Canadian Association of Radiologists
L'Association canadienne des radiologistes

## PEER-TO-PEER GUIDE

# TRANSITION TO RADIOLOGY RESIDENCY

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# RESIDENCY TIPS AND TRICKS

Welcome to radiology! Transitioning into radiology rotations can be challenging and quite a different experience compared to first year off-service rotations. Here are some tips and tricks from your colleagues to help get you started.

## IN GENERAL

- Get enough sleep and bring healthy snacks
- Prioritize and make time for the important things (hobbies, sports, etc) and people in your life
- Ask questions and seek help from your senior residents
- If you are feeling overwhelmed or stressed, your program administrators, program directors, fellow residents and staff are here to help. Resources are available through your university, hospital, and provincial resident house staff organization to help you through this transition.

## AT WORK

- Take breaks to go for a quick walk during the day
- Take time to adjust your chair, arm rests, and workstation before starting each day
- If there are adjustable workstations, try standing to dictate
- Don't be afraid to say, "I don't know." You are not expected to know everything on day one of a new rotation!

# COMMON ON-CALL PATHOLOGIES

Before starting your call shifts, take time to focus your reading and preparation around the following common pathologies and tests. As you move through your shifts, you can add to this list and tailor your reading appropriately.

### BODY CT

- Appendicitis
- Bowel Obstruction
- Colitis
- Diverticulitis
- Pancreatitis
- Renal Colic
- Trauma

### CHEST CT

- Acute Aortic Syndromes
- Pulmonary Embolism
- Trauma
- Infection

### NEURO CT

- Acute Spine Injuries
- Acute Stroke
- Intracranial Hemorrhages
- Vascular Dissection
- Trauma

### ULTRASOUND

- Appendicitis
- Cholecystitis
- Ectopic Pregnancy
- Orchitis/Epididymitis
- Ovarian Torsion
- Urinary Calculi
- Testicular Torsion

### FLUOROSCOPY

- Upper GI series for esophageal perforation or anastomotic leak
- Joint aspiration for septic joint
- Plain film for pneumonia, pulmonary edema, pneumothorax, pneumoperitoneum, and common fractures

### MRI

- Epidural Abscess
- Spinal Cord Compression
- Acute Appendicitis in Pregnancy

# INTRODUCTION TO RADIOLOGY DICTATIONS

| COMMON STRUCTURE | | | | |
|---|---|---|---|---|
| **CLINICAL HISTORY** | **TECHNIQUE** | **COMPARISON** | **FINDINGS** | **IMPRESSION** |
| Pertinent history and lab values | Anatomy, modality, slice thickness, imaging phases, reformats, etc. | Any studies used for comparison | Free form or structured reporting (some institutions use standard templates) | Summary, pertinent conclusions and recommendations |

## RECOMMENDED READING

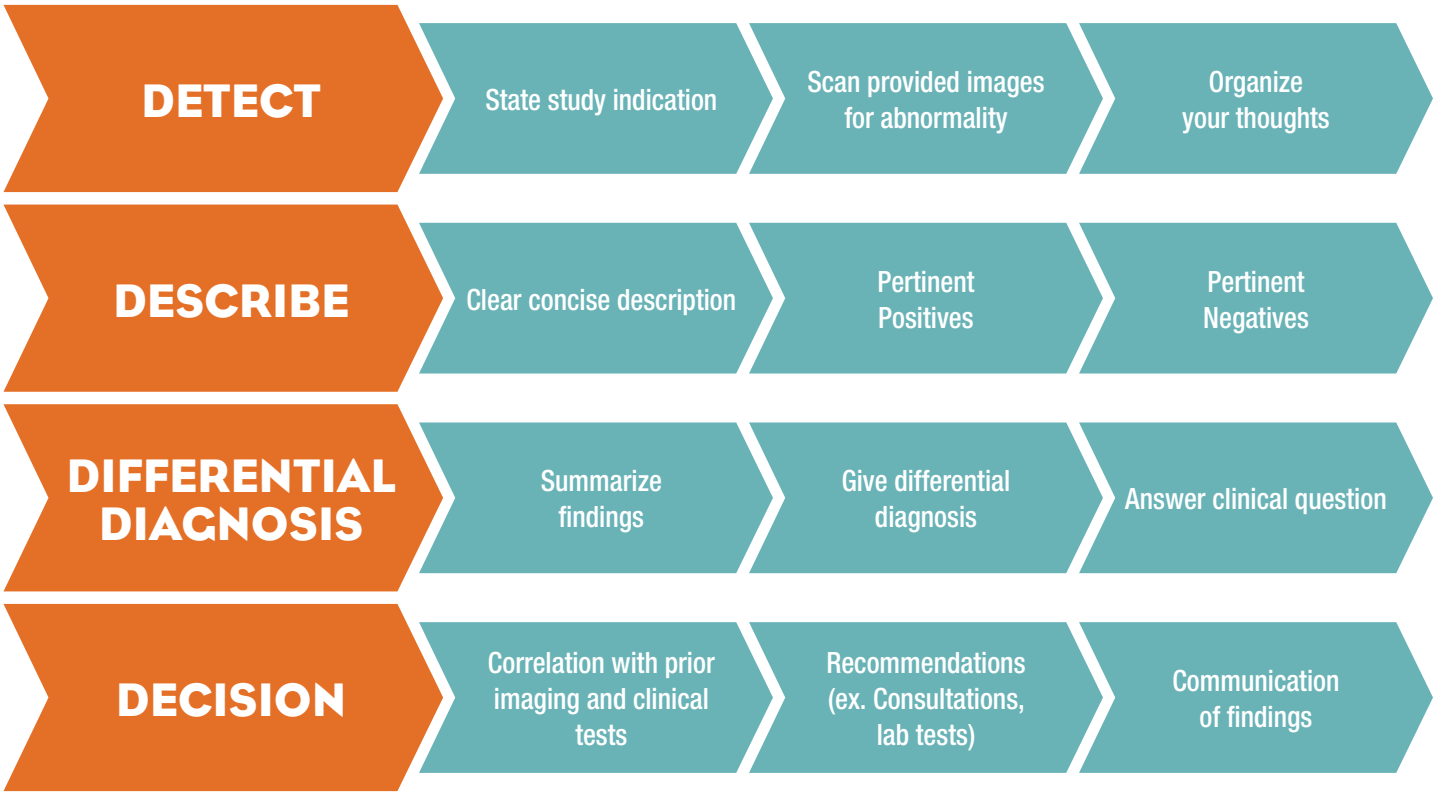
- Langlotz C. *The Radiology Report: A Guide to Thoughtful Communication for Radiologists and Other Medical Professionals*. CreateSpace; 2015.
- Coakley F, Liberman L, Panicek D. Style Guidelines for Radiology Reporting: A Manner of Speaking. *American Journal of Roentgenology*. 2003;180(2):327-328. **http://www.ajronline.org/doi/full/10.2214/ajr.180.2.1800327** Accessed May 11, 2017.
- **NOTE:** These two pieces of literature differ in opinion in some areas – use what you like

## HELPFUL TIPS

- Answer the clinical question in the impression when possible
- Avoid dictating large paragraphs and try spacing your text
- Describe the anatomical location of the abnormality as best you can
- Try not to hedge. If you need clinical correlation, try to find the relevant clinical information or speak with the ordering physician
- Remember that statements like, "this suggests...", "this likely represents...", "this is consistent with...", "this could represent...", all describe different levels of uncertainty – be careful which you use
- Structure your differential diagnosis with reasoning and in order of most to least likely
- Provide recommendations in your reports if appropriate (i.e. Consultations, further imaging)
- Don't be redundant
- Check your report to make sure there are no spelling mistakes
- Your impression should be considered the only thing the clinician will read or needs to read and should:
  - Answer the clinical question
  - Alert the clinician to any additional findings that require action
- One should never 'bury' anything in the body of the report that requires action and not put it in the impression; this is a common error.

In the end, every radiologist will develop their own approach. You will be taught different things throughout your residency; develop an approach that fits your style. These are just a few tips to start you off.

# PRACTICAL APPROACH TO TAKING CASES DURING ROUNDS



# LEARNING TO PROTOCOL STUDIES

Learning to protocol imaging studies is a continual process throughout residency. Over time, you will gain experience and feel comfortable with numerous inpatient, emergency, and outpatient study indications and their respective appropriate imaging modalities and protocols. This section will focus on learning to protocol on-call cases.

## PLAIN FILMS

X-rays are often an appropriate first line imaging study, especially for bone-centered pathologies.

## ULTRASOUND

There are few overnight on-call indications for ultrasound imaging, but this list is not exhaustive. Be sure to check with your home institution for any modifications to this list, as this list may differ from one institution to another.

### ADULT INDICATIONS

- Ectopic Pregnancy
- Torsion: Ovarian, Testicular
- Cholecystitis and Choledocholithiasis
- Appendicitis
- Organ Transplant-Related Indications (ex. immediate post-operative kidney transplant assessment)
- DVT*
- First Trimester Bleeds*
- Retained Products of Conception*

* Depending on your home institution, this may qualify as an overnight indication.

### PEDIATRIC INDICATIONS

- These are site specific and should be discussed with your home institution.

## COMPUTED TOMOGRAPHY (CT)

As radiology residents, we are the gatekeepers when it comes to performing CT scans overnight. It is imperative that we triage the urgency of each scan and determine the best imaging modality and protocol for the provided clinical indication. This often involves a discussion with the referring clinician to clarify symptoms and differential diagnosis prior to performing an imaging study.

CT protocolling can be divided into non-contrast and contrast-enhanced studies. Contrast administration includes: oral (PO), rectal (PR), intravenous (IV – peripheral or central venous access required) and miscellaneous (ex. through an ostomy, Foley or suprapubic catheter).

Transit of oral contrast through the gastrointestinal tract varies from one individual to another. Typically, oral contrast is administered in ‘short drinks’ (ex. 1 litre then imaged after 1 hour) and ‘long drinks’ (ex. 2 litres then imaged after 2 hours). Typically, oral contrast passes into the distal small bowel or proximal colon after 2 hours. In certain clinical scenarios, with a compliant patient, rectal contrast may be a suitable alternative.

Note that different institutions have subtle differences regarding how CT studies are performed (ex. volume of contrast, timing of study), but the general concepts remain the same and are as follows:

- Common Non-Contrast Study Indications:
  - High creatinine clearance or low glomerular filtration rate (check home institution for respective cut-off values)
  - If intravenous contrast is needed to answer the clinical question, it may still be appropriate to administer contrast despite renal function. This is institutionally dependent, and you should refer to your home institution's policies.
  - Iodine contrast allergy and cannot be pre-medicated
  - Assess for genitourinary stones
  - Assess for acute blood products

- IV Contrast-Enhanced Study:
  - The time of image acquisition post IV contrast administration is determined by the viscera/structures in question. The study can be tailored to scan the region of interest in the appropriate phases to best answer the clinical question
  - **TIP:** Take time to read about contrast-enhanced CT phases and the respective timing of each phase. Also, practice protocolling studies while on early rotations to get used to the indications and benefits of each phase

- Common PO and PR Contrast Indications:
  - Bowel obstruction*
  - Diverticulitis*
  - Intra-abdominal Abscess*
  - Trauma-related imaging to help exclude bowel perforation
  - Note that patients who cannot receive IV contrast due to clearance-related issues can still get PO/PR contrast. Patients with IV-contrast allergy can technically still get PO/PR contrast. However, many physicians tend to err on the side of caution and avoid contrast altogether, especially if IV-contrast leads to anaphylactic reactions.

    *Depending on your home institution, this may qualify as an indication to give PO/PR contrast

- Miscellaneous:
  - Via an ostomy
  - Via a Foley or suprapubic catheter, especially in trauma cases to assess for bladder injury (minimum of 250cc required to adequately distend the urinary bladder)

## MAGNETIC RESONANCE IMAGING (MRI)

- Gadolinium is the contrast agent for MRI

- Ensure the patient does not have an allergy and meets renal clearance requirements.

- At many institutions, MRI requests are approved by the fellow or staff physician on-call. They will help with protocolling and interpreting these studies while you are at a junior resident level. However, basic MRI sequences to become familiar include:
  - T1(with/without fat saturation)
  - T2 (with/without fat saturation)
  - Diffusion weighted imaging (DWI)
  - Post-contrast T1 fat saturated

- Broadly, on-call MRI indications are as follows (again, check with your home institution to verify the details of these indications):
  - Acute Stroke
    - This is particularly useful when there is a high clinical suspicion for acute posterior fossa stroke; the findings of which are not often seen on CT imaging
  - Spinal Cord Compression/Cauda Equina Syndrome:
    - Multiple causes for example: epidural collection (blood, abscess), neoplasm, metastases, and degenerative disc disease
    - Of note, if the clinical suspicion is on the background of a known primary malignancy, it is essential to scan the entire cervical, thoracic and lumbar spine
  - Cord Injury
    - Often in setting of trauma or immediate post-operative period
  - Acute Appendicitis (pregnant patient)
    - Equivocal ultrasound or appendix not seen on ultrasound

# CONTRAST MEDIA

## ADVERSE REACTIONS TO CONTRAST MEDIA

Adverse reactions to contrast media can range from mild symptoms to a severe anaphylactoid response. Consideration of the patient's risk profile prior to contrast administration may help mitigate this risk and determine which patients would benefit from premedication. In general, contrast medium administration for all patients should always be taken in the appropriate clinical context, considering the risks, benefits and alternatives.

### PATIENT-SPECIFIC RISK FACTORS FOR ADVERSE CONTRAST REACTIONS

- Allergies
  - History of prior reaction to contrast media is associated with up to 5-fold increased likelihood of subsequent reaction
  - Patients with a history of atopy are at a 2-3 times increased risk for an adverse contrast reaction (Note: no cross-reactivity between contrast and shellfish)
- Asthma
- Renal insufficiency
  - If intravenous contrast is needed to answer the clinical question, it may still be appropriate to administer contrast despite renal function. This is institutionally dependent, and you should refer to your home institution's policies.
- Significant cardiac disease (symptomatic angina or congestive heart failure, severe aortic stenosis, primary pulmonary hypertension, cardiomyopathy)
  - Consider limiting volume and osmolality of contrast media
- Anxiety

## PREMEDICATION

Premedication should be considered in those individuals who have had moderately severe or severe reactions to contrast media in the past. Oral administration of steroids is preferable to IV administration. **Prednisone and methylprednisolone** are equally effective. If possible, steroids should be given at least 6 hours prior to the injection of the contrast agent. Supplemental administration of an **H-1 antagonist** (e.g., diphenhydramine), orally or intravenously, may also help to reduce the frequency and severity symptoms. Refer to your institutional protocol on premedication for more information.

# MANAGEMENT OF ACUTE REACTIONS

For more information on acute reaction management in adults and children, please see ***ACR Manual on Contrast Media*** (version 10.2, 2016). The following table provides initial management suggestions for adult urticaria and bronchospasm.

| URTICARIA | BRONCHOSPASM |
|---|---|
| • No treatment needed in most cases<br>• Benadryl PO/IM/IV 25-50 mg<br>• If severe or widely disseminated: Epinephrine 0.3 cc (1:1000) IM | • Airway, breathing, circulation assessment<br>• Oxygen via mask<br>• Beta-agonist inhalers 2-3 puffs and repeat as necessary<br>• If unresponsive to inhalers, consider Epinephrine 0.1-0.3 cc (1:1000) SC/IM<br>• Call for assistance |

# CONTRAST-INDUCED NEPHROPATHY (CIN)

*From the ACR Manual on Contrast Media (2016) – Contrast-Induced Nephropathy in Adults*

### → Definition & Prevalence

Contrast-induced nephropathy (CIN) refers to the sudden deterioration in renal function caused by the intravascular administration of iodinated contrast media. Note that CIN **does not** occur with gadolinium administration. Recent studies suggest that CIN is much less common than previously believed. For example, in patients with a stable baseline eGFR ≥45 mL, IV iodinated contrast is not an independent nephrotoxic risk factor. Similarly, in patients with a stable baseline eGFR 30-44 mL, IV iodinated contrast media are either not nephrotoxic or rarely so.

### → Risk Factors

The general consensus is that the most important risk factor is **pre-existing chronic kidney disease**. Multiple other risk factors have been proposed including diabetes mellitus, dehydration, cardiovascular disease, diuretic use, advanced age, multiple myeloma, hypertension, hyperuricemia, and multiple iodinated contrast medium doses in a short time interval (<24 hours), although none of these have strong evidence for or against.

### → Risk Thresholds

There is no agreed-upon threshold of serum creatinine elevation or eGFR value at which the risk of CIN is considered so great that intravascular iodinated contrast media should not be administered. **However, if a threshold for CIN risk must be used, eGFR ≥30 has the greatest level of evidence**. In any patient, the risk of contrast administration must be weighed against the benefits, as failure to diagnose an important clinical entity can have serious consequences on patient morbidity and mortality.

### → CIN in Renal Disease

It is important to note that no serum creatinine or eGFR threshold is adequate to risk stratify patients with acute kidney injury (AKI) because the serum creatinine is unreliable in this setting. As a general rule, administration of iodinated contrast medium in patients with AKI should only be undertaken if the benefit to the patient outweighs the risk, as these patients are particularly susceptible to nephrotoxin exposure. Anuric patients with end-stage renal disease who do not have a functioning transplant kidney are not at risk for CIN because their kidneys are nonfunctional; therefore, they may receive intravascular iodinated contrast material without risk of additional renal injury. In those patients undergoing renal dialysis, there is no need for urgent dialysis after intravascular iodinated contrast medium administration unless an unusually large volume of contrast medium is administered.

### → Prevention

- Avoid use of contrast media when possible, especially in patients with a pre-existing AKI or severe chronic kidney disease (unless the benefits outweigh the risks)
- Opt for low osmolality contrast media over high osmolality contrast media
- Provide intravenous volume expansion prior to contrast medium administration with isotonic fluids i.e. Ringers lactate or 0.9% normal saline
- Use of sodium bicarbonate administration and N-acetylcysteine (NAC) as a preventative measure for CIN is controversial

### References

American College of Radiology (ACR) Committee on Drugs and Contrast Media. *ACR Manual on Contrast Media Version 10.2 (2016)*, Chapter 9: Post-Contrast Acute Kidney Injury and Contrast-Induced Nephropathy in Adults. **https://www.acr.org/Quality-Safety/Resources/Contrast-Manual** Accessed May 11, 2017.

Owen RJ, Hiremath S, Myers A, Fraser-Hill M, Barrett B. *Consensus Guidelines for the Prevention of Contrast Induced Nephropathy*, 2011. **http://www.car.ca/uploads/standards%20guidelines/20110617_en_prevention_cin.pdf** Accessed May 11, 2017.


# RADIATION SAFETY

Radiologists are responsible for ensuring patient safety during imaging studies that utilize ionizing radiation. Ultimately, the benefits of the examination should outweigh the potential hazards. The acronym **ALARA** – "As Low As Reasonably Achievable" – is often used when discussing radiation safety as a reminder that radiation exposure should be limited to only that which is necessary to obtain the appropriate diagnostic study. In addition to protecting patients, radiologists also have a key role in protecting themselves and other health-care professionals.

The purpose of this section is to serve as an overview of basic radiation safety concepts for residents. More detailed information on minimizing radiation risk can be found on the **Image Wisely** website (**http://www.imagewisely.org/**), or Image Gently (for Pediatrics, **http://www.imagegently.org/**).

## BACKGROUND & DEFINITIONS

- **Absorbed Dose [Grays (Gy)]:** The amount of radiation absorbed per unit mass, which depends on the material or tissue in the radiation field.
- **Equivalent Dose [Sieverts (Sv)]:** The product of the absorbed dose and a specific radiation weighting factor that takes into account the effect that a specific type of radiation has on the tissues.
- **Effective Dose [Millisieverts (mSv)]:** Reflects the sensitivity to radiation of different organs and tissues in order to estimate the overall risk associated with the imaging procedure.

While the type of radiation used and overall dose is important, the **radiosensitivity** of the tissue also plays a key role in determining the possible side effects. For example, bones and soft tissues are much more resistant to radiation exposure than the glandular tissues of the breast or thyroid. So, special care should be taken to minimize radiation to these areas.

## EFFECTS OF RADIATION EXPOSURE

The effects of radiation exposure can be divided into two categories: non-stochastic (or deterministic) and stochastic. The differences are outlined in the table below.

| NON-STOCHASTIC (DETERMINISTIC) EFFECTS | STOCHASTIC EFFECTS |
|---|---|
| • Severity increases with dose | • Cumulative effect over time |

The primary risk associated with exposure to ionizing radiation is **cancer induction**. It is estimated that approximately 1 in 1,000 individuals will develop cancer from an exposure of 10 mSv; this is relatively small compared to the risk of developing cancer from all other causes. Radiation-induced cancer has a **latency period of 10-20 years** or more, so those with a greater life-expectancy (i.e. children) are at greater risk.

# RADIATION RISK ASSOCIATED WITH COMMON IMAGING EXAMINATIONS

The **ACR Appropriateness Criteria** is a useful reference designed to guide physicians in selecting the most appropriate imaging test for a specific clinical question. The **relative radiation levels**, which is based on the effective dose, can be used to compare the relative risk of different imaging examinations (see table below – from the ACR Appropriateness Criteria).

| Relative Radiation Level* | Adult Effective Dose Estimate Range | Pediatric Effective Dose Estimate Range | Example Examinations |
|---|---|---|---|
| 0 | 0 | 0 mSv | Ultrasound; MRI |
| ☢ | <0.1 mSv | <0.03 mSv | Chest radiographs; Hand radiographs |
| ☢☢ | 0.1-1 mSv | 0.03-0.3 mSv | Pelvis radiographs; Mammography |
| ☢☢☢ | 1-10 mSv | 0.3-3 mSv | Abdomen CT; Nuclear medecine bone scan |
| ☢☢☢☢ | 10-30 mSv | 3-10 mSv | Abdomen CT without and with contrast; Whole body PET |
| ☢☢☢☢☢ | 30-100 mSv | 10-30 mSv | CTA chest abdomen and pelvis with contrast; Transjugular intrahepatic portosystemic shunt placement |
| *The RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, the region of the body exposed to ionizing radiation, the imaging guidance that is not used, etc.). The RRLs for the examinations are designated as "Varies". | | | |

## SPECIAL POPULATIONS

### CHILDREN

Radiation-induced cancer mortality risk in children is 3 to 5 times higher than adults due to their increased tissue radiosensitivity and longer life expectancy. The latency period for radiation-induced malignancy varies, but is approximately 10 years for leukemia and longer for solid tumors. Care should be taken to select the study with the lowest possible dose of radiation and to utilize pediatric-specific protocols whenever possible.

### PREGNANCY

Establishing the pregnancy status of female patients is imperative prior to exposing the patient and embryo/fetus to ionizing radiation. Potential radiation-induced effects on the fetus include prenatal death, intrauterine growth restriction, reduced IQ, organ malformation, and childhood cancer. The probability of these effects occurring is largely related to the fetal age at the time of the exam and the radiation dose. Alternatives that do not involve ionizing radiation should be considered (such as ultrasound imaging, if appropriate). Certain imaging exams can be safely performed, as there is minimal fetal radiation (plain films of the chest or extremities, CT head or chest). For imaging studies that involve directly irradiating the abdomen and pelvis, measures should be taken to reduce the overall dose; this could include adjusting scan parameters and avoiding dual-pass studies.

### Protecting Yourself

Appropriate measures should be taken to protect yourself and other members of the medical team that are involved in image acquisition. Maintaining a safe distance from the radiation source and wearing appropriate protective equipment (i.e. lead aprons), can help reduce your exposure.

### References

American College of Radiology (ACR). *ACR Appropriateness Criteria*. 2017. **https://www.acr.org/Quality-Safety/Appropriateness-Criteria** Accessed May 11, 2017.

American College of Radiology. *ACR-SPR Practice Parameter for Imaging Pregnant Patients*. 2013. **https://www.acr.org/~/media/9E2ED55531FC4B4FA53EF3B6D3B25DF8.pdf** Accessed May 11, 2017.

# RESOURCES

## FREE RESOURCES

**Radiology Assistant** (**www.radiologyassistant.nl**):
- High-yield radiology topics that are easy to understand and read
- Diagrams and tables to explain concepts

**Radiopaedia** (**www.radiopaedia.org**):
- Great for quick synopses of pathologies
- Images to demonstrate findings (some of which you can scroll through)
- Cases with detailed explanations and answers

**Radiology Masterclass** (**www.radiologymasterclass.co.uk/tutorials/tutorials**):
- General primer for starting radiology
- Interactive images including annotations

**HeadNeckBrainSpine** (**www.headneckbrainspine.com/index.php**):
- Interactive multi-planar CT/MRI neuroanatomy
- Cases with detailed explanations and answers
- Quiz mode to test your anatomy

**HeadAndNeckRad** (**www.headandneckrad.com**):
- Developed at the University of Toronto
- Multi-planar CT/MRI neuroanatomy
- Neuroradiology lectures
- Case of the month to test your knowledge

**Musculoskeletal MRI** (**www.freitasrad.net**):
- Multi-planar MRI musculoskeletal anatomy
- Helpful for learning anatomy and for senior rotations

**Interventional Radiology Procedures** (**pantry.ualberta.ca**):
- Developed at the University of Alberta
- Resource for image guided procedures throughout residency

## SUBSCRIPTIONS

**IMAIOS Anatomy** (**www.imaios.com/en/e-Anatomy**):
- Annual subscription with free modules to try out before purchasing
- Detailed interactive multi-planar anatomy with various options to display or hide certain systems (includes plain films, CT, and MRI)
- Helpful when trying to identify abnormal structures
- Quiz mode available

**StatDX** (**my.statdx.com**):
- Annual subscription, ***generally covered by your program***
- Detailed synopses of pathologies with images demonstrating pertinent imaging findings
- Helpful for call and for considering/ruling out differential diagnoses

**RADPrimer** (**www.radprimer.com**):
- Annual subscription, ***generally covered by your program***
- Detailed synopses of pathologies with images demonstrating pertinent imaging findings
- Subspecialty curriculums
- Repository of cases that are divided by subspecialty with explanations, percentage of individuals who got the question right, and annotations to explain the findings

## BOOKS

These books can be helpful resources while preparing for call shifts (not an exhaustive list):

- Webb, W. R., Brant, W. E. and N. M. Major (2014) *Fundamentals of Body* CT. Elsevier Canada.
- Hertzberg, B. S. and W. D. Middleton (2015) *Ultrasound: The Requisites*. Elsevier Canada.
- Mandell, J. (2013) *Core Radiology: A Visual Approach to Diagnostic Imaging*. Cambridge University Press.
- Schwartz, D. T. (2007) *Emergency Radiology: Case Studies*. McGraw-Hill Education.

*ON-CALL TEMPLATE* *Date:* *Staff On-Call (Body, Neuro, etc):* *PAGE: ___/___*

| MRN/ HOSPITAL RECORD NUMBER | PATIENT NAME | REQUESTING SERVICE | REQUESTING PHYSICIAN | PATIENT STATUS (INPT, ED, LOCATION) | STUDY | INDICATION/ HISTORY | RELEVANT PRIOR IMAGING? | ADDITIONAL INFO (BHCG, Cr, allergy to contrast?) | PROTOCOLED? ❑ | DICTATED? ❑ | DISCUSS WITH REFERRING PHYSICIAN (TIME, NAME) |
|---|---|---|---|---|---|---|---|---|---|---|---|
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*IMPORTANT PHONE NUMBERS (ER, techs, etc):*

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