Appropriateness and Imaging Utilization:

"Computerized Provider Order Entry and Decision Support"

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Modern imaging methods have been transformative in improving medical care. Cross-sectional imaging has largely eliminated the need for invasive "exploratory" surgery and is widely used to triage acutely ill patients. However, how to best use medical imaging with ongoing concerns related to overall costs and radiation risks remains controversial. Imaging saves lives, but overuse of imaging can add unnecessary costs to the health system and add to the radiation burden of the population. In this article, the American College of Radiology Appropriateness Criteria (ACRAC) are reviewed, while the Massachusetts General Hospital experience with a computerized physician (provider) order entry system and other approaches to utilization management are discussed. There are strong evidence-based indicators of appropriateness for a substantial percentage of common imaging applications and where this is the case, decision support systems based on ACRAC or other criteria can and should be used. Standardize health care delivery and elimination of wasteful practice variation can be achieved without the art of medicine being ignored or devalued.

Key Words: Appropriateness criteria; utilization; computerized physician order entry (CPOE).

Modern imaging methods have been transformative in improving medical care. Cross-sectional imaging with magnetic resonance imaging (MRI) and computed tomography (CT) has largely eliminated the need for invasive "exploratory" surgery and is widely used to triage acutely ill patients with resultant measurable positive impacts on morbidity, mortality, and costs (1–3). The introduction of breast cancer screening with mammography has been associated with reduced mortality from breast cancer. Imaging is now the guiding hand of medical practice in innumerable settings. Nonetheless, controversy still reigns over the correct utilization of medical imaging with ongoing concerns related, most importantly, to overall costs and radiation risks.

Finding the correct balance between the rising use of medical imaging and its costs and risks is a central question facing the health system at a policy level but also facing providers on a day-to-day patient-by-patient level. In short, imaging saves lives, but overuse of imaging can add unnecessary costs to the health system and add to the radiation burden of the population.

Four questions appear fundamental to achieving an ideal balance in imaging utilization and should be addressed before any imaging examination is undertaken. 1) Does this patient need an imaging examination in the first place? More specifically, is an imaging examination likely to generate medical information of value in caring for the patient? If the answer to the first question is negative, the additional considerations about imaging are moot. 2) If an imaging examination is felt indicated, exactly what should the examination be? 3) How should the examination be performed—what are the best modality and the best protocol?. And 4) Can the proposed imaging evaluation be performed with less ionizing radiation or no ionizing radiation? An additional important consideration is how to create practical approaches to addressing these questions that fit into and mesh with the work process or work flow of physicians and other providers that are neither disruptive to doctor–patient relationships nor excessively time consuming.

AMERICAN COLLEGE OF RADIOLOGY APPROPRIATENESS CRITERIA (ACRAC)

All the four key questions come back to the central concept of establishing criteria that address the relative appropriateness of use of imaging methods in different clinical settings. The ACRAC developed over the last 20 years define this linkage (4,5). The ACRAC are based on clinical scenarios of disease presentation where literature evidence and expert opinion are used to determine how likely it is that a particular imaging examination will yield medically meaningful information for a given indication or set of indications. The ACRAC use a scoring or scaling system from 1 (low

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likelihood of providing useful information) to 9 (high likelihood of providing useful information).

A more complete description and listing of the ACRAC are available on the ACR Web site. In brief, there are now ACRAC available for diagnostic, interventional, and radiation oncology topics. For diagnostic imaging, there are 197 topics, or clinical presentation scenarios, with over 900 variants (6). Each scenario variant has been assigned both an appropriateness score and an indication of the relative amount of radiation associated with the examination. The ACRAC are updated on an ongoing basis. There are expert teams for each part of the body that include radiologists and nonradiologists.

COMPUTERIZED PHYSICIAN ORDER ENTRY

The emerging standard for implementing the practical use of the ACRAC is the adoption of computer-based "decision support" (DS) systems either as stand-alone systems or integrated with "computerized physician order entry" (CPOE) systems. The DS systems typically run on hospital information technology platforms allowing physicians to readily access DS data in the normal course of caring for patients (7,8). In a typical case, once the provider has determined that an imaging examination might be indicated, he or she selects a proposed examination from a list of examinations for the respective body part and then the reason or reasons for doing it, such as headache for head CT (Figs 1, 2). The computer-based DS system then matches this combination of imaging examination and indication against a table containing all possible combinations of examinations and reasons for doing them and returns an appropriateness score (Fig 3). It is important to note that DS results are important data points, but it is still up to each institution or practice group to determine how to proceed after the score comes back. At the Massachusetts General Hospital (MGH), scores of 7–9 are considered to indicate a high likelihood of utility and providers can proceed on to order the test. Scores of 4–6 are considered to be in a marginal range where a provider's knowledge of the patient and assessment of intangibles are especially important. The provider is expected to consider this and use discretion (7).

Sores of 1–3 are considered to generally indicate a low likelihood of utility. The provider is asked to reconsider ordering the test but may continue if he or she feels that special circumstances apply that are beyond the ordinary scope of the appropriateness criteria. For example, there may be factors related to unusual physical findings, family history, or even a patient's psychological state (7).

The MGH philosophy toward DS is that however powerful and useful computer DS systems may be, in the end, they should not interfere with the doctor–patient relationship or trump the physician's best judgment. It is simply impossible to write enough rules to cover every variation or nuance to reduce the practice of medicine completely to a set of computerized rules. The importance and significance of the way a patient looks subjectively, the timbre of a patient's voice or the changing strength of a handclasp from one point in time to another can neither be fully addressed in a computer rule nor even be communicated well between people but can be pivotal in a physician's thinking about a patient.

Rather than interceding in individual cases during the active care process, the utilization performance of physicians is tracked over time at MGH. Simple metrics such as imaging utilization per patient visit and average appropriateness scores adjusted for practice setting help identify outliers who can then be engaged educationally. The medical leadership of the Massachusetts Hospital Physicians' Organization is actively involved in reviewing physician performance data and working with physicians to achieve reasonable utilization.

A unique feature of the MGH DS system is that it provides a utility score not only for the requested examination and reason for doing it but also for other protocols and other imaging modalities aimed at the same clinical problem. This addresses the issues of the best protocol and whether an examination can be performed with lower radiation or no radiation. For example, whenever a head CT with contrast is proposed, the DS system also provides a score for CT without contrast and MRI both with and without contrast. For body imaging, a request for a CT is often returned with a score for ultrasound as an alternative. This is very valuable to referring physicians who are challenged to stay current on the nuances of the hundreds of different imaging examinations and their variants.

For some scenarios, providers are asked for additional or more detailed information. In the case of CT or MRI for headache, providers are asked to specify what the nature of the headache is. A simple long-standing headache is a lower yield indication by far than a thunder clap headache, the worst of a patient's life, associated with a neurologic finding.

Likewise, to take advantage of integrating diagnostic knowledge across disciplines, DS systems can provide different scores depending on how much other information from other methods has been obtained. A comparatively low cost D-dimer test can effectively rule out pulmonary embolism. In the MGH DS system, a request for a pulmonary CT for suspected pulmonary embolism will receive a low utility score if there is no information on D-dimer or if the test is normal. The same request with notation that a D-dimer test was abnormal would receive a high utility score.

The use of computer-based DS systems also offers the opportunity to add many additional kinds of value to the test ordering process that can help the referring physician. In the MGH system, there is an associated search tool that automatically retrieves information on allergies and renal function studies when contrast media use is being considered, saving providers the considerable effort of going through the patient's medical record. The system calculates an estimated glomerular filtration rate. Another useful feature to help reduce unnecessary duplicate procedures alerts the ordering provider if the same or a similar test has been done recently or has been scheduled to be performed. Safety alerts are added especially for MRI to flag issues such as implanted devices for