

Overview of Goals and Objectives of Rotation: OHSU 8CSI Service

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The 8CSI service is designed to provide peri-operative support to Cardiovascular & Cardiothoracic Services along with a variety of other surgical subspecialties including Plastics, Orthopedics, OB-Gyn, Vascular Surgery, ENT, and Maxillo-Facial Surgery. Working closely with the Primary Surgical Service and under the direct supervision of Anesthesia and Medical Intensivists, fellows gain experience in management of a variety of peri-operative problems including post-operative mechanical ventilation, hemodynamic instability, surgical bleeding, wound management, and graft complications. In addition, fellows have the opportunity to provide care under different patient care models including primary care, co-management and direct consultation.

Medical Knowledge: *Residents are expected to demonstrate knowledge of established and evolving biomedical, clinical and social sciences, and the application of their knowledge to patient care and the education of others.*

Cardiovascular Surgery:

- Understand the common complications occurring during the first 24 hours of post-cardiac surgery including 1) routine and excessive post-operative bleeding 2) post-pump vasoplegia 3) post-operative ventricular dysfunction 4) heparin rebound 5) post-transplant Pulmonary Hypertension 6) peri-operative Atrial Fibrillation 7) peri-operative Atrial-Ventricular pacing 8) pericardial tamponade
- Understand the indications for and types of ventricular assist devices
- Describe the physiologic principles of intra-aortic balloon pumps (IABP)
- Describe the anatomy, classification, and workup of patients with thoracic aortic dissection. Discuss the treatment options for Type A (ascending) and Type B (descending) dissections
- Understand the basic principles of transplant immunosuppression and the mechanism of action of steroids, cyclosporine, azathioprine, mycophenolate, and OKT3
- Describe the acute complications and management of cardiac transplantation

Cardiothoracic Surgery:

- Describe the etiology and treatment of cardiac complications of noncardiac thoracic surgery
- Understand the risk factors, prevalence, treatment and outcome of post-pneumonectomy ARDS
- Describe radiologic manifestations of post-pneumonectomy CXR/CT scan
- Demonstrate working knowledge of chest drains
- Understand the etiology and management of mediastinitis and esophageal perforation

Orthopedics:

- Describe the techniques available to diagnose and manage infected orthopedic hardware
- Understand the prevalence of post-op delirium and medical complications of surgery

OB-Gyn:

- Describe the physiological changes of pregnancy and its impact on critical illness
- Understand the potential for airway complications during pregnancy
- Understand the common causes and management of hypertensive crises in pregnancy
- Understand the management of the common hepatic diseases of pregnancy

General Patient Management:

- Understand how post-operative pain contributes to peri-operative complications
- Describe the use of post-operative NIV to improve pulmonary outcomes
- Describe approaches to minimize complications in the elderly surgical patient
- Understand management of post-operative ileus and temporal patterns of post-op complications

Patient Care: *Residents are expected to provide patient care that is compassionate, appropriate and effective for the promotion of health, prevention of illness, treatment of disease and at the end of life.*

- Demonstrate proficiency in implementing and following the CABG/Cardiac Transplant pathway
- Develop a primary, patient-specific management plan, with a reasonable alternate plan
- Use data from appropriate invasive and non-invasive monitoring devices to diagnose, treat & titrate patient therapy

- Demonstrate use of temporary pacing devices to establish pacing thresholds, diagnose underlying rhythm disorders and modify cardiac performance
- Identify and manage complications of surgery including 1) surgical bleeding 2) hemodynamic instability 3) post-operative ventilatory failure
- Provide appropriate levels of post-operative sedation and analgesia
- Promote timely convalescence through early ambulation, appropriate nutrition, and scrupulous wound care

Practice-Based Learning: *Residents are expected to be able to use scientific evidence and methods to investigate, evaluate, and improve patient care practices.*

- Maintain a list of patients experiencing untoward events (morbidity and mortality) during their ICU stay
- Review relevant literature surrounding occurrences and presenting findings to fellows and faculty at monthly M&M conference
- Support ongoing basic and clinical science protocols in the ICU by participating in candidate identification or in proposing future projects
- Contribute to and support process improvements in the ICU by meeting with nursing or physician staff to assess current practice
- Participate in Multi-disciplinary rounds and be responsible for completion of daily goal sheets
- Understand the goals of and adhere to pathways developed for unique patient populations

Interpersonal and Communication Skills: *Residents are expected to demonstrate interpersonal and communication skills that enable them to establish and maintain professional relationships with patients, families, and other members of health care teams.*

- Provide effective and professional consultation to other physicians and health care professionals and sustain therapeutic and ethically sound professional relationships with patients, their families, and colleagues.
- Use effective listening, nonverbal, questioning, and narrative skills to communicate with patients and families
- Counsel and educate patients and families
- Communicate effectively in times of dynamically changing conditions
- Interact with consultants in a respectful, appropriate manner
- Communicates clearly, correctly, and concisely in a written report, stressing the important issues and an articulate plan.
- Maintain comprehensive, timely, and legible medical records
- Use nomenclature and writing standards consistent with that of the institution
- Transfer care of the patient in a manner that ensures patients safety, comfort and continuity of care
- Display support & empathy to patients and their families, as witnessed by attending staff or reported to staff
- Demonstrate respect for and recognition of particular skill sets possessed by other CC practitioners, such as CC nurses, RT, PT, OT, dieticians, pharmacists.
- Considers ethical issues and patient wishes in treatment decisions

Professionalism: *Residents are expected to demonstrate behaviors that reflect a commitment to continuous professional development, ethical practice, an understanding and sensitivity to diversity and a responsible attitude toward their patients, their profession, and society.*

- Demonstrate respect, compassion, integrity, and altruism in relationships with patients, families, and colleagues
- Demonstrate sensitivity and responsiveness to the gender, age, culture, religion, sexual preference, socioeconomic status, beliefs, behaviors and disabilities of patients and professional colleagues
- Adhere to principles of confidentiality, scientific/academic integrity, and informed consent
- Recognize and identify deficiencies in peer performance
- Teach junior colleagues or peers
- Admit to and seek help in remedying errors
- Interact with nursing staff and other professionals as two-way educational opportunities when current approach does not appear to be effective

Systems-Based Practice: *Residents are expected to demonstrate both an understanding of the contexts and systems in which health care is provided, and the ability to apply this knowledge to improve and optimize health care.*

- Understand, access and utilize the resources, providers and systems necessary to provide optimal care
- Apply evidence-based, cost-conscious strategies to prevention, diagnosis, and disease management
- Collaborate with other members of the health care team to assist patients in dealing effectively with complex systems and to improve systematic processes of care
- Demonstrate the Critical Care Practitioner's role as patient/quality care advocate
- Utilize established quality management procedures to facilitate care (e.g., massive transfusion protocol, standing order sets, ventilator pathway, CABG pathway, etc.)
- Participate actively in PCCM or multidisciplinary M&M or case conferences
- Interpret drug costs in context of outcomes (e.g., activated Protein C, rVIIa)
- Discuss the issues of patient safety including the medical systems that put patients at risk, medication, operations, transfusions & nursing ratios.
- Recognize, describe and ensure compliance with institutional and unit policies and procedures as well as regulatory policies from accreditation agencies, regulators, and payers

Instructional Methods:

Introductory Lecture Series, Web-Based Curriculum (RICU), Weekly Critical Care Fellows Conference, Multidisciplinary ICU lecture Series, ATS Hemodynamics Primer

Methods of Assessment:

- Competency-based staff evaluations
- Ancillary care provider evaluations
- Critical incident reporting
- Conference attendance and participation
- Structured evaluations of airway management, central line placement,
- Completion of PACEP / ATS Primer on Hemodynamic Monitoring

References:

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Websites:

The Cardiothoracic Surgery Network

<http://www.ctsnet.org/>

The Thoratec Corporation website

<http://www.thoratec.com/>

The Abiomed Corporation website

<http://www.abiomed.com/>

The Datascope Corporation Website

http://www.datascope.com/ca/cardiogenicshock.html?source=ca_home

<http://www.datascope.com/ca/caedelearning.html>

Texts:

Manual of Perioperative Care in Adult Cardiac Surgery, Fourth Edition, Robert Bojar, Blackwell Publishing

Principles and Practice of Intensive Care Monitoring, Martin Tobin, McGraw-Hill

Outline for Post-Operative Management of Cardiothoracic Patients

The goal of ICU care of the CT patient is patient survival and residency training. The ICU team will work to facilitate rapid, safe extubation and weaning of vasoactive meds as well as the recognition and management of bleeding, AMI, myocardial stunning, infection and stroke. Bolus volume resuscitation is often required and blood product use is minimized (excluding albumin). Packed cells are transfused when indicated based not only on Hct but on hemodynamics and the need for augmented oxygen delivery. Hct values less than 25% are routinely tolerated. The ordering of unnecessary labs and imaging studies outside of protocol guidelines is discouraged.

Immediately upon patient arrival in ICU

1. Airway: Check $\text{SaO}_2 > 94\%$, bilateral air entry by auscultation, note position of ETT at teeth.

2. Breathing: set vent to SIMV/PS with PEEP 5 cm, RR 14/m, tidal volume in the absence of ALI is 8 cc/kg predicted body weight BW (males) = $50 + 2.3(\text{ht inches} - 60)$, PBW (females) = $45.5 + 2.3(\text{ht inches} - 60)$ Is patient synchronized with vent. If not, is analgesia and sedation adequate.

3. Circulation: Check and correct abnormal rate, rhythm, BP. Check for the following:-

Adequacy of venous access.

PA line waveform, depth of placement, and SVO_2 ;

Pacing wires and pacemaker function.

Position and number drains (If blood in drains > 500 mL contact CT surgery)

Note infusions (vasoactive meds running through PA introducer side port, propofol and insulin peripherally) and doses (calculate "K"); urine output and skin temperature (will be low if core temp low).

IABP timing and distal pulses/signals.

4. Communicate with anesthesia/surgical teams.

Signs of pain- need for morphine bolus? Assess NM blockade.

5. Orders; confirm that the labs are SENT and CXR ordered.

Place OGT prior to CXR if absent and not contraindicated.

Within first 20 minutes

Cardiac output check and optimize inotropes and pressor.

Check ABG. Optimize ventilation and oxygenation. If base excess or lactate elevated assess volume resuscitation and consider fluid challenge.

Check CXR for signs of edema, compare with pre-op film, note position of ETT, PA and central lines, mediastinal and pleural drains, OGT and determine if atelectasis/ collapse. Correct any malpositioned tubes and optimize ventilator if edema or atelectasis.

Labs- correct abnormalities of K, Mg, Ca, PO_4 , Hct, aPTT, INR, platelets.

Check insulin infusion, and initial CBG.

Discuss 4 and 24 hr plans with CT surgery team.

At one hour

Can the hemodynamics be further optimized?

Can (or should) inotropic support and/or pressors be weaned?

Can the patient be extubated? If not what are the current barriers to extubation?

Does the patient need pain control or sedation?

Chest tube output? Call if greater than 500 mL initially, 400 1st hr, 300 2nd hour, or 200 3rd hour

At two hours

Same as above plus review the orders/MAR kardex to make sure that the orders have been properly implemented.

Remember

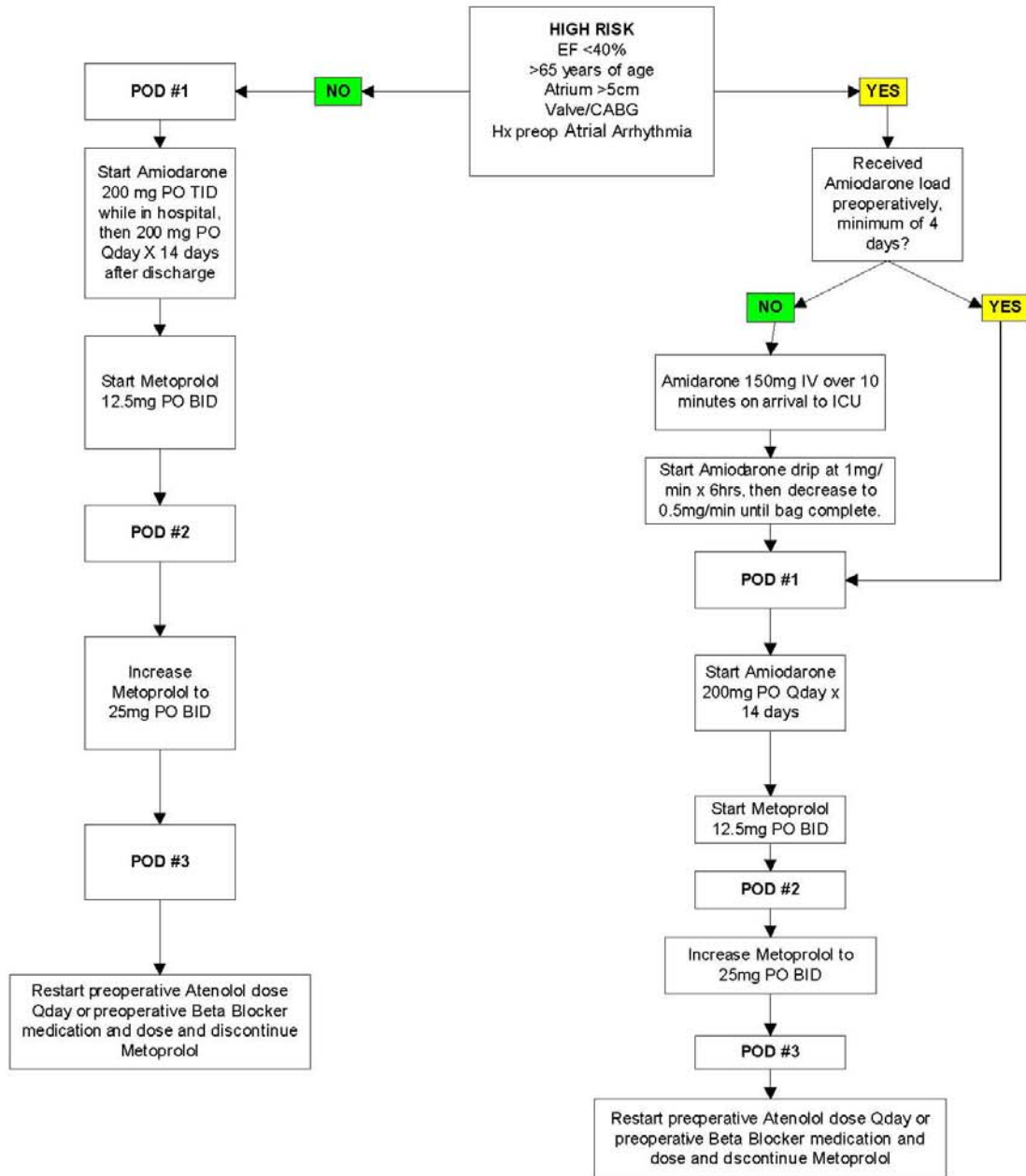
Patients frequently require repeated volume resuscitation as they warm (**500 mL per degree centigrade**), third space and have urinary and chest tube losses.

Early extubation is an important goal and may occur despite high doses of inotropes and pressor as long as this has been discussed with the faculty and the patient is on STABLE doses.

New atrial fib and flutter are common should be treated rapidly with amiodarone (bolus followed by infusion) cardioversion or overdrive pacing.

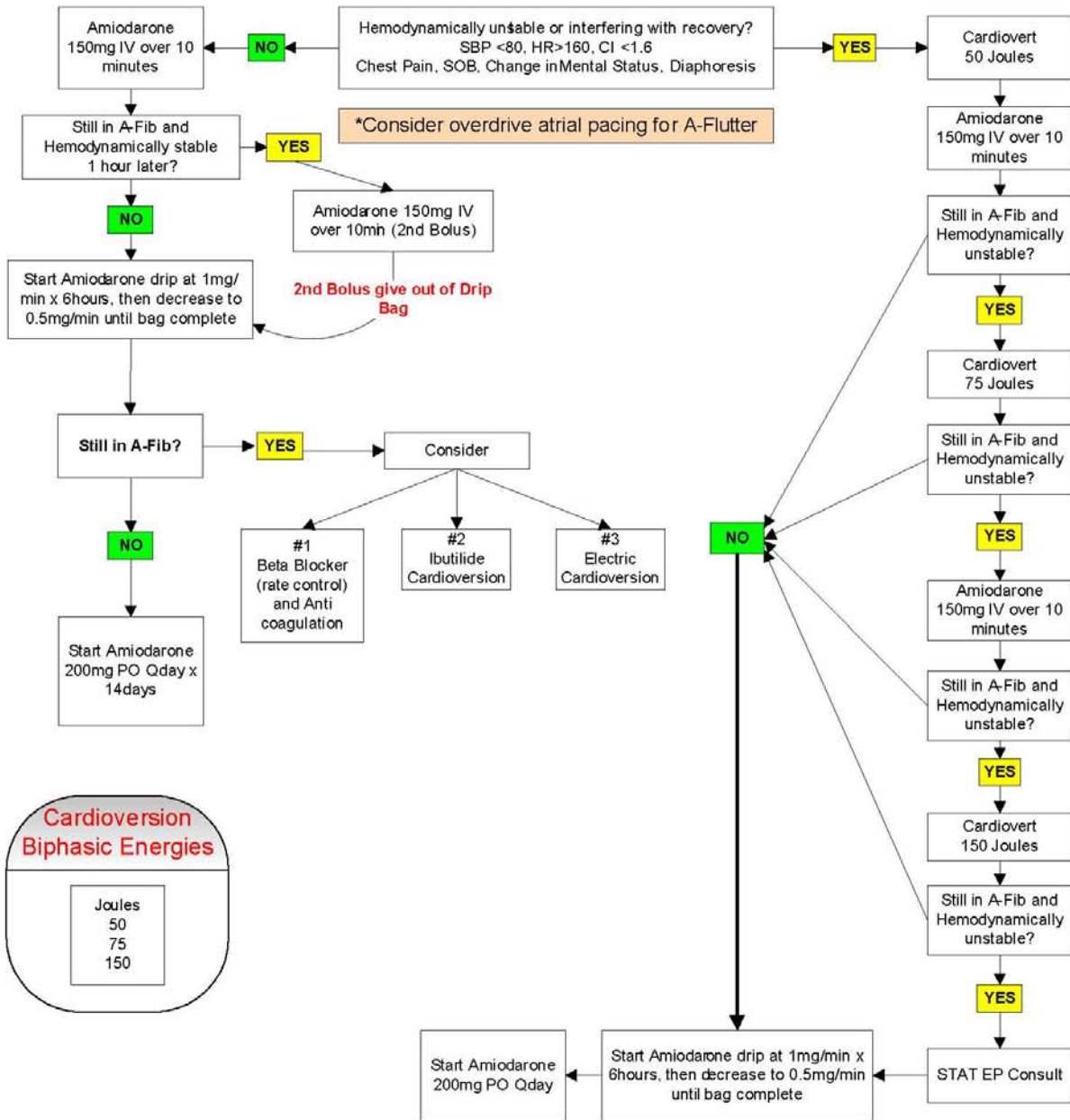
Read the postop orders carefully. They are very specific and will define many of the care goals.

Postoperative Prophylactic Atrial Fibrillation Guidelines



Postoperative Atrial Fibrillation Treatment Guidelines

Rule Out/Treat Precipitating Factors.
Keep $K^+ \geq 4.5$ and $Mg^{++} \geq 2.0$



CABG MULTIDISCIPLINARY VENTILATOR WEANING/EXTUBATION PROTOCOL

"SBT" - Spontaneous Breathing Trial Clinical Criteria

Check anesthesia record. If intubation grade 1-2 - OK. If intubation grade 3-4 or problem intubation, consult with MD.

Adequate oxygenation: $pO_2 \geq 60$ mm Hg; $SaO_2 > 93\%$; $FiO_2 \leq 0.4$; $PEEP = 5$ cmH₂O; pO_2/FiO_2 150-300.

Stable cardiovascular system: HR > 50 & < 120 ; SBP > 90 and < 140 ; CI > 2.2 .

Assess non intubated baseline ABG. If available (especially for COPD population).

Temperature > 36.5 and $< 38^\circ C$.

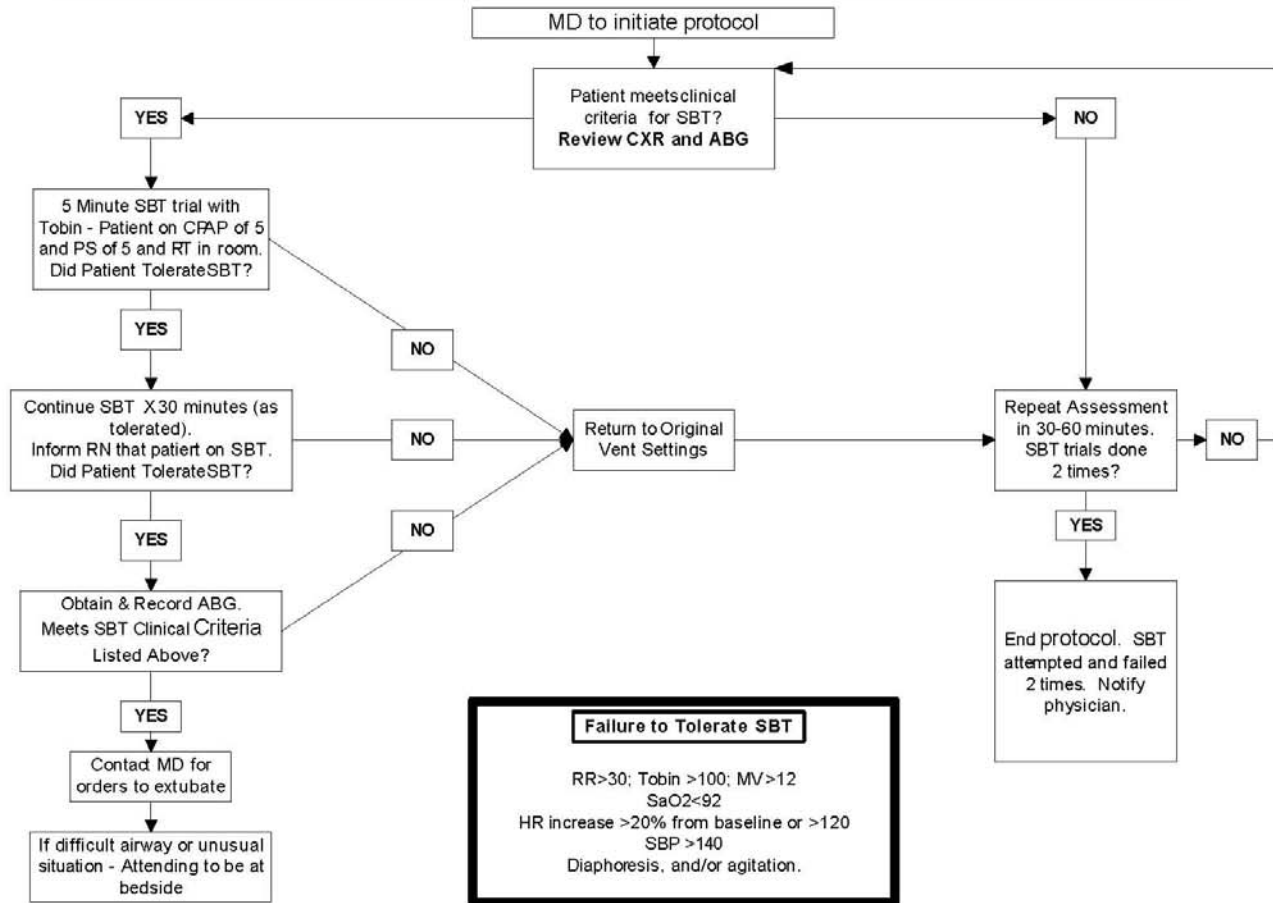
Adequate hemoglobin: Hgb 8 g/dL.
INR < 1.6 and no signs of Post OP Bleeding.
Chest tube output < 150 ml/hr and < 400 ml in first 2hrs Post OP.

pH > 7.30 and < 7.50 .

Adequate mentation and follows commands.

Motor Assessment: Grasp hands, Lower extremity function.

Acceptable electrolytes (K > 3.5 , Mg > 1.7 & Ionized Ca $> .99$).



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*Collective Task Force - American College of Chest Physicians - American Association for Respiratory Care - American College of Critical Care Medicine

Coronary Artery Bypass Graft (CABG) Pathway Reference Guide

Definitions:

Coronary Artery Bypass Graft Surgery: Treatment for coronary artery disease. Purpose is to restore blood flow to the heart muscle after one or more coronary arteries becomes clogged. The surgeon takes a piece of healthy vessel from another site in the body (usually chest, arm, or leg) and creates a new route for blood to reach the heart muscle.

In traditional bypass surgery, the heart is stopped while the surgeon sews the new vessel in place. A heart-lung machine takes over the job of circulating oxygenated blood during that time. Blood is diluted and patients are given blood thinners to keep clots from forming as it circulates through the machine. Also, the blood is cooled to prevent damage to other organs while the heart is stopped.

In off pump-bypass surgery, heart continues to beat throughout the operation. Special devices called stabilizers keep portions of the heart steady while the graft is sewn in place.

Saphenous Vein Graft SVG (SVG): Utilized as a venous conduit. Portions of the saphenous vein are sutured to a coronary artery beyond the arterial stenoses. Small punch openings are made in the ascending aorta and the proximal end of the saphenous vein is anastomosed to the aorta.

Internal Mammary Artery (IMA): Should be given primary consideration for revascularization of the LAD artery in every patient undergoing CABG. (Level of evidence B) 90% - 5 year LIMA patency rate. The pedicle strip with the IMA in the center is dissected from the chest wall, the distal end of the IMA is sutured beyond the area of arterial stenosis, usually on the LAD. In some studies, utilizing bilateral IMA's has been associated with an increased incidence of sternal wound infection.

Radial Artery Conduit: 84% - 5 year radial graft patency in 100 consecutive patients. After assessment for collateral circulation by the ulnar artery is made, the radial artery is harvested usually from the patient's nondominant hand. Portions of the radial artery are sutured beyond the arterial stenoses and the other end is anastomosed to the aorta.

Indications for CABG: 1. Significant left main disease > 50% diameter stenosis 2. Left Main equivalent disease – severe \geq 70% diameter stenosis of the proximal LAD & proximal left circumflex 3. Patients with significant 3-vessel CAD (> 50% diameter stenosis). 4. Decreased left ventricular function 5. Unstable angina 6. Chronic stable angina that is lifestyle limiting & unresponsive to medical therapy or interventional techniques.

More severe the symptoms, more proximal the LAD, & worse the LV function, the greater the benefit from surgery. CABG in the presence of or immediately after an acute MI is controversial. Reserved for patients with evidence of ongoing ischemia despite PCI or fibrinolytics or performed coincident with repair directed at mechanical complications of MI (VSD or papillary muscle rupture). Patients with shock as a complication of MI may also benefit. More attention paid to improvement in symptoms and quality-of-life measurements.

Risk Factors for Morbidity & Mortality after CABG: 7 Core Variables: 1. Urgency of operation 2. Age 3. Prior Heart Surgery (1st 3 greatest predictive power) 4. Sex 5. LVEF <40% 6. % stenosis of Left Main Coronary Artery 7. # of major coronary arteries with > 70% stenosis. **13 “Level 1” Variables:** 1. Height 2. Weight 3. PCI during index admit 4. History of angina 5. Ventricular arrhythmia 6. CHF 7. Mitral Regurgitation 8. Recent (< 1 week) MI 9. Diabetes 10. Cerebral Vascular Disease 11. PVD 12. Renal Dysfunction 13. Creatinine level.

Risk Factors for Neurological Deficit: Type I deficits: Major, focal neurological deficits, stupor & coma (Stroke). 21 % mortality. **Predictors:** 1. Advanced age, esp. > 70 years 2. History of HTN 3. Presence of proximal aortic atherosclerosis (Strongest Predictor) 4. History of prior neurological disease 5. Use of IABP 6. Diabetes 7. History of USA (Perioperative hypotension & ventricular venting – weak association) **Type II deficits:** Delirium and deterioration in intellectual function or memory (Encephalopathy). 10% mortality. **Predictors:** 1. Advanced age, esp. > 70 years 2. History of HTN 3. History of alcohol consumption 4. Dysrhythmia (a-fib) 5. Prior CABG, PVD or CHF (More likely to occur after periods of hypotension or inadequate perfusion)

During CPB, patients can experience hypoperfusion to the brain, air embolis, thrombi or plaque dislodgement. To prevent this complication, use of epiaortic ultrasound to identify calcified aortas, Embol-X cannulas to catch debris, off-pump CABG with use of IMA's only & maintaining a SBP > 90 & MAP > 65.

Institute for Healthcare Improvement (IHI): Goal is to save 100K lives across the country over 18 months. Lives will be saved by implementing 6 evidence-based bundles of interventions. 1. Rapid Response Team 2. Prevent Adverse Drug Events 3. Improve Care for Acute MI 4. Reduce

Surgical Site Infections 5. Prevent Central Line Infections 6. Prevention of Ventilator-Associated Pneumonia.

Atrial Fibrillation Prevention

Risk Factors	Occurs in the 1 st 5 days of cardiac surgery with peak incidence on POD #2. More than 90% of patients resume SR by 6 to 8 weeks after surgery. Risks Factors Include: 1. Age > 65 years (Every 10 years increase in age is associated with a 75% increase in the odds of developing a-fib) 2. Atrium > 5 cm 3. CABG/Valve (Older patients have changes in connective tissue in the atria & dilatation, also patients that require valve surgery have left atrial enlargement. 4. Ejection Fraction < 40%. 5. History of preop Atrial Arrhythmias. Associated with a 2 to 3 fold increase in postoperative stroke. Occurs in 30 % of patients undergoing CABG.
Beta Blockers	Class I recommendation, Evidence B. Preop or early postop administration reduces the incidence &/or clinical sequelae of A-fib after CABG. Withdrawal of B-Blockers in the periop period doubles the incidence of postop A-fib by 51 to 68% after CABG. Need to start at least 3 days preop. (Contraindications include symptomatic bradycardia, 2 nd /3 rd degree block without pacemaker, pacemaker dependent postoperatively, cardiogenic shock, decompensated heart failure, severe asthma or COPD, and patients on inotropic agents). Patients who did not receive beta blockers due to contraindications should be re-evaluated daily. Beta blockers diminish myocardial oxygen demand and cardiac work by reducing heart rate, arterial pressure, and myocardial contractility. These agents reduce the magnitude of infarction, frequency of life-threatening ventricular arrhythmias, mortality, and the risk of unstable angina. They also reduce the risk of developing heart failure and delay adverse cardiac remodeling.
Amiodarone	Class IIa, Evidence B. Preop administration decreases the incidence of post cardiectomy A-fib. Appropriate for high risk patients with contraindication to B-Blockers. Start 1 week preop (Oral loading takes 5-7 days for tissue saturation to occur). Use 24 hour IV infusion postop if unable to orally load preop. (Immediate bioavailability).
Anticoagulation	Post-CABG atrial fibrillation that is recurrent or persists more than 24 – 48 hours, warfarin anticoagulation for 4 weeks is probably indicated. (Class IIa, Evidence C) Consider adding warfarin in combination with aspirin in patients with a large infarction with extensive wall motion abnormality (Target INR =2.0-3.0), atrial fibrillation, visible LV thrombus, or documented thromboembolism. If patients has aspirin allergy, target INR should be 2.5-3.5. Heparin or LMWH therapy should be maintained until INR is therapeutic.

Antiplatelet Therapy

Graft Closure	A major complication of CABG is graft closure, largely related to platelet aggregation. SVG after harvest loses its endothelium and the raw surface is vulnerable to platelet aggregation.
Aspirin	Class I recommendation, Evidence A. Give indefinitely. <u>SVG Patency</u> – 1. No preop benefit 2. Benefits lost if started > 48 hours after surgery 3. Doses between 75 mg & 325 mg beneficial 4. Benefit if started at 1, 7 or 24 hours after operation. Recommend 75 to 325 mg/d, starting 6 hours after operation – Grade 1A. 5. As diameter increases, SVG patency rates improve & advantage of ASA is reduced 6. <u>IMA Patency</u> – 1. Recommend ASA 76 to 162 mg/d, indefinitely – Grade 1A. Benefits to decrease mortality, MI, stroke, renal failure, need for revascularization & bowel infarction.
Clopidogrel	Often used in <u>Off-pump CABG patients</u> : 75 mg daily, start 6 hours after OR if chest tube output < 150 ml/hr.

Vasospasm Prevention

Nitrates	IMA's – Not prone to vasospasm. No prophylaxis necessary. Radial Artery Grafts - prone to spasm. Periop Calcium Channel Blockers or long-acting nitrates are often used to reduce this complication.
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INFECTION CONTROL

Single Most Important Prevention against Infection:

Hand Hygiene	1. Decontaminate hands with either antimicrobial soap & H ₂ O (If hands visibly soiled) or with an alcohol-based waterless antiseptic agent. (Class 1A). Chlorhexidine gluconate hand scrubs (Avagard D – 61% alcohol – achieves reductions in skin microflora (Class 1A), Not
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inactivated by blood or serum proteins) **2.** Do before touching patient, pouring up medications, before putting on gloves & after contact with patient (Class 1A) **3.** Wear gloves for handling secretions (Class 1B)

Infection Prevention

Risk Factors	1. Smoking 2. Obesity 3. Steroid use 4. Diabetes or BS > 200 postoperatively 5. Malnutrition 6. Perioperative transfusions 7. Prolonged preoperative hospital LOS 8. Nasal colonization with Staph Aureus. <i>Skin & nasopharyngeal gram-positive organisms are the leading cause of deep sternal wound infections or mediastinitis.</i>
SURGICAL SITE INFECTION (SSI) PREVENTION	
	Surgical Site Infection (SSI): IHI bundle to prevent SSI includes: 1. Appropriate use of antibiotics 2. Appropriate hair removal (no shaving) 3. Perioperative glucose control 4. Perioperative normothermia. <i>Deep Sternal Wound infections carry a mortality rate of 25%.</i>
Antibiotic Prophylaxis	Class I recommendation, Evidence A. 1. Should be administered to all patients to reduce the risk of postop infections. 2. Reduces the risk 5-fold 3. Dependent on adequate <u>drug tissue levels</u> before microbial exposure (Below dosing regimens maintain adequate tissue levels) 4. Cephalosporin class is agent of choice 5. One day course as efficacious as 48 hour course 6. Administration should be within 30-60 minutes of incision & redosing if operation exceeds 3 hours. 7. <i>Beneficial effect is negated if drug is given after incision.</i> 8. Vancomycin is utilized for patients allergic to PCN 9. Mupirocin Ointment 2% (Bactroban) – a. Effective topical agent for eradicating S. Aureus from the nares of colonized patients b. Requires a 5 day treatment course to eradicate S. Aureus colonization.
Oral Care	1. Dental plaque is colonized with bacteria 2. Chlorhexadine Gluconate 0.12% oral solution used twice daily decreased nosocomial pneumonia rates by 52-71% in CT surgery patients (Class II) 3. CDC guidelines recommend a comprehensive oral care program (Class II) (Brushing teeth twice daily decreases dental plaque, perform oral care at least every 4 hours, keep lips & mucous membranes moist)
Skin Prep	1. Preoperative antiseptic shower or bath decreases skin microbial colony counts nine fold. 2. Chlorhexadine Gluconate (hibiclens) requires several applications to attain maximum antimicrobial benefit (2 showers – evening before & morning of surgery)
Hair Clipping	Preoperative shaving of surgical site the night before an operation is associated with a significantly higher risk than depilatory agents or no hair removal. Shaving causes microscopic cuts in the skin that later serve a foci for bacterial multiplication. Rate of infection – Shaving immediately before OR 3.1% versus 1.8% with clipping. Shaving within 24 hours of OR 7.1% & >24 hours of OR increased to 20%.
Hyperglycemia Management	Use of CPB results in: 1. Depression of insulin release with hypothermia 2. Increased epinephrine release during bypass which stimulates an increase in glycogenolysis 3. Insulin adheres to the CPB tubing 4. Increase in antidiuretic hormone. <u>Van den Berghe</u> – maintaining blood glucose at or below 110 mg/dl reduces morbidity and mortality among critically ill patients in SICU's. Patients require basal & nutritional insulin and often require supplemental or correctional insulin for treatment of unexpected hyperglycemia. Use of "sliding scale" insulin alone is discouraged. <u>Furnary</u> found that the lowest mortality were in patients with an average postoperative blood glucose < 150 mg/dl. Hyperglycemia (fasting blood glucose > 126 mg/dl), random blood glucose > 200 mg/dl was associated with an 18-fold increase in in-hospital mortality, a longer length of stay, more subsequent nursing home care, and greater risk of infection. Hyperglycemic patients undergoing cardiac surgery suffer greater mortality, increased deep wound infections and overall infections. Hyperglycemia on the first and second POD's was the single most important predictor of serious infectious complications. Hyperglycemic cardiac surgery patients treated with intravenous insulin infusions used for the first 3 postoperative days demonstrated reductions in absolute and risk-adjusted mortality of 57% and 50% respectively. LOS was reduced by one day for each 50 mg/dl lowering of the average 3-day postoperative blood glucose. After the first 24-48 hours, treatment should be individualized around insulin and oral hypoglycemic agents. Patients should receive intensive instruction on diabetes management/control and referral to Diabetic Education Class for new diagnosis. <i>Elevated blood glucose levels impair wound healing. Intravenous insulin infusions & aggressive control of periop hyperglycemia (Goal to maintain glucose 80-109 mg/dl) have been show to significantly reduce the incidence of deep sternal wound infections. (IIa, Evidence B)</i>
Leukoreduced PRBC's	Bleeding – Result of: 1. Inadequate heparin reversal 2. Heparin rebound effect 3. Hypothermia – depressed liver function 4. Disruption of suture lines or uncauterized vessel 5. Hypertension 6.

	<p>Consumption of clotting factors and platelets or platelet dysfunction 7. Hemolysis & platelet activation on bypass circuitry 8. Prolonged CPB runs 9. Preop anti-platelet agents or coagulopathies</p> <p>Treatment: 1. Protamine sulfate 2. Rewarm 3. Reexploration in OR 4. Maintain patency of chest tubes by milking 5. Increase PEEP if still on ventilator 6. Vasodilators (Nipride, Nicardipine, NTG) & adequate pain control & sedation 7. Replace volume with NS, Hespan (1500 ml max in 24 hours or increased risk of bleeding) or Leukoreduced RBC's, FFP or platelets. Autotransfusion of shed mediastinal blood contraindications: 1. Cases of sepsis, 2. Severe coagulopathy, 3. Renal failure, 4. Bowel perforation and 5. Cancer. Patients who receive autotransfusion have an increased incidence of early postoperative fever, band neutrophilia and plasma-free hemoglobin, as well as wound infections. Possibly due to bacterial contamination of shed blood or increased exposure to cytokines or other inflammatory mediators that may be present in the autotransfused blood.</p> <p>Homologous blood transfusions – correlated in a dose-related fashion to increased risk for viral & bacterial infections, increased LOS, antimicrobial use & mortality through transfusion-related immunomodulation (4% infection rate – 2 units PRBC's, 7% infection rate – 3 to 5 units PRBC's, 22% infection rate - \geq 6 units PRBC's). Leukoreduction has been shown to blunt the immunosuppressive effect of blood transfusion in surgical patients. All blood products to be leukodepleted.</p>
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VENTILATOR-ASSOCIATED PNEUMONIA (VAP) PREVENTION

	<p>Ventilator-Associated Pneumonia (VAP): Use of CPB can Result in: 1. Alveolar collapse during CPB – decreased surfactant production with unventilated lungs 2. Pulmonary microemboli or decreased perfusion 3. Alveolar-capillary membrane damage – complement activation & inflammatory response 4. Alterations in colloidal osmotic pressure resulting in interstitial pulmonary edema 5. History of COPD or other respiratory problems Treatment: 1. PEEP on ventilator 2. Postural drainage & early mobilization 3. Aggressive pulmonary toilet – IS, T,C & DB 4. Extubate \leq 6 hours 5. Bronchodilators as needed. 6. Comprehensive oral care program IHI bundle to prevent VAP includes: 1. HOB up 30-45 degrees 2. Daily “Sedation Vacation” and assessment of readiness to extubate 3. Peptic ulcer prophylaxis 4. Deep Vein Thrombosis prophylaxis.</p>
GERD/Aspiration Prophylaxis	<p>1. HOB elevated 30 – 45 degrees to prevent aspiration (Class II) 2. Check feeding tube placement & residuals (Class 1B) Recommend use of H₂-antagonists for stress-bleeding prophylaxis in ventilated patients. Proton Pump Inhibitors (PPI's) should be continued in patients with a history of GERD or at home on PPI's.</p>
Deep Vein Thrombosis	<p>Risk Factors for DVT: 1. Surgery 2. Trauma – major or lower extremity 3. Immobility 4. Malignancy 5. Cancer therapy 6. Previous VTE 7. Increasing age 8. Estrogen-containing oral contraceptives or HRT 9. Acute medical illness 10. Heart or respiratory failure 11. Obesity 12. Smoking 13. Varicose veins 14. Central Venous catheters 15. Nephrotic syndrome. (Critical Care patients – 10-80% risk of DVT)</p> <p>Thromboembolism Risk & Recommendations in Surgical patients</p> <ul style="list-style-type: none"> • Low risk – minor surgery in patients < 40 yr with no additional risk factors <ul style="list-style-type: none"> • No prophylaxis – early & “aggressive” mobilization (Grade 1C+) • Moderate risk – minor surgery in patients with additional risk factors. Surgery in patients aged 40-60 yr with no additional risk factors <ul style="list-style-type: none"> • LDUH 5,000 units BID, LMWH (daily), SCD's (Grade 1A) • High risk – surgery in patients > 60 yr, or age 40-60 with additional risk factors (prior VTE, cancer, molecular hypercoagulability) <ul style="list-style-type: none"> • LDUH 5,000 units TID, LMWH (daily), SCD's (Grade 1A) • Highest Risk – surgery in patients with multiple risk factors (age > 40 yr, cancer, prior VTE) <ul style="list-style-type: none"> • LMWH (daily), Coumadin (INR 2-3), or SCD's & LDUH 5,000 units TID (Grade 1C+) <p>Recommend against the use of aspirin alone as prophylaxis against VTE (Grade 1A)</p>
DVT Prophylaxis	<p>CT patients fall into the High & Highest Risk Category. Bleeding risk with use of LMWH very high after CT surgery. 1. SCD's on arrival (Must be worn 23 hours per day to be effective). Increase venous outflow &/or reduce stasis within the leg veins. Grade 2A recommendation in conjunction with anticoagulation-based prophylaxis. 2. Ace Wraps from OR will be replaced with Knee-high TED hose POD #1 after dressings removed 3. Early & “Aggressive” mobilization 4. Unfractionated Heparin 5,000 units SQ Q 8 hours. Start 6 hours after return from OR if chest tube drainage < 150 ml/hour</p>

CENTRAL VENOUS CATHETER INFECTION (CVC) PREVENTION

	Central Venous Catheter Infection (CVC): IHI bundle to prevent CVC includes: 1. Hand Hygiene 2. Maximal barrier precautions 3. Chlorhexidine skin antisepsis 4. Optimal catheter site selection 5. Daily review of line necessity with prompt removal of unnecessary lines.
Hand Hygiene	1. Decontaminate hands with either antimicrobial soap & H ₂ O (If hands visibly soiled) or with an alcohol-based waterless antiseptic agent. (Class 1A). Chlorhexidine gluconate hand scrubs (Avagard D – 61% alcohol – achieves reductions in skin microflora (Class 1A), Not inactivated by blood or serum proteins) 2. Do before touching patient, pouring up medications, before putting on gloves & after contact with patient (Class 1A) 3. Wear gloves for handling secretions (Class 1B)
Maximal Sterile Barrier Precautions	1. Use aseptic technique including the use of a cap, mask, sterile gown, sterile gloves and a large sterile sheet for insertion of CVC's (Including PICC's) or guidewire exchanges. (1A)
Chlorhexidine skin antisepsis	1. 2% Chlorhexadine/ 70% alcohol antiseptic (Chloraprep) is preferred to disinfect skin before insertion and during dressing changes (1A) 2. Allow antiseptic to remain on insertion site and to air dry before catheter insertion (1A)
Optimal catheter site selection	1. Weigh risks of site selection to decrease infection complications with risk of mechanical complications (1A) 2. Use subclavian site (rather than jugular or femoral) to minimize infection risk (1A) 3. Place hemodialysis catheters in jugular or femoral vein rather than subclavian to avoid venous stenosis (1A).

URINARY TRACT INFECTION (UTI) PREVENTION

	Urinary Tract Infections (UTI): 1. Avoid &/or curtail use of indwelling catheters 2. Maintain a closed drainage system 3. Aseptic insertion technique for catheters 4. Stabilize catheter 5. Clean perineal area at least daily with soap & H ₂ O 6. Don't raise collection bag above the bladder 7. Avoid use of leg bags 8. Avoid changing functioning catheters 9. Encourage fluids 10. Use antiinfection urinary catheters
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Inotropic/Vasopressor/Vasodilator Support

Low Cardiac Output/Low Blood Pressure	Results from: 1. Preexisting heart disease 2. Hypothermia 3. Catecholamine & renin secretion secondary to baroreceptor response to non-pulsatile flow 4. Hypoperfusion injury 5. Periop MI – decreased contractility from prolonged CPB time, inadequate myocardial protection or emboli 6. LV failure due to volume overload 7. Heart blocks – swelling at suture lines. 8. Tamponade 9. Arrhythmias (A-fib) Treatment: 1. Inotropic Support -Do NOT titrate. Ordered decreases. Need gradual withdrawal of these agents. 2. Rewarm 3. Vasodilators (Nipride, Nicardipine, Nitroglycerin) 4. Nitrates 5. Diuretics 6. Pacing 7. Pericardiocentesis or reexploration in the OR 8. Antiarrhythmic agents & cardioversion 9. IABP or Ventricular Assist Device Placement
Low Blood Pressure	Results from: 1. Postop diuresis 2. Loss of vascular volume due to third spacing (decrease colloid osmotic pressure & albumin dilution 3. Vasodilatation from rewarming 4. Heart blocks – swelling at suture lines. 5. Tamponade 6. Arrhythmias (A-fib) Treatment: 1. NS or Hespan bolus (max 1500 ml in 24 hours or increased risk of bleeding) 2. Vasopressor (Epinephrine, Neosynephrine, Levophed or Vasopressin) 3. Pacing or inotropic support 4. Pericardiocentesis or reexploration in the OR 5. Antiarrhythmic agents & cardioversion
Low Urine Output	Results From: 1. Oliguria secondary to hypothermia, microemboli, hypoperfusion or catecholamine release 2. Hemoglobinuremia due to damaged RBC's during CPB 3. Tamponade 4. Arrhythmias (A-fib) 5. ATN Treatment: 1. Replace fluids with NS or Hespan (1500 ml max in 24 hours or increased risk of bleeding) 2. Rewarm 3. Inotropic Support. 4. Maintain adequate renal perfusion pressure with vasoconstrictor agents 5. Pericardiocentesis or reexploration in the OR 6. Antiarrhythmic agents & cardioversion 7. Use of diuretics when appropriate.
High Blood pressure	Results from: 1. Increased vascular volume due to hemodilution 2. Catecholamine & renin secretion secondary to baroreceptor response to non-pulsatile flow 3. Vasoconstriction with hypothermia Treatment: 1. Diuretics 2. Vasodilators (Nipride, Nicardipine, Nitroglycerin) 3. Active rewarming

Miscellaneous Medications

Electrolytes	Abnormalities result from: 1. Decreased K ⁺ due to dilution, intracellular shifts &/or diuretics 2. Decreased Na ⁺ , Ca ⁺⁺ , or Mg ⁺⁺ - dilutional, fluid shifts or diuresis 3. Increased capillary permeability – fluid shifts, interstitial edema leading to intravascular hypovolemia Treatment: 1. Replace K ⁺ - keep K ⁺ 4.5 – 5.5 2. Na ⁺ - no treatment or free water restriction 3. Replace Mg ⁺⁺ - keep 2-3 & Ca ⁺⁺ - keep ionized Ca ⁺⁺ > 1.15.
Analgesia	Narcotics: If intravenous doses of an opioid analgesic are required, fentanyl, hydromorphone & morphine are the recommended agents (Grade C). Scheduled opioid does or a continuous infusion is preferred over an “as Needed” regimen to ensure consistent analgesia. A PCA device may be utilized to deliver opioids if the patient is able to understand and operate the device (Grade B). Morphine and hydromorphone are preferred for intermittent therapy because of their longer duration of effect. (Grade C) NSAIDs or acetaminophen may be used as adjuncts to opioids in selected patients. (Grade B) In combination with an opioid, acetaminophen produces a greater analgesic effect than higher doses of the opioid alone. NSAID’s: Toradol – can lead to renal failure & increased risk of bleeding. (Hypovolemia or hypoperfusion, elderly patients & those with preexisting renal impairment may be more susceptible to NSAID-induced renal injury). Propofol or Dexmedetomidine are the preferred sedatives when rapid awakening (for neurologic assessment or extubation) is important. (Grade B) Triglyceride concentrations should be monitored after two days of propofol infusion and total caloric intake from lipids should be included in the nutrition support prescription. (Grade B).
Ace Inhibitor	Ace Inhibitors can be used in conjunction with or in lieu of B-Blockers in patients with coronary artery disease. (Contraindications include clinically relevant renal failure, history of bilateral renal artery stenosis or angioedema, cardiogenic shock, hyperkalemia, and pregnancy). Angiotensin receptor blockers (ARB’s) should be used in intolerant patients. <i>Ace inhibitors have shown benefit (reduction in vascular events, mortality, and ventricular dilation) from early use. Use of an Ace Inhibitor was also associated with a reduction in CV mortality, MI, stroke, all cause mortality, cardiac arrest, revascularization procedures, and heart failure. This benefit was observed without HTN and with normal LVEF.</i>
Lipid Management	Class I recommendation, Evidence A. 1. All patients undergoing CABG should receive lipid lowering therapy unless contraindicated. 2. Decreases progression of disease in SVG’s 3. Decreases revascularization rates. Low Density Lipoprotein (LDL) cholesterol is the primary target of lipid lowering therapy as elevated levels are a major cause of coronary disease. These agents should be started in all patients, regardless of baseline LDL cholesterol. Baseline LFTs should be obtained before initiation of these agents and rechecked in two weeks for patients with chronic liver disease and in three months for all other patients. Statins should be stopped if there is a threefold elevation above the upper limit of normal of AST or ALT on two occasions. Creatine phosphokinase levels should be determined in patients presenting with persistent symptoms of myalgia during statin therapy. Withdrawal of the drug should be considered if significant elevations are observed. Rare cases of rhabdomyolysis with acute renal failure have been reported in patients receiving statins. Rhabdomyolysis may occur after a single dose. In the majority of cases reported, rhabdomyolysis abated after withdrawal of the drug. Target levels in patients with coronary, other vascular disease, or diabetics: LDL <70mg/dl; HDL >45mg/dl; Triglycerides <150mg/dL. If HDL is <45mg/dl, education should focus on exercise, weight loss, and smoking cessation, all of which will help to increase HDL. <i>Benefits are seen in patients with cholesterol and LDL of all levels, thus it is not necessary to await lipid levels prior to starting. Use of these agents lowers the risk of recurrent events, need for revascularization, hospitalizations, strokes, and mortality.</i>
Anticoagulation	1. Long term (3-6 months) anticoagulation is probably indicated for patients with recent anteroapical infarct and persistent wall-motion abnormality after CABG (IIA, evidence C) 2. Patients with severely depressed LV function should be considered for long-term anticoagulation to reduce the incidence of thromboembolic events.

Patient Education

Smoking Cessation	Class I recommendation, evidence B. Current smoking status and all smoking cessation interventions must be documented in the medical record. Both physicians and nurses should counsel current smokers through strong encouragement and smoking cessation information in the form of verbal instruction, smoking cessation packets, and videos. Patients should also be told to avoid secondhand smoke. Family members who live in the same household should also be encouraged to quit smoking and help to reinforce the patient’s effort to quit. Pharmacological therapy including nicotine replacement and bupropion should be offered to select patients indicating a willingness to quit. (Evidence B) <i>In patients with Coronary Artery Disease, smoking cessation is associated with a 36% reduction in all-cause mortality irrespective of patient age, sex or cardiac event.</i>
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Activity Progression	Core Components of a Cardiac Rehab Program are: 1. Assessment 2. Nutritional counseling 3. Risk Factor Management (Lipids, HTN, Weight, Diabetes, & Smoking) 4. Psychosocial management 5. Physical Activity and 6. Exercise Training. Phase I Cardiac Rehabilitation including early ambulation and education on sternal precautions, home exercise program, cardiac precautions, RPE & HR monitoring, sexual activity and Phase II Cardiac Rehab should occur during hospitalization. A <u>prescription</u> for Phase II Cardiac Rehabilitation should be given to all patients who underwent CABG surgery. (Class I recommendation, evidence B). This outpatient exercise training, family education and sexual counseling have been shown to reduce mortality. Should begin 2 to 3 weeks after CABG and consists of 3-times-weekly educational and exercise sessions for 6 weeks and is associated with a 35% increase in exercise tolerance, a slight but significant increase in HDL and a 6 % reduction in body fat. Exercise training is a valuable adjunct to dietary modification of fat and total caloric intake in maximizing the reduction of body fat while minimizing the reduction of lean body mass.
Dietary Counseling	Initial dietary goal and education after CABG should focus for the first 8-10 weeks on the patient meeting nutritional needs, including adequate amounts of calories, protein, vitamins (A, C & B complex) and Zinc to promote normal wound healing. Patients and family members should then receive counseling on the National Cholesterol Education Program diet which focuses on a diet high in soluble fiber and rich in vegetables, fruits, and whole grains, low salt (2,000 mg/day), reduced intake of fats and cholesterol, less than 7% of total calories as saturated fats, less than 200mg of cholesterol per day, increased consumption of omega-3 fatty acids, and appropriate caloric intake for energy needs. Sodium restriction should be discussed with all patients who have HTN or heart failure. Carbohydrate monitoring and no concentrated sweets should be discussed with all patients who have diabetes or hyperglycemia.
Weight Management	If BMI >25.0 and/or waist > 40 inches in men and > 35 inches in women, patient should receive weight management instruction including diet and physical activity.
Blood Pressure	Goal for blood pressure is <130/85 mmHg. If blood pressure is higher than this recommendation, add blood pressure reducing medications, emphasizing beta blockers and Ace inhibitors. If blood pressure is >120/80, lifestyle modification (weight control, dietary changes, physical activity, reducing alcohol consumption, and sodium restriction) should be initiated.
Patient Education	Education should begin before admission to the hospital when possible or in the early phase of hospitalization and occur until discharge. Patient should receive education on admission including orientation to unit, CABG procedure, lines & tubes to expect, infection prevention methods, use of IS, T,C & DB, activity progression, pain management, A-fib prophylaxis, hyperglycemic control and collaborative care pathway. Patients and family members should be involved in planning for adherence to the lifestyle changes and drug therapies that are important for the secondary prevention of CV disease. Patients should be educated on specific targets for LDL cholesterol, blood pressure, weight, exercise and glucose control. Patient should be instructed in home vital sign monitoring to include BP, Pulse, Weight, temperature & blood sugar measurement if needed. Patient should receive instructions on Cardiac Prudent diet & NAS. The patient and family members should be instructed regarding medications, to include purpose, dose, and major side effects of each medication during hospitalization and at discharge. Written medication sheets and a medication schedule should be provided to each patient. Patient should state plans for obtaining prescribed medications before discharge occurs. At regular intervals, patient and family understanding should be reinforced. Patients and family members should also be instructed on problems to call for, who to call and their contact phone numbers and receive follow up appointments.
* If medication is contraindicated or not tolerated, this must always be documented in the medical record.	

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