplant Patient

1. Immediate Post-Operative MSICU Phase

The patient will be extubated in the operating room or within 6-12 hours in the MSICU if possible. **Never extubate a patient if post-operative bleeding is a major concern or the graft shows signs of primary non-function** whereby re-transplantation is being considered. Any signs of bleeding, poor graft function (PT >20 seconds, INR >2, AST/ALT >2000), hemodynamic instability, or ventilation problems need to be related to the transplant surgeon immediately. Generally, if INR is ≥ 2 then FFP is given starting with 2 units. If oozing is present, INR is corrected to ~ 1.5 . Platelets should be replaced to $\sim 75,000$ in the immediate postoperative period and then left alone beyond POD2. At that point platelets are given for levels $< 25,000$ or for procedures (liver biopsy) and should then be pushed up closer to 75,000.

2. POD1

Patient is stable, graft working well, the large infusion line and Swan line are removed on POD1 and plans made for transfer to a private general bed on POD2. Deviations from this plan need to be discussed with the senior staff.

- a. *Fluids*. Generally, aim for the patient to be euvolemic and perhaps a bit on the dry side but not pre-renal. Urine output should be at least 0.5-1.0 mL/kg. Dopamine is usually discontinued. Diuretics are frequently needed since patients may not diurese spontaneously. Liver function impacts renal function. Prograf is nephrotoxic and is often not started until there is clear evidence of good renal function.
- b. *Wounds*. Staples should be intact, clean and dry, without erythema or significant drainage. JP drains #1 and #3 are removed.
- c. *Labs/Tests*. A STAT portable chest X-ray is performed. Liver tests, CBC, and ABG are measured every 8 hours. Postoperative ultrasound is obtained. A typical ultrasound should report on patency of all vessels, waveforms in these

vessels and a resistive index (RI) in the hepatic artery. A typical RI is 0.6-0.8 with higher levels reflecting high resistance due to parenchymal disease and/or edema. A lower value in the setting of blunted or dampened waveforms is of great concern for hepatic artery stenosis. Blunted waveforms or monophasic flat waves in the hepatic veins are usually indicative of hepatic vein outflow stenosis which can happen in 5% of patients. This would dictate additional workup.

- c. *Other.* Once extubated, the patient should use the incentive spirometer every hour. They should tolerate being out of bed to a chair. Physical therapy is ordered. If bowel sounds are present, patients may be started on clear liquids (low sodium \pm diabetic diet).
3. **POD2-3**
Stable course, transfer to the general ward (3N), an effort is made to advance diet and progress activity. Liquids are typically started by POD2. Make every attempt to remove most IV lines early on to avoid infection. Foley catheters should be removed on POD2 unless otherwise indicated.
4. **POD 4-5**
Discharge teaching should continue unless circumstances dictate otherwise. If a weekend discharge is anticipated, plans should be made in advance and the coordinator on call would come in if needed to execute the discharge.

More details on care progression are outlined in the liver pathway and will be discussed with the rounding staff on a day-by-day basis. (*See Appendix C*)

III. Procedure/Intervention(s) – N/A

IV. Documentation (Documents & Forms)

- A. Appendix A – MSICU Post-Operative Orders
- B. Appendix B – Transfer Orders
- C. Appendix C – Liver Transplant Pathway

V. Other Related Policies/Procedures

- A. Section 20. Medications & Pharmacy
- B. Section 21. Immunosuppressive Management
- C. Section 22. Rejection: Diagnosis & Treatment

VI. References – N/A

APPENDIX A
MSICU Post-Operative Orders
Adult Liver Transplant

1. Admit to MSCIU
2. Service: Transplant Surgery, Dr. _____, Attending
3. Dual Service: Hepatology, Dr. _____, Attending
4. Condition: Critical
5. Diet: NPO except medications
6. Allergies: _____
7. Vital Signs
 - SaO₂ and CVP every 15 minutes x 4, every 30 minutes x 2, then every 1 hour for 24 hours
 - Cardiac output and PA pressures every 4 hours for 24 hours, then every 8 hours
 - PCWP only per physician
 - D/C Swan in 24 hours unless otherwise indicated
8. Nursing:
 - Daily weights
 - SCD's to both legs
 - Dressing change with gauze every shift or prn for saturation
 - Strict I&O every 1 hour
 - NGT to low intermittent suction. Irrigate NGT with 30 mL Normal Saline every 4 hours
 - Foley to gravity drainage; tape securely to patient's leg
 - JP drains to bulb suction. Empty and record output every 4 hours and as needed. Label and record all drains separately.
 - K-thermia blanket for temperature less than or equal to 36°C; discontinue at 37°C
9. IVF:
 - D5 ½ Normal Saline at _____ mL/hour
10. Respiratory Therapy
 - Vent settings: TV _____ FIO₂ _____ mode AC
PEEP _____ RATE _____
 - ABG in 30 minutes, in AM, and with changes in vent settings
 - Chest PT every 4 hours and incentive spirometry every 1 hour when extubated
 - Endotracheal suctioning prn unless otherwise advised
11. Chest X-ray now and Post-op Day #1 in AM
12. EKG now
13. Schedule STAT Doppler Liver Ultrasound for AM
14. Send STAT labs now:
 - CBC and platelets
 - PT, PTT, Fibrinogen
 - Lytes-7 with ionized calcium, magnesium, phosphorus
 - Liver profile
 - Lactic Acid

APPENDIX A – cont.
MSICU Post-Operative Orders
Adult Liver Transplant

15. Lab every 6 hours x 3, then daily
- CBC and platelets
 - Lytes-7 with ionized calcium, magnesium, phosphorus
 - Liver profile
 - PT, PTT, Fibrinogen
16. Daily Cyclosporine or Tacrolimus level prior to AM dose
17. Call Transplant Surgery Resident (_____) for:
- Temperature greater than 38°C or less than 36°C
 - Pulse less than 60 or greater than 120
 - Systolic Blood Pressure greater than 165 or less than 100
 - Diastolic Blood Pressure greater than 100
 - Urine output less than 50 mL/hour for 2 hours
 - Bloody or coffee ground NG aspirate
 - ANY signs of bleeding from JP drains
 - Call with first set of labs after arrival from MSICU
18. Notify Transplant Surgery Resident of immediate emergencies, including:
- Unstable blood pressure based on parameters above
 - Worsening ABG
 - Change in mental status
 - Base excess greater than 5
 - Ventilation and oxygenation problems
 - Increasing bloody JP drainage / change in output

If unable to contact the transplant surgery resident, contact senior staff of record through the hospital operator.

19. Other _____
- _____
- _____
- _____

20. Medications with indications

Immunosuppression

- Cellcept 1000 mg by mouth/NGT at 0900 and 2100
- Solumedrol[®] 40 mg IV every 12 hours on Post-op day 1, _____.
- Prednisone 80 mg by mouth daily on Post-op Day 2, _____
- Prednisone 60 mg by mouth daily on Post-op Day 3, _____
- Prednisone 40 mg by mouth daily on Post-op Day 4, _____
- Prednisone 20 mg by mouth daily on Post-op Day 5, _____
- Prednisone 10 mg by mouth daily on Post-op Day 6, _____ and daily thereafter

APPENDIX A – cont.
MSICU Post-Operative Orders
Adult Liver Transplant

Antimicrobial

- Nystatin 5 mL 4 times a day. Give per NGT when intubated.
- Post-extubation, Mycelex troche 5 times a day
- Bactrim DS on tablet by mouth daily or 20 mL NG daily (10 mL = 80/400)
- Valcyte[®] _____ mg by mouth daily
- Ganciclovir (Cytovene[®]) _____ mg (5 mg/kg/day) IVPB daily (refer to nursing chemo policy)
- Vancomycin 1 gram IVPB every 12 hours x 48 hours
- Zosyn 4.5 grams IVPB every 8 hours x 48 hours
- Ambiosome _____ IVPB daily x 48 hours
- Metronidazole 500 mg IVPB every 6 hours x 48 hours
- Meropenem 500 mg IVPB daily x 48 hours
- Levofloxacin 750 mg IVPB daily x 48 hours

Ulcer Prophylaxis

- Esomeprazole 40 mg IV daily

Insulin Protocol

- See MSICU insulin drip protocol

Other Medication

- Aspirin 81 mg by mouth daily

APPENDIX B
Transfer Orders
from MSICU to 3 North Ward
Adult Liver Transplant

1. Admit to Transplant Surgery, Dr. _____, Attending
2. Dual Service: Hepatology, Dr. _____, Attending
3. Admit to private room.
4. Condition: _____
5. Diet: _____
6. Allergies: _____
7. Vital signs every 4 hours while awake.
8. Daily weight – please record on flow sheet.
9. Strict I&O – please record on flow sheet.
10. Ambulate in hall every shift.
11. Triflo at bedside – encourage use every 1 hour while awake.
12. IVF: _____
13. Labs daily – Mark tag STAT – Liver Transplant Patient
 - CBC with differential and platelet count
 - Lytes-7 profile with ionized calcium, magnesium, phosphorus
 - Liver profile
 - Accuchecks AC / bedtime
 - Daily Cyclosporine or Tacrolimus level prior to AM dose
14. Call Transplant Surgery Resident on call for:
 - Temperature greater than 38°C or less than 36°C
 - Pulse less than 60 or greater than 120
 - Systolic Blood Pressure greater than 165 or less than 100
 - Diastolic Blood Pressure greater than 100
 - Urine output less than 240 mL every 8 hours
15. Wound Care:
 - Dressing change three times daily between the hours of 0600 and 2200. Paint incision with Betadine. Apply Bacitracin ointment to all tube exit sites.
16. Other _____

APPENDIX B – cont.
Transfer Orders
from MSICU to 3 North Ward
Adult Liver Transplant

17. Medication

Insulin Sliding Scale

- | | | | |
|--------------------------|------------------|------------------|---------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> | If blood glucose | less than 60 | One amp of D50, call physician |
| <input type="checkbox"/> | If blood glucose | 61 – 150 | No insulin required |
| <input type="checkbox"/> | If blood glucose | 151 – 200 | Give 3 units regular insulin subcutaneously |
| <input type="checkbox"/> | If blood glucose | 201 – 249 | Give 5 units regular insulin subcutaneously |
| <input type="checkbox"/> | If blood glucose | 250 – 299 | Give 10 units regular insulin subcutaneously |
| <input type="checkbox"/> | If blood glucose | 300 – 349 | Give 15 units regular insulin subcutaneously |
| <input type="checkbox"/> | If blood glucose | 350 – 399 | Give 20 units regular insulin subcutaneously |
| <input type="checkbox"/> | If blood glucose | greater than 400 | Give 25 units regular insulin subcutaneously STAT serum glucose & call physician with the results |

Immunosuppression

- Prograf _____ mg by mouth twice a day at 0900 and 2100
- Cellcept 1000 mg by mouth twice a day at 0900 and 2100
- Prednisone 60 mg by mouth daily on Post-op Day 3, _____
- Prednisone 40 mg by mouth daily on Post-op Day 4, _____
- Prednisone 20 mg by mouth daily on Post-op Day 5, _____
- Prednisone 10 mg by mouth daily on Post-op Day 6, _____ and daily thereafter

Antimicrobial

- Mycelex troche 5 times a day
- Bactrim DS on tablet by mouth daily or 20 mL NG daily (10 mL = 80/400)
- Valcyte® _____ mg by mouth daily
- _____
- _____
- _____

Ulcer Prophylaxis

- Nexium 40 mg by mouth daily

Other Medication

- Aspirin 81 mg by mouth daily

APPENDIX C
Liver Transplant Pathway

| Category | POD #1 | POD #2 | POD #3 | POD #4 | POD #5 | POD #6 | POD #7 |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| WOUND/ TREATMENTS | Staples intact, no erythema or drainage; remove JP#1 & JP3 | Staples intact, no erythema or drainage; D/C NG tube | Staples intact, no erythema or drainage; Remove JP#2 | Staples intact, no erythema or drainage; | Staples intact, no erythema or drainage; | Staples intact, no erythema or drainage; | Staples intact, no erythema or drainage; |
| LABS/ DIAGNOSTICS | STAT CXR LFTs, CBC, ABG q8hr liver doppler ultrasound | STAT CXR Downward trend of PT, bilirubin, AST, ALT | Downward trend of PT, bilirubin, AST, ALT | Downward trend of PT, bilirubin, AST, ALT | Downward trend of PT, bilirubin, AST, ALT; Prograf or CyA levels should be therapeutic | Downward trend of PT, bilirubin, AST, ALT; Prograf or CyA levels should be therapeutic | Downward trend of PT, bilirubin, AST, ALT; Prograf or CyA levels should be therapeutic |
| FLUID STATUS/ DRIPS | Urine output 0.5-1 mL/kg D/C dopamine | Foley catheter out; urine output adequate; D/C PGE ₁ | Urine output adequate; weight trending down | Urine output adequate; weight trending down | Urine output adequate; weight trending down or stable | Urine output adequate; weight trending down or stable | Urine output adequate; weight trending down or stable |
| NUTRITION | Tolerating clears | Tolerating low Na diet/diabetic diet; PO intake adequate; Roux-Y patients tolerating clears | Tolerating low Na diet/diabetic diet; PO intake adequate | Tolerating low Na diet/diabetic diet; PO intake adequate | Tolerating low Na diet/diabetic diet; PO intake adequate | Tolerating low Na diet/diabetic diet; PO intake adequate | Tolerating low Na diet/diabetic diet; PO intake adequate |
| ACTIVITY | Tolerates OOB; Physical Therapy consultation; incentive spirometer q1 hr | Tolerates OOB TID; PT initiated | Ambulates with assistance | Ambulates with assistance for increasing distance; stair climbing initiated | Ambulates with assistance for increasing distance; continues stair climbing | Ambulates with assistance for increasing distance; displays stair climbing ability | Displays independent ambulation and stair climbing |
| DIABETIC POTENTIAL | Fasting blood sugar >150 – order diabetic diet | Fasting blood sugar >150, Fingersticks with sliding scale coverage ordered | Fingersticks >150 – diabetic regimen prescribed; diabetic teaching initiated | Demonstrates fingerstick and use of glucometer with assistance; Dietitian consult | Demonstrates prep & self injection of insulin and knowledge of signs and symptoms of hypoglycemia | Demonstrates independence in performing finger- sticks, using gluco- meter and preparing and administering insulin | |
| PATIENT/FAMILY KNOWLEDGE | Patient/Family understand the surgical procedure and outcome; Pt has a copy of med sheet and post-transplant teaching manual | Family member has attended group teaching session | Patient participates in self-care activities | Patient/Family member have participated in group teaching session | Patient re-states name, dose frequency, purpose, and side effects of immunosuppression; Pt/family aware of potential discharge | Pt restates date of first office visit, demonstrates knowledge of 24 hr emergency contact number; Pt/family education reinforced | Pt verbalizes understanding of medication regimen, potential signs and symptoms of rejection & infection |
| DISCHARGE PLANNING | | Potential home care needs assessed | Potential home care needs assessed; glucometer ordered if necessary | Potential home care needs assessed; Discharge rehab plans established; medications ordered | Home care referral made if necessary | | |

Expected Length of Stay = 7 days