

A. BODY IMAGING AND INTERVENTION 2012-13

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I. General Overview and Description of Body Division

The Body Division at Rhode Island Hospital (RIH) interprets Body CT and MR exams and also performs CT Guided Interventional procedures. The organizational structure of the Department of Diagnostic Imaging at Rhode Island Hospital includes Medical Directors of each *modality*, as well as Physician directors of each Organ System/Area. The Medical directors of CT, MR and Ultrasound are Drs. Mayo-Smith, Rogg, and Beland respectively.

The physician directors involved in the Body Division are as follows:

Director of Body Imaging & Intervention:	Dr. Mayo-Smith
Director of Body MR:	Dr. Grand
Director of Fluoroscopy:	Dr. B Murphy
Director of CT Colonography:	Dr. Chang
Director of Cardiac Imaging (CT & MR)	Dr. Atalay
Director of Tumor Ablation:	Dr. Dupuy

CT at Rhode Island Hospital

There are currently six helical CT scanners at Rhode Island Hospital which perform in excess of 85,000 examinations per year. The Main CT section has a 64 detector row scanner which performs diagnostic and cardiac imaging and a 16 detector wide bore scanner with CT fluoroscopy for CT guided interventional procedures. There are two multidetector scanners in the ER (64 and 128 detector rows). The Medical Office Center (MOC) has a 16 detector row scanner and the Pediatric Imaging Center has a new 20 detector row scanner. In the body reading room, we also read CT exams performed in the morning at the MDIC imaging center where a 16 detector row CT scanner with ASIR is being installed. All scanners have adaptive statistical iterative reconstruction software and hardware to help us perform low radiation dose CT exams. Our division has spent many years developing low dose CT protocols and our web site currently receives over 150 hits per day from around the world. You can see them on line by Googling "CT protocols" or visit the web site www.brownct.org. The department uses dual phase power injectors for every contrast enhanced examination.

Resident and fellow exposure to CT occurs in the Body rotation, Emergency Department, in Neuro, MSK and pediatrics. Computed tomography is used within all subspecialties of Radiology and this section will refer to the general daily operation of residents rotating through the Body Section. Pediatric scans are performed in the Meehan Building and interpreted in our Picture Archiving System (PACs) by the pediatric radiologists. Emergency CT scans are interpreted in the Emergency Department.

Body Rotation

The Body rotation begins with rounding on patients in the hospital who have had tubes placed by the CT/US radiologists. Any resident or fellow that has placed a tube in an

inpatient, should round on the patient to learn about follow-up catheter management. At 7:30 a.m. the resident/fellow reports to the Body reading room (Meehan 2) and pulls cases from the CT Body worklist. In PACs, under the Subspecialty tab, there is the “Body” Section, the subsections in this are “Body CT”, “Body MRI”, “Body Rec”, and “Body Tube”.

Morning rounds begin promptly at 8 a.m. in the body reading room using the large flat screen monitor. The senior resident or fellow will briefly present 1. Scheduled CT guided interventions for the day; 2. Tube rounds on inpatients; and 3. Present three interesting cases from the day or week before. The interesting body cases can be from the body CT, US, Body MR, ER, Miriam, or W&I. Interesting cases should be placed in the “Body Conf” folder and then deleted from the folder after being presented. Rounds should take approximately 35 minutes. The list of patients with tubes is on the whiteboard in the body reading room and worklist called “Body Tube.”

All CT studies that are on the “Body CT” worklist are to be read that day. This includes Abdomen and Pelvis exams, but will also include neck, chest, abdomen and pelvis exams if they are performed on the same patient at the same time. Dedicated chest exams, with the exception of CT PE exams, are read in the Chest Division and dedicated neck exams, with the exception of 4DCT exams (for occult parathyroid adenomas), are read in the Neuro Division. The day concludes at 5:30 p.m. or when the work is completed, whichever is later. The senior resident must stay until the nightfloat short resident is in the Body reading room. Readout of Body CT and MR exams in the Meehan area is divided between the residents rotating in the section and the cross-sectional imaging fellow. The senior resident (or fellow) on the body rotation is responsible for performing the CT guided interventions for the day. For Ablation patients, the NPs (Derek Tessier or Amy Doorley) will obtain consent in the patients and may participate in the procedure itself depending on staffing.

The resident/fellow should review relevant prior exams on PACS to help with accurate interpretation of the current exam. The resident/fellow should review prior discharge dictations and relevant pathology and surgical reports from the Lifelinks computer system and using the link provided to the electronic medical record (EMR) in PACS. All residents and fellows are expected to have activated Lifelinks account, which are activated through the IT help desk (4-6381). The resident/fellow should then review the films and form their own impressions. If you have a question about what is going on with a patient, look up the history in Lifelinks and prior reports! The more history we have, the better our interpretation will be. In addition, for outpatient CT and MR exams, all patients answer a questionnaire which is scanned into the PACS system. At this point, all cases will be reviewed with the attending. At mid-day and at the conclusion of the day the resident/fellow should review and sign all of their reports, making sure his or her queue is empty on the computer system before leaving work. Any unexpected or emergent findings should be communicated to the referring physician during the course of the day. All studies should be dictated within 24 hours of the exam.

As we sometime compare with RIMI exams, or are asked to perform a biopsy based on RIMI exams, all residents should have a password for login into the RIMI PACs system.

Kyle Schuster is the contact person for this: 401-427-7871. RIMI cell 401-639-2968. If Kyle is not available, Claire Warner is the secondary contact 401-427-7858. RIMI PACs can be accessed via the Synapse program, located on the desktop of most standalone PCs in the Body reading room or on the Virtual Desktop on the PACs workstations.

Second, third, and fourth year residents are expected to be able to form basic interpretations of thoracic, abdominal, and pelvic examinations. These residents are expected to help referring physicians interpret studies performed at Rhode Island Hospital when they come to the Body section. When residents are having difficulty interpreting these cases, the attending or fellow in the Body section should be consulted immediately.

Protocolling Cases

There is a comprehensive protocol book for CT examinations performed at Rhode Island Hospital. These are also online at the department web site or can be seen at www.brownct.org. You can also Google “CT protocols” and our site is one of the top three sites that comes up. Residents/fellows should read through the Rhode Island Hospital protocols and be able to describe them in detail to the attending in the section. First year residents should not protocol CT examinations. Please note that there is increasing scrutiny about how radiological examinations are performed and there will need to be careful attention to protocolling CT examinations. For example, if the history given is “liver disease” then the appropriate examination is a three phase liver CT not an abdominal CT. Likewise, if an abdominal CT is ordered, it does not necessarily mean a pelvic CT should also be performed. If we perform a pelvic CT in this circumstance, we will not be reimbursed for that study and in fact could be found guilty of over-billing Medicare with a possible \$10,000.00 per incident penalty.

The resident and fellow should protocol all upcoming cases in the morning and in the evening before leaving for the day. All electively scheduled cases should be protocollated at least 24 hours in advance.

When protocolling a case, the clinical history and prior findings of earlier radiology reports should be acknowledged. The relevant results of prior study should be entered in the appropriate portion of the CT protocolling sheet. On Friday, the resident should protocol all cases for the upcoming weekend and Monday. If abnormalities are found in the examination requested and prior studies, the referring physician should be called to confirm the area of interest to be scanned. The resident/fellow should print their name **legibly** at the appropriate position on the protocolling sheet so they can be contacted if further information on the patient is needed.

CT Intravenous Contrast

Evaluation of Serum Creatinine before IV contrast Administration:

It is the policy of the Rhode Island Hospital CT Scan Department to check the serum creatinine on all inpatients. The Patient Screening/Consent Form is completed for all patients with the assistance of a technologist. All out patients must fill out the Patient Screening/Consent form. A serum creatinine level is not needed for outpatients.

All Emergency Patients will be treated as outpatients; hence, a screening serum creatinine is not necessary for the performance of a contrast CT study. If the Ordering Physician is concerned that the patient has renal failure, s/he should wait until the appropriate screening blood work has been returned from the laboratory before ordering the CT.

Women and Infants inpatients that are accompanied by the patient's chart will have the creatinine level checked and Patient Screening/Consent form completed. Patients from Women and Infants Emergency Room are treated as outpatients.

Regarding administration of IV contrast in patients with compromised renal function, it is up to the radiologist and referring physician to decide if intravenous contrast is required to establish a diagnosis (or another imaging test is more appropriate). **There is no "threshold" for EGFR below which IV contrast can not be given.**

If a patient is found to have an eGFR of less than 40 or a serum Cr of greater than 1.6 the tech will contact the radiologist. The purpose of this contact is only to ensure that the study to be performed is necessary and that there is no viable non contrast alternative study. No study should ever be cancelled simply because the eGFR is low. If the study is necessary, the patient will be hydrated according to the following protocol:

- a. For patients without a cardiac history, 500 mL of (0.9%) Normal Saline is administered intravenously over approximately one hour immediately before the CT exam and a second dose of 500 mL Normal saline is administered intravenously over approximately one hour immediately after the contrast-enhanced CT exam.
- b. For patients with a cardiac history, 500mL of (0.45%) half Normal Saline is administered before and after the contrast-enhanced CT exam at the rate described above.

From: Katzberg, R. Lecture at ARRS Boston, 2009. Approved by Drs Goh and Dworkin from Nephrology Service 6/09.

Contrast Types:

We routinely use low osmolar intravenous contrast agents at a concentration of 350-370mgI/cc (omnipaque 350 or Isovue 370) in adults. The technologist notes the volume of the agent and rate of injection on the PACs screen in the lower left corner. The volume of the contrast agent should be included in the dictation. For CTPE protocols, we currently use 100cc of 370mgI/cc (Isovue 370) at 4cc/second followed by a saline flush. For routine body work, we administer 130 cc of 350mgI/cc (omnipaque 350). This is given in a split dose (30cc intravenously, then wait 5 minutes, then 100 cc at 3cc/sec followed by saline flush. The purpose of the split dose is to opacify the renal collecting system and bladder (the 30 cc delayed) and the liver in the portal venous phase to detect liver abnormalities with one exposure to radiation.

Omnipaque 300 is used for all pediatric patients. The contrast volume for pediatric patients is determined by 1cc of iv contrast per pound of patient's body weight for patients less than 100 pounds. Pediatric patients weighing over 100 pounds will receive the adult contrast volume of Omnipaque 300.

Visipaque 320 is a nonionic dimer is routinely used in coronary CTA exams due to its increased viscosity. Note that Visipaque is of no benefit in prevention of idiosyncratic contrast reactions, and has not been shown to definitively reduce the incidence of contrast nephropathy in high-risk patients.

Intravenous Catheter sizes and policy:

Intravenous catheters are started by the CT technologists or the IV team. The specific catheters to be used and the injection rates are summarized in the appendix. In general the injection rates depend on the type of contrast material and the catheter size.

Omnipaque 300/350/370 intravenous access requirements:

Injection rate of up to 2.4cc/second: 22 gauge or larger

Injection rate of 2.5cc/sec to 4cc/second: 20 gauge or larger

Injection rate of 4.1cc/sec or greater: 18 gauge or larger

Visipaque 320 intravenous access requirements:

Injection rate of up to 3cc/second: 20 gauge or larger

Injection rate of 3.1cc/sec or greater: 18 gauge or larger

CTA Scan Peripheral Intravenous Access Policy

A 20 gauge or larger IV in an antecubital vein is preferred to perform a CTA study. Exceptions can be made at the discretion of the radiologist and technologist if a patient's current iv access can yield a quality study without reducing the injection rate. The rationale is to prevent extravasation and poor quality exams from inadequate intravenous lines.

Central venous catheters can be injected depending on catheter type. Rates of injection also vary depending on catheter type. See appendix for details.

Acute Contrast Reactions:

Residents and fellows should be familiar with treatment of adverse contrast reactions and be able to treat the patient appropriately. The General Guidelines by Dr. B Murphy (6/09) are outlined below:

Bronchospasm – Mild

- Vital signs
- O2 via mask
- IV line
- Albuterol via spacer 8 puffs
- Hydrocortisone 250mg IV

Bronchospasm – Severe

- Call code
- If no cardiac contraindication: Epi Pen 1:1000, 0.3mg subQ
- If circulatory collapse: Epinephrine 1:10,000, 3ml IV

Hypotension – systolic 60-80mmHg

- Vital signs, inc. pulse oximetry
- O2 via mask
- IV Line
- Trendelenburg
- 1 liter N Saline IV in 15 min if normal heart rhythm
- 1 liter N Saline IV in 30 min if elderly/heart
- Atropine 1mg IV if bradycardia, x2 if needed
- CONSIDER CALLING CODE

Hypotension - systolic <60mmHg

- Follow same procedure as (systolic 60-80), If no response: Call code team - monitor rhythm
- Sinus rhythm: Epinephrine 1:10,000, 5ml IV (repeat if necessary)
- Hydrocortisone 250mg IV

Urticaria

- No Rx if mild and asymptomatic
- Benadryl (Diphenhydramine) 50mg IV, if symptomatic (patient will need ride home.)
- Auscultate chest to detect bronchospasm

Severe Urticaria or Laryngeal Edema

- Secure airway

- Vital signs
- O2 via mask
- IV Line
- Call code if intubation anticipated
- Epi Pen 1:1000, 0.3mg subQ
- Epinephrine 1:10,000, 1-5ml IV if vascular collapse

Seizures

- Protect patient from injury
- Vital signs
- O2 via mask
- IV Line
- OP airway if >2 min
- Ativan (Lorazepam) 2mg IV
- Neuro consult / ER transfer

Prophylaxis for Intravenous Contrast Reactions:

If a patient has a history of a serious contrast reaction and is scheduled for a CT scan with contrast, then an alternative exam should be attempted (noncontrast CT, ultrasound, or MR). If contrast is required and there is a strong clinical indication, then the premedication regimen recommended by the American College of Radiology should be followed: **Methylprednisolone (Medrol) 32 mg. p.o. 12 hours and 2 hours before the contrast injection.** In addition, the patient should receive low osmolar contrast material. In general, H2 blockers (cimetidine) are not recommended. The above assumes the patient does not have a contraindication to steroids (pediatric, pregnant, fungal infection, diabetes, immunocompromised patients, lymphoma, leukemia, peptic ulcer).

Metformin (Glucophage):

Metformin (Glucophage) is an oral hypoglycemic for which precautions should be taken when giving intravenous contrast. Our protocol for administering intravenous contrast in patients on Glucophage is approved by the ACR and is as follows: 1) patients undergoing intravenous contrast agents should stop taking Glucophage either before or at the time of the contrast examination. 2) Patients should remain off Glucophage for 48 hours after their contrast study and then have a serum creatinine drawn. If the creatinine is normal, the patient can resume medication. In the CT section, we will fill out a lab slip for creatinine to be drawn with the results to be sent to the patient's referring internist. The patient will be instructed to call their internist one day after the blood test to decide whether the medication can be restarted. This will save a step for the patient and the internist as the decision to restart the medication can be made by phone call rather than a visit. 3) Patients with elevated creatinine (greater than 1.5) and on Glucophage should have the contrast administered only if there is a high diagnostic yield to be obtained from

the contrast. 4) Note the patients do not need to be off Glucophage for 48 hours before the contrast examination is started.

Contrast Extravasation:

Our policy for contrast extravasation follows ACR guidelines and is listed below. Note this policy is the same for contrast extravasation of CT and MR contrast agents. When an extravasation occurs, the CT technologist will contact the radiologist who will evaluate the patient and fill out the data sheet listed below which will be scanned into PACS. In addition, the technologist will fill out a MERS report (Medical Event Reporting System) via the Lifespan intranet. The technologist should leave a note in PACs alerting the radiologists about the extravasation. For evening extravasations, the covering resident should also leave a note in PACS with 1. the exam findings and 2. course of action taken. We do **not** take radiographs of extravasated contrast.

Procedure:

- A Radiologist/physician should evaluate all extravasations.
- A cold pack should be applied to the site of extravasation.
- Evaluation should include a neurological exam of the affected extremity, documentation of presence of capillary refill, skin ulceration and documentation of presence of distal pulses and presence of pain. Documentation should be made on the attached IV extravasation fact sheet.
- The patient should be observed for a period of time at the Radiologist's discretion after the extravasation with the arm maintained in an elevated position above the heart.
- For outpatients, the attached discharge instructions should be completed by the Radiologist and given to the patient.
- If there are findings at the time of the exam (increased pain or swelling), decreased capillary refill, change in sensation or skin ulceration, a plastic surgery consult should be obtained at the discretion of examining Radiologist. **If urgent treatment is required, refer outpatients to Emergency Dept.**
- If a consult or ER referral is required, the patient's clinician should be contacted. For ED and in-house patients, a verbal communication should be given to the patient's nurse and/or in-house physician responsible for the patient's care.
- The extravasation, physical exam and steps taken in management should be documented in the final radiology report, and in the patient's chart if applicable.
- An addendum shall be dictated to the radiology report if the patient requires a follow-up visit.
- An electronic report should be entered through the Rhode Island Hospital Occurrence Reporting system by the lead technologist or manager.
- Both the IV extravasation fact sheet and the patient discharge instructions will be scanned into the Radiology Information System.
- For inpatients, the orders for patients who have had an extravasation are:

Follow-up orders for inpatients have to be communicated and entered electronically like all other orders in the hospital. It is straight forward and self-explanatory (similar to post-

procedure order sets for those who are familiar with electronic order). This is in compliance with ACR guideline/our policy although by necessity more detailed for nursing staff (with their input)

- A. How to do it.
 1. Find the patient in nurse census in Lifelinks
 2. Check “write orders” On next screen, check “ Other Order sets” under Order Sets and highlight "Post IV contrast extravasation"listed under Pre/post Procedure Orders column (just above post vertebroplasty os).
 3. Next screen, check "Post IV contrast extravasation"
 4. Next screen, specify which extremity e.g., “left arm” for extremity elevated, then hit “ok”
 5. Next screen, hit “sign

- B. What the order actually states when the nursing staff views it (you can also view the detail by clicking “list/change” on the last page after you highlight the individual order
 1. Elevate extravasation affected arm above the heart until no significant swelling.
 2. Ice pack to site of extravasation for 10-20 minutes q shift until swelling is resolved.
 3. Check extravasation site: for capillary refill, distal pulses, skin ulceration, increasing pain or swelling, numbness, and tingling q 15 min x 2, then q 30 min x 2, then q 1 hour x 2, then q shift for 24-48 hours.
 4. Notify responsible LIP: for increasing pain, swelling, numbness, tingling, decreased cap refill/distal pulses, skin ulceration (for possible plastic surgery consult needed.
 5. Discharge per criteria: Review and give IV contrast extravasation discharge instruction (see below.)

The IV contrast extravasation fact sheet and patient discharge sheet are included below:

**DIAGNOSTIC IMAGING DEPARTMENT
RHODE ISLAND HOSPITAL
IV EXTRAVASATION FACT SHEET** (to be scanned into PACs after completion)

DATE: _____

TIME: _____

PROCEDURE: _____

EXTRAVASATION SITE: _____

Estimated volume of extravasation: _____

Method of delivery: power injector or hand injection

Radiologist's assessment of extravasation site:

Follow up assessment

(if required)*

• Neurological exam within normal limits Yes or No

• Capillary refill within normal limits Yes or No

• Distal pulses within normal limits Yes or No

• Skin ulceration Yes or No

• Presence of pain Yes or No

Yes or No

Radiologist's comments, treatment & discharge instructions: _____

I have reviewed and signed discharge instructions with the patient / legal guardian. Yes or No

Print Radiologist name

Radiologist signature

Technologists: _____

*(if required) FOLLOW UP INFORMATION: _____

Radiologist:

Date:

**DIAGNOTIC IMAGING DEPARTMENT
RHODE ISLAND HOSPITAL
DISCHARGE INSTRUCTIONS FOR IV EXTRAVASATION
DIAGNOTIC IMAGING DEPARTMENT
RHODE ISLAND HOSPITAL
DISCHARGE INSTRUCTIONS FOR IV EXTRAVASATION**

During your exam you received an intravenous contrast injection or medication. At some point during that injection either some of the contrast and /or saline solution leaked outside of your vein causing swelling in that area. This fluid is routinely re-absorbed without any difficulty but for the next 24 hours you should check at or near the IV site for the following symptoms:

- **Prolonged stinging or burning at the site**
- **Increased swelling, tenderness or pain at the site**
- **Tingling or numbness**
- **Redness, warmth or blistering at or near the I.V. site**

If you experienced any of these symptoms or you have any questions or concerns, please call 401-444-8392
Additional instructions given:

These instructions have been explained to me and I have had the opportunity to have my questions answered.

Patient /Legal Guardian signature

Radiologist signature

Date: _____

Documentation of Contrast reactions and extravasations :

The exact procedure for documenting is currently under review. For extravasations, the technologists document in PACS notes and in the on line Medical Events Reporting system (MERS). For contrast reactions the technologists report in PACs, MERS and Lifelinks.

Contrast in Pregnant Patients:

The patient's referring physician needs to obtain informed consent (consent form in appendix) before an intravenous contrast CT scan is performed in a pregnant patient.

Contrast in Mothers who are Breast Feeding:

A small amount of iodinated contrast is transiently excreted in breast milk. We ask the mother to pump her breasts for milk in advance, then breast feed the baby immediately before the CT procedure. She should perform the next feeding with pumped breast milk, then resume normal breast feeding.

Radiation Dose Reduction

We employ protocols tailored to maximize diagnostic yield and minimize radiation exposure. All CT units at RIH modulate mA to decrease dose. It is important to choose the correct protocol carefully as each protocol is designed to minimize exposure. For example, a Renal Stone protocol uses lower dose than a routine abdomen and pelvis because the calculi are radio-opaque and will be easily visualized at a lower mA.

Scanning Pregnant Patients

All pregnant patients need an informed consent signed (by the patient and *referring* physician) before *any* CT exam is performed. This situation arises primarily in the ER and this policy has been approved by department chairs Drs. Cronan and Zink. A copy of the pregnancy consent form is attached at the end of this document.

Scanner Weight Limits

Given the epidemic of obesity, residents are frequently asked about the weight limits of our scanners: Scanners in the department have a weight limit of 500 pounds.

Dictations

Dictations are performed using the voice recognition software Powerscribe. Dictations should be performed and signed at the end of the day. Dictations in CT should include the relevant patient history, pertinent other studies and the CT technique. The CT dictation should include the volume of low osmolar contrast was administered. The body of the report should include the pertinent positive and negative findings given the clinical

history. The conclusion should be short and have a new sentence for each important impression. Due to legal issues and appropriate reimbursement, *multiple CT examinations in one patient should be dictated in separate paragraphs. For accuracy of communicating the aggregate results, the conclusion of the dictation should contain the results of all the CT examinations performed.* Thus for a chest, abdomen and pelvis CT to follow-up for lymphoma the dictation should read as follows:

“HISTORY: The patient is a 35-year-old male with lymphoma treated with chemotherapy, question recurrent disease.

TECHNIQUE: Helical scanning using multidetector row CT was performed from the lung apices through the pelvis after dynamic administration of 130 cc of low osmolar contrast material at 3cc/second. Image post-processing was performed in the coronal plane.

COMPARISON: is made with prior CT from 5/15/02.

CHEST: The lungs are clear. There is no evidence of hilar or mediastinal adenopathy. The heart and bones are normal

ABDOMEN: The liver, gallbladder, pancreas, kidneys and adrenal glands are normal. The spleen remains enlarged measuring 20 cm in cranial-caudal dimension. There is no evidence of retroperitoneal adenopathy. The bowel within the abdomen is normal.

PELVIS: There is new left iliac adenopathy with the largest node measuring 3 cm. The bowel, bladder and bones are normal.

Dr. _____ has reviewed the report and all images related to this patient encounter.

IMPRESSION:

1. Normal Chest CT
2. Stable splenomegaly
3. New left pelvic adenopathy since prior exam suggesting recurrent lymphoma.

Regulations put forth by CMS (Center for Medicare/Medicaid Services) require that residents and fellows attest to the participation of attendings in the work product. For diagnostic imaging that product is the report. Thus please add the following sentence at the end of the findings (NOT the conclusion) of every report. “Dr. _____ has reviewed the report and all images related to this patient encounter.”

We are migrating to template driven dictations and this will become uniform policy when the new system is installed later this year.

Important or unexpected clinical findings should be called to the referring physician at the time of the dictation. It can be difficult to contact the referring resident when the patient is followed in Medical and surgical clinics. Below is a list of the contact nurses for various clinics (as of 4/08):

Adult Medical Primary Clinic:

Contact: Rhonda Manco, RN, ACM

Extension: 4-4843

Alpha Pager: 350-0791

Adult Medical Specialty Clinics:

Contact: Deborah Burbank, RN, ACM

Extension: 4-8097

Alpha Pager: 350-7852

Adult Surgical Specialty Clinics:

Contact: Mary Stempien-Young, RN, ACM

Extension: 4-7425

Alpha Pager: 350-7847

Bridge ED:

Contact: Nancy Towers, RN, Director

Extension: 255-5734 Charge Nurse Nextel phone; if line is busy call 4-5411 and ask to be connected to the ACM on duty.

There is a QA “Red Results” departmental policy for emergent unexpected findings which is outlined below:

Red Results Procedure (updated 5/07):

If any of the following Critical Abnormal Results are discovered by the radiologist during the interpretation of an imaging exam, and it is not indicative of a known existing or improving condition, the result will be communicated within the shortest time possible to the ordering physician or covering LIP that can facilitate the appropriate course of therapy or treatment for the patient. For all telephonic reporting of these critical results, the person receiving the test result must “read-back” the complete result. Every attempt will be made to communicate the results within one hour of detection.

As part of the reporting process the radiologist will dictate the exam as soon as the abnormal result is discovered and in the impression include the abnormal result, the name of the ordering physician or LIP that was contacted and who read back the result, and the time the call was placed. The final impression must

contain the words RED RESULT in the first 320 characters. The Radiology System will then be searched for all reports with critical values for Quality Assurance purposes. Results of Quality Assurance monitoring will be reported monthly in the aggregate. The results of any individual retrospective case reviews will be non-discoverable pursuant to the Rhode Island Medical Malpractice Act, section 23-17-25 and such laws which supplement or replace it.

RED Critical Abnormal Result List:

- 1) Tension Pneumothorax
- 2) Unsuspected significant hemorrhage
- 3) Critically misplaced tube or catheter
- 4) Acute pulmonary Embolism
- 5) Infection related soft tissue gas
- 6) Unexplained pneumoperitoneum
- 7) Ischemic bowel
- 8) Ectopic pregnancy
- 9) Midgut volvulus
- 10) Testicular/ovarian torsion
- 11) Acute Intracranial Process
- 12) Acute cord compression
- 13) Acute DVT
- 14) Epidural process (includes mass, hematoma, and abscess)
- 15) Acute aortic dissection
- 16) Acute cholecystitis
- 17) Any diagnosis deemed clinically urgent by the Radiologist

Access to RIMI Images via Synapse:

Occasionally we are asked to review images from RIMI or Shields, particularly to book a patient for a biopsy. Residents should each have their own access code to Synapse. To get your RIMI account password, contact Kyle Schuster at RIMI cell 401-639-2968. To view images on Synapse, you have to log in twice - once for one application (RIMI or Shields) and a second time for the next application (RIMI or Shields). To do this, select the folder tab at the top left that you're not logged into (RIMI or Shields) after your initial log in displays the home page. There may be a slight delay when logging in or bringing up images but have patience - it should work eventually.

Diagnostic Body CT Exams

General Protocol Information:

We are routinely performing 5mm coronal reconstructions for neck, chest and abdomen on all MDCT exams. This offers more diagnostic information from routine scans

without need to use the 3D workstation or archive large data sets. As residents review the studies, they should also consider if additional reconstructed images in other planes, or thinner slices through a certain region, could be beneficial in the interpretation of a study (i.e. thin slices through a pulmonary hamartoma, or sagittal images for a skull base lesion, etc.) Residents can ask the technologist to reconstruct such images and forward them to PACs prior to attending readout.

All abdomen/pelvis non trauma CTs now have a dual phase injection protocol of 30 cc contrast followed by 20cc saline. This is followed by a 5 minute delay, then injection of 100cc contrast and image at a fixed delay of 55 seconds. The rationale is to opacify the ureters and bladder with contrast (30cc up front, flush, 5 min delay), without obscuring liver lesions (only 30 cc up front and 100cc contrast given dynamically). This protocol avoids the duplicate delayed scans through the kidneys and bladder and thereby reduces radiation dose.

CT Colonography Protocol, Post-Processing, & Reporting

Kevin J. Chang, MD
Updated 3/18/12

Indications:

1. **Incomplete or failed colonoscopy:** This is still the only reimbursable indication for Medicare patients. This may be secondary to a variety of factors including colonic tortuosity, nonvisualization of the colon proximal to an obstructing lesion, colonic spasm, diverticulitis, extrinsic compression, aberrant anatomy or scarring related to prior surgery. The reason for the failed colonoscopy should be mentioned in the dictation to get reimbursed.
 - a. DO NOT SCAN SAME-DAY FAILED COLONOSCOPY PATIENTS IF THE REASON FOR FAILURE IS "INADEQUATE BOWEL PREP." These patients will need to be re-prepped to perform the exam on another day.
2. **Contraindication to colonoscopy:** e.g. Anticoagulation which cannot be discontinued, significant medical/surgical complications from previous colonoscopy, contraindication to conscious sedation. When in doubt, get preauthorization.
3. **Screening:** Not yet covered by Medicare. Covered by many private insurers (including all insurers in RI). Referring physicians will need to confirm coverage and obtain preauthorization.

CPT codes: Category I (confirmed for 2010)

74261 — Computed tomographic (CT) colonography, diagnostic, including image postprocessing; without contrast material

74262 — ... with contrast material(s) including noncontrast images, if performed

74263 — Computed tomographic (CT) colonography, screening, including image postprocessing.

ICD9 code: Use **v643** (Traditional exam, ie. conventional colonoscopy, not carried out for other reasons) as the **primary code** to get reimbursed for indications 1 and 2 above. Other codes that may be used: v1000, v1005, v1006, v103, v160, v1272.

Patient preparation:

The most crucial aspect of performing a high-quality CT colonography exam involves a thorough colon prep. The prep protocol used differs from traditional colonoscopy preps in that instead of high volume "wet" preps involving agents such as GoLytely, a "drier" prep is used which leaves less residual fluid in the colon allowing much better visualization of the colon wall by CT. The only exception to this prep protocol would be a patient coming to CTC on the same day as an incomplete colonoscopy (already prepped for traditional colonoscopy). In general, these "dry" bowel preps are better tolerated by patients than the GoLytely prep.

There is **no need for IV contrast unless the cause of incomplete colonoscopy is an obstructing neoplasm which has not yet been staged** with a prior contrast-enhanced CT of the abdomen and pelvis. In the latter case, following colonic insufflation and scout topograms, perform the usual noncontrast low-radiation dose supine scan followed by a **prone scan using the routine IV contrast injection dose, injection rate, post-injection delay, and radiation dose that we use for a typical single-phase abdomen/pelvis CT**. This scan volume should include the whole liver.

“Dry” bowel prep:

Patient to pick up LoSo Prep and two 30 cc bottles of Gastroview from Radiology prior to the day before the exam. As an alternative to the LoSo Prep, the patient may pick up Magnesium Citrate and Dulcolax over the counter at any local pharmacy.

1. *24 hours prior to exam: Clear liquid diet only + bowel prep.* Avoid milk or dairy products. Patient may take regular medications.

Diet recommendations:

	ALLOWED	PLEASE AVOID
Fruit/Fruit Juices	clear fruit juices, canned fruits (no seeds, skin or membranes)	fresh fruits, raisins, dried fruits, prunes, prune juice, skins.
Beverages	decaffeinated: coffee (limited), fruit flavored drinks, tea, carbonated drinks	all others
Soup	bouillon/broth, strained soups	all others
Dessert	gelatin, fruit ice, popsicle (no red color)	coconut, nuts, seeds, hard clear candies, fruits that are <i>not allowed</i> on this list
Miscellaneous	salt, pepper, jelly, sugar, honey, syrup	cloves, garlic, seed spices, chili sauce, Bar-B-Q sauce, any strong flavored spice or sauce, mustard, jam, peanut butter, mayonnaise, marmalade

Magnesium Citrate may be picked up over the counter at any local pharmacy. (Rhode Island Hospital prep)
10 oz bottle of Mg-citrate + four 5 mg Dulcolax tabs at 6PM on the day before the exam

LoSo Prep (EZ-EM, Westbury, NY). Take as directed. (Miriam Hospital prep).
34 g Mg-citrate + four 5 mg Dulcolax (bisacodyl) tablets the day prior to the exam
Dulcolax suppository not necessary

The patient should be near a restroom after taking the above medications as bowel movements will become more frequent.

Note: If the patient has a history of poor bowel preparation for prior colonoscopy or CT colonography, have the patient take a “double-prep,” i.e. drink two 10 oz bottles of Mg-citrate, each bottle 3 hours apart (one bottle at 3PM, the second bottle at 6PM).

2. If the patient has picked up Gastroview ahead of time, he/she should drink the first 30 cc bottle just prior to going to bed the night before the exam and at least 1 hour after drinking the Mg-citrate (for the purposes of fluid tagging). This may be mixed with 8 oz of clear fruit juice or a carbonated beverage over ice. The patient should drink the second 30 cc bottle when they wake up the morning of the exam. If the patient has not taken the Gastroview the night before, the patient may drink one **30 cc bottle of Gastroview at least 2 hours** prior to the CT scan. The patient will need easy access to the restroom as this agent also acts as a laxative. If the patient is not able to wait 2 hours or Gastroview is not available, the exam may be performed immediately without fluid tagging (however, fluid tagging greatly aids in visualization of polyps otherwise obscured by retained fluid in the colon).

GE VCT Protocol:

The most crucial technical aspect of this study lies in adequate gaseous distension of the entire colon. In general, a thin-collimation low-dose technique is employed in both supine and prone positions following scout topogram confirmation of adequate colonic insufflation.

1. Allow **patient to use the restroom immediately prior** to positioning on the CT table to empty bowel one last time.
2. Position patient in **lateral decubitus** position for placement of silicone rectal catheter.
3. Radiologist, nurse, or technologist to **insert rectal catheter**. *Lightly* inflate balloon tip (~15-30 cc air using syringe) in order not to distort mucosal anatomy of the rectal vault. Gently pull back balloon cuff flush with the anal sphincter. If there is any residual fluid present in the rectum, allow it to drain into the collection bag prior to attaching tubing to the insufflator.
4. Attach tubing to automated CO₂ insufflator. Set **PRESSURE to 25 mm Hg**. Hit "**FLOW STOP/RUN**" button to begin inflation. Inflation will ramp up slowly. If the patient experiences discomfort, hit the FLOW STOP/RUN button to temporarily pause inflation until discomfort passes then resume inflation by hitting the FLOW STOP/RUN button again. General guideline for positioning the patient is left decubitus until 1 liter, then supine until 2 liters, then right decubitus until 3 liters, then supine. Scout when rate of increase in total CO₂ volume stabilizes and pressure remains 25 mm Hg +/- 2 mm Hg.

Generally, colonic distension requires at least 2-4 L of CO₂ with more needed depending on the redundancy of colon and presence of small bowel reflux. If > 4.0 L of CO₂ has been administered (which is quite common), the FLOW STOP/RUN button will have to be restarted to continue insufflation. FLOW STOP/RUN will also reset at every 2 L interval thereafter (safety feature).

*Excellent Bracco CO₂ inflation video tutorial available at:
http://www.braccoimaging.com/index.php?option=com_content&task=view&id=709&Itemid=567*

5. Position patient **supine** on CT table and perform end-expiratory **CT scout topogram**. Evaluate scout for adequacy of colon insufflation. If not completely inflated, roll patient to try to redistribute gas while continuing insufflation. Then repeat scout.
6. **Scan** abdomen and pelvis from above the colon to lesser trochanters using a single end-expiratory breath-hold with **noise index of 50** at **1.25 mm** collimation and a 350 mAs maximum (may need to scan lower if there is a large hernia).
7. **Confirm the colon prep and distension is adequate** on axial images before moving on to prone positioning. If the prep is inadequate, the exam should be terminated and the patient should be rescheduled for another day following a more thorough colon prep. Any colonic segments that are incompletely distended should be rechecked on prone images to insure an adequate exam.
8. Flip patient over **prone** while CO₂ insufflator is still on. Position pillow(s) beneath the patient's chest and pelvis to relieve pressure on the abdomen and permit better

distension.

9. When prone insufflation is complete (see criteria in Step 4), perform end-expiratory **prone CT scout topogram** to determine adequacy of colonic distension (especially sigmoid). If not completely inflated, roll patient to try to redistribute gas while continuing insufflation. Then repeat scout.
10. Perform **prone scan** using the same parameters as supine in a single end-expiratory breath-hold.
11. **Check** adequacy of supine and prone axial images prior to removing catheter and discharging patient. On occasion, lateral decubitus positioning may be necessary for limited re-scanning of the cecum or sigmoid in cases of inadequate distension on both supine and prone datasets.
12. **Remove rectal catheter and have patient go to restroom** to decompress colon prior to discharge to home. No specific instructions are necessary as the patient may return immediately to regular activity.
13. **Reconstruct supine and prone** datasets to 1.25 mm collimation with 0.625 mm overlap (**1.25 x 0.625 mm**) to send to **GE Advantage Workstation** and **GE PACS**.

Post-Processing on the GE Advantage Workstation:

1. Choose patient from local database list and open supine and prone 1.25 x 0.625 mm datasets simultaneously using **CTC Auto-Dissection** plugin.
2. **Edit lumen tracking** for both supine and prone datasets if necessary.
3. Use **Virtual Dissection 360 views** for initial 3D screen.
4. Use **3D VR endoluminal views** for correlation (shift-LMB on target).
5. **2D read for confirmation and to evaluate colonic surfaces beneath tagged fluid:** review axial images at “near-lung windows” (narrow windows enough to differentiate fat from soft-tissue density) on supine and prone volumes. Use coronal and sagittal MPR as necessary to follow colonic lumen. Evaluate ALL surfaces of colon on both supine and prone.
6. Placing bookmarks for the **Reporting Tool** aids in generating multiple reformatted images to send back to PACS (“DCBE” colon map, MPRs, 3D VR endoluminal views).

Reporting:

We will be following the CT Colonography Reporting and Data System (C-RADS, Working Group of the 5th International Symposium on Virtual Colonoscopy, October 2004)¹ for CTC reporting and management recommendations.

Colonic Findings

- ▶ C0: Inadequate study/awaiting prior comparisons. Use this category in cases of inadequate prep or insufflation (ie. collapsed segments on both supine and prone views), or when the image can't be read because of excess fluid or feces.
- ▶ C1: Normal colon or benign lesion. Use this category for cases of no polyp greater than 6 mm, and continue routine screening (Every 5 years per American Cancer Society screening guidelines).

¹ Zalis ME, Barish MA, Choi JR, et al. Working Group on Virtual Colonoscopy. CT colonography reporting and data system: a consensus proposal. Radiology 2005;236:3-9.

- ▶ C2: Indeterminate lesion. Use this category for cases of fewer than three polyps 6–9 mm. Recommend follow-up CTC in 3 years vs. consideration of colonoscopy.
- ▶ C3: Polyp, possibly advanced adenoma. Use this category for cases of three or more polyps 6–9 mm or any polyp 10 mm or larger. A follow-up colonoscopy is recommended.
- ▶ C4: Colonic mass, likely malignant. Use this category when a lesion compromises the bowel lumen, or there is evidence of extracolonic invasion. Surgical consultation is recommended.

Extracolonic Findings

- ▶ E0: Limited exam. Use this category when an exam is compromised by an artifact so that evaluation of extracolonic soft tissues is limited.
- ▶ E1: Normal exam or anatomic variant. Use this category when no extracolonic abnormalities are visible, or if there is an anatomic variant, eg. retroaortic left renal vein.
- ▶ E2: Clinically unimportant finding. Use this category when no work-up is indicated, eg. simple renal or hepatic cysts, cholelithiasis without cholecystitis, vertebral hemangioma,
- ▶ E3: Likely unimportant finding, incompletely characterized. Use this category when a work-up may be needed, based on practice and patient preference. eg. minimally complex renal cyst.
- ▶ E4: Potentially important finding. Communicate the details to the referring physician. eg. solid renal mass, lymphadenopathy, aortic aneurysm, pulmonary nodule > 1 cm

The full proposal can be found in Radiology at <http://radiology.rsna.org/content/236/1/3.full>

Polyps are defined as homogeneously soft-tissue attenuation structures arising from the colonic mucosa demonstrating a fixed point of attachment to the bowel wall. A **colonic mass** is defined as a similar structure measuring greater than 3 cm in largest dimension.

We will only report polyps 6 mm or greater in size. No polyps less than 6 mm should be reported (in the body or impression of the report) as the specificity of CTC is limited at this size (many of these represent adherent stool) and the clinical significance of polyps of this size is also limited (most true polyps of this size are hyperplastic and do not increase risk for developing colon cancer).

Polyp descriptors:

1. Size: in mm
2. Morphology: pedunculated, sessile (broad-based, width > height), flat (< 3 mm elevated above colonic mucosa)
3. Location: rectum, sigmoid, descending, transverse, ascending, cecum; relationship to adjacent haustral folds
4. Attenuation (i.e. fat = lipoma)

Extracolonic findings:

For a standard non-contrast CTC exam: "Limited non-contrast evaluation demonstrates no significant extracolonic findings..."

Impression and Management recommendations:

1. Normal or Benign findings (i.e. lipoma, diverticulosis; no polyps \geq 6 mm): routine screening (5 year follow-up CTC/endoscopy).
2. Polyps 6-9 mm, < 3 in number: 3 year follow-up CTC versus consideration of endoscopy (or repeat focused endoscopy).
3. Polyps 6-9 mm, \geq 3 in number: Endoscopy.
4. Polyp \geq 10 mm; Endoscopy.
5. Colonic Mass, likely malignant (compromises lumen or shows extracolonic invasion): Surgical consultation.

A repeat directed endoscopy is often successful even when the initial endoscopy was incomplete.

These guidelines are subject to consideration of the patient's history/presentation and local practice preference.

Do not hesitate to call the referring physicians with the results of the CTC, as we need all the good PR we can get. If the patient asks to be called with the results, I will not hesitate to give them a call as well since satisfied patients will recommend this study to others as well as relate positive experiences to their own physicians.

Questions, additional suggestions? Feel free to page me at 350-5841.

-Kevin

Cardiac CT Angiography:

The cardiac CT information and protocols are contained in the cardiac section of the resident manual.

CT Guided Interventional Procedures

The residents and fellows are responsible for performing interventional procedures in Ultrasound and CT. Interventional procedures include lung, abdominal, and bone biopsies, abscess drainages and tumor ablations. General guidelines for performing procedures is as follows. We require referring physicians call directly to book procedures so there is accurate transmission of clinical information. Procedure booking sheets (see end of this document) should be filled out for all patients when taking the request, and the person filling out the sheet should print their name legibly. First year residents should not book procedures. Lifespan images (RIH, TMH, Newport) can be reviewed on PACs and RIMI exams can be accessed via the web on a computer in CT. Women and Infants and images from Kent hospital can be viewed on the Woman and Infants PACS in the body reading room. If the images are from outside, have the CT secretary call that institution to fax the report at the time of the booking. Outside films reviewed for upcoming cases are kept in the biopsy bin area in CT and ultrasound and should be entered into PACS by the secretaries or residents into Life Image. The plan for the procedure (patient position, side of lesion, area to be scanned) can be entered onto the new procedure sheet. When the procedure sheet is completed, it is brought to the CT secretary who then books the case and can call either the patient or the booking doctor's office with the time. Patient procedure information sheets are kept in referring physicians' offices and should be given to the patient so they know what to expect in advance. If the referring doctor is seeing the patient in his/her office, they can be given a patient information sheet at the time of the booking.

Two days before the procedure, the secretary in the radiology recovery room calls all patients at home to confirm the date and time of their exam to minimize no-shows.

On the evening before the procedure, the fellow and resident should review upcoming cases for the following day to assure that all films and laboratories are in order. If the relevant films are not present, they can be retrieved or restored. Good residents will look at all procedures for the upcoming week to know what is happening, rather than have a "surprise" each morning at 7:30.

On the morning of the procedure, the cases will be reviewed with the attending in the body reading room with the lead CT technologist, charge nurse to decide the appropriate approach to a lesion. The plan for the procedure (patient position, side of lesion, area to be scanned and collimation) should then be entered into the biopsy book which is kept near the interventional CT console. This information should then be reviewed with the charge technologist so s/he can plan the day. When the patient arrives in the CT section, the secretary will stamp a procedure packet and the resident/ fellow will obtain informed consent from the patient. Informed consent includes 1) an explanation of the procedure, 2) expected benefits of the procedure, 3) risks of the procedure and 4) alternatives to the procedure. These all need to be documented. Pre-procedure assessments should be completed by the senior resident or fellow and the appropriate documentation completed in the Radiology holding area before the procedure. Derek Tessier NP and Amy Doorley

NP are also assisting with getting consent before the procedure and discharging patients to home after the procedure. Assessment before the procedure includes review of the indications for the procedure, relevant blood work and a brief physical exam. *The patient is told before the procedure that they will need to spend the night with another person (relative/friend) in their apartment/house in the event they need to call for help.*

All procedures are performed with the attending present. After the procedure, outpatients are observed in the holding area and inpatients are returned to the floor. A procedure note should be left in the EMR.

The format for a radiology procedure note should be as follows:

Date: **Radiology Procedure Note**

Procedure:

Operators:

Medications:

Findings:

Complications:

Orders for monitoring of vital signs and catheter irrigation should be entered on inpatient order sheets. Biopsy specimens for pathology are generally placed in formalin and cytology specimens in Cytolit. Specimens for microbiology should be placed in a sterilized red top tube. This tube can be used for aerobic cultures, anaerobic cultures and gram stains. Blood culture bottles should not routinely be used for cultures of aspiration specimens.

There is an interventional database sheet (see end of this document) which should be filled out for every CT guided procedure and placed in the green interventional database binder kept in the interpretation room.

Pre-operative blood work is not necessary or essential in most cases. A routine bleeding history should be obtained from the referring physician and from the patient. Has the patient had any difficulty with bleeding in the past, with dental extractions or prior surgery? If the patient is on any anticoagulants or drugs which could effect coagulation, this should be noted. When blood work is deemed necessary because of an underlying bleeding history or drug history, baseline INR and platelet count should be obtained. Patients with a history suggesting the potential for coagulopathy such as those with liver disease, sepsis, or poor nutritional status should be screened.

The department policy on use of anticoagulants and indications for transfusion have recently been modified and are outlined below.

**2011 RI Hospital -Brown University Suggestions for Coagulation Values
& Medication Usage Prior to Invasive Radiologic Procedures**

<u>Procedure</u>	<u>INR*</u>	<u>Rx</u>	<u>Notes</u>
Thoracentesis or Paracentesis	< 3.0	No FFP	
	3.0 – 4.0	FFP10 mls/Kg	Order 4 hrs before procedure
	> 4.0	FFP 15mls/Kg	Order 6 hrs before procedure
Liver, Renal or Lung Biopsy	< 2.0	No FFP	
	2.0 – 3.0	FFP10 mls/Kg	Order 4 hrs before procedure
	> 3.0	FFP 15mls/Kg	Order 6 hrs before procedure
Lumbar or other CNS Puncture	≤ 1.5	No FFP	
	1.5 – 2.0	FFP10 mls/Kg	Order 4 hrs before procedure
	> 2.0	FFP 15mls/Kg	Order 6 hrs before procedure

ANTI-PLATELET DRUGS:

- **Aspirin** (Excedrin, Bufferin) withhold 36 hours.

- **NSAIDs:**

Short T_{1/2}: Ibuprofen (Advil), Diclofenac (Voltaren) , Ketoprofen, Indomethacin(Indocin): 24 hours.

Intermediate T_{1/2}: Naproxen (Naprosyn,Aleve) Sulindac (Clinoril), Difusinal(Dolobid): 48 hours.

Long T_{1/2}: Meloxicam(Mobic), Nabumetome (Relafen), Piroxicam (Feldene): 7 days.

*For emergent intervention on NSAIDs or Aspirin: 1 blue/1 lavender tube to Coag lab on APC 11 (x 4-5560) Request Aspirin effect. Results in 60 min. Value > 550 ARU, OK for procedure.

- **Adenosine Diphosphate (ADP) receptor antagonists:***

Clopidogrel (Plavix) – withhold for at least 7 days.

Ticlopidine (Ticlid) – withhold for at least 10 days.

Prasugrel (Effient) – withhold for at least 7 days.

*For emergent intervention on above 3 meds: 1 blue/1 lavender tube to Coag lab on APC 11 (x 4-5560). Request Clopidogrel Effect Detection Test: Results in 60 min. Value PRU >240, OK for procedure.

- **Phosphodiesterase (PDE) inhibitors:**

Cilostazol(Pletal), Dipyridmole (Persantine) (plus ASA= Aggrenox): withhold 2 days.

- **Selective Cox 2 inhibitors** (Celebrex, Robecoxib) do NOT need to be discontinued before a procedure.

If medications cannot be withheld i.e. there is an urgent or immediate need for the procedure, avoid platelet transfusions prophylactically but administer platelets (see below) in the event of a procedure-related bleed.

ANTICOAGULANTS:

IV unfractionated heparin: hold 4 hours before procedure.

LMW Heparin: enoxaparin (Lovenox): hold 24 hours before procedure. No coagulation tests (INR, aPTT).

Fondaparinux (Arixtra) – hold 24 hours before procedure. No coagulation tests (INR, aPTT).

DIRECT THROMBIN INHIBITORS:

Dabigatran (Pradaxa): withhold 48 hours.

QUANTITATIVE PLATELET DISORDERS (THROMBOCYTOPENIA)

It is best to avoid biopsies in patients with <50,000 platelets. If required, however, give 1 standard adult dose (approximately 5 units equivalent) of platelets prophylactically 1-3 hours before the procedure. If bleeding occurs in spite of this, check the platelet count and consider an additional dose of platelets and red cells, if clinically appropriate.

As the regulatory world becomes more complex, we need to fill out several forms when performing interventional procedures in CT and ultrasound. The following is a summary on these procedures from Marie Kelley RN, nursing director of the radiology recovery area:

When doing invasive procedures in all areas of diagnostic imaging, the following documentation is required:

1. A pre-procedure note indicating the planned procedure, diagnosis/indication for study, allergies and current meds
2. Patient history
3. Review of systems
4. Physical exam
5. Documentation of pre-procedure "time out"
6. Marking patient on appropriate side of procedure
7. Post procedure note
8. Signed procedure orders
9. Discharge instructions

Pre procedure notes and history and physical must be either documented in the patient's chart or filled out on page 1 of the "sedation, invasive procedure & monitoring record." Post procedure notes are either documented in the patient's chart or on page 2 of the "ambulatory surgery record".

For all procedures or exams requiring sedation the following information **must** be documented on the lower portion of page 1 of the "sedation, invasive procedure & monitoring record."

1. ASA class
2. History of complications with sedation
3. Sedation plan and sedation meds intended
4. Mallampati airway class
5. Verification of NPO status
6. Consent received for administration of sedation
7. Availability of resuscitative equipment

Documentation compliance is reported monthly to the DI and RIH QA committees.

Dictation of Procedures:

Standardized interventional procedure dictation templates are in Powerscribe and should be used for CT guided interventions. These include "Body CT Lung Biopsy", "Body CT Abdomen Biopsy", "Body CT Drainage" and "Body CT Renal RF Ablation". These

templates include a brief history and indication for the procedure, the findings on the localizing CT images, the type and amount of anesthesia used and note of the follow-up period in the radiology holding area. In addition the dictation should include that the patient was discharged home in the care of his/her wife, family member etc with printed discharge instructions. Each procedure CT should include a brief diagnostic portion of the exam with imaging findings. The size and number of lesions, the type and gauge of needle (or catheter) and number of passes made should be included in the dictation. The resident should dictate that the attending radiologist was present during the entire procedure for all interventional cases. All interventional procedures are dictated at the conclusion of the procedure, these should never be dictated on the following day.

Sedation for Procedures:

In general, biopsies are performed with local anesthesia (lidocaine). Lorazepam (Ativan) 1mg IV is useful to decrease patient anxiety and is now used in advance of most CT guided biopsies performed without conscious sedation. Due to its safety profile, lorazepam can be given without the need for continuous monitoring of vitals signs by nurses. Lorazepam may cause confusion in elderly patients so is not generally administered in patients over 75 years. If a patient is particularly anxious, conscious sedation can be administered for biopsies.

Abscess drainages and tumor ablations are performed using conscious sedation (versed and fentanyl) administered by dedicated nursing personnel under the direction of the attending.

For booking general anesthesia cases for pediatric *interventional* procedures, the referring doctor and or radiologist should contact the Anesthesia Department at 444-5142 or 444-6030. Dr. Andrew Triebwasser is in charge of pediatric anesthesia.

An outline of specific CT Guided interventional procedures follows.

Biopsies:

Biopsy specimens are sent for cytology, pathology or both. Cytologic specimens are placed in blue top containers with that contain cytolyte liquid for specimen preservation. Pathology specimens are placed in white top containers that contain formalin. The specimen sheets *and the container holding the specimen itself* must be labeled with the site of origin of the sample. For example “right kidney.” Pathology samples should be hand delivered to surgical pathology (3rd floor, bridge building) and cytology samples delivered to c the cytology laboratory (13th floor APC building) at the end of the procedure.

The Needle types, specimen containers and laboratory for different types of biopsies are summarized below. (These may vary depending on attending preference.)

Needles, Solutions and Laboratories for Common CT Guided Biopsies

ANATOMIC REGION	NEEDLE	SOLUTION	LAB
Lung	Cook Co-axial 19-21G	Cytolyte	Cytology
Mediastinum	Temno 20 or 18G	Formalin	Pathology
Liver	Franseen 20G	Formalin	Pathology
Adrenal	Temno 20G	Formalin	Pathology
Kidney	Temno 20G	Formalin	Pathology
Lymph Nodes	Temno 18G	Formalin Flow cytometry	Pathology Pathology
Bone	Akerman 14G	Formalin	Pathology

Lung Biopsy:

CT guided lung biopsies are booked in a standard fashion using the CT booking sheet. It is the responsibility of the fellow and attending performing the procedure to review all relevant films before performing the actual procedure. Occasionally, patients with a lung lesion will have other intra-abdominal lesions such as an adrenal mass that are amenable to image-guided biopsy with fewer complications. In addition, for patients with old films showing a benign lesion which is stable, a biopsy may not be necessary. While the "booking" radiologist will attempt to get as much information as possible, it is the responsibility of the fellow and attending performing the procedure to biopsy the most appropriate area. In general, you should strive to perform lung biopsies in the morning as the patient can be discharged even if a pneumothorax develops if there is adequate observation period in the afternoon. Late lung biopsies in outpatients often require admission to the hospital which could be avoided if the procedure is performed early in the morning. If the patient has a chest tube placed, it is usually a good idea to check the pathology results to confirm a diagnosis has been made before withdrawing the chest tube. If the findings are nondiagnostic, it is best to re-biopsy the patient with a chest tube still in to obtain an adequate sample. In this scenario a “wet-read” can be performed by the pathology service to assure diagnostic material.

Management of Pneumothoraces

- In general, if the patient develops a pneumothorax before the lung biopsy is completed on the CT table, we will place a chest tube on the CT table and attach it to the pleurevac to reinflate the lung. There is a Pleurevac within the CT suite at all times specifically for this purpose. After the chest tube has been placed, while the patient is on the CT table, the lung biopsy is then performed. The patient is then brought to the recovery room and if there is no persistent air leak, the chest tube may be placed on straight drain and eventually removed in the recovery room and the patient sent home.
- The literature suggests that up to 15% of patients will have a delayed pneumothorax. Most of these occur within the first hour and a small percentage can be delayed as much as three or four hours. It is necessary, therefore, that the patient be in the department at least for two hours so the absence of a pneumothorax can be re-documented. If a small pneumothorax is detected on the immediate post biopsy CT images, I obtain a chest x-ray (PA only) immediately after the CT and at two hours. This way, I can compare chest x-ray to chest x-ray to assess for interval change. If the patient is asymptomatic, hemodynamically stable, the pneumothorax is stable and the patient is reliable and lives near Rhode Island Hospital, he may be sent home with instructions to return to the CT area the following morning. The patient should be given a stamped requisition, told to have a chest x-ray performed the following morning in the General Radiology area, and to bring the chest x-ray to the CT suite and contact the responsible fellow. In general, if the patient remains asymptomatic the following day and the pneumothorax is stable, the patient does not need follow-up. Obviously if the pneumothorax is bigger or the patient is symptomatic, then a chest tube should be placed.
- For a patient who develops a pneumothorax post-procedure and becomes symptomatic, a chest tube should be placed either in the recovery room or in VIR. If a chest tube is placed in the recovery room, I prefer using a 10 French drainage catheter inserted along the anterior axillary line at the level of the nipples. A chest x-ray should then be performed to assure resolution of the pneumothorax. If the patient is reliable, asymptomatic and there is no air leak, he may be sent home with a Heimlich valve with instructions to return if symptomatic. As stated above, these patient should be given a chest x-ray requisition and instructed to have a chest x-ray performed in the Main Department and to bring the radiograph to the CT suite.
- For patients with a pneumothorax who are old, unreliable, live far from the hospital or desire to be admitted, admission is generally performed to the radiology service. We do not admit patients for observation if they do not have a chest tube.

Abscess Drainage:

Abscess drainages should be performed with antibiotic coverage. If it is desirable to hold antibiotics until a specimen is aspirated, antibiotics should be initiated immediately following the procedure. It is the recommendation of the Infectious Diseases Division that 3 grams of Zosyn (which is a combination of 2 drugs: piperacillin and tazobactam) be given intravenously for broad spectrum coverage of abdominal abscess drainages. Piperacillin is a penicillin-type antibiotic that works by stopping the growth of bacteria. Tazobactam is an enzyme inhibitor (beta-lactamase inhibitor) that helps the piperacillin work better. Alternatively, 1 gram of Ancef and 80 mg of Gentamicin may be given intravenously at the time of procedure. Outpatients undergoing an abscess drainage generally should be admitted for overnight observation as all patients have a transient bacteremia from the procedure and may have an episode of hypotension.

Inpatients and outpatients who have tubes placed in CT/US are followed by the residents, fellows and attendings in the CT /US area. A whiteboard in the CT/US area has a list of patient name, location, tube type, date of tube, referring MD and plan. When a procedure is done, the patient data is entered on the whiteboard by the resident/fellow who performed the procedure. In addition, the patient should be entered into the "Body Tube" folder in the Body Worklist of PACs for review on a daily basis.

CT Guided Tumor Ablation:

We are one of the busiest image guided tumor ablation services in the world. The interventional tumor ablation service is administered by Derek Tessier NP and by Amy Doorley NP. All patients are seen in advance of the procedure in clinical consultation by Dr. Dupuy, Mayo-Smith, Haas, Healey, Iannuccili, or Prince. Dictations of these consults are available on Lifelinks and should be read by the residents/fellow in advance of the procedure.

All patients have the procedure performed with conscious sedation and antibiotics are not routinely administered. Tumor ablation is routinely an outpatient procedure. We perform Percutaneous radiofrequency (RF), cryo and microwave ablations. The modality used depends on tumor size, location and physician preference.

Derek Tessier has outlined the general procedure to be followed below:

1. Booking RF/Ablation procedures
 - a. Initial intake by Nurse Practitioner via referring physician or attending radiologist (Dupuy/Haas/Mayo-Smith/ Healey/ Iannuccilli).
 - b. Consultation booked through tumor ablation services (Secretary: Robin Holley 444-5707, Derek Tessier, NP 350-4205, Amy Doorley, Nurse Practitioner 350-5910).
 - Prior to consult, MD/Nurse Practitioner orders imaging as indicated. Patient seen in consultation by MD/Nurse Practitioner.
 - c. Nurse Practitioner books biopsy and/or ablation.

- Appropriate testing ordered by Nurse Practitioner (labs, EKG, medication adjustments, etc.)
 - d. Nurse Practitioner will coordinate with anesthesia as indicated.
 - e. Radiology resident and Radiology Recovery Room will be provided with patient H&P and lab work attached to procedure booking sheet.
2. Date of procedure: Nurse Practitioner will consent patient prior to ablation, manage, discharge patient post-ablation, and coordinate follow-up visit/imaging.
 3. Admission of Ablation Patients
 - a. Admitting to Observation **
 - Admit under radiology attending through radiology recovery room. Admitting orders will be submitted by NP. The following day, Nurse Practitioner will discharge patient from hospital and perform all necessary documentation in POM.
 - b. Admitting under Teaching Service (Med onc/surgery/medicine)
 - Nurse Practitioner/resident will contact referring physician who has admitting privileges to Rhode Island Hospital. Patient will be admitted under their service. Radiology will act as consulting specialty.
 - c. Admitting under Non-Admitting physician
 - Nurse Practitioner will determine whether patient is Coastal Medicine by contacting patient PCP office.
 - Nurse Practitioner will determine whether patient is IMIS/Hospitalist service by either contacting PCP office or contacting hospital operator.
 - Radiology will act as consulting specialty.
 - d. Admitting patient from out of network referring physician
 - Coordinate admission with Medical Admitting resident (350-0113) and/or Medical Consult resident (350-2365) and/or IMIS/unassigned medical admission (UMA) 350-0944, who will evaluate patient in Radiology Recovery Room and admit to teaching services.
 - Radiology will act as consulting specialty.
 - Nurse Practitioner will contact referring physician to update on current clinical situation/admission.
 4. Ablation patients should appear on radiology “Tube Board” for inpatient rounding purposes.
 5. Lung ablations will be performed exclusively on Mondays with dedicated VIR fellow. If patient requires admission, VIR fellow will assist in admitting and inpatient management as indicated.

** In cases of ablation patients, where a VIR resident has performed the procedure, the VIR on-call resident should be contacted.

** Cases performed by radiology residents during the daytime should be addressed to the night float short and long resident. Include a note for nursing to contact 4-4123(CT) until 10pm and 4-2727 (ER) after 10pm with acute issues. The resident who performed the procedure should “sign-out” the procedure to the NFS resident at 5pm.

Post Procedure Observation Patients who have undergone Image Guided Intervention:

Patients are observed in the radiology holding area or on the floor for inpatients. For inpatients, follow-up orders for vital sign monitoring and catheter irrigation should be made. A form regarding the history, physical, procedure and observation care should be filled out on each patient. A pulse oximeter should be utilized whenever conscious sedation is given and vital signs recorded. The hospital mandate for conscious sedation does indicate that patients must have basic monitoring with pulse oximeter if they are medicated with intravenous sedation.

Discharge of Patient:

All patients undergoing a CT guided procedure should be discharged home with another person to care for them overnight. Patients who have undergone a biopsy are told to contact their referring physician for the results of their biopsy. Following conscious sedation the patient must be alert and awake prior to discharge. Type and amount of sedation administered should be dictated in all interventional cases. A discharge form is available in the department that should be given to each patient documenting the instructions you have given them. The Interventional Radiology nurse calls each patient the next day and verifies that the patient is well. The ablation service NP will call ablation patients to check on their status.

Rounding on Inpatients Treated by CT Radiology:

Inpatients and outpatients who have tubes placed in CT/US are followed by the residents, fellows and attendings in the CT /US area. A whiteboard in the CT/US area has a list of patient name, location, tube type, date of tube, referring MD and plan. When a procedure is done, the patient data is entered on the bulletin board by the resident/fellow who performed the procedure.

NP will round on ablation patients who require any tubes Monday through Friday and present patients accordingly at "tube rounds." Resident and attending will be responsible for rounding on ablation patients over the weekend.

Each morning a resident and or fellow rounds on all patients and gather information on: 1. overall patient status; 2. fever; 3. white count; 4. tube drainage; and 5. irrigation. Residents and fellows will irrigate the tubes on the floor themselves if there is not drainage. A radiology progress note should be written in the chart. At 8 in the morning, we will have "tube rounds" with the residents, fellows and either the CT or US attending to decide on a plan. The person coordinating who will see each patient is the CT fellow/senior resident. Who sees which patient should be set up the afternoon before. Decisions on patient management, tube pulling, flushing, changing etc. will be made during tube rounds and communicated in the chart and with the appropriate referring

service. In addition, the patient should be entered into the “Body Tube” folder in the Body Worklist of PACs for review on a daily basis.

Needlestick injuries:

Should the resident suffer from a needlestick injury, s/he should notify their attending and be evaluated immediately at employee health at Rhode Island Hospital. Employee health is open from 7:15 am – 4:00 pm Monday through Friday. In the event of a needlestick injury outside of those hours, the resident should be evaluated at the Rhode Island Hospital emergency department.

Admitting Patients

Patients admitted for overnight observation can be admitted to the Radiology service. Unstable patients with complex medical problems should be admitted to the medical service. It is critical to get the bed assigned early in the day, so that the patient does not remain in the radiology recovery room after 5 p.m. It is the responsibility of the fellow/resident who did the procedure to write the admit note and admitting orders.

Tips on how to expedite an admission.

- 1- Do it as early in the day as possible. The later you wait, the more painful it is and the longer it takes.
- 2- DON'T call "admitting". DO call "Bed Control" (x44523)
- 3- Know the admitting diagnosis
- 4- Know patient's name, DOB, MR#
- 5- Know the admitting attending. They can't begin to book a bed without this.
- 6- If the plan is to discharge the patient the next day, make sure you book an "OBSERVATION BED". This costs a lot less than a "general" bed. You can't make the mistake of booking a general bed and try to change it to observation----they won't allow it. You can, however go the other way (i.e. change from observation to a general bed.)
- 7- Make sure an H&P and Ordered are done ASAP. Use "ADCVANDISL:"

Admitting Orders using the POM System

- ❑ Orders are placed using a computerized system called POM – Physician order management system. There is a link on the lifespan intranet home page under the medical section named POM video training tutorial for physicians, which is a useful guide at the beginning of the rotation to learn about the system.
- ❑ You will need a Lifelinks password. The login ID is assigned to you when you begin residency. You will be assigned a password at orientation or you can contact Lifelinks help desk at 46381 to get your password.

- ❑ After logging in click on Rhode Island hospital, and go to the Nurses station census. Pick up the nurses station that the patient is being admitted to, for e.g. JB 3 for Jane Brown third floor. The patient's name should already be on the list of that station. Double click on the patient's name. By default it opens the last lab result page.
- ❑ Click on Write orders/ Post procedure transfer orders. Go to order sets and pick admit/dsch/order. Alternatively go to New orders and pick Admit orders. It gives you various options like- Admit to Dr, Status observation vs. inpatient. Highlight the option you want by single clicking on it and hit o.k. tab at the bottom of the screen.
- Remember the basic format of writing orders, which should cover the following points:
 - Admit to Interventional Radiology, Dr Mayo-Smith (It should be noted that only certain attendings have admitting privileges and you may need to admit a patient under a different attending than the one who performed the procedure; you should notify an attending if you are looking to admit a patient under their name.)
 - Condition: Good
 - Activity: ad lib, or ambulate with assistance
 - Nursing: chest tube to wall suction at 20 mm hg. There is a comment box for each order in which you can put the changes you want like - change chest tube to water seal at 4.00 am following admission. WE have written two macro orders sets for routine chest tube and abscess catheter maintenance on inpatients which are being incorporated into the POM system.
 - Diet: Liquids and advance as tolerated
 - Vitals: Routine, or q shift with pulse oximeter
 - IV: Int after po.
 - Meds: you can go to new meds order, which gives a list of common meds to search from and includes the doses. There will be a prompt about frequency, if prn then reason for prn etc. After filling all the fields hit o.k. at the bottom.
 1. Common PRN medications should include medications for pain, insomnia, nausea, etc.
 - Tests: Go to Radiology and select CXR. Add in comments – CXR on waterseal and call CT section 444-4123 once it is done (you can check it on PACS).
 - There is a prompt for all these choices and you can select one and further add additional comments as needed.
 - The majority of these orders are under the:
 1. “Order sets”
 - “Admitting Med Orders:”
 - “General Med ADM PT1” and “General Med ADM PT2” ordersets.
 - “Other Order Sets:”
 - “RAD SP abscess” or “RAD SP Chest tube”
 - Additional follow-up labs/imaging should also be considered for the next morning to facilitate timely patient discharge.

- Additional instructions should also be included in the admission orders (for nursing) on how to reach radiology housestaff with over night issues. This can be done as a text order.
 1. In cases of ablation patients, where a VIR resident has performed the procedure, the VIR on-call resident should be contacted.
 2. Cases performed by radiology residents during the daytime should be addressed to the night float short and long resident. Include a note for nursing to contact 4-4123(CT) until 10pm and 4-2727 (ER) after 10pm with acute issues. The resident who performed the procedure should “sign-out” the procedure to the NFS resident at 5pm.

After you have put in all the orders, click the Sign orders tab, and put in your password in the space provided.

When the patient is DISCHARGED (usually the following day) the resident/fellow should write a brief DISCHARGE NOTE. This is important so that the admitting attending does not get nasty letters from the medical records department about suspension of admitting privileges. Discharge notes are required in all patients who are in the hospital for 48 hours or less. Patients admitted for more than 48 hours require a discharge dictation. The discharge note should be written in the following format and include the following information:

DATE:	Date of Discharge
TITLE OF NOTE:	“Final Note”
FINAL DISCHARGE DIAGNOSIS:	Whatever the diagnosis is.
SIGN THE NOTE	Sign and print your name

Discharges are initiated though the POM:

- “PT Care FNS”
 - “Admit/Disch/Transfer”

Additionally, a patient “Continuation of Care (COC)” must be separately completed. A link to this is provided on the left-hand column of the Lifelinks page once you have selected the specific patient and initiated discharge procedures. You should also verbally communicate your intentions to discharge the patient to the floor nurse to expedite the discharge.

For "add-on" patients to undergo a CT or US guided procedure, the following applies re coordination of patient care, and use of sedation and the recovery room space.

Guidelines for Sedation for Inpatient CT/US Guided Interventional Procedures

Add-on inpatients undergoing CT/US guided interventional procedures will have booking sheets filled out by the radiologist/PA in the standard fashion. The sheet and info will then be discussed with the lead CT tech /charge tech who will then notify the charge nurse and radiology secretary with a potential time. All image guided abscess drainages are performed using conscious sedation. The need for conscious sedation for other procedures is at the discretion of the attending physician.

Process for CT/US Add-On Procedures:

1. Radiologist/PA/NP takes booking for procedure & completely fills out Booking Sheet
2. Booking sheet given to Lead Tech/Charge Tech
3. Booking screened for:
 - Unit or Floor status
 - Need for moderate sedation, Ativan or no sedation needed
 - NPO status
4. Lead Tech brings copy of booking sheet to Recovery Charge Nurse
5. Procedure time determined by Attending Physician, Lead Tech and Charge Nurse and secretary told of procedure time by Lead Tech.
6. Charge Nurse calls floor/unit to notify them of procedure time and to confirm NPO and consent status and any other pertinent info.
7. Radiology secretary puts patient on transport list.

Recovery Room & Nursing Utilization for Scheduled and Add-on CT/US Inpatients:

1. Unit patients: Pt will go directly to CT/US; DI nurse will act as resource for unit nurse. Post procedure will return to unit.
2. Floor patients who will receive just Ativan or require no sedation: Pt goes to CT/US; DI nurse will give Ativan there if needed. (Preferably before patient gets on table). Post procedure will return to floor.
3. Floor level patients requiring conscious sedation *or sedation need is unclear at time of booking*: Pt brought to Recovery pre procedure; sedated in CT/US by DI nurses. Post procedure will be monitored in recovery by DI nurses until sedation criteria met.
4. Floor level lung biopsy patients will be monitored in recovery post procedure until chest x-ray has been obtained and cleared by radiologist.

Weekend Coverage:

Weekend processes are meant to mirror weekday policies providing optimal patient care.

1. For floor patients, W&I patents and ER patients requiring conscious sedation, the on-call nurse will be notified and come in to provide sedation. These patients will be returned to the floor, W&I and ER respectively after the sedation criteria have been met. The radiology recovery room will not serve as a holding area for ER patients to be admitted.
2. For ICU patients requiring conscious sedation, at the current time the on-call nurse will be called in to coordinate medication and procedural needs with the ICU nurses. The need for the Radiology nurse to stay will be determined by DI team in discussion with the ICU nurse.

NOTE: This process is a guideline only. The need for Recovery Room time and DI nursing support is at the discretion of the attending radiologist.

Body MR

By David Grand (updated 5/2012)

Welcome to Body MR. MR is a dynamic, exciting modality. The residents and fellows are critical to the success of our division. The following is intended to serve not only as an introduction to the service but also as a resource for protocolling studies and for basic study interpretation. Please consult it early and often. The utility of MR for evaluation of the chest, abdomen and pelvis has dramatically increased in the past decade due to more powerful scanners with faster gradients, faster pulse sequences and improved coils. Within the abdomen, MR has quickly become the test of choice for the evaluation of focal and geographic liver disease and the biliary tree. It is also used as a problem solving modality for lesions of the kidneys, adrenal glands and more recently the small bowel. With unparalleled soft tissue resolution, MR is the gold-standard imaging exam for evaluation of the female pelvis and is also useful for the staging of pelvic malignancies in either gender.

Currently, the Brown MR division has four 1.5 Tesla MR scanners and a 3T scanner

RIH Room 1: Siemens Verio 3T. This 3T scanner was installed in 6/2010 and is truly the prince of protons. At 3T it is high-field and has a bore as wide as the Espree (see below) for claustrophobic or obese patients. Although many people believe a good 1.5T is as good as 3T for body imaging, I must say, I've been very impressed with this magnet. There is one exception. Ascites. **IF A PATIENT HAS KNOWN ASCITES, do not image on the 3T.** It can cause significant degradation of the images due to dielectric effects.

RIH Room 2: Siemens Symphony: 444-3931. Installed in 2003, the majority of the body and all of the cardiac imaging is performed on this scanner.

RIH Room 3: Siemens Espree: 444-6403. Installed in 2007, and located in the pediatric imaging center in the basement of Hasbro, this scanner is not just for pediatric patients. It is not an "open" magnet, but does feature a wider bore than conventional scanners which is intended to ease claustrophobia. Being the newest of our 1.5T scanners, this magnet has the most advanced software platform including powerful diffusion weighted sequences and options for respiratory navigation.

TMH MRI: Siemens Symphony. 793-4475. Identical to room #2 at RIH.

W + I: Siemens symphony. 274-1122 ext 1875. The identical scanner to room 2 at RIH, except for hardware and software upgrade in 2010.

PROTOCOLING STUDIES:

The astute resident/fellow will notice four bins on the wall of the body reading room (located on the left as one enters). They include:

Body MR to be Protocolled – The technologists will place MD orders for MR's in this bin. These orders require protocols before being performed. (For notes on protocolling

studies, see below.) Residents/fellows MUST WRITE THEIR NAMES LEGIBLY FOR ALL STUDIES THEY PROTOCOL. All protocols will be discussed with the attending on service who will initial the protocol sheet.

Body MR Protocolled – Orders which have been protocolled should be placed in this bin.

Body MR to be Read – This bin contains completed studies, ready to be read.

Body MR Read – After reading the study, all paperwork should be placed in this bin. Currently, we must file this paperwork after the study is read. This is of particular importance for patients at risk of developing NSF (nephrogenic systemic fibrosis) for whom we need documentation of the GFR, communication with the referring physician, dose of and type of gadolinium, etc.

RAD-Check: All body MR's will be checked by a resident/fellow BEFORE the patient leaves the table. Please respond to the technologists' request for a rad-check courteously and expeditiously (translation: stop what you're doing and check the study). The goal of the rad-check is to assure that the protocol was performed appropriately and that the images are of diagnostic quality. The resident/fellow should not spend undue time interpreting the study at this point. If images are not of diagnostic quality or if additional sequences are required, please discuss with technologist (and consult with attending). Remember, sequences which require post-processing will not be available for rad-check as the post-processing occurs after the patient is off the table.

BODY MR PROTOCOLLING AND INTERPRETATION:

MR is fundamentally used as a problem-solving modality.

Examinations are therefore targeted to a specific diagnostic problem/lesion. The goal of MR interpretation is to put this diagnostic issue to rest.

It is critical that all previous imaging studies as well as laboratory data and clinic notes be thoroughly reviewed before protocolling and interpreting MR studies.

It is unacceptable to perform an MR incorrectly because the purpose of the examination was not known when it was protocolled.

If the purpose of an examination cannot be determined from all available data, the referring clinician should be contacted. When discussing cases with referring physicians, it is imperative to be friendly and to explain that we are contacting them to optimally image their patient with the goal of performing the final study necessary to answer their clinical question. When put this way, clinicians will (almost) always be happy to discuss the case. We can provide the best answer to the clinical question when we have all the data. When we attempt to interpret studies in a vacuum, everyone loses.

Within the protocolling book there is an introductory guide for interpretation of MR studies. Please read it carefully before coming on service. This guide is by no means exhaustive, rather it is a jumping-off point for further study.

Please do not hesitate to discuss protocolling questions with the attending on service or myself...anytime (David Grand). Cell: 524-0548.

WORKFLOW

The body MR rotation is a terrific opportunity to be exposed to a high volume of a wide-variety of different types of body MR's from multiple locations.

To that end, we have the opportunity to read the Body MRI from RIH and TMH (found on the centrality Body MRI worklist), as well as abdominal MRI from W+I and RIMI when there is NOT a body reader at the offices. An updated listed of body readers can be found posted by the RIMI workstation.

It is the job of the resident or fellow assigned to body MRI to look at the attending schedule each day, determine if there is a body reader at RIMI and notify the RIH body attending appropriately.

There is a lot of good MRI done at TMH, W+I and RIMI. They are all patients who need our help. The more MRI you see in residency the more confident you will be in practice. Read as many as you can get your hands on. Your future colleagues and patients will thank you.

IV. CONTRAST USED IN BODY MR:

A, Intravenous Contrast Agents

All intravenous MRI contrast agents available in the US are chelates of gadolinium. They function by increasing the T1-relaxivity of blood and tissue rendering them bright on T1 weighted images. They are typically power-injected and imaging may be performed dynamically, ie in multiple phases. Practically, there are two categories of gadolinium-agents.

Extracellular, Non-specific -- These are the most commonly used agents. They are used for all types of MR imaging. Obviously the pharmaceutical companies would disagree, but they are essentially interchangeable. We most commonly use Gadavist.

Gadobutrol (Gadavist)
Gadopentetate Dimeglumine (Magnevist)
Gadoteridol (ProHance)

Liver specific – There are currently two agents which are considered liver specific. Of the two, Multihance (Gd-BOPTA) and Eovist (Gadoxate Disodium), Eovist is better due to more efficacious hepatic uptake. It is taken up by functioning hepatocytes in the liver and approximately half is excreted through the biliary tree as opposed to the renal only excretion of the non-specific agents. Delayed images of the liver performed with these agents have been shown to be exquisitely sensitive for detection of small metastatic lesions against the bright background of the (still) enhancing liver.

Another use is distinguishing FNH (focal nodular hyperplasia) from hepatic adenoma. The imaging features of these two lesions often overlap when using non-specific gadolinium agents. Both are hypervascular on arterial phase imaging and are essentially isointense to liver parenchyma on portal venous and delayed phase imaging. Despite all the textbook chatter regarding central scars in FNH and heterogeneity due to internal blood and fat within adenomas, these features may only be found in 50% of lesions (as is typical of appearances described as “classic”). On delayed images, FNH will retain these liver specific agents and be hyperintense compared to liver whereas adenomas will be isointense.

Like most explanations, the following is postulated rather than known, but it makes us feel better and gives us something official sounding to tell the referring clinicians. Both FNH and adenomas have functioning hepatocytes, however whereas FNH has abnormal, blind ending bile ducts, adenomas have no ducts at all. FNH will therefore take up the contrast hoping to excrete it but its ducts are abnormal and the contrast has nowhere to go. Because adenomas have no ducts at all, biliary metabolism is blocked entirely and its hepatocytes will neither take up nor excrete the contrast. Currently, we use Eovist to characterize focal liver lesions (as many of them will turn out to be FNH) and to r/o mets as small mets will be black on the delayed Eovist image (no hepatocytes).

Because these agents are excreted through the biliary tree (in addition to renal excretion) it is possible to use them to make very pretty T1-weighted MRCPs. While interesting in principle, this technique has not proven particularly useful.

The dosing of intravenous contrast agents should be determined by weight. A standard or “single” dose of a conventional, nonspecific gadolinium agent is 0.1 mmol/kg.² A “double” dose is 0.2 mmol/kg. Traditionally, MRA’s and cardiac exams are performed with a double dose, although this is changing with better scanners, better contrast agents, and fear of NSF (nephrogenic systemic fibrosis – more below). At the time of writing, the optimal dose of Eovist (Gadoxate Disodium) is controversial. We use 10 cc

² The manufacturers have actually done us a favor here. The concentrations of all listed IV contrast agents except Eovist (Gadoxate Disodium) are such that the standard dose of 0.1 mmol/kg is roughly equal in cc’s to the patient’s weight in pounds divided by ten. Hence, a single dose of gadolinium for a 150 lb person is 15 cc’s. A double dose would be 30 cc’s.

regardless of weight (it comes in a 10 cc vial). Intravenous contrast agents are typically power-injected at 2 cc/sec followed by a 20 cc saline “chaser” to flush the contrast from the tubing into the vasculature.

B. Oral Contrast Agents

Oral contrast is currently used for two indications. First, we use a barium sulfate suspension (0.1% w/v, VoLumen) which is a low-concentration barium and sorbitol solution to distend the small bowel for MR enterography examinations. Small bowel distension is critical to the utility of these studies, and because of the sorbitol this contrast agent cannot be absorbed in the bowel. Secondly, we routinely use pineapple juice for MRCP's. It is cheap, delicious, turns the contents of the intestines black (and contains vitamin C!). Bright fluid signal within the duodenum could otherwise obscure the ductal anatomy on MRCP images (which are heavily T2-weighted).

MR Contrast Use (Gadolinium) in Patients with Renal Dysfunction

During my MR fellowship, elevated creatinine (poor renal function) was probably the single most common indication for performing MRI. Times have changed. Recently, a small number of patients with decreased renal function who received gadolinium for an MRI exam acquired a potentially fatal disease, Nephrogenic Systemic Fibrosis. Although gadolinium contrast agents have always been thought to be innocuous, the gadolinium ion itself is known to be quite toxic. By binding it into a larger molecule, it is rendered inert. Remember that all or nearly all of the excretion of these agents is renal. It is thought that patients' with poor renal function may not excrete all of the contrast agent before the gadolinium ion manages to dissociate itself from its larger molecule. It is then free to wreak havoc.³

Recent studies have linked a serious group of diseases known as Nephrogenic Systemic Fibrosis/Nephrogenic Fibrosing Dermopathy (NSF/NFD) to the administration of gadolinium-based contrast agents in dialysis-dependent patients and those with severe renal failure. Use of gadolinium in patients with moderately reduced renal function has also recently been cautioned by the FDA.

Gadolinium-chelate compounds, may pose a risk for NSF/NFD in patients with moderate renal failure, estimated Glomerular Filtration Rate (eGFR) of 30-60ml/min, and therefore should only be used if necessary for diagnosis, limiting dose to minimum required. Recent FDA advisory states that “the risk, if any, for developing NSF among patients with mild to moderate renal insufficiency or normal renal function is unknown”.

In patients with severe renal failure (eGFR < 30) exposure to gadolinium containing contrast agents increases the risk for NSF (estimated to be 3-7%). Significant risk is also present for patients with acute renal insufficiency of any severity, or renal insufficiency

³ This is also why we NEVER, NEVER, NEVER give gadolinium to a pregnant patient. The contrast agent can diffuse into the amniotic fluid and stay there – with plenty of time for the gadolinium ions to disassociate and cause trouble.

due to hepato-renal syndrome. A recent study identified a small group of patients with eGFR between 30-40ml/min who developed NSF. These patients were later found to have had undetected ATN at the time of Gd administration. Extreme caution should be exercised in all patients with acute renal insufficiency related to recent major surgery/vascular procedures, sepsis or in the peri-transplantation period. Acidosis and elevated serum Ca, Fe, P have also been associated with increased risk. High dose erythropoietin therapy and immunosuppression may be linked to NSF/NFD.

Among the factors that may increase the risk for NSF are repeated or higher than recommended doses of gadolinium containing contrast agents. Although this is a rapidly evolving topic these guidelines provide an initial framework for the care of patients who may be at risk for gadolinium associated NSF/NFD.

(Because NSF is a fatal disease we must be cautious. However, it is also important to understand that the actual risk of a patient contracting NSF is essentially nil. Nearly all of the cases of NSF reported have been with a single gadolinium agent which is no longer used. If you look critically at the number of cases of NSF worldwide compared to the number of gadolinium enhanced MRI's performed – statistically speaking, NSF essentially doesn't exist. That being said, our guidelines for contrast administration are based on the current recommendations of the experts and the FDA.)

OUR CURRENT GUIDELINES:

Guidelines are established to define procedures which reflect appropriate care practices for providing imaging and interventional procedures. These guidelines shall be used routinely; however, actual practice may be altered to fit specific patient conditions which may be recognized. Altered practices from these guidelines must first be approved by a Radiologist as he/she evaluates the patient's condition and clinical circumstances against the imaging or intervention services being requested.

A. Procedure: Guidelines for Patient Screening:

Adult Patient screening shall be performed for assessment of moderate or severe renal disease by obtaining serum creatinine and calculating eGFR (using the MDRD Study equation Modification of Diet in Renal Disease: located at <http://mdrd.com> or eGFR calculators available at each MR unit. For patients under 18 years of age the Schwartz Formula should be used to calculate eGFR: located at http://nephron.com/cgi-bin/peds_nic.cgi), when **any** of the following risk factors are present:

I. Inpatient/ER Patient: Creatinine value obtained during current hospitalization prior to MRI.

II. Creatinine value must be obtained within 24 hours prior to MRI when:

- a. Active renal disease / acute tubular necrosis
- b. Hepato-Renal Syndrome/Liver Transplant Recipient/ other recent transplant
- c. Any recent major surgery/vascular procedures/sepsis
- d. Following recent CT when pre-CT eGFR less than 60 or diabetes/hypertension.

III. Outpatient: Creatinine value must be obtained within 6 weeks of MRI examination when:

- a. Known or suspected renal disease
- b. Diabetes/Hypertension
- c. Liver transplant/other transplant surgery
- d. Age greater than 60 (exception may be when creatinine value is obtained within one year prior to MRI; patient is followed by a physician, has eGFR greater than 60 and has no additional risk factors).

B. Guidelines for Performance of Gadolinium Enhanced MRI Examinations based on patient risk category and examination type:

Inpatient/Outpatient

I. No risk factors - standard dose gadolinium agent (Gadavist/Magnevist/Eovist)

II. No risk factors MRA- Standard dose Gadavist/Magnevist.

III. Risk factors HTN or Diabetes/No Creatinine Available within 6weeks- Contrast may be administered per above guidelines if eGFR is greater than 60ml/min calculated from creatinine obtained within one year if the patient is followed by a physician for this condition and reports no recent change in condition, reason for exam does not include assessment of urinary tract, and there are no additional risk factors. Patients who have had a recent CE CT scan must have documentation of stable post CT renal function. If creatinine cannot be obtained then non-contrast examination performed when appropriate. If gadolinium is recommended following Radiologist review of non-contrast study, referring physician is notified. If upon discussion with referring physician the decision is made to proceed with CE portion of MRI examination, creatinine must be obtained, and reported to MRI at the time of limited CE examination scheduling. If eGFR >60, proceed with examination as described above, if <60 see below. All patients with <60 eGFR, needs an "eGFR evaluation patient sheet" (form A) completed and scanned into PACS/ Novius.

a. **eGFR less than 60ml/min, greater than 30ml/min** (moderate renal failure)- Non-contrast examination should be performed. If this is not diagnostic or based on clinical history there is a diagnostic imperative for gadolinium administration (i.e. rule out metastatic breast cancer for pre treatment staging) and gadolinium is indicated, consideration of risk benefit analysis documented by Radiologist in the patient record. Radiologist prescription of amount & type of gadolinium given must be recorded.

Limited Gadolinium dose is recommended which should be tailored to the specific examination requirement.

Gadavist dose should be tailored to limit total gadolinium exposure and take advantage of the increased T1 relaxivity of this agent to reduce overall contrast

volume. (I.e. double dose exams may be performed using single dose Gadavist, and single dose studies may at times be performed with a reduced dose).

eGFR=30-40, creatinine obtained within 24 hrs, ensure no risk for ATN (stable Cr), Assess prior Gadolinium administration (cumulative dose over preceding year may present risk) or recent CT contrast exposure (ATN risk-stable post CT Cr must be recorded), no additional risk factors for NSF. If Gd required recommend ½ dose Gadavist. It should be remembered that risk for NSF relative to eGFR is a continuum. As eGFR levels approach 30, risk may approach that of severe (Gr 4, 5) renal disease.

eGFR=40-50, creatinine obtained within 6 weeks, Assess prior Gadolinium administration (cumulative dose over preceding year may present risk) or recent CT contrast exposure (ATN risk-stable post CT Cr must be recorded), no additional risk factors for NSF. If Gd required recommend minimum necessary Gadavist dose, not to exceed single dose.

eGFR=50-60, creatinine obtained within 6 weeks, Assess prior gadolinium administration (cumulative dose over preceding year may present risk) or recent CT contrast exposure (ATN risk-stable post CT Cr must be recorded), no additional risk factors for NSF. If Gd required recommend single dose Gadavist.)

b. eGFR less than or equal to 30ml/min (severe renal failure) or acute renal insufficiency of any severity due to the hepato-renal syndrome or in the peri-operative transplantation period, recent major surgery, sepsis, major vascular procedures. Prudent to not administer gadolinium compound if previous gadolinium administration within preceding year. Non-contrast examination should be performed. If this is not diagnostic, Radiologist review of gadolinium indication is required in consultation with the Referring Physician and Nephrologist. If gadolinium is indicated, consultation and consideration of alternative examinations should be documented in the patient record.

Patient/Guardian informed consent should be obtained with estimated risk clearly stated (estimated risk of NSF/NFD 3-7%).

Limit dose necessary for MR procedure, half dose Gadavist is recommended. If patient receives hemodialysis, follow-up dialysis treatment must be performed within 2 hours and again within 24 hours of gadolinium administration. It is unknown however if hemodialysis prevents NSF.

Peritoneal Dialysis is not believed to be effective in clearing gadolinium. Patients undergoing peritoneal dialysis may not receive gadolinium unless Nephrology is consulted and hemodialysis is planned.

Patients receiving gadolinium who are at risk for NSF require clinical follow-up and long term monitoring for the disease.

Fundamentally, like everything else we do in medicine, this is a calculation of risk/benefit. We tend to lose sight of this calculation, inherent in all medical tests and procedures, because radiology tests and procedures are typically quite safe. However, there is risk to the patient in everything we do, and our willingness to perform a test/procedure implies that after careful consideration we believe the benefit of the test/procedure to outweigh the risk. It is important to remember that to date not a single person with normal renal function has acquired NSF. NSF has certainly increased the risk in the risk/benefit equation, however we should our judgment in addition to the above guidelines to calculate the risk/benefit ratio for each patient at risk.

II. CT EDUCATIONAL GOALS AND OBJECTIVES

First Year Residents:

Medical Knowledge

1. Describe the basic physics of computerized tomography
2. Describe Hounsfield units, window and level settings
3. Describe proper CT protocols for specific disease processes
4. Describe dynamic vs. equilibrium phase imaging and differentiate between these entities
5. Describe normal thoracic parenchymal, mediastinal and vascular anatomy
6. Describe normal abdominal and pelvic anatomy
7. State indications for aortic dissection CT and the protocol to be followed with this examination
8. Describe the differences between axial CT, helical CT, and MDCT
9. Describe indications for body MR exams

Patient Care:

1. Become familiar with CT protocols
2. Be able to manage contrast reactions

Practice-based Learning and Improvement:

1. Identify, rectify and learn from personal errors
2. Incorporate feedback into improved performance
3. Efficiently use electronic resources (Lifelinks) to access information
4. Schedule exams appropriately

Communication and Interpersonal Skills:

1. Appropriately communicate and document in the patient record urgent or unexpected radiologic findings
2. Produce radiologic reports that are accurate, concise and grammatically correct
3. Communicate effectively with all members of the health care team

Professionalism:

1. Demonstrate respect for patients and all members of the health care team
2. Serve as a role model for medical students
3. Respect patient confidentiality
4. Present oneself as a professional in appearance and communication.

System-based Practice:

1. Demonstrate knowledge of how radiologic information is integrated with the other parts of the health care system in the treatment of the patient

2. Demonstrate knowledge of ACR standards and appropriateness criteria
3. Demonstrate knowledge of cost-effective imaging practices

Second Year Residents:

Medical Knowledge

1. Describe the basic physics of computerized tomography
2. Describe Hounsfield units, window and level settings
3. Describe proper CT protocols for specific disease processes
4. Describe dynamic vs. equilibrium phase imaging and differentiate between these entities
5. Describe normal thoracic parenchymal, mediastinal and vascular anatomy
6. Describe normal abdominal and pelvic anatomy
7. State indications for aortic dissection CT and the protocol to be followed with this examination
8. Describe the differences between axial CT, helical CT, and MDCT
9. Describe indications for body MR exams
10. Describe Body MR protocols and indications for intravenous MR contrast

Patient Care:

1. Become familiar with body CT and MR protocols for patients
2. Be able to manage contrast reactions

Practice-based Learning and Improvement:

1. Identify, rectify and learn from personal errors
2. Incorporate feedback into improved performance
3. Efficiently use electronic resources (Lifelinks) to access information
4. Schedule exams appropriately

Communication and Interpersonal Skills:

1. Appropriately obtain informed consent for CT guided interventional procedures
2. Appropriately communicate and document in the patient record urgent or unexpected radiologic findings
3. Produce radiologic reports that are accurate, concise and grammatically correct
4. Communicate effectively with all members of the health care team

Professionalism:

1. Demonstrate respect for patients and all members of the health care team
2. Serve as a role model for medical students
3. Respect patient confidentiality
4. Present oneself as a professional in appearance and communication.

System-based Practice:

1. Demonstrate knowledge of how radiologic information is integrated with the other parts of the health care system in the treatment of the patient
2. Demonstrate knowledge of ACR standards and appropriateness criteria
3. Demonstrate knowledge of cost-effective imaging practices

Third Year Residents:

Medical Knowledge:

1. Respond logically and with competence as a Body Radiology consultant.
2. Prescribe and interpret CT/MR exams in the chest and abdomen.
3. Describe radiation dose reduction principles in CT
4. Describe volume, doses and administration rates of contrast for CT examinations.
5. Provide a differential diagnosis for
 - a) thoracic, abdominal and pelvic pathology
6. Indications for CT-guided chest, abdominal and pelvic CT interventions
7. Indication and techniques of CT-guided abscess drainages and biopsies.
8. Describe Body MR protocols and indications for intravenous MR contrast
9. Orient and supervise the proper imaging investigation of a patient or of a specific disease.

Patient Care:

1. Develop a management plan based upon CT, US and or MR findings and clinical information.
2. Demonstrate proper technique in planning and performing CT procedures
3. Know the appropriate indications for body CT and MR examinations and alternatives depending on the suspected diagnosis.
4. Appropriately protocol CT and body MR cases based upon the indication for the examination
5. Minimize adverse reactions to iodinated contrast through appropriate patient selection and medication.

Practice-based Learning and Improvement:

1. Identify, rectify and learn from personal errors
2. Incorporate feedback into improved performance
3. Efficiently use electronic resources (Lifelinks) to access information
4. Schedule procedures appropriately
5. Use appropriate protocols and techniques for radiation dose reduction in CT

Communication and Interpersonal Skills:

1. Appropriately obtain informed consent
2. Appropriately communicate and document in the patient record urgent or unexpected radiologic findings
3. Produce radiologic reports that are accurate, concise and grammatically correct
4. Effectively teach junior residents and medical students

5. Communicate effectively with all members of the health care team

Professionalism:

1. Demonstrate respect for patients and all members of the health care team
2. Serve as a role model for junior residents and medical students
3. Respect patient confidentiality
4. Present oneself as a professional in appearance and communication.
5. Demonstrate a responsible work ethic with regard to work assignments

Systems-based Practice:

1. Demonstrate knowledge of how radiologic information is integrated with the other parts of the health care system in the treatment of the patient
2. Demonstrate knowledge of ACR practice guidelines for CT examinations
3. Demonstrate knowledge of cost-effective imaging practices
4. Understand treatment implicated by findings on CT or MR (e.g. what is the next treatment that should occur based on the CT/MR findings).

Fourth Year Residents:

Medical Knowledge:

1. Respond logically and with competence as a Body Radiology consultant.
2. Prescribe and interpret CT/MR exams in the chest and abdomen.
3. Describe radiation dose reduction principles in CT and the ALARA (as low as reasonably achievable principles)
4. Describe volume, doses and administration rates of contrast for CT examinations.
5. Provide a differential diagnosis for
 - a) thoracic, abdominal and pelvic pathology
6. Indications for CT-guided chest, abdominal and pelvic CT interventions
7. Indication and techniques of CT-guided abscess drainages and biopsies.
8. Indications for image guided tumor ablation.
9. Describe Body MR protocols and indications for intravenous MR contrast
10. Orient and supervise the proper imaging investigation of a patient or of a specific disease.

Patient Care:

1. Develop a management plan based upon CT, US and or MR findings and clinical information.
2. Demonstrate proper technique in planning and performing CT procedures
3. Know the appropriate indications for body CT and MR examinations and alternatives depending on the suspected diagnosis.
4. Appropriately protocol CT and body MR cases based upon the indication for the examination
5. Minimize adverse reactions to iodinated contrast through appropriate patient selection and medication.

Practice-based Learning and Improvement:

1. Identify, rectify and learn from personal errors
2. Incorporate feedback into improved performance
3. Efficiently use electronic resources (Lifelinks) to access information
4. Schedule procedures appropriately
5. Use appropriate protocols and techniques for radiation dose reduction in CT

Communication and Interpersonal Skills:

1. Appropriately obtain informed consent
2. Appropriately communicate and document in the patient record urgent or unexpected radiologic findings
3. Produce radiologic reports that are accurate, concise and grammatically correct
4. Effectively teach junior residents and medical students
5. Communicate effectively with all members of the health care team

Professionalism:

1. Demonstrate respect for patients and all members of the health care team
2. Serve as a role model for junior residents and medical students
3. Respect patient confidentiality
4. Present oneself as a professional in appearance and communication.
5. Demonstrate a responsible work ethic with regard to work assignments

Systems-based Practice:

1. Demonstrate knowledge of how radiologic information is integrated with the other parts of the health care system in the treatment of the patient
2. Demonstrate knowledge of ACR practice guidelines for CT examinations
3. Demonstrate knowledge of cost-effective imaging practices
4. Understand treatment implicated by findings on CT or MR (e.g. what is the next treatment that should occur based on the CT/MR findings).

III. EVALUATION of RESIDENTS on BODY ROTATION

These are the evaluation mechanisms used to evaluate the resident and determine that the program goals and objectives are met.

Evaluation Forms

Monthly rotation evaluation by faculty

Evaluation by CT technology staff.

Exams

ACR inservice exam

Mock Oral Board exam

Portfolio

Procedure Logs

The residents will also be evaluated on:

1. Attendance during Body rotation.
2. Efficiency during Body rotation.
3. Knowledge of Body protocols.
4. Knowledge of relevant anatomy, physiology and pathology.
5. Knowledge of proper prescription of CT/MR examinations.
6. Ability to provide a reasonable differential diagnosis for a CT/MR imaging finding and suggest the next most appropriate step in the work-up of the patient.
7. Ability to appropriately book and perform CT-guided interventions.
8. Efficiency in dictating studies.
9. Quality of dictations.
10. Interactions with referring physicians.
11. Affability with coworkers, technologists, secretaries, nursing staff and radiology support staff.

IV. CT REFERENCES

- 1) Fundamentals of Body CT by W. Richard Webb, William E. Brant, William E. Brant, Clyde A. Helms (Great for 1st years - quick intro to CT) 3rd Edition, Saunders, October 2005
- 2) Fundamentals of Diagnostic Radiology by William E. Brant, Clyde A. Helms Lippincott Williams & Wilkins, June 2006
- 3) Body MRI by Evan S. Siegelman Saunders, December 2004
- 4) The Radiology of Emergency Medicine by John H Harris and William H Harris Lippincott Williams & Wilkins, December 1999
- 5) Thoracic Radiology: the Requisites by Theresa C. McLoud Mosby, August 1999
- 6) Teaching Atlas Of Chest Imaging by Mark Parker, Melissa De Christenson, and Gerald Abbott Thieme, December 2005
- 7) Thoracic Imaging : Case Review Series by Phillip M. Boiselle, Theresa C. McLoud Mosby, January 2001
- 8) Genitourinary Imaging : Case Review Series by Ronald J. Zagoria, William W. Mayo-Smith, Julia R. Fielding, Mosby, September 2006
- 9) Gastrointestinal Imaging : Case Review Series by Robert D. Halpert Mosby, 2007
- 10) Diagnostic and Surgical Imaging Anatomy: Chest, Abdomen, Pelvis: by Michael P Federle, Melissa L Rosado-de-Christenson, Paula J Woodward, Gerald F Abbott and Akram M Shaaban. Lippincott, Williams & Wilkins, December 2006.
- 11) Diagnostic Imaging: Abdomen. by Michael Federle, R. Brooke Jeffrey, Venkat Sridhar Anne. 2004
- 12) Mayo Clinic GI Review book-4th year, recommend using this book during board prep as a review of barium studies

Reference to various anatomy texts and atlases will often be necessary.

V. Appendix:

- CT Procedure Booking Sheet
- CT Database Entry Sheet
- Post Procedure Discharge Sheet
- CT Division central line policy
- Pregnant Patient Consent form

CT/US Imaging Interventional Procedure Booking/Order Sheet

Rhode Island Hospital, Department of Diagnostic Imaging 6-06

Patient Name: _____ DOB: ____ / ____ / ____
Patient Location: _____ Patient Home/Cell #: _____
Ordering Physician: _____ MD Page/Back line #: _____

Brief History: _____

Procedure Requested: _____

Lab test desired on sample / Special instructions: _____

Can patient give Consent? Yes No If not, who will give consent? _____ Contact

Translator necessary? Yes No Language: _____

Diagnostic Exam From?

RIH RIMI (fax report) Shields (fax report) W&I (fax report) Outside (fax report): _____

Is patient taking anticoagulants/Aspirin/NSAID? No Yes, what medication?: _____

Hold Medications as follows: Aspirin 36 hrs; NSAIDS 24 hrs; Enoxaprin (lovenox) 12 hrs; Plavix (clopidogrel) 7 days

If yes, who will tell patient to stop? _____ When? _____ Hx liver dysfunction/coagulopathy?

Lab Work:

Not necessary Done Date drawn: ____ / ____ / ____ Where?

Referring Physician to do **Last resort:** to be done on admission (**have patient arrive 2 hours early**)

PT/PTT: ____ / ____ INR: _____ PLATELETS: _____ H/H: ____ / ____

Type & Cross: _____

Patient Position for Procedure: Supine Prone Decubitus Side of

Lesion: R L

For Tumor Ablation: RF: Microwave: Cryo: Other: _____

Scheduled Date: ____ / ____ / ____ Time: _____

Resident & Attending Approving Procedure: _____ Today's Date: ____ / ____

Radiology Procedure Data Sheet

Pt. Name: _____

MR #: _____

Anesthesia: 1. Local 2. Conscious Sedation 3. General

Patient Location: 1. Inpatient 2. Outpatient 3. W&I

Fellow: 1. Caiati 2. Husain 3. Iafrate 4. Singh 5. Resident

Radiologist: 1. Atalay 2. Cronan 3. Dupuy 4. Haas 5. Mayo 6. Murphy 7. Pezz 8. Ridlen

9. Other: _____

CA History: 1. No known primary 2. Lung 3. Breast 4. Colon 5. Pancreas 6. Cervix 7. Ovarian

8. Endometrial 9. Lymphoma 10. Prostate 11. Renal 12. Other: _____

Procedure DATE: ____ / ____ / ____ **CT Fluoro time:** _____ seconds **CT Room**

time: _____ min

I. BIOPSY

Pre Bx Probability of CA: 0 (defin. not) 1 (prob not) 2 (equivocal) 3 (prob malignant) 4 (defin. malignant)

Biopsy Site: 1. Neck 2. Thyroid 3. Lung 4. Mediastinum 5. Liver 6. Adrenal 7. Renal 8. Pancreas

9. Retroperitoneal Node 10. Spine 11. Pelvic Node 12. Bone 13. Other: _____

Lesion Size: <1 cm 1 cm 2 cm 3 cm 4 cm >4 cm

Lesions Present: 1. 2. 3. 4. >4

Needle Type: 1. Franseen 2. Temno (20/18G) 3. Biopsy Gun (18G) 4. Coax Lung (19/21) 5. Ackerman (14)

BX Needle Size: 14g 16g 18g 19g 20g 21g 22g Other _____

Passes: 1. 2. 3. 4. >4 **Technique:** 1. Coaxial 2. Tandem **On Site Cytopath:** 1. No 2. Yes: + 3. Yes: -

II. DRAINAGE

Procedure type: 1. Aspiration 2. Drainage **Technique:** 1. Trocar 2. Seldinger

Location: 1. Neck 2. Pleural space 3. Lung 4. Liver 5. Pancreas 6. Spleen 7. Renal

8. Diverticula

9. Pelvis 10. Spine 11. Extremities 12. Other: _____

Etiology: 1. Postop 2. Diverticula 3. Immunocompromised 4. Other: _____

Catheter Size: 8F 10F 12F 14F 21F Other: _____ **Number of**

Catheters: 1 2 >2 **Aspirate Vol #1:** _____ **Vol #2:** _____ **Infection:** Yes

No **Cavity Collapse:** Yes No

III. TUMOR ABLATION

(circle type →) 1. RF

2. Cryo 3. Microwave

4. ETOH

Site: 1. Neck 2. Lung 3. Liver 4. Node 5. Spine 6. Bone 7. Renal 8. Other: _____

Lesions Treated: 1. 2. 3. 4. >4 **Max dimension** (of each lesion) lesion 1. _____ lesion 2. _____

Probe Type: 1. Single 2. Triple **# of Probes:** 1 2 3 4 5 6 >6 **Tip Length:** 1cm 2cm 2.5 cm.(cluster only) 3cm

Treatments per lesion: _____ **Avg Imped (ohms)** _____ **Avg Current (amps)** _____ **Avg Power (watts)** _____

Average T max: _____ **Average Treatment Time:** _____ (min) **Thaw Time (cryo) :** _____ **Vol.**

(etoh) _____

IV. OTHER PROCEDURE

Type: _____

V. COMPLICATIONS

1. None 2. PTX (no tube) 3. PTX (+tube) 4. Bleed 5. Patient Admitted 6.

Other: _____

VI.

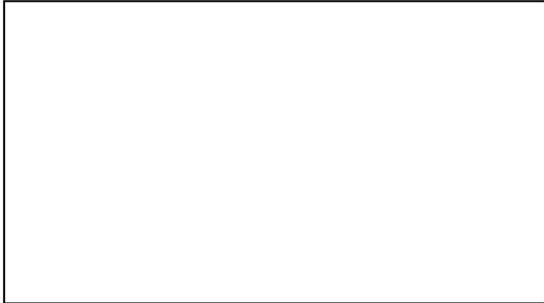
COMMENTS: _____

_____ 7/05

Post procedure discharge sheet:



Rhode Island Hospital
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Department of Diagnostic Imaging

POST PROCEDURE INFORMATION SHEET

You have had a needle biopsy/fluid aspiration of your _____ using CT / Ultrasound guidance today.

You should resume all of your normal medications after this procedure and you may use acetaminophen (Tylenol) as a pain reliever. You should not have alcoholic beverages for 24 hours. Clear liquids, such as apple juice, ginger ale, and water are best tolerated, and should be encouraged. Gradually advance from liquids to a regular diet. If vomiting occurs, take nothing by mouth for two hours, or until a sensation of hunger is felt. You may shower 24 hours after the procedure and resume normal activity tomorrow as pain permits. No operation of potentially dangerous equipment, such as power tools, automobiles, etc. for 24 hours. *You should contact your referring doctor for the results of this test.*

We do not anticipate any major problems after your procedure, however with any invasive procedure there is always a small risk of complication. If within 24-48 hours you have persistent nausea and vomiting, persistent drowsiness, develop increased pain, skin redness, fever or shortness of breath or you have any other concerns, please contact us without delay. If these symptoms are severe, you should go to the Emergency Department. Please bring this sheet with you as this is important information to provide to the physician on duty.

Our daytime telephone number is 401-444-8392 (CT) or 401-444-5309 (Ultrasound). Please ask to speak to the radiologist at this number. If any of these symptoms develop after 5 PM you may call the interventional radiologist through the page operator at (401) 444-5611.

We will be calling you after the procedure to see how you are doing. The number you would like to be called at is _____.

Please check one of the following:

_____ I prefer not to be called.

_____ Please leave a message (on voice mail or with family member) if I am unavailable.

_____ Please do not leave a message if I am unavailable.

Physician Signature

Patient Signature

Date

The RIH CT Policy for Contrast Administration and Catheter size/type, (4-07):

Types of intravenous contrast

- Omnipaque 350 will be used on all adult patients needing iv contrast.
- Visipaque 320 will be used for patients with decreased renal function. The Radiologist will protocol when a patient will receive Visipaque 320.
- Visipaque 320 is also used, by protocol, for ct scans of the heart. (cardiac cta and pulmonary vein mapping)
- Omnipaque 300 will be used on all pediatric patients needing iv contrast. The contrast volume for pediatric patients is determined by 1cc of iv contrast per pound of patient's body weight for patients less than 100 pounds. Pediatric patients weighing over 100 pounds will receive the adult contrast volume of Omnipaque 300.

CT Scan Peripheral IV Access Policy

- Omnipaque 300/350 intravenous access requirements:
 - Injection rate of up to 2.4cc/second: 22 gauge or larger
 - Injection rate of 2.5cc/sec to 4cc/second: 20 gauge or larger
 - Injection rate of 4.1cc/sec or greater: 18 gauge or larger
- Visipaque 320 intravenous access requirements:
 - Injection rate of up to 3cc/second: 20 gauge or larger
 - Injection rate of 3.1cc/sec or greater: 18 gauge or larger

CTA Scan Peripheral Intravenous Access Policy

- A 20 gauge or larger IV in an antecubital vein is preferred to perform a CTA study. Exceptions can be made at the discretion of the radiologist and technologist if a patient's current iv access can yield a quality study without reducing the injection rate.
- The rationale is to prevent extravasation and poor quality exams from inadequate intravenous lines.

CT Scan Adult Patient Central Line Policy

- It is the policy of the CT department to establish, whenever possible, adequate peripheral iv access. Central lines will be used only when our own peripheral iv access cannot be attained.
- If a nurse accompanies the patient, always defer to her/him as to which line to use for an iv contrast injection. There are some lines that cannot be used at all.
- If a patient needs to have a port-a-cath accessed and the clinic is unable to do it, then a Radiologist can access the port. Access kits are available in the CT department for this purpose.
- All iv contrast injections will be monitored for as long as possible prior to the start of the scan.
- If there is any question or concern regarding the use of a central line, consult a Radiologist.

Types of Central Lines in Adult Patients at Rhode Island Hospital

- **Port-a-cath / perm-a-cath / Hickman catheter:** These are generally found in the chest, however there are some versions that are placed in a patient's arm. A Hickman catheter is identifiable by its white color and usually has one or two ports. A port located in the patient's arm cannot be used for an iv contrast power injection. Only hand injections can be used with a port-a-cath, perm-a-cath, or Hickman catheter. Port-a-cath, perm-a-cath, or Hickman catheters cannot be used for CT angiography. Any implanted venous access device on adult patients should be accessed, flushed and deaccessed as described in Rhode Island Hospital Nursing Practice Manual, File K-7. The flush of heparinized saline is 5cc, 100 units/mL.
- **Swan-Ganz catheter:** These are identifiable by their yellow colored sheath. This catheter can sometimes go into a pulmonary artery. Never use a Swan-Ganz port that goes into a pulmonary artery. This port is identified on its outer tubing by the letters "PA". If iv contrast is injected directly into a pulmonary artery, flash pulmonary edema can occur. Usually, the blue "CVP" line can be used for iv contrast injection. When performing routine diagnostic contrast CT scans, an injection rate of 2cc/sec will be used. When performing CT angiography, an injection rate of 3cc/sec will be used.
- **Triple lumen catheter:** These can be located in the neck, chest or groin. They are identifiable by their three ports on the outer end of the catheter. The colors of the ports are blue, brown, and white. If possible, use a port that is not being used for anything else. When performing routine diagnostic contrast CT scans, an injection rate of 2cc/sec will be used. When performing CT angiography, an injection rate of 3cc/sec will be used.
- **PICC lines:** These can be found in both adult and pediatric patients. They are located in the patient's arm. PICC lines can never be used for power injection or hand injection. PICC lines are too small and easily ruptured.
- **Power PICC lines:** These can be found in adult patients and are approved for power injections. These are located in the patient's arm. Power PICC lines have two or three ports. One of the ports has purple tubing with a red end. The purple and red port can be used for CT scans. Power PICC lines can be injected up to a rate of 5cc/sec at a maximum of 300psi. The port for injection is labeled "5ml/sec MAX" directly on the clamp. Prior to and after each contrast power injection, the Power PICC is to be checked for patency via flushing with a 10cc normal saline. Do not proceed with power injection if complete catheter patency cannot be established.
- **Morpheus CT PICC lines:** These can be found in adult patients and are approved for power injections. These catheters can only be relied upon for CT studies with an injection rate of up to 4cc/second. Use **only warm contrast** when injecting through a Morpheus line. These are located in the patient's arm. Morpheus CT PICC lines may have a single port or a double port. Angio Dynamics states Morpheus CT PICC lines can be injected up to a rate of 6cc/sec at a maximum pressure of 250psi only if the iv contrast is warmed to body temperature. They also require that the catheter be flushed with heparinized saline after each use. The port for injection is labeled "6ml/sec" directly on the tubing. Prior to and after each contrast power injection, the Morpheus CT PICC

- is to be checked for patency via flushing with a 10cc normal saline. Do not proceed with power injection if complete catheter patency cannot be established.
- **Arterial lines (A lines):** These can never be used for any form of contrast injection.

CT Scan Pediatric Patient Central Line Policy

- It is the policy of the CT department to inject iv contrast through adequate peripheral iv access whenever possible. Central lines will be used only when peripheral iv access cannot be attained.
- Pediatric patients 14 years old and up **with adult sized central lines**, can have their central lines used as per the adult policy.
- Children 14 years old and under should only have central lines used if no peripheral iv access is available. If a central line needs to be used on a pediatric patient in this age category, only hand injections of iv contrast should be performed.
- The **iv contrast should always be warm** whenever performing a hand injection in an effort to reduce contrast viscosity.
- If a nurse accompanies the patient, always defer to her/him as to which line to use for an iv contrast injection. There are some lines that cannot be used at all.
- If a patient needs to have a port-a-cath accessed and the clinic is unable to do it, then a Radiologist can access the port. Access kits are available in the CT department for this purpose.
- All iv contrast injections will be monitored for as long as possible prior to the start of the scan.
- If there is any question or concern regarding the use of a central line, consult a Radiologist.

Types of Central Lines in Pediatric Patients at Rhode Island Hospital

- **Port-a-cath / perm-a-cath / Hickman / Broviac catheter:** These are generally found in the chest, however there are some versions that are placed in a patient's arm. Hickman and Broviac catheters are identifiable by their white color and usually have one or two ports. A port located in the patient's arm cannot be used for an iv contrast power injection. Only hand injections can be used with a port-a-cath, perm-a-cath, Broviac, or Hickman catheter. Port-a-cath, perm-a-cath, Broviac, or Hickman catheters cannot be used for CT angiography.
- **PICC lines:** These can be found in both adult and pediatric patients. They are located in the patient's arm. PICC lines can never be used for power injection. PICC lines can be used for hand injections of iv contrast on pediatric patients.
- **There are four other central lines specifically used for pediatric patients:**
 1. 4 french, 8cm, double lumen. These lines are usually in babies less than 12 months old.
 2. 4 french, 13cm, double lumen.
 3. 5.5 french, 8cm, triple lumen.
 4. 5.5 french, 13cm, triple lumen.The four lines above can only have iv contrast hand injected through them. The 5.5 french lines are rated to have a maximum flow of 1300cc of saline/hour.

This translates to .36cc of saline/second. Therefore, only hand injections of iv contrast are permitted.

Accessing a Central Venous Catheter for Intermittent Infusion

(From Rhode Island Hospital Nursing Practice Manual, File C-53)

- Perform hand hygiene, using alcohol based gel and hand washing.
- Don non-sterile gloves. This is not a sterile procedure.
- Wipe the injection cap with alcohol. Cleanse using friction for 1 minute with each of three alcohol wipes. Allow residual alcohol to dry.
- Attach a 10 mL syringe of normal saline to the injection cap. Aspirate for blood return and flush.
- Connect iv contrast tubing access device to the injection cap.
- When the iv contrast injection is completed, disconnect tubing.
- Alcohol wipe injection cap, and flush with 10 mL normal saline.
- If a flush of heparinized saline is required, the patient's nurse should flush the line with heparin using positive pressure to prevent reflux of blood into the catheter.



Rhode Island Hospital

A Lifespan Partner

Consent for Imaging Studies Using Ionizing Radiation

During Pregnancy

Dr. _____ is requesting the following imaging
referring physician
study __ which uses radiation to
study to be performed
evaluate _____. Because you are pregnant, we
indication

would like you to understand what we know about the effects of the imaging study on you and your baby and need your consent before performing this exam. A patient information sheet that explains some of the risks from radiation in pregnancy is located on the back of this consent.

The following checked items apply:

- You and your baby will be exposed to low levels of radiation. This imaging study uses low doses of radiation and the risks from this test are much smaller than the normal risks of pregnancy. This examination might slightly increase the possibility of cancer later in my child's life, but the actual potential for a healthy life is very nearly the same as that of other children. The imaging study does not add to risks for birth defects. Birth defects occur in small numbers of pregnancies even without exposure to radiation.
- You will be given intravenous contrast during the scan. The FDA has not confirmed the safety of this contrast in pregnancy. Intravenous contrast can cross the human placenta and enter the fetus when given in usual clinical doses, but no well-controlled studies of the effects of this media have been performed in pregnant women. Tests in animals have shown no evidence of increased cancer or birth defects.

I understand this document and have had the opportunity to have my questions answered. I am aware that the practice of medicine is not an exact science and I acknowledge that no guarantees have been made to me regarding the outcome of this pregnancy. I agree to have the imaging study performed.

Patient's Name (printed)

Patient's Signature

Patient's Agent or Representative
(If patient unable to consent)

Relationship to Patient

Date Signing: _____, 20____ Time: _____ A.M./P.M.

Physician's Acknowledgement

The undersigned confirms that informed consent, as described above, has been given by the patient. I have also discussed the possible need for contrast including the potential risks, benefits and consent was obtained.

Referring Physician's Signature

Emergent situation precluded obtaining written informed consent.

Emergency

Rationale: _____

Please fax a copy of this form to Medical Physics at 444-4446, and place a copy in the patient's chart.

Rhode Island Hospital

Patient Information Sheet for Radiation Risks in Pregnancy

Your doctor has recommended that you have an imaging study to help in your care. Pregnant women may be concerned that radiation from these tests could harm the baby in some way. There is no specific amount of x-ray radiation that is totally free of adverse affects, so risks can never be said to be zero, however, in your case, the amounts of radiation used to make the pictures is very small. Common imaging studies use low doses of radiation and the risks from these studies are much smaller than the normal risks of pregnancy. The imaging study your doctor has ordered might slightly increase the possibility of cancer later in the child's life, but the actual potential for a healthy life is very nearly the same as that of other children. The imaging study does not increase the risk of birth defects.

Birth defects occur in 1 in 33 (3.0%) of all babies at birth, and cancer occurs in 1 or 2 in 1,000 children. Therefore a small percentage of all babies will have or will develop one of these problems whether the imaging study is performed or not. We can never guarantee that a baby will not have any of these problems. What we can say is that the chance of one of these problems occurring is not significantly increased by most of the examinations that we use for diagnosis. We would not recommend this study unless we felt that the information we will get from it is necessary to give you the best possible care.

Radiation Risks in Perspective

The millisievert (mSv) is the measurement used to assess the amount of radiation. Each year, people who live in New England are exposed to about 3 mSv of radiation from naturally occurring sources including radon and cosmic rays.

The following are the approximate radiation doses to the mother from common radiology examinations:

Chest X-ray	0.1 mSv
Mammogram	0.4 mSv
Head CT	2 mSv
Chest CT	10 mSv
Abdomen or Pelvis CT	10 mSv each

The largest dose of 10mSv may be taken to have a risk to the mother that is comparable to the risk of dying in an automobile accident when driving a distance of ~8,000 miles.

References:

1. ACR Practice Guidelines for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation- 2008 (Res. 26)
2. Cohen and Lee, "A Catalogue of Risks," Health Physics, vol. 36, June 1979
3. Centers for Disease Control and Prevention (CDC). Birth Defects: Frequently Asked Questions July 18,2007
4. American Cancer Society: Cancer Statistics 2008