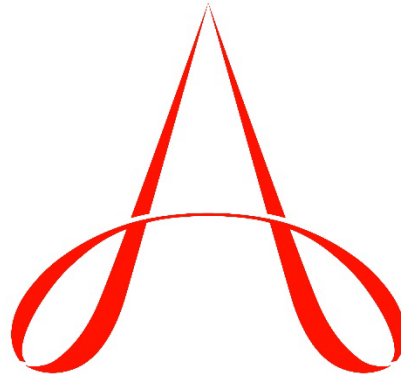




Supplemental Guide: Neuroendovascular Intervention



A C G M E

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Milestones Supplemental Guide

This document provides additional guidance and examples for the Neuroendovascular Intervention Milestones. This is not designed to indicate any specific requirements for each level, but to provide insight into the thinking of the Milestone Work Group.

Included in this document is the intent of each Milestone and examples of what a Clinical Competency Committee (CCC) might expect to be observed/assessed at each level. Also included are suggested assessment models and tools for each subcompetency, references, and other useful information.

Review this guide with the CCC and faculty members. As the program develops a shared mental model of the Milestones, consider creating an individualized guide (Supplemental Guide Template available) with institution/program-specific examples, assessment tools used by the program, and curricular components.

Additional tools and references, including the Milestones Guidebook, Clinical Competency Committee Guidebook, and Milestones Guidebook for Residents and Fellows, are available on the [Resources](#) page of the Milestones section of the ACGME website.

Patient Care 1: Pre-Procedural Consultation Overall Intent: To ensure progressive development of knowledge and skill required to evaluate and manage patients prior to intervention	
Milestones	Examples
Level 1 <i>Gathers a complete history and performs a physical</i> <i>Formulates a pre-procedural assessment and plan, including risks, benefits, and alternatives, with guidance from a faculty member</i>	• Performs a complete history and physical exam and begins to formulate treatment plan, but may need assistance in identifying most relevant findings and appropriate therapies • Functions across a variety of settings including clinic, emergency department, and inpatient wards, and angiography suite • Identifies indications and contraindications to performing a simple intervention using evidence to objectify risk
Level 2 <i>Chooses pre-procedural laboratory and imaging studies</i> <i>Formulates a pre-procedural assessment and plan with minimal guidance from a faculty member</i>	• Focuses physical exam and history, identifies relevant issues and formulates basic treatment plan with minimal guidance • Needs guidance in appropriate pre-procedure testing and final plan
Level 3 <i>Interprets pre-procedural imaging studies</i> <i>Independently formulates pre-procedural assessments and plans for common disorders</i>	• Provides appropriate independent consultation for common procedures ○ large-vessel occlusion stroke ○ subarachnoid hemorrhage • May need assistance with complex procedures and critically ill patients • Orders appropriate pre-procedure testing as needed • Identifies indications and contraindications to performing a complex or rare intervention using evidence to objectify risk
Level 4 <i>Adjusts procedural plan based upon pre-procedural laboratory and imaging results</i> <i>Independently formulates pre-procedural assessments and plans for complex disorders</i>	• Independently provides pre-procedure consultation on complex and critically ill patients • Adjusts management appropriately when care for the following needs to change: ○ abnormal coagulation parameters ○ acute myocardial infarction ○ hydrocephalus ○ intracranial pressure elevation ○ respiratory failure ○ sepsis ○ shock
Level 5 <i>Mentors other learners in the pre-procedural consultation</i>	• Develops patient teaching materials for patients with unruptured cerebral aneurysms

<i>Develops patient care protocols/teaching materials</i>	• Updates pre-procedure large vessel occlusion protocols for the department • Participates in the design of research protocols and trials
Assessment Models or Tools	• Direct observation • Medical record (chart) audit • Multisource feedback • Objective structured clinical examination (OSCE)
Curriculum Mapping	•
Notes or Resources	• American Heart Association. Get with The Guidelines – Stroke Overview. https://www.heart.org/en/professional/quality-improvement/get-with-the-guidelines/get-with-the-guidelines-stroke/get-with-the-guidelines-stroke-overview. 2020. • Hill M, Glenn BA, Reese BJ, Morrow B. Recommendations for endovascular care of stroke patients. <i>Intervent Neurol</i>. 2018;7:65-90. https://www.karger.com/Article/Fulltext/481541. 2020. • Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the early management of patients with acute ischemic stroke: 2019 updated to the 2018 guidelines for the early management of acute ischemic stroke: A guidelines for healthcare professionals from the American Heart Association / American Stroke Association. <i>Stroke</i>. 2019;50(12):e344-e418. https://www.ahajournals.org/doi/10.1161/STR.0000000000000211. 2020.

Patient Care 2: Performance of Procedures	
Overall Intent: To ensure progressive development of technical skills required to perform procedures	
Milestones	Examples
Level 1 <i>Performs basic procedures (e.g., cerebral angiography, hemostasis, vascular access)</i> <i>Effectively uses basic image guidance (e.g., visualize needle tip with ultrasound)</i>	Performs a cerebral angiography, hemostasis, and vascular access with effective real-time ultrasound visualization of needle tip
Level 2 <i>Performs advanced basic procedures (e.g., spinal angiography, venous angiography, Wada test)</i> <i>Demonstrates basic catheter and wire skills</i>	Performs spinal angiography, venous angiography, and Wada test
Level 3 <i>Performs moderately complex procedures (e.g., coiling of aneurysm, carotid stent, mechanical thrombectomy)</i> <i>Integrates catheter and wire skills with imaging of complex anatomy</i>	Performs coiling of aneurysm, carotid stent, and mechanical thrombectomy
Level 4 <i>Performs complex procedures (e.g., intracranial stent, flow diverter, liquid embolics)</i> <i>Integrates catheter and wire skills with advanced imaging guidance and device utilization</i>	Performs intracranial stent placement, flow diversion, and embolization using liquid embolics
Level 5 <i>Develops new techniques or tools</i>	Researches new device development in cooperation with biomedical engineering
Assessment Models or Tools	- Direct observation - Evaluations - Self-assessment - Simulation lab
Curriculum Mapping	
Notes or Resources	- Chen M, Nguyen T. Emerging subspecialties in neurology: Endovascular surgical neuroradiology. <i>Neurology</i>. 2008;70(6). https://n.neurology.org/content/70/6/e21. 2020. - CIRSE. Library. https://library.cirse.org. 2020. - IR Curriculum

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| | <ul style="list-style-type: none">● Riina HA. Neuroendovascular surgery. <i>Journal of Neurosurgery</i>. 2019;131(6):1690-1701. https://thejns.org/view/journals/j-neurosurg/131/6/article-p1690.xml. 2020.● Society of Interventional Radiology. Annual Meeting and Video Library. https://www.sirweb.org/special-pages/learning-center-list/. 2020.● Society of Interventional Radiology. RFS Trainee Website. http://rfs.sirweb.org. 2020.● Society of Interventional Radiology. Spring Practicum. https://www.sirweb.org/learning-center/rfs-landing-page/fellows-spring-practicum/. 2020. |
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Patient Care 3: Post-Procedural Patient Care	
Overall Intent: To ensure progressive knowledge base for the appropriate post-procedure care of patients and the skills to manage post-procedure complications	
Milestones	Examples
Level 1 <i>Manages routine post-procedural care with guidance</i> <i>Evaluates post-procedural complications</i> <i>Generates reports with appropriate elements for coding</i>	• Places post-angiogram orders for bed rest, groin checks, etc., and appropriately evaluates pulses post-procedure • Will see the patient when a nurse calls about oozing at the groin site, gathers appropriate clinical information and relevant clinical exam, and holds pressure until bleeding resolves • Generates a report that includes an accurate portrayal of the procedure • For a procedure with moderate sedation, writes report including sedation type, time, and statement of monitoring as well as any institutional requirements
Level 2 <i>Manages post-procedural care with minimal guidance</i> <i>Manages minor post- procedural complications</i> <i>Efficiently generates clear and concise reports that do not require substantive correction</i>	• Confirms blood pressure parameters with attending prior to intensive care unit (ICU) sign-out • Obtains hemostais at bedside for small hematoma • Orders imaging when there is concern for pseudoaneurysm or retroperitoneal hemorrhage • Generates an accurate and complete procedure report for diagnostic angiography
Level 3 <i>Formulates and implements post-procedural imaging and clinical follow-up for patients after basic procedures</i> <i>Manages major post- procedural complications</i> <i>Efficiently generates clear and concise reports that rarely require correction</i>	• Orders follow-up cross sectional imaging in four weeks after catheter directed locoregional therapies to assess for response and arranges clinic visit • In a patient complaining of a cold leg and pain after angiogram, performs appropriate clinical exam, imaging if appropriate or urgent intervention • Obtains neuroimaging after concern with change in neurologic exam • Generates a concise procedure report for aneurysm coiling
Level 4 <i>Formulates and implements post-procedural imaging and clinical follow-up for patients after complex procedures</i> <i>Anticipates and mitigates post-procedural complications</i>	• Orders most appropriate clinical follow-up and imaging following embolization with a flow diverter and medication management • Ensures heparin is given during stent placement

<i>Generates tailored reports meeting the needs of the care provider and complex interventional reports with appropriate elements for coding</i>	• Generates a procedural report and understand proper coding as it relates to the procedure
Level 5 <i>Mentors other learners in post-procedural care and management of complications</i> <i>Develops a clinical pathway or guideline for post-procedural care</i>	• Provides didactic curriculum to junior learners on post procedural care of patients after angiogram • Develops department policy for closure device use
Assessment Models or Tools	• Direct observation • End-of-rotation evaluation • Multisource feedback • Quality and safety presentations • Morbidity and mortality (M and M) conferences
Curriculum Mapping	•
Notes or Resources	• American College of Radiology. Practice Parameters and Technical Standards. https://www.acr.org/Clinical-Resources/Practice-Parameters-and-Technical-Standards. 2020. • Catapano JS, Fredrickson VL, Fujii T, et al. Complications of femoral versus radial access in neuroendovascular procedures with propensity adjustment. <i>Journal of NeuroInterventional Surgery</i>. 2020;12:611-615. https://jn.is.bmj.com/content/12/6/611.info. 2020. • Eskey CJ, Meyers PM, Nguyen TN, et al. Indications for the performance of intracranial endovascular neurointerventional procedures: A scientific statement from the American Heart Association. <i>Circulation</i>. 2018;137(21):e661-e689. https://www.ahajournals.org/doi/full/10.1161/CIR.0000000000000567. 2020. • Society of Interventional Radiology. Clinical Practice Essentials. https://www.sirweb.org/practice-resources/guidelines-by-document-type/. 2020. • Society of Interventional Radiology. Guidelines: Clinical Topics. https://www.sirweb.org/practice-resources/guidelines-by-document-type/guidelines-by-service-line/. 2020. • SIR. Syllabus: Patient Care in Vascular and Interventional Radiology. https://sir.personifycloud.com/PersonifyEBusiness/Default.aspx?tabid=251&productId=3516736. 2020. • Society of Interventional Radiology. Quality and Safety Toolkit https://www.sirweb.org/practice-resources/toolkits/quality-and-safety-toolkit/. 2020.

Medical Knowledge 1: Imaging and Procedural Anatomy Overall Intent: To apply knowledge of anatomy, pathophysiology, and cellular and molecular systems to generate a differential diagnosis	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of imaging anatomy</i> <i>Identifies normal anatomy during procedures</i>	• Identifies neurovascular anatomy • Performs femoral and radial arterial sheath placement with and without the use of ultrasound • Accurately identifies normal and variant aortic arch anatomy during cervicocerebral angiography
Level 2 <i>Applies knowledge of anatomy to make common imaging diagnoses</i> <i>Identifies anatomic variants during procedures</i>	• Accurately identifies lobar pneumonia • Correctly identifies variants of the circle of Willis during angiography (aplasia of A1 or P1 segment, fetal posterior cerebral artery, trigeminal artery)
Level 3 <i>Applies knowledge of anatomy to make uncommon imaging diagnoses</i> <i>Articulates the implications of varying anatomy for procedural planning</i>	• Accurately recognizes subarachnoid hemorrhage on computerized tomography (CT) imaging and understand implications for location of potential ruptured aneurysm • Understands implications of internal carotid artery tortuosity on the choice of equipment for coiling or flow diversion of anterior communicating artery aneurysms • Correctly identifies high origin of profunda femoral artery during arterial access
Level 4 <i>Proficiently integrates knowledge of anatomic imaging with pathophysiology to formulate a diagnosis</i> <i>Identifies post-operative anatomy and its implications for procedures</i>	• Identifies cortical venous hypertension from dural arteriovenous shunting and implications for symptomatology • Identifies iatrogenic distal embolus to an M3 branch during cerebral angiography • Identifies subtle active extravasation after stroke thrombectomy • Classifies aneurysm residual or recurrence post embolization
Level 5 <i>Proficiently integrates knowledge of anatomic imaging with pathophysiology to formulate a diagnosis and treatment plan at the expected level of a subspecialist</i> <i>Develops simulation models or other resources</i>	• Recognizes the external carotid artery supply to a sigmoid sinus dural arteriovenous malformation and anastomotic connection to cranial nerve supply • Develops curriculum for training medical students and residents to perform safe ultrasound-guided vascular access
Assessment Models or Tools	• Assessment of Case Conference Presentation

	• Direct observation • Faculty member evaluations • Exam scores • Report review
Curriculum Mapping	•
Notes or Resources	• American College of Radiology. Practice Parameters and Technical Standards. https://www.acr.org/Clinical-Resources/Practice-Parameters-and-Technical-Standards. 2020. • Geibprasert S, Pongpech S, Armstrong D, Krings T. Dangerous extracranial-intracranial anastomoses and supply to the cranial nerves: Vessels the neurointerventionalist needs to know. <i>AJNR Am J Neuroradiol</i>. 2009;30(8):1459-1468. https://pubmed.ncbi.nlm.nih.gov/19279274/. 2020. • Morris P. <i>Practical Neuroangiography</i>. 3rd ed. Philadelphia, PA: Lippincott, Williams, and Wilkins; 2013. • Shapiro M, Raz E, Nossek E, et al. Neuroanatomy of the middle cerebral artery: Implications for thrombectomy. <i>Journal of NeuroInterventional Surgery</i>. 2020;12:768-773. https://jn.is.bmj.com/content/12/8/768.citation-tools. 2020.

Medical Knowledge 2: Physics and Imaging Technology Overall Intent: To apply knowledge of physics to optimize imaging, including dose reduction strategies, and minimizing risk to patient; to optimize image acquisition	
Milestones	Examples
Level 1 <i>Discusses the basic physics for imaging and image-guided intervention</i> <i>Discusses imaging technology and image acquisition</i>	• Understands optimal positioning of image intensifier for obtaining an image • Understands how to use ultrasound for vascular access
Level 2 <i>Demonstrates knowledge of basic medical physics and radiobiology in imaging and image-guided intervention</i> <i>Demonstrates knowledge of basic image acquisition and image processing, and recognizes common imaging artifacts and technical problems</i>	• Discusses the stochastic and deterministic effects of radiation • Evaluates the patient's renal function prior to angiography • Identifies beam hardening artifact on CT
Level 3 <i>Applies knowledge of basic medical physics and radiobiology to imaging and image-guided intervention</i> <i>Demonstrates knowledge of instrument quality control and image reconstruction; troubleshoots for artifact reduction</i>	• Appropriately positions image intensifier to reduce radiation and minimizes use of fluoroscopy during procedure • Knows how to use three-dimensional reconstruction workstation to assist with the generation of the images
Level 4 <i>Applies physical principles to optimize image quality, including dose reduction strategies</i> <i>Proficiently optimizes image acquisition and processing in collaboration with the technology/imaging team</i>	• Uses pulse fluoroscopy to minimize radiation dose in pediatric patients • Modifies standard contrast dosing for reduced renal function • Works with radiation technologists to optimize image quality
Level 5 <i>Teaches physical principles to optimize image quality to other specialties</i> <i>Presents or publishes research on imaging technology</i>	• Teaches dose reduction strategies to radiology, neurology and neurologic surgery residents • Presents or publishes original research on flow dynamics within aneurysms at angiography
Assessment Models or Tools	• Direct observation

	• End-of-rotation evaluation • Evaluation of fluoroscopy times • Exam and quiz scores • Multisource feedback • Protocol engagement report
Curriculum Mapping	•
Notes or Resources	• American College of Radiology. Appropriateness Criteria. https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria. 2020. • American College of Radiology. Radiation Safety in Adult Medical Imaging. https://www.imagewisely.org/. 2020. • American College of Radiology. Manual on Contrast Media. https://www.acr.org/Clinical-Resources/Contrast-Manual. 2020. • American College of Radiology. Radiology Safety https://www.acr.org/Clinical-Resources/Radiology-Safety. 2020. • Hassan AE, Amelot S. Radiation exposure during neurointerventional procedures in modern biplane angiographic systems: A single-site experience. <i>Intervent Neurol</i>. 2017;6:105-116. https://www.karger.com/Article/FullText/456622. 2020. • Image Gently. Pediatric Radiology and Imaging. https://www.imagegently.org/. 2020. • Radiological Society of North America (RSNA). Physics Modules. https://www.rsna.org/en/education/trainee-resources/physics-modules. 2020. • Slater L, Hadley C, Soufan C, et al. O-010 radiation safety in neurointervention: Is it time for dose reference levels?. <i>Journal of NeuroInterventional Surgery</i>. 2014;6:A6. https://jn.is.bmj.com/content/6/Suppl_1/A6.1. 2020.

Medical Knowledge 3: Pathophysiology and Treatment	
Overall Intent: To demonstrate progressive knowledge of pathophysiology and treatment of disease conditions in endovascular surgical neuroradiology; to ensure understanding how treatment affects underlying pathophysiology	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of pathophysiology of common conditions (e.g., stroke, ruptured aneurysm)</i>	• Demonstrates knowledge of pathophysiology of patients with: ○ Cerebral aneurysms: ruptured and unruptured ○ Ischemic stroke
Level 2 <i>Demonstrates knowledge of pathophysiology and treatment of patients with common conditions</i>	• Demonstrates knowledge of treatment options for patients with common diseases that are informed by an understanding of the underlying pathophysiology • Consults on a patient with unruptured cerebral aneurysm and recommends appropriate treatment whether it is endovascular, open surgery, or no treatment
Level 3 <i>Demonstrates knowledge of pathophysiology and treatment of patients with complex conditions (e.g., arteriovenous [AV] fistula, arteriovenous malformation [AVM])</i>	• Demonstrates knowledge of treatment options for patients with complex diseases that are informed by an understanding of the underlying pathophysiology • Consults on a patient with arteriovenous malformation and recommends appropriate treatment whether it is embolization, surgery, radiosurgery, or no treatment
Level 4 <i>Demonstrates knowledge of the pathophysiologic changes after treatment</i>	• Understands the pathophysiologic changes after embolization of the arteriovenous malformation and the potential complications (e.g., normal perfusion pressure breakthrough)
Level 5 <i>Contributes to peer-reviewed literature on pathophysiology and/or treatment</i>	• Publishes retrospective series • Designs clinical trial • Contributes patients to clinical trials • Develops educational materials
Assessment Models or Tools	• Direct observation • Faculty member evaluation • In-service exam • M and M conference • Multiple choice knowledge tests
Curriculum Mapping	•
Notes or Resources	• Connolly Jr ES, Rabinstein AA, Carhuapoma JR, et al. Guidelines for the management of aneurysmal subarachnoid hemorrhage: A guideline for healthcare professionals from the American Heart Association / American Stroke Association. <i>Stroke</i>. 2012;43(6):1711-1737. https://pubmed.ncbi.nlm.nih.gov/22556195/. 2020. • Derdeyn CP, Zipfel GJ, Albuquerque FC, et al. Management of brain arteriovenous malformations: A scientific statement for healthcare professionals from the American Heart Association / American Stroke Association. <i>Stroke</i>. 2017;48(8):e200-e224. https://pubmed.ncbi.nlm.nih.gov/28642352/. 2020.

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| | <ul style="list-style-type: none">• Thompson BG, Brown Jr RD, Amin-Hanjani S, et al. Guidelines for the management of patients with unruptured intracranial aneurysms: A guideline for healthcare professionals from the American Heart Association / American Stroke Association. 2015;46(8):2368-2400. https://pubmed.ncbi.nlm.nih.gov/26089327/. 2020.• Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the early management of patients with acute ischemic stroke: 2019 updated to the 2018 guidelines for the early management of acute ischemic stroke: A guideline for healthcare professionals from the American Heart Association / American Stroke Association. <i>Stroke</i>. 2019;50(12):e344-e418. https://www.ahajournals.org/doi/10.1161/STR.0000000000000211. 2020. |
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Medical Knowledge 4: Pharmacology and Contrast	
Overall Intent: To build progressive knowledge base of medications used in interventions to make procedures safe, patient comfortable or alter physiological states	
Milestones	Examples
Level 1 <i>Demonstrates basic knowledge of the pharmacologic and contrast agents used in endovascular surgical neuroradiology procedures</i>	Knows commonly used medications for moderate sedation, local anesthesia, anticoagulation, antiplatelet therapy, thrombolysis, and spasmolysis
Level 2 <i>Demonstrates knowledge of dosing and drug choice for contrast agents, sedation drugs, and commonly used pharmacologic agents</i>	Knows dose limit of contrast agents according to renal function and weight/age
Level 3 <i>Demonstrates knowledge of the indications, contraindications, side-effects, and complications of pharmacologic agents</i>	In a patient with decreased oxygen saturation during a procedure, appropriately orders reversal agent and knows that the patient needs to have extended post-procedure monitoring
Level 4 <i>Applies functional knowledge of pharmacology to endovascular surgical neuroradiology procedures and peri-procedural care</i>	Appropriately adjusts anti-hypertensive drip dosing for blood pressure control after mechanical thrombectomy to treat M1 emergent large vessel occlusion
Level 5 <i>Develops pharmacologic protocols or departmental guidelines</i>	Helps to develop departmental guidelines for the dosing and adjustment of dual antiplatelet therapy in the acute setting
Assessment Models or Tools	- Direct observation - End-of-rotation evaluation - In-training exam - Multisource feedback
Curriculum Mapping	
Notes or Resources	- American College of Radiology. ACR-SIR Practice Parameter for Sedation Analgesia. https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Sed-Analgesia.pdf. 2020. - American College of Radiology. Manual on Contrast Media. https://www.acr.org/Clinical-Resources/Contrast-Manual. 2020. - Society of Interventional Radiology. SIR Standards of Practice Pre-Procedure Patient Safety Checklist. https://www.jvir.org/article/S1051-0443%2816%2900390-0/pdf. 2020. - Anesthesiology. Practice Guidelines for Moderate Procedural Sedation and Analgesia 2018. http://anesthesiology.pubs.asahq.org/article.aspx?articleid=2670190. 2020. - Olsen JW, Barger RL Jr, Doshi SK. Moderate sedation: what radiologists need to know. <i>American Journal of Roentgenology</i>. 2013;201(5): 941-946. https://www.ajronline.org/doi/10.2214/AJR.12.9501. 2020. - Institutional Pharmacy

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| | <ul style="list-style-type: none">• Tonetti DA, Jankowitz BT, Gross BA. Antiplatelet therapy in flow diversion. <i>Neurosurgery</i>. 2020;86(1):S47-S52. https://academic.oup.com/neurosurgery/article-abstract/86/Supplement_1/S47/5675145?redirectedFrom=fulltext. 2020.• Hendén PL, Rentzos A, Karlsson JE, et al. General anesthesia versus conscious sedation for endovascular treatment of acute ischemic stroke. <i>Stroke</i>. 2017;48:1601-1607. https://www.ahajournals.org/doi/full/10.1161/strokeaha.117.016554. 2020. |
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Systems-Based Practice 1: Patient Safety Overall Intent: To engage in the analysis and management of patient safety events, including relevant communication with patients, families, and health care professionals	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of common patient safety events</i> <i>Demonstrates knowledge of how to report patient safety events</i>	• Recognizes limb ischemia following vascular access in patient recovery area • Knows clinical presentation of retroperitoneal hematoma
Level 2 <i>Identifies system factors that lead to patient safety events</i> <i>Reports patient safety events through institutional reporting systems (simulated or actual)</i>	• Identifies that poor communications and poor patient hand-offs contribute to patient safety events • Has identified and reported a patient safety issue (real or simulated), along with system factors contributing to that issue
Level 3 <i>Participates in analysis of patient safety events (simulated or actual)</i> <i>Participates in disclosure of patient safety events to patients and families (simulated or actual)</i>	• Participates in departmental M and M conferences • Participates in a root cause analysis group • Participates in quality measures group discussions (e.g., high-reliability organizations, Performance Improvement Committee) • Discloses contrast reaction to a patient or family with supervising physician present
Level 4 <i>Conducts analysis of patient safety events and offers error prevention strategies (simulated or actual)</i> <i>Discloses patient safety events to patients and families (simulated or actual)</i>	• Collaborates with a team to analyze a patient safety event, develops, and implements an action plan to prevent future reactions • Competently communicates with patients/families about the contrast reaction
Level 5 <i>Actively engages teams and processes to modify systems to prevent patient safety events</i> <i>Role models or mentors others in the disclosure of patient safety events</i>	• Competently assumes a leadership role at the departmental or institutional level for patient safety, possibly even being the person to initiate action or call attention to the need for action
Assessment Models or Tools	• Direct observation • E-module multiple choice tests

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	• Medical record (chart) audit • M and M conference • Multisource feedback • Portfolio • Reflection • Simulation
Curriculum Mapping	•
Notes or Resources	• Institute for Healthcare Improvement. http://www.ihl.org/Pages/default.aspx. 2020.

Systems-Based Practice 2: Quality Improvement (QI) Overall Intent: To demonstrate knowledge of core quality improvement concepts and how they inform the modern practice of medicine and demonstrate competence to conduct a QI project	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of basic quality improvement methodologies and metrics</i>	Knows that QI methodologies include root cause analysis
Level 2 <i>Describes local quality improvement initiatives</i>	Is aware of institutional QI initiatives including handwashing initiatives and time-outs
Level 3 <i>Participates in local quality improvement initiatives</i>	- Participates in hospital or departmental QI committee - Has participated in a QI project, though the fellow may not have yet designed a QI project
Level 4 <i>Demonstrates the skills required to identify, develop, implement, and analyze a quality improvement project</i>	Fellow works with department QI committee to analyze data from handwashing project and proposes strategies to improve compliance
Level 5 <i>Creates, implements, and assesses quality improvement initiatives at the institutional or community level</i>	- Competently assumes a leadership role at the departmental or institutional level for patient safety and/or QI initiatives, possibly even being the person to initiate action or call attention to the need for action - Obtains advanced QI training
Assessment Models or Tools	- Direct observation - E-module multiple choice tests - Medical record (chart) audit - Multisource feedback - Portfolio - Reflection - Simulation
Curriculum Mapping	
Notes or Resources	- Agency for Healthcare Research and Quality. https://www.ahrq.gov/. 2020. - Institute for Healthcare Improvement. http://www.ihl.org/Pages/default.aspx. 2020. - Shams T, Zaidat O, Yavagal D, Xavier A, Jovin T, Janardhan V. Society of Vascular and Interventional Neurology (SVIN) Stroke Interventional Laboratory Consensus (SILC) criteria: A 7M management approach to developing a stroke interventional laboratory in the era of stroke thrombectomy for large vessel occlusions. <i>Intervent Neurol</i>. 2016;5:1-28. https://www.karger.com/Article/Fulltext/443617#. 2020. - Society of Interventional Radiology. Quality and Safety Toolkit. https://www.sirweb.org/practice-resources/toolkits/quality-and-safety-toolkit/. 2020.

Systems-Based Practice 3: System Navigation for Patient-Centered Care Overall Intent: To effectively navigate the health care system, including the interdisciplinary team and other care providers, to adapt care to a specific patient population to ensure high-quality patient outcomes	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of care coordination in endovascular surgical neuroradiology imaging/procedures</i> <i>Identifies key elements for safe and effective transitions of care and hand-offs</i> <i>Demonstrates knowledge of population and community health needs and disparities</i>	• Identifies the members of the interprofessional team and describes their roles • Describes an effective sign-out to the next endovascular surgical neuroradiology team member • Knows that patients without insurance are less likely to get an angiogram
Level 2 <i>Coordinates care of patients in routine endovascular surgical neuroradiology imaging/procedures effectively using the roles of interprofessional team members</i> <i>Performs safe and effective transitions of care/hand-offs in routine clinical situations</i> <i>Identifies specific population and community health needs and inequities for the local population</i>	• Works with other members of the endovascular surgical neuroradiology team (nurses, technologists) to coordinate patient imaging, but requires supervision to ensure all necessary imaging is performed • Hands off a follow-up of cerebral angiogram • Identifies that the local population as high risk for stroke
Level 3 <i>Coordinates care of patients in complex endovascular surgical neuroradiology imaging/procedures effectively using the roles of interprofessional team members</i> <i>Performs safe and effective transitions of care/hand-offs in complex clinical situations</i> <i>Identifies local resources available to meet the needs of a patient population and community</i>	• Coordinates the imaging sequencing for complex patients such as complex vascular malformations, brain aneurysm, and stroke • Hands off stroke, post embolization patients to the neurologic care unit and stroke team • Identifies a subarachnoid hemorrhage support group in the community
Level 4 <i>Role models effective coordination of patient-centered care among different disciplines and specialties</i>	• Role models and educates students and more junior team members regarding the engagement of the endovascular surgical neuroradiology team as needed for each patient, and ensures the necessary resources have been arranged

<i>Role models safe and effective transitions of care/hand-offs</i> <i>Participates in adapting the practice to provide for the needs of specific populations (actual or simulated)</i>	• Provides efficient hand-offs to ICU team at the end of a rapid response event that occurred in endovascular surgical neuroradiology • Coordinates and prioritizes consultant input for a new high-risk diagnosis to ensure the patient gets appropriate follow-up • Guides residents in an effective post-procedure hand-off to the referring service • Participates in stroke awareness outreach programs
Level 5 <i>Analyzes the process of care coordination and leads in the design and implementation of improvements</i> <i>Improves quality of transitions of care to optimize patient outcomes</i> <i>Leads innovations and advocates for populations and communities with health care inequities</i>	• Works with hospital or ambulatory site team members or leadership to analyze care coordination in that setting, and takes a leadership role in designing and implementing changes to improve the care coordination process • Works with a QI mentor to identify better hand-off tools or to improve teaching sessions • Works with local outreach programs to develop screening for carotid stenosis • Works with local emergency medical services to create guidelines for pre-hospital triage of stroke
Assessment Models or Tools	• Direct observation • Learning portfolio • Medical record (chart) audit • Multisource feedback • OSCE • Review of sign-out tools • Use/Completion of checklists
Curriculum Mapping	•
Notes or Resources	• Working with the local population the fellow can participate in areas within or outside of endovascular surgical neuroradiology (e.g., open door clinics) • Institutional hand-off guidelines • Joint Commission Center for Transforming Healthcare. Hand-off Communications Targeted Solutions Tool. https://www.centerfortransforminghealthcare.org/tsthoc.aspx. 2020.

Systems-Based Practice 4: Physician Role in Health Care Systems Overall Intent: To understand the physician's role in the complex health care system and how to optimize the system to improve patient care and the health system's performance	
Milestones	Examples
Level 1 <i>Identifies key components of the complex health care system (e.g., hospital, finance, personnel, technology)</i> <i>Describes the mechanisms for reimbursement, including types of payors</i>	• Recognizes that multiple components exist in a health care system, including various practice settings, reimbursement models, and types of insurance • Describes various payment systems, such as Medicare, Medicaid, the US Department of Veterans Affairs (VA), and commercial third-party payors • Describes various practice models
Level 2 <i>Describes how components of a complex health care system are interrelated, and how this impacts patient care</i> <i>States relative cost of common procedures</i>	• Understands that pre-authorization may impact patient care and remuneration to the health system • States relative costs of CT angiography versus catheter angiography
Level 3 <i>Discusses how individual practice affects the broader system (e.g., length of stay, readmission rates, clinical efficiency)</i> <i>Describes the technical and professional components of neurointerventional procedural costs</i>	• Understands that turnaround times and dictation errors may affect patient care, e.g., length of stay, which impacts the broader system • Differentiates between the technical and professional costs of a cerebral angiogram
Level 4 <i>Manages various components of the complex health care system to provide efficient and effective patient care and transitions of care</i> <i>Describes the endovascular surgical neuroradiology revenue cycle and measurements of productivity (e.g., relative value units)</i>	• Works collaboratively with pertinent stakeholders to improve procedural start times • Works collaboratively to improve informed consent for non-English-speaking patients requiring interpreter services • Understands the multiple components of the revenue cycle applied to a cerebral angiogram • Understands how relative value units differ between imaging exams and how they are calculated
Level 5 <i>Advocates for or leads systems change that enhances high-value, efficient, and effective patient care and transitions of care</i> <i>Participates in health policy advocacy activities</i>	• Publishes original research on high-value patient care in peer-reviewed journal • Works with community or professional organizations to advocate for stroke awareness programs

Assessment Models or Tools	• Direct observation • Medical record (chart) audit • Multiple choice test • OSCE • QI project
Curriculum Mapping	•
Notes or Resources	• Agency for Healthcare Research and Quality (AHRQ). Measuring the Quality of Physician Care. https://www.ahrq.gov/talkingquality/measures/setting/physician/index.html. 2020. • AHRQ. Major Physician Performance Sets. https://www.ahrq.gov/talkingquality/measures/setting/physician/measurement-sets.html. 2020. • The Commonwealth Fund. Health System Data Center. http://datacenter.commonwealthfund.org/?_ga=2.110888517.1505146611.1495417431-1811932185.1495417431#ind=1/sc=1. 2020. • Henry J Kaiser Family Foundation. https://www.kff.org/. 2020. • Hirsch JA, Leslie-Mazwi TM, Nicola GN, et al. Current procedural terminology; A primer. <i>Journal of NeuroInterventional Surgery</i>. 2015;7:309-312. https://jn.is.bmj.com/content/7/4/309.citation-tools. 2020. • Lam DL, Medverd JR. How radiologists get paid: resource-based relative value scale and the revenue cycle. <i>AJR</i>. 2013;201:947-958. https://www.ajronline.org/doi/full/10.2214/AJR.12.9715. 2020. • Dzau VJ, McClellan M, Burke S, et al. Vital directions for health and health care: priorities from a National Academy of Medicine Initiative. <i>NAM Perspectives</i>. Discussion Paper, National Academy of Medicine, Washington, DC. https://nam.edu/vital-directions-for-health-health-care-priorities-from-a-national-academy-of-medicine-initiative/. 2020. • Oklahoma State University Medical Center Diagnostic Radiology Residency. Business of Radiology. http://www.osumcradiology.org/educationschedule/lectures/BusinessofRadiology/#0. 2020. • RSNA Online Learning Center. Level 1: Reimbursement Basic. http://education.rsna.org/diweb/catalog/item?id=2210377. 2020. • RSNA Online Learning Center. Level 2: Service Valuation and Costs. http://education.rsna.org/diweb/catalog/item?id=2223133. 2020.

Systems-Based Practice 5: Radiation Safety	
Overall Intent: To demonstrate competence in and to be an advocate for radiation safety awareness	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of the mechanisms of radiation injury and the ALARA ("as low as reasonably achievable") concept</i>	Describes fundamental concepts in radiation biology addressing the mechanism of injury at different radiation exposures
Level 2 <i>Accesses resources to determine exam-specific average radiation dose information</i>	Determines dose and radiation exposure for angiography and neurointerventional procedures
Level 3 <i>Communicates the relative risk of exam-specific radiation exposure to patients and practitioners</i>	- Effectively communicates relative risks of the radiation exposure during a angiography and neurointerventional procedures to the patient, patient's family or referring provider - Effectively communicates risks of radiation exposure secondary to interventional procedures to the patient, patient's family or referring provider
Level 4 <i>Applies principles of ALARA in daily practice</i>	Actively uses radiation controls to minimize exposure to patient and health care team including self
Level 5 <i>Creates, implements, and assesses radiation safety initiatives at the institutional level</i>	Begins a radiation safety initiative with the Radiation Safety Officer addressing angiography use for venous sinus thrombosis in a pregnant woman
Assessment Models or Tools	- Chart, protocoling or other system documentation by fellow - Direct observation - Documentation of QI or radiation safety project processes or outcome - Multiple choice test - OSCE
Curriculum Mapping	
Notes or Resources	- American College of Radiology. ACR Appropriateness Criteria. https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria. 2020. - American College of Radiology. Radiation Safety. https://www.acr.org/Clinical-Resources/Radiology-Safety/Radiation-Safety. 2020. - American College of Radiology. Radiology Safety. https://www.acr.org/Clinical-Resources/Radiology-Safety. 2020. - Image Gently. Pediatric Radiology and Imaging. https://www.imagegently.org/. 2020. - Image Wisely. https://www.imagewisely.org/. 2020. - RSNA. Physics Modules. https://www.rsna.org/en/education/trainee-resources/physics-modules. 2020.

Practice-Based Learning and Improvement 1: Evidence-Based and Informed Practice and Technology Assessment Overall Intent: To incorporate evidence and patient values into clinical practice	
Milestones	Examples
Level 1 <i>Demonstrates how to access and use available evidence to guide routine patient care</i> <i>Discusses the evolution of device or other technology development</i>	• Offers evidence of relative advantages of thrombectomy versus other treatment in stroke care • Discusses use of various catheters and utility in various patient-specific situations
Level 2 <i>Articulates clinical questions and elicits patient preferences and values to guide evidence-based care</i> <i>Discusses regulatory framework (e.g., FDA, IRB, HDE) of a device and its consent and use</i>	• Articulates evidence that endovascular surgical neuroradiology versus surgical treatment of a cerebral aneurysm is best option for patient with renal insufficiency and is consistent with patient's preferences • Understands role of the Institutional Review Board (IRB) in compassionate-use situations
Level 3 <i>Locates and applies the best available evidence, integrated with patient preference and values, to care for complex patients</i> <i>Discusses evidence for currently available devices, limitations for use, and reporting requirements</i>	• Identifies potential treatment options for management of a patient with an arteriovenous malformation, incorporating available guidelines • Demonstrates knowledge of current trials of interventional therapies to accurately convey information to patient while respecting patient preference • Is familiar with current literature on devices and uses
Level 4 <i>Critically appraises conflicting evidence to guide care, tailored to the individual patient</i> <i>Critically assesses new technology and available evidence</i>	• Discusses the conflicting evidence for treatment of an unruptured arteriovenous malformation • Discusses the conflicting evidence for treatment of unruptured cerebral aneurysm • Understands the evidence and results for use of intrasaccular occlusion devices
Level 5 <i>Coaches others to critically appraise and apply evidence for complex patients, and/or participates in the development of guidelines</i>	• Participates in development of national guidelines for catheter directed therapy for stroke • Participates in the development of institutional guidelines for treatment of carotid stenosis
Assessment Models or Tools	• Analysis of journal club presentations and discussion • Direct observation • Patient evaluations • Presentations at interdisciplinary rounds • Reflection

Curriculum Mapping	•
Notes or Resources	• American College of Radiology. ACR Appropriateness Criteria. https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria. 2020. • American College of Radiology. Practice Parameters. https://www.acr.org/Clinical-Resources/Practice-Parameters-and-Technical-Standards. 2020. • Budovec JJ, Kahn CE Jr. Evidence-based radiology: a primer in reading scientific articles. <i>American Journal of Roentgenology</i>. 2010;195(1):W1-W4. https://www.ajronline.org/doi/pdf/10.2214/AJR.10.4696. 2020. • Center for Evidence-Based Medicine. https://www.cebm.net/. 2020. • Erturk SM, Ondategui-Parra S, Otero H, Ros PR. Evidence-based radiology. <i>Journal of the American College of Radiology</i>. 2006;3(7):513-519. https://www.jacr.org/article/S1546-1440(06)00006-8/pdf. 2020. • Fargen KM, Mocco J, Spiotta AM, Rai A, Hirsch JA. A pilot study of neurointerventional research level of evidence and collaboration. <i>Journal of NeuroInterventional Surgery</i>. 2017;9:694-697. https://jn.is.bmj.com/content/9/7/694.citation-tools. 2020. • Lavelle LP, Dunne RM, Carroll AG, Malone DE. Evidence-based practice of radiology. <i>Radiographics</i>. 2015;35(6):1802-1813. https://www.ncbi.nlm.nih.gov/pubmed/26466187. 2020. • Sheehan JJ, Ridge CA, Ward EVM, et al. The process of evidence-based practice in radiology: an introduction. <i>Academic Radiology</i>. 2007;14(4):385-388. https://www.academicradiology.org/article/S1076-6332(07)00024-4/pdf. 2020. • Society of Interventional Radiology. Guidelines: Clinical Topics. https://www.sirweb.org/practice-resources/guidelines-by-document-type/guidelines-by-service-line/. 2020.

Practice-Based Learning and Improvement 2: Reflective Practice and Commitment to Personal Growth Overall Intent: To seek clinical performance information with the intent to improve care; reflect on all domains of practice, personal interactions, and behaviors, and their impact on patients and colleagues (reflective mindfulness); develop clear objectives and goals for improvement in some form of a learning plan	
Milestones	Examples
Level 1 <i>Accepts responsibility for professional development by establishing goals</i> <i>Identifies factors that contribute to gap(s) between expectations and actual performance</i> <i>Actively seeks opportunities to improve performance</i>	• Understands the importance of continued self-improvement • Identifies that lack of sleep, incomplete preparation, and other social factors can lead to performance gaps • Seeks additional material to review to prepare for call • Meets with assigned mentor
Level 2 <i>Is receptive to performance data and feedback and uses them to inform goals</i> <i>Analyzes and reflects on factors that contribute to gap(s) between expectations and actual performance</i> <i>Designs and implements a learning plan, with prompting</i>	• Uses feedback from others to improve patient care • After working in clinic with an attending asks for recommendation on how to describe flow diversion to a patient and family • Requests meeting with mentor to begin developing a learning plan
Level 3 <i>Episodically seeks performance data and feedback with humility and adaptability</i> <i>Analyzes, reflects on, and institutes behavioral change(s) to narrow the gap(s) between expectations and actual performance</i> <i>Designs and implements a learning plan independently</i>	• Takes input from nursing staff members, peers, and supervisors to gain insight into personal strengths and areas to improve • Acts on input and is appreciative of feedback • Changes daily practice habits to increase efficiency • Documents goals in a more specific and achievable manner, such that attaining them is measurable
Level 4 <i>Consistently seeks performance data and feedback with humility and adaptability</i> <i>Analyzes effectiveness of behavioral changes, where appropriate, and considers alternatives in</i>	• Independently follows up with neurosurgical ICU staff on status of unstable patients • Consistently identifies learning gaps and addresses areas to work on

<i>narrowing the gap(s) between expectations and actual performance</i> <i>Uses performance data to measure the effectiveness of the learning plan, and improves it when necessary</i>	• Uses feedback from attendings to create a learning plan
Level 5 <i>Coaches other learners to consistently seek performance data and feedback</i> <i>Coaches others on reflective practice</i> <i>Facilitates the design and implements learning plans for others</i>	• Actively discusses learning goals with supervisors and colleagues • Mentors other learners on the team to consider how their behavior affects the rest of the team • Advocates for improved work environment and develops concrete action plan • Provides constructive feedback to peers for improvement • Provides relevant learning plans for medical students
Assessment Models or Tools	• Direct observation • Faculty member evaluation • Multisource feedback • Review of learning plan
Curriculum Mapping	•
Notes or Resources	• Hojat M, Veloski JJ, Gonnella JS. Measurement and correlates of physicians' lifelong learning. <i>Academic Medicine</i>. 2009;84(8):1066-1074. https://www.ncbi.nlm.nih.gov/pubmed/19638773. 2020. • Lockspeiser TM, Schmitter PA, Lane JL, Hanson JL, Rosenberg AA, Park YS. Assessing residents' written learning goals and goal writing skill: validity evidence for the learning goal scoring rubric. <i>Academic Medicine</i>. 2013;88(10):1558-1563. https://www.ncbi.nlm.nih.gov/pubmed/23969364. 2020.

Professionalism 1: Professional Behavior and Ethical Principles Overall Intent: To recognize and address lapses in ethical and professional behavior, demonstrate ethical and professional behaviors, and use appropriate resources for managing ethical and professional dilemmas	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of expectations for professional behavior and describes how to appropriately report professional lapses</i> <i>Demonstrates knowledge of the ethical principles underlying informed consent, surrogate decision making, advance directives, confidentiality, error disclosure, and stewardship of limited resources</i>	- Identifies and describes potential triggers for professionalism lapses, describes when and how to appropriately report professionalism lapses, and outlines strategies for addressing common barriers to reporting - Discusses the basic ethical principles (beneficence, nonmaleficence, justice, autonomy) and professionalism (professional values and commitments), and how they apply in various situations (e.g., informed consent process) - Obtains informed consent for procedures
Level 2 <i>Demonstrates insight into professional behavior in routine situations and takes responsibility for own professionalism lapses</i> <i>Analyzes straightforward situations using ethical principles</i>	- Demonstrates professional behavior in routine situations and uses ethical principles to analyze straightforward situations, such as those where: - there are no or few conflicts (between values or patients) - the fellow may be tired or hungry, but is not excessively fatigued, overwhelmed, or otherwise distressed - workload is not unusually high, and there is no significant time pressure to make decisions - Acknowledges and takes responsibility for lapse - Apologizes and takes corrective action for the lapse(s) if necessary - Articulates strategies for preventing similar lapses in the future
Level 3 <i>Demonstrates professional behavior in complex or stressful situations</i> <i>Recognizes need to seek help in managing and resolving complex ethical situations</i>	- Analyzes complex situations, such as how the clinical situation evokes strong emotions, conflicts (or perceived conflicts) between patients or between professional values; the learner navigates a situation while not at personal best (due to fatigue, hunger, stress, etc.), or the system poses barriers to professional behavior (e.g., inefficient workflow, inadequate staffing, conflicting policies) - Recognizes own limitations and seeks resources to help manage and resolve complex ethical situations - Analyzes difficult (real or hypothetical) ethical dilemmas and situations, or professional case scenarios - Recognizes own limitations, and consistently demonstrates professional behavior
Level 4 <i>Recognizes situations that may trigger professionalism lapses and intervenes to prevent lapses in oneself and others</i>	- Monitors and responds to fatigue, hunger, stress, etc. in self and team members - Recognizes and responds effectively to the emotions of others - Actively seeks to consider the perspectives of others

<i>Recognizes and uses appropriate resources for managing and resolving ethical dilemmas as needed (e.g., ethics consultations, literature review, risk management/legal consultation)</i>	• Models respect for patients and expects the same from others • Recognizes and uses appropriate resources for managing and resolving ethical dilemmas (e.g., ethics consultations, literature review, risk management/legal consultation)
Level 5 <i>Coaches others when their behavior fails to meet professional expectations</i> <i>Identifies and seeks to address system-level factors that induce or exacerbate ethical problems or impede their resolution</i>	• Coaches others when their behavior fails to meet professional expectations, either in the moment (for minor or moderate single episodes of unprofessional behavior) or after the moment (for major single episodes or repeated minor to moderate episodes of unprofessional behavior) • Identifies and seeks to address system-wide factors or barriers to promoting a culture of ethical and professional behavior through participation in a work group, committee, or taskforce (e.g., ethics committee or subcommittee, risk management committee, root cause analysis review, patient safety or satisfaction committee, professionalism work group, IRB, fellow grievance committee, etc.
Assessment Models or Tools	• Direct observation • End-of-rotation evaluation • Multisource feedback • Oral or written self-reflection • OSCE • RSNA professionalism modules • Simulation
Curriculum Mapping	•
Notes or Resources	• American Association of Physicists in Medicine. ABR/ACR/RSNA/AAPM/ASTRO/ARR/ARS Online Modules on Ethics and Professionalism. https://www.aapm.org/education/onlinemodules.asp. 2020. • American College of Radiology. Code of Ethics. https://www.acr.org/-/media/ACR/Files/Governance/Code-of-Ethics.pdf. 2020. • AMA. Ethics. https://www.ama-assn.org/delivering-care/ethics. 2020. • Association of University Radiologists. Professionalism and Ethics Competencies for Radiology Residents. http://www.aur.org/Secondary.aspx?id=10263. 2020. • Association of University Radiologists. Professionalism Curriculum Resources. http://www.aur.org/ProfessionalCurriculum/. 2020. • Byyny RL, Papadakis MA, Paauw DS, Pfiel S, Alpha Omega Alpha. <i>Medical Professionalism Best Practices</i>. Menlo Park, CA: Alpha Omega Alpha Honor Medical Society; 2015. https://alphaomegalpha.org/pdfs/2015MedicalProfessionalism.pdf. 2020. • Holmen SJ. Neurointerventions and informed consent. <i>Journal of Medical Ethics</i>. 2020. https://jme.bmj.com/content/early/2020/09/10/medethics-2020-106358. 2020.

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| | <ul style="list-style-type: none">• Levinson W, Ginsburg S, Hafferty FW, Lucey CR. <i>Understanding Medical Professionalism</i>. 1st ed. New York, NY: McGraw-Hill Education; 2014. https://accessmedicine.mhmedical.com/book.aspx?bookID=1058. 2020.• Radiological Society of North America. Professionalism for Residents. https://www.rsna.org/education/professionalism-and-quality-care/professionalism-self-assessments/professionalism-for-residents. 2020. |
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Professionalism 2: Accountability/Conscientiousness	
Overall Intent: To take responsibility for one's actions and the impact on patients and other members of the health care team and recognize the limits of one's own knowledge and skill set	
Milestones	Examples
Level 1 <i>Responds promptly to requests or reminders to complete tasks and responsibilities</i>	• When prompted, enters clinical and educational work hours and case logs • Answers pages promptly
Level 2 <i>Performs tasks and responsibilities in a timely manner to ensure the needs of patients, teams, and systems are met in routine situations</i>	• Promptly addresses patient's pain after procedure and orders appropriate medications, communicating with all teams involved • Dictates reports for routine cases in a timely fashion
Level 3 <i>Performs tasks and responsibilities in a timely manner to ensure the needs of patients, teams, and systems are met in complex or stressful situations</i>	• Counsels angry patient with complaints about care while having multiple other clinical responsibilities • Promptly updates patient's family after an emergent procedure • Efficiently dictates reports and communicates results for emergent cases in a timely fashion
Level 4 <i>Recognizes and raises awareness of situations that may impact others' ability to complete tasks and responsibilities in a timely manner</i>	• Preemptively identifies strategies to lessen the impact of scheduled electronic health record down time • Advises residents on how to manage their time in completing patient care tasks
Level 5 <i>Takes ownership of system outcomes</i>	• Sets up a meeting with the nurse manager to streamline pre-procedural work-up of patients • Volunteers to take extra call during unplanned absences of colleagues
Assessment Models or Tools	• Compliance with deadlines and timelines • Direct observation • Multisource feedback • Self-evaluations • Simulation
Curriculum Mapping	•
Notes or Resources	• Code of conduct from institutional manual • Goyal M, van Zwam W, Moret J, Ospel JM. Neurointervention in the 2020s: Where are we going?. <i>Clinical Neuroradiology</i>. 2020. https://link.springer.com/article/10.1007/s00062-020-00953-8. 2020. • Gunderman RB, Brown BP. Excellence and professionalism in radiology. <i>American Journal of Roentgenology</i>. 2013;200(6):W557-W559. https://www.ajronline.org/doi/pdf/10.2214/AJR.12.9130. 2020. • Halpern EJ, Spandorfer JM. Professionalism in radiology: ideals and challenges. <i>American Journal of Roentgenology</i>. 2014;202(2):352-357. https://www.ajronline.org/doi/pdf/10.2214/AJR.13.11342. 2020.

- Hryhorczuk AL, Hanneman K, Eisenberg RL, Meyer EC, Brown SD. Radiologic professionalism in modern health care. *Radiographics*. 2015;35(6):1779-1788. <https://pubs.rsna.org/doi/full/10.1148/rq.2015150041>. 2020.

Professionalism 3: Self-Awareness and Help-Seeking Overall Intent: To identify, use, manage, improve, and seek help for personal and professional well-being for self and others	
Milestones	Examples
Level 1 <i>Recognizes status of personal and professional well-being, with assistance, and is aware of available resources</i> <i>Recognizes limits in the knowledge/skills of oneself or the team, with assistance</i>	• Requests and/or accepts feedback and exhibits positive responses to corrective feedback • Is aware of or can identify potential stressors specific to the learner, or in this specialty
Level 2 <i>Independently recognizes status of personal and professional well-being using available resources when appropriate</i> <i>Independently recognizes limits in the knowledge/skills of oneself or the team and demonstrates appropriate help-seeking behaviors</i>	• Identifies possible sources of personal stress or lack of clinical knowledge and independently seeks help • Recognizes own knowledge gap and reaches out to faculty members for assistance
Level 3 <i>With assistance, proposes a plan to optimize personal and professional well-being</i> <i>With assistance, proposes a plan to remediate or improve limits in the knowledge/skills of oneself or the team</i>	• With supervision, develops a personal learning or action plan to address stress and/or burnout for self or team and gaps in personal clinical knowledge
Level 4 <i>Independently develops a plan to optimize personal and professional well-being</i> <i>Independently develops a plan to remediate or improve limits in the knowledge/skills of oneself or the team</i>	• Independently develops a personal learning or action plan to address stress and/or burnout for self or team and gaps in personal clinical knowledge
Level 5 <i>Coaches others when emotional responses or limitations in knowledge/skills do not meet professional expectations</i>	• Mentors colleagues in self-awareness • Establishes health management plans to limit stress and burnout
Assessment Models or Tools	• Direct observation • Group interview or discussions for team activities • Institutional online training modules • Participation in institutional well-being programs

	• Personal learning plan • Self-assessment • Semi-annual review
Curriculum Mapping	•
Notes or Resources	• This subcompetency is not intended to evaluate a fellow's well-being. Rather, the intent is to ensure that each fellow has the fundamental knowledge of factors that affect well-being, the mechanisms by which those factors affect well-being, and available resources and tools to improve well-being. • Local resources, including Employee Assistance Program. • ACGME. "Well-Being Tools and Resources." https://dl.acgme.org/pages/well-being-tools-resources. Accessed 2022. • Stanford Medicine. WellMD. https://wellmd.stanford.edu/. 2020.

Interpersonal and Communication Skills 1: Patient- and Family-Centered Communication Overall Intent: To deliberately use language and behaviors to form a therapeutic relationship with a patient and the patient's family; to identify communication barriers, including self-reflection on personal biases, and minimize them in the doctor-patient relationship; to organize and lead communication around shared decision making	
Milestones	Examples
Level 1 <i>Accurately communicates own role within the health care system</i> <i>Identifies the need to adjust communication strategies based on assessment of the patient/patient's family's expectations and understanding of their health status and treatment options</i>	• Identifies that they are a fellow during patient interactions • Understands that communication may need to be adjusted for an anxious patient during an awake procedure
Level 2 <i>Identifies barriers to effective communication (e.g., language, health literacy, cultural)</i> <i>Organizes and initiates communication with the patient/patient's family by clarifying expectations and verifying understanding of the clinical situation</i>	• Identifies need for an interpreter; knows to speak in a manner at a level of understanding commensurate with education level of patient; realizes when the presence of a caregiver will be needed to aid in management decision making • Before and/or after communication with patient/family closes the loop and asks them if they are clear about expectations and have knowledge of the clinical situation
Level 3 <i>Identifies biases that hinder effective communication</i> <i>With guidance, sensitively and compassionately delivers medical information, elicits patient goals and preferences, and acknowledges uncertainty and conflict</i>	• Recognizes own bias about sexuality and gender identity • With guidance, relays bad news to a patient or patient's family
Level 4 <i>Actively minimizes communication barriers</i> <i>Independently uses shared decision making to align patient goals and preferences with treatment options to make a personalized care plan</i>	• Takes responsibility for and apologizes after using wrong pronoun with a patient • Independently relays bad news to a patient or patient's family
Level 5 <i>Coaches other learners to minimize communication barriers</i>	• Role models and supports colleagues in self-awareness and reflection to improve therapeutic relationships with patients, and demonstrates intuitive understanding of a

Coaches other learners in shared decision making	patient's perspective; uses a contextualized approach to minimize barriers for patients and colleagues • Role models proactive self-awareness and reflection around explicit and implicit biases with a context-specific approach to mitigating communication barriers • Leads shared decision making with clear recommendations to patients and families even in more complex clinical situations
Assessment Models or Tools	• Direct observation • Kalamazoo Essential Elements Communication Checklist (Adapted) • Mini-clinical evaluation exercise (CEX) • Multisource feedback • OSCE • Self-assessment including self-reflection exercises • Simulation • Skills needed to Set the state, Elicit information, Give information, Understand the patient, and End the encounter (SEGUE) • Standardized patients or structured case discussions
Curriculum Mapping	•
Notes or Resources	• Laidlaw A, Hart J. Communication skills: an essential component of medical curricula. Part I: Assessment of clinical communication: AMEE Guide No. 51. <i>Med Teach</i>. 2011;33(1):6-8. https://www.tandfonline.com/doi/full/10.3109/0142159X.2011.531170. 2020. • Makoul G. Essential elements of communication in medical encounters: the Kalamazoo consensus statement. <i>Acad Med</i>. 2001;76(4):390-393. https://insights.ovid.com/crossref?an=00001888-200104000-00021. 2020. • Makoul G. The SEGUE Framework for teaching and assessing communication skills. <i>Patient Educ Couns</i>. 2001;45(1):23-34. https://www.sciencedirect.com/science/article/abs/pii/S0738399101001367?via%3Dihub. 2020. • Symons AB, Swanson A, McGuigan D, Orrange S, Akl EA. A tool for self-assessment of communication skills and professionalism in residents. <i>BMC Med Educ</i>. 2009;9:1. https://bmcmmededuc.biomedcentral.com/articles/10.1186/1472-6920-9-1. 2020. • American Academy of Hospice and Palliative Medicine. Hospice and Palliative Medicine Competencies Project. http://aahpm.org/fellowships/competencies#competencies-toolkit. 2020.

Interpersonal and Communication Skills 2: Interprofessional and Team Communication Overall Intent: To effectively communicate with the health care team, including with consultants, in both straightforward and complex situations	
Milestones	Examples
Level 1 <i>Respectfully receives a consultation request</i> <i>Uses language that values all members of the health care team</i>	• Accepts a request to do a late afternoon procedure and offers to discuss with the attending without offering resistance • Listens to and considers others' points of view, is nonjudgmental and actively engaged
Level 2 <i>Clearly and concisely responds to a consultation request</i> <i>Communicates information effectively with all health care team members</i>	• Offers consulting service guidance on the necessity of the procedure and when it can be reasonably be performed after discussion with the attending • Uses teach-back strategies to confirm understanding
Level 3 <i>Checks understanding of recommendations when providing consultation</i> <i>Uses active listening to adapt communication style to fit team needs</i>	• Communicates management of blood pressure parameters with neurological ICU team after pre-operative embolization of a brain arteriovenous malformation • Uses verbal and written communication strategies to improve understanding during consultations
Level 4 <i>Coordinates recommendations from different members of the health care team to optimize patient care</i> <i>Solicits and communicates feedback to other members of the health care team</i>	• After discussion with the stroke neurologist, decides that emergency carotid stenting is indicated in setting of acute cervical carotid occlusion with associated hemodynamic insufficiency • Respectfully provides end-of-rotation feedback to other members of the team
Level 5 <i>Role models flexible communication strategies that value input from all health care team members, resolving conflict when needed</i>	• Role models the resolution of conflict between operating room (OR) and interventional suite for anesthesiology services
Assessment Models or Tools	• Direct observation • End-of-rotation evaluation • Multisource feedback • OSCE • Simulation
Curriculum Mapping	•
Notes or Resources	• American College of Radiology. Communication Curriculum for Radiology Residents. https://www.acr.org/Member-Resources/rfs/learning/Communication-for-Radiology-Residents. 2020.

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| | <ul style="list-style-type: none">• Dehon E, Simpson K, Fowler D, Jones A. Development of the faculty 360. <i>MedEdPORTAL</i>. 2015;11:10174. https://www.mededportal.org/publication/10174/. 2020.• François J. Tool to assess the quality of consultation and referral request letters in family medicine. <i>Can Fam Physician</i>. 2011;57(5):574–575. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3093595/. 2020.• Pierot L, Jayaraman MV, Szikora I, et al. Standards of practice in acute ischemic stroke intervention: International recommendations. <i>Journal of NeuroInterventional Surgery</i>. 2018;10:1121-1126. https://jnis.bmj.com/content/10/11/1121.citation-tools. 2020. |
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Interpersonal and Communication Skills 3: Communication within Health Care Systems Overall Intent: To effectively communicate using a variety of methods	
Milestones	Examples
Level 1 <i>Demonstrates knowledge of institutional communications policies</i>	Describes the appropriate and inappropriate use of cell phone, email, and social media
Level 2 <i>Communicates appropriately as required by institutional policy</i>	Uses secured email for communication of patient information
Level 3 <i>Communicates systems concerns in a respectful manner</i>	Communicates with the appropriate radiology department supervisor or hospital reporting system about systems concerns in an objective respectful manner
Level 4 <i>Communicates clear and constructive suggestions to improve systems</i>	Develops pathways for improvement in efficiency for acute stroke treatment
Level 5 <i>Facilitates dialogue regarding systems issues among larger community stakeholders (institution, health care system, field)</i>	Participates with county health, referring hospitals, and emergency medical services to facilitate rapid delivery of emergent large vessel occlusion patients to comprehensive stroke centers for rapid treatment or triage
Assessment Models or Tools	- Assessment of QI projects - Audit of hospital notification system submissions - Direct observation - Medical record (chart) audit - Multisource feedback - Simulation
Curriculum Mapping	
Notes or Resources	- American College of Radiology. Communication Curriculum for Radiology Residents. https://www.acr.org/Member-Resources/rfs/learning/Communication-for-Radiology-Residents. 2020. - Clinical Trails. Direct Transfer to an Endovascular Center Compared to Transfer to the Closest Stroke Center in Acute Stroke Patients With Suspected Large Vessel Occlusion (RACECAT). https://clinicaltrials.gov/ct2/show/NCT02795962. 2020. - HIPAA training - Hryhorczuk AL, Hanneman K, Eisenberg RL, Meyer EC, Brown SD. Radiologic professionalism in modern health care. <i>Radiographics</i>. 2015;35(6):1779-1788. https://pubs.rsna.org/doi/pdf/10.1148/rq.2015150041. 2020. - Institutional communication policies - Kelly AM, Mullan PB. Designing a curriculum for professionalism and ethics within radiology: identifying challenges and expectations. <i>Acad Radiol</i>. 2018;25(5):610-618. https://www.academicradiology.org/article/S1076-6332(18)30091-6/pdf. 2020.

To help programs transition to the new version of the Milestones, the ACGME has mapped the original Milestones 1.0 to the new Milestones 2.0. Indicated below are where the subcompetencies are similar between versions. These are not exact matches, but are areas that include similar elements. Not all subcompetencies map between versions. Inclusion or exclusion of any subcompetency does not change the educational value or impact on curriculum or assessment.

Milestones 1.0	Milestones 2.0
PC1: Intracranial Aneurysm	PC1: Pre-Procedural Consultation PC2: Performance of Procedures PC3: Post-Procedural Care
PC2: Vascular Malformations	PC1: Pre-Procedural Consultation PC2: Performance of Procedures PC3: Post-Procedural Care
PC3: Arterial Occlusive Disease (AOD)	PC1: Pre-Procedural Consultation PC2: Performance of Procedures PC3: Post-Procedural Care
PC4: Acute Ischemic Stroke (AIS)	PC1: Pre-Procedural Consultation PC2: Performance of Procedures PC3: Post-Procedural Care
PC5: Vascular Imaging	MK4: Pharmacology and Contrast SBP5: Radiation Safety
MK1: Intracranial Aneurysm	MK1: Imaging and Procedural Anatomy MK2: Physics and Imaging Technology MK3: Pathophysiology and Treatment
MK2: Vascular Malformation	MK1: Imaging and Procedural Anatomy MK2: Physics and Imaging Technology MK3: Pathophysiology and Treatment
MK3: Arterial Occlusive Disease (AOD)	MK1: Imaging and Procedural Anatomy MK2: Physics and Imaging Technology MK3: Pathophysiology and Treatment
MK4: Acute Ischemic Stroke (AIS)	MK1: Imaging and Procedural Anatomy MK2: Physics and Imaging Technology MK3: Pathophysiology and Treatment MK4: Pharmacology and Contrast
MK5: Vascular Imaging	MK1: Imaging and Procedural Anatomy MK2: Physics and Imaging Technology MK4: Pharmacology and Contrast

SBP1: Radiation Safety	SBP5: Radiation Safety
SBP2: Patient Safety	SBP1: Patient Safety
SBP3: Systems-Based Management	SBP3: System Navigation for Patient-Centered Care SBP4: Physician Role in Health Care Systems
PBLI1: Self-Directed Learning	SBP2: Quality Improvement PBLI1: Evidence-Based and Informed Practice and Technology Assessment PBLI2: Reflective Practice and Commitment to Professional Growth
PROF1: Professional Values	PROF1: Professional Behavior and Ethical Principles
PROF2: Accountability to Patients, Society, Profession, and Self	PROF2: Accountability/Conscientiousness
	PROF3: Self-Awareness and Help-Seeking
ICS1: Communication with Patients and Families	ICS1: Patient- and Family-Centered Communication
ICS2: Communication with Health Care Professionals	ICS2: Interpersonal and Team Communication ICS3: Communication within Health Care Systems

Available Milestones Resources

Milestones 2.0: Assessment, Implementation, and Clinical Competency Committees Supplement, 2021 - <https://meridian.allenpress.com/jgme/issue/13/2s>

Milestones Guidebooks: <https://www.acgme.org/milestones/resources/>

- *Assessment Guidebook*
- *Clinical Competency Committee Guidebook*
- *Clinical Competency Committee Guidebook Executive Summaries*
- *Implementation Guidebook*
- *Milestones Guidebook*

Milestones Guidebook for Residents and Fellows: <https://www.acgme.org/residents-and-fellows/the-acgme-for-residents-and-fellows/>

- *Milestones Guidebook for Residents and Fellows*
- *Milestones Guidebook for Residents and Fellows Presentation*
- *Milestones 2.0 Guide Sheet for Residents and Fellows*

Milestones Research and Reports: <https://www.acgme.org/milestones/research/>

- *Milestones National Report*, updated each fall
- *Milestones Predictive Probability Report*, updated each fall
- *Milestones Bibliography*, updated twice each year

Developing Faculty Competencies in Assessment courses - <https://www.acgme.org/meetings-and-educational-activities/courses-and-workshops/developing-faculty-competencies-in-assessment/>

Assessment Tool: Direct Observation of Clinical Care (DOCC) - <https://dl.acgme.org/pages/assessment>

Assessment Tool: Teamwork Effectiveness Assessment Module (TEAM) - <https://team.acgme.org/>

Improving Assessment Using Direct Observation Toolkit - <https://dl.acgme.org/pages/acgme-faculty-development-toolkit-improving-assessment-using-direct-observation>

Remediation Toolkit - <https://dl.acgme.org/courses/acgme-remediation-toolkit>

Learn at ACGME has several courses on Assessment and Milestones - <https://dl.acgme.org/>