Educational Exhibit Posters Chosen by the Annual Scientific Meeting Committee

In advance of the upcoming annual meeting of the Society of Interventional Radiology in Washington, DC, the program committee wishes to highlight the educational exhibit e-posters that will be presented. The posters were chosen using blinded review. Authors are congratulated for their contributions.

Daniel Sze, MD, FSIR
Chair, 2017 Annual Meeting Scientific Program

Abstract No. 581

Hepatic artery pseudoaneurysms: a pictorial review of different scenarios and managements

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PURPOSE: The focus of this educational exhibit is to present a pictorial review of the anatomical considerations and management in varied cases of hepatic artery pseudoaneurysms (HAPs) secondary to different etiologies. Special attention is given to troubleshooting HAPs with varied anatomical presentations.

MATERIALS: Hepatic artery pseudoaneurysm (HAP) is an unusual but serious complication of acute or chronic injury to the hepatic artery that can potentially be fatal. HAPs are classified as intrahepatic or extrahepatic. There are many etiologies of HAP formation, including trauma, iatrogenic, tumor, pancreatitis, inflammatory and idiopathic. Early detection and treatment is critical to decrease morbidity and mortality. Endovascular therapy is the preferred initial management. Different endovascular techniques can be utilized depending on anatomical considerations.

RESULTS: We present a pictorial review of singular cases of hepatic pseudoaneurysm with remarkable anatomical considerations and their management with different endovascular techniques (see table).

CONCLUSIONS: Clinical presentation and radiographic characteristics of HAPs. Explore endovascular techniques for the management of HAPs. Special considerations and troubleshooting for variant hepatic vascular anatomy.

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<th>Etiology</th>
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<td>Portal hypertension</td>
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<td>Idiopathic</td>
<td>Otherwise healthy male</td>
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Etiology          | Technique Used
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Trauma            | Gelfoam with intraprocedural cone-beam 3D CT imaging
Gunshot injury    | Coiling
Iatrogenic        | Onyx embolization
Post biliary drain placement | Coiling
Post ERCP         | Gelfoam
Hemorrhage        | Embozene
Post TACE         | N-Butyl cyanoacrylate
Portal hypertension | iCAST covered Stent
Otherwise healthy male | Coiling with sandwich technique

Abstract No. 582

Stenting as a first-line therapy for symptomatic acute phase ICA dissection: review and institutional experience

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PURPOSE: Review the evolving role of stent placement as a primary therapy for acute phase ICA dissection. Provide a pictorial review of cases performed at our institution and briefly outline techniques. Identify patients who are candidates for intervention.
**MATERIALS:** Internal carotid artery (ICA) dissection may be spontaneous, traumatic, or iatrogenic. While often asymptomatic, symptoms related to flow limitation and distal emboli may be present. Arterial dissections account for a significant portion of the strokes seen in young patients. Anticoagulation has been the mainstay of therapy in the past as the pathogenesis has been thought to relate primarily to thromboembolism. Although anticoagulation has a clear role in ICA dissection treatment, patients presenting with large vascular territory ischemia are candidates for stenting to restore flow and prevent infarct completion. A large randomized controlled trial has not been performed; however, systematic review of the literature and our own experience shows efficacy and safety.

**RESULTS:** Procedure details will include techniques for microcatheterization of the true lumen and subsequent stent choice and deployment. Our algorithm for patient selection is reviewed. Patients presenting with ischemic symptoms, but demonstrating penumbra on CT perfusion imaging are candidates for emergent endovascular intervention. Dual antiplatelet therapy is initiated following a bridge with a fast-acting agent such as Integrilin (eptifibatide). Excellent outcomes with reversal of symptoms such as hemiparesis have been achieved in some cases.

**CONCLUSIONS:** Patients with ICA dissection and ischemic symptoms who are found to have evidence of penumbra are candidates for emergent endovascular stenting. Although larger studies are needed, review of the literature and our own experience shows promising results with satisfactory safety and efficacy.

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**Abstract No. 583**

Off the beaten path: alternative access sites for endovascular recanalization

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**PURPOSE:** 1. To review the indications and rationale for performing alternative forms of access to perform or guide arterial recanalization. 2. Techniques include radial, brachial, popliteal, and pedal access. 3. To guide the reader through the anatomy, patient selection, interventional methods, benefits, and potential complications of these different access techniques. 4. Case examples will be presented to highlight the techniques.

**MATERIALS:** The conventional access point for performing lower extremity and pelvic arterial intervention is the common femoral artery. However, the failure rate in recanalizing chronic total occlusions (CTOs) approximates 20% from this approach for lower extremity intervention. In these cases (and even for primary intervention), alternative arterial access sites can be utilized to facilitate or perform endovascular recanalization.

**RESULTS:** A. Review of rationale for patient selection for different access sites for pelvic and lower extremity arterial recanalization. B. Graphic and radiographic guide to radial, brachial, popliteal, and pedal access, as well as various recanalization techniques, with case examples. C. Overview of relevant inventory for arterial recanalization via these access sites. D. Visual overview of outcomes and complications.

**CONCLUSIONS:** Ultrasound-guided arterial access via radial, brachial, popliteal, or pedal arteries provide alternatives or adjuncts to traditional access techniques for successfully treating lower extremity chronic total occlusions. Interventionalists treating peripheral arterial disease should be familiar with these techniques.

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**Abstract No. 584**

Midaortic syndrome: a rare cause of hypertension in children

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**PURPOSE:** To review the pathophysiology, clinical presentation, radiologic diagnosis and therapeutic management of mid aortic syndrome in children.

**MATERIALS:** Midaortic syndrome (MAS) is a rare cause of hypertension in children. It is characterized by significant stenosis of the mid abdominal aorta and is frequently associated with concomitant involvement of visceral (celiac and superior mesenteric) and renal arteries. The etiology of MAS is unclear and controversial.

**RESULTS:** Depending upon the site of vascular stenosis, the child may be asymptomatic or may present with uncontrollable hypertension with or without renal failure. Other clinical manifestations include lower limb claudication, headache, epistaxis, chest pain, cardiac failure and abdominal pain. If left untreated, MAS is associated with significant morbidity and mortality. Diagnostic images of MAS with Doppler ultrasonography, contrast-enhanced CT, and MRI are presented. Each imaging modality is correlated with the patient’s clinical presentation and diagnosis. The indications for treatment, timing, and rationale for various management strategies are discussed. The traditional therapeutic intervention is open surgical reconstruction with bypass grafting, however, depending upon the nature of the vascular involvement, percutaneous angioplasty with or without stenting may be performed. Finally, the specific procedural details and the goals of therapeutic options are reviewed.

**CONCLUSIONS:** Radiologic evaluation is critical for the diagnosis and development of patient-specific treatment strategy. Both, traditional open surgical bypass and newer endovascular techniques may be employed during the management of mid aortic syndrome. Open surgery is the primary treatment of choice; however, endovascular intervention may provide a safe and less invasive treatment option for patients with mid aortic syndrome.
Abstract No. 585

Inadvertent arterial puncture and arterial placement of the central venous catheter. The spectrum of iatrogenic complications

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PURPOSE: To review radiologic diagnosis and IR management of iatrogenic arterial injuries and catheterization during attempted central venous catheter placement.

MATERIALS: Central venous catheter placement (CVCP) is a common procedure in many clinical settings for a variety of indications. More than 5 million central venous catheters are inserted annually in the United States and are frequently delegated to the least experienced personnel. Therefore, many instances of unintentional puncture and catheterization of arteries have occurred. Its incidence ranges from 1% to 15%. Inadvertent arterial puncture is often without consequence. However, it can lead to catastrophic consequences- hemorrhage, thromboembolism causing major stroke, arteriovenous fistula and pseudoaneurysm, especially with large bore dilation and catheterization. Therefore, early recognition and prompt endovascular management is critical.

RESULTS: Imaging appearance of arterial injuries and inadvertent placement of the CVC in the arteries: carotid, innominate, subclavian, and brachial, are reviewed. Interventional radiologic (IR) management via endovascular approach include- placement of stents of different types with and without embolization of bleeding sites or tract. Evidence based review for selecting from various types of stents-covered, uncovered, self-expanding or balloon-expandable is investigated. Technical details of removing the catheters inadvertently placed in the arteries are depicted. The outcome of the procedures is reviewed.

CONCLUSIONS: Inadvertent insertion of central venous catheters in the arteries is an uncommon complication of CVCP, but is increasing in frequency in this era of aggressive medical care and lack of expertise of the operators. IR has a critical role in managing these complications using different tricks-of-the-trade: stenting with and without embolization.

Abstract No. 586

Femoral artery pseudoaneurysms: diagnosis and management

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PURPOSE: This educational exhibit aims to familiarize interventional operators with the risk factors, the diagnosis of, and the current and novel management of femoral artery pseudoaneurysms.

MATERIALS: The femoral artery is the vessel of choice for most endovascular arterial interventions. A femoral artery pseudoaneurysm (FAP) is a known complication and has been reported to occur in up to 6% after interventional procedures and up to 2% postdiagnostic catheterization. Independent risk factors associated with FAP are female gender, obesity, hypertension, the use of antiplatelet and/or anticoagulant therapy and faulty puncture techniques and puncture location.

RESULTS: FAPs can occur iatrogenically, after trauma, after catheterization, at the site of native artery and synthetic graft anastomosis and secondary to infection. Iatrogenic pseudoaneurysms occur when an arterial puncture does not seal, which allows arterial blood to enter the local surrounding tissues and form a pulsatile hematoma. FAPs do not have a fibrous wall and are encased by an outer layer of hematoma and the overlying soft tissues. It may present clinically as a pulsatile hematoma, a new thrill or bruit, or marked pain and tenderness. In addition, there may be hemodynamic instability particularly if the FAP is complicated. However, in many cases, FAPs may not be associated with any symptoms whatsoever. Femoral pseudoaneurysmal complications include rupture, distal embolization, local pain, neuropathy and local skin ischemia. Treatment options include ultrasound-guided compression and thrombin injection, stent repair, embolization and surgery. Risk mitigation and strategies for immediate management of these complications will be discussed.

CONCLUSIONS: Given the wide and expanding use of femoral artery access for diagnostic and for interventional procedures, familiarity with this common and potentially life threatening complication is essential.

Abstract No. 587

Technique, tips, and pitfalls of Supera® stent deployment in the superficial femoral and popliteal arteries

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PURPOSE: We review indications, proper vessel preparation, and optimal placement of the Supera peripheral stent system (Abbott Laboratories, Abbott Park, IL). Tips for deploying this unique stent will be discussed.

MATERIALS: Endovascular treatment of peripheral arterial disease (PAD) affecting the superficial femoral (SFA) and popliteal arteries has long been a challenge for interventionalists as these arteries are prone to heavily calcified, long segment disease or occlusion. Additionally, the distal SFA and popliteal artery are exposed to compression, bending, and stretching forces during daily activities which make stents placed in this region at risk for fracture and subsequent restenosis of the artery.

RESULTS: The Supera peripheral stent is a self-expanding Nitinol stent. Its interwoven wire construction provides increased radial strength, flexibility, and resistance to kinking and fractures-factors that are key for use in the SFA and popliteal artery across the knee joint. Appropriate stent sizing, predilation of the vessel, and deployment at the nominal length are important to maintain stent patency. Further, the Supera deployment system’s unique design first releases the distal end of the stent to contact the vessel and then the stent is deployed as the
Abstract No. 588

The management of symptomatic enlarged kidneys in adult dominant polycystic kidney disease with transcatheter arterial embolization: a systemic review

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**PURPOSE:** To perform a systemic literature review on the usage of transcatheter arterial embolization (TAE) to reduce renal volume prior to kidney transplantation, and to relief compression symptoms in adult dominant polycystic kidney disease (ADPKD).

**MATERIALS:** ADPKD is an autosomal dominant disorder that affects approximately 1 in every 400 to 1000 live births. ADPKD accounts for 5% of patients on dialysis in the United States, and 50% of patients with ADPKD will develop renal insufficiency requiring dialysis. Individuals present with increased renal volume measured on abdominal CT: increased renal volume has been shown to be prognostic of renal insufficiency risk. Due to increase in renal volume, patients who require kidney transplantation must reduce renal volume in order to increase room in the pelvic area, and decrease symptoms associated with compression. In this systematic review, we look at the efficiency of TAE in treating symptomatically enlarged kidneys to relieve compression symptoms, and to decrease renal size prior to transplantation.

**RESULTS:** PubMed, Web of Science, and Cochrane Library were searched for articles focused on the usage of TAE to reduce renal volume in symptomatic enlarged kidneys or prior to kidney transplantation. Literature reviews and case reports were excluded from analysis. Renal volume data were compiled, and meta-analysis was performed where applicable. Six papers in total satisfied the inclusion and exclusion criteria: four of which were retrospective chart review studies, and two were prospective observational studies. Significant renal volume reduction was observed by 12 months in all studies. Success of TAE was measured by renal volume and for relief of compression symptoms.

**CONCLUSIONS:** Overall, current studies conclude that TAE is an effective, and minimally invasive alternative to nephrectomy in reduction of renal volume and for relief of compression symptoms.

Abstract No. 589

Prostate artery embolization prior to prostatectomy in a high-risk patient

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**PURPOSE:** Present a case of prostatic artery embolization (PAE) as a means of preoperative risk reduction to mitigate blood loss in a high-risk patient. Preoperative, intraprocedural, and postoperative imaging will help illustrate the use of PAE prior to prostatectomy, with histologic specimens demonstrating embolic distribution and ischemic changes.

**MATERIALS:** Prostate artery embolization has historically been utilized as a means of controlling hemorrhage after surgery or biopsy. Recently, PAE has been proposed as an alternative treatment of lower urinary tract symptoms due to benign prostatic hyperplasia (BPH). Although transurethral resection of the prostate (TURP) remains the gold standard, several studies have been performed in recent years demonstrating that PAE is a viable treatment option. However, there is no documented case of PAE used for preoperative risk reduction. We report a novel application of PAE performed in a chronically anticoagulated Jehovah’s Witness prior to simple prostatectomy.

**RESULTS:** The patient is a 61-year old male with a history of BPH and lower urinary tract symptoms, including urinary retention and hematuria, eventually requiring an indwelling Foley catheter. He failed conservative medical management and surgical removal was desired. Due to chronic anticoagulation for atrial fibrillation and religious beliefs preventing intraoperative blood products, he was at high-risk to undergo surgery. After a multidisciplinary conference, preoperative PAE was employed as a means of risk reduction. One day prior to surgery, bilateral PAE was performed using 100-300 and 300-500 µm microspheres until stasis. Intraprocedural cone-beam CT was utilized to delineate the vascular anatomy and ensure targeted embolization. The following day, he underwent robotic-assisted simple prostatectomy with minimal blood loss. Pathologic specimens demonstrated ischemic changes and the presence of microspheres within the prostatic tissue, confirming a successful PAE.

**CONCLUSIONS:** Preoperative prostate artery embolization can be an invaluable tool to reduce the surgical risk in complex prostate surgeries, as well as offer surgical options to patients whose belief system precludes the use of blood products.

Abstract No. 590

Pulmonary arteriovenous malformation embolization: illustrative overview of the anatomy, indications, and procedure techniques

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**PURPOSE:** Review the anatomy, types, and methods of diagnosis of pulmonary arteriovenous malformations (PAVMs) Review the indications
and contraindications of PAVM embolization. Demonstrate the techniques of PAVM embolization using coils, nitinol vascular plugs, PTFE-coated nitinol plugs or combination of these with numerous case examples from our extensive institutional experience. Briefly review the outcomes of PAVM embolization.

**MATERIALS:** PAVMs can either occur sporadically (30%) or as a part of an autosomal dominant genetic disorder, hereditary hemorrhagic telangiectasia (70%). AVMs can be simple or complex with optimal visualization of all feeding arteries essential for complete embolization. Although large AVMs can cause cardiopulmonary symptoms from shunting, the primary indication for embolization is the prevention of paradoxical emboli. The tendency for progressive enlargement of native AVMs, 20% recanalization rates, and the possibility of new AVMs to develop after neighboring AVM embolization, make follow up of these patients essential.

**RESULTS:** Technological advances in imaging, catheters, and embolization materials have refined the procedure and challenged the “3-mm guideline.” We will focus on these novel materials and techniques that will assist the interventional radiologist. This will include a demonstration of catheters optimally designed to access the pulmonary artery and to select increasingly smaller caliber feeding arteries. Additional emphasis will be placed on a variety of embolic coils and plugs including when and how to deploy such devices and common pitfalls to avoid. We will highlight the unique considerations of working in the pulmonary arterial system including the use of anticoagulation and the prevention of iatrogenic air embolism. We will also briefly review the results of PAVM embolization using various different embolic materials.

**CONCLUSIONS:** PAVM embolization is often performed at tertiary care centers and, therefore, may be unfamiliar to many practicing interventional radiologists. We highlight unique considerations when performing this procedure and provide an overview of the recent advances in materials and methods that our institution has adopted.

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**Abstract No. 591**

Rectal artery embolization for hemorrhoid disease—emborrhoid: how I do it

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**PURPOSE:** List the indications of the superior rectal arteries (SRA) embolization. Describe the appropriate devices and tricks for the procedure. Identify the target arteries in the corpus cavernosum recti. Manage the anatomical variations and the anastomosis with the middle rectal arteries.

**MATERIALS:** Hemorrhoid embolization (emborrhoid) is emerging as an alternative technique to surgical treatment for chronic and disabling rectal bleeding. Symptoms are related to an increased arterial blood flow into the internal hemorrhoid cushions. The internal hemorrhoid network is known to be supplied principally by the terminal branches of the SRA, arising from the inferior mesenteric artery. First results about the emborrhoid procedure suggest that coil embolization of SRA is feasible, safe and effective.

**RESULTS:** A preprocedure clinical examination by a proctologist is very important to evaluate the stage of hemorrhoidal disease and to detect any anorectal tumor. Pre-embolization Pelvic Angio CT is useful to identify anatomical variations and atherosclerotic stenosis in order to prevent technical failure. Emborrhoid technique is performed using a femoral approach. After catheterization of the inferior mesenteric artery, the SRA are then catheterized with a microcatheter. Selective angiograms are useful to recognize the target vessels feeding the corpus cavernosum recti, and the anastomosis with the middle rectal arteries. Terminal branches of the SRA are occluded by micro-coils. The embolization should be as complete and distal as possible to restrict the reloads by middle rectal arteries. Technical success of this procedure has been reported in up to 90%.

**CONCLUSIONS:** Hemorrhoid embolization is technically feasible and safe. Coils placement is based on a good knowledge of the vascular anatomy of rectal arteries.

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**Abstract No. 592**

Interventional radiology onboard the Navy hospital ship USNS Comfort

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**PURPOSE:** Utilizing interventional radiology (IR) skills in nonideal conditions? War, disasters, mass casualty situations, and humanitarian missions that we can be prepared to handle with limited resources. How IR can contribute in trauma care, surgical morbidity mitigation and short in-patient stay. Success stories from the most recent US Navy humanitarian mission in Central America, South America, and the Caribbean highlighting what interventional radiologists can do beyond the closed doors of IR suites.

**MATERIALS:** This exhibit will give an overview of interventional radiology assets onboard the USNS Comfort hospital ship during US Navy Continuing Promise 15 humanitarian mission throughout Central and South America and the Caribbean. We discuss interesting IR cases performed on the ship and in the field with limited resources and successful outcomes as well as how this can be translated to disaster relief and warfighter support.

**RESULTS:** IR was found to be valuable in preventing intraoperative blood loss during surgery by utilizing preoperative tumor embolization prior to surgery. IR was also successfully utilized for gonadal vein embolization in patients with both pelvic venous insufficiency or symptomatic varicoceles. Having IR aboard the ship increased the treatment options and capabilities of surgical staff. IR-assisted pediatric surgical teams with esophageal dilatation in cases of esophageal stricture. The most unexpected benefit was utilization of the interventional radiologist’s understanding of anatomy and radiologic procedures in the field with a make-shift IR suite for medical site IR procedures.
CONCLUSIONS: Interventional radiology integrated into the suite of surgical capabilities of forward-deployed medical assets, is synergistically valuable. The treatment options levied by the IR team allow numerous interventions to be performed in concert with various surgical procedures. As previously demonstrated on prior missions aboard the USNS MERCY, the sister ship of the USNS Comfort, the presence of IR aboard US Navy hospital ships is an invaluable asset in a humanitarian setting.

Abstract No. 593
Advanced endobronchial mass causing unilateral lung atelectasis, treated with pulmonary arterial embolization as a palliative means of treating V-Q mismatch

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PURPOSE: 1) To discuss the pathophysiology and management of refractory hypoxemia in the setting of advanced lung neoplasm. 2) To discuss the concept of V-Q mismatch as a source of refractory hypoxemia and to present a case of a malignancy related V-Q mismatch in a terminally ill patient, which was treated via selective pulmonary artery embolization, improving ventilation. 3) To describe how pulmonary artery embolization can be integrated in the management algorithm of refractory hypoxemia in end stage lung cancer.

MATERIALS: Dyspnea is a critical issue in terminally ill cancer patients. 55.7% of patients with terminally ill cancer involving the lung experience dyspnea. The concept of refractory hypoxemia due to massive intrapulmonary shunting has been described previously. Redirecting pulmonary vascular flow to restore V-Q match has been reported in a single case report of a patient with refractory hypoxemia due to large invasive mucinous adenocarcinoma of the lung with a positive outcome.

RESULTS: In this exhibit, we present a case of an elderly male with unilateral endobronchial neoplastic disease of the right lung resulting in progressively worsening hypoxemia that required high percentage oxygen supplementation, likely from large V-Q mismatch. Right main pulmonary artery balloon occlusion resulted in increased arterial oxygen saturation from range of 80-85% to 90-95% while on 100% non-rebreather mask. Subsequent embolization of four basilar branches of the right lower lobe pulmonary artery with a combination of microcoils and 40%-cyanoacrylate (n-BCA) resulted in immediate transition from non-rebreather mask to nasal cannula. The role of pulmonary artery embolization will be discussed in the larger frame of current clinical management of refractory hypoxemia in lung cancer with reference to our institutional experience as well as published literature.

CONCLUSIONS: We present a novel use for treating V-Q mismatch in a patient with refractory hypoxemia from lung malignancy. Further literature review and clinical studies and may be beneficial to see how pulmonary artery embolization may be included in algorithms for palliative management of refractory hypoxemia.

Abstract No. 594
Imaging guidance in direct percutaneous embolization of visceral pseudoaneurysms

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PURPOSE: Due to a high risk of rupture, visceral pseudoaneurysms require treatment regardless of etiology. When endovascular approaches fail, direct percutaneous puncture of pseudoaneurysms has been shown to be a viable alternative. We present three consecutive cases of direct visceral pseudoaneurysm puncture after failed endovascular attempts. We discuss the imaging modalities employed in these situations, including the recent application of cone-beam CT (CBCT) with needle path overlay.

MATERIALS: Three patients underwent percutaneous embolization of pseudoaneurysms of the pancreaticoduodenal or hepatic arteries. In each case, endovascular embolization attempts failed due to the inability to cannulate or identify all significant feeding vessels. None of the cases were amenable to ultrasound guidance due to body habitus or overlying gas. One case employed fluoroscopic guidance using existing fiducial coils. In another case, percutaneous needle placement was performed during the attempted transarterial procedure using digital subtraction roadmapping. The third case utilized CBCT guidance with needle path overlay. Each case used a 21-gauge EchoTip trocar needle to directly puncture the pseudoaneurysm. Once direct puncture was confirmed, either Onyx embolic agent or Onyx in combination with coils was employed to abolish the pseudoaneurysm.

RESULTS: In all the cases, the pseudoaneurysm was successfully embolized and bleeding resolved. There were no significant complications due to the embolization procedures. In the case guided by CBCT, the patient recovered completely and was discharged to subacute rehabilitation. In the remaining two patients, one eventually succumbed to other medical issues and the other was transferred to palliative care.

CONCLUSIONS: Our experience supports the observation that direct puncture of pseudoaneurysms is a viable approach to pseudoaneurysm embolization. A number of imaging modalities are available to guide these procedures, including ultrasound, fluoroscopy, and CT. We believe that this is the first report of the application of CBCT in the embolization of a bleeding visceral pseudoaneurysm. We conclude that it is a useful addition to the imaging guidance options for this approach.

Abstract No. 595
Vascular closure devices: past, present, and future

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PURPOSE: Review manual compression technique as the gold standard. Discuss complications of femoral arteriotomy, leading to development
of vascular closure devices (VCDs). Analyze currently available active closure device VCDs and their mechanisms of action, techniques, patient selection, technical success rates, complication rates, and learning curves. Review the SIR “Quality Improvement Guidelines for Vascular Access and Closure Device Use.” Update on the most recently developed VCDs: efficacy, indications, complications

**MATERIALS:** Although manual compression is the “gold standard” for achieving hemostasis following femoral arteriotomy, its use is limited due to patient discomfort, required bedrest, and obesity. Therefore, vascular closure devices (VCD) were developed in the early 1990s as means to earlier ambulation, improved patient comfort, and potentially less complications. VCDs are categorized as active closure devices, compression assist devices, or topical hemostasis devices. Active closure devices either physically close the arteriotomy with sutures, clips or staples, or seal the arteriotomy site, with plugs, sealants, or gels. Compression assist devices provide external pressure directly on the arteriotomy site. Topical hemostasis devices are pads with procoagulant to accelerate hemostasis. We aim to provide an overview as well as review the current literature regarding active closure devices Angio-Seal, FISH, Mynx, Exoseal, Perclose, and StarClose. Additionally, newer devices, specifically for large-bore arteriotomy closure, will be discussed.

**RESULTS:** Since the publication of the SIR “Quality Improvement Guidelines for Vascular Access and Closure Device Use,” a new large meta-analysis, and a Cochrane Review evaluating VCDs have been published, demonstrating their safety and efficacy. Some newer literature demonstrates decreased risk of hematoma with VCD compared with manual compression.

**CONCLUSIONS:** There are many different types of VCDs, each with advantages, disadvantages, and individual risks. Newer devices are on the horizon with focus on large-bore arteriotomy closure. Manual compression remains the “gold standard.”

**Abstract No. 596**

**Nanomedicines and stem cells: a combinatorial approach to the treatment of peripheral arterial disease**

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**PURPOSE:** 1) To contextualize utilization of nanomedicines and stem cells to treat peripheral arterial disease (PAD) 2) To summarize delivery vehicles, therapeutic targets and routes of delivery that may be applied to treat PAD in an effort to improve amputation free survival 3) To present an overview of preclinical and clinical findings on nanoscale therapy for PAD 4) To discuss the applicability of nanomedicines and stem cells in the treatment of PAD.

**MATERIALS:** PAD is one of the most common complications of atherosclerosis and is estimated to affect 12-20% of the population >65 years of age in the US. Currently, endovascular interventions play a critical role in the treatment of PAD. However, patients with critical limb ischemia are often confronted with few options for revascularization. These patients may benefit most from the application of nano-based gene/stem cell therapies designed to promote robust angiogenesis.

**RESULTS:** Over the past 20 years, new therapeutic agents and targets have been exploited for the treatment of PAD. Pro-angiogenic genes and proteins are among the chief therapeutic targets. As important as the therapeutic agent, the delivery vehicle is also critical to treatment response. Nanoparticles (NPs) are emerging as a promising technology for the treatment of PAD; they can be optimized for passive targeting and/or tuned with PAD-specific ligands to direct therapy to the disease site. Stem cells, genetically engineered to express proangiogenic genes, have been exploited as delivery vehicles to treat cancer and in regenerative medicine. The application of stem cells to induce angiogenesis has been successful in preclinical studies and has the potential to become an alternative for PAD patients. Unfortunately, few nanomedicine-based platforms have made it to clinical trials. Here we also aim to delineate possible reasons for suboptimal results from prior clinical studies.

**CONCLUSIONS:** Endovascular interventions have the potential to become the preferred method of delivery for theranostics designed to treat PAD. Future work is required to optimize and design nanoscale therapeutics to provide robust neovascularization for patients who face the grim prospect of limb amputation.

**Abstract No. 597**

**Up in arms: upper extremity angiography: a pictorial Essay**

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**PURPOSE:** Review of normal and variant upper extremity arterial anatomy. Review common angiographic findings and diagnosis of upper extremity arterial conditions including ischemia, aneurysms, trauma, vasculitides, thoracic outlet syndrome, arteriovenous malformations, and arteriovenous fistulas. Review of potential endovascular therapies for upper extremity angiographic findings.

**MATERIALS:** Arterial disease in the upper extremities is less common than in the lower extremities leading to less familiarity with the typical imaging findings, diagnoses, and endovascular therapies. Additionally, there are unique pathologies that occur only in the upper extremities. Familiarity of these disease processes and therapy is crucial for the astute interventional radiologist.

**RESULTS:** This poster will start with a review of the normal and variant upper extremity arterial anatomy as it relates to the angiographer. Subsequently, this poster will provide a detailed pictorial essay of the most common upper extremity angiographic findings including background, angiographic images and key findings, as well as a review of the clinical or endovascular management. The review will start with ischemic pathology including acute ischemia, chronic ischemia, and ischemia of the digits—Raynaud’s disease. This will be followed by atherosclerotic disease, thoracic outlet syndrome, aneurysms, trauma, arteriovenous fistulas, vascular malformations, and neoplasms. The
final section will review the different types of vasculitis seen in the upper extremity arteries.

CONCLUSIONS: Upper extremity angiography is an important tool for the diagnosis and management of numerous vascular pathologies. It is imperative that interventional radiologists be comfortable with diagnosis, and when indicated endovascular therapy of these sometimes unique disease processes.

Abstract No. 598

Microfluidic bioreactors in interventional radiology

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PURPOSE: To review current and future applications of microfluidic bioreactors. To highlight the potential of lab-on-a-chip technology for drug discovery, creation of highly biomimetic disease state models, and emphasize interventional radiology (IR) applications.

MATERIALS: Advances in the field now allow for three-dimensional (3D) bioprinted models within a microdevice, creating a biomimetic system using human cells and blood components. Of particular note to IR, tissue obtained by biopsy can be loaded onto a chip and subjected to drugs to understand susceptibility, toxicity, and metabolism. In oncology, it can be utilized to learn the effects of radiosensitizers prior to application of therapeutic radioactive material. Probes in microfluidic channels can study irreversible electroporation, microwave, cryo- and radio frequency ablation on tumor tissue. Microfluidics can underpin the personalization in management of disease.

RESULTS: A microfluidic chip is a set of micro-channels in glass, silicon, or a polymer, such as polydimethylsiloxane. The micro-channels are interconnected creating a network amenable to external manipulation by various liquids and gases. An organ-on-a-chip is a microfluidic cell culture device containing living cells. This arrangement is utilized to simulate tissue and organ physiology to a degree impossible with 2D or static 3D cultures. Furthermore, they are capable of integrating multiple laboratory functions into one cohesive unit. They are amenable to high-resolution, real-time imaging, genetic and biochemical analysis. Organs-on-chips are in development allowing advanced investigation of drug interactions and discovery.

CONCLUSIONS: Microfluidic bioreactors in medicine and IR can enhance understanding of disease thereby changing directions for research ultimately shifting clinical practice to treat patients in a customized approach.

Abstract No. 599

Update on contrast-induced nephropathy for interventional radiologists

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PURPOSE: At the conclusion reading this poster the viewer will: Understand a brief history of computed tomography contrast media and what it constitutes. Understand the definition of contrast-induced nephropathy (CIN), and the new term introduced by the American College of Radiology (ACR) post contrast acute kidney injury (PC-AKI). Understand the new data on CIN, and why the ACR introduced PC-AKI. Understand the at risk population for CIN and PC-AKI. Understand the current methods (and their logic) employed to prevent CIN.

MATERIALS: Contrast is used in nearly every procedure in interventional radiology. Despite the ubiquity of contrast media, and the apparent universal clinical concern for CIN, there is no single dominant theory as to the mechanism of CIN. Furthermore, many of the studies that “proved” CIN to exist were undertaken with an earlier generation of contrast media than what is currently used. This poster will examine the arguments (including the above among others) which undermine the validity of the concept of CIN, and support the recent introduction of the term post-contrast acute kidney injury (PC-AKI), by the American College of Radiology to the 2015 contrast manual.

RESULTS: An in-depth review of the literature was conducted (see references). The pertinent papers will be succinctly discussed, with special attention paid to the controversy between Dr. McDonald and Dr. Davenport. Further, the natural history, epidemiology, and at risk population of CIN/PC-AKI will be presented. Finally, the relevant trials which have attempted to prevent CIN/PC-AKI will be discussed.

CONCLUSIONS: At the conclusion of reading this poster, the viewer will be able to summarize the arguments and salient literature which undermine the validity of CIN and support the introduction of the term post contrast acute kidney injury.

Abstract No. 600

Viscoelastic testing: a replacement or adjunct to conventional coagulation assays?

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MATERIALS: Prothrombin time, partial prothrombin time, and international normalization ratio have been widely accepted as the gold standard of conventional preprocedural tests. And while these assays do provide a picture of the patient’s ability to achieve hemostasis, other characteristics of the patient’s blood properties go uncharted.
Viscoelastic testing has been shown to decrease perioperative complications, especially in the setting of coagulopathy.

RESULTS: The exhibit outlines the different types of viscoelastic coagulation tests and their role in the periprocedural care. It relates the deficiencies in conventional testing and explains viscoelastic testing's role in interventional procedures. The most common viscoelastic analyzers, thromboelastograph (TEG) and rotational thromboelastometry (ROTEM), will be explained and correlated with cases for educational purposes.

CONCLUSIONS: Teaching Points: 1. Pitfalls to conventional coagulation tests. 2. Role of viscoelastic testing in limiting periprocedural complications in the setting of coagulopathy.

Abstract No. 601

The use of penile angiography for the diagnosis and endovascular treatment of complex penile disease

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PURPOSE: Impotence and priapism are common causes of functional disorders of the penis. We will describe the role of interventional radiology in helping diagnose different penile disorders and treatments. Learning objectives include: 1. Performing an angiogram and venogram of the penis. 2. Describing the normal penile anatomy and normal anatomical variants. 3. Describing the abnormal pathologic findings and endovascular treatment options. This article will serve as a guide for the practical utilization of penile angiography and penile venography in clinical practice.

MATERIALS: Penile angiography can be utilized to diagnose and treat some causes of impotence or priapism. Although US is the first modality to diagnose some penile pathology, US is sometimes unable to make an accurate diagnosis. Using penile angiography, diagnosis can be made quickly while simultaneously allowing for endovascular treatment. Low flow impotence can be treated with a stent or angioplasty of the cavernosal artery. Alternatively, selective embolization can be performed for impotence due to vasogenic leak seen in erectile dysfunction. Low flow priapism is painful and requires immediate treatment via cavernous aspiration. High flow priapism is painless and involves a short circuit of the vascular system in the penis and does not require emergent treatment, although IR can assist.

RESULTS: Four of five patients with venogenic impotence achieved resolution of impotence after embolization of bilateral pudendal veins. Angiography confirmed venous leak. Two patients with high flow priapism were treated successfully with common penile artery embolization. Pelvic angiography was used as an adjunct along with US for diagnosis to locate a cavernous artery fistula in high flow group.

CONCLUSIONS: Interventional radiology can provide a role for the diagnosis and the endovascular treatment of impotence and priapism. 1. Penile venous ablation can be used to treat high flow impotence. 2. Penile arterial embolization can be used to treat high flow arterial priapism. 3. Penile arterial stenting or angioplasty can be used to treat low flow arterial impotence. 4. Cavernosal aspiration can be used to treat priapism in sickle-cell patients with low venous flow.

Abstract No. 602

Full-court press(or) approach to hemodynamic therapy

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PURPOSE: 1. Review the major classes of hemodynamic drugs and their physiologic effects. 2. Compare and contrast these physiologic effects to better understand which specific drug is better suited in various cases of shock. 3. Review the major trials evaluating various hemodynamic drugs to create an implementable algorithm for hemodynamic drug therapy.

MATERIALS: As the role of the interventional radiologist (IR) continues to expand, so will their involvement in patient care. Furthermore, with the development of the new IR/DR residency and the emphasis placed on obtaining critical care training, understanding the various hemodynamic drugs is integral for any interventional radiologist. Having a foundational familiarity with this class of drugs can better position an IR to safely and comprehensively manage their critically ill patients.

RESULTS: We will present the major hemodynamic drugs and their effects using tables. This pictorial display will not only show the effects of each drug but also allow visual comparison with other similar drugs (adrenergic vs inotropic agents). Furthermore, the latest literature (surviving sepsis guidelines, VASST Study, SOAP II Trial, etc.) will be presented to provide an evidence based approach to picking the various available agents. We will also present categories of shock (cardiogenic, distributive, obstructive, and hypovolemic) in table format in order to outline their unique hemodynamic characteristics. This will allow the reader to match the hemodynamic effects of the various drugs to the hemodynamic characteristics of the various types of shock. Lastly, a decision flow chart will be created that IRs can potentially utilize to help guide their decision making in terms of initial therapy.

CONCLUSIONS: As IRs are taking on sicker patients, knowledge of the intricacies of critical care is becoming more crucial to ensure patient safety before, during, and after interventions. By knowing the different hemodynamic drugs available and their effects and appropriate use, the IR can continue to play an active role in patient care at all levels.
Interventional radiology rotation in the third year of medical school

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PURPOSE: Discussion of an interventional radiology (IR) curriculum for Third Year Medical Students (MS3) Expansion of the role of the medical students within the IR department Provide for MS3 to experience IR at an earlier point in their careers, presenting it as an alternative career to surgical sub-specialties.

MATERIALS: Starting this year, IR transitions from a fellowship based specialty to residency based training. As a result, recruiting prospective applicants to the field must target medical students instead of residents. Furthermore, students must be ready to commit to a field that most are not exposed to until their fourth year. Moving this exposure to third year will encourage MS3 to choose IR as a career path.

RESULTS: This year, our institution has started a 2-week selective for MS3 students taking place during their surgery clerkship block. This selective provides an alternative course for MS3 to take instead of surgical subspecialties. While not required, many of the students will have already taken a diagnostic radiology course prior to the IR clerkship. During the rotation, students will learn imaging techniques for IR procedures, learn indications for basic IR procedures, learn to evaluate and manage patient in the outpatient setting, and learn the basic principles of radiation safety. Students will spend one day a week in clinic learning outpatient management of different areas of IR. For 3.5 days a week, students will assist fellows and residents in various IR procedures, preoperative preparation, and post procedure management. In order to learn IR indications, students will rotate once a week on inpatient consult service. MS3 will attend weekly didactic lectures, rounds on IR patients, and interdisciplinary conferences.

CONCLUSIONS: Exposing medical students to IR at an earlier point in their career will give them more time to consider IR as a potential field. By placing this third year selective within their surgical clerkship, students will be able to contrast the different styles and techniques between surgery and IR. The goal for this clerkship is to make IR a more integral part of the medical school curriculum and recruit more medical students to the field.

Update to dose reduction techniques in the interventional suite

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PURPOSE: 1) Discuss methods in which to reduce radiation exposure to the patient. 2) Discuss recent developments and technologies in radiation exposure reduction. 3) Review recent studies concerning risks of occupational radiation. 4) Discuss societal guidelines, studies and awareness efforts.

MATERIALS: With increased demand for imaging and image-guided procedures, a heightened awareness has developed in the medical community regarding the deleterious effects of radiation. While fluoroscopic-guided interventional procedures are universally regarded as beneficial, many procedures have the potential of high radiation doses. Biologic effects of radiation are manifested through stochastic effects (cancer induction) and deterministic effects (reproductive-sterilization of cells). These risks should be mitigated through safe practice and adoption of a dose reduction mentality.

RESULTS: The exhibit will review methods for radiation dose reduction. The interventional radiologist controls the exposure parameters. Safe practice is achieved through optimization of various factors from radiation parameters to patient and operator positioning relative to the table. Operators should know the intricacies and tradeoffs (i.e. beam hardening with collimation). Recent developments in angiography equipment and dose reducing technology will be explained. Novel protective equipment for staff and patient dose reduction will be reviewed including the literature behind it. This includes but not limited to zero gravity lead, active monitoring radiation systems and sterile disposable drapes for scatter radiation. Updated literature on occupational radiation risks will be reviewed and the strength of evidence pertaining to radiation induced cataracts, brain tumors and heart disease will be explained. Societal guidelines and current research supported by the Society of Interventional Radiology (SIR) will be discussed.

CONCLUSIONS: Adherence to safe practice is paramount in identifying and managing radiation exposure in the procedure room. Knowledge of novel tools and recent advancement in technologies is paramount. SIR continues to promote continual dose reduction.
Abstract No. 605

Early medical student exposure to interventional radiology: the impact of the SIR Student and Resident Committee and the Medical Student Council

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PURPOSE: To present the impact of the efforts of the Society of Interventional Radiology’s Student and Resident Committee (SARC) and Medical Student Council (SIR-MSC) in promoting interventional radiology (IR) to medical students through IR interest groups (IRIG’s), local IR symposia, and involvement with SIR.

MATERIALS: With the implementation of the integrated interventional radiology residency, early medical student exposure to IR is imperative for recruiting top talents to the field and for preparing potential applicants. SARC’s mission is to increase awareness of interventional radiology as a specialty and as a career option for residents and medical students by providing educational and career resources. SIR-MSC was formed in 2011 as a grassroots movement to promote medical student education. The main goals of the SIR-MSC include promoting formation of IRIG’s and IR symposia across the country through the distribution of instructional “cookbooks,” increasing medical student SIR membership, and encouraging attendance at the SIR national meeting, while working closely with the SARC’s IRIG and IR Symposia Subcommittee.

RESULTS: Since the first local IR symposium in 2012, the number of IR symposia has doubled annually from 2013-2015 and the total number reached 13 in 2016. The first regional symposium was formed in 2016. Currently, there are 77 existing IRIG’s. This represents a 22% and 133% increase from 2015 (63) and 2014 (33), respectively. These increases coincide with the growing demand for symposium and IRIG cookbooks. Cookbook requests have increased by 2.7-fold and 2.2-fold, respectively. SIR student membership has also increased 38% in the last year from 923 to 1277.

CONCLUSIONS: The growing numbers of IRIG’s, IR symposia, and SIR medical student members reflect the collective efforts of SARC and SIR-MSC to actively promote early medical student exposure to IR. Based on several measures of student engagement, SARC and SIR-MSC are effective conduits for SIR to educate medical students about the field of IR during this crucial transitional period.

Abstract No. 606

Off-label use of medical devices in interventional radiology: a word of caution

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PURPOSE: To review the regulations behind the off-label medical device use in interventional radiology and to make interventional radiologists aware of the limitations of these regulations.

MATERIALS: The United States FDA is responsible for clearing or approving medical devices to be used for specific indications. Given the rapid pace of development within interventional radiology, it is not uncommon for existing devices to be used for “off-label” indications. This was most recently supported within the Food and Drug Administration Modernization Act of 1997 but is not without its limitations, which largely lie within the areas of commercialization and research.

RESULTS: This exhibit will review the statutes that define the ability of a physician to use a legally marketed medical device for an off-label indication. It will review the circumstances in which this is and is not permissible. Specifically, it will review the limitations as they concern commercialization (including the perception of commercialization on social media and practice/department websites) and research (including the differentiation between prospective and retrospective studies evaluating off-label medical device use). Finally, this exhibit will discuss the role of industry and the limitations placed upon medical device manufacturers and their representatives in this area.

CONCLUSIONS: The off-label use of medical devices has historically been and will likely continue to be an important part of interventional radiology practice. By definition, the innovation that sets this field aside from others almost mandates creativity with existing devices. This exhibit will enable interventional radiologists to understand the rationale behind this use and will raise awareness of the limitations that must always be considered.

Abstract No. 607

A personal touch: the use of image texture analysis in precision medicine

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PURPOSE: 1. Review the steps for Image feature extraction: image acquisition, image segmentation, and feature extraction 2. Discuss the different methods for feature extraction with a focus on image texture analysis 3. Understand the role of radiomics in interventional oncology using image texture analysis as an example.

MATERIALS: The heterogeneity of tumors has been known to influence diagnosis and treatment response, prompting efforts to accurately diagnosis and predict tumor treatment response. Radiomics,
the extraction of quantitative data from routine medical images, and its subsequent correlation to clinical outcomes to be used for clinical decision support, is one such effort. Within radiomics, image texture analysis is a mathematical method for quantitative data extraction and feature extraction, that is showing aptitude in the diagnosis, classification, and prediction of treatment response for tumors.

**RESULTS:** This educational exhibit provides a comprehensive outline of feature extraction as applied to medical images. This includes discussing the capabilities and limitations of the steps required to extract features from medical images: Image acquisition, segmentation, processing, and feature extraction. Furthermore, feature extraction is expounded by defining the different methods for feature extraction: fractal dimensions, intensity based, texture based, shape based, and wavelet based. Then, first, second, and higher order statistical texture analyses are described and used as practical examples of feature extraction. Lastly, examples of the current state of the art in the application of image texture analysis to renal, hepatic, and pulmonary malignancies are enumerated.

**CONCLUSIONS:** Radiomics is a promising method for quantifying and monitoring tumor heterogeneity. With an understanding of image feature extraction, the interventional radiologist is poised to play a key role in the personalization of cancer care.

**Abstract No. 608**

**CTA and MRA in the evaluation of peripheral arterial disease**


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**PURPOSE:** After reviewing this educational exhibit the audience will be able to: 1. Describe the pathophysiology/classification of peripheral arterial disease (PAD) and its clinical appearance. 2. Understand common computed tomographic angiography (CTA)/magnetic resonance angiography (MRA) scan parameters and protocols for the evaluation of PAD. 3. Be familiar with the basics of CTA/MRA interpretation, including the normal anatomy and common descriptive terms. 4. Describe the typical imaging characteristics of PAD. 5. Understand the role of CTA/MRA in guiding the interventional radiologist/vascular surgeon’s decision for treatment of PAD.

**MATERIALS:** An estimated 8 million Americans are affected by PAD with a prevalence of 14-29% in people older than 70 years. CTA/MRA with lower extremity runoff has largely replaced conventional angiography in the initial evaluation and follow-up of PAD. A thorough understanding of the image acquisition process, anatomy, and appearance of PAD with its resultant impact on the treatment algorithm is crucial in CTA/MRA interpretation.

**RESULTS:** This exhibit will illustrate the pathophysiology, clinical presentation, and classification schemes of PAD. Key scan parameters and technical considerations in protocling CTA/MRA for PAD will be discussed. We will provide a brief review of normal anatomy and practical descriptive terms. Finally, the authors will present common CTA/MRA imaging patterns of PAD as well as salient information that should be conveyed to assist interventional radiologists and vascular surgeons in treatment planning.

**CONCLUSIONS:** The interventional radiologist maintains an important role as a diagnostician. As such, an understanding of and organized approach to the CTA/MRA is fundamental for assessment of peripheral arterial disease. Familiarity with classification schemes and treatment algorithms allow for concise reporting of pertinent findings and efficiency in patient care.

**Abstract No. 609**

**CO2 to the rescue: when traditional contrast just won’t do**

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**PURPOSE:** 1. Identify scenarios in which carbon dioxide (CO2) should be utilized as a contrast agent for angiography. 2. Review of basic physiology of intravascular CO2 and how we can utilize it to our advantage. 3. Recognize and manage possible complications associated with intravascular CO2 administration.

**MATERIALS:** CO2 has been utilized as a contrast agent since the 1950s. With the recent advent of smaller and more user-friendly devices, it has become increasingly practical to use CO2 in clinical practice. There are a variety of situations in which it is favorable to use CO2 as a contrast agent, including in the setting of a contrast allergy, renal failure not on dialysis and for visualization of the portal venous system. With an understanding of the physiology of intravascular CO2 and imaging physics, one is able to generate clinically useful fluoroscopic images. Though complications related to CO2 angiography are rare, it is important to recognize and know how to treat them.

**RESULTS:** Following a review of the pertinent physiology, proper indications and usage of CO2 angiography, we present two case examples: 1. 94-year-old male with a dialysis fistula, presents with low flow during dialysis. His history is complicated by a severe contrast allergy which once resulted in anaphylaxis. A fistulogram is performed utilizing CO2 as a contrast agent. Regions of stenosis are identified in the outflow vein and are treated with balloon angioplasty. Post treatment images demonstrate an improved appearance. 2. 67-year-old female with a history of renal failure not on dialysis presents for an IVC filter following surgery with expected prolonged immobilization. CO2 was selected as a contrast agent on account of the patient’s poor renal function. A cavogram is performed demonstrating the location of the renal veins and an IVC filter is deployed.

**CONCLUSIONS:** CO2 is an excellent alternative when traditional contrast media is contraindicated. It is relatively safe and easy to use. One can utilize a basic understanding of its physiology in order to generate excellent images. It is prudent to recognize the rare but potentially life threatening complications and know how to respond instantly.
Abstract No. 610

Improving immunotherapy: boosting anticancer immunotherapy with locoregional modalities

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PURPOSE: The purpose of this abstract is to discuss thermal ablation as a tool to boost anticancer immunotherapy.

MATERIALS: Thermal ablation is capable of inducing an anticancer immune response and can boost the anticancer effect of immunotherapeutics.

RESULTS: A review of the current literature on anticancer immunostimulatory effects of various thermal ablation techniques will be discussed. Here, the immunogenic effects of locoregional interventional oncology treatments will be presented along with basic and translational research that has identified immune system targets associated with concomitant locoregional therapies. Moreover, the current knowledge and scientific rationale to combine locoregional therapies with immunotherapeutics such as the immune checkpoint inhibitors anti-CTLA-4 and anti-PD-1 to boost the overall systemic anticancer immune response will be outlined and discussed as potential combination therapy to improve cancer therapy.

CONCLUSIONS: CT-guided cryoablation is a safe and effective alternative in select patients with isolated axillary lymph node metastasis. The performing radiologist requires keen awareness of the important structures of the axilla to successfully perform this procedure without significant complication.

Abstract No. 611

CT-guided cryoablation for the treatment of isolated axillary lymph node metastasis from breast cancer

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PURPOSE: The educational goal of this exhibit is to describe the anatomy, diagnostic imaging, indications, contraindications, potential complications, procedural approach, and outcomes related to percutaneous CT-guided cryoablation of axillary lymph node metastasis from breast cancer.

MATERIALS: The use of percutaneous CT-guided cryoablation for the treatment of breast cancer has been well-described as an alternative to surgical lumpectomy. However, its use for treatment of axillary lymph node metastasis has not been well described. In patients who have undergone axillary lymphadenectomy, surgical excision of recurrent axillary nodal disease is often not possible, making cryoablation an important therapeutic option. The purpose of this exhibit is to discuss the technical aspects of CT-guided cryoablation of axillary lymph node metastasis and its potential as an alternative treatment.

RESULTS: A detailed understanding of the anatomy of the axilla is required to select the proper approach for percutaneous cryoablation.
technical success rate (100% vs 95%), larger displaced distance (2.7 vs 1.7 cm, p<0.05), and lower complication rate (0.0% vs 2.5%) than without iodinated contrast.

CONCLUSIONS: Hydrodissection is a safe and effective technique to prevent non targeted thermal injury with an excellent technical success and low complication. The threshold displaced distance of 2 cm is feasible and can be safely recommended to provide multiple benefits, eliminating the operator dependant threshold inconsistencies. Iodinated contrast mixed with DSW achieves higher displaced distance and allows for better differentiation of vital structure from the renal tumor.

Abstract No. 613
Aim for success: useful techniques for difficult CT-guided biopsies

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PURPOSE: 1. Identify techniques for CT-guided biopsy to help avoid crossing critical structures. 2. Identify techniques for CT-guided biopsy to help displace critical structures. 3. Identify structures that can safely be traversed for percutaneous biopsy. 4. Identify other useful techniques for successful CT-guided percutaneous biopsy.

MATERIALS: Interventional radiologists are called on to biopsy myriad lesions throughout the body. While many biopsies are straightforward with image guidance, some lesions pose a greater challenge. This may be due to intervening organs or blood vessels one does not which to cross. One may employ techniques for successful and safe CT-guided percutaneous biopsy.

RESULTS: Avoiding structures can be accomplished with patient positioning and changing the CT gantry angle. This can aid in vertebral body lesion biopsy by visualizing the pedicle in a single slice. Additionally, a craniocaudal gantry angle can delineate a safe path not seen on standard axial images. Patient positioning can also be used to accentuate the scan angle (1). For adrenal lesions, positioning the patient lesion side down compresses lung so that it need not be crossed (2). Hydrodissection is a useful technique to displace structures and create a safe path. This has been routinely used with thermal ablation to displace bowel (1,2). Additionally, hydrodissection can aid in retrocrural lymph node or posterior mediastinal biopsy to avoid traversing lung. Bowel may also be displaced with use of a blunt cannula, or simply removing the sharp styllet. Certain structures in the way may be safely crossed. A transgastric route for pancreatic lesions is safe, as this route is often used for pancreatic pseudocyst drainage (3). The IVC can safely be crossed with a 19 G guide needle to obtain 20 G cores of retroperitoneal masses. Bowel may be safely crossed with 22G needles, though limiting this approach to fine needle aspiration (2,3). A transosseous approach can be used, including transsternal or transiliac (4). Especially mobile masses/lymph nodes can be “fixed” in place with use of a second, smaller needle.

CONCLUSIONS: Multiple techniques exist to aid in successful CT-guided biopsy of difficult lesions.

Abstract No. 614
Preoperative CT-guided lung nodule wire localization: a single-institution experience

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PURPOSE: To understand the role of image-guided lung nodule wire localization prior to video-assisted thoracoscopic surgery (VATS) for wedge resection including the indications, techniques, imaging findings, and complications of the procedures. To review our institution’s experience using three different preoperative lung nodule localization wires (microcoil, Q-wire, Homer) and their respective outcomes.

MATERIALS: Localization of small nodules offers a challenge to surgeons. CT-guided percutaneous wire placement involves deployment of a localizing device through a needle with one end of the device at the nodule and the other end located outside the pleural surface. The pleural end is identified on the collapsed lung during surgery localizing the nodule to be selectively excised. Our institution utilizes a microcoil wire approach, a Q-wire approach, and Homer wire approach. We aim to compare and contrast the different techniques in this review.

RESULTS: Retrospective review at our institution (2013-2016) demonstrated 13 patients (age 67.9 ± 11.3 years) who underwent CT-guided lung nodule localization, 10 using microcoils, 2 using Q-wire and 1 using Homer wire. The average nodule size was microcoil 13 ± 4 mm, Q-wire 14 ± 1 mm, Homer 11mm. The average distance of localizing wire to center of lesion was microcoil 7 ± 4 mm, Q-wire 1 ± 1 mm, Homer 15 mm. Average time to perform procedure with microcoils 32.9 ± 10.8 minutes, Q-wires 17.9 ± 8.9 minutes, Homer 49.1 minutes. Pneumothorax developed in one microcoil case and the Homer case. Pleural surface was not reached by one of the microcoil wires. The diagnostic yield was 100% in our cohort.

CONCLUSIONS: Our institution performs preoperative CT-guided lung nodule localization utilizing various wires. Our data suggests the Q-wire approach offers the fastest method to localize these nodules and localized closest to the lesion. After reviewing this exhibit, the attendee will be able to understand the differences in the three devices used in our institution and learn from our experience with the devices.
Abstract No. 615

Institutional experience from CT-guided calvarial biopsy: dose-conscientious CT-fluoroscopy and drill-based sampling allows for safe and efficient procedural completion via combination of less-frequent sampling, device stability, and lower dose exposure

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PURPOSE: Image-guided calvarial biopsy is challenging. Notable risks include traversing meninges, brain injury, infection, and hemorrhage. CT can be used to characterize osseous matrix, detect cortical erosions, and plan biopsy tracks. Core biopsy and FNA are often employed in visceral and bone sampling. Drill systems have been used for osseous biopsy, though their implementation in the calvarium is infrequent. We reviewed our experience with CT-guided techniques and devices employed during calvarial biopsies performed at our institution.

MATERIALS: Retrospective review from 2012 to 2016 of 10 patients was performed under IRB approval. 3 techniques used: biplane fluoroscopy with cone-beam CT (1 patient), CT-fluoroscopy with pre- and postbiopsy CT (6 patients), and dose-conscientious CT-fluoroscopy with prebiopsy CT exclusion (3 patients). 7 cases conducted with needle/spring-loaded co-axial technique (18-20G needle/spring loaded core and 22G FNA). 3 cases performed with drill systems (14G Bonopty® and 11G OnControl®), Bilateral frontal-parietal and non-skull base temporal-occipital surfaces sampled. Lesions ranged in size, with erosion of the entire calvarium, isolated outer/inner table mass, or focal diploic sclerosis.

RESULTS: Dose from fluoroscopic biopsy measured >1Gy due to cone-beam CT confirmation of needle position and sampling under fluoroscopy. CT-biopsies with high-gauge co-axial and drill-based systems provided comparable operator comfort and device stability. 1 pass with drill-based systems was sufficient for histologic and molecular diagnosis. Average 2-4 passes with higher-gauge co-axial systems needed for cytometry, with histologic diagnosis insufficient in 2 of 6 patients. Elimination of preplanning CT and adjusting kV/mA produced a 10-fold reduction in radiation exposure.

CONCLUSIONS: Calvarial biopsy with the Bonopty® and OnControl® is safe and feasible. These drill systems reliably provide diagnostic quality specimens with 1 time biopsy, thereby minimizing risks from repetitive calvarial sampling. Elimination of prebiopsy CT and modifying side table dose parameters further contributes up to a 10-fold reduction in radiation exposure.

Abstract No. 616

Value of interventional radiology in a community hospital lung cancer screening program

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PURPOSE: To study the value of implementing a community hospital lung cancer screening program on an interventional radiology practice.

MATERIALS: Elkhart county’s (Indiana) population of smokers is among the state’s highest at 23.4%. Elkhart General Hospital’s (EGH) cancer registry over past 10 years showed that 50% of lung cancer diagnosed were stage IV. In 2012 a multidisciplinary Thoracic Oncology Clinic (TOC) was developed, which included a lung cancer screening program. Interventional radiologists are critical members of the TOC, and unique to our program is that patients and their family members are invited to this conference to discuss their imaging findings and management. Patients with abnormalities, typically on CT, which are suspicious or suggestive of malignancy underwent CT-guided biopsy by an interventional radiologist. A low dose CT biopsy protocol was developed.

RESULTS: Since the inception of the program, 892 LDCT were performed of which 27 biopsy requests were made. Often these lesions were small, but the technical success of biopsy was 100%, with a positive biopsy rate of 74%, and a pneumothorax rate of 5%. Four referrals for radiofrequency ablation were made through TOC. Many patients were diagnosed at an earlier stage with an estimated 5-year mortality reduction of approximately 50%. Radiation dose for CT-guided lung biopsy was reduced by 63%. The perception of IR as a clinical specialty improved significantly among clinicians attending TOC. Due to unique “patient centered” approach of this program, patient appreciation of an IR physician as an essential member of the care team increased, which has been the subject of an American College of Radiology Imaging Case Study (available at http://www.acr.org/Advocacy/Economics-Health-Policy/Imaging-3/Case-Studies/Patient-Engagement/Patient-Forward).

CONCLUSIONS: Implementation of a lung cancer screening program in a community hospital resulted in increased IR referrals for CT-guided lung biopsy and improved perception of clinicians and patients for IR. CT-guided biopsy radiation dose was reduced and patients were diagnosed with lung cancer at an earlier stage, allowing for less invasive therapies, such as radiofrequency ablation.
Abstract No. 617

The role of cone-beam CT in TACE for HCC: a systematic review and meta-analysis

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PURPOSE: To review the available evidence in the use of cone-beam CT (CBCT) during transcatheter arterial chemoembolization (TACE) in hepatocellular carcinoma (HCC) for detection of tumor and feeding arteries.

MATERIALS: Literature searches were conducted from inception to May 15, 2016 in PubMed (includes MEDLINE), SCOPUS and the Cochrane Central Register of Controlled Trials. Search terms included “cone beam,” “CBCT,” “c-arm,” “CACT,” “cone-beam CT,” “volumetric CT,” “volume computed tomography,” “volume CT,” AND “liver,” “hepatic,” “hepatoc.” Full search strategies available on request. Studies that involved adult populations with only HCC treated via TACE utilizing CBCT were included.

RESULTS: Eighteen studies were found to fit the inclusion criteria. Pooled sensitivity of CBCT for detecting tumor was 90% (95% CI 82-95%), whereas the pooled sensitivity of digital subtraction angiography (DSA) for tumor detection was 67% (95% CI 51-80%). The pooled sensitivity of CBCT for detecting tumor feeding arteries was 93% (95% CI 91%-95%) whereas the pooled sensitivity of DSA was 55% (95% CI 36-74%).

CONCLUSIONS: CBCT can significantly increase the detection of tumors and tumor feeding arteries during TACE. Consideration should be given to utilization of CBCT as an adjunct tool to DSA in TACE treatments of HCC.

Abstract No. 618

VX2 rabbit tumor model development for interventional oncology research: a recipe for success.

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PURPOSE: To describe a step-wise method and practice for rabbit VX2 tumor model development, inoculation, propagation, and maintenance for interventional oncology research models.

MATERIALS: A VX2 rabbit tumor model has been incompletely described. VX2 rabbit tumor cell maintenance propagation and inoculation are described in a recipe for interventional oncology research programs in New Zealand white rabbits. Cell suspension and image-guided inoculation techniques are described for donor and recipient animals with harvesting of aliquots from donors. Inoculation success rates were analyzed and fluoroscopic, cone-beam CT, CT, and microCT imaging of tumors was performed in vivo or ex vivo.

RESULTS: Tips and tricks for successful maintenance of a VX2 tumor model program are described. Specific tools and techniques for successful inoculation, harvest, and imaging are detailed. Expected successful inoculation rates are characterized along with techniques to minimize peritoneal tumor nontarget growth during intrahepatic inoculation including coaxial ultrasound guidance techniques with gel foam pledgets. Imaging features are described for liver VX2.

CONCLUSIONS: VX2 rabbit tumor model may provide a cost effective method for optimization and characterization of interventional oncology applications, models, and technology. Publication of difficulties and failures during model development may help others avoid similar problems. A recipe for success requires understanding the shortcomings, risks, and pitfalls of such model development.

Abstract No. 619

Establishing the role and importance of interventional radiology in pain management and palliative care of oncology patients with emphasis on novel techniques for pain amelioration

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PURPOSE: To identify the utility of interventional radiology (IR) in pain management and palliative needs of oncology patients with numerous novel examples provided from our institution while emphasizing IR’s responsibility and importance to establish ourselves as clinicians with a primary role on the oncology patient-care team.

MATERIALS: IR has forged a now well-established role in diagnosing and treating oncology patient’s underlying malignancy, yet IR’s utility for palliation is highly underutilized in many IR practices. As IR evolves into a primary specialty, our responsibility as clinicians is to not only develop and utilize these resources and techniques, but also to raise awareness and educate other physicians and patients of all available options, either in interdisciplinary conferences or dedicated IR clinics.

RESULTS: At our institution, close interaction with both patients and clinicians has allowed us to optimize patient care and provide various and sometimes novel palliative procedures that can reduce pain and discomforting symptoms, thus improving quality of life. Procedures that are generally considered nonconventional yet commonly performed at our institution include intercostal, pudendal, maxillary branch of cranial nerve V, and celiac plexus neurolysis with ethanol, microwave ablation, and radiofrequency ablation followed by cementoplasty of painful extraspinal metastases. The aforementioned procedures are
straightforward using image guidance with relatively few complications, and examples of each are provided.

CONCLUSIONS: IR has shown its utility in diagnosing and treating the oncology patient’s underlying disease, yet a broad and often underutilized toolbox exists to treat the patient’s pain and other debilitating symptoms. Numerous nonconventional examples from our institution are provided to demonstrate IR’s evolving role in continued patient care. Through close interactions with other physicians and with patients in dedicated clinics, interventional radiologists can establish our role as primary clinicians while securing our future as a critical element of the patient-care team.

Abstract No. 620

The abscopal effect and interventional radiology: key concepts, review of the literature, and future directions
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PURPOSE: 1. Review the concept of the abscopal effect and current literature on this topic. 2. Detail available literature on the role of interventional radiology (IR) in inducing the abscopal effect. 3. Suggest future IR-related studies that are needed to further understand this phenomenon and explore the potential role of IR in inducing this effect.

MATERIALS: The abscopal effect was first described by R.H. Mole in 1953 as the effect of radiation at a distance away from the irradiated field but within the same organism. Currently, this effect has gained more interest in the oncologic community, as it refers to systemic response of tumors from a localized treatment of one tumor. With recent advances in immunotherapy, there is increased interest in various targeted therapies that may be used with immunotherapy to improve systemic responses with the goal of achieving the abscopal effect.

RESULTS: The abscopal effect is likely an immune-mediated phenomenon. A targeted therapy (the most commonly described is local radiation therapy) causes tumor cell death, which then is followed by a systemic immune system response. Thus, a focal therapy may stimulate the immune system to fight other sights of cancer in the body. It is currently thought that T-cells and dendritic cells play the primary role. This exhibit thoroughly reviews the abscopal effect, mechanism of action, available literature on the topic (including medical oncology, radiation oncology, and interventional oncology), and suggests future IR-related studies involving ablation and/or embolization that are needed to better understand this phenomenon. With the increased use of immunotherapy, studying the addition of local ablative therapies to achieve increased rates of the abscopal effect is warranted.

CONCLUSIONS: Combining local ablative therapies with immunotherapy may lead improved systemic responses and increased rates of achieving the abscopal effect. Additional research from the medical oncology and interventional oncology community is needed to study this further.

Abstract No. 621

Building an interventional oncology patient database in REDCap
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PURPOSE: Our goals in this exhibit are: 1) to share our experiences building an interventional oncology patient database from scratch 2) to describe the necessary steps and pitfalls to avoid 3) to demonstrate with examples how a smoothly working database will ease the IR research 4) to better show the capabilities of REDCap.

MATERIALS: Researchers generally use data entry forms such as excel spreadsheets. But once the columns and rows start to expand and number of patients becomes huge, new inputs and analyses based on these spreadsheets carry risks such as incorrect data entries, duplicates, falsely excluded/included patients. As the amount of data is accumulating continuously, there is an increased interest for databases that combines information from different sources (EMR, PACS) for targeted patient populations.

RESULTS: After we have finalized our need of an IR database in the section, we looked for the best tool that would fit our needs. At that point, REDCap seemed a good starting point with its user friendly, research oriented focus. We chose our data parameters based on the baseline and follow up needs of TACE/TARE. For each patient, there is only one record, which associates with its medical record number, which would then prevent duplicates. Our patient data comes from two main sources: EMR (EPIC) and PACS. Especially for tumor related parameters (e.g. size, location), a manual data entry is the only way possible. For some parameters (lab values), it is possible to pull data from EMRs automatically. Most patients have more than one treatment targeting liver, so each procedure has its own arm with as many follow ups as needed. To set the database, a HiPAA secured server is a must. Data import and export is doable and it is also easy to export your desired report into a statistical program.

CONCLUSIONS: We now have an IR database to track patients having liver directed treatments. REDCap is a feasible and user friendly tool to start for even non-experienced people in the field. Once a database decision has been made, you should define your needs and expectations first. A database will not give you quick answers but it will direct you to a smooth way to reach your goals.

Abstract No. 622

Oncological interventions in pediatric patients
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PURPOSE: While the use of interventional techniques to treat adult oncology patients is well established, the translation of these techniques to the pediatric realm continues to evolve. Interventional approaches provide a valuable alternative for disease treatment and
symptom management. The pioneering use of interventional techniques to treat and palliate oncologic disease in pediatric patients is overdue. We evaluated pediatric patients who underwent different interventional procedures for cancer treatment or palliation at our institution.

**MATERIALS:** We retrospectively reviewed the medical records and imaging studies of all pediatric patients with cancer who underwent interventional procedures e.g. cryoablation, radiofrequency ablation, sclerotherapy and transarterial embolization at our institution. Patient and disease demographics, interventional procedures performed and outcomes were documented. Symptomatic and radiological changes were evaluated and compared pre- and postprocedure.

**RESULTS:** 30 pts (5-20 yrs.; mean age 12.5 yrs.) underwent interventional oncological procedures for different indications. The outcome of these interventions was individually evaluated at procedural level.

**CONCLUSIONS:** Interventional oncology in pediatric age group is an evolving specialty. Our experience demonstrates that these procedures are feasible and provide a safe and minimally invasive treatment and/ or palliative option in clinical care of children with cancer.

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**Abstract No. 623**

Preclinical efficacy of transarterial therapies employing Lipiodol®: systematic review in animal models of liver cancer

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**PURPOSE:** c-TACE is a therapeutic mainstay for liver cancer. Even so, knowledge of the safety/efficacy of Lipiodol®-based LRTs in animal liver cancer models is critical to developing novel LRT approaches, using Lipiodol® with new anticancer agents and precision therapies. This study systemically reviewed the pharmacokinetics (PK), safety, and efficacy of Lipiodol®-based LRTs for liver cancer in preclinical models.

**MATERIALS:** A MEDLINE search was performed from 1988-2016. Terms included: hepatocellular carcinoma, HCC, liver cell carcinoma, liver or hepatic, or hepatocarcinoma; transarterial or chemoembolization or TACE; animal; Lipiodol, Ethiodol, iodized oil, or poppy-seed oil. Inclusion criteria spanned: peer-reviewed journal, accepted animal model, safety/efficacy data reported. Exclusion criteria were: inadequate safety/efficacy data, anticancer drug name/dose not available, article not in English. Outcomes included drug uptake in tumor, PK/tolerance, tumor response, and survival.

**RESULTS:** Of 114 identified articles, 54 (47%) met inclusion criteria. Three, 2, 19, 27, and 3 articles used cell line, mice, rat, rabbit, and pig models. 21 papers reported drug uptake, PK, and tolerance data, showing 0.5-9.5% injected chemo dose (mainly dox/epirubicin) in tumor. Tumor-to-normal liver drug distribution ratio ranged from 2-157. Toxicology data showed transient serum liver lab elevation 1-day post-LRT. There was no noteworthy liver or extra-hepatic histologic damage. 11 articles reported tumor response (9 Lipiodol®/chemo and 2 Lipiodol®/Re-188), and showed 0-30% viable tumor and -10% to -34% tumor growth 7-days post-LRT. 2 articles reported survival (Lipiodol® + epirubicin/Re-188 in rats), showing significantly longer survival post-LRT vs. untreated controls (56/60 days vs. 33/28 days). 14 articles described Lipiodol® mixed with radiopharmaceutical (7 papers) or novel immune (2 papers), anti-angiogenic (5 papers), and gene (5 papers) therapies.

**CONCLUSIONS:** c-TACE animal studies show preferential tumor uptake of anticancer agent, good hepatic/systemic tolerance, high response, and enhanced survival after Lipiodol® LRT. Innovative Lipiodol®-based LRTs can be evaluated with animal models and translational techniques.

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**Abstract No. 624**

RESIN registry: 15-month enrollment update


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**PURPOSE:** 1) Educate the interventional radiology (IR) community about the Radiation-Emitting SIR-Spheres in Non-resectable Liver Tumor (RESIN) registry, an ongoing interventional oncology big data project. (2) Demonstrate data capture for the registry using a Research Electronic Data Capture (REDCap) database. (3) Provide an update regarding recruitment and pathologies treated to date.

**MATERIALS:** Yttrium-90 (90Y) is being increasingly used to treat both primary and metastatic unresectable liver cancer. Reported data is primarily single-center and retrospective, which limits publication impact. RESIN is a multi-center prospective registry with the goal of increasing big data publications within IR.

**RESULTS:** The RESIN registry is capturing patient demographics, primary and secondary diagnoses, medical history, treatment details, laboratory measures, tumor markers, complications, and outcomes via a secure, online interface. Efficacy outcomes include time to progression and overall survival. Treatment details include 90Y alone as well as combinations of 90Y plus systemic and biologic therapies. Toxicities are being tracked using CTCAE v4. We will show how REDCap allows easy exportation of data into graphical format and assists in formatting for statistical analysis. The selected sites for RESIN include both
Abstract No. 625

Pictorial guide for angiographic correlates and treatment modifications to abnormal activity on 99m-Tc-MAA shunt studies prior to Y-90 microsphere radioembolization

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PURPOSE: To demonstrate the angiographic correlates for abnormal activity on 99m-Tc-MAA hepatopulmonary shunt studies and to discuss techniques addressing these findings to prevent complications following Y-90 microsphere selective internal radiation treatment.

MATERIALS: Prior to Y-90 microsphere radioembolization for surgically unresectable malignancy within the liver, patients undergo arteriography and a 99m-Tc-MAA hepatopulmonary shunt study. Arteriography is performed for planning a treatment location and to determine if there are any extrahepatic arteries that should be embolized to prevent extrahepatic administration of Y-90, which can lead to serious complications. While the MAA scan is performed to determine the lung shunt, it can also be utilized to identify unwanted extrahepatic activity. This information can be very beneficial to the interventional radiologist and can be addressed on treatment day to prevent complications.

RESULTS: Our institutional database of patients treated with Y-90 radioembolization was reviewed for patients that had extrahepatic activity on pretreatment MAA imaging. Of the patients with extrahepatic activity, planning and treatment arteriograms were reviewed to identify correlates and subsequent therapy modifications addressing the findings of the MAA study. Angiographic correlates for abnormal extrahepatic activity included patent retroduodenal, falciform, cystic, accessory left gastric, replaced left hepatic, and gastroduodenal arteries. Modifications on the day of therapy included embolization, most commonly with coils, and microcatheter tip placement distal to the artery of concern. Post treatment scintigraphy on all patients demonstrated no extrahepatic activity, and follow up showed no complications.

CONCLUSIONS: Tc-99m MAA scans can be very helpful in preventing complications of Y-90 therapy by identifying abnormal extrahepatic activity. Being able to identify the angiographic correlates for these findings and intervene appropriately is crucial for preventing complications related to radioembolization.

Abstract No. 626

Draining of ovarian cysts during pregnancy: tips, tricks, techniques (and pitfalls)

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PURPOSE: Ovarian cysts are common and are usually asymptomatic and don’t usually need to drained. Indications for drainage are: large or increasing size, increasing symptoms (usually pain), complex architecture (for diagnosis). Types of pregnancy-related ovarian cysts, characteristics and clinical indices for intervention are reviewed.

MATERIALS: Adnexal cysts have an incidence rate of 1% (clinical) to 20% (autopsy) and most cysts are benign, incidental findings. Adnexal masses found during pregnancy have an incidence of 1-2%. Malignancy rates are estimated at 1-5% of these. Percutaneous aspiration of simple cysts is rarely indicated, the indications may include pain and increasing size. Pregnancy related (hormonally influenced) functional cysts may increase or decrease in size, depending on the etiology.

RESULTS: Functional cysts (including hemorrhagic cysts) resolve over time (weeks to months) and need only be followed if not resolved by 12-16 weeks. Non-functional cysts need to be followed more closely for size criteria, clinical history, changing or increasing symptoms and may need to be considered as possible indicators for drainage. Endometriomas, degenerated ectopics, cystic dermoidos are considered. If a simple cyst is <5cm in size and is stable, it may only need routine follow-up. Over 7cm in size, or especially if it is enlarging, a cyst may need to be followed for possible complications (torsion, rupture, enlarging nodule). Complete abdominal/pelvic examination is important, for common sources of pain (e.g.: pancreatitis/ascites, paraovarian cysts, ectopic endometriosis, hydrenephrosis, cholecystopathy, bladder, bowel and retroperitoneal and solid organ cysts). Technical considerations are emphasized. Polycystic ovarian syndrome (PCOS), ovarian hyperstimulation syndrome (OHSS) and fertility-induction related controlled ovarian hyperstimulation (COH) are specialized topics.

CONCLUSIONS: 1. Consider diagnostic and clinical parameters to rule out (most) cysts that do not need to be drained. 2. Knowledge of cyst types is important. 3. Examine the entire abdomen and pelvis for displaced/compressed organs. 4. Careful adherence to anatomy, procedural considerations and technique may assure successful aspiration.

Abstract No. 627

Dropped once drained many times: radiographic appearance, unusual complications and treatments of dropped gallstones

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PURPOSE: To describe the radiographic appearance and limitations in the diagnosis of intra-abdominal abscess caused by dropped gallstones after laparoscopic cholecystectomy. 2. To review the spectrum
of complications related to dropped gallstones. To discuss the approaches for treatment of intra-abdominal and intra-thoracic abscess caused by dropped gallstones.

**MATERIALS:** Laparoscopic cholecystectomy is the procedure of choice for routine gallbladder removal. The use of laparoscopic technique has resulted in an increased incidence of spillage of stones into the peritoneal space to as much as 30 percent of cases secondary to perforation of the gallbladder. Complications such as infection and abscesses, although uncommon, can be fatal. The diagnosis of such complications is challenging due to unusual clinical presentations, radiologically occult calculi, and variable locations of the dropped gallstones. Radiologists must be aware of techniques for identifying dropped gallstones and the complications and diagnostic limitations in patients who have undergone laparoscopic cholecystectomy.

**RESULTS:** This educational exhibit will focus on complications, radiographic appearance of dropped gallstones and abscess and treatments of dropped gallstones. Appropriate imaging correlates and clinical history are key to diagnosing and providing appropriate treatments to patients. A. Radiographic appearance of dropped gallstones and abscess. B. Complications. C. Treatments.

**CONCLUSIONS:** Although the incidence of abscesses caused by dropped gallstones is an uncommon complication, it should be recognized as a potential source of both intra-abdominal and intra-thoracic abscess formation in any patient presenting months to years after undergoing laparoscopic cholecystectomy and a history of multiple abscess drainage. Radiologists play a critical role in identifying these complications and recognition of the imaging findings in addition to knowledge of appropriate interventional procedural technique is crucial to the proper management of these patients and earlier definitive surgical stone removal.

**Abstract No. 628**

**Non-operative management after percutaneous drainage of diverticular abscesses: is it time for a change?**

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**PURPOSE:** To review current literature regarding the non-operative management of patients who successfully underwent percutaneous drainage for diverticular abscesses.

**MATERIALS:** Diverticular disease is one of the most costly gastrointestinal disorders in the U.S accounting for 300,000 hospitalizations per year. Diverticular abscesses present in 10-20% of patients with diverticulitis. Abscesses larger than 3 cm can be successfully managed with CT-guided percutaneous drainage. According to current surgical guidelines, elective sigmoidectomy should typically be considered after recovery from an episode of complicated diverticulitis. These recommendations have been challenged by several studies proposing observation over elective surgery.

**RESULTS:** Elective surgery is routinely performed 6-8 weeks after resolution of complicated diverticulitis. This is based on the assumption that diverticulitis is a progressive disease and the complication rate increases with each subsequent attack. Recently, it has been shown most patients who present with complicated diverticulitis do so at the time of their first attack. Furthermore, the risk of requiring emergency surgery or stoma creation is not associated with elective surgery. Several studies have demonstrated non-operative management of diverticular abscesses after successful percutaneous drainage is a safe and effective option in a selected group of patients. Predictors of recurrence such as immunosuppression, chronic renal failure, vascular collagen disease or COPD may be important factors in the selection of patients who would benefit from this practice. Limitations of previous studies (sample size, limited follow-up and patient selection) favor the need for large-scale prospective studies to evaluate long-term outcomes from the interventional radiology standpoint.

**CONCLUSIONS:** Non-operative management after percutaneous drainage of diverticular abscesses appears to be a safe, effective and low cost therapeutic option in a selected group of patients. Risk factors associated with high recurrence rates may be useful in patient selection. Discussion from the interventional radiology point of view as well as prospective data are needed in this controversial matter.

**Abstract No. 629**

**Experiences with percutaneous removal of infection nidus**

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**PURPOSE:** Abscess secondary to a specific nidus requires removal of the nidus to fully clear the infection. This can require repeat surgical interventions in the case of a retained appendicolith. This study reports our experiences with percutaneous removal of infection nidus at our institution.

**MATERIALS:** Electronic medical records and PACS were searched for drain placements that also included the attempted removal of an abscess nidus from January 2013 through December 2015 by our interventional radiology department. Procedure details and clinical follow up including operative management were added to a HIPPA compliant database.

**RESULTS:** There were 5 patients who received an abscess drain and also attempted removal of infection nidus in IR. Four were appendicoliths and one was a pellet retained from an injury that occurred the year prior. Of the appendicoliths, one presented with acute perforated appendicitis, two as retained stones after surgery, and one stone that had migrated into the right chest with resultant empyema. Removal of the nidus or fragmentation and aspiration was successful in all cases except for the perforated appendicitis. The treated abscess resolved in all cases. The case of perforated appendicitis underwent uneventful interval appendectomy 2 months after presentation.

**CONCLUSIONS:** Percutaneous removal of an abscess nidus at the time of drain placement is feasible. Attempts to remove an abscess nidus during drain placement may obviate the need for additional surgical intervention.
Abstract No. 630
Beyond the procedure: choosing the best therapy for acute cholecystitis based on clinical assessment

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Purpose: Review acute calculous and acalculous cholecystitis, its pathophysiology, and morbidity/mortality. Discuss clinical assessment tools and the Tokyo guidelines, a severity grading system. Discuss the treatment options, including a historical perspective, current therapies, and future perspectives. Discuss treatment algorithms and the best clinical setting for percutaneous cholecystostomy.

Materials: Acute calculous cholecystitis carries a mortality risk of 12% in patients older than 80 years, and acute acalculous cholecystitis carries a mortality risk of 41%, irrespective of age (1,2). Additionally, acute acalculous cholecystitis is most commonly seen in already critically ill patients, complicating the situation. Urgent therapy is therefore indicated, although determining the optimal therapy is not always clear. We aim to discuss current treatment options and their outcomes, algorithms to choose the best therapy, and future perspectives.

Results: Main therapeutic options include medical therapy/observation, “early” laparoscopic cholecystectomy (LC) (during first presenting admission), and percutaneous cholecystostomy (PC) with or without delayed LC (6-12 weeks after initial nonoperative management). The Tokyo guidelines (3) is a severity grading system largely based on lab values, physical exam findings, and vital signs. Treatment algorithms based on this grading system have since been developed. Although LC and PC are currently the main interventions for acute cholecystitis, new minimally invasive therapies are being developed, including natural orifice transluminal endoscopic surgery (NOTES) and peroral endoscopic transpapillary/transmural drainage (4,5).

Conclusions: Acute cholecystitis is a potentially lethal condition, especially acalculous cholecystitis, requiring urgent therapy. The best therapy is not always clear, although clinical assessment can help lead to the best option.

Abstract No. 631
Use of biloma injection cholangiography to facilitate percutaneous biliary drain placement for bile leaks: predictors of technical success and complication rates

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Purpose: Percutaneous biliary drain (PBD) placement is a well-established method of treatment for bile leaks. In the setting of a leak, however, the biliary tree is typically non-dilated, making percutaneous transhepatic cholangiography (PTC) and subsequent PBD placement technically difficult. Injection of an extrathepatic biloma can facilitate PBD placement if contrast can be forced retrograde into the intrahepatic bile ducts. The purpose of this study was to identify factors predicting technical success in opacifying the biliary tree through biloma injection and to report complication rates associated with this technique.

Materials: In this retrospective study, 22 patients (11 male, median age = 57 years) underwent 24 PBD placement procedures involving attempted cholangiography via biloma injection between 2007 and 2016. Medical records were reviewed to determine clinical history and outcomes. Multivariate logistic regression was used to identify variables correlating with successful opacification of intrahepatic bile ducts via extrahepatic biloma injection.

Results: Bile leaks were diagnosed on the basis of fluid analysis (n = 5), HiDA scan (n = 7), intraoperative (n = 4) or percutaneous cholangiography (n = 2). The inciting injury was cholecystectomy (n = 9), partial hepatectomy (n = 6), liver transplant (n = 4), or Whipple procedure (n = 3). PBD placement was attempted a median of 31 days after the inciting injury (range = 3 to 191). After biloma injection, sufficient contrast refluxed into the intrahepatic bile ducts to allow PBD placement in 15 procedures. In the remaining 9 procedures, intrahepatic bile ducts were not opacified; conventional PTC using blind passes was successful in 6 of these procedures. Longer time since inciting injury (p = 0.04) and immunocompetence (p = 0.04) correlated with successful opacification of intrahepatic ducts for PBD placement. No episodes of cholangitis were observed.

Conclusions: Extrathepatic biloma injection for cholangiography prior to PBD placement is a safe technique that is more likely to be successful in chronic bilomas in immunocompetent patients, presumably because these factors are associated with mature encapsulation of the biloma, thus allowing the collection to be pressurized.

Abstract No. 632
Alternative management of chronic iatrogenic biliary leaks by embolization with covered plugs, liquid embolics, and retrievable stents

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Purpose: Conventional approaches to biliary leaks rely on percutaneous biliary diversion drains and/or surgery. Refractory leaks face limited alternative options. Use of embolization in biliary leaks is only described in case reports and small series. This study describes initial experience treating refractory biliary leaks with microvascular plugs (MVP), liquid embolic agents, and retrievable metallic stents.

Materials: A single-center, retrospective review from 1/2011 to 9/2016 examined medical records and imaging to identify iatrogenic biliary leaks refractory to conventional management wherein alternative interventions using MVPs, liquid embolic agents, and retrievable stents were performed. Clinical follow-up was conducted with cholangiography, labs, and drain observation.

Results: Four (n = 4) patients underwent subtotal hepatectomy: three for cholangiocarcinoma and one for metastatic colon adenocarcinoma;
all four were diagnosed with biliary leaks. An average of 4.25 conventional procedures ($\bar{x} = 2.88, 0-6)$ including percutaneous biloma drain, percutaneous transhepatic biliary drainage (PTBD), and serial PTBD exchanges were performed per patient over an average of 161 d ($\bar{x} = 134, 25-330$) with refractory leaks. Two patients also had failed repeat revision laparotomy. Subsequently, one patient had seven total alternative procedures, four with N-butyl cyanoacetate (n-BCA) for tract embolization and three with sodium tetradecyl sulfate (STS) foam for biloma sclerotherapy. The other three patients had one biliary embolization procedure each with either n-BCA, an MVP, or an MVP plus a metallic retrievable stent. All patients had complete resolution of clinical, laboratory, and radiographic findings of biliary leak after an average of 52 d ($\bar{x} = 81, 1-173$) from initial alternative treatment. No complications are known. Two patients are deceased secondary to underlying malignancy; two remain under active surveillance.

**CONCLUSIONS:** Alternative approaches to biliary leaks include embolization with n-BCA, STS, MVP, and stents. These methods show early promise regarding both efficacy of treatment as well as rapidity of leak resolution versus conventional means (52 d vs. 161 d, $p = 0.21$). Larger trials are needed.

**Abstract No. 633**

**Interventional management of postoperative gastrointestinal fistula and leakage**

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**PURPOSE:** 1) To discuss fistulas in the digestive tract including clinical and therapeutic features, and imaging modalities. 2) To give an overview of the various interventional management of fistulas in the digestive tract.

**MATERIALS:** Postoperative gastrointestinal (GI) fistula represents a major complication of gastrointestinal surgery, leading to increased postoperative morbidity; it the foremost cause of mortality after intestinal resection. Identification of risk factors is essential for the prevention. GI fistula can present with various clinical pictures, ranging from the absence of symptoms to life-threatening septic shock. As an alternative to surgery, recent technical advances in interventional radiology and percutaneous techniques have been shown as advantageous to lower the morbidity and mortality rate, and allow for superior accessibility to the fistulous tracts via the use of fistulography.

**RESULTS:** 1) Introduction 2) Clinical Features of GI Fistulas 3) Imaging Modalities of GI Fistulas 4) Interventional Management of GI Fistulas

**CONCLUSIONS:** Interventional management of GI fistulas is a valuable non-surgical therapy for seriously ill patients and is a comprehensive treatment option that includes percutaneous drainage and several other interventional procedures.

**Abstract No. 634**

**The balloon-assisted gastrostomy (BAG): an alternative push technique for placing large bore soft gastrostomy tubes**

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**PURPOSE:** Placement of feeding tubes by interventional radiologists (IR) is an effective and safe procedure. Traditionally, small bore pigtail tubes were placed and then later upsized. Specially designed, larger peel-away sheaths now allow large bore gastrostomy tube placement de novo. We describe our experience with a procedure that avoids dilators by utilizing a standard angioplasty balloon placed coaxially within the tube to provide one step dilatation and advancement into the stomach.

**MATERIALS:** After institutional IRB approval, the medical records of 50 consecutive patients were reviewed. Of these patients, 12 had ALS, 32 had head/neck cancer, 1 had gastroparesis, and 15 had another underlying diagnosis. The mean age was 61.93 years (SD 12.21). Sedation time, fluoroscopy time, radiation dose, and short and long term complications were recorded.

**RESULTS:** Out of 50 procedures, 48 were technically successful; 2 could not be completed due to lack of a percutaneous gastric window. 45 procedures were done with moderate sedation while 3 were completed with local bupivacaine only. At the time of writing, 70.8% of tubes remained in the patient, 25% were removed for completion of therapy, and 4.2% were removed due to patient death. None were removed for complication.

**CONCLUSIONS:** The BAG is an alternative push method for placing de novo 20 French gastrostomy tubes without the pain and inconvenience of multiple dilators. The procedure is well tolerated with minimal or no sedation, making it ideal for patients with neurologic dysfunction (ALS) or head and neck cancers with obstructing tumors.

<table>
<thead>
<tr>
<th>Complications</th>
<th>n (Percent of total)</th>
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<tr>
<td>Minor Complication</td>
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<tr>
<td>None</td>
<td>40 (83.3%)</td>
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<tr>
<td>Pain with T-fasteners</td>
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<td>Early T-fastener removal</td>
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<tr>
<td>Infection at insertion site</td>
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<tr>
<td>Granulation tissue</td>
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<tr>
<td>Generalized abdominal pain</td>
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<tr>
<td>Major Complications</td>
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<td>Death related to procedure w/in 30 days</td>
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Abstract No. 635

Subhepatic ectopic pregnancy: image-guided intervention

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PURPOSE: To provide a novel treatment option for termination of a sub- hepatic ectopic pregnancy. An illustrative case report and review of the literature will be provided.

MATERIALS: A 29-year-old female G7P1051 presented to an outside Emergency Department with abdominal pain and was found to have a positive urine pregnancy test. Pelvic sonography failed to reveal an intrauterine pregnancy. Upon further investigation, a subhepatic ectopic pregnancy was confirmed in Morrison’s pouch. Upon transfer, sonography revealed a gestational sac with fetal pole in the hepato- renal space measuring 8 weeks 5 days gestational age. The serum beta-hCG was elevated measuring 37455 mIU/mL. The right upper abdominal quadrant location was further evaluated on MRI. Multidis- ciplinary consensus between interventional radiology, pediatric radiol- ogy, and obstetrics and gynecology was that the best treatment option was percutaneous injection of methotrexate into the gestational sac and potassium chloride into the fetal thorax.

RESULTS: Sonographic evaluation was performed with the patient in a left posterior oblique position under moderate sedation. The gesta- tional sac was verified in the hepatorenal fossa. Using a subcostal trans-hepatic approach, a 20-gauge Chiba needle (Cook Medical Inc., Bloomington, Indiana, U.S.A) was inserted into the gestational sac. Methotrexate 25 mg was injected directly into the gestational sac. The needle was then repositioned into the fetal thorax and potassium chloride 16 mEq was injected into the fetal heart. Fetal cardiac activity was monitored throughout the performance of the procedure with docu-mentation of cardiac activity prior to treatment and cessation noted upon treatment completion. The needle was then removed and a ster- ile adhesive bandage was applied to the puncture site. The patient was transferred back to her room in stable condition. Sonography performed on postoperative days #1 and #5 confirmed the absence of fetal cardiac activity. The serum beta-hCG values were also noted to be decreasing.

CONCLUSIONS: Feticide by percutaneous injection of both methotrex- ate and potassium chloride is a safe and effective option for the treat- ment of a subhepatic ectopic pregnancy.

Abstract No. 636

Improving the yield of repeat CT-guided musculoskeletal lesion sampling following a non-diagnostic biopsy: tips and tricks to make second time the charm

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PURPOSE: Adequate and precise sampling of suspicious musculoskel- etal (MSK) lesions is becoming increasingly important in an era of emerging targeted therapies. Strategies and success rates for initial percutaneous image-guided biopsy of MSK lesions have been well documented; however, success rates for repeat MSK biopsy (RMB) fol-lowing initially non-diagnostic sampling of MSK lesions have not been well documented in the literature. The purpose of this study is to 1) evaluate the success rates of CT-guided RMB following initial non-di- agnostic sampling at a single large academic medical center and 2) describe strategies that may help increase RMB success rates.

MATERIALS: IRB approval was obtained for this retrospective study. A search of the electronic medical record yielded 42 patients that received 1 or more repeat biopsies for a single musculoskeletal patho-logic process, defined as a lesion (or group of similar lesions in dis- parate locations) in the skeleton, extremities, or wall or musculature of the pelvis, abdomen, or chest after an initial non-diagnostic biopsy attempt. Lesion location, initial and RMB imaging and histopathology results, type and size of biopsy needle, and change in technique and/ or biopsy strategy between biopsy attempts was documented. Suc- cessful repeat biopsy attempts were categorized as employing 1 of 5 technique strategies to improve diagnostic yield.

RESULTS: Four of 42 patients were excluded due to lack of final histo-pathology results for the first or second biopsy attempt. 24 of 38 (63%) RMB attempts were successful. Most common results for successful RMB were neoplasm in 18/24 (75%) and infection in 3/24 (13%). Suc- cessful RMB were described as employing 1) Improved lesion targeting using prior diagnostic MRI or CT (9/24), 2) specific targeting of a soft tissue component of the lesion (6/24), 3) increasing number/size of core-biopsy samples (4/24), 4) targeting an enhancing portion of the lesion as seen on prior contrast-enhanced MRI (2/24), 5) sampling a separate lesion (2/24), and 6) no change in strategy (1/24).

CONCLUSIONS: Repeat image-guided biopsy of MSK lesions can often yield new diagnostic information, and certain strategies may optimize success rates.

Abstract No. 637

Utility of cone-beam CT in complex non-vascular cases

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PURPOSE: To illustrate the utility of cone-beam CT (CBCT) in complex non-vascular procedures through presentation of a four case series.
abstract no. 638

Reducing the need for narcotics: the role of the interventional radiologist in palliative care pain management

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purpose: 1. To review interventional pain procedures and the advantages they hold for patient management. 2. To review case examples where IR and palliative care positively impact patient care and quality of life. 3. To illustrate a model of where palliative care and IR clinicians work together to achieve rapid and improved pain control.

materials: A patient in severe pain is an emergency that needs to be evaluated and treated quickly, particularly for those with end-stage disease on the palliative care service. Large doses of opioids and adjuvants are the mainstay of treatment for many physicians unfamiliar with interventional options for therapy. Opioids are sedating and may be incompletely effective, particularly in patients with neuropathic pain. In such situations, an IR procedure may relieve pain far faster than the time it takes for radiation and/or chemotherapy to be effective. A pretherapeutic IR pain procedure may allow the definitive treatment to be better tolerated and more likely to be completed.

results: We present a series of clinical vignettes in which the palliative care clinician works closely with interventional radiology to provide better pain management than was possible with either therapy alone. The decision-making process including patient selection, choice of procedure, equipment and follow-up are described. Case histories and diagnostic and procedural images are presented for each case. Cases will stress indications and contra-indications as well as risks, benefits, and complications. Procedures include: epidural steroid injections, nerve root and facet blocks, vertebral augmentation, celiac ganglion impolr block for perineal and pelvic pain, trigeminal ganglion and sphenopalatine blocks for facial pain and spinal pumps and stimulators for pain and spasticity.

conclusions: IR can play a significant role in optimal pain management of palliative care patients by providing better pain control and reducing narcotic dependence. It is incumbent on all IR physicians to have knowledge of the variety of procedures that can be offered and to collaborate with our palliative care colleagues to provide optimal care for all of our patients.
CONCLUSIONS: Our method for CT-guided CGN is easily reproducible, precise, and well-tolerated by patients. Our method is more accurate and less prone to vascular and neurologic complications than fluoroscopically and anatomically guided techniques utilizing a posterior approach. Unlike EUS-guided techniques, our method allows for direct visualization of the injected solutions, and it is better tolerated by poor anesthesia candidates.

Abstract No. 640

Advantages and disadvantages of cone-beam CT for pediatric interventions

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PURPOSE: Illustrate the advantages and disadvantages of cone-beam CT (CBCT) as an alternative to conventional CT guidance and an adjunct to angiography.

MATERIALS: CBCT was performed on both single and biplane units for biopsy guidance. 3-D angiography was utilized to plan and guide vascular interventions. CBCT images are compared side-by-side to conventional CT images both for image quality as well as radiation dose.

RESULTS: There is a steep learning curve to optimize utilization of CBCT. We found that CBCT reliably identifies high-contrast lesions. However, the lower dose and decreased penetration of CBCT resulted in poorer visualization of low-contrast lesions. Also, CBCT can be degraded by streak artifact from hardware or dense contrast. The relatively narrow field of view can be restrictive for peripherally located lesions in larger patients. However, the anatomic display is adequate for guidance in most instances. These findings are illustrated in a series of CBCT-guided cases including pulmonary nodule localization, osteoid osteoma ablation, ABC sclerotherapy, renal AV fistula embolization, and liver lesion biopsy.

CONCLUSIONS: The advent of CBCT as an adjunct modality in the IR suite has significantly decreased the use of conventional CT guidance and significantly decreased the radiation dose in children. We have found CBCT to be a practice changer.

Abstract No. 641

The role of adjunctive techniques in pediatric primary antegrade percutaneous gastrostomy and gastrojejunostomy tube placements

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PURPOSE: To describe our experience utilizing adjunctive techniques to increase the safety and success of primary antegrade percutaneous gastrostomy (G) and gastrojejunostomy (GJ) tube placements in a subspecialty of children.

MATERIALS: A retrospective review was performed to identify primary antegrade percutaneous G- and GJ-tubes placed using adjunctive techniques over a 10-year period. 16F Corpak Gastrostomy and 6F Cor-flo jejunostomy tubes (CORPAK MedSystems, Inc., Buffalo Grove, IL) were placed.

RESULTS: Seven primary placements (4 GJ- and 3 G-tubes) using adjunctive techniques in seven children were identified, median age 2.9 years (4 months–12.8 yrs), mean weight 14.4 kg (4.5–31 kg). Adjunctive techniques included the use of low dose C-arm CT guidance for more adequate determination of a percutaneous window in 2 cases, for confirmation of intra-gastric needle location in one case, and for confirmation of final gastrostomy tube position in one case. Additionally, needle decompression of anterior jejunal loops, live percutaneous needle guidance using iGuide software, and inflation of a Fogarty balloon within the proximal duodenum to reduce gastric decompression following insufflation were each used in one case. Indications for adjunctive techniques included severe congenital scoliosis, capacious anterior colon, post-conjoint twin separation, history of jejunal atresia, and rapid gastric decompression following insufflation which had precluded recent prior tube placement. No intra-procedural complications occurred. No major complications occurred during a follow-up consisting of a total of 5505 days of tube life. Mean procedure time was 80 minutes (35–120 min). Mean dose area product for procedures was 401.2 microGy-m² (17.6–1040 microGy-m²).

CONCLUSIONS: The use of adjunctive techniques in primary antegrade percutaneous G- and GJ-tube placements may be considered in particularly challenging anatomic situations to increase technical success, for example in children with scoliosis, aberrant intra-abdominal anatomy, or dilated jejunal loops precluding safe access into the stomach.

Abstract No. 642

Utility of intravascular ultrasound and pressure monitoring guidewire for pediatric renal artery angioplasty

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PURPOSE: To evaluate the clinical outcomes, safety, and efficacy of percutaneous transiunimal renal angioplasty (PTRA) in children with renovascular hypertension (RVH) treated at a single center over 9 years, including the adjunctive use of intravascular ultrasound (IVUS) and pressure monitoring guidewires.

MATERIALS: A retrospective review of data for hypertensive children (ages 1-18 years old) who underwent PTRA at a single center between October 2007 and August 2016 was performed. Patients who were either posttransplant or posturgery were excluded. Procedural angiograms, along with available IVUS imaging and pressure measurements, were reviewed and correlated with chart data to determine safety, technical success, and clinical outcome. We defined clinical success as reduced medication units, as described by Srinivasan et al.
or resolution of hypertension in postintervention nephrology or PCP follow-up.

RESULTS: A total of 22 children underwent 34 PTRA procedures. 9 children had angiographic findings of fibromuscular dysplasia (FMD), 5 had Williams syndrome, and 2 had neurofibromatosis type 1. Technical success was achieved in 33 of 34 (97.1%) procedures. Intra-arterial IVUS was used in 4 of 34 (11.8%) procedures and pressure monitoring guidewires in 10 of 34 (29.4%) procedures. The number of complications encountered, all minor, was 4 of 34 (11.7%) procedures. Postintervention, antihypertensive medication units were decreased in 15 of 22 (68.2%) children with a cure in 8 of 22 (36.4%). In the 10 procedures utilizing pressure monitoring guidewire, 5 (50%) obtained clinical success compared to 15 of 24 (62.5%) procedures without a guidewire. The most recent 6 procedures utilizing pressure monitor guidewire were clinically successful.

CONCLUSIONS: PTRA provided clinical benefit in 15 of 22 children with RVH (68.2%), which is concordant with previously published series. Use of intravascular ultrasound and pressure monitoring guidewire may increase the accuracy of intervention. Further investigation is necessary to determine the clinical success rate of PTRA in children which can be improved with the use of these tools.

Abstract No. 643

“Out and about”: the development of IR ambulatory centers

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PURPOSE: To define what an interventional radiology ambulatory surgery center is and explain the reasoning behind a growing trend of IRs shifting procedures from the hospital to a free standing ambulatory center, especially during the current transition of IR to a standalone specialty. Understand why insurers are pushing for cases to be moved from the hospital to ambulatory centers and explore the cost savings across the board by making this push. Learn about existing and upcoming surgical CPT codes for IR, enabling an ambulatory surgical center to bill and collect outpatient IR surgical facility fees. Identify barriers and conflicts to the development of such ambulatory surgery centers.

MATERIALS: In the past, ownership of imaging centers was lucrative for radiologists. The technical reimbursement radiologists received quickly declined to the point that ownership led to red bottom lines. However, in regards to an IR ambulatory surgery center, reimbursement is based on a CPT coded facility fee. Insurers favor the idea of procedures being performed in such a center as opposed to a hospital setting due to the significant cost savings. IRs belonging to a center can benefit from a facility fee in addition to a professional fee. Additionally, with the transition of IR to its own specialty, an ambulatory center will help further define the field and expand the referral base.

RESULTS: Until recently, IR has often been viewed as a service rather than a specialty. This has resulted in an artificial cap on referrals from other specialties. With the advent of an ambulatory center and the growing scope of facility fee reimbursements, the range of referral sources broadens significantly, as the center contributes to the fact that IR is a standalone specialty. Forward development of these centers also comes with barriers and conflicts. Competition from the hospital is the easiest to perceive. Additionally, legal issues such as accreditation and compliance also come into play.

CONCLUSIONS: As IR continues to grow, the creation of IR ambulatory surgical centers will result in overall health care cost savings, bring in more revenue to IRs, and help continue solidify IR as its own specialty.

Abstract No. 644

Establishing a trainee-run IVC filter retrieval clinic

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PURPOSE: 1. Indications for an IVC filter 2. Complications of an IVC filter 3. Latest FDA recommendations for retrieval 4. How to design an IVC filter retrieval clinic

MATERIALS: IVC filters (IVCF) protect against PE, but not without complication risks, including IVCF fracture, strut penetration, and migration. The majority of IVCF placed today are retrievable, although the majority of patients are lost to follow-up. In 2014, the FDA referred to a model suggesting that if the patient’s transient risk for PE has passed, the risk/benefit profile begins to favor removal of the filter between 29 and 54 days after implantation. An IVCF retrieval clinic may be an effective means to ensure adequate follow-up and potential removal of IVCF that are no longer needed.

RESULTS: A trainee-run IVCF retrieval clinic is proposed to establish a baseline retrieval rate and demonstrate the effectiveness of the protocol. Control group: 6 months of patients with IVCF, who will undergo current management. Retrospective group: Comprises a subsequent 6 months of patients. The resident team will send letters to the patient and PMD, advising IR follow-up. Prospective group: Inpatients receiving an IVCF, who will have a letter and refrigerator magnet, supplied by the device manufacturer, placed on their chart. The assisting resident or fellow will use a macro in their dictation and postprocedure note, advising the ordering physician for IR follow-up after discharge. The plan is for a 6-week post-IVCF placement appointment (within the FDA’s referral to 29-54 days). A 6-week follow-up letter will be sent to the patient and PMD by the IR PA, as a reminder. The clinic will be staffed by residents and fellows, who will assist in determining eligibility. If eligible, the patient will be booked for IVCF retrieval.

CONCLUSIONS: The updated FDA statement is a useful guide in IVCF management. An organized trainee-run clinic could be a strong resident/fellow learning tool in clinical management and quality improvement. Research has shown that an IVCF retrieval clinic facilitates an increase in retrieval rate and an increase in revenue. Added benefits may include IR’s greater ownership of patient care and more referrals.
**Abstract No. 645**

**Best sterile practice for increasingly complex interventional computed tomography (CT) procedures**

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**PURPOSE:** Identify best practice recommendations for sterile room and patient preparation in complex image-guided interventions performed in the CT suite.

**MATERIALS:** Over past decades, increasingly complex interventional procedures have been performed in the CT environment. Traditionally, biopsies, abscess drainage catheter placements, and pain injections were performed. In recent years, more complex interventions are being performed with CT-guidance including percutaneous ablation procedures, screw fixations, sacroplasty, and osteoplasty. Soloman and Silverman reported such interventions require intra-procedural targeting, multiplanar guidance, and post procedure imaging where CT and CT fluoroscopy have proven essential. While CT is superior for these complex interventions, the environment was not designed to the strict sterile conditions of the operating room (OR).

**RESULTS:** The National Academy of Sciences / National Research Council categorize procedures into four categories: clean, clean-contaminated, contaminated, and dirty. Clean and clean-contaminated must be performed under absolute sterile technique, modeling the OR. However, CT suites were not constructed to perform these complex interventional procedures. A unique aspect during CT procedures is the movement of the patient in and out of the gantry. Maintaining sterile integrity of accessory equipment needed for these procedures including ablation probes and cables, grounding pads, and hardware is a challenge and poses a safety concern. Strategies to address these obstacles including patient prep, gantry, and equipment draping protocols will be presented.

**CONCLUSIONS:** Interventional radiology is performing increasingly complex procedures in the CT environment. Oncologic patients, often immunosuppressed along with the implantation of hardware demand absolute sterile technique. Although many institutions are moving their suites “behind the red line,” there is a need for updated sterile techniques for increasingly complex interventional procedures performed within CT.

**Abstract No. 646**

**Utilization of time-driven activity-based costing in interventional radiology**

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**PURPOSE:** To familiarize interventional radiologists with time-driven activity-based costing (TDABC) and how it may be utilized to accurately measure costs associated with a treatment pathway.

**MATERIALS:** In order to meet the challenges faced by modern healthcare delivery systems, efficiency is crucial for maximizing resources and providing value to patients. In healthcare, value is measured by patient outcomes relative to the costs incurred to achieve those outcomes. However, accurately determining costs is challenging because of the fragmentation of how medical care is delivered. In efforts to more accurately measure cost associated with a treatment pathway, TDABC determines the value of each step in a given pathway based on its rate of consumption of clinical and/or administrative resources. In addition, TDABC can provide valuable insight into time-management and resource allocation decisions that may be leveraged to provide the best value to patients.

**RESULTS:** An IR department can create a process map for each procedure or condition utilizing the following steps: 1. Define a condition and determine the scope of its care cycle. 2. Identify all activities within the care cycle. 3. Identify resources provided and consumed by each activity. 4. Assign time estimates for each activity. 5. Determine supply cost associated with each resource. 6. Determine the capacity of each resource provider. 7. Determine the capacity cost rate of each resource. 8. Multiply capacity cost rate of each resource by the amount of time the given resource was utilized by the patient. 9. Sum all resource cost rates to determine total cost rate of the care cycle.

**CONCLUSIONS:** TDABC analysis can be used in IR to objectively demonstrate and improve value. It provides a framework to accurately calculate costs based on resource consumption rates across a treatment pathway. In addition, it helps identify wasteful processes that contribute little to patient outcomes and ultimately encourages IR departments to utilize improved practices to increase efficiency, reduce costs, and maximize patient value.

**Abstract No. 647**

**Optimizing cost and workflow: a quality improvement initiative in outpatient placement of gastrostomy tubes**

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**PURPOSE:** The current practice for outpatient placement of percutaneous gastrostomy tubes (G-tubes) by interventional radiology (IR) at our institution is overnight admission and fluoroscopic G-tube check the next morning, prior to initiation of enteral feeding. Our primary objective is to examine the clinical need for routine admission and next day G-tube checks. Secondarily, we aim to quantify the potential cost savings of a policy change.

**MATERIALS:** There are both IR and gastroenterology (GI) data which shows no significant difference in complication rates between same day discharge versus admission and also show safety in early enteral use of the G-tube in properly selected patients.

**RESULTS:** 93 outpatients who underwent new G-tube placement from 2011-2016 were included. All next day fluoroscopic G-tube tube exams were normal. Median and mean length of stay (LOS) were 1.0 and 1.6 days, respectively. 26% had a LOS >1 day: 11 related to nutrition, 7 of 11
Air embolism: diagnosis, clinical management, and outcomes

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Purpose: Air embolism is a rare but potentially fatal complication in a wide range of endovascular procedures including angiography and venous access. A high degree of awareness among interventional radiologists is essential for rapid recognition, as proactive management is critical for reducing morbidity and mortality. We sought to characterize 67 cases of air embolism cases to understand their causes, symptoms, clinical management, morbidity and mortality and outcomes.

Materials: This IRB approved retrospective study reviewed our experience with air embolism during medical procedures at a tertiary medical center. Electronic medical and radiology records were data mined for all cases of air embolism over a 25-year period; patients with imaging evidence or high clinical suspicion of air embolism fulfilling the inclusion criteria and an antecedent event that could cause air embolism were identified. Variables including location of the event, immediate signs/symptoms, outcome at discharge and treatments utilized were noted and analyzed. Statistical analysis to assess for differences between groups of patients was performed using Fisher’s exact test.

Results: 67 air embolism cases were identified; mean age was 59 years (range 3-89). 94% occurred in hospital, of which 77.8% were during an operation/invasive procedure. Vascular access-related procedures (33%) were the most commonly associated with air embolism. Clinical signs and symptoms were related to the location of the air embolus; 36 cases to the right heart/pulmonary artery, 21 to the cerebrum, and 10 were attributed to patent foramen ovale. 21% of patients underwent hyperbaric oxygen therapy, 7.5% aspiration of the air and 63% had no sequelae. Mortality rate was 21%; 69% died within 48 hours. 13 patients had immediate cardiac arrest where mortality rate was 53.8%, compared to 13.5% (p = 0.0035) in those without.

Conclusions: Air emboli are mainly iatrogenic, primarily associated with endovascular procedures. Mortality rate is high; high clinical suspicion and early treatment is critical for survival.
radiologists to provide the best possible care to patients suffering from portal hypertension.

**Abstract No. 650**

A simplified algorithmic approach for the treatment of Budd-Chiari syndrome

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**PURPOSE:** To describe the use of a simplified algorithmic approach for the treatment of patients with chronic Budd–Chiari syndrome.

**MATERIALS:** Budd–Chiari syndrome (BCS) is a complex disorder with various interventional treatment options, including recanalization of the hepatic venous outflow and transjugular intrahepatic portosystemic shunts. Significant variation in patient symptomatology and morphology of the obstructive hepatocaval lesion is encountered, based on which an appropriate treatment option is chosen. An algorithmic approach is useful when treating this wide disease spectrum.

**RESULTS:** Eighty-nine consecutive patients with symptomatic chronic BCS were considered for interventional radiological treatment. Depending on the extent and morphology of occlusive disease, a stepwise treatment strategy was employed using various interventional procedures such as hepatic vein stenting, IVC stenting, complex hepato-caval stenting, TIPS, and IVC stenting combined with TIPS. A simplified algorithmic approach is described using these assorted treatment options in a systematic manner.

**CONCLUSIONS:** BCS is a complex disorder with variable treatment options that depends largely on the morphology of hepatic venous outflow obstruction. An excellent clinical outcome is obtained with the use of this simplified approach.

**Abstract No. 651**

Management of prehepatic portal hypertension secondary to portomesenteric stenosis or occlusion in the setting of necrotizing or chronic pancreatitis

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**PURPOSE:** 1. Review venous complications of pancreatitis. 2. Review basic principles of transhepatic portomesenteric venoplasty and stent placement. 3. Share institutional experience in the management of prehepatic portal hypertension secondary to portomesenteric venous stenosis or occlusion

**MATERIALS:** Portomesenteric venous stenosis or occlusion is a well-known complication of pancreatitis and may cause abdominal pain, variceal hemorrhage, or ascites. Significant portomesenteric venous stenosis warrants urgent intervention, as it may progress to complete thrombosis and subsequent bowel infarction. This exhibit will report our institution’s experience in the percutaneous treatment of symptomatic portomesenteric venous obstruction related to pancreatitis.

**RESULTS:** Retrospective review from March 2014 to June 2016 yielded a total of 7 patients treated for portomesenteric obstruction due to necrotizing pancreatitis (6) or chronic pancreatitis (1). Six patients were found to have hemodynamically significant stenosis of the portal and/or superior mesenteric veins, and one patient had main portal vein occlusion. In all patients, portal access was obtained via a transhepatic approach and all lesions were successfully crossed. One patient was treated with venoplasty alone, and 6 patients were treated with venoplasty and stenting. All patients had resolution of the venous pressure gradient. In all cases a good clinical response was achieved with resolution of symptoms related to prehepatic portal hypertension including: pain, ascites, and bowel edema. Complications were subcapsular hematoma in two patients, one of which required right hepatic artery embolization.

**CONCLUSIONS:** Portomesenteric venous stenosis or occlusion may complicate chronic or acute necrotizing pancreatitis. The resultant prehepatic portal hypertension may lead to the development of abdominal pain, ascites, variceal hemorrhage, portal vein thrombosis, or bowel infarction. Portal and mesenteric venoplasty alone or more often with stent placement can be a safe and efficacious therapeutic option.

**Abstract No. 652**

Systematic review of transsplenic portal venous access

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**PURPOSE:** Transsplenic portal venous (TSPV) access is increasingly utilized for interventions involving the portal venous system and associated variceal pathology, especially in cases of portal vein thrombosis or when sparing a future liver remnant from percutaneous intervention. The purpose of this study is to systematically review the efficacy and risk of TSPV interventions in the published literature.

**MATERIALS:** A MEDLINE (PubMed) search from June 1954 to August 2016 was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Search parameters included studies in the English language with adult human subjects receiving TSPV access for any indication. Intervention type, reason for TSPV access, needle and sheath size, and technical success were recorded. Major and minor complications were defined by the Society of Interventional Radiology Clinical Practice Guidelines.

**RESULTS:** Twenty-one studies consisting of 156 patient-cases (mean age 51 years, range 22-74) met the inclusion criteria. There were 9 retrospective reviews and 12 case series/reports. Portal interventions performed after TSPV access included variceal embolization (n = 76), portal vein recanalization with transjugular intrahepatic portosystemic shunt (n = 50), portal vein embolization (n = 26), portal vein angioplasty/portal vein stenting (n = 10), and splenic vein covered
Failure or pulmonary edema in 2% of cases and sepsis in 1%.
Renal failure in 3% of cases, hepatorenal syndrome in 2% of cases, heart
respectively. The incidences of other complications were as follows:
Worsening liver dysfunction was observed in 4% and 5% of the cases
Gastrointestinal or variceal bleeding and worsening or new onset hepatic encephalopathy was the major complica-
tion with an incidence of 41%. Gastrointestinal or variceal bleeding and
worsening hepatic encephalopathy is the most worrying complication although these articles report that many of the
cases were subclinical and did not warrant further therapy. Complica-
tion rate apart from hepatic encephalopathy is low.

Abstract No. 653
Updated systematic review on outcomes of transjugular intrahepatic portosystemic shunts for refractory ascites
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PURPOSE: Cirrhotic patients commonly present with ascites that is refractory to medical treatment. Repeated large volume paracentesis is often required for symptom alleviation in these patients. Transjugular intrahepatic portosystemic shunts (TIPS) provide a viable therapeutic alternative and precludes the necessity for repeated paracentesis and its associated risks such as infection and organ injury. We aim to provide an updated systematic review on the clinical outcomes of TIPS used for refractory ascites.

MATERIALS: The MEDLINE and Embase databases were searched from 1990 to January 2015 for randomized control trials and retrospective studies evaluating the clinical outcomes of TIPS in patients with refractory ascites. Relevant data were extracted from the final list of articles following scrutiny of their methodological quality. SPSS software, version 17 (SPSS, Chicago, IL) was used for statistical analysis.

RESULTS: A final list of 11 articles including a total of 514 patients were selected. TIPS placement had a technical success rate of 97% with 57% of patients achieving symptom alleviation within 30 days of the procedure. Portosystemic pressure gradient was reduced from a mean of 20.8 to 9.1 mm of Hg. Shunt insufficiency or dysfunction was observed in 17% of the cases with frank occlusion occurring in 8% of them. Worsening or new onset hepatic encephalopathy was the major complication with an incidence of 41%. Gastrointestinal or variceal bleeding and worsening liver dysfunction was observed in 4% and 5% of the cases respectively. The incidences of other complications were as follows: renal failure in 3% of cases, hepatorenal syndrome in 2% of cases, heart failure or pulmonary edema in 2% of cases and sepsis in 1%.

CONCLUSIONS: TIPS has an excellent technical success rate and provides symptom alleviation in a proportion of cases that are refractory to medical treatment. Worsening hepatic encephalopathy is the most worrying complication although these articles report that many of the cases were subclinical and did not warrant further therapy. Complication rate apart from hepatic encephalopathy is low.

Abstract No. 654
The left-to-left TIPS
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PURPOSE: To describe the left-to-left transjugular intrahepatic portosystemic shunt (TIPS) procedure and to evaluate its clinical and technical indications, efficacy, and safety. Left-to-left TIPS is defined as left or middle hepatic vein (HV) access to the left main or branch portal vein (PV).

MATERIALS: From September 2010 through December 2015, a total of 23 left-to-left TIPS procedures were performed. Clinical indications were as follows: refractory ascites (n = 10); refractory ascites + hydrothorax (n = 1); refractory ascites + progressive PV thrombosis (n = 2); progressive PV thrombosis (n = 5); variceal bleeding (n = 8); recurrent variceal bleeding + failed right TIPS (n = 1); occlusion of right TIPS (n = 1). Pre-TIPS liver CT or MRI and TIPS creation procedure angiograms were retrospectively reviewed.

RESULTS: Twenty-two of 23 (96%) left-to-left TIPS creations were technically successful. One left-to-left access was successful but an exaggerated tortuous wire course could not be reduced; a right-to-right access was secured, allowing for successful TIPS creation. Technical considerations for the left-to-left TIPS approach were: small right PV, larger left PV (n = 7); diseased right HV (n = 2); no right PV (n = 2); extra-hepatic right PV (n = 1); right TIPS thrombosis and need for new, parallel TIPS creation (n = 1); no dominant or early arterizing main right PV (n = 4); right liver hepatocellular carcinoma (HCC) (n = 2); right liver HCC + right PV thrombosis (n = 1); cavernous right PV (n = 1); hepatofugal portal venous flow (n = 1); non-specific (n = 1).

CONCLUSIONS: Left or middle hepatic to left portal vein TIPS creation is technically feasible. This approach to transhepatic portal decompression is indicated in the appropriate clinical and technical settings.

Abstract No. 655
Percutaneous removal of stuck central venous devices: a task for interventional radiologists
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PURPOSE: Central venous devices can become retained to the wall of central veins, requiring removal though endovascular intervention or open sternotomy, possibly avoiding vascular injury or fracture of the catheter. The aim of this study is to identify the risk factors associated with the adherences formation of central venous devices and describe possible endovascular technical strategies for their removing.

MATERIALS: A retrospective single-center review of all central venous devices removal was performed from March 2012 to August 2016. Cases were retrieved from radiology reports. The device was defined
stuck if the catheter was classified irretrievable and a firm adherence to the venous vessel wall was demonstrated. Twenty-two patients, four of which presented superior vena cava syndrome, were attended to our center for endovascular removal because of the presence of stuck device.

RESULTS: Thirteen hemodialysis tunneled cuffed central venous catheters, 7 totally implanted venous access ports, 1 temporary catheter left in situ for 4 years and 1 ventriculoatrial shunt in situ for 40 years were removed in angiographic suite, except 1 tunneled cuffed femoral venous catheter, which required open surgery removal. 18 of 22 (81%) venous devices were successfully and completely removed through over-the-wire endoluminal balloon dilation, without any procedure-related complications. One case with the tip of the line attached to the leaflet of the tricuspid valve showed a small piece embedded to the tip after the percutaneous removal, but postprocedure period was uneventful. We noticed an association of stuck condition with long dwell time.

CONCLUSIONS: Stuck central venous device is uncommon, but probably underreported. The management of stuck lines is a task for interventional radiologists, using as initial approach the angioplasty balloon inside the lumen, which may represent a simple and safe technique in these complex cases.

Abstract No. 656

Use of the PowerWire radiofrequency guidewire in the treatment of chronic venous occlusions

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PURPOSE: This exhibit is designed to review the PowerWire Radiofrequency Guidewire and its use in the treatment of chronic venous occlusions.

MATERIALS: Chronic venous occlusions can occur in the setting of venous thromboembolic disease as well as in patients requiring hemodialysis and prolonged venous access. This condition can be associated with significant morbidity and in some cases, particularly in patients with SVC syndrome, can potentially be life threatening. Endovascular treatment options can be used in these patients but this is dependent on the ability of an interventionalist to cross the occlusion with a guidewire. This may occur in almost 25% of patients using standard catheter and guidewire techniques. The use of the PowerWire is a potential option for patients in whom standard techniques fail to result in guidewire passage across a chronic occlusion as a prelude to endovascular stent placement.

RESULTS: This teaching exhibit will review the construction of this wire and the mechanism by which it can be used in the treatment of chronic venous occlusions. The available literature will be reviewed to highlight the indications for treatment, the clinical outcomes that have been demonstrated, and the potential complications that may be associated with it use. Case studies will be provided to demonstrate the potential success that can result in this use of the PowerWire in patients with chronic venous thromboembolic disease, occluded TIPS stents, thrombosed dialysis access, and SVC syndrome.

CONCLUSIONS: The use of the PowerWire Radiofrequency Guidewire has significantly changed the approach to treating patients with chronic venous occlusions. Standard catheter and guidewire techniques are limited in their ability to treat all patients with this condition. The PowerWire has expanded the number of patients that can be treated by interventional radiology. However, the use of this wire must be accompanied by an understanding of the guidewire itself in addition to how the product should be used and its potential outcomes and complications.

Abstract No. 657

Denver peritoneovenous shunt outcomes: a systematic review

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PURPOSE: Malignant ascites (MA) occurs in as many as 50% of patients with cancer particularly in those with ovarian, colorectal and hepatobiliary tumors. MA is often refractory to sodium restriction and diuretic therapy and significantly deteriorates the quality of life of the patient. Peritoneovenous shunt (PVS) placement offers an alternative to repeated paracentesis and PleurX catheter placement in refractory cases. We conducted a systematic review elucidating the outcomes of Denver PVS placement with the aim of summarizing its role in current practice.

MATERIALS: The MEDLINE and Embase databases were searched from inception to June 2016 for papers that evaluated Denver PVS placement for management of refractory malignant ascites. Two reviewers independently reviewed and compiled a final list of relevant articles and extracted data pertaining to outcomes such as technical success, symptom alleviation and complication rate. SPSS software, version 17 (SPSS, Chicago, IL) was used for all analyses.

RESULTS: A total of 8 articles were finalized for data extraction including a total of 262 patients. A technical success rate of 100% was observed across all studies. Symptom alleviation was achieved in 82.4% of the cases. Shunt occlusion was observed in 9.9% of cases with a shunt revision/replacement rate of 5%. The shunt related mortality was 3.4%. Overall complication rate aside from shunt occlusion was 33.2% with disseminated intravascular thrombosis (7.6%), gastrointestinal bleeding (5%) and fever (4.2%) being most common.

CONCLUSIONS: Despite difficulty in maintenance of shunt patency and potential for other serious complications, Denver PVS placement is technically straightforward with excellent symptom alleviation rates and remains an attractive option for treatment of malignant refractory ascites. With appropriate patient selection Denver PVS can continue to be considered as a viable alternative in current practice.
Abstract No. 658

Pelvic congestion syndrome: iliac venous stenting or gonadal vein embolization—what way to go?

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PURPOSE: 1) To outline the pathophysiology of pelvic congestion syndrome (PCS); 2) to highlight the important pelvic venous anatomy seen in reflux disease; 3) to demonstrate similarities and differences in endovascular treatment approaches, i.e. gonadal vein embolization and/or iliac venous stenting in this disease entity; 4) which way to go—evidence based analysis.

MATERIALS: Pelvic venous congestion is a common, overlooked condition that can be severely painful for many middle-aged women. The term PCS specifically refers to the condition characterized by chronic, dull pelvic pain, pressure and heaviness that persists for longer than six months with no other cause. The underlying pathophysiology behind this condition is attributable to dilated tortuous and congested veins that occur within the pelvis, as a result of ovarian or internal iliac vein reflux. The majority of these patients undergo gonadal vein embolization, however iliac venous stenting may also be an equally successful treatment option in select patients.

RESULTS: A pictorial review of patients with nonthrombotic pelvic venous outflow obstruction will be illustrated. Specific attention will be made to highlight the important anatomical findings of PCS seen on cross-sectional imaging and/or pelvic venography. Treatment approaches and indications for gonadal vein embolization and iliac venous stenting will be outlined and demonstrated. Key technical points to consider with each method will be illustrated though case examples. Risks and complications to each method will also be shown.

CONCLUSIONS: In patients with pelvic venous incompetence, it is important to understand the venous anatomy when proceeding with endovascular treatment. Gonadal vein embolization and/or iliac vein stenting can both result in symptom improvement in these patients. It is of the utmost importance to understand the similarities and differences in each of these endovascular methods, and to determine the best strategy for each patient encountered.

Abstract No. 659

Stop the arterial bleeding? Recognizing rectal varices as a culprit in massive lower GI bleeding and portal hypertension

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PURPOSE: 1. Recognize rectal varices as potential source of rapid lower GI bleeding in patients with portal hypertension. 2. Describe methods of rectal variceal embolization and highlight potential pitfalls.

MATERIALS: Rectal varices may present as massive rectal bleeding in patients with portal hypertension. These patients come to the attention of the interventional radiologist when life-threatening rectal bleeding is refractory to endoscopic interventions such as banding, clipping, or direct injection of epinephrine or sclerosant. While it may be intuitive to attribute rapid GI bleeding to an arterial source, we need to keep in mind the possibility of rectal varices in this patient population so that prompt, appropriate intervention may be offered.

RESULTS: This educational poster will highlight awareness of ectopic varices in patients with portal hypertension. In particular, we focus on rectal varices as a cause of acute onset, massive lower GI bleeding in this patient population. A brief retrospective review of cases from our institution revealed that a majority of these patients have failed endoscopic therapies or may have presented to us with a request for mesenteric angiography to localize an arterial source of bleeding. At times, the interventional radiologist was the first clinician to recognize the presence of rectal varices. Astute detection and embolization of these lesions was crucial in resolving the acute hemorrhagic episode and contributed to rapid patient stabilization, allowing time for possible transplant and/or TIPS workup.

CONCLUSIONS: Acute, rapid lower GI bleeding can be life-threatening and difficult to treat. In patients with portal hypertension, this bleeding may stem from rectal varices rather than the more common arterial source. It is crucial for the interventional radiologist to rapidly recognize and treat rectal varices, as intravenous embolization or obliteration can effectively halt the bleeding when multiple endoscopic therapies have failed. The patient’s condition can rapidly stabilize following successful intervention, allowing time for transplant and/or TIPS work-up and, thus, the possibility of meaningful, long-term symptomatic improvement.

Abstract No. 660

An initial description of a novel embolic agent

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PURPOSE: To report our initial experience with the use of a new implantable, self-expanding vascular plug.

MATERIALS: Vascular plugs are permanent mechanical embolic devices that activate the clotting cascade leading to vessel thrombosis. The most popular plug is the Amplatzer Vascular Plug (AVP) which consists of a self-expanding nitinol mesh with a detachable deployment wire. However, a major issue with the AVP is the prolonged occlusion time and this is problematic in the embolization of high flow, large diameter vessels or in coagulopathic patients. The following report details our experience with the EMBA™ Hourglass™ peripheral embolization device. In contrast to the AVP, the Hourglass™ is designed to immediately obstruct or reduce blood flow in vessels sized 3-8mm in diameter.

RESULTS: The device consists of a self-expanding vascular plug in a preloaded catheter based system. The embolic implant is delivered on
a tri-axial catheter based system containing a guidewire, pusher and outer body which provides integrated contrast injection capability. A guidewire is inserted through a 0.018-0.035” selective catheter to the target. The catheter is removed and the device is advanced over the guidewire until the device and delivery system are in the desired location. The position and stability of the device is then checked under fluoroscopy by injecting contrast through the integrated delivery system before the device is deployed. Once the Hourglass™ has been deployed, the occlusion can be verified by injecting contrast through the delivery system. The embolic implant device is an hour glass shape with a covering on the proximal 50% and this covering is used to occlude the vessel. The shape and covering allows the rapid occlusion of the target vessel and stable placement of the device.

**CONCLUSIONS:** In our experience, the main advantages of the Hourglass™ are the rapid occlusion time, stability in the target vessel and precise delivery. This has several benefits including shorter operating times and a smaller likelihood of requiring other embolic agents such as coils due to an incomplete occlusion.

### Abstract No. 661

**A new catheter technique to correct severe IVC filter tilt**

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**PURPOSE:** IVC filter tilt leads to reduced filter efficacy and lower retrieval success. One way to mitigate tilting is retrieval and replacement of the filter, but routine methods of filter retrieval have a low success rate of only 73%. Advanced retrieval techniques have success rates of up to 95% but are associated with significantly higher rates of major complications such as IVC dissection, filter fracture with embedded strut, and IVC injury with hemorrhage. This study presents a new catheter technique to correct severely tilted cone-shaped IVC filters without having to retrieve and replace the existing filter.

**MATERIALS:** A retrospective review was performed for patients at our institution over the last three years who had severely tilted filters and underwent correction with the new technique. An SOS catheter was passed through the same femoral access used for the initial filter placement. The catheter tip was reformed inside the cone of the filter and the catheter shaft was curved against the IVC wall on the side of tilt to create counter pressure. The catheter tip was then used to push the filter tip towards the IVC midline. Once correction was achieved, the catheter was carefully pulled back to avoid entanglement in the filter struts. This was done under fluoroscopy, and completion venogram was used to document amelioration of tilt. Patient demographics, medical comorbidities, postprocedure outcomes, and complication rates were recorded and analyzed.

**RESULTS:** 28 patients had severely tilted IVC filters that were corrected using the catheter technique. 17 were male. Patient age ranged from 16-94yrs. 27/28 (96.4%) patients had successful correction of their filters back to mid-line of IVC. One (3.5%) had a minor complication where the filter struts became entangled with the catheter tip, however simple maneuvering of the catheter and use of a stiff wire to straighten the catheter loop freed up the entanglement. No major complications occurred.

**CONCLUSIONS:** The catheter technique for correcting severely tilted IVC filters had a high success rate of 96.4%. Compared to advanced filter retrieval techniques, this novel technique was associated with fewer complications and improved outcome.

### Abstract No. 662

**Mechanochemical endovenous ablation as a viable alternative to radiofrequency ablation and endovenous laser therapy for treatment of venous insufficiency**

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**PURPOSE:** Our exhibit will provide up to date information on mechanochemical endovenous ablation (MOCA), including latest data on efficacy and safety. Advantages and disadvantages over endovenous radiofrequency ablation (RFA) and endovenous laser therapy (EVLT) will be discussed.

**MATERIALS:** Mechanochemical endovenous ablation (MOCA) is a relatively new procedure for the treatment of varicose veins, which utilizes a rotating wire along with infusion of a liquid sclerosant to induce scarring of the venous endothelium. The procedure eliminates the need for tumescent anesthesia as utilized by RFA and EVLT techniques, and therefore removes the risk for heat related injury to the adjacent nerves, blood vessels, muscle and skin. Several studies have also reported reduced postprocedural pain and shorter recovery times of MOCA compared to RFA. Long term efficacy of MOCA remains an active area of interest. Several studies have documented comparable efficacy rates to RFA and EVLT at 12 months, while several others have suggested lower efficacy rates of MOCA compared to RFA and EVLT.

**RESULTS:** All articles evaluating efficacy of MOCA from June 2000 to June 2016 were included (n = 12), with 4 studies having follow up time equal to or greater than 12 months. Number of subjects, follow up time, efficacy rates, and complication rates were evaluated. A total of 281 treated veins were followed up at 12 months with efficacy rates ranging between 88.2% and 95%. Since the definitions of success rates differed between studies, a discussion and comparison of the various definitions as well as differences in techniques and methods will be provided. Additional studies which assessed postprocedural pain levels and recovery times will be discussed.

**CONCLUSIONS:** Mechanochemical endovenous ablation is a safe, feasible and efficacious technique for treatment varicose veins. Although some initial studies demonstrate decreased efficacy of MOCA compared to EVLT and RFA, reduced postprocedural pain and earlier resumption of normal activities may justify its use. Prospective comparison studies are needed for further comparison to RFA and EVLT.
Recanalization of chronic central venous occlusions: a review of current techniques

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PURPOSE: After reviewing this exhibit, the reader should be able to recognize the options available for endovascular treatment of chronic central venous occlusions, including imaging findings, techniques, and differential applications.

MATERIALS: Chronic central venous occlusion (CVO) can result from a number of pathologies, both benign and malignant. It is frequently encountered in patients with end stage renal disease undergoing hemodialysis, and is a significant source of patient morbidity and mortality. The incidence of CVO has been on the rise for the past decade, paralleling increased usage of tunneled central venous catheters and dialysis grafts. CVOs present challenging scenarios for interventional radiologists due to the dense intimal fibrosis associated with chronic occlusions which prevents passage of traditional hydrophilic catheters and guidewires.

RESULTS: A variety of options exist for the treatment of CVO including use of hydrophilic guidewires, blunt dissecting and subintimal reentry catheters, sharp needles, and radiofrequency guidewires such as PowerWire™ (Baylis Medical, Montreal, QC Canada). Blunt dissecting catheters are designed to penetrate through dense fibrotic lesions, while subintimal reentry catheters bypass the occluded segment by exiting and re-entering the vascular lumen. Sharp needle technique involves the use of a sheathed TIPS needle or, alternatively, the stiff end of a glide wire to traverse the lesion. A number of instruments may be used as a target during recanalization including a guide wire, snare, balloon, or catheter. RF guidewires can be particularly useful for crossing long-segment, tortuous occlusions. Intra-procedural cone-beam CT is a useful adjunct by delineating anatomy and preventing penetration of neighboring arterial vessels and viscera.

CONCLUSIONS: A variety of new devices are now available for percutaneous treatment of chronic central venous occlusions. Imaging findings and techniques will be reviewed, with a focus on RF guidewires with and without cone-beam CT.

Endovenous laser ablation for varicose veins: a resident primer

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PURPOSE: To review the clinical and technical aspects of treating varicose veins. Topics to be covered include lower extremity venous anatomy, patient selection, ultrasound interpretation, endovenous laser therapy (EVLT), and post procedure follow.

MATERIALS: Varicose veins are a result of venous insufficiency, i.e., backflow and pooling of venous blood in the superficial leg veins due to damaged valves. These damaged valves prevent forward flow of blood into the deep venous system and ultimately back to the heart. Endovascular laser therapy (EVLT) is one commonly used treatment for varicose veins. Extensive expertise with ultrasound and percutaneous venous access make interventional radiology (IR) one of the most qualified specialties to perform this procedure. It is important for residents interested in IR to understand the basics of venous ablation as it becomes an important aspect of a complete IR practice.

RESULTS: We plan to illustrate the deep and superficial lower extremity venous system as well as review the pathophysiology and symptoms of venous insufficiency. We will depict and summarize the interpretation of venous insufficiency on ultrasound and the technical aspects of EVLT. Lastly, we will discuss post procedure and follow up care.

CONCLUSIONS: It is important for residents interested in IR to have a basic understanding of how to treat venous insufficiency. Both the technical and clinical aspects of endovenous ablation for varicose veins are important for successful treatment. The workup of a patient
for potential endovenous ablation requires the IR physician to diagnose, treat, and follow up the patient. Endovenous ablation provides yet another opportunity for IR practices to expand into a potentially new patient population.

Abstract No. 666

Fluoroscopic targeting of Wallstents and Amplatzer vascular plugs in sharp recanalization of chronic venous occlusions

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PURPOSE: To report results of fluoroscopic targeting of Wallstents and Amplatzer vascular plugs in sharp recanalization of chronic venous occlusions.

MATERIALS: Wallstent and Amplatzer vascular plug (AVP) targeting was performed in 15 patients (8 females; mean age 50 years) from October 2015 until September 2016. 8 (53%) patients presented with venous occlusions in the upper extremity or superior vena cava and 7 (47%) had occlusions in the lower extremity or inferior vena cava. 11 (73%) presented with symptomatic venous occlusion characterized by swelling and pain and 4 (27%) required recanalization prior to pacemaker lead exchange. Once the chronic venous occlusion could not be traversed, sharp recanalization was employed. Instead of targeting a snare, however, a Wallstent or AVP was partially deployed and targeted using a transseptal needle under rotational fluoroscopy. This technique was used in the ilio caval (7), brachiocephalic/SVC (6), and upper extremity (2) segments in regions of multiple critical vascular structures. When targeting had been achieved and the device punctured, a wire was advanced into the punctured device and the Wallstent or AVP was retracted into its deployment sheath. Targeted device, technical success, procedural success, complications, and follow-up were recorded.

RESULTS: A Wallstent was targeted in 13 (85%) and an AVP in 2 (15%). Technical success was achieved in all patients. Procedural success, defined as successful recanalization and stenting, was achieved in 14 (93%) patients. There were no immediate complications directly related to targeting using Wallstents or AVPs. 1 (17%) patient developed a retroperitoneal hematoma 5 cm rostral to the ilio caval confluence and required covered stent placement. Follow-up imaging was available in 6 (40%) patients and demonstrated patency of all recanalized and stented veins. Mean follow-up time in those 6 was 2.9 months (range: 0.5-6 months).

CONCLUSIONS: Fluoroscopic targeting of Wallstents and AVPs is a useful technique in sharp recanalization of chronic venous occlusions in regions with multiple adjacent critical vascular structures and is associated with few complications.

Abstract No. 667

Transvenous liver biopsies in patients with congenital heart disease using the transjugular or transfemoral approach: a single-center experience

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PURPOSE: Patients with congenital heart disease (CHD) can present with congestive hepatopathy in the setting of longstanding right heart failure, and frequently need liver biopsies with pressure measurements. At our institution, transvenous liver biopsies are often performed at the time of cardiac catheterization precluding patient from undergoing a separate procedure. CHD patients have multiple corrective surgeries including Fontan in which the superior (SVC) and inferior vena cava (IVC) are ultimately anastomosed to the pulmonary artery (PA), with the IVC anastomosis via an extracardiac PTFE conduit or intra-atrial baffle. The SVC to PA anastomosis and IVC conduit/intra-atrial baffle may not aligned which may make it difficult to advance the stiff biopsy cannula from the internal jugular vein (IJ) into the hepatic vein. Liver biopsy can be achieved from a femoral venous approach using the transfemoral translacaval technique (TFTC) in patients where IJ access is difficult or not possible. In addition, when the femoral vein is the desired access for cardiac catheterization, the same access can be used without requiring another puncture.

MATERIALS: In a retrospective review of patients who had transvenous liver biopsies, thirteen patients were identified as having CHD. Congenital heart defects, corrective surgeries, site of venous access to obtain biopsy specimen, portosystemic pressures, and pathology results were recorded and reviewed.

RESULTS: Fourteen transvenous liver biopsies were performed in thirteen patients with CHD. Twelve out of thirteen patients had a Fontan procedure. Seven biopsies were performed from an IJ approach and seven from a TFTC approach. Thirteen out of fourteen biopsies obtained adequate specimen. A moderate sized hematoma was reported in one patient with liver biopsy from an IJ approach in 2011 requiring four units of blood transfusion. No complications were reported via TFTC approach.

CONCLUSIONS: Transvenous liver biopsies are often indicated in patients with CHD and can be performed in conjunction with cardiac catheterization. Both IJ and TFTC approach can be used. TFTC may be advantageous in patients with a Fontan or who have femoral access from cardiac catheterization.
Abstract No. 668

Acute thrombosis in large venous spaces: mechanical thrombectomy with a 15-mm rotational thrombectomy device

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PURPOSE: To discuss techniques and outcomes of mechanical thrombectomy with a 15-mm rotational thrombectomy device, the Cleaner 15, in large venous spaces including thromboses within an IVC filter, iliac veins, a subclavian vein, and an aneurysmal cephalic vein that was part of a dialysis fistula. We will provide tips on how to successfully and safely use this device.

MATERIALS: Ideally, a rotational thrombectomy device is a wall contact device and it should fit the size of the vessel it will be used in. Mechanical thrombectomy in large venous spaces has been accomplished, but has been challenging with thrombectomy devices, many of which are designed for smaller vessels. The Cleaner 15 is a rotational thrombectomy device that uses a sinusoidal shaped wire with a 15-mm amplitude while spinning. It is FDA approved for mechanical thrombectomy in the peripheral vasculature, native vessel dialysis fistulae, and synthetic dialysis access grafts. However, because of its 15-mm diameter, it can be used off-label for mechanical thrombectomy in larger venous spaces.

RESULTS: We will review the use of a 15-mm mechanical thrombectomy device for treatment of thrombosis within an IVC filter, iliac veins, a subclavian vein, and an aneurysmal cephalic vein that was part of a dialysis fistula. We will discuss: 1. Patient selection. 2. Technique including use in combination with other clot removal strategies. 3. Results. 4. Possible complications, including distal embolization, with techniques to prevent them.

CONCLUSIONS: The Cleaner 15 can be used safely and effectively to treat acute thrombosis in a variety of large venous spaces, including filter bearing IVCs, iliac veins, subclavian veins, and aneurysmal cephalic veins.
Abstract No. 669

Drug-coated balloons: a primer in understanding global device evidence base, availability, and cost

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PURPOSE: This educational exhibit aims to review and compare drug-coated balloons (DCBs) in terms of their indicated uses, evidence support, cost and availability, and technical differences.

MATERIALS: Drug-coated balloons, first approved in the USA in 2014 for the treatment of femoropopliteal disease, have shown potential in the treatment of peripheral vascular disease compared to conventional balloon angioplasty (1). Since this initial success another DCB has received approval for use in the USA for a similar indication in 2015 (2). Today, the indications for DCBs are expanding, and approvals are being sought for other DCBs in the USA.

RESULTS: This exhibit will highlight the major drug-coated balloons available for use in the US, European, and Asian markets. It will explore the indications for each device and which of these devices are available for use in the USA. It will also delineate the technical differences between devices including drug coating type and concentration, balloon sizing requirements, and compatible angioplasty balloons for vessel preparation. The exhibit will also compare the costs of the DCBs in the markets they are available.

CONCLUSIONS: With the rapid influx of DCBs it is judicious for interventional radiologists to understand the device landscape. Armed with the information of each DCB the operator is able to make informed decisions on when to use which device. Understanding the evidence base and cost of each DCB is also fundamental when optimizing patient care in the current healthcare environment.

Abstract No. 670

Balloon pulmonary angioplasty: beyond the webs

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PURPOSE: Review the indications and contraindications for balloon pulmonary angioplasty in patients with chronic pulmonary thromboembolic hypertension (CPTEH). Overview of balloon pulmonary angioplasty (BPA) technique. Review procedural complications and patient management. Summarize the results of major clinical trials in BPA and evaluate future areas of interest.

MATERIALS: Chronic pulmonary thromboembolic hypertension (CPTEH) is a debilitating complication of thromboembolic disease typified by progressive right heart dysfunction secondary to pulmonary vessel occlusion. Balloon pulmonary angioplasty (BPA) was introduced 1988 but has only recently emerged as an alternative treatment for non-surgical candidates with CPTEH. Modern pulmonary reperfusion angioplasty techniques can reverse sequelae of pulmonary hypertension, improve patient functional status, and promote cardiac remodeling. Knowledge of appropriate assessment, imaging evaluation, and optimal technique is critical to the treatment of these patients.

RESULTS: In this educational exhibit, we will review patient selection criteria and initial diagnostic studies including ventilation/perfusion scans, dual-energy CT angiography, diagnostic angiography, and intravascular ultrasound. We will further review seminal clinical trials that evaluate the efficacy of the procedure. Selected cases from the current practice will be utilized to illustrate diagnostic angiographic assessment and BPA techniques. Potential complications including pulmonary arterial perforation and reperfusion edema will be discussed.

CONCLUSIONS: Balloon pulmonary angioplasty is an emerging technique for the treatment of chronic pulmonary thromboembolic hypertension. This presentation will promote understanding of the CPTEH pathophysiology, preprocedural assessment, BPA technique and complications, and future directions of therapy.

Abstract No. 671

Approach to endovascular management of high-flow priapism

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PURPOSE: 1. Review different types and causes of priapism. 2. Discuss the clinical presentation of HFP. 3. Demonstrate the imaging findings of HFP. 4. Outline the management options with focus on the endovascular embolization of HFP. 5. Evaluation of Different types of embolic materials used with the advantages and disadvantages of each. 6. Outline Potential treatment complication. 7. Review the outcomes of endovascular treatment.

MATERIALS: Priapism is defined as a persistent erection that lasts for several hours or beyond, independent of ongoing sexual stimulation. Because priapism can have serious long term consequences that include loss of sexual function, it requires prompt evaluation and management. There are essentially two types of priapism. The first is low-flow or ischemic priapism which accounts for the majority (95%) of cases. High-flow priapism (HFP) or non-ischemic priapism is often associated with trauma to the perineum. Although the initial management may be similar, HFP is often due to an underlying arteriovenous fistula or pseudoaneurysm and can be safely and reliably treated with
Liquid embolic agents for the treatment of refractory pulmonary arteriovenous malformations

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PURPOSE: 1) Review pathophysiology of pulmonary arteriovenous malformations (pAVM) with focus on pertinent anatomical and imaging considerations. 2) Highlight techniques and principles for initial endovascular management of pAVM and reasons for long-term failure of endovascular treatment. 3) Focus on use of liquid embolic agents for adjunctive management of complex and refractory pAVM. 4) Discuss follow-up care, postembolization imaging, and pros versus cons of using liquid embolics as coils and plugs.

MATERIALS: Liquid embolic agents are increasingly being utilized for treatment of peripheral vascular lesions. Despite feared complications of non-target embolization, case reports have shown that liquid embolic agents can be highly effective when utilized judiciously in specific peripheral applications. Herein we discuss the use of liquid embolic agents for treatment of refractory “leaking” pulmonary arteriovenous malformations (pAVM) despite aggressive and repeated attempts at coil embolization. Current methods of endovascular treatment of pAVMs have questions of long term efficacy.

RESULTS: This exhibit includes two cases of “leaking” pAVMs in patients with Hereditary Hemorrhagic Telangiectasia (HHT). The first patient had a large high flow complex right lower lobe pAVM with persistent flow through coil, subsequently treated with 50% n-BCA mixture, resulting in immediate positive result. One year post treatment, there is no further flow through the pAVM treated with nBCA. The second patient had multiple prior coil embolizations for treatment of a right lower lobe basilar pAVM, with prior coiling and repeat packing with microcoils, again demonstrating persistent leaking. 45% nBCA was utilized to close off the entrance to the large embolic coil mass, with immediate positive result. Utility and rationale of using liquid embolic agent for treatment of persistent leaking refractory pAVMs will be discussed with focus on our institutional experience.

CONCLUSIONS: We present a novel use for treatment of refractory pAVM with nBCA liquid embolic agent. Liquid embolics, despite risks, may be helpful in select situations by experienced operators where prior treatments have failed.
Abstract No. 674

Superior hypogastric nerve block in uterine fibroid embolization patients with radial artery entry: vascular considerations, anesthetic choices, and rescue options

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PURPOSE: 1. Review the classification and anatomy, aortic and iliacal bifurcations, in relation to the L4-S1 vertebral bodies. 2. Review important properties of anesthetics used: ropivacaine vs. bupivacaine. 3. Review rescue options, such as intravenous lipid emulsion, in the event of an unintentional intravascular injection.

MATERIALS: For the past 20 years, uterine fibroid embolization (UFE) has been a successful treatment option for women with symptomatic fibroids and adenomyosis. Adequately treating the patient’s pain and nausea is a continuing challenge. Recently, superior hypogastric nerve block (SHNB) has been revisited as a successful adjunct technique for decreasing pain postembolization. This form of regional anesthesia has been found to be effective. Previous studies on SHNB are based on a femoral approach and fluoroscopic evaluation of the aortic bifurcation. As we transition to radial access, this guidance is not available.

RESULTS: MRI images are readily available in UFE patients, as this study is usually performed prior to UFE. We will examine the location of vascular structures relative to the mid-to-inferior L5 vertebral body, the typical target for SHNB, so that these vessels can be avoided. Selection of the optimum anesthetic choice (ropivacaine versus bupivacaine) and rescue options, such as administration of intravenous lipid emulsion in the case of unintentional intravascular injection, will be discussed.

CONCLUSIONS: With understanding of the varying anatomic locations of the aortic and iliacal bifurcations and preprocedure evaluation of the patient’s MRI images, intravenous anesthetic injection can be avoided during SHNB administration. Additionally, having intravenous lipid emulsion and standard resuscitation methods on hand in case of unintentional intravascular injection can improve the postoperative experience of UFE patients.

Abstract No. 675

Massive hemoptysis in cystic fibrosis: more than bronchial artery embolization

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PURPOSE: 1. Review the classification and management of massive hemoptysis in Cystic Fibrosis patients, with a focus on transarterial embolization. 2. Educate the interventional radiologist and trainee about the arterial supply in patients with massive hemoptysis, including those with prior embolization who may have alternative or parasilited arterial supply from other thoracic arterial vessels. 3. Review techniques utilized when performing transarterial embolization for patients with massive hemoptysis.

MATERIALS: In the western hemisphere, cystic fibrosis (CF) is a leading cause of massive hemoptysis, defined as acute bleeding with a volume greater than 240 mL within 24 hours. Bronchial artery embolization (BAE) is an established, effective treatment for massive hemoptysis in CF patients. However, recurrence of hemoptysis can be observed in up to 50% of CF patients having undergone an initial successful BAE. Studies report up to 75% incidence of bleeding from non-bronchial systemic collateral vessels in patients with recurrent hemoptysis after a previous BAE.

RESULTS: In CF, chronic inflammation in the lungs promotes hypotrophy of the bronchial arteries and angiogenesis. Having undergone these deleterious changes, the systemic arterial supply to the lungs is the source of major hemoptysis in CF patients and can be life-threatening, carrying a substantial risk of asphyxiation or exsanguination. Despite high recurrence of hemoptysis, only a small percentage of patients require more than two embolization procedures. A wide variety of other vessels in the thorax may be recruited to feed abnormal CF lung parenchyma. This exhibit will provide an image-rich review of the arteries in the thorax, provide examples of the numerous vessels that may require embolization, and review pertinent embolization techniques, relevant literature, and pre- and postprocedure management.

CONCLUSIONS: Although BAE is the mainstay of treatment in CF patients with massive hemoptysis, interventional radiologists must be aware of other thoracic arterial vessels that may require embolization, particularly in patients with recurrence after initial BAE.

Abstract No. 676

Tips and tricks for bariatric embolization

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PURPOSE: To discuss the appropriate preprocedure work up of Bariatric Embolization including patient selection, inclusion/exclusion criteria, preprocedure labs, imaging and examinations. To discuss intra-procedural technical pearls that contribute to a high rate of technical and clinical success. To discuss post procedure management and long term follow up after Bariatric Embolization

MATERIALS: Bariatric embolization is an emerging, minimally invasive, endovascular therapy for obesity. The procedure involves transarterial bead embolization of the gastric fundal arterial supply for suppression
of the orexigenic hormone ghrelin. Early clinical data from two ongoing trials have shown that it is well tolerated and efficacious.


CONCLUSIONS: Bariatric embolization is an emerging minimally invasive endovascular procedure with the potential to play a role in the management of obesity. Factors that contribute to clinical success include appropriate patient selection, a comprehensive work up and enrollment in a weight management program. Factors that contribute to technical success are careful attention to gastric fundal arterial anatomy and a conservative approach to embolization. Long term follow up should include continued lifestyle modification as part of a weight management program, tracking of appetite/food intake, basic laboratory assessment as well as endoscopic surveillance for ulcers.

Abstract No. 677

Bariatric embolization: understanding the possible role of the interventional radiologist in treating obesity

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PURPOSE: 1. To review the anatomy and physiology related to hunger and satiety. 2. To review the current behavioral, pharmacologic, and surgical approaches to treating obesity. 3. To introduce emerging techniques in bariatric therapy including endoscopic and percutaneous approaches. 4. To review the current literature pertaining to Bariatric Embolization.

MATERIALS: Obesity is an epidemic in the US and worldwide. In addition to significant comorbidities, obesity has a severe economic impact including direct and indirect costs. Currently, standard treatment is based on diet, exercise, and or medications, with bariatric surgery reserved for patients with severe obesity or significant associated comorbidity conditions. Newer, minimally invasive treatments are now being developed to obviate the need for surgery, including endoscopic and percutaneous intervention. Bariatric Embolization is a new minimally invasive treatment for obesity. Knowledge of the current and developing treatment options for obesity will be helpful in understanding the potential role of Bariatric Embolization in treating obesity.


CONCLUSIONS: Obesity is a worsening epidemic in the United States with a significant impact on healthcare costs and expenditures. Current treatment paradigms are based solely on behavioral medication, pharmacotherapy, and surgery. Newer minimally invasive techniques including endoscopy and percutaneous approaches are being developed. By reviewing the current and developing therapies, including bariatric embolization, the reader will be more informed on the obesity epidemic and the possible role of the interventional radiologist in treating patients with obesity.

Abstract No. 678

Taking advantage of innovations in embolization coil technology

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PURPOSE: To review the evolution of coil technology and the role that coils play in contemporary embolization procedures.

MATERIALS: Since the mid 1970s, coils have been widely used for mechanical vascular occlusion. Pushable coils served interventional radiologists well and have been used successfully for a wide range of clinical applications. In 1990, the Guglielmi Detachable Coil (GDC) was invented, which revolutionized coil technology. Detachable coils have since been developed for use in the periphery and are becoming increasingly popular, given the degree of control they permit during deployment.

RESULTS: This educational exhibit will review the history of coil embolization, focusing on the development of this technology beginning with the wool-tailed coil and progressing through fibered pushable coils and detachable coils. In addition, the clinical indications best served by the use of coil embolization, the technical details associated with the use of coils, and the procedural and economic rationale needed to optimize coil selection will be reviewed. Finally, new innovations in coil technology will be introduced.

CONCLUSIONS: Coils are a mainstay of embolic technology and with the passage of time, new technology has enhanced the role that coils play in the treatment of an expanding array of indications. This exhibit will help interventional radiologists gain an appreciation for the features of the newest coil technology by helping them gain an understanding of how different features of embolic coils have evolved over time. In addition, the cost and technical considerations discussed in
this exhibit will assist interventional radiologists with coil selection for both existing and expanding indications for embolization.

**Abstract No. 679**

“The empty pelvis sign” in prostate artery embolization

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**PURPOSE:** To describe an angiographic sign that helps in identifying the extra-pelvic origin of the prostatic artery, from an aberrant obturator artery (AOA) during prostate artery embolization (PAE).

**MATERIALS:** From May 2013 to September 2016 our institution had 100 patients undergo PAE for benign prostatic hyperplasia (BPH) and prostate cancer (PCa). Five of these patients had prostatic arteries arising from the AOA. Their ages ranged from 56 to 64 years old (mean 59.6 ± 3.8) and they underwent bilateral superselective PAE using 300-500μ embospheres [Merit Medical Systems, South Jordan, UT] with digital subtraction angiography (DSA). No patient underwent CT angiography before PAE.

**RESULTS:** The incidence of AOA in our series was 5%. All 5 patients demonstrated an “Empty Pelvis sign” characterized by paucity of the arterial branches of the internal iliac artery due to absence of the prostatic and obturator arteries from their usual locations. Four patients had left sided AOA’s arising from a common trunk with the left inferior epigastric artery, branching off the left external iliac artery. There was immediate resolution of hematuria in two patients, and they underwent bilateral superselective PAE using 300-500μ embospheres [Merit Medical Systems, South Jordan, UT] with digital subtraction angiography (DSA). No patient underwent CT angiography before PAE.

**CONCLUSIONS:** This work highlights the need to consider the possibility of an aberrant prostatic arterial supply arising from an extra-pelvic obturator artery when an “empty pelvis” sign is encountered.

**Abstract No. 680**

Intraprocedural utility of cone-beam CT in prostate artery embolization

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**PURPOSE:** Illustrate utility of cone-beam CT in delineating normal and variant prostate arterial anatomy. Using cone-beam CT to determine appropriate catheter positioning before embolization. Immediate post procedure assessment of embolization zone with cone-beam CT. Correlate clinical outcomes with findings on cone-beam CT. Review technique, interpretation and utilization of cone-beam CT during prostate artery embolization.

**MATERIALS:** Prostate artery embolization (PAE) has been recently described in the literature as an emerging therapy for treating benign prostatic hyperplasia. Due to its minimally invasive nature and relatively low complication rate, PAE is being increasingly used as an alternative to more invasive treatments such as surgery. Successful technical and clinical outcomes depend on in-depth knowledge of the often variant arterial anatomy supplying the prostate gland. Additionally, as the prostate arteries often arise in common with vasculature supplying other pelvic structures—it is imperative to identify appropriate catheter position before delivering any embolic agents.

**RESULTS:** Multiple clinical cases will be used to illustrate key aspects of PAE. These include variant arterial anatomy, unilateral dominant supply, optimal catheter positioning for embolization, and avoidance of malpositioned catheter that could result in non-target embolization to other pelvic structures (e.g. urinary bladder, rectum, or pelvic musculature). Postembolization cone-beam CT images demonstrating embolization treatment zones are used in conjunction with postprocedural prostate specific antigen (PSA), volumetric assessment, and clinical course.

**CONCLUSIONS:** Cone-beam CT is a valuable tool that can be used during PAE to delineate prostatic artery anatomy, ensure delivery of embolic agent to appropriate target bed and confirm a technically successful embolization.

**Abstract No. 681**

Black mucosa after Onyx® embolization: do not be afraid

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**PURPOSE:** 1. Onyx® is a liquid nonadhesive embolic agent and has been used off label in non-neurovascular embolization. 2. Onyx® when used for peripheral AVMs has been noted to stain the cutaneous tissue black. In the GI tract, a similar side effect can cause staining of the mucosa, which can be mistakenly confounded for postembolization mucosal necrosis under direct visualization. 3. It is important to treat symptoms from postembolization syndrome while differentiating them from postembolization necrosis.

**MATERIALS:** Onyx®, a liquid non-adhesive embolic agent comprised of ethylene-vinyl-alcohol copolymer and commonly used for brain aneurysm embolization, has shown positive outcomes in controlling acute gastrointestinal bleeding in selected patients with good long-term results. Onyx® is intrinsically black, so it has the property of staining the embolized area. This is not to be confused with tissue necrosis on direct scope visualization.

**RESULTS:** We will review several mesenteric embolization cases using Onyx® in our tertiary academic medical center, focusing on technical challenges and more importantly the use of Onyx® versus other options, including but not limited to particles, coils, liquid glue, etc. Some of our cases are highlighted as follows: Case 1: 43M p/w refractory UGI bleed s/p GI and IR management. The bleeding artery originates from the right gastric artery instead of the GDA or left gastric
artery. Onyx® was selected for its ability to occlude distal branches and prevent collateral refilling of the bleeding vessels. Black mucosa was visualized at the gastric antrum under endoscopy. Case 2: 61M p/w massive hemothysis from right bronchial artery pseudoaneurysm. Onyx® was used for distal embolization because particles risk shunting and coils could produce a counterproductive proximal embolization preventing any future intervention. Case 3: 41M p/w right hepatic pseudoaneurysm s/p CCY. Onyx® embolization was done.

**Conclusions:** 1. Onyx® as a choice of embolization agent a. Chemical and physiological properties b. Less common use of Onyx® in non-nerovascular embolization c. Black mucosal staining: not to confuse this with postembolization necrosis 2. Review relevant anatomical variants

**Abstract No. 682**

Geniculate artery anatomy and implications for embolization in the setting of hemorrhosis and arthritis

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**Purpose:** To illustrate arterial anatomy of the knee for performing geniculate artery embolization (GAE) in for spontaneous hemorrhosis after arthroplasty or osteoarthritis

**Materials:** GAE has been utilized with success in the treatment of spontaneous hemorrhosis of the knee after arthroplasty and more recently as an effective palliative therapy for pain related to osteoarthritis (OA). An understanding of the arterial anatomy of the knee is essential to for GAE

**Results:** Retrospective review of angiographic images from patients who underwent geniculate artery embolization was performed. Arterial anatomy is categorized into medial and lateral synovial compartments as follows: The descending genicular artery (DGA) is the most superior supply of the medial compartment, originating from the distal superficial femoral artery at the level of the adductor canal and has an inverted ‘Y’ appearance. The medial superior genicular artery (MSGA) arises above the medial femoral condyle, courses superficial to the semimembranosus and semitendinosus muscles, and runs deep to the tendon of the adductor magnus. The medial inferior genicular artery (MIGA) originates from the popliteal artery and supplies branches to the popliteus as it descends along the upper margin of the muscle. The most superior branch of the lateral compartment is the descending branch of the lateral circumflex femoral artery (LCA), arising anterior to the intertrocanteric line. The lateral superior genicular artery (LSGA) arises from the mid-popliteal artery at the level of the lateral femoral condyle, courses over the posterior aspect of the lateral femoral condyle, deep to the biceps femoris tendon. The lateral inferior genicular artery (LIGA) courses laterally above the fibular head, and travels anterolaterally, deep to the lateral head of the gastrocnemius muscle belly. The anterior tibial recurrent artery supplies the lateral aspect of the knee originating from the anterior tibial artery just after it courses through the interosseous membrane

**Conclusions:** Understanding of key target vessels, as well as intrinsic anastomoses, will allow the interventionalist to avoid non-target embolization with novel applications in knee embolization.

**Abstract No. 683**

Initial experience with trans radial artery access for management of high-grade splenic trauma at a major metropolitan trauma center

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**Materials:** Transfemoral endovascular embolization is a well-established and effective therapy for achievement of hemorrhage control in abdominal-pelvic trauma. Pelvic binders are often utilized for early stabilization of pelvic injuries but limits trans femoral access (CF), necessitating alternative arterial access for management. The purpose of this study is to report the initial experience with trans radial (TR) embolotherapy in management of moderate-high grade splenic traumas.

**Results:** 13 patients underwent conventional angiography during the study period of which 12 (92%) (6 males, 7 females) required embolization; one patient was excluded from the review due to the splenic artery being occluded at time of angiography. Of the included set, 8 patients had CF and 4 had TR access. The mean patient age for CF and TR was 47.2 /63.5 years, respectively. All patients sustained splenic injuries of grade IV. The mean preprocedural INR for CF/TR was 1.2 (rng: 1.2-1.4) / 1.5 (rng: 0.97-2.0). The mean Door-to-closure/fluoroscopic times were for CF and TR was 115.8/22.0 and 115.8/15.1 minutes. Embolic agents utilized included coils and glue. Hemorrhage was effectively controlled with transarterial embolization in 12/12 (100%) patients, of whom 12/12 (100%) required no further blood transfusion after embolization. Of the 12 embolized patients, 12 (100%) survived to discharge. 0% of TR set demonstrated complications related to arterial access; 1 patient of the CF arm had a closure device failure requiring open surgical evacuation.

**Conclusions:** Embolotherapy utilizing trans radial access appears to be a viable, and potentially preferential technique in some circumstances, approach for endovascular control of hemorrhage from blunt abdominal trauma with potential door-to-closure time and access point complication advantages over standard common femoral arterial access.
Beyond the ABI: assessing real-time tissue perfusion in critical limb ischemia in the interventional suite

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PURPOSE: Develop an understanding of the mechanism, advantages and disadvantages of different physiologic and imaging modalities for assessing tissue perfusion intra-procedurally.

MATERIALS: Critical limb ischemia remains a public health challenge in the United States, affecting 3 million Americans. While interventional technologies and treatment strategies for CLI have improved significantly, many interventionalists still rely on the ankle-brachial index (ABI) as a measure of tissue perfusion before and after intervention. However, new technologies to assess tissue perfusion in the interventional suite have been developed and can play an important role in determining endpoints for intervention. Through the use of these newer physiologic assessment and imaging tools, interventionalists can decide whether the intervention will be enough to heal that patient’s wound, or whether further revascularization is needed while the patient is still on the table. This real-time feedback, going beyond the postprocedural ABI represents the next frontier in peripheral vascular intervention and is a tool that interventional radiologists, with their expertise in medical imaging can employ to provide better patient care.

RESULTS: Methods of assessing tissue perfusion in the interventional suite include photoplethysmography (PPG), transcutaneous oxygen saturation (TcPO2), 2D perfusion and fluorescence angiography, tissue oxygenation saturation mapping and implantable tissue oxygen sensors. Modalities which rely on physiologic parameters include toe PPG, TcPO2, oxygen saturation mapping as well as implantable tissue oxygen sensors. Angiographic/anatomic methods for assessing tissue perfusion include 2D perfusion angiography and fluorescence angiography. The mechanisms, advantages and disadvantages of these tools to assess intraprocedural tissue perfusion will be demonstrated with a clear understanding of the science behind each method.

CONCLUSIONS: Angiographic appearance and postintervention ABIs are insufficient to stratify the probability of clinical improvement following CLI interventions. Newer, sophisticated tools exist to provide quantitative data to guide therapeutic endpoints, which IRs are well-equipped to use.

Review of vascular closure devices and complications

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PURPOSE: The purpose of this exhibit is to give an overview of current vascular closure devices, their mechanism of action, individual strengths and weaknesses, evidence base and complications in interventional radiology (IR) practice.

MATERIALS: Manual compression is an established technique for hemostasis following percutaneous arterial puncture. However, it is labor and time intensive, and presents a challenge in patients who are coagulopathic, unable to bed rest, or are obese. There are a variety of vascular closure devices (VCDs) available. Overall, the evidence suggests that most VCDs are effective in achieving hemostasis with a similar rate of complications to MC although the complication profile associated with VCDs is different to that of MC. VCD’s can be subdivided into three main categories including 1) active approximates which deploy a plug, sealant or gel at the site and 3) external hemostatic devices, which are used on top of skin providing mechanical compression.

RESULTS: Complications of MC such as hematoma, continued bleeding, vessel thrombosis, arteriovenous fistula and pseudoaneurysm formation are well established. The use of VCDs introduces the potential for novel complications such as infection of implanted material, distal embolization of device components, luminal narrowing or distortion and foreign body reactions. There may also be complications secondary to attempted early repeat access following VCD deployment.

CONCLUSIONS: A wide variety of VCDs are available to the interventional radiologist with evidence suggesting VCD use is effective in achieving hemostasis with a similar rate of complications to MC. The types of complications associated with VCDs are generally distinct to those of MC and often unique to the type of VCD. The interventional radiologist should have a thorough understanding of the range of techniques available for hemostasis and be able to identify and use the most appropriate device and strategy best suited to the individual patient.
**Abstract No. 688**

**Mouse models of hepatocellular carcinoma: a review for the interventionalist**

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**PURPOSE:** 1. To review mouse hepatocellular carcinoma (HCC) models for interventional radiologists. 2. To assess available mouse models and grade them according to cost, complexity, and reproducibility, and pathologic correlation. 3. To provide guidelines for choosing a mouse model for proof of concept, tumor-host interaction, and treatment effect studies.

**MATERIALS:** Mouse models of HCC are thoroughly studied and widely available. These models are divided into three categories. Chemically induced models rely on injection of a carcinogenic substance to induce HCC proliferation. Direct inoculation models are either xenografts of human HCC lines into immunodeficient mice, or allografts into immune competent mice. Genetically engineered mice (GEMs) are produced with either upregulation of oncogenic genes, or knockout of a specific anti-tumor gene, and can be either whole mouse or mosaic where gene expression is tissue specific.

**RESULTS:** Relevant technical aspects of each category of model will be reviewed. Content will be organized as follows: A. Relevant HCC tumor biology background. B. Critical review of mouse models for reliability, ease of use, cost, and similarity to human HCC pathology. C. Rationale for selection of mouse models according to experimental purpose. D. Tools for evaluating mouse model basic science research.

**CONCLUSIONS:** Animal models are a foundation of basic sciences research. Mouse models have been thoroughly studied and produce the widest available range of pathology. These models are the best characterized human HCC model, and can mimic human pathology if carefully selected for experimental design. Chemically induced models...
are technically easy to produce, but are often aggressive and multifocal, most closely mimicking advanced metastatic disease. Direct inoculation methods can be variable in tumor production speed, require a stable source of tumor cells, and in immunodeficient mice provide incomplete models, but these methods give a single HCC lesion with known genetics for studying locoregional therapies. GEMs provide a specific true disease model for a variety of states, but can be the most expensive model.

Abstract No. 689

3D printing: how to create a custom life-size vascular model for teaching or preprocedure planning without breaking the bank

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PURPOSE: 1) Review existing applications for 3D vascular models in IR. 2) Describe some affordable 3D printers and printable materials, including technical parameters, limitations, and costs. 3) Outline a process for converting CT .DICOM files to .STL for model fabrication. 4) Provide a cost-effective stepwise production method for creating a portable custom arterial model, achievable by a novice builder

MATERIALS: Large medical 3D printing labs have already demonstrated tremendous innovation and impact on patient care, producing custom anatomic models and prostheses with remarkable accuracy and fast turnaround times. Unfortunately, high capital requirements and ongoing expenses make launching a large-scale lab challenging in the current cost-conscious environment. Fortunately, smaller printers the size of a countertop appliance can be rented or purchased for increasingly affordable prices. Various printable materials can be creatively utilized. Finally, free or low-cost software is available to facilitate the necessary conversion from DICOM imaging files to printable STL files. This project represents a collaboration between physicians with no prior experience in 3D printing and a production engineer with significant industrial 3D printing experience. Our aim is to demonstrate a stepwise method for creating a life-size arterial model, using a small affordable desktop printer, commonly used material and free software.

RESULTS: Printers: Overview of printers, describing printer type, maximum printable volume, resolution, filament size, and approximate cost for each Printable material: Review various types (resin, filament) Software: Free sources for DICOM to STL conversion Production process: 10 steps including pictures

CONCLUSIONS: 1. 3D vascular models can be successfully used in IR practice for patient communication, teaching, and preprocedure planning. 2. Numerous printers and materials are increasingly available at non-prohibitive costs 3. DICOM conversion to STL is readily achievable using free or low-cost software. 4. A high-quality, portable, custom vascular model can be printed and constructed with reasonable budgetary and time constraints on the builder.

Abstract No. 690

Using thromboelastography (TEG) to assess coagulation status in the cirrhotic patient prior to percutaneous interventions

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MATERIALS: Assessing bleeding risk prior to percutaneous intervention is often complicated by patient co-morbidities. SIR has established a consensus of risk-stratified guidelines for the peri-procedural management of these patients in which common tests of hemostasis (INR/PT, platelet count) are discussed and recommended values are based on expert consensus and meta-analysis of literature (1). In cirrhosis, these tests may misrepresent bleeding risk as there is an imbalance in procoagulants and anticoagulants. In decompensated cirrhosis, platelets may be redistributed from the circulating pool to the splenic pool from portal hypertension (i.e. sequestration), limiting utility of platelet transfusion. The complex coagulation of the cirrhotic patient can lead to erroneous assessments of bleeding risk based on common tests of hemostasis, resulting in ineffective and costly transfusions.

RESULTS: The exhibit will describe TEG’s evolution and potential application in a new patient population. It was developed as a research tool for studying coagulation and later gained surgical applications in the US, with a current trend in the trauma population. Recent literature describes safe and cost-effective application of TEG in cirrhotic patients undergoing invasive procedures (2). The exhibit will illustrate its pin/wire transduction system used to create a tracing as clot forms in a slowly oscillating cup containing the blood sample. Tracings pertinent to the interventionalist will be described, including assessments of anticoagulant and procoagulant states, and the presence of fibrinolysis and platelet dysfunction. Blood product transfusion guidelines based on tracings will be reviewed.

CONCLUSIONS: TEG has been shown to be applicable to cirrhotic patients undergoing percutaneous interventions to safely assess bleeding risk and curb fiscal and temporal costs of blood product transfusions in this setting.
Abstract No. 691

Biosensors: sensing the future of interventional radiology

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PURPOSE: To summarize the capabilities of biosensors, their current and potential roles in disease detection and treatment, and emphasize their particular relevance to interventional radiology (IR).

MATERIALS: Recent advances in material science and micro/nanoelectronics herald the advent of 21st century medicine; novel stretchable polymer-electronic composite material can integrate onto or into the human body with the ability to detect highly sensitive and specific elements of disease. Biosensors have the potential to decrease the cost of patient care by early detection and diagnosis for many common diseases. It has been estimated that rapid diagnosis from utilizing sensors for cancer detection and glucose monitoring in diabetes would lead not only to improved outcomes, but also a saving in cost ranging from $75 to $90 billion. IR has been afforded access to a burgeoning new class of tools, namely highly advanced state of the art catheters covered by dense arrays of sensors. The creation of biocompatible interfaces promises to enhance our scope of practice.

RESULTS: The various composition of biosensors and how they function will be reviewed. Biosensors are defined as medical devices that sense and transmit information about a biological process and can grossly be subdivided into soft, injectable or bioabsorbable. There are biosensors that measure temperature, flow, tactile, and electrophysiological data. Micro- and nanosensors detect mechanical, chemical, optical, electrical, and biological signals. Particularly relevant for IRs, the cellular structure of tissue that our catheters interact with can now be evaluated by utilizing biosensors, furthermore they can even decipher the condition of a vessel wall and its susceptibility to dissect.

CONCLUSIONS: Understanding the potential of biosensors will truly prime IRs to be at the forefront in this new and exciting field. Biosensors can aid in rapid, continuous monitoring, and even potentially provide early diagnosis of patients in novel ways.

Abstract No. 692

Hemodialysis access management: reviews and novel benchtop concepts for blood flow measurement

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MATERIALS: Vascular access is the “lifeline” of hemodialysis patients often challenged by stenosis and thrombosis due to pathological events in response to new access. NKF/KDOQI guidelines suggest routine surveillance of dialysis access based on BFR, pressure measurements or imaging technologies. Thermodilution (TD) is most common method for BFR measurement in interventional radiology; however, it requires insertion of a flow catheter which increases overall procedural time and cost. Angiographic images acquired during fistulography contain necessary information required for BFR measurement and are currently being investigated due to ease of acquisition, and possibility of achieving higher accuracy and reproducibility.

RESULTS: This exhibit will first review key concepts and technologies available for access monitoring and surveillance based on NKF/KDOQI guidelines. We will then discuss our benchtop models developed for BFR measurement. MATLAB programming is used to compute BFR from angiographic images by tracking the distance and time taken by contrast bolus to travel through a given region of interest in dialysis access. Next, we will present six BAT algorithms for time computation and classify them according to accuracy and reproducibility. Finally, we will present an optimized algorithm for clinical BFR measurement and discuss the challenges and future developments.

CONCLUSIONS: BFR calculation using angiographic images is a convenient and economical alternative to TD method. Cross correlation algorithm had the best accuracy and reproducibility among other BAT algorithms, and may be used for developing integrated BFR measurement tool for angiography suite.

Abstract No. 693

Coding hemodialysis access maintenance correctly: what every practicing Interventionalist should know

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PURPOSE: 1) To provide a brief overview of the RVU system. 2) To review the most common CPT codes pertaining to hemodialysis access. 3) To provide examples of bundled reimbursements for common hemodialysis interventions. 4) To explore the impact that the multiple procedure payment reduction (MPPR) rule on bundled reimbursements.

MATERIALS: Billing in healthcare is ever changing. Multiple factors impact re-imbursement and the relationships between these factors have been extremely convoluted. There are numerous CPT codes used for hemodialysis access interventions and a number of rules apply to their use. When bundled services are rendered, the multiple procedure payment reduction (MPPR) is utilized to calculate the reimbursable dollar amount. At least 9 multiple procedure paradigms exist via MPPR rules. Most interventional procedures fall under the “Standard Payment Adjustments.” Under this paradigm, the CPT codes are ranked...
in order from highest to lowest based on complexity. The highest CPT code is reimbursed at full value, while the subsequent 4 CPT codes are reimbursed at fifty percent (50%) of the fee schedule.

RESULTS: This exhibit will briefly explore the components of the RVU system (physician Work RVU, practice expense RVU, malpractice RVU), the geographic practice cost index (GPCI) and the conversion factor (CF) in order to show how a CPT code translates into billable dollars. 14 common current procedural terminology (CPT) codes pertaining to maintenance of hemodialysis (HD) access will be analyzed and the rules for coding each of the CPT codes will be reviewed. Eleven examples of bundled procedures will be provided in order to highlight the impact of the MPPR on the reimbursement of bundled services/CPT codes.

CONCLUSIONS: Knowing how to correctly bill for HD access procedures will continue to be important for the financial future of any interventional practice. By using simple rules for each CPT code, billing can be optimized and under-coding can be avoided.

Abstract No. 694
The “stuck” catheter: what to do when the catheter won’t come out
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PURPOSE: Identification and preprocedural assessment of potentially problematic vascular access catheters. Basic and advanced techniques for the removal of stuck and fractured catheters in adults and pediatric patients. Potential complications of catheter removal and retained catheter fragments

MATERIALS: Interventional radiologists are tasked with maintaining long-term venous access in a number of challenging populations in both children and adults, including catheters used for hemodialysis, parenteral nutrition and chemotherapy. Central catheters may need to be replaced or removed at the completion of therapy, infection and/or malfunction. Infrequently, a catheter may not release from the vein with attempted removal. These “stuck” or adherent catheters can be complicated by catheter fracture, retained foreign body, venous thrombosis and venous stenosis. Residual catheter fragments are also a nidus for chronic infection. Knowledge of techniques to safely remove these catheters is critical to the care of these patients.

RESULTS: A review of 28 published case and technical reports involving the removal of stuck catheters will be presented. The average age of patients was 19.5 years (range 7 months–94 years). More difficult removals were reported with left compared with right subclavian lines. Equal numbers of stuck catheters in the right and left internal jugular vein were reported. Catheters were implanted from 4 months to 146 months. The most frequently reported stuck dialysis catheter was the Tesio 10 Fr dual lumen. The most frequently reported implantable port was the Cook 6.5-F silicone catheter, though most were successfully removed. Techniques including targeted thrombolysis, sheath over catheter, endovascular cutting wire, laser-assisted removal and endoluminal wall dilatation will be discussed. Selected cases from the author’s current practice will also be presented to highlight advanced techniques. Discussion of potential complications from catheter removal and retained catheter fragments will be included.

CONCLUSIONS: Viewers of this presentation will have an understanding of the preprocedural assessment, techniques for removal and potential complications of stuck catheters.

Abstract No. 695
Be a smooth operator! Understanding appropriate and safe periprocedural management of anticoagulation and antiplatelet therapy
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PURPOSE: 1. Understand the available anticoagulant and antiplatelet agents and their main clinical indications. 2. Review the current consensus guidelines on when to preoperatively hold and postoperatively resume anticoagulant and antiplatelet therapy. 3. Compare current SIR guidelines with those of other societies (American College of Chest Physicians (ACCP), American Society for Gastrointestinal Endoscopy (ASGE), and American Society of Regional Anesthesia (ASRA), for other minimally invasive procedures. 4. Update on the current status on the trials for Direct Oral Anticoagulant agent reversal.

MATERIALS: Antithrombotic therapy has become an integral part of current medical care and something frequently encountered by any practicing interventional radiologist (IR). As a result, having a foundational knowledge of these drugs and their properties is integral for patient care.

RESULTS: A diverse selection of classic and novel anticoagulant and antiplatelet medications is currently in use with drastically different mechanisms of action, widely variable biological half-lives, and distinctly different reversal agents. This educational exhibit discusses these dynamics with respect to vitamin K inhibitors, factor Xa inhibitors, direct thrombin inhibitors, COX1 inhibitors, ADP P2Y inhibitors, Gilb/Illa inhibitors, and PDEIII inhibitors. The current trial status and mechanism of action for the direct oral anticoagulant reversal agents, idarucizumab, andexanet alfa, and ciraparantag, are also enumerated. Furthermore, the exhibit outlines, in table format to facilitate visual comparison, the current SIR, ACCP, ASGE, and ASRA consensus periprocedural guidelines on withholding and resuming anticoagulation and antiplatelet drugs.

CONCLUSIONS: An in depth understanding of antiplatelet, anticoagulation, and anticoagulation reversal is essential for the interventional radiologist (IR). By knowing the current state of the art for antithrombotic pharmacokinetics, periprocedural management, and reversal agents, the IR can safely and effectively manage anticoagulated patients.
**Abstract No. 696**

Direct oral anticoagulants: what the interventional radiologist needs to know

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**PURPOSE:** To describe the direct oral anticoagulants (DOACs) including their generic and brand names, mechanism of action, and average costs. To list current recommendations regarding periprocedural use of DOACs for interventional radiology (IR) procedures.

**MATERIALS:** The DOACs are newer medications, more attractive than the traditional anticoagulants (ACs) because of their pharmacokinetics, stability, and improved outcomes. However, with new agents and recommendations released each year, it is difficult for interventional radiologists to stay apprised of the most current information.

**RESULTS:** DOACs include agents acting at two steps in the coagulation cascade. First, direct thrombin inhibitors prevent thrombin from cleaving fibrinogen to fibrin. Dabigatran etexilate (Pradaxa) is the only oral drug in this class. Direct Xa Inhibitors, by contrast, bind factor Xa to prevent activation of thrombin. Three are approved in the US: rivaroxaban (Xarelto), apixaban (Eliquis), and edoxaban (Savaysa). Cost remains a burden for DOACs, with a typical price of $10–12 per day, compared to $0.13 for warfarin. Appropriate use of perioperative AC remains uncertain. Experts currently recommend a decision algorithm of: 1) estimating patient thromboembolic risk, 2) estimating procedural bleeding risk, and 3) determining timing of AC interruption. In this analysis, the DOACs’ predictability allow for shorter cessation periods and decreased complications. For high bleeding-risk procedures (e.g. TIPS, renal biopsy), all DOACs should be held the two preceding days, and restarted 2–3 days following. In medium-risk procedures (e.g. gastrostomy placement, intraabdominal abscess), DOACs can be held the day prior, restarting POD 1. Low-risk interventions such as venography, thoracentesis, or superficial biopsies do not require cessation of AC. Timing is adjusted for decreased renal function, particularly when using Dabigatran.

**CONCLUSIONS:** The various DOACs available offer predictable AC, with decreased complications and periprocedural cessation time. The decision whether or not to discontinue anticoagulation periprocedurally should be based upon both the individual’s thromboembolic risk and the procedure-specific bleeding risk.

**Abstract No. 697**

Case-based review of the liver imaging reporting and data system: direct comparison of LI-RADS score with angiographic and clinical correlation

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**PURPOSE:** Review the ACR Liver Imaging Reporting and Data System (LI-RADS) with case examples Correlate LI-RADS scores on cross-sectional imaging with angiographic findings Understand the clinical implications of LI-RADS scoring Learn about new research and treatment outcomes related to LI-RADS staging

**MATERIALS:** Over 700,000 new diagnoses of hepatocellular carcinoma (HCC) occur annually, with approximately 39,230 expected in the US in 2016 alone. Consistent interpretation and reporting is essential for the diagnosis of HCC reduction of interpretation variability and errors, improvement of communication with clinicians, and facilitation of research. LI-RADS was developed by the American College of Radiology as a standardized system for the interpretation, reporting, and data collection of computed tomography (CT) and magnetic resonance (MR) imaging for HCC. Treatment recommendations are commonly based on the LI-RADS score including the use of locoregional therapy, radiation, and systemic therapies, along with transplant evaluation and prioritization. It is essential that interventional radiologists be well versed in the findings and lexicon used by the diagnostic radiologists, hepatologists, and transplant teams.

**RESULTS:** Through a case-based approach, this exhibit will comprehensively review the important aspects of the ACR LI-RADS. Cases will cover not only the cross-sectional imaging findings of LI-RADS, but also illustrate corresponding angiographic findings seen during transarterial therapies. CT, MR, and angiographic cases will illustrate the importance of standardized hepatic mass evaluation for accurate diagnosis and improved patient outcomes. Clinical history, treatment course, and clinical outcomes will be presented alongside the imaging to illustrate the LI-RADS scoring and its impact on clinical decision-making.

**CONCLUSIONS:** The ACR LI-RADS was created to standardize the reporting and data collection of CT and MR imaging for HCC. This exhibit will explain and illustrate what an interventional radiologist needs to know about LI-RADS to be an effective part of the clinical team.

**Abstract No. 698**

Clinical use of 3D Slicer segmentation and visualization with examples in pretreatment planning of Y90 and TIPS procedures

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**PURPOSE:** Step-by-step approach to vessel, organ, and lesion segmentation and visualization using 3D Slicer software. Case examples of using 3D Slicer for planning yttrium 90 (Y90) and TIPS procedures.

**MATERIALS:** 3D Slicer is a free open-source software system developed for use in image processing and analysis research. There are multiple tools available in 3D Slicer that demonstrate clinical applicability in treatment planning for multiple therapeutic applications. Extraction of vessels and other structures in three dimensions can provide crucial information aiding in pretreatment planning for interventional liver procedures. A step-by-step approach on how the software can be...
used to provide a visual 3D reconstruction will demonstrate hepatic vascular anatomy and vasculature adjacent to hepatic lesions.

**RESULTS:** Use of 3D slicer to aid in treatment planning of hepatic lesions can be divided into 4 stages: 1) Registration of multiphase CT scans; 2) Preprocessing of image data to reduce image noise while preserving feature edges; 3) Segmentation of anatomic structures of interest including vessels, lesions, and liver; and 4) Producing models of these structures for visualization. A brief tutorial of vessel segmentation in 3D slicer will be presented. Each subsection of the process, including scan registration, prefiltering, vessel segmentation, and liver segmentation will be discussed as part of the tutorial. Preprocessing filters for improving segmentation of arteries and veins will be presented. Y90 embolization and TIPS case examples will be shown to demonstrate the process of segmentation. With regards to TIPS, 3D vasculature reconstruction will be presented focusing on the anatomic relationship between the hepatic vein and the portal vein prior to and after stent placement. Additionally, vascular anatomy of metastatic hepatic lesions during the Y90 pretreatment planning phase, will be shown in 3D reconstructed formats to emphasize the relationship of the vasculature with regards to the lesion.

**CONCLUSIONS:** A tutorial on using 3D Slicer from an interventional radiologist point of view. Clinical use of 3D slicer will be presented by showing examples in clinical cases of Y90 and TIPS procedures.

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**Abstract No. 699**

**Read the fine print: practical considerations for protective garments for the interventionalist**

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**PURPOSE:** 1: Brief review of physics 2: Current technologies 3: Methods for quantifying protection 4: Important considerations for garment selection

**MATERIALS:** It can be difficult for the interventionalist to sort through the dizzying array of garments available. This exhibit provides basic background and practical information to aid selection.

**RESULTS:** Scatter radiation is the primary source of exposure in IR. Scatter spectrum is influenced by, but not the same as, the primary beam. Lead (Pb) garments are a mature technology and provide good attenuation in fluoroscopy owing to high atomic number (Z) and density. Pb-free and Pb-composite garments use lower Z elements, exploiting k-edge interactions, to attenuate X-rays. Their attenuation varies with X-ray energy, precluding the use of “Pb equivalence” to quantify protective value. Bilayers reduce weight by better managing fluorescent radiation. Pb-composite and Pb-free garments are newer technologies and present technical challenges related to high loading fractions of metal in the polymer matrix. Manufacturers were surveyed about products they offer and testing standards used. A literature search of existing data on protective garments was performed, and testing standards were reviewed, including those from the ASTM and IEC. While many manufacturers comply with standards, this is not required in the USA. Some standards in use do not adequately evaluate Pb-free and Pb-composite garments, as they evaluate transmission at a single beam quality and may not include fluorescent radiation. New research has explored better methods. An ideal method would consider scatter radiation quality, use cases, and garment mass. Important selection criteria for garments include protective matrix, thickness, and design. Garments are typically available in 0.25, 0.35, and 0.5 mm “thicknesses,” and may differ in the front and back of the garment.

**CONCLUSIONS:** Intelligent selection of a protective garment that balances protection and orthopedic strain is possible without a detailed understanding of radiation physics. This exhibit outlines key practical considerations for the selection process.

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**Abstract No. 700**

**Primer on medical 3D printing for interventional radiologists**

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**PURPOSE:** 1) Understand the basic history of 3D printing and its medical applications. 2) Describe the various 3D printing processes, from image protocoling to model printing. Finished printed example models will be available. 3) Discuss currently published and potential future applications of 3D printing in medicine.

**MATERIALS:** 3D printing (also termed additive manufacturing) first developed in the 1980s but did not garner significant interest in medicine until the early 2000s. Technology advances have improved the cost and variety of available 3D printing methods and materials. 3D printing applications in customized device and prosthesis design, and treatment planning are increasing with modern examples in neurosurgical, orthopedic, and vascular medicine. Of particular interest in IR, arterial and venous models simulating disease can assist in training and assessing technical competency.

**RESULTS:** 1) Medical 3D printing involves conversion of a DICOM dataset (typically CT) into a compatible 3D printing file format (typically STL, Standard Tessellation Language). 2) Compatible file formats are then optimized for printing using dedicated 3D printing software. 3) Finished 3D printing files combined with unique compounds and polymers can print therapeutic devices or anatomic models.

**CONCLUSIONS:** 1) Examples of 3D printing medical applications include prosthesis design, fracture modeling, and vasculature casting for treatment planning and simulation. 2) The medical 3D printing process can be summarized as: a. Image protocol and DICOM acquisition b. DICOM conversion to 3D printing file (e.g. STL). c. Optimization of 3D printing file d. Printable material selection and printing e. Postprinting evaluation and optimization. 3) 3D printing provides interventional radiologists a unique opportunity to customize therapeutic devices and create anatomic models for IR procedures and referring clinician needs.
Abstract No. 701

MACRA under a microscope

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PURPOSE: 1) Understand MACRA’s clinical and financial effect on diagnostic radiology and interventional radiology. 2) Discuss the robust analytics and IT infrastructure needed to support MACRA standards. 3) Review MACRA’s expected effect on optimizing the patient care experience.

RESULTS: The exhibit outlines potential strategies private and academic practices should utilize to maximize Medicare reimbursement under MACRA while continually enhancing the patient care experience. Furthermore, it discusses the collaborative efforts of the ACR and SIR in developing an IR Registry for MIPS and APM in order to create a standard toolkit that can be accessed and used across the industry. Lastly, the exhibit will focus on the long term downstream financial effects of radiology sub-specialties being categorized as “patient-facing” or “non-patient-facing” providers.

CONCLUSIONS: Teaching Points: 1) Transition timeline from SGR to MACRA 2) MACRA’s implementation 3) Overview of the MIPS core performance categories 4) Path forward for APMs

Abstract No. 702

Uses of contrast-enhanced ultrasound in interventional radiology

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PURPOSE: 1. Understanding basics of contrast-enhanced ultrasound (CEUS) 2. Applications of CEUS in an interventional radiology setting as discussed in the literature

MATERIALS: There have been multiple developments in the use of contrast-enhanced ultrasound in the pre, intra-, and postprocedural settings. CEUS involves using microbubble contrast agents with specialized sonographic techniques to demonstrate pertinent information with respect to blood flow and tissue perfusion. It is a safe and effective technique that is becoming more widely implemented on a global scale and in the context of interventional radiology. Significantly, a contrast agent (LUMASON) was recently approved by the FDA for liver and pediatric imaging indications. CEUS is a diagnostic tool and also an adjunct to interventional radiology techniques. Increased safety has been described with ultrasound contrast agents as they are non-nephrototoxic, avoid ionizing radiation, in some instances decrease examination time (compared to CT or MRI), and have increased portability.

RESULTS: This education exhibit will describe CEUS in the context of oncologic, non-oncologic, and vascular interventions. Recent literature describes CEUS improving detection of lesions by increasing conspicuity in different phases of contrast, comparable to CT or MRI. This has further optimized ablation techniques in both malignant and benign tumors by enabling real-time assessment of tumor viability, decreasing need for repeat treatment and increasing overall cost effectiveness. CEUS can also be used in the traumatic setting, expediting determination of traumatic vascular injury, differentiating pseudoaneurysm, hematoma, and active contrast extravasation. This dynamic evaluation has also been used in visceral organ injury by enhancing embolization techniques.

CONCLUSIONS: Contrast enhanced ultrasound is a valuable diagnostic tool, and is now emerging with multiple advantages in the pre, intra-, and postprocedure interventional settings. This role in oncologic, non-oncologic, and vascular intervention has significant implications in multiple medical disciplines, and further prospective investigation would be beneficial for its future evolution.

Abstract No. 703

Cone-beam computed tomography: changing the way we practice interventional radiology

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PURPOSE: To describe the benefits and demonstrate images of the numerous uses of cone-beam computed tomography (CBCT) during interventional radiology (IR) procedures.

MATERIALS: Over the past ten years, CBCT has become a standard technology on all high-end fluoroscopy units. The ability to obtain cross-sectional imaging and manipulate these data sets with postacquisition software provides many benefits during IR procedures. CBCT, as its name suggests, uses a cone-shaped photon beam that is directed at the patient as both the source and the image intensifier partially rotate around the patient. The result is cross-sectional imaging that can be reconstructed in any plane or rendered into a 3-D image. The use of intra-imaging contrast material injection as well integrated image manipulation software, creates numerous opportunities for CBCT to improve patient care within IR.

RESULTS: Preprocedurally, CBCT can be used to evaluate a target for drain placement or biopsy. When the target is identified on the CBCT, a laser projecting from the image intensifier can guide precise needle placement. CBCT with catheter-directed power injection can be used prior to intervention to obtain cross-sectional angiography. These images can then be used for target vessel identification when planning embolization. The can also be rendered into a 3-d image and overlaid onto the live fluoroscopy to create a dynamic roadmap to guide
Abstract No. 704

Construction of an interventional radiology fluoroscopy suite: a DIY guide based on experience at our institution

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PURPOSE: The reader will have a basic understanding of the steps needed to plan the construction of an IR fluoroscopy suite, including equipment evaluation and anticipated costs, FDA regulations, as well as knowledge of where to pursue further resources.

MATERIALS: All interventional radiologists are familiar with the operation of a fluoroscopy suite of one specification or another. And, many of us have a general idea of the cost of a fluoroscopy suite. However, few of us, if tasked with coordinating and overseeing the construction of a new suite, would even know where to start. Specifically, what resources are needed before one can consider building a new suite, including capital, equity, and space? A practical guide for the construction of a fluoroscopy suite can be of benefit to the interventional radiologist whether it pertains to actually constructing a suite or simply having a deeper understanding of one’s value in group/hospital system. This educational exhibit will be based on experience at our institution after having built a new state-of-the-art vascular intervention radiology department including.

RESULTS: Specifications for room construction stipulate nearly every detail of construction including door width, ceiling height, wall shielding, and air-pressure, among numerous other nuanced details. Each specification is often associated with a commensurate cost. Additionally, an appropriate contractor must be selected who can meet these specifications. This is all in addition to equipment selection and purchase. This educational exhibit will feature a step-by-step guide to the prospective radiologist who desires to plan the build his or her own room.

CONCLUSIONS: Interventional radiology fellowship is a whirlwind of technical and clinical learning. However, many of us begin practicing without sufficient knowledge of the economics of our basic tool-of-the-trade. This guide will empower the reader with this information, whether it is used to actually build a suite, or simply to better understand the value of IR in the ecosystem of medicine.

Abstract No. 705

Applications for 4D flow in interventional radiology

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PURPOSE: 1. Understand the basic imaging and physical concepts for 4D phase contrast MRI imaging (4D flow). 2. Evaluate the advantages and limitations of 4D flow, especially compared to other vascular imaging modalities (Doppler ultrasound, MR angiography, etc.). 3. Review current and future applications of 4D flow as they pertain to the interventional radiologist.

MATERIALS: Phase contrast angiography relies on dephasing moving spins submitted to a bipolar gradient. The further the spin moves (velocity * time), the more it will be submitted to high gradient effect variation. For a bipolar gradient of a given intensity and time, the moving spins will dephase in proportion to their velocity. To create a 4D flow phase contrast image raw datasets are collected to measure three-directional blood flow velocities (vx, vy, vz). This results in a combined angiographic data and 3D blood flow visualization that can be visualized with postprocessing to create colored vector graphs and streamlines.

RESULTS: 1. Perform literature review of 4D flow applications with specific attention to the field of interventional radiology. 2. Initial studies have been performed comparing 4D flow, venography, and doppler US in transjugular intrahepatic portosystemic shunt (TIPS) evaluation; quantifying splenic hemodynamics and portal hypertension; and evaluating flow distribution after vascular procedures (e.g. embolization).

CONCLUSIONS: 1. 4D phase contrast MRA (4D flow) is an emerging imaging technique with applications in interventional radiology. 2. As vascular imagers, interventional radiologists are poised to use 4D flow for both diagnosis and procedural planning.

Abstract No. 706

Non-inflammatory systemic vasculopathies: imaging and endovascular therapy

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PURPOSE: The exhibit focuses on the following non-inflammatory, non-atherosclerotic disorders—fibromuscular dysplasia, segmental arterial mediolysis, neurofibromatosis, and midaortic syndrome. The Clinical presentation, image findings, indications for therapy, and endovascular treatment options will be discussed.

MATERIALS: Systemic vasculopathies refer to various groups of disorders that share a common underlying problem of blood vessel dysfunction with resultant susceptibility to luminal irregularities, occlusion, dissections, aneurysms, hemorrhage and ischemia. Non-inflammatory
vasculopathies can be hard to differentiate due to their wide involvement of various arterial beds, absence of inflammatory markers, and the end-organ damage they produce. To avoid the invasiveness of histopathology, noninvasive imaging findings combined with clinical presentation become the mainstay of diagnosis. Treatment is dependent on clinical symptoms, end-organ damage, the vessels involved and vascular abnormalities.

**RESULTS:** CT angiography is the most common modality used to diagnose these diseases. MR angiography is helpful in assessing the vessel wall abnormalities and luminal pathology. Angiography is usually reserved for indeterminate cases or for endovascular therapy. US Doppler is useful to detect hemodynamic significance of stenotic lesions. Each disease can be distinguished based on location, and specific findings such as arterial dissections, aneurysms, beaded appearance, arterial wall thickening, hemorrhage, skip lesions, and stenosis/occlusion of the vessels. Once the diagnosis is made, depending on the location and abnormality, angioplasty and/or stent placement can be considered for the management of these diseases.

**CONCLUSIONS:** Diagnosing and treating non-inflammatory systemic vasculopathies can be challenging to physicians. At the conclusion of the exhibit, readers will have gained a familiarity of the most common non-inflammatory vasculopathies, be able to recognize radiological findings of these disorders, and have a thorough understanding of the endovascular therapies used for treatment. Knowledge of these diseases will reduce the delay in diagnosis and treatment.

**Abstract No. 707**

**Imaging features of iliac vein compression syndrome: what every interventional radiologist should know**

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**PURPOSE:** To review the various imaging findings of iliac vein compression syndrome, or May-Thurner syndrome (MTS). To illustrate pre- and posttreatment changes seen on intravascular ultrasound, computed tomography, and catheter venography using case examples.

**MATERIALS:** Iliac vein compression syndrome is typically seen in young, otherwise healthy individuals and can result in substantial morbidity due to venous outflow obstruction and potentially deep vein thrombosis. However, iliac vein compression can manifest with disparate features, including simple compression, thrombosis, intraluminal webs and spurs, and iliac vein aneurysms. As noninvasive imaging modalities are increasingly used to diagnose venous thrombosis, underlying iliac vein compression syndrome may not be recognized at the time of presentation. Interventional radiologists can play an important role in the prompt diagnosis and management of these obstructive lesions. This exhibit explores various multimodality imaging features of MTS using illustrative cases.

**RESULTS:** The following topics are illustrated in detail along with example cases. 1. Multimodality imaging in the diagnosis and treatment of MTS with Doppler ultrasound, CTV, MRV, catheter venography, and intravascular ultrasound. 2. Comprehensive review of the different imaging presentations of MTS including complete iiliofemoral vein thrombosis, diffuse venous atrophy and fibrosis, compression, spur or web formation, and aneurysms. 3. Expected post treatment imaging characteristics of MTS.

**CONCLUSIONS:** Interventional radiology has become the primary therapeutic option for patients with MTS, and familiarity with the multifaceted imaging characteristic of MTS is vital for early diagnosis and prevention of the disease progression.

**Abstract No. 708**

**Adrenal vein sampling: angiographic curve balls and hitting the cortisol home run**

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**PURPOSE:** Comprehensive review of adrenal vein sampling at our institution is presented as a pictorial essay focused on variant adrenal vein angiographic patterns. Catheter selection and customization, along with procedural pearls for confident adrenal vein cannulation is reviewed.

**MATERIALS:** Studies show that 5-10% of hypertensive patients suffer from primary hyperaldosteronism. Of these patients, it is estimated over half have a potentially curable adenoma. When identified, unilateral adenomas are cured surgically, eliminating the burden of lifelong medications. Adrenal vein sampling is considered the gold standard for localizing such lesions and distinguishing functional adenomas from bilateral adrenal hyperplasia.

**RESULTS:** Many consider adrenal vein sampling a technically challenging procedure, most notably, accessing the right adrenal vein. Our institution has confirmed several angiographic variations that increase confidence in correct catheter placement for sampling. Five known right adrenal vein angiographic patterns will be presented in pictorial form including gland-like, delta, triangular, stellate/branching and lack of discernible patterns, all with confirmatory cortisol selectivity indices. Inferior emissary and capsular veins, which are confident markers of appropriate catheter position, are demonstrated. Moreover, identification of right adrenal vein mimics is detailed. Left adrenal vein variations are displayed including implications of retroaortic and circumaortic left renal veins. Cather selection and customized side hole position is explained together with technical pearls for difficult adrenal vein sampling.

**CONCLUSIONS:** Successful adrenal vein sampling is critical in the treatment of primary hyperaldosteronism. Knowledge of the adrenal vein angiographic patterns, including mimics, is paramount to procedure success.
Abstract No. 709

Review of pelvic arterial anatomy using 3-D fluoroscopic spins
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PURPOSE: 1. Review the anatomy of the internal iliac artery as it relates to embolization procedures. 2. Discuss the most commonly encountered internal iliac anatomic variations. 3. Discuss the utility of 3D angiographic fluoroscopic spins in imaging pelvic vascular anatomy.

MATERIALS: Although complex and variable, it is important for the interventional radiologist to be familiar with the anatomy of the internal iliac artery as it relates to embolization procedures for uterine fibroids, prostate pathology, and pelvic trauma. Current standard educational references primarily rely on two dimensional fluoroscopic images to characterize pelvic arterial anatomy.

RESULTS: This image-based educational exhibit will utilize three dimensional fluoroscopic spins performed during pelvic angiograms to better illustrate internal iliac artery anatomy. The most commonly encountered and relevant anatomic variations will also be reviewed.

CONCLUSIONS: Currently utilized two dimensional techniques are insufficient in accurately illustrating the complex pelvic arterial system. Utilizing three-dimensional fluoroscopic spin technology currently in clinical use for procedures such as prostate artery embolization, we aim to more clearly characterize the internal iliac arterial system as a review both for trainees and physicians in practice.

Abstract No. 710

High intensity focused ultrasound (HIFU): what junior radiologists need to know
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PURPOSE: To educate junior radiologists about the basics of High Intensity Focused Ultrasound (HIFU) as well as its current applications and promising research trends.

MATERIALS: HIFU is a noninvasive technology with many applications including ablation of tumors. Advantages of HIFU include its completely noninvasive nature as well as the ability to monitor the treatment process either by real time ultrasound or MRI. Currently, HIFU is FDA approved for treatment of uterine fibroids, bone metastasis and prostate cancer. Ablation of other tumors, like liver and pancreatic tumors, is widely available in Europe and Asia but not yet approved in the US. Active research is currently conducted in different fields, especially in interventional neurology. Despite the advantages of HIFU, it still has its limitations that need to be addressed and further investigated.

RESULTS: HIFU entails focusing of high energy ultrasound beams into one focal point. This is achieved using special ultrasound generators and focusing techniques. Once ultrasound waves get focused at one spot, different biological effects take place that contribute to tissue damage at the focus. Interestingly, temperature at the focal point can reach 70 °C or more within milliseconds. Also, changes at the focal point can be monitored using MRI or ultrasound imaging. Typically, damage occurs at the focus without significant tissue damage before or after the focal point, making HIFU a completely noninvasive technology and adding more to the safety profile of this ablation technique. Different ablation techniques are applied to increase the ablation volume and reduce the ablation time.

CONCLUSIONS: 1. To understand the physical principles, modes of action and mechanisms of HIFU ablation through a simplified illustrated approach. 2. To highlight the main limitations, advantages and disadvantages of HIFU in contrast to current ablation technologies in practice e.g.: RF ablation. 3. To be updated about the current FDA approved applications of HIFU. 4. To be oriented about selected non-FDA-approved applications showing success in clinical trials.
extra-peritoneal sites, as well as the hemodynamic nature of the liver, ablative therapy provokes challenges when the tumor is located in the subcapsular space.

CONCLUSIONS: Challenges are faced when tumors are located in the subcapsular region of the liver from the fear of needle-track seeding and increased bleeding due to the anatomic and hemodynamic characteristics of the liver. By the end, the reader will have gained a familiarity of the anatomy of the liver and tumor locations, and a more thorough understanding of ablative therapies. They will be able to predict complications based on the image findings, and use our guide to help them perform a procedure that will give the patient the highest probability of successful eradication of the tumor.

Abstract No. 712

Imaging percutaneous pulmonary cryoablation: when to image and what to expect

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PURPOSE: 1. Understand procedural details of pulmonary cryoablation and recommendations for follow-up imaging. 2. Describe imaging characteristics of a successful cryoablation and identify the range of normal appearances in follow-up exams. 3. Identify complications such as pneumothorax, excessive hemorrhage, or residual/recurrent disease.

MATERIALS: Percutaneous ablation is a viable treatment option for lung tumors in non-operative patients. Recent studies have demonstrated superior efficacy of cryoablation compared to other ablative modalities with similar complication rate. As this modality is increasingly employed, follow-up imaging protocols will need standardization and clinicians will need familiarity with the normal and abnormal postoperative imaging characteristics.

RESULTS: We review the experience at our institution, including cryoablation of 68 nodules in 57 patients with Galil Medical cryo-probes and an average follow-up of 322 days. We demonstrate normal intra-procedural imaging including probe positioning and postablation hemorrhage as well as postprocedural complications including large pneumothorax (19, 28%) and hemodynamic instability (3, 4%). The normal postprocedural appearance of ablated nodules follows a predictable pattern of size increase at 30 days with predictable exponential tapering of lesion size; we provide examples at multiple time points. A majority (46, 68%) of the lesions cavitated, about half (22, 48%) of which eventually resolve. Finally, we have encountered a 7% (5) recurrence rate, and we demonstrate features of recurrent disease on follow-up imaging.

CONCLUSIONS: Percutaneous cryoablation of pulmonary nodules is an effective modality for treatment of select lung tumors. Interpretation of intra-procedural and follow-up imaging is essential for successful treatment and identification of complications.

Abstract No. 713

Cryoablation of breast lesions: physiology, technique, clinical outcomes, and cryo-immunotherapy

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PURPOSE: 1. Describe the physiology of cryoablation of breast tumors. 2. Describe the technique of cryoablation of breast lesions. 3. Review the literature of outcomes in cryoablation of the breast in both benign and malignant lesions. 4. Describe cryo-immunotherapy in breast cancer as a means to activate immune response and potentially improve curative rates.

MATERIALS: Thermal ablation, specifically cryoablation, has emerged as an alternative treatment to surgical resection of tumors such as that of the kidney, liver, lung, and more recently breast. Cryoablation utilizes the insertion of a probe into the tumor in order to achieve an ablative freeze, resulting in cellular damage, death and necrosis. In vivo animal studies have demonstrated that a freezing temperature of -20˚C reliably renders cell death. With improvement in breast cancer screening, most diagnosed breast cancers today in the United States are less than 2 cm, allowing ablation to be a viable alternative treatment to lumpectomy. In this environment, multiple trials have demonstrated the feasibility, efficacy, safety, well tolerance, and cosmesis satisfaction of cryoablation of the breast. In addition to local treatment of tumor, cryoablation of the breast has the added benefit of positive cryo-immunologic effects.

RESULTS: 1. Description of the physiology of cryoablation of breast tumors. 2. Description of technique of cryoablation of breast lesions. 3. Review of the literature of outcomes in cryoablation of the breast in both benign and malignant lesions. 4. Describe cryo-immunotherapy in breast cancer as a means to activate immune response and potentially improve curative rates.

CONCLUSIONS: In conclusion, cryoablation of breast tumors is an emerging technique in the current era of breast cancer screening and treatment. Studies have demonstrated its feasibility and efficacy and its potential added benefit in conjunction to immunotherapy. Reviewers will be able to describe the physiology and technique of cryoablation of breast tumors, as well as describe assessed clinical outcomes, and the potential benefit of cryo-immunotherapy.
Abstract No. 714

Protective techniques to provide safe margin in difficult ablations

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PURPOSE: To describe and illustrate protective techniques used for organs at risk of thermal injury during percutaneous ablation procedures.

MATERIALS: There are many limitations to performing a safe and effective ablation procedure. These include the absence of a safe margin or access path due to proximity of the targeted lesion to an organ at risk of injury. There are different techniques that can mitigate these limitations.

RESULTS: The authors aim to showcase a few techniques that allowed them to achieve safe margins in otherwise unattainable or high-risk tumors due to adjacent organs. Examples include conventional and unconventional ways to use hydro and pneumo-dissection. In the event that a safe margin cannot be achieved through usual means, creation of artificial heat sink by way of continuous fluid infusion through a catheter interposed between the targeted lesion for ablation and the organ at risk can help dissipate the thermal energy in locations at risk. Single lung ventilation can help provide trans-pulmonary access in liver dome lesions. Cases showed satisfactory technical success and extension of the ablation margins up to but not involving the organs at risk. There was no evidence of complications or injury immediately after the procedure and at follow-up.

CONCLUSIONS: Tumors in difficult or high-risk locations due to absence of adequate marginal distances can be successfully ablated with the appropriate protective measures. In the event that conventional measures fail to produce a safe margin, continuous fluid infusion can be used to create a protective artificial heat sink effect. Single lung ventilation can allow a trans-pulmonary approach to liver ablation. Temporary organ displacement can create safe access path for needle placement and does not need to be reserved for margin creation.

Abstract No. 715

Robot-assisted navigation system for CT-guided target localization

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PURPOSE: 1. To understand the work flow of robotic navigational system for CT--guided placement of needles during biopsy and ablation procedures. 2. To familiarize and adapt to the requirements of the robotic system, and there by troubleshoot and prevent non-target localization.

MATERIALS: CT-guided biopsy and ablations are performed with continuous or intermittent fluoroscopic guidance. Precise needle positioning through a short, safe and accessible window avoiding vital and non-target structures can be challenging. Robotic guidance facilitates precise needle placement and provides a platform for optimal treatment opportunity. There is additional benefit of decreased procedural times and decreased radiation. However, there is a learning curve which requires familiarity with the environment and the system.

RESULTS: 1. Illustrate cases with difficult to reach lesions, and utility of robotic system in such scenarios to achieve target localization. 2. Demonstrate the ease and utility for planning and accurate placement of multiple needles. 3. Discuss techniques to optimize the target localization by preventing and monitoring patient motion. Technical aspects and limitations would be illustrated.

CONCLUSIONS: Robotic needle placement provides accurate localization of the target with implications on diagnosis and loco-regional therapies such as ablation. In an appropriate clinical scenario, robotic assistance is useful for difficult to reach or lesions with challenging anatomy and for placement of multiple simultaneous probes in a quick and safe manner.

Abstract No. 716

Role of contrast-enhanced ultrasound in evaluation of microwave ablation zone

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PURPOSE: 1. Share institutional experience in the use of contrast-enhanced ultrasound in the treatment of hepatocellular carcinoma with microwave ablation 2. Review basic principles of contrast-enhanced ultrasound, specifically its utility in pre-, intra-, and postprocedural evaluation of the ablation zone 3. Comparison and description of two leading microwave ablation technologies

MATERIALS: Percutaneous microwave ablation (MWA) under CT and/or ultrasound guidance is a mainstay therapy for hepatocellular carcinoma (HCC). Postablation contrast-enhanced CT is occasionally performed to assess satisfactory ablation margins however requires additional ionizing radiation and iodinated contrast load. Contrast-enhanced ultrasound (CEUS) is an imaging technique utilizing microbubble contrast agents that can demonstrate blood flow and tissue perfusion, enabling visualization of tumor and ablation zone in real-time without requiring additional radiation or iodinated contrast exposure. This exhibit outlines the utility of CEUS for MWA of HCC.

RESULTS: All MWAs performed for HCC at our institution for the two-year period spanning September 2014 through August 2016 were retrospectively reviewed. A total of 40 patients received microwave ablation for hepatocellular carcinoma, 19 of which received intra-procedural evaluation of the microwave ablation zone with CEUS. 22 MWAs were performed with a Covidien Emprint™ ablation system and 18 were performed with NeuWave Certus® ablation system. 33/40
(83%) patients received follow-up imaging with CT, MRI, and/or CEUS, revealing residual tumor in 2/33 (6.1%). None of the patients who received CEUS-guidance during their procedure had residual tumor, yielding a residual tumor rate of 0% (0/19) for the patients whose procedures were guided with CEUS.

**CONCLUSIONS:** Intra-procedural CEUS evaluation during MWA can potentially increase the treating physician’s confidence in the adequacy of immediate ablation zone without exposing the patient to additional ionizing radiation and iodinated contrast.

Abstract No. 717

**Growing roles of image-guided biopsy in the era of precision medicine in oncology: what interventional radiologists need to know**

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**PURPOSE:** To review the impact of image-guided biopsy on the recent precision medicine in oncology and to understand the required knowledge and techniques to obtain suitable biopsy specimens for genomic analysis.

**MATERIALS:** In the era of precision medicine in oncology, the role of image-guided biopsy has been dramatically expanding. Biopsy at the time of initial diagnosis is aimed not only for traditional histologic diagnosis but revealing specific genetic changes used for molecular targeted therapies for more than 25 histologic types of cancers. In addition, biopsies at multiple time points are also required to predict response, side effects and new mutations after the prior targeted therapy. Moreover, in exploratory early phase clinical trials, sequential biopsies are indispensable to evaluate putative predictive biomarkers and proof of target. Also, recently invented biomarker-driven clinical trials (basket trials) demand broad screening of genome with next-generation sequencing (NGS) technology. Image-guided biopsy has a potential benefit to provide timely and less-invasive sampling of required specimens.

**RESULTS:** In this educational exhibit, the following topics will be discussed: 1. Review of the state-of-the-art genomic analyses. 2. Considerations for image-guided biopsy to obtain suitable specimens including (i) selection of the site with relevant image findings, (ii) choice of a biopsy needle and guiding images, (iii) required tissue volume and adequate tissue handling, and (iv) how to avoid and manage biopsy-related adverse events. 3. Feasibility of genomic analyses with biopsy specimens: the literature review, the results from our institutional experiences, and the challenges regarding the molecular profiling, whole-genome sequencing with NGS, and sequential biopsies will be demonstrated.

**CONCLUSIONS:** Image-guided biopsy plays a crucial role in the precision medicine in oncology. Deep understandings of the current trends of precision medicine and the requirements for the biopsy will allow interventional radiologists to actively participate in this emerging field.

Abstract No. 718

**Deflategate: review of methods to prevent iatrogenic pneumothorax from lung biopsy**

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**PURPOSE:** The purpose of the study is to review the literature for variables associated with pneumothorax rate and methods used to decrease the occurrence.

**MATERIALS:** As lung cancer screening becomes more prevalent, there will be an inevitable increase in biopsies performed. Pneumothorax is the most common complication not uncommonly requiring tube thoracostomy and hospital admission. This exhibit includes a comprehensive review of the reported risk factors associated with iatrogenic pneumothorax and techniques for managing it prior to tube thoracostomy.

**RESULTS:** A systematic review of the literature was performed. The PUBMED database was searched using the MESH terms ("Biopsy, Needle"[Mesh] AND "Lung"[Mesh]) AND "Pneumothorax"[Mesh]). All published trials assessing pneumothorax rate in CT-guided lung biopsies were reviewed. Variables which were reported in the literature to be associated with pneumothorax rate were placed in one of four categories including: non-modifiable risk factors, potentially modifiable risk factors, prophylactic management, and prethoracostomy management. There were 181 articles from Oct 1972 to Jan 2016 within the search criteria. Non-relevant articles were excluded and 76 articles were reviewed. The largest non-modifiable risk factor was presence of emphysematous changes in the lungs. Potentially modifiable risk factors include crossing aerated lung, number of times crossing pleura, and needle size. The most effective prophylactic management includes sealant tract injection, plug placement, and post procedure positioning. The most effective management methods prior to tube thoracostomy include manual aspiration and opposite position aspiration.

**CONCLUSIONS:** There are many variables in percutaneous lung biopsy planning that the operator should be aware of that can decrease the pneumothorax rate. After development of pneumothorax, there are several techniques that can decrease the need for tube thoracostomy.

Abstract No. 719

**CT-guided percutaneous prostate biopsy**

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**PURPOSE:** To illustrate the potential use of computed tomography (CT) guidance for percutaneous prostate biopsy.

**MATERIALS:** Prostate cancer is the second most common malignancy in men in the United States with surgery for localized disease being a
common therapy. Biopsies are traditionally performed using trans-rec-
tal ultrasound or magnetic resonance imaging (MRI) guidance. Per-
cutaneous CT guidance for solid organ biopsy is well-established, however, percutaneous prostate interventions have not been studied robustly in part due to the perception of a prohibitive location deep within the pelvis. We present a successful method of CT-guided pro-
state biopsy for patients referred to the department of interventional radiology by urologists who had previously experienced non-diagnos-
tic biopsies.

RESULTS: Initial diagnostic imaging in patients was performed with MRI. Patients were positioned supine on the CT table and scout imag-
ing was acquired, after which anatomic landmarks were compared with MRI to plan a safe trajectory for biopsy. Moderate sedation and local anesthetic was supplied by the IR staff for pain control. A transad-
ductor approach was used for access into the anterior portion of the prostate mass using a coaxial system, and FNA as well as core biopsies were taken. Light manual compression was used to achieve hemosta-
sis, and a sterile dressing was applied. Patients were discharged after 2 hours of observation without complication.

CONCLUSIONS: CT-guided prostate biopsy may be a technically fea-
sible minimally invasive procedure that may potentially offer a robust method for focal therapy of the prostate with a favorable complication profile. While visualization of the prostate is traditionally performed by MRI, anatomic landmarks can help guide the interventionalist in perfor-
ming these procedures through CT imaging.

### Abstract No. 720

**Balloons, plugs, and other things: flow redistribution
techniques during hepatic embolotherapy**

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**PURPOSE:** This exhibit will present a review of techniques employed for flow redistribution during hepatic embolotherapy when subselection of treatment vessels is limited by technical or temporal factors. Pre-
procedural and intraprocedural imaging will be reviewed with a focus on vascular anatomy, technical nuances and endovascular devices used for flow redistribution. Case-based illustrative examples will be presented.

**MATERIALS:** Hepatic embolotherapy is the standard of care for interme-
diate stage hepatocellular carcinoma (HCC) in patients with relatively preserved hepatic function. In some instances, variations in vascular anatomy limit microcatheter subselection of target vessels, which may restrict adequate treatment of the target zone and compromise pres-
vervation of non-target hepatic parenchyma. A number of techniques, including temporary distal balloon occlusion with and without concurrent use of a microcatheter, use of a double-lumen microballoon catheter and balloon blocking technique have been described to optim-
ize treatment. Similarly, we have employed microvascular plugs at our institution to achieve a similar outcome. A thorough understanding of these techniques is helpful in achieving adequate treatment during embolotherapy.

**RESULTS:** Examples from our institutional experience will demonstrate variations in tumor vascular supply, as detailed on pre- and peri-pro-
cedural imaging, which limit effective microcatheter subselection of target vessels. We will present the methods used to achieve adequate coverage of the treatment zone, using both balloon and microvascular plug mediated techniques. Technical and clinical outcomes from our institutional experience will be reviewed, including demonstration of adequate tumor staining on intraprocedural cone-beam CT, lesion response on postprocedural imaging and procedural complications.

**CONCLUSIONS:** Variations in tumor vascular supply may limit microca-
theter subselection of treatment vessels during hepatic embolother-
apy, leading to inadequate tumor coverage and possible non-target embolization. A thorough understanding of balloon and microvascular plug mediated flow redistribution techniques is essential to achieve optimal therapeutic effect.

### Abstract No. 721

**Clinical significance of heterogeneous Lipiodol deposition pattern on noncontrast CT immediately after cTACE: correlation of imaging and pathological findings**

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**PURPOSE:** To demonstrate findings of heterogeneous lipiodol deposi-
tion on noncontrast CT performed after TACE. To determine whether this type of pattern affects therapeutic outcome of TACE, or not, and to correlate with MRI and pathologic findings (explanted liver). To access relationships among pre-TACE MRI, angiographic findings, and lipiodol deposition pattern on post TACE CT. To access Whether this deposition pattern can be related to technical issues or technical error.

**MATERIALS:** Hepatocellular carcinoma (HCC) is the most common malignant tumor of the liver. Although oil-based transcatheter arterial chemoembolization (TACE) has been widely performed in the treat-
ment of HCC, the predicting value for therapeutic outcomes of lipiodol deposition pattern, especially heterogeneous deposition pattern, on noncontrast enhanced CT scan still not fully established. Therefore, A thorough understanding of its predicting value for tumor destruction and correlated with pathology and imaging findings are imperative.

**RESULTS:** Data of patients with STACE /OLT Superselective TACE/OLT N = 42 Hepatitis C and cirrhosis (N = 36) Hepatitis B and cirrhosis (N = 6) Child classification Child A = 14 Child B = 18 Child C = 10 Therapeu-
tic characteristics STACE and OLT, N = 42 Successful super-selective TACE N = 40 Lobar TACE N = 2 Explanted liver and pathologic studies, N = 42 Complete necrosis with no viable cancer cells, N = 25(60%), including 7 patients with heterogeneous lipiodol deposition pattern (60%) >95% necrosis, N = 7 (17%), including 2 patients with HLDP <50% necrosis, N = 10 (23.8%), including 1 patient with HLDP.
**CONCLUSIONS:** Clinical and pathological findings indicate that Tumor destruction ability of heterogeneous lipiodol deposition pattern on noncontrast CT post TACE varies depending on etiology. However, 100% of tumor necrosis can be achieved in most cases in this group of patient.

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**Abstract No. 722**

**Temporary balloon occlusion techniques to safely and effectively treat inaccessible or hypovascular tumors during hepatic arterial embolotherapy**

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**PURPOSE:** 1. Review several techniques that utilize temporary balloon occlusion to facilitate embolization of hypovascular tumors or otherwise inaccessible target vessels during hepatic arterial embolotherapy. 2. Compare and contrast how these techniques can be implemented in different clinical scenarios to successfully embolize a target tumor. 3. Understand possible risks associated with these techniques and how to prevent or resolve possible complications.

**MATERIALS:** Hepatic arterial embolotherapy plays an important role in the treatment of hepatocellular carcinoma and liver metastases. These interventions utilize superselective technique to spare healthy parenchyma while still providing adequate oncologic control. This balance is especially critical in cirrhotic patients. When faced with challenging anatomy, target vessels can prove inaccessible with standard microcatheter techniques, resulting in failure of therapy or intraprocedural complications. With the development of technologies such as small occlusion balloon catheters, several alternative techniques have recently been described which utilize temporary balloon occlusion to provide an alternate method of embolization for vessels previously deemed inaccessible or for tumors considered hypovascular (1-3).

**RESULTS:** Target vessels can be inaccessible when using traditional microcatheter methods secondary to narrowed origins, acute angles, tiny vessel caliber, or dilatation and tortuosity of the parent vessel. The procedural details of several alternative techniques which utilize single and double occlusion balloon catheters to exclude non-target vessels and manipulate flow dynamics to direct therapy into these hard to reach places will be illustrated and representative cases exhibited. Possible risks related to temporary balloon occlusion and applicable precautions will also be discussed.

**CONCLUSIONS:** Hepatic arterial embolotherapy requires superselective technique to provide oncologic control while sparing uninvolved liver. When difficult anatomy or tumor hypovascularity renders target vessels inaccessible by standard microcatheter techniques, occlusion balloon catheters can be used to facilitate successful embolization and reduce complications.

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**Abstract No. 723**

**Chemoembolization of lung tumors: a summary of outcomes**

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**PURPOSE:** 1. Define lung transcatheter arterial chemoembolization (lung TACE) and other targeted lung chemotherapy techniques such as bronchial artery infusion and isolated lung perfusion. 2. Describe unique challenges and differences between lung TACE and liver TACE. 3. Summarize major studies implementing TACE in lung tumors with a literature review. 4. Discuss future directions of TACE as an alternative therapy and as part of a combination therapy regimen in unresectable pulmonary tumors.

**MATERIALS:** Lung TACE is a promising technique for unresectable lung tumors, much in part to the lungs’ dual blood supply from the pulmonary and bronchial arteries. However, unlike the predictable hepatic arterial supply of hepatoma (HCC), lung tumors are often supplied by multiple vessels, including the pulmonary, bronchial, internal thoracic, inferior phrenic, and even subclavian arteries, requiring unique angiographic investigation for each patient. A thorough literature review was performed to ascertain all studies utilizing lung TACE. Both primary lung cancer (particularly non-small cell lung cancer, NSCLC) and metastatic disease were investigated. TACE-only and combination TACE + RFA (radiofrequency ablation) treatment cohorts were studied. Primary outcomes and reported side effects were reviewed.

**RESULTS:** In the largest lung TACE patient cohorts (Yang, N = 61; Vogl, N = 52; Seki, N = 16), over half of treated lung tumors demonstrated at least partial response. The procedure was universally well-tolerated, with the most common side effect being fever and nausea from postembolization syndrome. The two largest lung TACE + RFA patient cohorts reported even more positive results; Yang et al (N = 43, advanced NSCLC) had increased 1, 2 and 3-year survival rates (91%, 58%, 21%, P<0.01) compared to either TACE or RFA alone. Gadaleta et al (N = 17, metastases and NSCLC) showed a one year complete response rate of 65%.

**CONCLUSIONS:** While only a handful of authors have studied chemoembolization of the lung, early outcomes are positive in terms of survival and overall tumor burden, with few side effects. Combining lung TACE with RFA appears to deliver even more promising results, though further investigation is needed.
Use of advanced applications of the angiography suite to optimize transarterial chemoembolization with radiopaque beads

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PURPOSE: 1. To learn how advanced applications of a modern-day angiography suite can optimize precise and controlled embolization, and end-point determination during transarterial chemoembolization using drug-eluting beads (DEB-TACE) with radiopaque (RO) microspheres (LC bead LUMI™, Biocompatibles UK Ltd., BTG International, Farnham, UK). 2. To understand how the differences in physical properties affect the handling of the radiopaque beads compared to non-radiopaque beads (LC bead™, Biocompatibles UK Ltd., BTG International, Farnham, UK).

MATERIALS: Transarterial chemoembolization (TACE) using drug-eluting beads (DEB-TACE) is a proven treatment option for unresectable hepatocellular carcinoma (HCC). Non-radiopaque beads require mixture with soluble contrast for visualization. However, the soluble contrast is faintly visible and washes out rapidly. Therefore, precise distribution of the embolic beads during or after the TACE procedure cannot be predicted, and hence cannot be controlled for accuracy. Newer RO microspheres enable visualization during and after TACE using X-ray based imaging. Their permanent radiopacity combined with advanced applications of angiography suite enable precise delivery of the microspheres and end-point determination while reducing non-target embolization. We present our institutional protocol for DEB-TACE using RO microspheres with emphasis on advanced applications.

RESULTS: A digital subtraction angiography (DSA) and rotational cone-beam computed tomography (CBCT) are obtained from proper or lobar hepatic artery. Multiplanar reconstruction (MPR) and volumetric images are generated to enable identification of tumors and supplying branches. Embolization guidance is used for superselective catheterization. After fluoroscopy-guided embolization, embolic distribution is evaluated by scout image and CBCT without and with contrast. Residual enhancement, if any, is identified by image fusion software and then embolized to achieve complete tumor coverage.

CONCLUSIONS: Advanced applications of the angiography suite can optimize precise and controlled embolization, and accurate end-point determination during DEB-TACE with radiopaque beads.

Demystifying stereotactic body radiation therapy: a concise guide for junior interventionalists

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PURPOSE: 1. To overview the stereotactic body radiation therapy (SBRT) including rationale, technical aspects, clinical applications and considerations relevant to interventional radiology (IR). 2. To explain with illustrated clinical cases the role of interventional radiologists in placing fiducial markers for optimizing SBRT of some abdominal and pelvic malignancies.

MATERIALS: SBRT is a local non-invasive ablative therapy that has emerged recently as a very effective and less toxic therapy for unresectable nonmetastatic primary cancer in the lung, liver, pancreas, kidney, adrenal gland and prostate in addition to oligometastasis in the lung, liver, bone and spine. It has demonstrated feasibility, safety, and efficacy with good to excellent local control based on retrospective and prospective studies. SBRT involves the delivery of very high dose of radiation to the target or tumor volume with high precision, while minimizing the radiation exposure of normal tissue. This results in tumor cell death via direct DNA damage as well as indirect DNA and cell damage through free radicals formation. Image guidance and respiratory motion management are playing an important key role in precise irradiation of target tumors in the abdominal or pelvic cavities. To improve the targeting discrimination, interventional radiologists are asked to place fiducial markers in several disease sites based on careful treatment planning and patient section.

RESULTS: The poster will explain the technology and techniques of SBRT and the role of IR in enhancing the delivery of SBRT with focusing on 1. Rationale and clinical applications including indications, efficacy and safety 2. Process for planning and delivering SBRT 3. Fiducial markers placement 4. Illustrated clinical cases 5. Future directions

CONCLUSIONS: SBRT is an effective and safe local ablative therapy for unresectable primary cancer and oligometastasis. Interventional radiologists should be aware of the technical aspects and clinical applications of SBRT to be able to facilitate the delivery of effective and safe SBRT and enhance the therapeutic outcome and patient care in collaboration with the radiation oncologists in multidisciplinary settings.
Abstract No. 726

Translating novel nanotherapeutics into the treatment of hepatocellular carcinoma from bench to bedside: a case study of the LDL-DHA nanoparticle

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PURPOSE: To examine an investigational nanomedicine and discuss the steps needed for clinical translation.

MATERIALS: For HCC, translating investigational therapies from the lab to the IR suite is complicated and expensive. We will examine the steps involved in obtaining approval of a novel drug with the LDL-DHA (low-density lipoprotein docosahexaenoic acid) nanoparticle as a case study for promising preclinical results in treating a rodent model of HCC. The agent has selective cytotoxicity toward HCC cells using redox-mediated processes, showing three-fold regression of tumor mass with no adverse effects on normal liver tissue.

RESULTS: PRECLINICAL: Nanotherapeutic created from well-known delivery systems easily tailored for desired target, size, charge, and hydrophobicity. Cellular mechanism must be shown along with efficacy and off-target effects in animal models, with comparison to nanoparticles devoid of the drug. In our case, biological effects were compared to controls in healthy rats with orthotopic tumors using both open surgical and transarterial approaches. Investigational New Drug (IND) application must be submitted to the FDA, describing pharmacology, manufacturing information, and clinical protocols (supplemented by an IRB). Some manufacturers can take part in a pre-IND consultation program, but the service is currently unavailable for nanotherapeutics. CLINICAL: Initial phases assess the safety/efficacy of the drug in increasing numbers of patients, first in healthy volunteers and then in those with the disease. Phase III verifies long-term effects in randomized controlled trials. New Drug Application (NDA) must be filed to allow marketing according to specific labeling. POSTMARKET: Surveillance after drug is on the market. FDA may request studies on specialized populations and clinicians may compare the drug to other treatments.

CONCLUSIONS: With the success of transarterial therapies, we can expect to see newer agents for treating HCC. At a cost of roughly $1 billion over 10-15 years for the development of new drugs, investigators involved in creating embolics should understand the process and special considerations in translating nanotherapeutics into clinical use.

Abstract No. 727

Needle navigation software for combined transarterial embolization (TAE) and percutaneous radiofrequency ablation (RFA) of unresectable liver tumors in a single session: technical considerations

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PURPOSE: To describe the technique of TAE followed by RFA for unresectable liver tumor performed in a single session utilizing needle navigation software provided by the fluoroscopy equipment.

MATERIALS: Combined liver-directed therapies, including TAE and RFA has become the preferred treatment option for unresectable liver tumors in many institutions. Several randomized control trials have addressed the benefits of this approach and a recent meta-analysis including 2210 patients confirmed better overall survival after combined therapy compared to single therapy only. The strategy varies with TAE performed first followed by RFA or vice-versa. Also, imaging modality for needle positioning can include CT or US and interval between treatments can vary from hours to several weeks.

RESULTS: 8 lesions were treated (2 hepatocellular carcinomas; 2 cholangiocarcinomas; 2 colorectal and 1 lung cancer metastases) with mean size of 2.9 cm. Under general anesthesia, TAE was performed through femoral or radial access. TAE was done with a combination of Lipiodol® (Guerbet, Villepinte, Fr), polyvinyl alcohol particles (300-500µm) with/without Mitomycin. This was followed by cone-beam computed tomography (CBCT) after placing the grid on patient’s skin. Once skin entry point was marked, the needle navigation software provided by the fluoroscopy equipment. Needle navigation software for combined transarterial embolization (TAE) and percutaneous radiofrequency ablation (RFA) of unresectable liver tumors in a single session utilizing needle navigation software provided by the fluoroscopy equipment.

CONCLUSIONS: Needle navigation software is an important tool that allows combination of two treatment modalities in the same setting, which can increase hospital efficiency and patient satisfaction. Procedure length decreases as operator becomes familiar with the system.
Abstract No. 728

Various techniques and anatomical variants in portal venous embolization: a pictorial review

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PURPOSE: 1. Review various techniques commonly used in portal venous embolization. 2. Explore various embolization material used in portal venous embolization. 3. Discuss challenging cases with troubleshooting techniques.

MATERIALS: Portal vein embolization (PVE) is a minimally invasive technique developed to enable major hepatic resection in patients who have extensive tumor burden and therefore previously deemed unresectable disease, given inadequate liver remnant volume. By cutting off the portal venous (PV) blood supply to the diseased portion of the liver, selective hypopropyphy of the remaining healthy liver, i.e., the future liver remnant (FLR), is expected to provide sufficient postoperative liver function via postembolization hypertrophy and allow safe major hepatic resection. Although a well-established technique, PVE cases often present with unique challenges.

RESULTS: Via review of multiple PVE procedures, we will demonstrate practical challenges in various aspects of these cases including important anatomic portal venous variants, technical challenges, and use of different embolization materials. Highlights of some of our cases are as follows. Case 1. Ipsilateral midaxillary puncture with transhepatic use of different embolization materials. Case 2. Ipsilateral midaxillary puncture with transhepatic use of different embolization materials. Case 3. Extensive right hepatic lobe access to portal vein supplying segment IV for lateral left lobe hypertrophy. Case 4. Extensive right hepatic lobe tumor burden distorts transsplenic approach to gain access. Material used: microparticles and coils.

CONCLUSIONS: 1. To provide a basic overview on the transarterial radiolabeled lipiodol therapy for hepatocellular carcinoma (HCC). 2. To explain the physical characteristics of radioisotopes labeled with lipiodol including iodine 131 (I-131) and rhenium 188 (Re-188) and related technical aspects.

MATERIALS: Hepatocellular carcinoma (HCC) has the tendency to remain confined to the liver predominantly. It has unique preferential arterial supply from the branches of hepatic artery in addition to the excess arterial neovascularization in the tumor bed. Lipiodol is an iodized oily agent that is selectively retained by HCC when injected into the hepatic artery. It has been used as a delivery vehicle of therapeutic agents including radioactive agents I-131 and Re-188 for selective targeting of HCC. The radiolabeled lipiodol therapy allow delivering the radioactive agent to provide selective high dose of radiation to the targeted HCC tumors with limited toxicity to the normal liver tissue. Both I-131 and Re-188 are β- and γ- emitters with similar biodistribution allowing imaging with a γ camera. Re-188 has advantages compared to I-131 including lower cost, lower γ energy and higher β energy and much shorter half-life, which doesn’t require hospitalization for radioprotection. However, I-131 has lower tissue penetration allowing homogeneous tumor radiation despite heterogeneous tumor uptake.

RESULTS: The poster will provide an overview on transarterial therapy with lipiodol labeled with I-131 or Re-188 for HCC. It will focus on the followings: 1. Rationale of transarterial radionuclide therapy. 2. Lipiodol as a delivery vehicle. 3. Physical characteristics and technical considerations of I-131 and Re-188. 4. Technical comparison with Yttrium 90 (Y-90) 5. Future directions.

CONCLUSIONS: Transarterial therapy with lipiodol labeled with I-131 or Re-188 is catheter-based therapy that used exclusively for selective targeting of HCC with high radiation dose. It is inexpensive treatment with straightforward technique. Interventional radiologists should be aware of the physical characteristic of the certain radionuclides and the technical aspects of the procedure to maintain their prominent role in the management of HCC.

Abstract No. 729

Transarterial radiolabeled lipiodol therapy for hepatocellular carcinoma: an overview for interventionalists

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Abstract No. 730

Predictive and prognostic biomarkers for yttrium-90 (Y90) radioembolization therapy of colorectal liver metastases

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PURPOSE: The purpose is to provide an overview on biomarkers predicting the outcome of patients with colorectal liver metastases treated with Y90-radioembolization.

MATERIALS: Personalized medicine has become increasingly important to provide the best possible care for each individual patient. Thus, appropriate patient selection is key to improve the overall outcome. We therefore will present biomarkers which predict the outcome to colorectal liver metastases treated with Y90-radioembolization.
RESULTS: This critical review aims to explore predictive and prognostic biomarkers of Ytrium-90 (Y90) radioembolization therapy of colorectal liver metastases. A brief overview of established and newly proposed predictive and prognostic physiologic, molecular and genetic biomarkers in colorectal cancer therapies will be presented. A special focus will be made on the most recent advancements on imaging parameters, genetic mutations, metabolic and other molecular markers and their predictive value on Y90 radioembolization therapy. For example, the recently established connection of poor outcomes in RAS and PIK3CA mutant CRC liver lesions treated with Y90 along with liver function tests will be outlined and critically discussed. Finally, the evaluation on applicability and potential impact on clinical routine and patient care will be made to eventually help to make informed locoregional treatment decisions in the clinical setting of metastatic colorectal cancer lesions of the liver.

CONCLUSIONS: This review will provide an overview of the opportunities for personalized cancer treatment in the setting of Y90 radioembolization. The ability to predict tumor response after yttrium-90 (Y90) radioembolization therapy can greatly impact clinical decision making including appropriate patient selection and enhance treatment outcomes. Thus, further research into the field is needed.

Abstract No. 731

Image-guided salpingostomy in the management of noninfectious pyosalpinx in the pediatric population

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PURPOSE: Upon reviewing this presentation, the learner will 1) obtain an enhanced understanding of noninfectious pyosalpinx in the pediatric population, 2) grasp the role of the pediatric interventional radiologist in the treatment of this disease process, 3) describe 2 common techniques for image-guided fallopian tube drainage, and 4) appreciate the broad spectrum of organisms isolated in this condition as well as the effect this has on appropriate specimen collection techniques.

MATERIALS: While most cases of pyosalpinx materialize from the ascent of infectious organisms arising from the lower genitourinary tract, noninfectious cases have been reported, often in the setting of predisposing intervention and/or anatomic abnormality. In the majority of reported cases, surgical management is the most commonly-employed treatment. We have successfully treated at least 4 cases in the past five years in which a teenage female presents with unexplained pyosalpinx in the setting of negative STI panels, all in patients with a body mass index (BMI) greater than 30. Ordering providers have speculated that this emergence is influenced by undiagnosed insulin-resistance, untreated bacterial vaginosis, and/or indolent urinary tract colonization.

RESULTS: The dilated fallopian tube can be accessed either percutaneously or transrectally. In the percutaneous approach ultrasound is utilized to target and access the fallopian tube with an 18-gauge needle through which a wire can be passed and exchange can be made for a 10 Fr pigtail Skater catheter following dilatation of the tract. Alternatively, the fallopian tubes can be accessed via a transrectal approach utilizing ultrasound guidance. In these cases an 18-gauge Chiba needle is used to aspirate the dilated tube. Fluid can be subsequently cultured in order to obtain sensitivities thus guiding antibiotic management.

CONCLUSIONS: At our institution, image-guided salpingostomy has emerged as a standard treatment for noninfectious pyosalpinx in adolescent females, a condition which may be on the rise in the setting of recent increases in adolescent BMI. Given the potential to isolate vaginal flora from these collections, anaerobic specimen preservation is recommended.

Abstract No. 732

Percutaneous management of intra and extra-hepatic biliary leakage: alternatives to bile diversion

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PURPOSE: 1. Review the different classifications of biliary leaks and fistulas. 2. Describe the presenting symptoms and signs. 3. Highlight the role of different imaging modalities in the diagnosis of intra-hepatic and extra-hepatic biliary leakage and fistulas. 4. Demonstrate different percutaneous techniques for management of bile leaks. 5. Emphasize the percutaneous embolization of biliary leak and fistulas using different embolic materials. 6. Outline the technique-related outcomes and the potential complications.

MATERIALS: Biliary leaks (BLs) and fistulas are common complications following liver and biliary surgery. Biliary leaks are an abnormal passage or communication from the biliary system to intra-hepatic or extra-hepatic location. The accepted definition of a BL requires the presence of biliary discharge from an abdominal wound or drain, with a total bilirubin level of the discharge of >5 mg/ml or three-times the serum level. BL can occur at biliary-digestive anastomoses or other intraoperative bile duct injury. The incidence mainly depends on the type of surgery done ranging from 0.2-0.3% after cholecystectomy and up to 30% after liver resection. The exhibit will provide a review on anatomy, pathophysiology, diagnosis, and imaging findings of BL. Finally, the interventional techniques used for the management of BL will be discussed.

RESULTS: The presentation will be supported with multiple cases from our institution. We will present the etiology, as well as, the clinical presentation and radiological findings (Ultrasound, CT and MRI) of these cases. A discussion of the details of percutaneous management technique and the outcomes will be provided.

CONCLUSIONS: Several percutaneous interventional techniques can be used in the management of bile leaks. Apart from the standard biliary diversion procedures, embolization of the intra-hepatic or extra-hepatic leaking ducts can be attempted.
Abstract No. 733

Percutaneous transhepatic cholangioscopy: techniques and role in the management of biliary disease

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PURPOSE: The purpose of this educational exhibit is to provide an overview of the percutaneous transhepatic cholangioscopy procedure and its clinical applications. Major points of procedure detail include preparation, instruments, and techniques. Important clinical applications include both diagnostic and therapeutic pursuits. Several of these points will be expressed with the aid of digital photography and video created during actual cases of: electrohydraulic lithotripsy of choledocholithiasis and cholelithiasis, biliary cast syndrome, and cutaneobiliary fistula.

MATERIALS: Percutaneous transhepatic cholangioscopy provides direct visualization of the biliary system and can be used to diagnose and treat many biliary conditions. These include but are not limited to, choledocholithiasis, cholelithiasis, biliary cast syndrome, and biopsy of biliary masses. This procedure offers an opportunity for interventional radiologists to treat conditions in non-operative candidates and patients with altered anatomy, such as Roux-en-Y gastric bypass.

RESULTS: This educational exhibit will focus on the technique and therapy of four separate cases, all with digital photography and video to demonstrate the clinical findings and procedural technique. The cases detailed include, but are not limited to: electrohydraulic lithotripsy (EHL) and stone retrieval of choledocholithiasis and cholelithiasis in non-surgical candidates, removal of debris in biliary cast syndrome, and diagnostic visualization of a cutaneobiliary fistula. Each case will include details on instrumentation, technique, and pre- and postprocedural management.

CONCLUSIONS: Percutaneous transhepatic cholangioscopy can be used to diagnose and treat a variety of biliary conditions. The procedure can be easily learned by following our step-wise approach detailed in digital photography and video in this educational exhibit. A subset of patients is most likely to benefit from this approach, including those deemed to be non-surgical candidates and those with altered surgical anatomy. Percutaneous transhepatic cholangioscopy provides an opportunity for the interventional radiologist to diagnose and treat biliary disease.

Abstract No. 734

Percutaneous endoscopy techniques: a problem-solving tool for the interventional radiologist

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PURPOSE: To review the technique of percutaneous biliary and GU endoscopy and applicable direct vision interventions to be used to treat biliary and ureteral stones, to traverse and intervene on recalcitrant strictures or short segment occlusions, and to visualize biliary and urologic pathology to facilitate performance of a biopsy to obtain a tissue diagnosis.

MATERIALS: Many patients with choledocholithiasis, nephrolithiasis and ureteral or biliary strictures suffer from obstructive symptoms. When combined with cholangitis or urosepsis, these conditions can cause significant mortality and morbidity. ERCP and endourologic techniques have limitations for patients with prior enteric bypass, ureteral diversion/reimplantation and neobladder reconstruction. Percutaneous transhepatic or transrenal endoscopy with established interventions are effective treatment options in these settings and should become a procedure offered to these patients by interventional radiology.

RESULTS: This exhibit will review the techniques of percutaneous biliary and renal endoscopy with established interventions. To summarize, these patients first require percutaneous access, cholangiography or pyelography and placement of a 12F drain. At the time of endoscopy, the drainage catheter is exchanged for a 12F peel-away sheath to allow for standard low pressure endoscopy using a 7.5F ureteroscope with direct vision of the pathology. Large stones can be treated with laser lithotripsy with basket retrieval of fragments, recalcitrant strictures can be traversed, and abnormal tissue can be sampled.

CONCLUSIONS: Percutaneous transhepatic or renal endoscopy with established interventions is effective as a problem-solving tool for the interventional radiologist, particularly for patients who are not candidates for ERCP or traditional endourologic techniques. This exhibit will review the materials, technique, and outcomes associated with procedure to enable interventional radiologists to include it in their armamentarium when treating patients with complicated biliary or GU pathology.

Abstract No. 735

Percutaneous interventional management of endoscopic procedural adverse outcomes

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PURPOSE: To illustrate through presentation of a series of cases how image-guided procedural techniques can salvage adverse outcomes of endoscopic procedures in the treatment of hilar biliary disease.

MATERIALS: Endoscopic and image-guided procedures generally complement one another in the management of gastrointestinal and hepatobiliary diseases. However, in the setting of adverse outcomes related to endoscopic procedures, creative image-guided techniques employed by the interventional radiologist can be used to successfully manage these challenging scenarios.

RESULTS: We present several cases to illustrate image-guided techniques used to successfully manage adverse outcomes of endoscopic procedures in the treatment of hilar biliary disease. Cases include image-guided percutaneous management of ductal rupture after endoscopic retrograde cholangiopancreatography (ERCP), removal or
The reality of fetal image-guided surgery and the role of interventional radiology

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PURPOSE: Understand the role of IR in the multidisciplinary care of fetal disease. Review fetal disease pathophysiology. Review the data supporting fetal intervention.

MATERIALS: Fetal intervention can be categorized into open fetal surgery, fetendo, and fetal image-guided surgery (FIGS). Open fetal surgery has fallen out of favor. Fetendo is performed percutaneously using endoscopy and sonography. FIGS is performed entirely with sonography to guide percutaneous intervention. Risks include fetal trauma, placental abruption, amniotic leakage, preterm premature rupture of membranes, and fetal demise. Intervention is acceptable.

CONCLUSIONS: Administration of autologous blood into the pleural cavity is a simple and effective technique to reduce the incidence of pneumothorax following imaging-guided lung biopsy and to treat the complication and reduce the necessity of chest tube placement.

Abstract No. 736

Role of autologous blood patch in pneumothorax following lung biopsy

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PURPOSE: We aim to review the role of autologous blood patch in the management of pneumothorax complicating computed tomography (CT) and ultrasound (US)-guided lung biopsy. A schematic representation of the steps involved in blood patch administration will be discussed along with its importance in reducing the incidence of chest tube placement following CT-guided lung biopsies.

MATERIALS: Pneumothorax is the most common complication following lung biopsies with a reported incidence of 20% following CT-guided biopsy and 4% following US-guided biopsy. Traditionally this has been managed either conservatively or by insertion of a chest tube. Increasingly, administration of autologous blood into the pleural cavity has been adopted as a treatment option with studies demonstrating reduction in the necessity of chest tube insertion. This technique has also been shown to be effective in post pneumonectomy patients with persistent postoperative leaks.

RESULTS: Administration of both clotted and nonclotted blood has been described in literature without any conclusive differences between the two techniques. Approximately 5-10 ml of the patient’s blood is drawn in a sterile fashion from an intravenous line and is administered through the coaxial needle through which biopsy was performed. Patient may then be positioned in a manner so as to keep the area that was biopsied dependent for about 5-10 minutes. Opinions differ as to the mechanism of action. The most commonly accepted explanation is that coagulated blood forms a patch over the site of leak while the theory that pleurodesis is encouraged by the autologous blood being considered less likely.

CONCLUSIONS: Administration of autologous blood into the pleural cavity is a simple and effective technique to reduce the incidence of pneumothorax following imaging-guided lung biopsy and to treat the complication and reduce the necessity of chest tube placement.

Abstract No. 737

Frustrated from the gastric fundal loop in gastrojejunostomy catheter placement and exchange: how can I reduce it?

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PURPOSE: We present a technique for reduction of the fundal loop which is safe, simple, reliable, fast and inexpensive. This technique has also been useful in initial gastrojejunostomy placement in the situation when a wire loops in the fundus and then traverses the pyloric sphincter.

MATERIALS: Placement of gastrojejunostomy (GJ) catheters for enteral feeding has become a mainstay in the Interventional radiology department. Patients return frequently for catheter exchange due to a multitude of reasons including the catheter becoming looped in the gastric fundus with tip pulled back from the jejunum. Unfortunately, in order to reduce the fundal loop, access to the duodenum must often be sacrificed. Re-accessing the duodenum is often time-consuming. Traditional techniques for reducing the fundal loop without using access to the duodenum are highly unreliable.

RESULTS: This poster will illustrate our technique for using a Fogarty balloon catheter to reduce the fundal loop in GJ placement and exchange. We will support the poster with diagrams and cases from our institution. As we will show, this is a simple, easily mastered technique that leads to decreased fluoroscopy and procedure time.

CONCLUSIONS: We introduce a technique for reduction of the fundal loop using a Fogarty balloon that proved to be successful and can be used in GJ catheter placement or exchange.
only if the fetal anomaly is diagnosable, and, if left untreated, is lethal or associated with high morbidity. A multidisciplinary team, which can include IR, is required for optimal patient care.

RESULTS: There are multiple indications for FIGS with varying levels of data to support its use, ranging from case reports to multicenter randomized controlled trials. Twin-to-twin transfusion syndrome can be treated with endoscopic laser ablation of placental vessels, frequent amnioreduction, selective bipolar cord coagulation, or radiofrequency ablation. Congenital diaphragmatic hernias can be treated with balloon fetal tracheal occlusion. Lower urinary tract obstruction, as caused by posterior urethral valves, may be treated with vesicoureteral shunts. Fetal pleural effusions can be treated with fetal chest pleuroamniotic shunt insertion. Hypoplastic left heart syndrome can be treated with percutaneous ultrasound-guided balloon dilation of the fetal aortic valve. Polyhydramnios can be treated with amnioreduction. Oligohydramnios can be treated with amnioinfusion. Massive intrapartum hemorrhage due to placenta accreta can be prevented with internal iliac artery balloon catheter placement. Technology is available to create 3D physical and virtual models to improve understanding of complex fetal anatomy, assist in surgical planning, and provide intraoperative guidance.

CONCLUSIONS: IR has a role in the multidisciplinary treatment of fetal disease. The supporting data ranges from case reports to multicenter randomized controlled trials.

Abstract No. 739

3D laser-guided navigational software for RFA of metastatic bone tumors: safety, utility, and efficacy

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PURPOSE: To illustrate the utility of 3D laser-guided navigational software in facilitating safe and accurate percutaneous radiofrequency ablation (RFA) of bone tumors.

MATERIALS: RFA is uniquely challenging when dealing with metastatic bone lesions due to the destruction of anatomical landmarks, need for accuracy in targeting smaller/radiolucent lesions, and the presence of stabilization hardware or cement. Syngo iGuide (Siemens Medical Solutions, Malvern, PA) is able to combine a predefined approach from cone-beam computed tomography (CBCT), with live fluoroscopic imaging to provide 3D guidance for needle placement. This not only increases safety, ease, and effectiveness of the procedure, but also broadens the spectrum of lesions amenable to treatment.

RESULTS: From July 2015-September 2016, 21 patients (mean age = 60.9 years, M:F = 11/10) with metastatic bone tumors of varying etiology (spine = 23, pelvic bone = 2, sacral = 1) underwent RFA under fluoroscopy using the Star (Dfine, San Jose, CA) (16) or Osteocoool (Medtronic, Minneapolis, MN) (5) systems after utilization of DynaCT (Siemens Medical Solutions, Malvern, PA) and the iGuide navigational system for planning. Select images from these cases have been selected to highlight the challenges faced with safely targeting bone tumors and to demonstrate the utility of navigational laser guidance and cone-beam CT in performing RFA ablation for bone tumors. 100% technical success was achieved in all cases without any postprocedure complications. Details regarding clinical background, indications and outcomes will be discussed in the exhibit.

CONCLUSIONS: Laser-guided navigational systems allow for the safe, effective, and technically successful treatment of challenging metastatic bone lesions with high precision and is a practical solution for aiding interventional radiology workflow.

Abstract No. 740

Percutaneous treatments for sympathetic syndromes: a role for IR

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PURPOSE: The purpose of this educational exhibit is to 1. Review clinical syndromes resulting from sympathetic autonomic nervous system dysfunction including chronic abdominal and pelvic pain, refractory ventricular tachycardia, and chronic regional pain syndrome (CRPS). 2. Describe six cases employing minimally-invasive interventional radiologic procedures to treat the above clinical syndromes. 3. Demonstrate the associated clinical and radiologic manifestations. 4. Review the relevance of these procedures to palliative care, pain management, neurology, and cardiology.

MATERIALS: The sympathetic autonomic nervous system originates from spinal nerves from the T1-L2 levels and is responsible for mediating various aspects of homeostasis, including blood pressure, heart rate, noxious sensation, alertness, and other components of the “fight-or-flight” physiologic response. The symptoms and manifestations resulting from sympathetic dysfunction are distinct, and based on which specific sympathetic ganglion is affected. These conditions can be debilitating, causing significant functional impairment and worsening quality of life. While ganglion blocks are often performed by other medical specialists under direct intraoperative visualization or by anatomic landmarks, interventional radiologists are uniquely positioned to treat these disorders.

RESULTS: A combination of text and images will be linked in a didactic format to review the anatomy and physiology of the sympathetic nervous system and illustrate the key findings of six cases involving sympathetic nerve dysfunction treated percutaneously: chronic pain treated by blockade of the sphenopalatine ganglion, celiac plexus, superior hypogastric plexus, and inferior hypogastric plexus, respectively; paroxysmal ventricular tachycardia treated by blockade of the stellate ganglion; and complex regional pain syndrome treated with blockade of the lumbar plexus.

CONCLUSIONS: Various debilitating clinical syndromes may result from sympathetic nervous system dysfunction. Minimally-invasive, image-guided procedures may play a significant role in the treatment and management of these patients. Interventional radiologists are uniquely positioned to treat these patients.
Thoracic splanchnic, celiac, and hepatic plexus nerve block for pain control during percutaneous liver procedures

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PURPOSE: Know the anatomy and location of the liver’s innervation. Review evidence for such nerve block in controlling pain related to liver procedures. Know approaches and guidance modalities that are used for the thoracic splanchnic, celiac and hepatic plexus nerve block. Discuss the advantages and disadvantages over general anaesthesia, deep conscious sedation or spinal block.

MATERIALS: The autonomic nervous system to the liver can be subdivided into the sympathetic and parasympathetic nervous system. Branches of both the vagal and splanchnic nerves innervate the liver via the portal area, and are closely associated with the portal vein and bile ducts. The vagus nerve is comprised of motor and sensory fibers, while the splanchnic nerves consist of both visceral efferent and sensory afferent fibers. The sympathetic nerves (T7–10) reach the liver via the celiac plexus and intermingle with parasympathetic nerves arising from the right and left vagus and perhaps the right phrenic nerve. Nerves originating from the left portion of the celiac plexus and the right abdominal branch of the vagus reach the liver via an anterior plexus that surrounds the hepatic artery. Nerves originating from the right portion of the celiac plexus travel through a posterior plexus located around the portal vein with occasional innervations accompanying the hepatic vein. Evidence regarding the use of these blocks in controlling pain related to hepatic interventions and techniques used are discussed.

RESULTS: Various imaging approaches can be used to do these nerve block including ultrasound, CT, and fluoroscopy. The aim of the procedure is to localize the needle where the plexus or nerve is located: for the celiac plexus nerve block the tip of the needle will be located at the base of the celiac axis; for the splanchnic nerve block the target is the sympathetic nerves as they course through the paravertebral space at T11; and for the hepatic plexus block around the hepatic plexus in the hepatic hilum. Examples will be provided.

CONCLUSIONS: The splanchnic, celiac and hepatic plexus nerve blocks are relatively safe and straightforward procedures that can be used for pain control during liver intervention.

Kyphoplasty/vertebroplasty devices: a comparative review of current treatments of osteoporotic vertebral compression fractures (VCF)

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PURPOSE: We present a review of the current devices available for the treatment of vertebral compression fractures (VCF). Several recent trials evaluating vertebroplasty (VP), balloon kyphoplasty (BKP), and non-surgical management (NSM) are reviewed herein. We present a table reviewing the differences in the BKP/VP devices available in the US in regards to technique (i.e., features that allow unipedicular approach, cement preparation, delivery times, etc.) and compare outcomes (i.e., safety, efficacy, complication rates, and cost).

MATERIALS: Percutaneous vertebral augmentation (BKP and VP) involves injection of bone cement into the vertebral body. BKP allows creation of a cavity within the vertebral body to facilitate filling of the bone cement by unilateral or bilateral transpedicular approach.

RESULTS: Two randomized masked trials in 2009 studied patients with pain duration up to 12 months and pain level > 3/10. Both studies showed that VP was non-efficacious in this patient population. The FREE and Vertos II trials demonstrated efficacy of BKP and VP, respectively, compared to NSM. However, these open-labeled trials were considered lower level of evidence compared to the masked trials. The 2016 VAPOUR masked trial showed compelling evidence contrary to the 2009 masked trials, but with different patient selection. Participants had acute (< 6 weeks) VCF, pain grade > 7/10, and included inpatients and outpatients. VP proved efficacious in pain relief after 6 months. A recent retrospective study has shown 4-year mortality risk for the NSM cohort was significantly higher than that of the BKP/VP cohorts. Adjusted risk of mortality proved 17% lower for BKP than VP. A recent study also demonstrated that VP is more costly than BKP after 4 years due to increased pharmaceutical consumption.

CONCLUSIONS: The most recent clinical studies (level I and II) suggest significant clinical improvement in patients with acute and painful osteoporotic VCF undergoing BKP/VP. Understanding the differences in patient selection of the masked trials discussed above will aid in selecting the appropriate treatment for each patient.
Abstract No. 743
The novelty and diversity in the treatment of congenital duodenal stenosis: a review of interventional and endoscopic techniques
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PURPOSE: 1. To review the indications, techniques and treatment outcomes of interventional balloon dilation as a treatment option for congenital duodenal stenosis in infants. 2. To compare and discuss the interventional treatment approach to that of endoscopy in order to further understand the determinants and scope of practice of each treatment option.

MATERIALS: Duodenal stenosis is a rare congenital digestive disorder with an incidence of 1 in 10,000 to 1 in 40,000. Diagnosis is often made shortly after birth using ultrasound, abdominal radiograph, or upper GI series. The mainstay of treatment has been surgical bypass, utilizing duodenodudenedostomy or duodenotomy with excision of the web. However, with the advent of therapeutic endoscopy and pediatric interventional radiology, less invasive treatment options are more readily available. Discussion in the literature of newer treatment options for the pediatric population is lacking. However, reported initial experiences of nonsurgical interventions utilizing endoscopic and interventional approaches have been positive.

RESULTS: 1. Review the clinical presentation, anatomy, embryology, pathophysiology, and radiographic diagnosis of congenital duodenal stenosis. 2. Discuss the utilization of common interventional wires and catheters in the treatment of congenital duodenal stenosis with a case study. 3. Compare the technical aspects and treatment outcomes from endoscopic excision/dilation and interventional approach via search of literature.

CONCLUSIONS: Both interventional and endoscopic techniques are safe, inexpensive and efficacious alternatives to the surgical treatment of congenital duodenal stenosis. The interventional approach has additional feasibility in small neonates when compared to endoscopic approach and may be offered as an initial treatment step to reduce complications associated with surgery in selected patients.

Abstract No. 744
Recognition and diagnosis of the RASA1-related disorders: a pictorial exhibit of the protean manifestations of capillary malformation-arteriovenous malformation (CM-AVM) and Parkes Weber syndrome
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PURPOSE: 1) Review the role Ras-GTPase-activating protein (RASA1) plays in the Ras cyclic AMP signal transduction pathways regulating VEGF expression, endothelial cell proliferation, and angiogenesis. 2) Review the different phenotypes and imaging characteristics of the complex combined vascular anomalies capillary malformation-arteriovenous malformation (CM-AVM) and Parkes Weber syndrome (PWS).

MATERIALS: Germline and de novo mutations in the RASA1 gene have been implicated in the development of CM-AVM, PWS, and cerebrospinal arteriovenous anomalies. The RASA1 gene, located on chromosome 5, encodes for the Ras-GTPase-activating protein p120RasGAP, which negatively regulates Ras activity and is widely expressed in human tissues including the brain, muscles, and placenta. Ras is a signal transducer for vascular endothelial growth factor (VEGF)-mediated angiogenesis, and Ras activation promotes phosphorylation and stabilization of the hypoxia-inducible factor-1 alpha transcription factor, inducing VEGF synthesis and subsequent angiogenesis. As a negative regulator of Ras activity, p120RasGAP modulates endothelial cell proliferation, organization, and migration. p120RasGAP loss or inhibition, as seen in patients carrying the RASA1 mutation, leads to aberrant activation of Ras and downstream signaling molecules with resultant aberrant and disordered angiogenesis.

RESULTS: This pictorial exhibit will define and elucidate the details of the Ras-cyclic AMP signal transduction pathway and its vital role in VEGF expression, endothelial cell proliferation, and angiogenesis. Representative clinical images, magnetic resonance angiographic, and conventional angiographic images will be used to define the protein manifestations of CM-AVM, PWS, and cerebrospinal arteriovenous malformations so as to facilitate better clinical recognition of these challenging diagnoses. Histopathologic images of the altered microvascular angioarchitecture characteristic of these vascular anomalies will be depicted.

CONCLUSIONS: Recognition of the phenotypes characteristic of patients with coexistent combined vascular anomalies and mutations in the RASA1 gene is requisite to proper diagnosis and treatment of these underrecognized patients.

Abstract No. 745
Beyond nice images: 3D lab utility for pediatric IR procedural planning
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PURPOSE: Through a series of illustrative cases, the reader will understand how to utilize 3D reconstructions from CT and MR imaging to assist with procedural planning for complex pediatric interventions.

MATERIALS: Two technologists specifically trained in 3D postprocessing created images in a dedicated 3D lab from both CT and MR for procedural planning with varying levels of guidance from both diagnostic and interventional radiologists. A variety of cases from the last two years are selected to highlight the benefit of this creative work.

RESULTS: 3D imaging can be useful in all stages of preprocedural planning, from interdisciplinary discussions to parental consent to
Abstract No. 746

A major change in reimbursement: MACRA and its implications for interventional radiology

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PURPOSE: 1. Describe the differences in reimbursement that will exist with MACRA, compared to the traditional fee-for-service model. 2. Review The Quality Payment Program and detail its two payment paths. 3. Report the timeline of these changes, and educate interventional radiologists (IRs) and trainees about the impact on interventional radiology reimbursement.

MATERIALS: Traditionally, Medicare reimbursement has been based on fee-for-service and volume (sustainable growth rate). However, the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) eliminates the fee-for-service reimbursement and replaces it with a system that links reimbursement to value and quality of care. This is called The Quality Payment Program (QPP). The purpose of this exhibit is to review MACRA, why and how it is being instituted, and detail the impact on interventional radiology.

RESULTS: MACRA was passed in 2015. Physicians are expected to begin to follow this system in 2017, but payments according to these changes will not be instituted until 2019. It is important for IRs to understand these changes so that they can participate appropriately, and thus be reimbursed properly for their work. Major concepts of MACRA will be reviewed, specifically how the fee-for-service Medicare reimbursement that was based on volume will be replaced with a new system that focuses on value and quality of care. The QPP. The QPP consists of two payment paths: the Merit-based Incentive Payment System (MIPS) and the Advanced Alternative Payment Models (APMs). This project will review these payment paths, including a discussion of who participates in MIPS, who is exempt from MIPS, and review of the four categories within the MIPS program. In addition, APMs will be defined, including discussion of APM criteria and how this can impact payment. Finally, implications for IR will be thoroughly detailed, including an in-depth review of the 22 performance criteria for radiology included in MACRA, with a focus on those that are most relevant to IR.

CONCLUSIONS: It is imperative for IRs and trainees to understand MACRA, what makes it different from traditional fee-for-service payments models, and how this will impact IRs across the United States.

Abstract No. 747

Interventional radiology RVUs: development, current use, modern debates, and the impact of MACRA

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PURPOSE: 1. Review the history of the Relative Value Unit (RVU) system that is currently used for reimbursement in the US. 2. Provide the interventional radiologist (IR) and/or trainee with information about the current formula for RVU calculation and how this impacts reimbursement. 3. Highlight debates, controversies, and changes that impact reimbursement, including a detailed review of MACRA, its development, and how this is a major change to reimbursement.

MATERIALS: In 1992, Medicare adopted a national system of payment using the Resource-Based Relative Value Scale (RBRVS). RVUs play a large role in the reimbursement and productivity infrastructure. Under the RBRVS, procedures are weighted and assigned a value based on their difficulty, intensity, time, and resource utilization. This exhibit provides a detailed review of the history of the RBRVS and RVU, including a discussion of the components of the RVU, CPT codes, and how payments have historically been calculated. Many current issues and debates about reimbursement will be reviewed, with a large focus on MACRA and how this is an impending major change to reimbursement.

RESULTS: While this project reviews the history of the RVU and CPT codes, a major focus is current reimbursement controversies, including the Affordable Care Act, code bundling, and MACRA. MACRA will replace the traditional volume based, fee-for-service model in Medicare with value and quality of care measurements. This Quality Payment Program has two pathways, the Merit-based Incentive Payment System (MIPS) and the Advanced Alternative Payment Models (APMs). We review the four categories of MIPS, who is expected to participate, and who is exempt. In addition, APM criteria are reviewed. Implications for IR are detailed, as reimbursement will now be tied to quality of care, including outcomes and costs. IRs will need to stay competitive in these areas in order to receive referrals from primary care specialties. CMS has heavily focused on primary care in their work on APM, thus certain aspects of integration in IR remain unclear.

CONCLUSIONS: IRs must understand the impact of MACRA and its Quality Payment Program on reimbursement to ensure compliance and appropriate payment.
**Abstract No. 748**

**Taking the lead: keys to developing a successful IR admitting service**

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**PURPOSE:** 1. Review the importance and benefits of providing interventional radiology (IR) admitting services for patient care. 2. Discuss obstacles that may be faced by IR physicians who wish to establish an IR admitting service, and provide potential solutions to allow for successful implementation.

**MATERIALS:** Traditionally, all patients requiring an IR procedure are admitted to an internal medicine or surgery service. As such, the IR physician typically serves as a consultant. The American College of Radiology has recognized the importance of patient-physician relationships to interventional radiologists, and encouraged the development of clinical and admitting services in IR.

**RESULTS:** This exhibit reviews the history of the role of interventional radiologists in patient care, specifically the initial creation and evolution of the IR admitting service. Thorough literature review will provide readers with a better understanding of the history of the IR admitting service, from its initial description in 1985 (Kinnison et al.) to various admitting service paradigms that are currently used in IR. Multiple advantages of establishing an IR admitting service are discussed, such as increased contact between IR physicians and patients, increased visibility and respect by other specialties, broadening the patient referral base, and dissemination of information about the value and role of IR procedures. In addition, concerns and obstacles that may be encountered are detailed, including in-house call coverage, radiology residents receiving minimal training in clinical management during residency, patient handoffs, and addressing a potential decreased availability for IR to read diagnostic studies due to increased involvement in patient care. Each of these concerns is thoroughly reviewed, and multiple solutions are detailed, with the goal of assisting IR physicians and trainees in establishing and maintaining successful IR admitting services at their institutions.

**CONCLUSIONS:** Understanding the advantages of and potential obstacles to developing and maintaining an IR admitting service is crucial for interventional radiologists to establish themselves as clinical practitioners and provide optimal patient care.

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**Abstract No. 749**

**From consult, to intervention, to follow-up: billing and coding practices that will best reflect your real value**

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**PURPOSE:** To educate providers on how value is determined by payers to improve billing and coding accuracy.

**MATERIALS:** As more interventional radiologists embrace clinical practice, there can be pressure from administrators to prove the value of inpatient and outpatient consultations. By using appropriate billing and coding practices for both consultations and procedures, providers can maximize their RVUs to accurately reflect the work that already they do.

**RESULTS:** This educational exhibit will describe how payers assess value for procedures and consultations. Topics covered include coding for bundled and unbundled procedures, Evaluation and Management billing and coding considerations, and best documentation practices.

**CONCLUSIONS:** Implementation of proactive efforts and retrospective audits will help the provider ensure appropriate practices while maximizing RVUs. This is an easy, but important way that interventional radiologists can assess and demonstrate their value.

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**Abstract No. 750**

**Implementation of prostate cancer diagnosis and management techniques in interventional radiology practice**

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**PURPOSE:** Prostate cancer (PCa) diagnosis and management increasingly depends on imaging with the advent of prostate multi-parametric MRI (mpMRI) and guided biopsies. The purpose of this exhibit is to provide the IR community with an update on the relevance of imaging in guided biopsies and in therapies for the diagnosis and management of PCa.

**MATERIALS:** Traditionally, PCa has been diagnosed by systematic biopsy under transrectal ultrasound (TRUS) guidance. However, research has shown that these systematic biopsies result in under-diagnosis of aggressive and over-diagnosis of indolent PCa. MRI/TRUS fusion biopsy increases the detection rate of high-risk tumors. Its use in diagnosis has led to more treatment options for localized disease. For the past 10 years, we have refined a multidisciplinary approach for better detection and management of PCa. A workflow utilizing the expertise of interventional radiologists in both MR/TRUS-guided biopsy and MR-guided focal PCa therapy is presented.

**RESULTS:** Acquisition and interpretation of mpMRI and related potential challenges will be discussed in concordance with the recent PI-RADSv2 guidelines. Preparation of mpMRI data for MRI/TRUS-guided biopsies along with tips and tricks will be presented. Utilization of MRI/TRUS fusion-guided biopsies with common clinical scenarios (e.g. patients with inconclusive prior PCa workup, biopsy naïve status, undergoing active surveillance) will be explained and illustrated. MRI-guided focal therapy techniques particularly useful for treatment of localized PCa, such as focal laser ablation, HIFU, and cryotherapy, will be reviewed. The applications and technical details of these procedures will be discussed. The real-time combination of imaging and intervention makes these ideal procedures for IR departments.
CONCLUSIONS: Interventional radiologists have tremendous opportunity to employ their expertise in image-guided biopsy and therapy in PCA care. In a setting in which IR is connected to diagnostic radiologists, pathologists, urologists, radiation oncologists, and medical oncologists, an understanding of this potential is extremely useful.

Abstract No. 751

Establishing IR led venous practice in a large teaching hospital in Saudi Arabia

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PURPOSE: In this exhibit, we share our experience of developing IR led venous intervention service in a large teaching hospital in Saudi Arabia. We outline our strategy which can serve as a template for other units in situation similar to ours.

MATERIALS: Traditionally, the management of venous disorders has been the realm of the surgical speciality. As endovascular techniques to treat venous disorders have become widespread, various specialities including interventional radiology (IR), cardiology and vascular surgery are in competition to assume the role of the treating physician. For IR to prevail in this arena, a multifaceted approach is essential focusing on providing comprehensive care to our patients.

RESULTS: Historically, referrals for venous disorders (mainly for IVC filter placement with occasional case for deep venous thrombosis management) to our unit came randomly from different specialties. In order to take lead in providing comprehensive care for venous disorders, our IR team adopted a multifaceted approach. To recruit new patients, we made concerted efforts to forge partnerships with primary care physicians (PCP), internists, hematologists and diagnostic radiologists. This included organizing seminars on the role IR in managing venous disorders and creating referral pathways to our unit. Patients were offered prompt appointments in the IR clinic where they were formally assessed prior to arranging procedures. Dedicated weekly slots for outpatient and day case venous procedures resulted in performing interventions in a timely fashion which led to high patient satisfaction. Regular follow-up in the IR clinic established longitudinal care. Implementation of these simple measures allowed rapid progress in our venous practice resulting in a steady stream of referrals. Overall, venous procedures have now blended well into our routine practice.

CONCLUSIONS: It is now well-known that in order to compete with other specialities possessing similar skills, interventional radiologists have to adapt to this new environment of blurred turf boundaries. This adaptation includes forging partnerships with referring specialties and providing comprehensive clinical care.

Abstract No. 752

Advanced practitioners in interventional radiology: the current landscape and future trends

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PURPOSE: 1. Identify the current types of advanced practice providers (APPs) in interventional radiology. 2. Understand current trends in the utilization of APPs in interventional radiology, including scope of practice. 3. Discuss ideal use of APPs in radiology practices in current and future healthcare delivery models.

MATERIALS: Advanced practice providers include nurse practitioners, physician assistants, and radiology assistants. APPs are playing a larger role in the new health care landscape, which emphasizes value and cost reduction. They may act as providers of clinical services, including performing minor procedures.

RESULTS: The number of APPs in the United States has been growing since 1990. APPs can function as referring clinicians or providers within interventional departments. APP involvement in interventional radiology services has steadily been increasing since 2000. Some of the major responsibilities include performing minor procedures such as biopsies, and assisting in the inpatient and outpatient setting by providing patient evaluation and producing clinical documentation. Many of these tasks assist with patient care in a system where physicians face ever increasing demands on their time. Lastly, appropriate utilization of APPs can increase revenue capture for interventional practices.

CONCLUSIONS: 1. The number of APPs is increasing, and their role in IR practices is expanding. Familiarity with the potential benefits and limitations is essential. 2. Multiple types of APPs exist, and knowing their respective scopes of practice will help integrate them productively into the IR workflow.

Advanced Practice Providers: The Basics

<table>
<thead>
<tr>
<th>Nurse Practitioners (NPs)</th>
<th>Physician Assistant (PAs)</th>
<th>Radiology Assistant (RAs)</th>
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</thead>
<tbody>
<tr>
<td>Training</td>
<td>2–4 years after RN</td>
<td>2–3 years</td>
</tr>
<tr>
<td>Scope of practice</td>
<td>Varies by state</td>
<td>Varies by state</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Variety of certifying organizations available</td>
<td>Required to pass the NCCPA certifying exam</td>
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Abstract No. 753
Palliative care: formalizing the role as an interventionalist
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MATERIALS: An interventionalist taking an active role in the management of terminally ill patients joins the patient and family through many stages of disease. As the transition towards patient-facing practice comes to a helm, being a cornerstone for care cements the IR Department in the center of a family unit during this time of need. In the new era of IR, managing expectations, and psychosocial issues become especially relevant for the practice. Joining forces with a comprehensive palliative care team, IRs can use imaging and technical expertise along with patient relationships to offer opinions and plan future course. Palliative care, which is inherently multi-disciplinary in approach, provides a growing opportunity for IRs to participate in clinical medicine and provide minimally invasive palliative procedures to improve quality of life in the setting of end-of-life discussions.
RESULTS: Inpatient and outpatient IR practices are optimized for low-risk procedures such as chronic pain and palliative intervention. Image-guided palliation procedures offer targeted intervention with lower morbidity and shorter recovery time compared with surgical intervention. IRs have the technical expertise and medical knowledge to effectively perform palliative care and pain management procedures with low associated morbidity, however few practices implement an organized practice model that formally integrates them into the Palliative care team.
CONCLUSIONS: IRs are technical and imaging experts seeing patients longitudinally over the course of an illness (e.g. Fistula), and chronically (e.g. paracentesis). With unique patient relationships, there is a natural progression to formalizing IR’s position in the Palliative Care team. Pain and Palliative care is a framework to support and co-manage patients from specialties which span hematology/oncology to OB/GYN. Additionally, palliative care IR can introduce the general public to the specialty.

Abstract No. 754
Continuous inventory and device management and surveillance (CIDMS)
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PURPOSE: We describe the process of the continuous inventory and device management and surveillance (CIDMS) where we strive to decrease inventory costs and improve the attributes of the used devices to match the continuous feedback we receive from end users of the devices (Dialysis Centers and Chemotherapy Infusion Centers). The overall process leads to cost savings for the Department and improved communication and relations with the referring services.
MATERIALS: The 2010 Patient Protection and Affordable Care Act (ACA) has spurred a focus on quality and costs, particularly through capitated payments (lump sum payment for each patient) for hospitals and health care providers. Given capitated payments, IR physicians and radiology departments need to work together to provide the best health care at the best price. IR physicians utilize expensive devices for their procedures. The prices are not always correlated with the cost of producing the device, but with what providers and hospitals are willing or able to pay. We noticed substantial price differences in similar products and noticed that for many devices, IR physicians had no stated preference. We instigated a review of major product categories and opened discussion with product vendors to review desired product characteristics and pricing. Simultaneously, we reached out to end users in the Infusion Center and Dialysis Center for their thoughts on the devices.
RESULTS: We illustrate what we developed as CIDMS where we have an open platform with the vendors to offer their products (new or otherwise) to address product category needs and pricing. We show that this enabled the Department to obtain substantial cost savings with perceived better quality devices, both according to IR physicians and end users. By simultaneously incorporating relevant end users in the process, we not improved the perceived quality by the end users but enhanced communications and relations between our departments.
CONCLUSIONS: CIDMS describes the process by which we lowered our hospital costs, improved perceived quality of devices used and improved relationships between our IR department and referring services and the hospital.

Abstract No. 755
A novel approach for the wireless integration of PACS into the interventional radiology suite using a gesture control armband
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PURPOSE: 1) Evaluating implementation of a new low-cost, wireless solution for easy-to-use touch less integration of PACS controls in the interventional radiology suite. 2) Establishing how wireless touch less integration of PACS can result in an overall decrease in procedure time and fluoroscopy time, as well as increased technical success. 3) Evaluating the ease-of-use of the technology regarding operator training.
MATERIALS: A thorough review of prior imaging is essential during complex procedures for a higher likelihood of technical success. Often, intra-procedural PACS use is necessary to assess prior imaging in order to improve the odds of greater technical success and reduce the procedure time. Patient and operator radiation exposure may also be reduced. Examples include small vessel assessment to assess catheter...
position and tumor localization. The Myo™ Gesture Control Armband (Thalamic Labs, Kitchener, ON, Canada) is an inexpensive (MSRP $199.99), easy to use, stand-alone device that can be used to integrate wireless touchless controls with the native PACS station.

RESULTS: The device is connected with a PACS workstation. A one-time training session is performed, and a profile is generated for the operator. Custom gestures can be created based on the raw EMG data generated by the armband, which allows the software to be tailored for user preferences. The armband is worn by the operator under their sterile scrubs and can be used to remotely control the PACS station. At our institution, the PACS images are projected on the monitor in the interventional suite and reviewed with the wireless device, thereby decreasing the need to halt the procedure to review imaging.

CONCLUSIONS: The Myo™ Gesture Control Armband is a feasible and inexpensive device for the touchless integration of PACS systems. With simple training, multiple operators can use the same reusable armband. Ease-of-use permits reduced procedure time, as well as radiation exposure for both operators and patients as well as increasing the likelihood for technical success. Wireless nature of the device improves portability over previously described devices.

Abstract No. 756

Communicating with patients and staff: insights from mediation and negotiation literature

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PURPOSE: We illustrate key insights and techniques from the mediation and negotiation literature that help in communicating effectively with patients and staff (nurses and technologists). We focus on key skills such as listening and focusing on interests, not positions.

MATERIALS: The 2010 Patient Protection and Affordable Care Act links payment to patient satisfaction. The importance of good communication with patients is important to avoid malpractice claims. Good communication skills are also vital for IR physicians with the hospital staff to develop a team-focused approach to patient care. It is also important to the future success of a IR physician. We review the mediation and negotiation literature to show important insights and techniques to improve communication skills with patients and staff.

RESULTS: We review concepts from the mediation and negotiation literature such as listening to the other side, focusing on interests (not positions), working together to generate options and using objective criteria to evaluate the options. We also discuss techniques such as taking notes, identifying issues and how to ask information gathering questions. We also discuss how an important insight by Blaise Pascal can be used to help persuade people. Pascal stated “People are generally better persuaded by the reasons which they have themselves discovered than by those which have come into the mind of others.”

CONCLUSIONS: By reviewing major insights and techniques from the mediation and negotiation literature, we hope to improve communication skills between IR physicians and their patients and staff. We believe that this will lead to improved patient satisfaction which is now an important element in medical reimbursement.

Abstract No. 757

“IR” genomics: avoiding work-related musculoskeletal injury in the angiography suite

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PURPOSE: To raise awareness of the occupational health hazards affecting interventional radiologists on a daily basis, leading to potentially debilitating musculoskeletal injury. We outline basic precautions physicians, nurses and technologists may take to avoid such work-related injuries in the angiography suite.

MATERIALS: Work-related musculoskeletal morbidity is commonly encountered among clinical personnel involved in image-guided procedures. Neck and back problems are the most often reported physical complaints made by interventionalists. The results of recent survey among interventional physicians reported musculoskeletal injury is prevalent in this group affecting up to 63% of those practicing for 20 years or more. As the volume and length of interventional procedures rise, IRs must employ ergonomic principles imminently.

RESULTS: While many other specialties encounter potential procedure related ergonomic issues, IRs are at an increased risk of musculoskeletal morbidity due to increased weight burden of the lead apron. Appropriate sizing, material and positioning of protective aprons increase comfort and reduce the risk of potential injury. While performing cases, it is not always feasible to maintain ergonomically appropriate positioning, however remaining cognizant of proper position is critical. This includes maintaining awareness of shoulder elevation, monitor positioning, head and neck posturing, and table height. Stretching before and after lengthy procedures as well as taking breaks during lengthy procedures for stretching and postural reset should be routine. When unable to achieve ideal positioning, techniques may be employed to offset imbalances which may lead to strain. Repetitive movements specific to the angiography suite, such as injections, are also discussed. It is vital that physicians, nurses and technologists have each other’s backs.

CONCLUSIONS: IRs should familiarize themselves with risk factors for occupational injury which are encountered daily. Precise ergonomics is a developed habit which should be formed early and repeated often. We must place ourselves in an optimal position to maintain long-lasting, pain-free careers.
Abstract No. 758

Comprehensive review of guidelines for sterile technique and infection control

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PURPOSE: We review the recommendations and guidelines from CDC, WHO, SIR and Association of Surgical Technologists (AST) for optimizing sterile technique in the IR suite. By reviewing the literature and standards from multiple organizations, we provided a best in practice guide to maintaining the sterile field in the IR suite and minimizing infectious complications from IR procedures.

MATERIALS: Section 5001(c) of the Deficit Reduction Act (DRA) of 2005 states that CMS (Medicare) will no longer reimburse health care providers for certain Hospital Acquired Conditions (HAC). As a result, hospitals have scrutinized HACs and targeted groups or individual practitioners associated with HACs. The most relevant to interventional radiology is vascular catheter-associated infection or central line-associated blood stream infection (CLABSI). There are not only financial penalties but potential regulatory penalties. IR practitioners must be up to date on the current guidelines to not only minimize infectious morbidity and mortality in the IR suite but to comply with scrutinized regulations.

RESULTS: We review the Joint Practice Guidelines for Sterile Technique during Vascular and interventional radiology Procedures. We also discuss the WHO and CDC guidelines as relevant to IR and as they shed light in areas not discussed in detail by the SIR guidelines. We cover additional literature such as from the Association of Surgical Technologists. The whole process of sterile preparation of the patient and standards of practice for surgical attire, surgical scrub, hand hygiene and hand washing is detailed. The role of peri-operative antibiotics is also expounded upon. We show there are significant questions that are not explicitly covered in the guidelines and even differences. For example, the WHO guidelines discourage the use of surgical scrub brushes versus brushless surgical hand antisepsis. We discuss potential best practices.

CONCLUSIONS: By reviewing the guidelines and standards of practice from multiple organizations concerned about infection control and providing insights into best practices, we prepare the IR practitioner to minimize morbidity and mortality of potential procedural infectious complications.

Abstract No. 759

Portal hypertension pictorial essay: classification and management

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PURPOSE: Review of portal hypertension. Causes of portal hypertension (prehepatic, hepatic, posthepatic). Treatment of portal hypertension (medical, procedural). Compare and contrast procedural findings with TIPS performed for prehepatic, hepatic, and posthepatic causes of portal hypertension, including advantages of trans-splenic access when there is portal vein thrombus.

MATERIALS: Portal hypertension is defined as elevated portal venous pressure. Elevated portal pressure may be prehepatic, intrahepatic, or posthepatic with numerous causes within each subset. Worldwide, cirrhosis and hepatic schistosomiasis are the two most common causes, with cirrhosis being the most common cause in western countries. Transjugular intrahepatic portosystemic shunt (TIPS) is an accepted procedure worldwide for the management of complications related to portal hypertension. Advantageous variations in the TIPS technique have been developed which enhances the approach and outcomes depending on the cause of portal hypertension.


CONCLUSIONS: 1. Describe the anatomical features and clinical manifestations of portal hypertension and the role of the hepatic venous pressure gradient (HVPG) in diagnosis. 2. Discuss TIPS as a minimally invasive technique in the management of portal hypertension. 3. Explore variation in TIPS technique such as transsplenic access and direct intrahepatic portosystemic shunt.

Abstract No. 760

TIPS reduction using a combination of a flared stent graft and a noncovered stent

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PURPOSE: To present a novel technique for TIPS reduction using a commercially available FLAIR® Stent Graft (BARD) in combination with a non-covered stent.

MATERIALS: TIPS reduction is a solution for patients with post TIPS refractory hepatic encephalopathy (HE) or hepatic decompensation (HD) but not candidates for expedited transplantation. TIPS reduction using a FLAIR® stent has been reported in the literature in a 2012 single case report by Nwawka et al who raised the concern of stent migration.
We describe TIPS reduction successfully performed in five patients, using a FLAIR® stent with an overlapping non-covered stent, to provide stability of the FLAIR® stent and avoid migration.

**RESULTS:** A portal venogram was performed with pressure measurements. A 6-8 mm diameter FLAIR® stent was then deployed within the TIPS. The length of the FLAIR® stent was made intentionally shorter than the length of the covered segment of the GORE VIATORR® stent to allow for an optimal landing zone for the non-covered stent. The caudal end of the FLAIR® stent was aligned with the circumferential radiopaque gold marker band in the VIATORR® stent. Next, an 8-12 mm diameter non-covered stent was deployed to overlap the FLAIR® stent, extending across both the proximal and distal ends of the FLAIR® stent. Portal venogram and pressure measurements were repeated after TIPS reduction. Post reduction, all patients demonstrated increased gradients. The longest retained shunt demonstrated a patency of two years post reduction. No stent migration was encountered. 3 patients with HE improved. 1 patient with hepatic decompensation needed a transplant and another had hyperbilirubinemia that stabilized.

**CONCLUSIONS:** Using a FLAIR® stent in combination with an overlapping non-covered stent provides an effective method of TIPS reduction with minimal risk of migration.

### Abstract No. 761

Mesocaval shunts, parallel TIPS, and left-to-left TIPS: various approaches in an illustrated case-based review

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**PURPOSE:** 1. Inform the reader on the indications for mesocaval shunts, parallel TIPS and left-left TIPS. 2. Describe and illustrate the anatomic and physiology components the procedures. 3. Present cases from our institution with an emphasis on the technical aspects unique to these procedures. 4. Understand patient outcomes based on available literature and our experience.

**MATERIALS:** TIPS is a primary treatment for complications of portal hypertension and ascites. The shunt is typically created between the right portal vein and right hepatic vein. In patients with prior right hepatectomy, a left-to-left TIPS may be the only option for treatment of portal hypertension. A parallel tips may be utilized in patients with insufficient portosystemic gradient reduction. Mesocaval shunts provide an option for patients with portal vein thrombosis as they cannot tolerate TIPS or DIPS.

**RESULTS:** Clinical cases from our institution will illustrate each of the procedures. Through the cases, we will illustrate the technique, difficulties, anatomy and patient outcomes based on our experience and the available data. Patency will be reviewed at 6 months.

**CONCLUSIONS:** Knowledge of the different approaches allows the interventional radiologist to improve the portosystemic gradient and sequelae of portal hypertension in patients with complicated anatomy and for patients who are not traditional TIPS or DIPS candidates.

### Abstract No. 762

Current status of lung transplantation and the role of interventional radiology

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**PURPOSE:** To describe the demographics and organ allocation system of lung transplants, to discuss the role of IR in the management of these patients, and to outline differences in physiology between normal and transplanted lungs that may influence the outcome of interventions.

**MATERIALS:** Lung transplantation has become an established therapeutic option in the last decade after the implementation of the lung allocation score (LAS) in 2005. A single, double, or combined heart-lung transplant may be performed based on clinical condition and organ availability. As of 2012 there were an estimated 9,000 living lung recipients. It is important to understand the unique aspects of transplant patients and what to expect when they require intervention.

**RESULTS:** Interventional radiology may be called upon in both routine or urgent care of lung transplant patients. Prior to transplantation, routine procedures include placement of feeding tubes, central lines, chest tubes, and IVC filters. Emergent procedures include embolization for bleeding in patients who are bridged to transplantation on extracorporeal membrane oxygenation (ECMO) and in cystic fibrosis patients with hemothysis. The altered anatomy and physiology after transplantation can change management of complications such as pulmonary embolism (PE) and immunosuppression-induced malignancies. For instance, single lung transplant causes redistribution of cardiac output to the transplanted lung, increasing the risk of severe hemorrhage with graft lung biopsy. The absence of bronchial arteries in transplanted lungs increases the risk of necrosis in the event of PE and necessitates emergent thrombolysis.

**CONCLUSIONS:** While interventionalists may not encounter lung transplant patients with the same frequency that they do other populations, it remains important to understand their differences from the general
public. Many complications are more frequent or more severe in these patients, both pre- and postoperatively. By familiarizing themselves with the physiology of transplanted lungs and the myriad factors that contribute to mortality, IR physicians can contribute to improved outcomes of this relatively new therapy.

Abstract No. 763

The role of interventional radiology in the management of complications of pancreatic transplantation

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PURPOSE: Illustrate relevant surgical anatomy in pancreatic transplantation focusing on vascular techniques. Discuss various vascular and non-vascular complications of pancreatic transplantation. Review the role of imaging in evaluation of pancreatic transplant and its complications. Discuss the role of Interventional radiology (IR) in the management of complications of pancreatic transplant

MATERIALS: Approximately 1200 pancreatic transplantations are performed in the United States annually, typically simultaneously with kidney transplantation. Despite the evolution of surgical technique, pancreatic transplantations are associated with considerable morbidity and technical failure. Complications of pancreatic transplantation include various vascular and non-vascular etiologies. Vascular thrombosis is the main non-immunological cause of graft failure with an approximate 2:1 ratio between venous and arterial graft thrombosis. Various imaging modalities are essential in the diagnosis of these complications. To minimize the morbidity associated with surgical management, a growing trend in minimally invasive image-guided therapy is now seen with safe and effective results.

RESULTS: We present cases highlighting the role of IR in the diagnosis and management of both vascular and nonvascular complications of pancreatic transplantations including venous and arterial thrombosis, graft rejection, early and late sequelae of pancreatic necrosis including bleeding and pseudoaneurysm, pancreatic abscess and pseudocyst formation.

CONCLUSIONS: IR has an expanding role in pancreatic transplant complications ranging from early diagnosis to treatment, including nonvascular and endovascular management, with safe and effective results.

Abstract No. 765

Emerging techniques for achieving liver hypertrophy for safe resection: portal vein embolization and newer alternatives

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PURPOSE: Explore different methods for optimizing the future liver remnant in patients with hepatocellular carcinoma and metastatic colon carcinoma prior to subtotal liver resection.

MATERIALS: Percutaneous portal vein embolization (PVE) is a technique used prior to hepatic resection to increase the size of liver remnant that will remain after surgery. This treatment redirects portal venous blood to segments of the future liver remnant (FLR), with subsequent hypertrophy. PVE is indicated when the FLR is either too small to support essential function or marginal in size and is associated with a complicated postoperative course, specifically post hepatectomy liver failure.
RESULTS: This exhibit seeks to explore and compare newer alternatives to percutaneous PVE including sequential radioembolization, associating liver partition and portal vein ligation in staged hepatectomy (ALPPS) as well as modified ALPPS with intra-operative cannulation of the inferior mesenteric vein followed by portal vein embolization in staged hepatectomy. We will discuss patient selection, techniques, possible complications as well as expected outcomes. Representative cases will be included.

CONCLUSIONS: Satisfactory liver hypertrophy can be achieved safely using alternatives to percutaneous PVE for the purposes of optimizing the FLR.

Abstract No. 766
Comprehensive review of filter-specific issues with IVC filter placement and retrieval
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PURPOSE: We will review IVC filter designs and specific IVC filters in the context of issues with placement such as problems with deployment mechanism and tilting after placement. We will discuss techniques commonly used to deal with these issues. We will also discuss specific IVC filters in the context of issues with retrieval such fracturing or embedded tips and techniques commonly used to avoid or address these problems.

MATERIALS: The FDA is recommending and encouraging physicians to remove IVC filters when they are no longer needed. It is also advising physicians to actively examine the risk versus benefit for IVC filter placement and retrieval. With this mandate and as more advanced techniques have been developed to recover IVC filters and as IVC filter clinics develop and grow, IR physicians are not only retrieving more filters but are being consulted for more challenging cases. Given that there are over 20 types of IVC filters, we review the known issues with placement and retrievals of these filters.

RESULTS: The presentation is organized into issues with placement and issues with retrieval. Within both sections, discussion is broken down into the categories of IVC filters: conical, conical with umbrella, conical with cylindrical element, biconical with cylindrical element, helical, spiral and complex. Specific challenges with each filter is discussed. We also discuss the challenge of removing permanent filters.

CONCLUSIONS: IR physicians not only place IVC filters but are increasingly tasked with the challenge of retrieving a variety IVC filters, not uncommonly placed by others. Our comprehensive review of the issues with placement and retrieval IVC filters by filter type prepares IR physicians for potential pitfalls to avoid and techniques to overcome possible hurdles.

Abstract No. 767
Novel uses of drug-coated balloons
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MATERIALS: Drug-coated balloons (DCBs) are FDA approved for treatment of peripheral arterial disease in the superficial femoral and popliteal arteries, with superior primary patency and non-inferior safety compared to standard balloon angioplasty. DCBs have been used to treat in-stent stenosis after transjugular intrahepatic portosystemic shunt (TIPS), with prolonged secondary patency and no systemic effects compared to plain optimal balloon angioplasty. Central venous stenosis in hemodialysis fistulas has been treated with DCBs with superior, prolonged freedom from target lesion revascularization compared with standard balloon angioplasty. Thus, DCBs appear to have the potential to treat a variety of conditions beyond peripheral arterial disease. In this exhibit, we aim to review other potential novel indications of DCBs.


CONCLUSIONS: DCBs are currently well established for use in peripheral arterial disease, however additional novel applications of DCBs can be considered, including deep vein thrombosis, hemodialysis arteriovenous fistulas and grafts, central venous stenosis secondary to catheter related occlusion, biliary stenosis and arterial in-stent restenosis.

Abstract No. 768
Chronic central venous occlusions: spectrum of recanalization techniques and tools
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PURPOSE: 1. To review the etiology, risk factors, clinical sequelae, and natural history of chronic central venous occlusion. 2. To review the various techniques for recanalization of chronically occluded central veins. 3. To review the contemporary tools and supplies available for central venous recanalization.

MATERIALS: Chronic central venous occlusion (CCVO) is a relatively common problem particularly in patients with a history of central venous catheter (CVC) use and hemodialysis. When CCVO develops ipsilateral to an arteriovenous access, the resulting arm swelling can be
massive. Restoration of patency can be imperative for improvement of these symptoms. Additionally, restoration of patency can allow central catheter insertion, which can be vial to allowing hemodialysis, chemotherapy, parenteral nutrition, and other therapies. There is an increasing armamentarium available for interventionalists for recanalization of central venous occlusions.

RESULTS: This education abstract will review basic and advanced techniques for conventional blunt CCVO recanalization. Anatomic considerations and practical tips will be discussed. Advantages and disadvantages of techniques and numerous conventional catheters and guidewires will be delineated. This exhibit will also focus on the increasing new tools and techniques for central venous recanalization.

The radiofrequency PowerWire will be discussed, with instructions for use as well as tips for optimal safe utilization. The multiple sharp recanalization techniques will be reviewed in a step by step fashion. The various approaches for sharp recanalization will be included, with emphasis of the pros and cons of the various approaches. Direct transmediastinal access will be described, which is for use in patients with no appropriate superficial veins for access. The recently described inside-out technique will also be discussed, along with strengths and weaknesses of this approach. Other novel devices will be reviewed.

CONCLUSIONS: CCVO are increasing in frequency, particularly in the hemodialysis population. Interventional radiologists should be well versed in tools and techniques and achieve high recanalization success rates.