Preauthorization of CT and MRI Examinations: Assessment of a Managed Care Preauthorization Program Based on the ACR Appropriateness Criteria® and the Royal College of Radiology Guidelines

Arye Blachar, MDa,b,c, Sigal Tal, MDb,c,d, Anat Mandelc, Ilya Novikov, PhDe, Gabriel Polliack, MDb,d, Jacob Sosna, MDf, Yehuda Freedman, MDc, Laurian Copel, MDb,c, Joshua Shemer, MD, MBAb,d,e

Purpose: To evaluate computed tomography (CT) and magnetic resonance imaging (MRI) utilization patterns before and after the implementation of a preauthorization program based on the ACR Appropriateness Criteria® and the guidelines of the Royal College of Radiologists.

Materials and Methods: All CT and MRI requests received at the preauthorization center and CT and MRI examinations actually performed were identified by our health care service’s centralized computerized database between January 1, 2000, and December 31, 2003. The obligatory preauthorization of CT and MRI requests was established for CT in September 2001 and for MRI in February 2002. All ambulatory CT and MRI examination requests sent for approval during the study period by most of our health care physicians were included in the study. The preauthorization program model is presented, and multiple parameters were evaluated from January 2000 to December 2003, before and after preauthorization was established.

Results: Before preauthorization was required, the CT and MRI utilization rates were constantly increasing by 20% and 5% per year for CT and MRI, respectively. After preauthorization was implemented, CT and MRI annual performance rates decreased from 25.9 and 7 examinations per 1,000, respectively, in 2000 to 17.3 and 5.6 examinations per 1,000, respectively, in 2003. The decreases in the utilization of MRI and CT imaging between 2001 and 2003 were 9% (12,129 compared with 11,070 MRI examinations) and 33% (81,223 compared with 57,204 CT examinations), respectively, resulting in substantial, statistically significant cost savings. The deferral rate ranged from 7.5% to 12.2% (mean = 9.8%) for CT and 13.9% to 21.4% (mean = 17%) for MRI. Deferred cases in CT were most commonly in neuroradiology, musculoskeletal radiology, and CT angiography (ranges of deferred cases 9% to 12%, 11% to 12%, and 10% to 12%, respectively). Deferred cases in MRI were most commonly in abdominal and chest radiology (ranges of deferred cases 32% to 37% and 20% to 31%, respectively). Computed tomography was more commonly utilized inappropriately by pediatric professions, and MRI was more commonly utilized inappropriately by medical subspecialty professions.

Conclusion: Preauthorization of CT and MRI requests results in a substantial decrease in utilization of these modalities with reduction in imaging costs.

Key Words: Computed tomography, MRI, preauthorization, imaging utilization

INTRODUCTION

During the past few decades, the costs of health care services have increased considerably while inherently scarce health care resources have decreased. In 1965, the United States devoted 5.9% of its gross national product to health expenditures. By 1995, this figure had risen to approximately 14%, and if current projections hold, it is estimated that expenditures will double to $2.3 trillion, or approximately 17% of the gross national product by 2007 [1]. The present situation in Israel is similar, with a significant increase in the portion of the gross national product devoted to health expenditures in the past few decades. Rationing health resources has become inevitably necessary with the rapid emergence of managed care organizations that have developed programs designed to intervene with the delivery of services, judging the appropriateness of procedures before they are performed.

Diagnostic radiology plays an important role in medical practice, providing physicians with valuable clinical information that may guide the management of their patients. Diagnostic radiologic services constitute a significant portion of health care costs, accounting for approximately 8% of health care costs paid to physicians in the United States [1]. In the past few decades, the utilization of radiologic services has increased dramatically [2,3]. This is largely due to the increased use of newer and more expensive technologies, such as computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound; the shift toward an older population; patient demand; the fear of litigation; and fee-for-service systems that encourage physicians, radiologists, and especially nonradiologists to perform more studies. Selecting the most appropriate diagnostic imaging procedure has become a complex task, with evident inappropriate utilization subjecting patients to unnecessary radiation exposure [4], expense, physical risk, emotional distress, and sometimes prolonged hospitalization.

In 1990, the guidelines of the Royal College of Radiologists (RCR) [5] were introduced in the United Kingdom to encourage the appropriate use of radiologic examinations and to reduce the use of clinically unhelpful examinations. The RCR’s guidelines set the clinical situation for requesting an examination, provide possible imaging techniques, and give a graded recommendation on whether the investigation is appropriate, with explanatory comments. The recommendations used are as follows: examination indicated (will most likely contribute to clinical diagnosis and management), examination not indicated initially (clinical problem may resolve with time, and examination should be initially deferred for 3 to 6 weeks), examination not indicated routinely (examination should not be performed unless the clinician provides cogent arguments for it), examination not indicated (the rationale for the examination is untenable), and specialized investigation (complex or expensive investigations that should be performed for physicians with relevant clinical expertise).

In 1993, the ACR formed a task force that developed the ACR Appropriateness Criteria® [6,7]. The ACR Appropriateness Criteria® are evidence-based guidelines developed to help referring physicians make the most appropriate imaging or treatment decisions. The guidelines were developed by expert panels in diagnostic imaging, interventional radiology, and radiation oncology. Each panel included leaders in radiology and other specialties. Currently, more than 170 topics and 800 variants are addressed by these criteria. Each clinical condition is discussed by its variants, and a radiologic examination or procedure is recommended using an appropriateness scale ranging from 1 (least appropriate) to 9 (most appropriate). The RCR and ACR guidelines aid with the management of clinical problems and provide an orderly sequence of studies that are most likely to provide a diagnosis.

In the past, programs requiring the preauthorization of radiology requests have received a great deal of criticism from the public as well as from physicians [8-10]. However, a vast majority of these programs were based on a paucity of clinical guidelines, were not intended to cause physician behavior modification and education, and simply created cumbersome barriers that interfered with patient care [8]. A few articles have addressed the applicability of the ACR Appropriateness Criteria® as well as the RCR’s guidelines [11-13], implying that they may be applied to general practice and may influence referrals by general practitioners. With the rising costs of radiologic services and especially the high rate of nonradiologist-performed procedures, preauthorization programs operated by radiologists seem to be a possible solution. Given the rapid advance in imaging technology, preauthorization programs run by medical management companies, insurance companies, or nonradiologist physicians may not provide an adequate solution. They may lack the professional radiologic expertise to be able to identify the preferred study, they may have professional biases, and they may be legally or morally committed to group or corporate benefits. However, we are not aware of any articles reporting large-scale preauthorization programs operated by board-certified radiologists and based on these guidelines. We present a preauthorization program for CT and MRI examinations based on the ACR and the RCR guidelines.

MATERIALS AND METHODS

Background

Macabbi Health Care Service’s is the second largest health care provider in Israel, serving more than 1.7
millions of insured people. The services are divided into 6 separate national geographic operational districts. Until September 2001, the preauthorization of CT examinations was not required, but the preauthorization of MRI examinations was performed by the districts’ chief radiologists. In September 2001, the Center for Preauthorization and Consultation of CT and MRI was established, and between September 2001 and December 2002, all districts gradually joined the preauthorization process. By February 2002 and May 2003, the preauthorization of MRI and CT examinations, respectively, was obligatory.

The Preauthorization Model

The goals of our center are to screen and assess imaging requests and reduce the utilization of imaging examinations that are noncontributory to patient treatment and thus are inappropriate clinically and to provide the most cost effective high-quality imaging method. The Center for Preauthorization and Consultation of CT and MRI is staffed by 14 experienced, board-certified radiologists, most after subspecialty fellowship training in North America and all practicing in leading radiology departments. All ambulatory (outpatient) noninterventional CT and MRI requisitions of primary care physicians and specialists of our health care service from all regions are sent by fax to the Center for Preauthorization and Consultation of CT and MRI. The imaging requests are classified into 3 groups: body imaging (abdominal and chest), neuroradiology, and musculoskeletal imaging. Radiologists with corresponding subspecialty expertise then evaluate the requests for the appropriateness of the requested examinations on the basis of the ACR Appropriateness Criteria® and the RCR’s guidelines. Because both guideline systems are credible and established, we decided to use the RCR’s guidelines in addition to the ACR Appropriateness Criteria® to maximize the guidelines available for our radiologists. In case no definite guidelines have been established, our radiologists use their clinical experience and judgment to determine the appropriateness of the imaging procedures. The actual rate of the use of the ACR Appropriateness Criteria® and the RCR’s guidelines was not recorded prospectively, and because this was a retrospective study, we cannot provide this information. However, the ACR and RCR guidelines were readily available at all times, the radiologists were instructed to use them in all applicable cases, and we believe that they were very frequently used.

The radiologists review imaging requests and have access to patients’ electronic medical files, including complete medical histories, laboratory test results, and the results of previous imaging examinations. Imaging requests may be approved or deferred or may be classified as indeterminate when additional clinical information is required or if prior imaging studies are needed for review. Referring physicians may be contacted by phone or in writing (by fax) for additional clinical information. Prior studies are delivered to our center for evaluation when necessary. In the event that referring physicians do not agree with the recommendation to defer an examination, they may talk to our radiologists, and if they remain firm in their opinion, the CT or MRI examination may still be ordered. The preauthorization center guaranteed a 48-hour response time to imaging requests throughout the study period. In case a referring physician feels that an examination should be performed immediately without delay, they can ask for an immediate approval of the request.

In some cases, radiologists might encourage the use of less costly but acceptable modalities, but in others, more expensive procedures may be recommended, if those procedures would depict suspected abnormalities and avoid the use of multiple diagnostic tests (eg, MRI of the brain for suspected multiple sclerosis instead of CT).

The Center for Preauthorization and Consultation of CT and MRI initiated a national educational program providing all practicing health care physicians of our health care service with more than 50 2-hour mandatory lecture series on the appropriate utilization of CT and MRI between May 2002 and December 2003.

Study Protocol

We used our health care service’s centralized computerized database to identify all CT and MRI requisitions received at our preauthorization center and CT and MRI examinations actually performed between January 1, 2000, and December 31, 2003. Because this was a retrospective study evaluating a preauthorization program initiated for clinical, not research, purposes, institutional review board approval was not required.

We divided our evaluation into the preintervention period (the period before the establishment of the preauthorization process) and the postintervention period. The preintervention period was determined for CT examinations as January 1, 2000, to September 1, 2001, and for MRI examinations as January 1, 2000, to February 1, 2002. The postintervention period for CT was September 1, 2001, to December 31, 2003, and for MRI February 1, 2002, to December 31, 2003. For each district, the preintervention and postintervention periods were defined according to the actual dates of recruitment into the preauthorization program.

The total number and the number per 1,000 standardized capita of CT and MRI examinations performed quarterly for our health care service during the preintervention and postintervention periods (from 2000 to 2003) were evaluated. The numbers of CT and MRI examinations performed quarterly during the preinterven-
vention and postintervention periods were also evaluated by district per 1,000 standardized capita. The distribution by gender and age of insured people in each district was also considered. To evaluate the effect of compliance on the preauthorization process, we compared the CT and MRI performance rates per 1,000 standardized capita of the most compliant and the least compliant districts. The numbers of imaging requests that were sent to our center before and after the consultation became obligatory were evaluated over time and by district. The percentage of imaging requests that were deferred was examined over time by district and by the radiologic subspecialty of the requested imaging examination (abdominal imaging, chest, breast, musculoskeletal, neurologic, and CT or magnetic resonance angiography). The imaging requests were also classified by the referring physician’s specialty into 3 subspecialties: medical subspecialties (general practice, internal medicine, and internal medicine subspecialties such as gastroenterology and cardiology), surgery subspecialties (all surgical subspecialties, such as general surgery; ear, nose, and throat; and orthopedic surgery), and pediatric subspecialties. The percentage of imaging requests that were deferred or approved was examined over time by this professional classification. We also evaluated the deferral of CT and MRI requests by clinical diagnosis in 2003.

**Statistical Analysis**

Comparison between districts was made per 1,000 standardized capita with the standardization of rates by gender and age [14]. The entire insured population of our health care service in the same period was used as a standard.

The various forms of multiple Poisson and cross-sectional time-series regressions were used to test the effects of the various factors on the rates of CT and MRI examinations. In the Poisson regression, the outcome was the number of imaging procedures in a certain subgroup in a certain period. The subgroup was defined by district, gender, age, and time period (year and month or quarter). The covariates always included gender, age group, district, and the number of members in the subgroup as an offset.

The effect of the intervention was studied by cross-sectional time-series regression. The outcome was the difference between the logarithms of the number of imaging procedures and the number of members in a subgroup in a certain time period defined by year and month. The covariates included gender, age group, district, and the indicator variable before and after the implementation of preauthorization in the district. All P values are 2 tailed. No corrections for multiple comparisons were applied. The results were considered significant at $P < .05$. All calculations were performed using SAS version 9.0 (procedures MEANS, FREQ, GENMOD, and TSCSREG; SAS Institute Inc., Cary, NC).

**RESULTS**

There was a statistically significant ($P < .0001$) 33% decrease in the total number of CT examinations performed between 2001 and 2003 from 84,709 to 57,204 examinations, with resulting substantial cost savings (Table 1). Evaluation of the quarterly CT performance rate per 1,000 during the preintervention period between January 1, 2000, and September 1, 2001 (Figure 1), showed that the rate of CT examination performance increased ($P < .001$). Between July and September 2001,

### Table 1. Total number of computed tomography (CT) and magnetic resonance imaging (MRI) examinations in Maccabi Healthcare Services from 2000 to 2003

<table>
<thead>
<tr>
<th>Year</th>
<th>MRI Examinations</th>
<th>CT Examinations</th>
<th>Total Cost*, CT and MRI (Local Currency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>10,359</td>
<td>81,223</td>
<td>67,947,537</td>
</tr>
<tr>
<td>2001</td>
<td>12,129</td>
<td>84,709</td>
<td>71,667,281</td>
</tr>
<tr>
<td>2002</td>
<td>11,815</td>
<td>76,301</td>
<td>63,474,290</td>
</tr>
<tr>
<td>2003</td>
<td>11,070</td>
<td>57,204</td>
<td>52,904,980</td>
</tr>
</tbody>
</table>

**a**Cost was defined as money paid to the providers of CT and MRI services.  
**b**The $P$ value for the difference in the cost between 2001 and 2003 was .0032 (1-way analysis of variance using quarterly data).

![Fig 1. Evaluation of the quarterly computed tomography (CT) performance rate per 1,000 standardized capita from 2000 to 2003.](image)
when discussions regarding the establishment of the Center for Preauthorization and Consultation of CT and MRI were held, there was a decrease in the CT performance rate per 1,000 in comparison with the same period in 2000 ($P < .001$). In the postintervention period, after September 2001, there was an initial stabilization followed by a decrease in the rate of CT performance in comparison with the same months of 2000. ($P < .001$; Figure 1). The decrease in CT examinations continued in 2002 in comparison with 2001 ($P < .001$), and by 2003, the number of CT examinations was lower than in 2001 ($P < .001$). Evaluation of the quarterly CT performance rate per 1,000 during the 3 years of the study, from January 1, 2000, to December 31, 2003, showed a statistically significant ($P < .0001$) decrease from 25.9 to 17.3 examinations per 1,000 (Figure 1). The number of MRI examinations performed in 2003 was 11,070, approximately 1,000 examinations (9%) fewer than in 2001, with substantial cost savings (Table 1). During the preintervention period between January 1, 2000, and January 30, 2002, the rate of MRI examination performance per 1,000 increased linearly ($P < .001$ for linear trend; Figure 2), with a maximum of 7 examinations per 1,000 in February 2002. After the establishment of obligatory preauthorization at the preauthorization center on February 1, 2002, there was a statistically significant ($P < .001$) decrease in the linear trend of MRI examination performance to 5.6 examinations per 1,000 at the end of 2003. The significant decrease in the number of MRI and CT examinations performed from 2001 to 2003 resulted in substantial, statistically significant ($P < .0032$) cost savings (Table 1).

To evaluate the effect of compliance on the preauthorization process, we compared the CT performance rate per 1,000 of the most compliant and the least compliant districts (Figure 3) and the MRI performance rate per 1,000 of the least compliant district with all other districts (Figure 4). The impact of the preauthorization was most significant in the most compliant district, the first to join the preauthorization process (the pilot-study district). In that district, there was very close cooperation of the management with the chief radiologist of the preauthorization center, and the commitment to the success of the preauthorization process was mutual. In the least compliant district, where the cooperation and commitment of the management were lower, the impact of the Center for Preauthorization and Consultation of CT and MRI was less significant initially and became significant only after preauthorization became obligatory.

Evaluation of the number of imaging requests that were sent to our center over time and by district showed that although the preauthorization center was operating nationally from July 2002, the percentage of imaging requests received at our center of all requests generated nationally in our health care services increased dramatically from 50% to nearly 80% only in May 2003, when consultation became obligatory. The implementation of the preauthorization process was approximately 5

---

**Fig 2.** Evaluation of the quarterly magnetic resonance imaging (MRI) performance rate per 1,000 standardized capita from 2000 to 2003.

**Fig 3.** Effect of compliance on the preauthorization process: comparison of computed tomography (CT) performance rate per 1,000 standardized capita of the most compliant and least compliant districts.

**Fig 4.** Effect of compliance on the preauthorization process: magnetic resonance imaging (MRI) performance rate per 1,000 standardized capita, comparison of the least compliant district with all others.
months long, and by September 2003, nearly all CT requests and all MRI requests of our health care service were being evaluated at the center for preauthorization.

The ranges of deferral rates from January 2000 to December 2003 were 7.5% to 12.2% for CT (mean = 9.8%) and 13.9% to 21.4% for MRI (mean = 17%).

The overall CT deferral rate in 2003 decreased significantly from 10% in January to 7% in December ($P < .001$ for linear trend). The overall MRI deferral rate in 2003 also decreased from 19% in January to 15% in December 2003 ($P < .001$ for linear trend). There was no significant difference in the deferral rates among the various districts. The deferral rates over time were more or less constant in all the various districts, excluding one district with a CT deferral rate of 18% in January 2003 that decreased to 9% in December 2003 and a second district with an initial 30% MRI deferral rate in January 2003 that decreased to 11% in December 2003.

In 2002, 12% of musculoskeletal, neuroradiology, and CT angiography; 9% of abdominal; and 8% of chest CT imaging requests were deferred. In the following year, the rates of deferral decreased slightly by 1% to 3%. The range of deferrals for MRI requests was 11% to 37%. The rate of deferrals for neuroradiology and musculoskeletal imaging requests was much lower than for the other subspecialities. As with CT, the deferral rate for MRI requests decreased in 2003 for all subspecialities, with the least change in MRI requests of the abdomen. The difference in deferral rate of imaging requests by the radiology subspecialty of the requested imaging examination (Table 2) was significant for CT examinations (maximum 12% for musculoskeletal, minimum 7.6% for breast; $P < .001$) as well as for MRI (maximum 31.5% for abdominal imaging, minimum 14.7% for neuroradiology imaging; $P < .001$).

Differences in deferral rates by the subspeciality of the referring physician (Table 3) were statistically significant. For CT, the highest deferral rate was for pediatricians (13%), and the lowest was for the surgical professions (7.5%) ($P < .001$). For MRI, the highest deferral rate was for the medical subspecialty professions (17.5%) and the lowest for pediatricians (11.2%) ($P < .001$).

Evaluation of deferral rates by diagnosis showed that the highest CT deferral rate was 18.1% for neck pain, and the lowest was 5% for back pain and sciatic pain ($P < .001$). For MRI, the highest deferral rate was for abdominal pain (49%), and the lowest was for dizziness (17%) ($P < .01$).

**DISCUSSION**

The past few decades have been characterized by a constant rise in health care costs in Western, developed countries [15]. In Israel, 7.3% of the gross domestic product was spent on health care in 1970, compared with 8.8% in 2002 [16].

The increase in health care expenditures stems partially from the development and diffusion of new, expensive medical technologies, including the introduction and development of CT and MRI. During the past 2 decades, there has been a surge in the availability of CT

<table>
<thead>
<tr>
<th>Referring Physician Specialty</th>
<th>Computed Tomography</th>
<th>Magnetic Resonance Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>Internal medicine</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td>Surgery</td>
<td>9%</td>
<td>8%</td>
</tr>
<tr>
<td>Pediatric</td>
<td>13%</td>
<td>12%</td>
</tr>
</tbody>
</table>
and MRI in most member countries of the Organisation for Economic Co-operation and Development. The first MRI scanner was installed in the United States in the early 1980s. By 1985, 300 MRI scanners had been installed, and by 2000, more than 2,200 MRI scanners had been installed in the United States [17,18]. With the technologic progress, improvement in imaging quality, and increasing availability, there has been a tremendous increase in the utilization of CT and MRI.

Recent advances in diagnostic radiology, especially the development of multidetector CT scanners and high-quality MRI scanners, have resulted in the replacement of old technologies and examinations by these newer and more sophisticated ones. For the appropriate use of imaging modalities, physicians are now required to have vast knowledge in imaging utilization. Unfortunately, not all clinicians keep up-to-date with this “imaging revolution,” and redundant ordering or the selection of lower yield studies in the diagnosis of specific clinical conditions is not uncommon [4,8]. It has been shown that there is wide variability in test-ordering behavior among physicians, depending partly on education but also on personality, specialization, time elapsed between graduation and present age, estimated test charges, the expectations of patients, and other patient-dependent factors [19]. Some doctors consume substantially more imaging resources than others apparently doing the same type of work, using imaging examinations inappropriately, failing to appreciate the financial cost to the health care system and the needless risk for contrast reactions, radiation exposure, and further invasive procedures to their patients when false-positive results occurs. Furthermore, it has been demonstrated that no substantial consensus exists among doctors even about the appropriate use of common radiographic procedures, let alone sophisticated cross-sectional imaging procedures [20]. Much of the inappropriate use of diagnostic imaging tests is said to be caused by defensive medical practice because of the fear that failure to perform imaging may lead to future claims of negligence by patients or their families. However, with patients’ increasing awareness of radiation exposure, there is a concern that a claim for negligence may actually result from excessive and needless imaging utilization.

There is a clear need for a mechanism to control utilization and the subsequent costs of inappropriate or marginally effective imaging examinations [4,8, 20-22]. It has been shown that explicit guidelines improve clinical practice [23-26]. Grimshaw and Russell [23] examined 59 papers evaluating clinical guidelines and showed that all but 4 detected significant improvements in the process of care after the introduction of guidelines, and 9 of 11 papers that assessed the outcomes of care reported significant improvements. However, the implementation of practice guidelines is difficult with multiple administrative, educational, patient-centered, and economic barriers and may have only a short-term effect unless embedded in a broader program that addresses the need for the translation and implementation of the guidelines with incentives operating at local levels [27]. We believe that a preauthorization program staffed by experienced radiologists with subspecialty training that is based on explicit and acceptable guidelines may provide the solution.

Preauthorization programs introduced initially may have been incorrectly implemented, lacked good clinical guidelines (such as the ACR Appropriateness Criteria®), and have not produced lasting modifications of physicians’ behavior [28-30]. With the emergence of credible guidelines such as the ACR Appropriateness Criteria® and the RCR’s guidelines, preauthorization of CT and MRI examinations is possible and may lead to greater efficiency in patient management, reductions in radiation exposure and in the rate of referral (self-referral in particular), and thus to a reduction of the global cost of services [1,9,14, 19-21, 25-27].

It has been shown that preauthorization may be valuable if it is used as an educational tool providing clinicians with information regarding best medical practice and guidelines [18, 31-33]. It has also been shown that direct contact, verbal or written, between clinicians and radiologists has a measurable benefit for patient care [34] and can facilitate obtaining the appropriate study.

Our preauthorization model is primarily a behavior modification program intended to create an educational interface with our clinicians. Before the implementation of the program, a series of lectures on appropriate imaging guidelines were given, and the issue of the preauthorization of CT and MRI was debated openly to decrease resistance and to gain the trust of clinicians. Our preauthorization center encroaches on physicians’ privilege to make unimpeded diagnostic decisions, although after a consultation is performed, the choice to eventually perform an examination is left in the hands of the physician. However, the preauthorization center benefits physicians by providing a rapidly available online consultation regarding the best imaging modality to be performed. Unfortunately, we did not record the number of consultations during the study period, but we noticed, subjectively, a trend of increasing use of this option with time.

Preauthorization needs to be obligatory, and cooperation with referring physicians and especially with local management is essential for its success. The most compliant district in our study reached more than 80% compliance even before preauthorization was obligatory and 100% compliance much sooner than the least compliant district.

The preauthorization program resulted in a statisti-
cally significant decrease in the number of CT and MRI examinations performed, with significant cost savings as well as the probable prevention of unjustified patient radiation exposure. There was a 33% decrease in the total number of CT examinations, and the number of CT examinations per 1,000 decreased from 25.9 to 17.3. The decrease in the total number of MRI examinations performed was 8.5%, but this was especially significant given that the preauthorization of MRI requests was obligatory and performed by the districts’ chief radiologists even before the preauthorization center was established. This finding also emphasizes the impact of the preauthorization center’s highly trained radiologists using the ACR and RCR guidelines, as opposed to the districts’ chief radiologists working with no guidelines. We chose to present the decrease in the number of examinations, not the actual cost savings, because there is significant variability in the price of both CT and MRI examinations among various countries.

The deferral rates for both CT and MRI examinations were much lower than the actual decreases in the numbers of examinations. This may be explained by the “gatekeeper” effect. Knowing that ordering CT and MRI was monitored and not automatically approved made referring physicians consider the clinical question more thoroughly, sending only those examinations that were thought to be appropriate.

After implementing the preauthorization program, there was an initial increase followed by a slight decrease in deferral rates, reaching a plateau after 3 months for CT examinations and after 6 months for MRI examinations. We think that this finding reflects the impact of the preauthorization center and demonstrates a change in the ordering behavior of referring physicians. We assume that the consistent verbal and written contact with referring physicians had an educational effect, resulting gradually in the better utilization of these modalities.

Evaluation of deferral rates by radiology subspecialty revealed that CT was inappropriately utilized more in patients evaluated with CT angiography (ordering CT angiography for incorrect indications instead of CT scans) and in patients evaluated for neuroradiology and musculoskeletal problems. The utilization of MRI by our health care physicians was more commonly inappropriate than that of CT imaging. The deferral rates for MRI were constantly higher than those for CT imaging. Magnetic resonance imaging was inappropriately utilized, especially for abdominal and chest problems and for magnetic resonance angiography. Evaluation of deferral rates by specific diagnoses showed that the highest deferral rates were for neck pain, dizziness, and vertigo for CT and for abdominal pain and headache for MRI. These findings may suggest focusing educational programs for referring physicians on CT and MRI utilization of these anatomic regions and specific clinical diagnoses.

Evaluation of deferral rates by the profession of the referring physician showed that CT was more commonly utilized inappropriately by pediatric professions, and MRI was more commonly utilized inappropriately by medical subspecialty professions. Given the increased risk for radiation-induced malignancies in children and this finding, the preauthorization center serves an important task.

Because this was an observational study, there were no changes in the process of implementation of the center to simplify the subsequent statistical analysis. The estimation of a causal effect of an intervention using just observational data is a difficult problem [35]. The study was an ecologic study in which the groups (districts) of individuals (our health care system members) were subject to an intervention, the obligatory preauthorization of CT and MRI requests. Observational studies such as our study are usually considered to be subject to various types of bias (ecologic and cross level bias, temporal ambiguity, migration across groups, problems of confounder control, etc.), thus giving little evidence for causal inferences [36]. To overcome these biases in our study, we used the internal comparison between districts that joined the consulting center at different times. These comparisons showed that the number of CT examinations was reduced substantially when a district joined the center, in comparison with the other districts that were not included in the preauthorization program at that time. We therefore concluded that the implementation of the preauthorization process led to a substantial decrease in the rates of performance of CT and MRI examinations.

There are a few limitations to our study. First, this was a retrospective study, and it was therefore difficult to isolate and differentiate the educational impact of the study from the gatekeeper effect. We did not evaluate the outcomes of patients who had CT or MRI examination requests deferred. This is the main purpose of another study that we are presently conducting. However, our radiologists evaluating the requests at the preauthorization center are instructed to engage in telephone debates with referring physicians who insist on performing studies that were requested and initially deferred and to leave the final decisions in cases of disagreement in the hands of the referring physicians. Although the rate and the fate of telephone debates were not quantified, we believe that the referring physicians are usually requested and initially deferred and leave the final decisions in cases of disagreement in the hands of the referring physicians. Although the rate and the fate of telephone debates were not quantified, we believe that patients who truly need imaging studies will usually have the studies done, even after initial deferrals. Unfortunately, because this was a very large retrospective study evaluating tens of thousands of imaging requests, we cannot provide the exact number of requests that were deferred or approved specifically using the ACR or RCR guidelines. However, both the ACR and RCR guidelines
were individually available to our radiologists during the preauthorization process, and all of our radiologists underwent training that familiarized them with these guidelines at the time of their recruitment to our program.

In conclusion, with the increasingly expensive and sometimes inefficient utilization of CT and MRI, a preauthorization program based on credible guidelines such as the ACR Appropriateness Criteria® and the RCR’s guidelines may enable more appropriate utilization of these modalities, improved patient management, and reductions in imaging costs.

REFERENCES