Clinical Experience Requirements
Clinical Competency Requirements and
Examination Content Specifications
for ARRT Certification in
Magnetic Resonance Imaging

MAGNETIC RESONANCE IMAGING
PRACTICE ANALYSIS

Final Report
Fall 2019

TABLE OF CONTENTS

APPENDICES

Introduction

This report summarizes a project to review the C*ontent Specifications* and *Clinical Requirements* for MRI, which was conducted between September 2017 and November 2019. The ARRT certification examination for Magnetic Resonance Imaging (MRI) was first offered in 1995, after an extensive practice analysis study which began in the fall of 1992 and lasted through 1994. A second comprehensive practice analysis was conducted in 2002, and then in conjunction with an interim practice analysis study in 2005 a primary exam pathway was established, allowing students from ARRT-recognized MRI programs to take the MRI exam. Another interim update was conducted in 2008, and fitting the normal schedule, a comprehensive practice analysis study was conducted in 2011 – 2012. An interim update occurred in 2016, and the current project was initiated in the fall of 2017 with the goal of updating all requirements in 2020. Periodic updates are important in professions that continually evolve over time. Advances in science, technology, and clinical knowledge require that content specifications be revised to remain current. Appendix A contains the time and task schedule followed for the project.

Advisory Committee

The ARRT Board of Trustees appoints an Advisory Committee for comprehensive practice analysis projects for the following purposes: (1) to provide guidance to project staff by reviewing the plans for the study; (2) to revise documents as required; and (3) to review the results of all data collected during the project. Based on the results of its deliberations, the Advisory Committee made recommendations to the Board of Trustees concerning the final composition of the *Task Inventory*, *Content Specifications*, *Clinical Competency Requirements* and *Clinical Experience Requirements*.

The Committee represented multiple perspectives in terms of expertise, geographic location, and type of work experience (i.e. staff technologists, educators, and administrators). Along with ARRT staff members Blaze Lanoue, Dan Anderson, and Roxanne Koenen, ARRT Trustees Elizabeth Romero and Barbara Smith, the following R.T.s served on the MRI Practice Analysis Advisory Committee:

Amanda Bain, R.T.(R)(MR)
Forest Carmichael, R.T.(R)(MR)
Rimmon Greenidge, R.T.(R)(MR)
Martha Kennedy, R.T.(MR)
Brandon Ehrin, R.T.(R)(CT)(MR)
John Watson, R.T.(R)(MR)
Meghan Nelson, R.T.(R)(MR)
Richard Apotheker, R.T.(R)(CT)(MR)(BD)

Practice Analysis Survey

The purpose of conducting a Magnetic Resonance Imaging practice analysis survey is to define the typical job functions of an MRI technologist. A national job analysis survey was conducted with the goal of forming a list of the job functions, or tasks, that are typically performed by a significant percentage of entry-level MRI technologists.

The committee began work on the MRI *Practice Analysis Questionnaire* by first reviewing the current task list, a final product of the previous practice analysis study, an interim update conducted in 2016. Most of the tasks on the current list were retained for use in the 2017 survey, but some of the tasks were edited and many new tasks were added. Also, in effort to shorten what was now becoming a very lengthy survey, 15 tasks that the committee was certain were being performed by virtually all MRI technologists were taken off the survey. These tasks, the *omitted task list*, will be included on the final task list but will not be included on the practice analysis survey. It was thought that there was no knowledge to be gained by including these tasks on the survey since informed opinion was that close to 100% of MRI technologists were performing them all. The exception to this line of thinking was that all imaging procedure tasks were included on the survey, even if they were candidates for the omitted task list; ARRT believes it is important to track data on all imaging procedures so that we can recognize trends for each imaging field. Where it may not be considered important if certain equipment related tasks are performed by 97% or 94% of MRI technologists, it may be of interest to note a few percent change in participation in a certain imaging study.

The task list that was in effect at the time of the survey (last updated during the interim PA project in 2016) consisted of 129 tasks. The committee reviewed these tasks along with some new

tasks and selected those that fit the criteria for the omitted task list. The omitted task list is in appendix B. The remaining tasks were reviewed, and some were modified for clarity. Additional tasks that the committee thought reflected recent changes in practice were also added, and the final survey consisted of 112 tasks.

Demographic questions were also included on the survey, primarily to aid in selection of the target group for analysis. Demographic variables were used to slice the sample of returned surveys to determine if differences in work setting, or years of experience, have an influence on response to the survey questions. A few questions concerning current practice in departments were also included in the demographic section. A sample page from the survey is in Appendix C.

Survey Return Rate Research

ARRT has a research interest in methods to improve survey response rates and this project continued that research. Two hypotheses were tested: *Do shorter surveys increase response rate?* and, *Does the inclusion of an incentive ($5 Starbucks gift card) increase response rate?* In addition to the full-length survey there were three shorter surveys, each consisting of 52 tasks plus the demographics section. Tasks were somewhat randomly assigned to the three surveys with a design that allowed all tasks to be on the full survey and at least one of the shorter surveys. For each of the four surveys there was one group that received a gift card and one group that did not. The gift card was included as a gift with no obligation to respond to the survey. To completely cover these conditions there were eight survey groups. The response rates across the survey conditions will be analyzed in depth, but those results are not presented in this report.

Survey Sample

The focus of the survey was on the job duties of MRI technologists at entry level. For this project we focused on full-time staff technologists, with primary discipline of employment in MRI, with one to ten years of experience. Each of the eight survey groups consisted of 750; the *Practice Analysis Questionnaire* was distributed to a total random sample of 6,000 R.T.s meeting these criteria.

Survey Response

A total of 2,015 surveys were returned. The returned surveys were first filtered to exclude those that did not seriously fill out the survey (e.g., partial surveys), and those that filled out the QC tasks incorrectly – there were two tasks on each survey asking the respondent to select a response

(e.g., daily, monthly), and if they did not the survey was excluded; this reduced the sample to 1,980. Finally, the sample was filtered to only include staff technologists working in MRI more than 32 hours per week with 1 to 10 years of experience. At this point the analysis included 1,018; this was the group that was used for most analyses and will be referred to as the *target group.*

Review of Survey Data

When reviewing the data, keep in mind that to place a task on the final task list, the normal criterion is that it is part of the responsibilities of at least 40% of the MRI technologists who respond to the practice analysis survey. Tasks may be included if they do not meet this threshold, but a convincing rationale must then be supplied. For example, if the practice analysis committee feels strongly that a task is trending towards being more commonly performed and the survey data indicates that 35% are currently performing it, the committee may choose to write a justification that the task will soon be performed by a larger percent (over 40%) of MRI technologists. Since an exception indicates that the expert panel believes they know something beyond what the data of this project indicates, it is best to use caution and limit the number to those that the committee feels the strongest about.

Once decisions are made about what tasks will make up the final task list, changes to the content specifications, clinical competency requirements, and clinical experience requirements are discussed. All topics on the content specifications need to relate to one or more tasks on the final task list, so for any deletions from the task list we must make sure that any corresponding content that is only linked to the deleted task is also removed from the content specifications. Likewise, when new tasks are added, the content for the new tasks must also now be included on the content specifications.

Demographics of the Sample and Target Groups

Appendix D contains tables summarizing the total- and target-group responses to the demographic questions in Section 2 of the MRI *Practice Analysis Questionnaire.* About 60% of survey respondents are employed in some type of hospital (private, university, community). Another common work setting for MRI technologists is the outpatient imaging facility; approximately 30% of the survey population works in outpatient imaging centers. About 55% of the target group had 1 – 5 years of experience and about 45% had 6 – 10 years of experience. When the data was analyzed it was further broken down by work setting and years of experience.

Analysis of Task Statements

Section 1 of the *Practice Analysis Questionnaire* contained 113 task statements describing job responsibilities of MRI technologists. For each of the 113 task statements, respondents were asked how often they performed each task. The options were: *Never Perform*, *Yearly, Quarterly, Monthly, Weekly, or Daily.* On average how often did the technologist perform this task?

Comparisons Based on Demographics of Sample

Table 1 of Appendix F lists the percent of the target group responsible for each task and the percent that perform the task daily or weekly.

Respondents were divided into two groups based on their years of experience in MRI: 1 - 5 years and 6 - 10 years. Table 2 in Appendix F shows the proportion of MRI technologists in each group responsible for each of the 113 tasks

Survey data were split into groups based on the employment setting (Table 3, Appendix F). The groups were first split between those working in hospitals and all others. Those working in hospitals were then split by size of hospital (less than 250 beds, 251 – 500 beds, and more than 500 beds). A comparison with results from the previous comprehensive practice analysis surveys (2014) is listed in Table 5. Finally, Table 6 lists the Rasch rating of tasks on the survey. The Rasch rating is based on a model that orders tasks considering the frequency ratings of the tasks and can provide another piece of information for helping make difficult decisions on whether borderline tasks should be included on the final task list.

Development of Task Inventory

The content of the MRI *Task Inventory* is a direct result of the responses to the *Practice Analysis Questionnaire*. The normal criterion used by the ARRT is that at least 40% of the target group must be responsible for performing the task for it to appear on the final task list. If a task falls below this threshold, a compelling argument must be made for it to be included. Most of the decisions of whether to include a survey task on the final list were relatively easy, because most tasks were either clearly above or clearly below the cut-off percentage. The Advisory Committee carefully reviewed tasks that were near the cut-off percentage and considered a variety of data, as listed in the tables in Appendix F.

Several of the patient care and image production tasks were removed from the task inventory because the committee determined they were redundant with other tasks. The following procedures were removed from the task inventory because the committee determined there was overlap with other tasks:

- *Head trauma, Brain for stroke.* This procedure overlaps with *Brain (e.g., trauma, stroke)*.
- *Face.* This procedure overlaps with other head and neck procedures.
- *Parotids, Salivary glands.* These procedures overlap with *Soft tissue neck.*
- *Posterior fossa.* This procedure overlaps with *Brain* and *IAC.*
- *Axilla.* This procedure overlaps with *Chest* and *Breast*.
- *Liver specific contrast study (Eovist), Diffusion liver.* These procedures overlap with *Liver.*
- *Psoas muscle.* This procedure overlaps with *Lumbar* and *Soft tissue pelvis (e.g., bladder, rectum)*.
- *Bladder, Rectum*. These procedures overlap with *Soft tissue pelvis (e.g., bladder, rectum)*.
- *Vagina*. This procedure overlaps with *Female soft tissue pelvis (e.g., uterus)*.
- *Achilles tendon, Hind foot*. These procedures overlap with *Ankle*.
- *Fast imaging techniques (HASTE, SSFSE)* and *Susceptibility weighted imaging.* These sequences overlap with *Select appropriate imaging sequences* and *Select alternate sequences to compensate for patient related issues or patient limitations (e.g., patient motion, metal artifact, claustrophobia, RF heating).*
- *Post-processing (e.g., subtraction, mean curves).* This task overlaps with *Perform image post-processing (e.g., MPR, subtraction).*
- *Dynamic pituitary.* This procedure overlaps with *Pituitary.*

The following procedures were performed by less than 40% of survey respondents and were removed from the task inventory:

- *Vascular spine.* 29.3% of respondents perform this procedure and very few perform it daily or weekly.
- *Perfusion (non-brain).* 28.9% of respondents perform this procedure. The committee believes this task should be re-evaluated at the next practice analysis.
- *Spleen.* 37.9% of respondents perform this procedure with a very low daily/weekly response. The committee believes this percentage is this high only because of confusion with visualizing the spleen in routine abdominal imaging.
- *Spectroscopy (non-brain).* 17.5% of respondents perform this procedure.

The following procedure is currently on the task inventory and was performed by less than 40% of survey respondents. The committee decided this task should remain on the MRI task inventory:

- *Brain spectroscopy.* 34.5% performed this procedure, it was 32.2% in 2012. The committee believes that spectroscopy is an important concept for entry level MRI technologists to understand and is growing.

In the Patient Care section, 15 new tasks were added. All these tasks were performed by well over 40% of the survey respondents and represent patient care tasks consistent with other ARRT primary exam task inventories.

In the Safety section:

- *Monitor cryogen levels* was reworded to *Monitor scan room (e.g., cryogen levels, temperature, humidity).* Each task *(cryogen levels, temperature,* and *humidity)* was surveyed separately, and all were performed by at least 76% of survey respondents.

In the Image Production section:

- *Select appropriate imaging sequences* (99.8%) was added.

In the Procedures section, the following tasks were added:

- *Vascular head MRA* (95.7%) and *Vascular head MRV* (94.2%). *Vascular head* was previously listed as one procedure but was separated into MRA and MRV for this survey. The committee decided to keep them separate on the task inventory.
- *Fingers (non-thumb)* (96.1%). *Hand/fingers* was previously listed as one task but was separated for this survey. The committee decided to keep them separate on the task inventory.
- *Lumbar plexus* (65.7%). A new task that was performed by over 40% of survey respondents.
- *Long bones (upper extremity)* (99.8%) and *Long bones (lower extremity)* (99.4%). *Long bones* were previously listed as one procedure but was separated for this survey. The committee decided to keep them separate on the task inventory.

The culmination of the process of analyzing and making judgments regarding the task survey data was the creation of The *Task Inventory for MRI*, and this final task list may be found at Task Inventories. The final task list was approved by the ARRT Board in July 2018.

Revision of the Content Specifications

The draft *Content Specifications* was completed during the April 2018 meeting, after the Advisory Committee reviewed the *Practice Analysis Questionnaire* results. Additional changes were made to section B. *Imaging Procedures*, by adding topics that addressed new tasks, and eliminating topics that dealt with deleted tasks.

In October 2018, the committee reviewed and discussed the comments from the professional community and finalized their proposed changes to the content specifications for MRI. The following reflect the recommended changes and the rationale for the changes:

- The content in the Patient Care section was reorganized and detail was added to be more consistent with other ARRT primary disciplines. Rationale: This change is a direct result of developing patient care tasks within the task inventory that were consistent between all primary disciplines.

- Topics concerning the handling and disposal of toxic or hazardous material was added to the Patient Care section. Rationale: This content was added to the task inventory.

- Topics concerning the spatial gradient of the static magnetic field were added to the Safety section. Rationale: This content was added to the task inventory.

- Topics concerning informatics were added to the Image Production section. Rationale: This content is on the task inventory.

- The content in the Procedures section was organized and retitled to match the task inventory, clinical experience requirements, and didactic and clinical competency requirements for MRI. Rationale: This provides consistency across all MRI foundational documents.

- Topics concerning brain perfusion, cranial nerves (non-IACs), sinuses, whole spine, and lumbar plexus were added to the neurological subsection of Procedures. Rationale: This content was added to the task inventory.

- Topics concerning angiography in the neurological subsection of Procedures were separated into vascular head (MRA), vascular head (MRV), and vascular neck. Rationale: This clarification matches the task inventory.

- Topics concerning head trauma and brain for stroke were removed from the neurological subsection of Procedures. Rationale: These procedures were redundant with pathological considerations of a brain and only require additional sequences and not additional slice positioning.

- Topics concerning vascular spine were removed from the neurological subsection of Procedures. Rationale: Vascular spine was removed from the task inventory.

- The spleen procedure was removed from the body subsection of Procedures. Rationale: Spleen as a stand-alone procedure was removed from the task inventory.

- Topics concerning hand/fingers were separated in the musculoskeletal subsection of Procedures. Topics concerning long bones (humerus, forearm, femur, lower leg) were also separated in this subsection into long bones (upper extremity) and long bones (lower extremity). Rationale: This matches how the procedures appear on the task inventory.

- Topics concerning CINE (e.g., CSF flow study) and surgical planning were added to the focus of questions subsection of Procedures. Rationale: This content was added to the task inventory.

Assignment of Content Weights

The process of establishing weights involved both independent judgment and consensus building. A common theme of the discussion was that Safety and MSK Procedures were underrepresented on the content specifications, and so the committee thought more questions should be devoted to those sections. At the April/May 2018 meeting, the committee agreed upon the following numbers of questions for the content areas:

Section	2020 # of questions	2018 # of questions
Patient Care	18	17
Safety	20	15
Physical Principles of Image Formation	39	40
Sequence Parameters and Options	36	38
Data Acquisition and Processing	30	34
Neurological Procedures	25	26
Body Procedures	15	20
MSK Procedures	17	10

For additional information regarding the number and distribution of items refer to Content Specifications | ARRT - The American Registry of Radiologic Technologists.

Revision of MRI Clinical Experience and Clinical Competency Requirements

All applicants for the examination in MRI are required to perform certain clinical procedures to establish eligibility. Another purpose of the MRI Practice Analysis project was to review and revise these requirements to assure that they accurately reflect current practice. This was accomplished through careful review of data from the MRI *Practice Analysis Questionnaire* at the April 2018 meeting of the Advisory Committee.

Data collected from the target group of interest, that is, technologists with up to 10 years of experience was especially relevant for this process. The Advisory Committee reviewed the proportion of the target group responsible for each procedure and the frequency with which the procedure was performed (See Table 5, Appendix F), and decided whether a procedure should be mandatory, elective, or not included in the requirements. The considerations are somewhat different when deciding on what procedures are eligible for the Clinical Requirements, as compared to what procedures are covered on the exam; a rule-of-thumb is that at least 80% of the target group should be responsible for performing a task before it is listed as a mandatory requirement. The committee used their expert judgment to balance the importance of candidates having experience with a procedure versus their ability to gain access to performing the procedure.

Clinical Experience Requirements

After analyzing all factors, the following changes were implemented for the 2020 Magnetic Resonance Imaging Clinical Experience Requirements.

- Organized and retitled individual procedures to match the task inventory, examination content specifications, and didactic and clinical competency requirements for MRI. Rationale: This provides consistency across all MRI foundational documents.

- Sacroiliac (SI) joints and enterography were added to the list of possible procedures. Rationale: These procedures are on the task inventory.

- Spectroscopy and perfusion were clarified to only include brain spectroscopy and brain perfusion. Rationale: This clarification matches the task inventory.

- Posterior fossa and head trauma were removed from the list of possible procedures. Rationale: These procedures are redundant with other procedures and were removed as separate procedures from the task inventory.

- Scapula was removed from the list of possible procedures. Rationale: This procedure was removed as a separate procedure from the task inventory.

- Diffusion (non-brain) was removed from the list of possible procedures. Rationale: Diffusion is a sequence and not a procedure. A diffusion sequence is commonly performed as part of the standard protocol for many imaging procedures.

- ADC mapping was removed from the list of image post-processing options. Rationale: ADC mapping is commonly performed without any technologist interaction.

- Peripheral MRA was removed from the list of procedures. Rationale: The committee felt that this procedure was performed too infrequently (9% daily/weekly).

- Quality control procedures were moved from the list of possible MRI procedures and placed onto a mandatory list of MRI quality control procedures. Rationale: The committee believes that all MRI technologists need to perform quality control procedures.

- Equipment inspection, monitoring cryogen levels, and monitoring room temperature and humidity were added to list of MRI quality control procedures. Rationale: These procedures are on the task inventory.

- All MR imaging procedures remained elective. The number of possible procedures decreased from 53 to 47 procedures, primarily due to moving the quality control procedures. The maximum number of repetitions per procedure was increased from five to six while the total number of required repetitions remained the same. Rationale: The committee believes that it is important for the candidate to perform at least 125 imaging procedures. To balance

the reduction in possible procedures, the committee increased the maximum number of repetitions per procedure.

An extensive discussion involved whether to change one of the allowed clinical experience verifiers from an ARRT certified and registered technologist to an ARRT MRI certified and registered technologist. The committee debated the merits and drawbacks of this issue and then decided to make this change to the draft of the clinical experience requirements that was posted on ARRT.ORG for public comment. Many comments were received, several supporting this change, but there were also some others that pointed out potential problems that could cause technologists to not be able to qualify to take the exam if the policy was changed. After reviewing the comments, the committee stuck with the recommendation for the policy change and forwarded the edited requirements to the ARRT Board for consideration. The Board discussed this potential change and decided that, at this time, it was better to keep in place the policy that the verifier is required to be ARRT certified and registered but is not required to be ARRT MRI certified and registered. In other words, the Board decided that for this update to the clinical experience requirements there would be no change to the required credentials for R.T.s that verify clinical experience. This issue will continue to evolve and is certain to be a discussion point for future practice analysis studies.

Clinical Competency Requirements

The following changes were implemented for the 2020 Magnetic Resonance Imaging Didactic and Clinical Competency Requirements:

- Organized and retitled individual procedures to match the task inventory, examination content specifications, and clinical experience requirements for MRI. Rationale: This provides consistency across all MRI foundational documents.

- Cranial nerves (non-IACs), brain perfusion, spinal trauma, pancreas, adrenals, kidneys, male soft tissue pelvis (e.g., prostate), and CINE (e.g., CSF).
  Rationale: These procedures are on the task inventory and on the clinical experience requirements. The committee believes that it is important to have consistency between

the two clinical documents. That is, a procedure listed in one MRI pathway should be an option for the other MRI pathway.

- Soft tissue pelvis was split into female and male soft tissue pelvis. Wrist/hand was split into wrist and hand procedures. Femur and lower leg were combined into long bones (lower extremity). Humerus and forearm were combined into long bones (upper extremity). Rationale: This matches how the procedures appear on the task inventory.

- Spectroscopy was clarified to only include brain spectroscopy. Rationale: This clarification matches the task inventory.

- Scapula was removed from the list of elective procedures. Rationale: Scapula as a separate procedure was removed from the task inventory.

- ADC mapping was removed from the list of image post-processing options. Rationale: ADC mapping is commonly performed without any technologist interaction.

- The number of mandatory procedures remained at 17. The number of required elective procedures increased from 10 to 11. Rationale: The number of available elective procedures increased from 25 to 30. The committee believes that with this increase, requiring that an additional elective procedure be performed is justified.

The following links can be used to view the MRI *Clinical Experience Requirements* and *Clinical Competency Requirements* Clinical Experience Requirements | ARRT - The American Registry of Radiologic Technologists; Competency Requirements | ARRT - The American Registry of Radiologic Technologists.

Performance Standard

The passing standard for the MRI exam was established with a standard setting study in 1995. It was decided that it was time to conduct a new standard setting study as part of this project, and the study was held in August 2019. Members of the PA committee were joined by the current Exam Committee for this study, along with two additional MRI technologists and two ARRT Board of Trustee members, making a total panel of 17. The suggested new standard was communicated to the ARRT Board at the January 2020 meeting. The decision of the Board of Trustees was to keep the existing passing standard for 2021 and moving forward.

Conclusion

Many members of the professional MRI community contributed their ideas on different aspects of the project from responding to the *Task Analysis Questionnaire* to commenting on proposed changes to the *Content Specifications,* the *Clinical Experience Requirements,* and the *Clinical Competency Requirements*. Meanwhile, the MRI Practice Analysis Advisory Committee provided a consistent perspective and presence to the project. Using a data-driven approach, the committee added their professional perspective to the interpretation of the survey data, and considered a combination of factors, ranging from the amount of emphasis to place on exam content to the ability of candidates to gain access to the procedures included in the eligibility requirements. The ARRT appreciates and acknowledges the efforts of these individuals. The result of this collaborative effort is an examination that validly represents an important and growing profession, enabling the ARRT to fulfill its mission of recognizing qualified individuals and promoting high standards of patient care.

Appendix A

MRI Practice Analysis Project Schedule

January 2017 – January 2021

Steps	Approx. Date	Activity
1	January 2017 BOT meeting	Board appoints members to the MRI PA Advisory Committee. Staff mails appointment letter, contract, and proposed dates for meeting.
2	Upon return of contract	Welcome letter with date of first meeting and introductory materials sent to committee members.
3	Sept 2017	Staff compiles existing task inventory and other materials for Advisory Committee review.
4	Sept 2017	Advisory Committee reviews materials and makes additions to task inventory.
5	*October 2017	Advisory Committee meets to review and update TI and discuss survey content.
6	Oct/Nov 2017	Staff prepares first draft of survey and mails to Advisory Committee for review.
7	Oct/Nov 2017	Advisory Committee members contact staff to discuss survey changes.
8	December 2017	Staff prepares survey copy and sends to Survey Systems for printing. (Note: send file with sample so that names and addresses can be laser printed onto surveys.)
9	December 2017	Survey Systems returns survey for final proof.
10	January 2018	Survey Systems mails surveys to large sample of MRI technologists. • 1/8/2018: initial mailing • 1/26/2018: send thank you/reminder post card with information to request a survey
11	February 2018	Survey System returns final comprehensive data file.
12	March 2018	Psychometrics team analyzes data and prepares preliminary report.
13	*April 2018	Advisory Committee meets to 1) review survey results, 2) finalize new task inventory, 3) develop draft clinical requirements, and 4) develop draft content specifications.
14	Summer 2018	Board of Trustees approves the task inventory.
15	Summer 2018	Draft clinical requirements and content specifications posted on ARRT website and sent to professional community for review and comment.
16	Summer 2018	Staff collates comments from professional community.
17	*October 2018	Advisory Committee meets to finalize content specifications and clinical requirements and to assemble SSA according to new content specifications
18	Fall 2018	Board reviews and approves clinical requirements and content specifications.
19	Spring 2019	Exam Committee meets to assemble test forms according to new content specifications.
20	Spring 2019	Revised content specifications and clinicals placed into 2020 Candidate Handbooks.
21	*Summer 2019	Advisory committee and Exam committee perform standard setting study.
22	January 2020	New exam content specifications and clinical requirements go into effect.
23	January 2020	Board approves new standard.
24	2020	Publish impact results for new standard. Recalibrate the item bank.
25	January 2021	New standard goes into effect.

(* indicates onsite committee meeting)

APPENDIX B

MRI Omitted Task List

1 Verify patient's identity.
2 Demonstrate and promote professional and ethical behavior (e.g., confidentiality, regulation compliance).
3 Practice Standard Precautions.
4 Use sterile or aseptic technique when indicated.
5 Administer contrast agents as required by the examination.
6 Assess patient after administration of a contrast agent to detect adverse reactions.
7 Screen patient for ferrous and RF-sensitive material prior to entrance into magnetic field.
8 Inspect equipment to make sure it is operable and safe (e.g., coils, cables, door seals).
9 Notify appropriate personnel of equipment malfunctions and potential repairs as needed.
10 Research implantable medical devices for safe, conditional, or unsafe labeling.
11 Select optimal imaging coils.
12 Perform automatic or manual frequency tuning.
13 Select or adjust one or more imaging parameters (e.g., TR, TE, FOV, imaging plane, bandwidth, gap, slice thickness).
14 Select or adjust one or more imaging options (e.g., saturation pulse, flow compensation, fat suppression, gating).
15 Store, transfer, or retrieve images from data storage devices.

APPENDIX C

Practice Analysis Questionnaire Sample Page

FREQUENCY
D - Daily
W - Weekly
M - Monthly
Q - Quarterly
Y - Yearly
NP – NEVER PERFORM

		NP	Y	Q	M	W	D
1.	Coordinate pre and post exam arrangements with other departments for patient support services (e.g., transportation, anesthesia, nursing)	○	○	○	○	○	○
2.	Consult radiologist and verify protocol as needed	○	○	○	○	○	○
3.	Assist with scheduling patients and coordinating exams to assure smooth work flow	○	○	○	○	○	○
4.	Determine patient's mobility status and assist special needs	○	○	○	○	○	○
5.	Assist patient on and off the scanning table using proper body mechanics and if needed transfer devices	○	○	○	○	○	○
6.	Review and record patient's medical history prior to scan (e.g., duration, location, signs and symptoms)	○	○	○	○	○	○
7.	Recognize life threatening changes of the patines vital signs (blood pressure, pulse, respiration)	○	○	○	○	○	○
8.	Observe patient's level of consciousness during scanning procedure	○	○	○	○	○	○
9.	Observe patient's physical status prior to release from the department after the scanning procedure	○	○	○	○	○	○
10.	Evacuate patient in emergency situation (e.g., quench, code, metallic object)	○	○	○	○	○	○
11.	Maintain controlled access to magnetic field to ensure safety of patients, visitors, and hospital personnel (e.g., zones 3 and 4)	○	○	○	○	○	○
12.	Monitor specific absorption rate (SAR)	○	○	○	○	○	○
13.	Perform and document the results of QC tests (center frequency, signal to noise, image quality and artifacts)	○	○	○	○	○	○
14.	Interpret results of QC tests to assure that performance standards are met	○	○	○	○	○	○
15.	Inspect equipment to make sure it is operable and safe (e.g., coils, cables, door seals)	○	○	○	○	○	○
16.	Notify appropriate personnel of equipment malfunctions and potential repairs as needed	○	○	○	○	○	○
17.	Research implantable medical devices	○	○	○	○	○	○
18.	Monitor cryogen levels	○	○	○	○	○	○
19.	Store, transfer or retrieve images from data storage devices	○	○	○	○	○	○

APPENDIX D

Demographic Characteristics

SECTION 2: DEMOGRAPHIC AND WORK EXPERIENCE

1.	Place of employment	%
	University hospital	16.0
	Private hospital	13.4
	Community hospital	30.4
	Outpatient imaging center	29.8
	Physician's office or clinic	5.0
	Other	5.4

2.	Size of hospital	%
	Less than 100 beds	7.8
	100 – 250 beds	17.6
	251 – 500 beds	21.6
	More than 500	23.0
	Not hospital	30.1

3.	Years as an MRI technologist	%
	1 – 3 yr	25.9
	4 – 5 yr	29.4
	6 – 10 yr	44.7

4.	Hours per week in MRI	%
	Greater than 32 hr/wk	100.0

5.	Job title	%
	Staff technologist	100

6. Do you image patients with pacemakers?

Yes	49.4%
No	50.6%

7. What image do you use for a brain hemorrhage?

Gradient echo	38.4%
SWI	11.0%
Gradient echo or SWI	46.1%
N/A	4.6%

8. How do you monitor RF heating?

SAR	80.0%
B_{1+rms}	0.8%
SAR and B_{1+rms}	17.4%
N/A	1.8%

9. What field strength are your MRI scanners?

Less than 1.5 T	10.7%
1.5 T	91.6%
3 T	49.8%
Greater than 3 T	0.8%

10. Are you aware of the spatial gradient magnetic field values of your scanner used to screen patients with implanted medical devices?

Yes	82.6%
No	17.4%

11. In a typical month, approximately what percentage of time do you spend working in the various areas of MRI listed below?

Neuro	47.7%
Body	20.9%
MSK	31.4%

APPENDIX E

Survey Results Tables

Table 1 provides data for the percent of the target group that perform each task, and the percent that perform the task often (either daily or weekly). The third column lists the percent that perform the task, regardless of job title, years of experience, or hours per week performing MRI. The values for this total group is on average 1% below the target group, and for most tasks the difference is small.

Table 2 breaks the data for each task down by years of experience. Most of the differences between groups here are minor. There are a few tasks that it appears more experienced technologists perform more commonly and there are a few others that newer technologists are more likely to perform, but no significant trends appear in this analysis.

Table 3 breaks the data down by work setting (hospital by size or non-hospital). There are major differences seen for some tasks in this table. Several tasks, including *brain perfusion* and *vascular spine* are much more commonly performed in large hospitals than in the other job environments.

Table 4 lists the percentage that perform tasks on the current survey, and the corresponding percent from the 2012 task analysis survey. Many tasks were common between the two surveys but there were also many differences in specificity or just wording of tasks. Comparisons are only provided for tasks that were essentially the same across surveys.

Table 5 lists the Rasch rank of tasks along with the percent that perform. The Rasch rank is a way of ordering tasks that integrates the frequency data by more heavily weighting the more frequent responses (e.g., daily weighted more heavily than weekly, etc.) The top of the list represents those tasks that most MRI techs perform frequently. The task with Rasch rank 100, ***Vascular Extremities*** is highlighted. It can be argued that all tasks up to and including this task should be included on the final task list and all tasks below should be excluded. There are no tasks in the table above Rasch rank #100 for which fewer than 40% perform, and there is only one task, ***Sternum***, below #100 for which greater than 40% perform.

Table 6 lists responses to the procedures on the survey, broken down by if or how an R.T. obtained ARRT certification and registration in MRI. 107 of the target group are not R.T.(MR), 828 went through the post-primary pathway, and 83 used the primary pathway.

Table 7 lists more detailed survey responses of the target group to the 15 tasks that have the lowest Rasch ranks.

Table 1

2018 Target group - % that perform and % performing daily or weekly; % responsible for all filtered returned surveys

		TARGET		ALL
	TASK	%PERF	%DAY/WK	%PERF
1	Sequence imaging examinations to avoid affecting subsequent examinations	92.8	85.3	90.9
2	Evaluate patient's ability to understand and comply with requirements for the requested exam	100.0	100.0	99.8
3	Obtain pertinent medical history.	100.0	99.5	99.6
4	Manage interpersonal interactions in an effective manner.	98.5	98.1	97.9
5	Explain and confirm patient's preparation (e.g., diet restrictions, preparatory medications) prior to imaging	93.8	90.2	91.8
6	Review imaging request to verify information is accurate, appropriate and complete	100.0	99.8	99.9
7	Explain imaging instructions to patient or patient's family (e.g., pre and post procedure)	99.8	98.9	99.4
8	Respond as appropriate to imaging inquiries from patients or patient's family	99.6	99.1	99.6
9	Verify examination protocols as needed.	100.0	97.0	99.9
10	Follow environmental protection standards for the handling of biohazardous materials	99.4	97.8	98.3
11	Follow environmental protection standards for handling hazardous materials	96.8	95.1	97.7
12	Provide for patient safety, comfort, and modesty.	100.0	99.9	100.0
13	Notify appropriate personnel of adverse events or incidents	97.9	55.6	97.3
14	Verify informed consent as necessary.	96.2	89.0	95.2
15	Recognize abnormal or missing lab values relative to the imaging ordered	97.5	94.3	96.4

16	Communicate relevant information to appropriate medical professionals	99.4	97.4	99.6
17	Follow appropriate procedures when caring for patients with communicable diseases	99.8	88.4	99.4
18	Use immobilization devices or positioning aids, as needed, to prevent patient movement	100.0	99.1	100.0
19	Use proper body mechanics and/or patient transfer devices when assisting a patient	100.0	98.1	100.0
20	Prior to the administration of a medication other than a contrast agent review information to prepare	56.7	44.7	56.0
21	Prior to the administration of a contrast agent, review information to prepare appropriate type and dosage	98.3	98.0	98.0
22	Prior to the administration of a contrast agent, determine if patient is at risk for an adverse reaction	97.7	93.4	98.1
23	Perform venipuncture.	92.7	88.7	92.5
24	Assess patient after administration of a contrast agent to detect adverse events	99.2	97.3	98.2
25	Obtain vital signs.	64.4	38.2	62.2
26	Recognize and communicate the need for prompt medical attention	98.3	66.0	97.7
27	Administer emergency care (e.g., evacuate patient from zone IV, quench, code)	66.6	11.9	65.9
28	Clean, disinfect, or sterilize facilities and equipment.	100.0	99.5	99.7
29	Document required information on patient’s medical record.	97.1	93.8	96.9
30	Provide hearing protection to patient and others in zone IV.	99.6	99.3	99.6
31	Maintain controlled access to zones III and IV to ensure safety of patients, visitors, and personnel	99.6	99.5	99.6
32	Monitor RF induced heating (e.g., specific absorption rate	96.1	92.3	95.3
33	Perform and document the results of QC tests (e.g., center frequency	87.6	77.1	87.1
34	Interpret results of QC tests to assure that performance standards are met	75.7	66.1	78.8
35	Monitor cryogen levels.	76.5	62.6	78.7

36	Monitor scan room temperature.	88.8	83.8	91.0
37	Monitor scan room humidity.	81.4	74.1	82.5
38	Select appropriate imaging sequences.	99.8	99.5	99.9
39	Select alternate sequences to compensate for patient related issues or patient limitations	100.0	98.6	99.9
40	Manipulate parameters to compensate for patient related issues or patient limitations	100.0	99.7	100.0
41	Perform image post-processing (e.g., MPR, subtraction).	97.3	90.5	96.8
42	Assess images to determine successful completion of the procedure	100.0	99.8	100.0
43	Determine corrective measures and adjust parameters for images not of diagnostic quality	99.6	98.3	99.6
44	Brain (e.g., trauma, stroke)	98.8	95.5	97.9
45	Brain for MS	97.6	79.5	96.7
46	Brain for seizure	97.3	80.2	96.9
47	Infant brain (less than one year old)	41.1	17.4	41.2
48	Brain for CSF flow study	64.9	19.0	61.5
49	Brain perfusion	56.8	32.8	52.3
50	Brain spectroscopy	34.5	9.9	32.1
51	Functional brain	25.2	11.9	24.4
52	IAC	96.9	71.2	96.7
53	Pituitary	97.1	69.4	97.0
54	Orbits	96.1	56.3	95.8
55	Cranial nerves	91.1	48.9	90.9
56	*Dedicated sinuses	50.7	11.4	53.1
57	Soft tissue neck	97.8	37.0	96.9

58	Vascular head MRA	95.7	80.2	95.2
59	Vascular head MRV	94.2	41.0	91.4
60	Vascular neck	95.1	68.4	94.2
61	Cervical	100.0	98.6	99.8
62	Thoracic	99.6	97.0	99.5
63	Lumbar	100.0	98.3	99.7
64	*Dedicated sacroiliac joints	90.4	23.0	90.7
65	Sacrum-coccyx	98.4	29.5	97.4
66	Spinal trauma	87.2	54.1	84.6
67	Whole spine	93.3	58.4	90.3
68	Brachial plexus	95.7	14.1	92.6
69	Lumbar plexus	65.7	11.2	66.9
70	Vascular spine	29.3	6.3	22.4
71	Chest	71.3	12.5	77.5
72	Breast	52.5	37.8	51.6
73	Cardiac	29.0	18.0	27.2
74	Vascular thorax	52.0	12.0	51.4
75	Liver	94.0	79.8	92.8
76	Pancreas	92.3	71.1	91.5
77	MRCP	91.6	76.6	90.3
78	*Dedicated spleen	37.9	6.2	40.2
79	*Dedicated adrenals	82.9	18.7	81.8
80	Kidneys	92.3	56.0	90.4
81	Enterography	65.0	29.7	49.5

82	Vascular abdomen	74.1	13.3	72.7
83	Soft tissue pelvis (e.g., bladder, rectum)	88.2	43.4	87.0
84	Female pelvis (e.g., uterus)	94.3	47.0	93.2
85	Male pelvis (e.g., prostate)	66.4	34.5	72.7
86	Placenta/fetus	34.8	6.7	34.2
87	Vascular pelvis (femoral, iliac)	57.2	6.1	57.7
88	Temporomandibular joint	76.1	10.0	74.3
89	Sternum	68.8	3.7	66.5
90	SC joints	69.5	9.1	70.1
91	Shoulder	99.6	90.9	99.1
92	Long bones (upper extremity)	99.8	63.5	98.3
93	Elbow	99.2	59.8	99.1
94	Wrist	98.8	66.4	98.7
95	Hand	98.6	59.6	97.8
96	Fingers (non-thumb)	96.1	40.9	95.9
97	Thumb	93.3	33.5	94.0
98	Bony pelvis	99.6	71.6	98.9
99	Hip	99.8	88.1	99.5
100	Long bones (lower extremity)	99.4	71.6	98.5
101	Knee	99.7	94.9	99.5
102	Ankle	99.5	88.9	99.3
103	Foot	99.8	91.5	98.9
104	Arthrogram	79.3	57.3	77.0
105	Vascular extremities	54.6	9.0	52.5

106	CINE	54.5	21.4	49.4
107	Perfusion (non-brain)	28.9	13.6	27.1
108	Spectroscopy (non-brain)	17.5	4.3	15.6
109	Surgical preplanning (e.g., stealth, brain lab, gamma knife)	64.0	41.3	58.5
110	Biopsies	28.0	11.4	25.7
N		1,018	1,018	1,980

Table 2

Target group - % that perform by years of experience in MRI

	TASK	%PERF	1–3 YR	4-5 YR	6-10 YR
1	Sequence imaging examinations to avoid affecting subsequent	92.8	95.2	92.3	91.6
2	Evaluate patient's ability to understand and comply with	100.0	100.0	100.0	100.0
3	Obtain pertinent medical history.	100.0	100.0	99.2	100.0
4	Manage interpersonal interactions in an effective manner.	98.5	100.0	97.8	98.1
5	Explain and confirm patient's preparation (e.g., diet restrictions	93.8	91.6	94.9	94.2
6	Review imaging request to verify information is accurate,	100.0	100.0	100.0	100.0
7	Explain imaging instructions to patient or patient's family	99.8	99.3	100.0	100.0
8	Respond as appropriate to imaging inquiries from patients or	99.6	100.0	98.6	100.0
9	Verify examination protocols as needed.	100.0	100.0	100.0	100.0
10	Follow environmental protection standards for the handling	99.4	100	100	98.7
11	Follow environmental protection standards for handling hazardous	96.8	97.8	97.8	94.9
12	Provide for patient safety, comfort, and modesty.	100.0	100.0	100.0	100.0
13	Notify appropriate personnel of adverse events or incidents	97.9	98.5	97.6	97.8
14	Verify informed consent as necessary.	96.2	95.8	96.6	96.2
15	Recognize abnormal or missing lab values relative to the imaging	97.5	95.6	98.5	98.1
16	Communicate relevant information to appropriate medical professionals	99.4	100.0	100.0	98.7
17	Follow appropriate procedures when caring for patients with	99.8	100.0	99.3	100.0
18	Use immobilization devices or positioning aids, as needed,	100.0	100.0	100.0	100.0

19	Use proper body mechanics and/or patient transfer devices	100.0	100.0	100.0	100.0
20	Prior to the administration of a medication other than a contrast	56.7	56.0	58.5	56.0
21	Prior to the administration of a contrast agent, review info	98.3	98.5	98.5	97.1
22	Prior to the administration of a contrast agent, determine	97.7	98.5	98.5	97.3
23	Perform venipuncture.	92.7	91.6	91.2	94.3
24	Assess patient after administration of a contrast agent to	99.2	100.0	99.3	98.6
25	Obtain vital signs.	64.4	66.2	65.6	62.6
26	Recognize and communicate the need for prompt medical attention	98.3	97.7	100.0	97.8
27	Administer emergency care (e.g., evacuate patient from zone	66.6	63.0	63.9	70.7
28	Clean, disinfect, or sterilize facilities and equipment.	100.0	100.0	100.0	100.0
29	Document required information on patient's medical record.	97.1	97.7	96.1	97.4
30	Provide hearing protection to patient and others in zone IV.	99.6	100.0	98.5	100.0
31	Maintain controlled access to zones III and IV to ensure safe	99.6	100.0	98.6	100.0
32	Monitor RF induced heating (e.g., specific absorption rate	96.1	96.2	95.6	96.4
33	Perform and document the results of QC tests (e.g., center	87.6	87.3	88.4	87.2
34	Interpret results of QC tests to assure that performance	75.7	72.8	80.9	74.2
35	Monitor cryogen levels.	76.5	68.8	81.1	78.3
36	Monitor scan room temperature.	88.8	83.7	88.8	91.2
37	Monitor scan room humidity.	81.4	77.9	82.4	83.0
38	Select appropriate imaging sequences.	99.8	100.0	100.0	99.5
39	Select alternate sequences to compensate for patient related	100.0	100.0	100.0	100.0
40	Manipulate parameters to compensate for patient related issues	100.0	100.0	100.0	100.0

41	Perform image post-processing (e.g., MPR, subtraction).	97.3	98.1	97.3	96.9
42	Assess images to determine successful completion of the procedure	100.0	100.0	100.0	100.0
43	Determine corrective measures and adjust parameters for	99.6	99.3	100.0	99.5
44	Brain (e.g., trauma, stroke)	98.8	99.2	99.0	98.5
45	Brain for MS	97.6	98.5	98.5	96.5
46	Brain for seizure	97.3	99.3	97.8	95.8
47	Infant brain (less than one year old)	41.1	47.5	38.9	38.5
48	Brain for CSF flow study	64.9	62.2	70.3	63.4
49	Brain perfusion	56.8	57.4	58.2	55.5
50	Brain spectroscopy	34.5	32.6	33.6	36.3
51	Functional brain	25.2	32.6	25.2	20.8
52	IAC	96.9	98.5	98.5	94.8
53	Pituitary	97.1	99.3	97.2	95.6
54	Orbits	96.1	97.7	97.7	94.3
55	Cranial nerves	91.1	91.9	92.6	89.5
56	*Dedicated sinuses	50.7	45.8	55.0	50.8
57	Soft tissue neck	97.8	97.9	99.3	96.9
58	Vascular head MRA	95.7	97.8	96.2	94.3
59	Vascular head MRV	94.2	97.1	94.8	92.1
60	Vascular neck	95.1	97.9	94.4	93.8
61	Cervical	100.0	100.0	100.0	100.0
62	Thoracic	99.6	100.0	100.0	99.1
63	Lumbar	100.0	100.0	100.0	100.0
64	*Dedicated sacroiliac joints	90.4	85.8	90.9	92.9
65	Sacrum-coccyx	98.4	97.0	99.2	98.7
66	Spinal trauma	87.2	95.6	85.4	82.9
67	Whole spine	93.3	93.6	92.4	93.7
68	Brachial plexus	95.7	95.6	93.7	96.9
69	Lumbar plexus	65.7	63.0	66.9	66.7
70	Vascular spine	29.3	22.0	33.6	31.1
71	Chest	71.3	77.6	72.9	78.1
72	Breast	52.5	60.3	48.9	49.8
73	Cardiac	29.0	24.3	34.9	27.8
74	Vascular thorax	52.0	51.5	52.7	52.0
75	Liver	94.0	95.8	94.3	92.7

76	Pancreas	92.3	94.3	90.8	92.0
77	MRCP	91.6	92.5	94.8	89.0
78	*Dedicated spleen	37.9	32.4	37.3	41.7
79	*Dedicated adrenals	82.9	82.8	84.5	82.1
80	Kidneys	92.3	93.4	94.9	90.0
81	Enterography	65.0	66.8	66.6	62.9
82	Vascular abdomen	74.1	72.1	75.7	74.4
83	Soft tissue pelvis (e.g., bladder, rectum)	88.2	90.8	88.7	86.3
84	Female pelvis (e.g., uterus)	94.3	97.0	92.9	93.4
85	Male pelvis (e.g., prostate)	66.4	78.7	72.8	69.5
86	Placenta/fetus	34.8	36.2	35.7	33.5
87	Vascular pelvis (femoral, iliac)	57.2	52.6	55.8	60.8
88	Temporomandibular joint	76.1	72.3	79.2	76.5
89	Sternum	68.8	59.3	71.3	73.1
90	SC joints	69.5	58.8	73.5	73.7
91	Shoulder	99.6	100.0	99.7	99.3
92	Long bones (upper extremity)	99.8	100.0	100.0	99.6
93	Elbow	99.2	99.3	98.4	99.6
94	Wrist	98.8	98.5	99.3	98.7
95	Hand	98.6	100.0	99.3	97.2
96	Fingers (non-thumb)	96.1	92.9	97.2	97.3
97	Thumb	93.3	91.9	91.5	95.2
98	Bony pelvis	99.6	99.3	99.3	100.0
99	Hip	99.8	100.0	99.7	99.8
100	Long bones (lower extremity)	99.4	98.3	99.2	99.6
101	Knee	99.7	100.0	99.7	99.6
102	Ankle	99.5	99.6	99.7	99.3
103	Foot	99.8	100.0	100.0	99.6
104	Arthrogram	79.3	76.3	84.7	77.7
105	Vascular extremities	54.6	50.0	55.9	56.6
106	CINE	54.5	54.8	53.9	54.6
107	Perfusion (non-brain)	28.9	25.5	35.4	26.8
108	Spectroscopy (non-brain)	17.5	16.2	19.0	17.4
109	Surgical preplanning (e.g., stealth, brain lab, gamma knife)	64.0	63.9	65.3	63.2
110	Biopsies	28.0	28.9	22.3	30.7
	N	1,018	264	299	455

Table 3

Target group - % that perform by size of hospital

SMALL – less than 250 beds
MED – 250 to 500 beds
LARGE – more than 500 beds
NOT – not in a hospital

	TASK	TOT	SMALL	MED	LARGE	NOT
1	Sequence imaging examinations to avoid affecting subsequent	92.8	94.1	94.4	91.4	91.9
2	Evaluate patient's ability to understand and comply with	100.0	100.0	100.0	100.0	100.0
3	Obtain pertinent medical history.	100.0	100.0	100.0	99.1	100.0
4	Manage interpersonal interactions in an effective manner.	98.5	100.0	97.8	97.1	98.8
5	Explain and confirm patient's preparation (e.g., diet restrictions	93.8	96.0	95.7	90.7	93.0
6	Review imaging request to verify information is accurate,	100.0	100.0	100.0	100.0	100.0
7	Explain imaging instructions to patient or patient's family	99.8	100.0	99.0	100.0	100.0
8	Respond as appropriate to imaging inquiries from patients	99.6	99.2	99.1	100.0	100.0
9	Verify examination protocols as needed.	100.0	100.0	100.0	100.0	100.0
10	Follow environmental protection standards for the handling	99.4	100	100	100	98.0
11	Follow environmental protection standards for handling hazardous	96.8	95.7	95.7	97.2	96.8
12	Provide for patient safety, comfort, and modesty.	100.0	100.0	100.0	100.0	100.0
13	Notify appropriate personnel of adverse events or incidents	97.9	97.2	97.1	99.1	98.2
14	Verify informed consent as necessary.	96.2	98.0	94.3	95.5	96.7
15	Recognize abnormal or missing lab values relative to the imaging	97.5	99.1	97.8	97.2	96.5
16	Communicate relevant information to appropriate medical professionals	99.4	98.5	99.1	100.0	100.0

17	Follow appropriate procedures when caring for patients with	99.8	100.0	100.0	100.0	99.4
18	Use immobilization devices or positioning aids, as needed,	100.0	100.0	100.0	100.0	100.0
19	Use proper body mechanics and/or patient transfer devices	100.0	100.0	100.0	100.0	100.0
20	Prior to the administration of a medication other than a contrast	56.7	56.1	58.0	55.9	56.8
21	Prior to the administration of a contrast agent, review info	98.3	100	100	99.1	97.4
22	Prior to the administration of a contrast agent, determine	97.7	100.0	99.0	97.3	96.6
23	Perform venipuncture.	92.7	95.5	96.2	90.1	90.1
24	Assess patient after administration of a contrast agent to	99.2	100.0	100.0	100.0	97.6
25	Obtain vital signs.	64.4	70.2	71.5	67.9	53.3
26	Recognize and communicate the need for prompt medical attention	98.3	98.1	98.1	99.0	98.2
27	Administer emergency care (e.g., evacuate patient from zone	66.6	73.5	72.2	78.5	51.2
28	Clean, disinfect, or sterilize facilities and equipment.	100.0	100.0	100.0	100.0	100.0
29	Document required information on patient’s medical record.	97.1	97.2	94.2	98.2	98.2
30	Provide hearing protection to patient and others in zone IV.	99.6	100.0	97.8	100.0	100.0
31	Maintain controlled access to zones III and IV to ensure safety	99.6	100.0	100.0	100.0	98.8
32	Monitor RF induced heating (e.g., specific absorption rate	96.1	95.5	96.2	97.8	95.5
33	Perform and document the results of QC tests (e.g., center	87.6	90.7	84.2	81.8	91.3
34	Interpret results of QC tests to assure that performance	75.7	76.3	77.2	61.7	83.3
35	Monitor cryogen levels.	76.5	80.3	74.3	60.8	84.7
36	Monitor scan room temperature.	88.8	92.5	82.5	85.3	92.4

37	Monitor scan room humidity.	81.4	81.7	76.1	77.8	86.4
38	Select appropriate imaging sequences.	99.8	100.0	98.9	100.0	100.0
39	Select alternate sequences to compensate for patient related	100.0	100.0	100.0	100.0	100.0
40	Manipulate parameters to compensate for patient related issues	100.0	100.0	100.0	100.0	100.0
41	Perform image post-processing (e.g., MPR, subtraction).	97.3	99.2	99.5	98.7	93.6
42	Assess images to determine successful completion of the procedure	100.0	100.0	100.0	100.0	100.0
43	Determine corrective measures and adjust parameters for image	99.6	100.0	99.1	100.0	99.4
44	Brain (e.g., trauma, stroke)	98.8	100.0	100.0	100.0	96.4
45	Brain for MS	97.6	99.1	100.0	100.0	93.6
46	Brain for seizure	97.3	98.3	100.0	100.0	93.5
47	Infant brain (less than one year old)	41.1	39.8	56.4	67.6	13.5
48	Brain for CSF flow study	64.9	60.2	78.0	89.1	44.8
49	Brain perfusion	56.8	46.0	60.9	88.8	41.3
50	Brain spectroscopy	34.5	22.6	45.5	62.4	19.3
51	Functional brain	25.2	20.6	32.4	37.3	16.0
52	IAC	96.9	100.0	97.8	100.0	92.4
53	Pituitary	97.1	99.2	100.0	100.0	91.4
54	Orbits	96.1	99.1	100.0	100.0	89.5
55	Cranial nerves	91.1	92.9	91.2	98.1	85.3
56	*Dedicated sinuses	50.7	44.5	46.0	66.7	47.7
57	Soft tissue neck	97.8	99.2	98.2	100.0	95.1
58	Vascular head MRA	95.7	99.1	100.0	100.0	88.4
59	Vascular head MRV	94.2	98.3	100.0	100.0	84.6
60	Vascular neck	95.1	97.0	98.2	100.0	88.3

61	Cervical	100.0	100.0	100.0	100.0	100.0
62	Thoracic	99.6	100.0	100.0	100.0	98.8
63	Lumbar	100.0	100.0	100.0	100.0	100.0
64	*Dedicated sacroiliac joints	90.4	85.0	88.4	93.1	94.5
65	Sacrum-coccyx	98.4	96.3	98.0	100.0	98.8
66	Spinal trauma	87.2	93.0	96.8	99.1	70.2
67	Whole spine	93.3	94.7	97.3	100.0	85.1
68	Brachial plexus	95.7	92.5	99.0	99.1	93.5
69	Lumbar plexus	65.7	61.4	64.8	80.6	59.5
70	Vascular spine	29.3	25.6	28.6	53.9	17.3
71	Chest	71.3	59.3	86.4	94.5	70.0
72	Breast	52.5	48.7	60.9	62.0	44.4
73	Cardiac	29.0	24.2	38.9	49.8	12.1
74	Vascular thorax	52.0	38.3	67.0	74.5	37.2
75	Liver	94.0	96.4	99.5	100.0	84.7
76	Pancreas	92.3	96.2	96.4	99.0	82.2
77	MRCP	91.6	95.7	100.0	100.0	79.0
78	*Dedicated spleen	37.9	38.2	40.9	42.2	32.9
79	*Dedicated adrenals	82.9	85.2	89.3	92.7	71.5
80	Kidneys	92.3	96.5	100.0	99.1	80.8
81	Enterography	65.0	54.5	74.5	92.0	48.3
82	Vascular abdomen	74.1	79.8	90.2	88.1	52.4
83	Soft tissue pelvis (e.g., bladder, rectum)	88.2	91.7	93.8	93.1	78.4
84	Female pelvis (e.g., uterus)	94.3	96.3	96.1	100.0	88.4
85	Male pelvis (e.g., prostate)	66.4	71.3	79.6	87.0	61.5
86	Placenta/fetus	34.8	30.1	42.9	64.4	14.8

87	Vascular pelvis (femoral, iliac)	57.2	51.9	69.9	76.1	40.9
88	Temporomandibular joint	76.1	74.4	77.9	82.4	72.4
89	Sternum	68.8	63.6	65.0	81.8	66.1
90	SC joints	69.5	64.3	62.4	72.9	74.7
91	Shoulder	99.6	98.8	100.0	100.0	99.7
92	Long bones (upper extremity)	99.8	100.0	100.0	100.0	99.4
93	Elbow	99.2	98.1	100.0	99.1	99.4
94	Wrist	98.8	98.0	99.1	99.1	99.1
95	Hand	98.6	99.1	98.9	97.2	98.8
96	Fingers (non-thumb)	96.1	94.7	94.7	97.1	97.5
97	Thumb	93.3	88.0	91.3	95.5	96.5
98	Bony pelvis	99.6	100.0	98.9	100.0	99.4
99	Hip	99.8	99.2	100.0	100.0	100.0
100	Long bones (lower extremity)	99.4	98.1	100.0	100.0	99.4
101	Knee	99.7	99.2	100.0	100.0	99.7
102	Ankle	99.5	98.8	100.0	100.0	99.4
103	Foot	99.8	100.0	100.0	100.0	99.4
104	Arthrogram	79.3	84.2	90.3	82.5	68.5
105	Vascular extremities	54.6	50.8	62.8	73.3	40.5
106	CINE	54.5	51.4	59.8	82.6	35.5
107	Perfusion (non-brain)	28.9	23.3	30.4	46.1	21.6
108	Spectroscopy (non-brain)	17.5	12.2	30.1	22.9	10.7
109	Surgical preplanning (e.g., stealth, brain lab, gamma knife)	64.0	55.2	88.0	88.4	38.9
110	Biopsies	28.0	16.7	35.0	40.0	23.3
111	N	1,018	248	211	225	334

Table 4

Target group - % that perform 2018 survey versus 2012 survey

	TASK	% 2018	% 2012
1	Sequence imaging examinations to avoid affecting subsequent	92.8	
2	Evaluate patient's ability to understand and comply with	100.0	
3	Obtain pertinent medical history.	100.0	
4	Manage interpersonal interactions in an effective manner.	98.5	
5	Explain and confirm patient's preparation (e.g., diet restrictions	93.8	
6	Review imaging request to verify information is accurate,	100.0	
7	Explain imaging instructions to patient or patient's family	99.8	
8	Respond as appropriate to imaging inquiries from patients	99.6	
9	Verify examination protocols as needed.	100.0	
10	Follow environmental protection standards for the handling	99.4	
11	Follow environmental protection standards for handling hazardous	96.8	
12	Provide for patient safety, comfort, and modesty.	100.0	
13	Notify appropriate personnel of adverse events or incidents	97.9	
14	Verify informed consent as necessary.	96.2	
15	Recognize abnormal or missing lab values relative to the imaging	97.5	
16	Communicate relevant information to appropriate medical professionals	99.4	
17	Follow appropriate procedures when caring for patients with	99.8	

18	Use immobilization devices or positioning aids, as needed,	100.0	
19	Use proper body mechanics and/or patient transfer devices	100.0	
20	Prior to the administration of a medication other than a contrast	56.7	
21	Prior to the administration of a contrast agent, review info	98.3	
22	Prior to the administration of a contrast agent, determine	97.7	
23	Perform venipuncture.	92.7	
24	Assess patient after administration of a contrast agent to	99.2	
25	Obtain vital signs.	64.4	
26	Recognize and communicate the need for prompt medical attention	98.3	
27	Administer emergency care (e.g., evacuate patient from zone	66.6	
28	Clean, disinfect, or sterilize facilities and equipment.	100.0	
29	Document required information on patient’s medical record.	97.1	
30	Provide hearing protection to patient and others in zone IV.	99.6	
31	Maintain controlled access to zones III and IV to ensure safety	99.6	
32	Monitor RF induced heating (e.g., specific absorption rate	96.1	
33	Perform and document the results of QC tests (e.g., center	87.6	80.2
34	Interpret results of QC tests to assure that performance	75.7	
35	Monitor cryogen levels.	76.5	69.3
36	Monitor scan room temperature.	88.8	
37	Monitor scan room humidity.	81.4	
38	Select appropriate imaging sequences.	99.8	
39	Select alternate sequences to compensate for patient related	100.0	
40	Manipulate parameters to compensate for patient related issues	100.0	98.5

41	Perform image post-processing (e.g., MPR, subtraction).	97.3	94.6
42	Assess images to determine successful completion of the procedure	100.0	
43	Determine corrective measures and adjust parameters for image	99.6	
44	Brain (e.g., trauma, stroke)	98.8	95.9
45	Brain for MS	97.6	95.4
46	Brain for seizure	97.3	94.4
47	Infant brain (less than one year old)	41.1	
48	Brain for CSF flow study	64.9	67.6
49	Brain perfusion	56.8	39.5
50	Brain spectroscopy	34.5	32.2
51	Functional brain	25.2	13.4
52	IAC	96.9	95.9
53	Pituitary	97.1	
54	Orbits	96.1	95.4
55	Cranial nerves	91.1	91.0
56	*Dedicated sinuses	50.7	78.8**
57	Soft tissue neck	97.8	95.6
58	Vascular head MRA	95.7	
59	Vascular head MRV	94.2	
60	Vascular neck	95.1	
61	Cervical	100.0	98.5
62	Thoracic	99.6	98.5
63	Lumbar	100.0	98.0
64	*Dedicated sacroiliac joints	90.4	
65	Sacrum-coccyx	98.4	97.3
66	Spinal trauma	87.2	90.7
67	Whole spine	93.3	86.8
68	Brachial plexus	95.7	93.9
69	Lumbar plexus	65.7	
70	Vascular spine	29.3	
71	Chest	71.3	76.3
72	Breast	52.5	
73	Cardiac	29.0	27.1
74	Vascular thorax	52.0	
75	Liver	94.0	91.2

76	Pancreas	92.3	88.8
77	MRCP	91.6	90.2
78	*Dedicated spleen	37.9	81.2**
79	*Dedicated adrenals	82.9	89.5**
80	Kidneys	92.3	90.7
81	Enterography	65.0	36.1
82	Vascular abdomen	74.1	
83	Soft tissue pelvis (e.g., bladder, rectum)	88.2	90.5
84	Female pelvis (e.g., uterus)	94.3	86.8
85	Male pelvis (e.g., prostate)	66.4	62.4
86	Placenta/fetus	34.8	27.8**
87	Vascular pelvis (femoral, iliac)	57.2	64.4
88	Temporomandibular joint	76.1	80.5
89	Sternum	68.8	71.7
90	SC joints	69.5	81.2
91	Shoulder	99.6	99.5
92	Long bones (upper extremity)	99.8	
93	Elbow	99.2	99.5
94	Wrist	98.8	99.0
95	Hand	98.6	98.3
96	Fingers (non-thumb)	96.1	96.1
97	Thumb	93.3	
98	Bony pelvis	99.6	97.8
99	Hip	99.8	98.8
100	Long bones (lower extremity)	99.4	
101	Knee	99.7	99.0
102	Ankle	99.5	98.8
103	Foot	99.8	99.0
104	Arthrogram	79.3	81.0
105	Vascular extremities	54.6	
106	CINE	54.5	44.6
107	Perfusion (non-brain)	28.9	38.5**
108	Spectroscopy (non-brain)	17.5	32.0**
109	Surgical preplanning (e.g., stealth, brain lab, gamma knife)	64.0	
110	Biopsies	28.0	26.6

** asked differently on previous survey

Table 5

RASCH RANK OF TASKS

TASK	#	RASCH	%PERF
Provide for patient safety, comfort, and modesty.	12	1	100.0
Evaluate patient's ability to understand and comply with	2	2	100.0
Assess images to determine successful completion of the procedure	42	3	100.0
Review imaging request to verify information is accurate,	6	4	100.0
Select appropriate imaging sequences.	38	5	99.8
Maintain controlled access to zones III and IV to ensure safety	31	6	99.6
Obtain pertinent medical history.	3	7	100.0
Explain imaging instructions to patient or patient's family	7	8	99.8
Provide hearing protection to patient and others in zone IV.	30	9	99.6
Manipulate parameters to compensate for patient related issues	40	10	100.0
Clean, disinfect, or sterilize facilities and equipment.	28	11	100.0
Use immobilization devices or positioning aids, as needed,	18	12	100.0
Use proper body mechanics and/or patient transfer devices	19	13	100.0
Select alternate sequences to compensate for patient related	39	14	100.0
Determine corrective measures and adjust parameters for imaging	43	15	99.6
Lumbar	63	16	100.0
Respond as appropriate to imaging inquiries from patients	8	17	99.6
Manage interpersonal interactions in an effective manner.	4	18	98.5
Verify examination protocols as needed.	9	19	100.0
Assess patient after administration of a contrast agent to	24	20	99.2

Cervical	61	21	100.0
Prior to the administration of a contrast agent, review info	21	22	98.3
Prior to the administration of a contrast agent, determine	22	23	97.7
Communicate relevant information to appropriate medical professionals	16	24	99.4
Brain (e.g., trauma, stroke)	44	25	98.8
Follow environmental protection standards for the handling	10	26	99.4
Document required information on patient’s medical record.	29	27	97.1
Follow environmental protection standards for handling hazardous	11	28	96.8
Recognize abnormal or missing lab values relative to the	15	29	97.5
Thoracic	62	30	99.6
Knee	101	31	99.7
Monitor RF induced heating (e.g., specific absorption rate	32	32	96.1
Follow appropriate procedures when caring for patients with	17	33	99.8
Shoulder	91	34	99.6
Verify informed consent as necessary.	14	35	96.2
Perform image post-processing (e.g., MPR, subtraction).	41	36	97.3
Explain and confirm patient’s preparation (e.g., diet rest	5	37	93.8
Perform venipuncture.	23	38	92.7
Foot	103	39	99.8
Ankle	102	40	99.5
Sequence imaging examinations to avoid affecting subsequent	1	41	92.8
Hip	99	42	99.8
Monitor scan room temperature.	36	43	88.8
Brain for MS	45	44	97.6
Brain for seizure	46	45	97.3
Vascular head MRA	58	46	95.7

Liver	75	47	94.0
IAC	52	48	96.9
Bony pelvis	98	49	99.6
Long bones (lower extremity)	100	50	99.4
Recognize and communicate the need for prompt medical attention	26	51	98.3
MRCP	77	52	91.6
Pituitary	53	53	97.1
Wrist	94	54	98.8
Pancreas	76	55	92.3
Long bones (upper extremity)	92	56	99.8
Monitor scan room humidity.	37	57	81.4
Vascular neck	60	58	95.1
Elbow	93	59	99.2
Perform and document the results of QC tests (e.g., center	33	60	87.6
Hand	95	61	98.6
Orbits	54	62	96.1
Notify appropriate personnel of adverse events or incidents	13	63	97.9
Whole spine	67	64	93.3
Kidneys	80	65	92.3
Spinal trauma	66	66	87.2
Female pelvis (e.g., uterus)	84	67	94.3
Cranial nerves	55	68	91.1
Monitor cryogen levels.	35	69	76.5
Interpret results of QC tests to assure that performance	34	70	75.7
Fingers (non-thumb)	96	71	96.1
Arthrogram	104	72	79.3
Soft tissue neck	57	73	97.8
Vascular head MRV	59	74	94.2
Sacrum-coccyx	65	75	98.4
Soft tissue pelvis (e.g., bladder, rectum)	83	76	88.2
Thumb	97	77	93.3
Male pelvis (e.g., prostate)	85	78	66.4
*Dedicated sacroiliac joints	64	79	90.4

Prior to the administration of a medication other than a contrast	20	80	56.7
Brachial plexus	68	81	95.7
Surgical preplanning (e.g., stealth, brain lab, gamma knife)	109	82	64.0
Obtain vital signs.	25	83	64.4
*Dedicated adrenals	79	84	82.9
Breast	72	85	52.5
Brain perfusion	49	86	56.8
Enterography	81	87	65.0
Brain for CSF flow study	48	88	64.9
Chest	71	89	71.3
Vascular abdomen	82	90	74.1
Temporomandibular joint	88	91	76.1
CINE	106	92	54.5
Lumbar plexus	69	93	65.7
SC joints	90	94	69.5
Administer emergency care (e.g., evacuate patient from zone IV	27	95	66.6
Vascular thorax	74	96	52.0
Infant brain (less than one year old)	47	97	41.1
*Dedicated sinuses	56	98	50.7
Vascular pelvis (femoral, iliac)	87	99	57.2
Vascular extremities	105	100	54.6
Functional brain	51	101	25.2
*Dedicated spleen	78	102	37.9
Sternum	89	103	68.8
Cardiac	73	104	29.0
Brain spectroscopy	50	105	34.5
Perfusion (non-brain)	107	106	28.9
Biopsies	110	107	28.0
Placenta/fetus	86	108	34.8
Vascular spine	70	109	29.3
Spectroscopy (non-brain)	108	110	17.5

Table 6

Percent that perform by how certified and registered in MRI by ARRT: not certified (n = 107); post-primary (n = 828); primary (n = 83).

	PROCEDURE	%PERF	NOT CERT	POST	PRIMARY
44	Brain (e.g., trauma, stroke)	98.8	99.1	98.8	98.8
45	Brain for MS	97.6	98.2	97.4	97.9
46	Brain for seizure	97.3	97.8	97.7	94.1
47	Infant brain (less than one year old)	41.1	35.2	40.6	53.7
48	Brain for CSF flow study	64.9	56.4	65.7	68.1
49	Brain perfusion	56.8	45.7	57.9	58.8
50	Brain spectroscopy	34.5	25.6	35.4	41.5
51	Functional brain	25.2	19.3	25.0	34.0
52	IAC	96.9	93.3	97.4	96.1
53	Pituitary	97.1	92.6	97.8	95.1
54	Orbits	96.1	96.5	96.1	95.7
55	Cranial nerves	91.1	80.0	92.5	90.0
56	*Dedicated sinuses	50.7	42.1	52.2	47.0
57	Soft tissue neck	97.8	94.4	98.3	97.6
58	Vascular head MRA	95.7	96.5	95.9	93.6
59	Vascular head MRV	94.2	94.4	95.4	92.0
60	Vascular neck	95.1	90.7	95.9	92.5
61	Cervical	100.0	100.0	100.0	100.0
62	Thoracic	99.6	96.5	99.7	97.9
63	Lumbar	100.0	100.0	100.0	100.0
64	*Dedicated sacroiliac joints	90.4	75.5	91.8	95.1
65	Sacrum-coccyx	98.4	93.0	99.0	100
66	Spinal trauma	87.2	89.1	86.6	90.2
67	Whole spine	93.3	86.3	94.2	92.7
68	Brachial plexus	95.7	89.5	96.1	80.9
69	Lumbar plexus	65.7	54.5	66.1	72.5
70	Vascular spine	29.3	22.2	30.4	26.8
71	Chest	71.3	71.9	75.8	89.1
72	Breast	52.5	35.6	54.2	54.0
73	Cardiac	29.0	18.7	29.3	39.0
74	Vascular thorax	52.0	45.6	51.5	63.8
75	Liver	94.0	87.9	94.5	96.4

76	Pancreas	92.3	81.5	93.7	92.7
77	MRCP	91.6	77.8	93.2	92.0
78	*Dedicated spleen	37.9	40.7	38.0	33.3
79	*Dedicated adrenals	82.9	78.9	83.3	84.8
80	Kidneys	92.3	84.4	93.0	94.1
81	Enterography	65.0	47.6	66.0	77.1
82	Vascular abdomen	74.1	60.0	75.5	76.5
83	Soft tissue pelvis (e.g., bladder, rectum)	88.2	74.1	89.4	95.0
84	Female pelvis (e.g., uterus)	94.3	93.0	94.1	97.8
85	Male pelvis (e.g., prostate)	66.4	60.9	74.2	74.5
86	Placenta/fetus	34.8	20.4	36.8	34.1
87	Vascular pelvis (femoral, iliac)	57.2	54.4	56.3	68.1
88	Temporomandibular joint	76.1	63.0	77.9	75.6
89	Sternum	68.8	66.7	67.5	82.6
90	SC joints	69.5	56.5	70.4	74.5
91	Shoulder	99.6	97.2	99.9	100
92	Long bones (upper extremity)	99.8	100.0	99.8	100
93	Elbow	99.2	96.5	99.5	100
94	Wrist	98.8	96.3	99.0	100
95	Hand	98.6	97.8	98.7	98.0
96	Fingers (non-thumb)	96.1	90.7	96.4	100
97	Thumb	93.3	89.5	93.3	97.9
98	Bony pelvis	99.6	100	99.5	100
99	Hip	99.8	98.1	100	100
100	Long bones (lower extremity)	99.4	96.5	99.7	100
101	Knee	99.7	98.1	99.9	100
102	Ankle	99.5	97.2	99.8	100
103	Foot	99.8	100	99.8	100
104	Arthrogram	79.3	76.1	79.3	84.0
105	Vascular extremities	54.6	40.7	55.6	63.4
106	CINE	54.5	43.9	53.9	72.3
107	Perfusion (non-brain)	28.9	22.2	30.0	26.8
108	Spectroscopy (non-brain)	17.5	13.3	19.0	9.8
109	Surgical preplanning (e.g., stealth, brain lab, gamma knife)	64.0	55.1	64.7	68.7
110	Biopsies	28.0	33.2	27.7	36.2

Table 7

SURVEY RESPONSES OF TARGET GROUP TO LOWEST RASCH RANKED TASKS

TASK	%PRF	DAILY	WKLY	MTHLY	QTRLY	YRLY	NOT	TOT
Spectroscopy (non-brain)	17.5	10	11	19	17	28	401	486
Vascular spine	29.3	21	11	28	42	47	360	509
Placenta/fetus	34.8	13	21	42	43	58	331	508
Biopsies	28.0	13	43	33	28	21	355	493
Perfusion (non-brain)	28.9	37	32	32	21	25	362	509
Brain spectroscopy	34.5	16	34	49	41	35	332	507
Cardiac	29.0	83	100	34	36	41	721	1015
Sternum	68.8	12	6	20	91	209	153	491
*Dedicated spleen	37.9	16	15	44	46	70	313	504
Functional brain	25.2	35	23	21	22	22	365	488
Vascular extremities	54.6	22	24	50	69	113	231	509
Vascular pelvis (femoral, iliac)	57.2	12	18	65	85	101	210	491
*Dedicated sinuses	50.7	49	66	137	134	128	499	1013
Infant brain (less than one year old)	41.1	46	43	47	27	47	301	511
Vascular thorax	52.0	20	39	49	70	78	236	492