Best in Practice: A Model for Improved Radiologist-Technologist Collaboration and Image Optimization

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INTRODUCTION

The past several years have seen rapid innovation in imaging techniques, with both hardware and software changes. These changes have occurred in all modalities, including the development of multichannel CT scanners with low-radiation dose scanning protocols and reconstruction algorithms, ultrasound elastography, parallel transmit and receive MR coils, and the widespread implementation of 3-T field strengths. These imaging changes have led to increasing complexity in the performance of examinations, requiring extensive protocol optimization. At the same time, the development of digital, filmless technology has led to the formation of large, geographically divided departments whose members have limited interactions. The geographic dispersion of imaging departments has led some to advocate for a more independent, decision-making role for technologists [1,2]. However, it has been our experience that the physical separation of technologists and radiologists has led to a breakdown in the traditional team approach between them. This has been particularly true in the areas of protocol development and image optimization.

In an attempt to counteract these developments, New York University Langone Medical Center's (NYULMC) Department of Radiology implemented a program called Best in Practice (BIP) in our MRI department in the summer of 2009. In this column, we describe the operational details and initial results of this program at NYULMC.

BEST IN PRACTICE OPERATIONAL DETAILS

Goals and Planning

The NYULMC Department of Radiology implemented BIP to achieve the following goals: maximize the potential of our imaging equipment to provide best-in-class imaging for patients, develop internal technical support and protocol optimization, provide ongoing teaching and educational opportunities for all the stakeholders in our department (technologists, radiologists, and physicists), and improve the collaboration between stakeholders.

We chose to begin the program with one modality, MRI, with plans to expand to other modalities if BIP proved successful. We chose MRI as our initial modality because it has the greatest variability across our enterprise. This variability includes scanner specifications (field strength, hardware, coil availability, and software), scanning protocols, and image quality. In addition, it is one of our largest sections, with 14 scanners in 8 locations, with 35 technologists.

To develop internal technical support and lessen our dependency on our vendor for protocol optimization, we created two new positions, referred to as advanced practice specialists (APS). The APS serve as the primary applications support within the department, with vendor backup as needed. To keep their scanning skills up-to-date and relevant, our APS spend about 50% of their time scanning both clinical and research subjects, with the balance of their time spent learning and teaching.

One of our MRI lead technologists (who had previously spent much of his time working on MRI protocols and applications) was designated as the immediate supervisor of the APS. In addition, we identified one of our body imagers to serve as the APS radiologist coordinator and to work with the APS supervisor to support the APS' development and success in interweaving throughout each subspecialized radiology section and our robust research department. Finally, the department administrator actively participated in the development of the APS' role.

APS Training

Our APS technologists took 3 trips in fall 2009 to Cary, North Carolina, to attend 3 different MRI applications courses offered by our MR vendor, Siemens Medical Solutions (SMS). In addition, they were offered all of the Web-based training modules that a Siemens Clinical Education Specialist is offered. To facilitate the APS' training, SMS assigned a primary point of contact from their applications team to serve as the day-to-day support person for NYULMC in addition to a small interdisciplinary team for specific issues. Bimonthly

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conference calls with SMS were held to set training goals and make sure that the APS training schedule moved forward steadily. The calls were an important part of ensuring the success of the educational offerings and also furnished an avenue to allow APS questions to be addressed by SMS in a structured way.

Learning Plan Format

Once the APS were selected and trained, we needed to develop an operational plan to allow them to work with the radiologists to optimize our scanning protocols and to communicate this information to all of our technologists at all of our locations. Our first task was to select a radiologist in each subspecialty section who would serve as the section's liaison to the APS. The APS and the sectional liaison worked with the APS supervisor to identify areas in each section that needed improvement.

Initially, the APS made lists of all the major areas that needed attention and began to address them one by one. This became a problem, as not all issues required the same amount of effort. Although some were "quick fixes," others required hours of time and effort. We realized we had too many problems to address at once and had trouble prioritizing which problem should be addressed first. This challenge led us to form what we call "learning plans" (Figure 1). Our initial decision was to identify a problem of the month. This would allow us to concentrate on one topic for a defined period of time and to demonstrate discrete and identifiable results. Initially, both APS worked together on each topic. However, we soon realized that a more efficient method was for each APS to concentrate on one topic for a 2-month period. The first month would be devoted to understanding the problem using all of the BIP resources (scientific articles, SMS application specialists, online tutorials, basic scientists and clinical radiologists within the department). The second month would be devoted to devising solutions to the issues identified, communicating the solution to all of the MR technologists and the relevant clinical radiologists, as well as implementing the solution at all of our imaging locations.

Communicating the solution to the technologist team was accomplished in a variety of innovative manners, such as "did you know" e-mails, "clinical lessons" at the scanner, and monthly in-service presentations.

The "did you know" e-mails are one-page descriptions of a subtopic of the main topic of the month with attached relevant images. Clinical lessons at the scanner are 10- to 15-minute sessions that occur during patient scans. These sessions allow one-on-

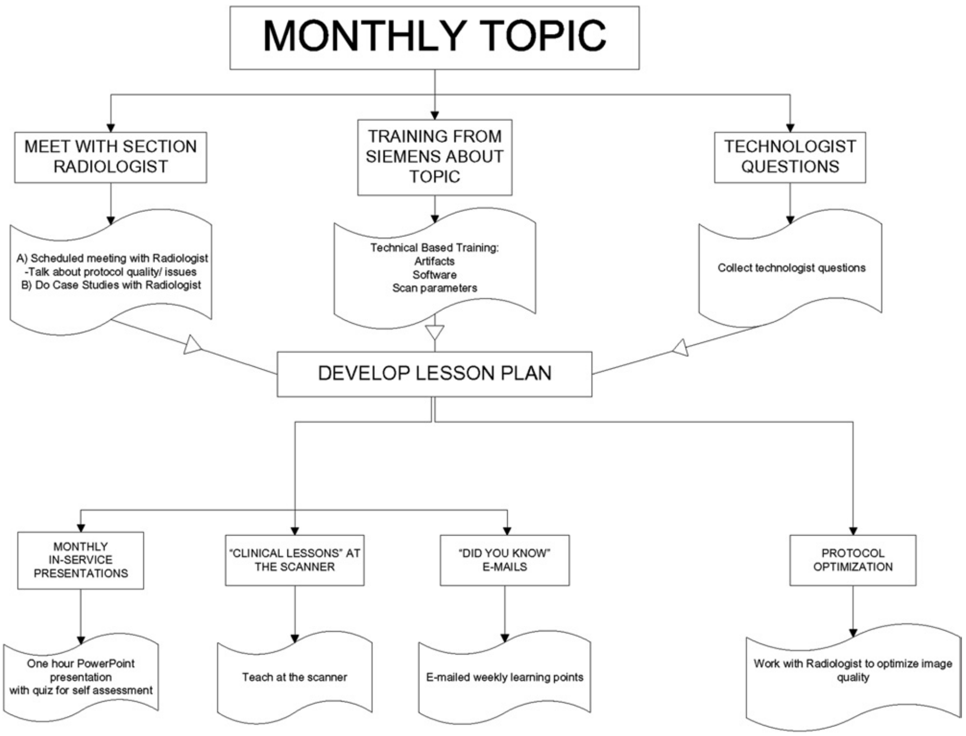

Fig 1. Example of a typical "learning plan" template. The top row activities occur in month 1 of the learning plan, with the bottom row activities occurring in month 2.

one training between an APS and individual technologists and provide opportunities for questions as well as allowing technologists to implement solutions during actual patient scans. The monthly in-service presentations last roughly 1 hour and revisit the major points of the topic as well as introducing smaller, nonessential points. In this session, a short 10 to 20-question quiz is given, which is not graded or collected but is used as a springboard for discussion and self-assessment by the technologists.

We have recently introduced monthly WebEx (Cisco Systems, San Jose, California) training into our program. These sessions cover unresolved issues within our "topic of the month" and are attended by the appropriate radiologist liaison, APS, and SMS application specialists.

BIP Educational Symposia

The formal educational aspect of the BIP program required the collaboration of all 3 stakeholder groups: radiologists, technologists, and MR physicists and basic researchers. Our first step was to assemble an organizational committee with representatives from each of these groups. The primary goal of the educational symposia seemed relatively straightforward: to provide best-in-class MRI. But what does this mean? This broad term encompasses many aspects of MRI, including patient comfort, safety, and satisfaction; the appropriate selection of examination and scanning protocols; utilization of the best sequences and technology; optimization of image quality; and accurate interpretation and diagnosis. This knowledge often tends to be segmented and presented to specialized groups. MR technologists attend conferences dedicated to the actual scanning techniques. MR physicists organize conferences studying sequence design and development, improving hardware and software, and exploring novel imaging techniques. Radiologists discuss the optimization of imaging protocols and review imaging appearances of pathology. How do you present material to these different groups in a manner that is relevant, informative, and interesting for everyone? After discussing different proposals, the committee decided on a collaborative approach to the educational material, in which a radiologist, technologist, and physicist were selected to create a team that would prepare a unified and cohesive lecture on a specific MR examination. This approach reflects one of the goals of the BIP program: to promote collaborative teamwork within the department.

More specifically, the committee decided to present an ongoing lecture series that would address different MR examinations. In our first symposium, three collaborative lectures addressed MR neurologic imaging, body MR imaging, and vascular MR imaging. In the second symposium, pediatric vascular malformations, breast MR imaging, cardiac viability MR imaging, and musculoskeletal MR imaging were presented. In each lecture, the radiologist presented the clinical background and imaging features important for making a diagnosis. The technologist discussed patient preparation and positioning and parameter optimization. The physicist reviewed the physics behind important sequences in the imaging protocol. Continuing technologist education credits were offered free of charge for any technologist who registered for the program.

INITIAL RESULTS AND OUTCOMES

Since the beginning of our program, we have completed 6 learning plans (Table 1). The APS, MR technologists, and involved radiologists all believe that imaging quality has been significantly improved by each learning plan. Our first learning plan concerned liver imaging and, in particular, addressed problems we were experiencing with breathing motion artifacts, parallel acquisition technique artifacts, and overall image quality on T2-weighted fat-suppressed images. Figure 2 demonstrates examples of improved image quality on T2-weighted fat-suppressed images after the learning plan compared with our prelearning plan images. Our second learning plan covered hip imaging and addressed coil choice, appropriate field of view, and standardization of protocols across multiple field strengths and software versions. Figure 3 demonstrates improved resolution, best demonstrated by the improved visualization of articular cartilage, that was achieved by optimized coil choice, positioning, and imaging parameters such as field of view. Similar improvements were seen after our other learning plans.

In an attempt to more objectively measure the impact of the learning plans, we have recently decided to implement prequizzes and postquizzes for the technologists. In addition, we have decided to have the involved radiologists complete a survey comparing images from before and after the learning plans. Measuring the effectiveness of our formal educational symposia has proven to be a challenge. The participation rates for MR technologists were 83% (29 of 35) and 86% (30 of 35) for the first two symposia. Interestingly, we had several technologists from other

Table 1. Monthly schedule of "learning plans"

Section	Topic	Research	Teaching
Body	Liver	February	March
Bone	Hip	March	April
Head and neck/neurologic	Neck MRI	April	May
Breast	Breast	May	June
Vascular	MRA hand	June	July
Cardiac	Thoracic aorta	July	August
Pediatrics	Vascular malformation	August	September
Neuroradiology	Brain/perfusion/SPECT	September	October
Bone	Wrist	October	November
Body	MRCP	November	December
Neuroradiology	Cervical spine	December	January

Note: MRA = MRA angiography; MRCP = MR cholangiopancreatography; SPECT = single photon-emission CT.

modalities attend the symposia, many of whom have requested that their modality be the next to be included in the BIP program. The results of evaluations filled out by technologists who attended the symposia indicated that 88% to 98% of the technologists learned new information that they could apply immediately to their daily practice, and 82% to 100% of the attendees stated that the symposia increased their knowledge of MR physics.

The attendance rates for our house staff were somewhat disappointing at 41% (26 of 64) and 34% (22 of 64). We are unsure of the reason for this relatively low turnout for house staff, a group we initially thought would be most receptive to this type of educational program. Possible reasons for the low turnout include conflicts with on-call schedules as well the perception among house staff that material covered in the symposia was also covered during regularly scheduled house staff didactic lectures. Participation rates for radiology faculty members were 46% (51 of 127) and 38% (48 of 127). Not unexpectedly, this number was decreased by the fact that sections with no involvement in MRI had minimal attendance at the symposia. We continue to experiment with finding a time convenient for all components of our target audience (technologists, house staff, staff radiologists, basic science researchers). Our MR department is open 7 days a week, so our initial programs were scheduled on Sunday mornings (a time when the fewest number of staff members were working). This allowed nearly everyone the opportunity to attend, and attendance at both programs

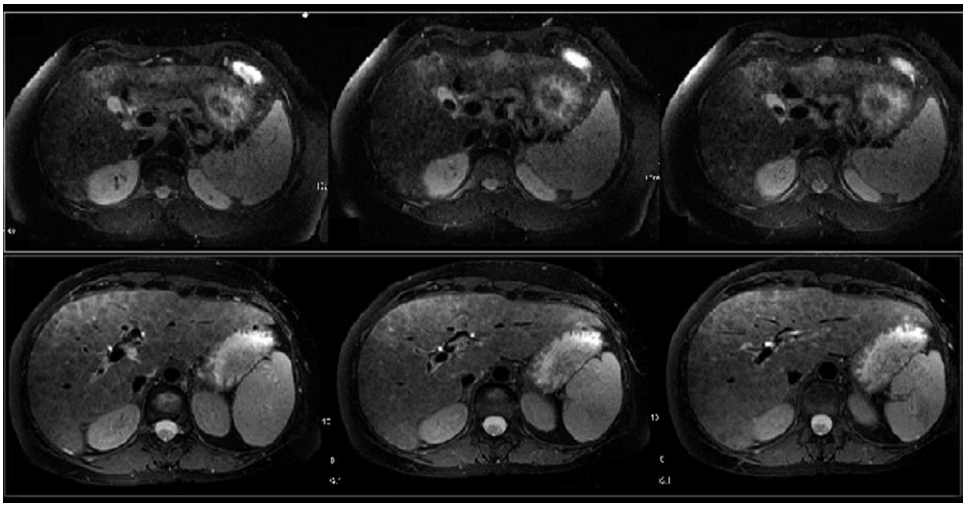

Fig 2. Examples of fat-suppressed T2-weighted images of the liver before (top row) and after (bottom row) the 2-month "learning plan." Image optimization and artifact reduction are evident in the postlearning plan images.

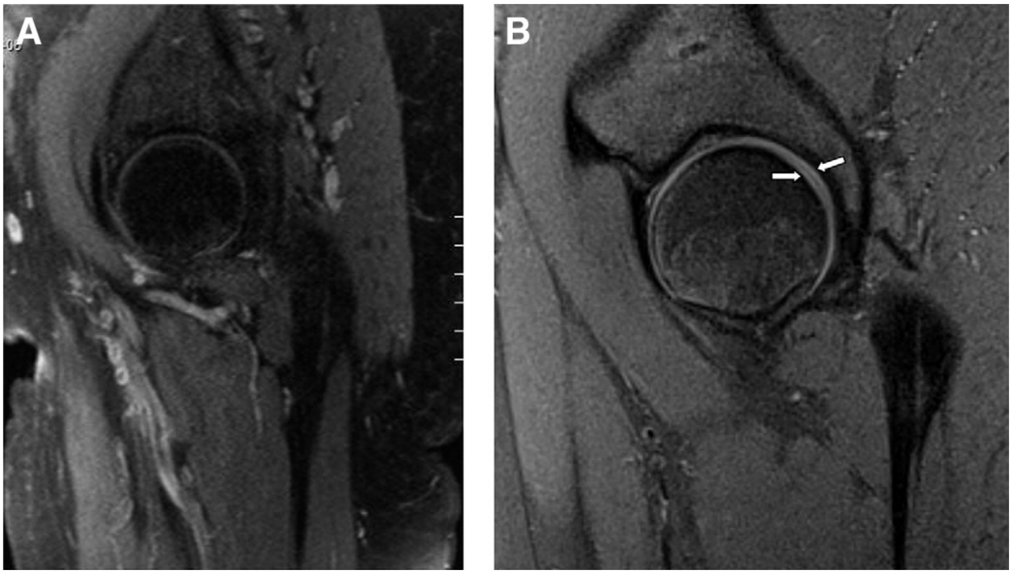

Fig 3. Hip optimization images before (A) and after (B) the "learning plan." Note the improved resolution, well demonstrated by the improved visualization of the articular cartilage of both the femoral head and acetabulum (arrows), after the hip learning plan protocol optimization.

was strong. However, the time of the programs proved unpopular, particularly among our attending staff members, because of the loss of a weekend day off. We are currently developing a new format that would include 1-hour grand rounds-type presentations 3 or 4 times per year at the end of a workday. Although this does not allow all members of the department to attend (as some are involved in clinical duties), we believe this may increase the popularity and enthusiasm for these educational symposia. We are also exploring online options for staff members who cannot attend the live symposia.

One of the major goals of the BIP program was to increase the interactions and teamwork between the key stakeholders in MRI. Although we have not been able to define a metric to demonstrate this, there is a strong consensus in the department that there has been more frequent and improved communication and collaboration between radiologists, technologists, and physicists since the BIP program began. In addition, there is a new appreciation among the stakeholders of the value of each other in creating best-in-class imaging for our patients.

CONCLUSIONS

Recent advances in imaging technology have increased the complexity of imaging procedures requiring careful protocol optimization to ensure the best imaging results. Ideally, this is accomplished through an integrated team approach between technologists, radiologists, and physicists. The ability for radiology departments to expand to geographically divided locations has decreased the contact among these 3 groups and we believe has contributed to an erosion of this team approach. We implemented the BIP program to reverse this erosion and provide a method to increase the collaboration, shared learning and integration between our MR technologists, radiologists, and physicists. Although the program is still in its early stages, we have experienced definable improvement in our MRI protocols and image quality. The program has also generated a new feeling of collaboration within the department and appreciation for the synergistic roles of different members of the department.

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