



Diagnostic Imaging and the Role of the Pharmacist

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Radiology is the area of medical practice that focuses on visualization of the interior of the human body through the use of various imaging technologies. Although this medical specialty has essentially been in existence since Wilhelm Roentgen published his work on x-rays in 1895, it is an area of practice that most pharmacists are rarely if ever exposed to during their academic training. In recent years, however, there has been increasing interest in pharmacist involvement in the radiology department, not from the perspective of the imaging modalities themselves but because of the widespread use of pharmaceuticals as adjunct agents in the acquisition of diagnostic imaging data. As the number of patients who undergo diagnostic imaging procedures increases, so does the number who are exposed to pharmaceuticals used to augment the data obtained through imaging. In some cases, as in nuclear medicine, the imaging procedure is entirely dependent on the administration of pharmaceutical agents. In other cases, as in x-ray and magnetic resonance imaging, pharmaceuticals are administered to provide various levels of contrast between the organs and vessels of the body, allowing a clearer picture of the complex anatomy being studied. Many of the pharmaceutical agents being used carry specific risks to patients; these risks must be understood, anticipated, and addressed when the drugs

are administered. In addition, like any pharmaceutical product administered to patients, these agents have the potential to create adverse reactions that should be monitored and reported.

Pharmacists' unique knowledge and understanding of drug therapy makes them the most logical providers of drug information related to diagnostic imaging. Historically, however, the role of the pharmacist in the radiology department has ranged from limited to nonexistent. As we will discuss, the control of all pharmaceuticals administered in this environment has usually fallen within the scope of medical practice of the radiologist, who ordered and administered the agents, and the use of these agents has been considered part of the imaging test rather than separate medication administration. With today's emphasis on medication therapy management (MTM) and pharmacists' expanding responsibility for providing this type of drug review, the administration of pharmaceutical agents in the radiology department should not be excluded. In some institutions pharmacists are becoming involved in the radiology department, but many pharmacists still are uncomfortable working with a class of drugs about which they generally know so little. It is our hope that this publication will assist practitioners who find their professional responsibilities expanding to include the area of radiology and radiologic pharmaceuticals.

Radiology

The four main areas of diagnostic radiology are x-ray, magnetic resonance imaging (MRI), ultrasound, and nuclear medicine. Within each of these areas are many different types of studies. For example, fluoroscopy is a type of x-ray study in which multiple x-rays are taken in rapid sequence to show movement within the body. In nuclear medicine, both single-photon emission computed tomography (SPECT) and positron emission tomography (PET) use radioactive pharmaceuticals to provide diagnostic information about various physiologic processes within the body. Each of the subspecialties is discussed in detail in the chapter on that specific imaging modality. The American College of Radiology recently estimated that more than 570 million medical imaging procedures are performed in the United States each year.¹ Adjunct pharmaceuticals play a role in many of these studies, either as essential components of the imaging study or to enhance the information obtained. In x-ray, ultrasound, and MRI imaging, the pharmaceuticals used are called

contrast agents because they enhance the contrast between various tissues, allowing better visualization of abnormalities within a field of tissues that radiographically look very similar. In nuclear medicine, the radioactive molecule being imaged is introduced into the body in the form of a radiopharmaceutical, while other nonradioactive agents are used to enhance the information obtained.

In most institutions, all aspects of the use of pharmaceuticals in radiology departments fall under the oversight of the radiology department staff rather than the pharmacy staff. Many institutional pharmacy departments have considered the administration of radiologic pharmaceuticals to fall within the radiologist's scope of practice, since most radiology-specific agents have no use outside the imaging suite. Often, oversight of the use of these agents has been passed on to the radiologic technologists who actually perform the imaging procedures, usually under a protocol reviewed and approved by the staff radiologists. Traditional pharmaceuticals that are used to enhance some imaging studies have provided the only link between many radiology departments and the in-house pharmacy department, with the pharmacy supplying these drugs to radiology in small quantities or on an as-needed basis to ensure maximum utilization of the products. This traditional arrangement has assumed that all pre-administration medication reviews and adverse drug reaction monitoring and reporting will be coordinated by the radiology staff.

The administration of pharmaceuticals in the radiology department is not without problems. As you will see in the individual chapters on the pharmaceuticals used for each imaging modality, some of these agents have the potential to cause severe and even fatal adverse reactions. In addition, these agents may be misused, as a result of variations in training, varying levels of staff experience, fatigue, increasing diversity of the patient population, increasing complexity of medical procedures and technologies, poor communication, poor reporting systems, reliance on automated systems, and increasing time constraints. In 2006, the United States Pharmacopeia Center for the Advancement of Patient Safety issued a report titled "Medication Errors in Radiological Service Areas."² Data for the report were collected over a 5-year period from 315 different radiology sites. A total of 2032 errors were identified, 56.8% of which occurred in the diagnostic radiology suite. Of these errors, 81.1% actually reached the patient, and 12% caused some level of patient harm. The report identified

several factors that contributed to these errors: limited published data on medication errors in this practice site, a lack of communication and lack of patient information being passed on to the radiology staff, and a system focused more on the imaging procedure than on the patient.

Medication Therapy Management

MTM was introduced as a result of the Medicare Prescription Drug Improvement and Modernization Act of 2003 (MMA).³ This act of Congress created several benefits that had direct applicability to pharmacy, including the Medicare Part D drug benefit and health savings accounts, and it defined the tenets of MTM. A major focus of the MMA was to ensure that Medicare patients being treated for chronic diseases with pharmaceuticals covered under Part D were using these medications appropriately to improve therapeutic outcomes and decrease the risk of adverse events. Since MMA did not explicitly define what services would be provided as part of medication review, 11 key pharmacy organizations collaborated to create and support a definition of MTM and outline the services considered to be within the scope of this type of review. This definition was approved July 27, 2004.⁴

MTM has five core elements: medication therapy review, a personal medication record, a medication-related action plan, intervention and/or referral, and documentation and follow-up.⁴ Each of these elements is discussed below.

Medication Therapy Review (MTR)

MTR is a systematic process for collecting patient information, assessing the patient's current medication therapies to determine if any medication-related problems exist, developing a prioritized list of medication-related problems, and then creating a plan to resolve the problems. The pharmacist initially performs a comprehensive review of the patient's drug therapy and then works with the patient, the primary care physician, and other health care professionals to resolve any issues that arise. In addition, targeted reviews can be performed to identify how any new drug added to the patient's regimen fits into the comprehensive MTR. If drug-specific problems arise, targeted reviews can be used to address these issues in the context of the patient's complete medication history.

Personal Medication Record (PMR)

One benefit of performing the MTR is that a PMR can be generated. The PMR is a complete record of the patient's medications, including both prescription and nonprescription or over-the-counter products, herbals, and dietary supplements. A PMR should be a dynamic, ideally electronic document that is updated each time a medication change occurs. A PMR should be written at a level that a patient would understand and should include patient-specific information (e.g., name and date of birth), contact information for each prescribing physician and the pharmacist who created the PMR, patient allergies, and medication-related issues. For each medication the patient is taking, the drug, indication, instructions for use, start date, projected stop date (if known), and any special instructions should be listed. Patients should be able to carry the PMR with them at all times and provide it to any new medical professional as a complete summary of all their pharmaceutical needs.

Medication-Related Action Plan (MAP)

The MAP is a patient-focused document that details how patients should be tracking their progress as part of a self-management program. A major goal of MTM is for patients to become an active part of the process and take partial responsibility for the success of their drug therapy. The MAP lists items for the patient to work on between health care visits.

Intervention and Referral

In this element of MTM, the pharmacist provides consultation and attempts to address any medication-related problems that were identified in the MTR. The pharmacist may need to intervene on the patient's behalf by communicating with physicians or other health care professionals and suggesting methods to address the identified problems.

Documentation and Follow-up

The pharmacist should document all services and interventions provided in the process of monitoring and evaluating patients' medication therapy. In addition, over time, thorough documentation will provide the pharmacist with a mechanism for billing for the services provided.

MTM in Radiology

A major concern with MTM in the radiology department is how to merge it with the standard dispensing and administration practices used in radiology departments for many years. This is not an insignificant problem, and it has created some issues in radiology departments as pharmacy departments have become more interested in the pharmaceuticals used in imaging procedures. Unfortunately, radiology does not fit easily into the standard MTM mold.

One issue is how radiology products fit into the MTR process. MTM is intended to be performed mainly to evaluate drug therapy for chronic diseases. For most patients, pharmaceuticals administered in a radiology department are single administrations that may or may not be repeated at some point, depending on whether the patients require additional radiology exams during their lifetime. Radiology administration records may not be readily available to the pharmacist performing MTR, and it is unlikely that a patient who reports problems with radiology-based pharmaceuticals would have enough information about the agents used to provide an adequate description of the medication-related problem.

The PMR is probably the most useful part of MTM in a radiology department, since it provides an up-to-date document that can be reviewed prior to administration of any pharmaceutical to identify potential interactions or adverse reactions to the radiologic pharmaceutical. This works well only if the person who reviews the PMR is able to interpret the information and make correlations with the drug product that the patient will be receiving in the radiology department. Many radiology technologists do not have strong training in pharmaceuticals used outside radiology departments. Although they may be familiar with radiologic pharmaceuticals, they may not be comfortable reviewing a patient's PMR and making judgments about whether the patient is a candidate for receiving the radiologic pharmaceutical. Under the scope of MTM, any *licensed* health care professional can perform this function, so it would fall to the physician in the department to provide the MTM review.

Unfortunately, the PMR does not lend itself to including single-administration pharmaceuticals. It is designed to be a summary of the patient's current drug therapy. Any single-administration dose would be on the PMR only at the time of administration and then would

immediately be removed. Including every single-administration agent on the PMR would quickly make it a very cumbersome document, limiting its usefulness. However, not having these single-administration agents on the PMR contributes to the difficulty of keeping track of adverse reactions to these agents. Although adverse reactions and major issues with a radiologic pharmaceutical could be noted on the PMR, making an addition to the patient's PMR would require accessing the original data and possibly reporting outside the institution, which would require time and effort on the part of the radiology staff. It is easy to see how minor problems could go unreported, but a minor problem can be a precursor to more severe problems with subsequent administrations.

Most radiology departments have a medication-related action plan in which the technologist gives the patient a spoken explanation of what to look for after the study or a written list of problems that would warrant a phone call to the department should they arise. Patients may not truly understand these instructions; often, patients are feeling stressed about undergoing the imaging procedure, and their instructions may go unheeded. Furthermore, given a complete list of potential side effects and adverse reactions, patients could, through the power of suggestion, believe they are experiencing these effects. Also, since many of the adverse reactions to the pharmaceuticals used in radiology are nonspecific, it would be easy to falsely identify an adverse reaction.

The Joint Commission

For most pharmacists in institutional practice, the primary impetus behind increased pharmacy department involvement in radiology is Joint Commission accreditation status. The Joint Commission requires for accreditation many areas of compliance that affect every hospital department, including radiology. In this book, we will discuss, in relation to the radiology department, Joint Commission requirements related to medication management (MM) and medication-related National Patient Safety Goals. The complexities of the MM standards are beyond the scope of this chapter, but it is important to recognize that the Joint Commission considers all contrast agents and radiopharmaceuticals as medications. The Joint Commission defines a medication as “any product designated by the FDA as a drug, as well as any sample medication, herbal remedies, vitamins, nutraceuticals, over the counter drugs, vaccines, diagnostic and contrast agents, respiratory

therapy treatments, parenteral nutrition, blood derivatives and intravenous solutions (plain, with electrolytes and/or drugs).⁵ This ensures that contrast agents and radiopharmaceuticals will have the same level of controls as other medications in the areas of prescribing, dispensing, storage, security, administration, and monitoring of adverse events.

The Joint Commission's MM standard 5.01.01 element of performance (EP) 1 requires that all medication orders or prescriptions be reviewed for appropriateness prior to dispensing. This review is to be performed by a licensed pharmacist unless a licensed independent practitioner (LIP) controls the ordering, preparation, and administration of the medication or unless the medication is urgently needed.⁵ Most radiology departments have practiced with the radiologist acting as the LIP. However, in most departments, the radiologist has passed all aspects of administration of contrast agents to the technologist staff, who work under the oversight, but not necessarily under the direct supervision, of the radiology physician. The Joint Commission believes that oversight includes the radiologist remaining with the patient during the administration process unless there has been prior review of the order by a licensed pharmacist. The American College of Radiology objected to this requirement, citing the interruption of workflow and the lack of physician and pharmacist resources to adequately carry out this requirement. In January 2007, the Joint Commission revised this standard, allowing a hospital radiology department to define the role of the LIP in the direct supervision of patients receiving contrast agents and radiopharmaceuticals. This can be done through the development of protocols or policies that clearly state the role of the LIP in direct supervision. The protocol or policy must be approved by the medical staff and must include a definition of the LIP's role in the administration process, ensuring that the LIP will be able to intervene in a timely manner in any case in which the patient experiences any type of adverse reaction due to the administration of the medications used.⁶

The American College of Radiology has issued a document titled "Practice Guidelines for the Use of Intravascular Contrast Media," which the Joint Commission recommends as a reference source for the development of protocols or policies in the area of radiology.⁷ The hospital pharmacy staff should also have input in the development of these policies and protocols. However, many pharmacists are uncomfortable providing information regarding these drug products.

Most pharmacy school curricula do not include courses emphasizing contrast agents or radiopharmaceuticals. Since pharmacy staff members lack training in this area, on-the-job training in the practice site is also limited. It generally falls to pharmacists themselves to gain more knowledge of contrast agents and radiopharmaceuticals in order to contribute to medication safety with these agents. It is our hope that this reference will help broaden and deepen the knowledge base of the practicing pharmacists who will be called on to provide this service in their institutions.

Conclusion

As you will see in the following chapters, we have approached this topic with the assumption that many pharmacists have not had this type of training as part of their pharmacy curriculum, nor have they had extensive education on the various diagnostic imaging modalities themselves. We have attempted to provide chapters that discuss in detail the various pharmaceuticals used in each of the different imaging modalities that we believed would be of greatest interest to practicing pharmacists. Furthermore, we believed that a basic understanding of the imaging modalities themselves would help pharmacists better understand the context in which the pharmaceuticals are being used. Thus, we have included an introduction to each imaging modality, followed by a chapter that discusses the specific pharmaceuticals used in that modality. We have also included some background information on ionizing radiation, used in both x-ray and nuclear medicine imaging, to provide additional detail on the risks and concerns associated with the use of radiation in imaging studies. Although this book can be no substitute for the judicious study of the package inserts of the various products, we believe it will provide pharmacists with the basic understanding they require to become more involved in and knowledgeable about this area of practice and the pharmaceuticals used therein.

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