The Role of Radiology in the Diagnostic Process: Information, Communication, and Teamwork

**Objective.** The diagnostic radiology process represents a partnership between clinical and radiology teams. As such, breakdowns in interpersonal interactions and communication can result in patient harm.

**Conclusion.** We explore the role of radiology in the diagnostic process, focusing on key concepts of information and communication, as well as key interpersonal interactions of teamwork, collaboration, and collegiality, all based on trust. We propose 10 principles to facilitate effective information flow in the diagnostic process.

Diagnostic radiology is unique in that it is one of three disciplines, along with anatomic pathology and laboratory medicine, focused almost exclusively on diagnosis rather than on treatment [1]. Unlike anatomic pathology, radiology typically informs the diagnostic process early in the patient’s treatment course and on multiple occasions thereafter. Unlike laboratory medicine, images are accompanied by an interpretation that is highly dependent on the skill of the radiologist.

With its focus on diagnosis, the diagnostic radiology process represents a partnership between the clinical and radiology teams. In such an environment, breakdowns in interpersonal interactions and communication can result in patient harm [2].

In this article, we explore the role of radiology in the diagnostic process, focusing on key concepts of information and communication, as well as key interpersonal interactions of teamwork, collaboration, and collegiality and how they contribute to the effectiveness of the specialty.

**The Diagnostic Process**

The clinical process can be divided into two major parts: diagnosis and treatment. The diagnostic process helps the clinical team understand the cause of the patient’s signs and symptoms, which then informs the best course of treatment [3].

In a 2015 report, the Institute of Medicine outlined the diagnostic process, as shown in Figure 1 [1]. According to this model, after the patient engages with the health care system, the diagnostic process enters a phase of iterative information gathering and interpretation, followed by integration of the information into a working diagnosis, which is refined as additional information becomes available. Once sufficient information has been collected, the process can move to treatment. At that point, the clinical team ascertains the patient’s realistic health outcome goals and works with the patient to determine the most appropriate treatment given the working diagnosis and likely outcomes of available treatment strategies.

The diagnostic process resembles the scientific method in that it is hypothesis driven; the working diagnosis is updated and refined as additional information becomes available [4, 5]. The working diagnosis often is composed of a differential diagnosis rather than a single diagnosis, with possible diagnoses ordered in some logical fashion, such as by likelihood of the presence of the diagnosis and the potential negative effect if the disorder is incorrectly diagnosed and treated [1, 6]. Normal or self-limited conditions may be included in the differential diagnosis.

To highlight the role of diagnostic radiology, we present an alternative depiction of the diagnostic process in Figure 2. In this representation, the clinical team starts with initial information-gathering activities, including a medical history, physical examination, and vital signs, which leads to an initial working diagnosis. We refer to the initially gathered information that leads to the initial
working diagnosis as the “clinical scenario.” The process then moves to additional information-gathering activities, if necessary, and then to communication with and treatment of the patient. Additional information-gathering activities are undertaken only as long as the likely benefit of the new information, which is primarily the decreased likelihood of misdiagnosis, outweighs the risks and costs of the information-gathering activities. Rather than depicting communication of the diagnosis with the patient as a step in the diagnostic process, we illustrate that frequent communication with the patient occurs in the background throughout the diagnostic process. We also depict the process loop in which the diagnostic process may move back into the information-gathering phase depending on how well the desired outcomes are achieved or depending on whether follow-up evaluation is required.

The culmination of the diagnostic process is the treatment decision. A decision can be defined as an irrevocable allocation of resources toward a course of action. Note that choosing not to act usually represents one decision alternative, because it allocates the resource of time.

The Role of Diagnostic Radiology

The diagnostic radiology process represents an information-gathering, interpretation, and integration activity embedded in the overall diagnostic process. Diagnostic radiology is composed of image acquisition and interpretation, which corresponds to both a diagnostic test and a referral for consultation (Fig. 1).

Figure 3 illustrates the role of radiology in the diagnostic process. By requesting a diagnostic imaging examination, the clinical team calls on the radiology process to answer a clinical question. Specifically, the clinical team requests information that it expects will further refine the working diagnosis to enable the team to move closer toward
making a treatment decision [9]. Given the existing working diagnosis, the clinical team may be seeking to increase confidence that a suspected disease is present (confirmation or rule in), increase confidence that a suspected disease is absent (elimination or rule out), or better characterize the extent or course of a known disease process [10].

Table 1 identifies seven key activities in the clinical process in the context of diagnostic imaging. Figure 3 illustrates how these questions fit into the diagnostic process. These diagnostic activities require clinical skill, as well as clinical guidelines, care pathways, and decision algorithms (Fig. 3). Such decision aids are based on individual and collective experience, as well as relevant published evidence [11]. Decision rules tend to be more easily applied to clinical scenarios that are encountered on a routine basis than to rare diseases or unusual presentations [12]. In addition, patients are involved to varying degrees at different points in the diagnostic process (Table 1).

The first activity, the initial assessment, represents the generation of an initial working diagnosis—usually a differential diagnosis—on the basis of the initial clinical information.

Second, after the initial working diagnosis is developed, the clinical team decides whether imaging is appropriate in the given clinical scenario, according to how likely imaging is to change the diagnosis in a meaningful way [13]. Appropriateness of imaging may also be influenced by contextual factors, such as the availability of imaging modalities or access to additional data sources, such as additional history, observational data, and laboratory data. Determination of appropriateness is typically conducted primarily by the clinical team, though the decision often depends on input from the radiology team or from decision rules that were created with input from radiologists, such as the American College of Radiology’s Appropriateness Criteria [14].

The third activity involves selecting the correct imaging modality and protocol on the basis of the clinical scenario. Although the clinical team’s request typically specifies the modality, the radiology team typically reviews the request, making recommendations for modifications as appropriate, and selects the specific imaging protocol.

The fourth activity is the interpretation of the images. The radiologist creates a radiology report that includes a summary of the findings and their likely implications given the clinical

**TABLE 1: Key Questions in the Diagnostic Process, Especially as Related to Diagnostic Imaging, Including Level and Nature of Patient Involvement**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Question or Decision</th>
<th>Responsible Team</th>
<th>Patient Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial assessment</strong></td>
<td>What is the differential diagnosis according to the initial clinical information?</td>
<td>Clinical team</td>
<td>High: History, physical examination, discussion regarding working diagnosis</td>
</tr>
<tr>
<td><strong>Imaging appropriateness determination</strong></td>
<td>How is imaging likely to change the working diagnosis?</td>
<td>Clinical team with input from radiology team</td>
<td>Medium: Discussion regarding appropriateness of imaging, patient-specific questions and concerns</td>
</tr>
<tr>
<td><strong>Modality and protocol selection</strong></td>
<td>Which imaging modality should be used? Specifically, how should it be performed?</td>
<td>Radiology team with input from clinical team</td>
<td>Medium: Image-specific questions, such as scheduling, contrast agent allergies, pregnancy status, patient identification, and so forth</td>
</tr>
<tr>
<td><strong>Interpretation</strong></td>
<td>What are the implications of the imaging findings, given the clinical scenario?</td>
<td>Radiology team</td>
<td>Low: Patient’s perspective of clinical scenario, question to be answered</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>On the basis of the interpretation, what is the new working diagnosis?</td>
<td>Clinical team with input from radiology team</td>
<td>Medium: Ongoing dialogue regarding revised working diagnosis</td>
</tr>
<tr>
<td><strong>Goal alignment</strong></td>
<td>What are the patient’s realistic health outcome goals?</td>
<td>Patient and clinical team</td>
<td>High: Understanding patient’s perspective in clinical context</td>
</tr>
<tr>
<td><strong>Treatment determination</strong></td>
<td>On the basis of the working diagnosis, what treatment would best achieve the desired outcomes?</td>
<td>Clinical team with input from and consent of patient</td>
<td>High: Alignment of patient goals with treatment strategies, understanding of treatment goals, expectations for follow-up</td>
</tr>
</tbody>
</table>
scenario. New techniques in machine learning may help automate this process [15], but for now, because of the considerable expertise required, image interpretation is almost completely based on radiologists’ skill and knowledge of the relevant medical literature.

Fifth, the interpretation must be integrated into the working diagnosis. In some cases, the diagnosis may be evident from the images alone, but appropriate integration of new information into the working diagnosis often requires specific knowledge of the clinical context.

Sixth, as the differential diagnosis is refined, the clinical team updates the patient and family members regarding the current level of understanding. Throughout the diagnostic process, and especially when the diagnostic process is complete, the clinician consults with the patient to determine how the available treatment options align with his or her realistic health care goals.

The seventh activity is the treatment decision, in which the clinical team and the patient consult together to determine which treatment is most appropriate given the working diagnosis, the patient’s goals, and the team’s estimation of the likely outcomes of different treatment options.

Note that, in some of these activities, the decision is driven by the anticipated results of the step. For example, the likely effect of the imaging procedure on the working diagnosis informs the decision about whether and how to perform the imaging procedure (Fig. 3). Similarly, the decision about which treatment to use is based on the anticipated outcome of the treatment strategies under consideration (Fig. 3). The dependence of optimal decision making on possible outcomes is one of the fundamental tenets of decision analysis [16].

Because the successful execution of the diagnostic process involves information-intensive activities of answering questions and making decisions by multiple parties, it is important that those involved in the process understand fundamental concepts of information and communication and their application to this context.

**Information and Communication**

Information can be described as a mathematical reduction in uncertainty [17]. This uncertainty is inherent in a differential diagnosis, which represents possible disease states with associated probabilities. When uncertainty is high, additional information is sought to reduce that uncertainty. Communication can be defined as the exchange of information between multiple parties to change understanding [18]. Several characteristics of information and communication are specifically relevant to our discussion.

Undesired changes often occur during communication as a result of information being lost, distorted, or obscured. For this reason, modern electronic communication systems contain processes to confirm the accurate receipt of information and to compensate for information losses [19]. Oral and written communication are also subject to information losses, requiring analogous strategies to recognize and correct communication errors [20].

In the health care setting, information only has value, or meaning, when it affects a decision [7]. “How is this test likely to change clinical management?” is a legitimate question when considering spending resources on information-gathering activities such as imaging.

Furthermore, information does not simply exist so much as it is possessed; information that is not in the possession of the decision maker at the time of the decision has no more
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value than if it did not exist at all [21]. Information loses its value over time when uninformed or underinformed decisions are made.

The costs associated with acquiring, verifying, clarifying, searching, processing, storing, and transmitting information are often underappreciated [22]. Information management costs may be explicit, such as those of maintaining electronic information systems, or implicit, such as increased cognitive load or demands on an individual’s time and attention [23]. These implicit costs may not be readily apparent to an external party.

For example, individuals who have viewed one of Martin Handford’s “Where’s Waldo” illustrations can appreciate the cognitive burden of sifting through visual clutter. This burden decreases significantly once the viewer discovers Waldo’s location [24]; a viewer who already knows the location of the visual target cannot objectively appreciate the cost of the clutter. Similarly, text buried in a long report or in a large medical record can be costly to retrieve, though an individual who knows exactly where to find the information may not recognize the cost of retrieval by another individual who does not know where to find it.

In a multiparty environment, costs associated with information may not be borne by the same entity that reaps the benefits. For example, refining and organizing information before transmitting it may be beneficial to the receiving party but costly to the sending party. Because of these hidden costs and misaligned incentives, such a scenario is highly prone to ineffective communication, especially when the sending party but costly to the sending party. Because of these hidden costs and misaligned incentives, such a scenario is highly prone to ineffective communication, especially when the parties are not bound by strong interpersonal relationships or other enforcement mechanisms.

**Practical Implications**

As shown in Figure 3, some of the described activities are performed exclusively by the clinical team, some are performed exclusively by the radiology team, and some are shared. This shared responsibility implies that the clinical and radiology teams must work well together in two ways: For activities performed exclusively by one team, the team must consistently provide information to the other team in a form that supports their activities. For shared activities, the teams must develop processes, systems, and behaviors that enable them to interact effectively.

**Consistently Providing Relevant Information**

To answer questions and make decisions, both the clinical and radiology teams need relevant information from each other. The radiology team needs a basic understanding of the clinical scenario to help determine whether imaging is appropriate, which imaging modality and protocol should be used, the implications of the imaging findings, and how the interpretation may affect the working diagnosis. Conversely, the clinical team needs to know the imaging findings and their potential implications on treatment decisions.

To help the recipient better understand the context of the information provided, when information is passed from one entity to another, it should contain a brief statement that includes both the information and relevant supporting evidence. For example, a request for imaging from the clinical team should include a brief statement of any relevant medical history, salient findings of the history of the present illness and physical examination, the working diagnosis, and any specific clinical questions. This can usually be distilled to a simple one-line note [25]. For example, at our institution, our emergency clinicians have adopted the term “what-when-where-concern for” (or “WWW-C”) to remind referring clinicians of the relevant elements of an appropriate history. Information supplied by the clinician may be complemented by information supplied by the patient [25]. Examples of statements that meet and do not meet these criteria are listed in Table 2.

In turn, radiologists should provide information to clinicians in a report that succinctly reflects their thought process. The recommended structure of a radiology report has been described elsewhere [26, 27]. In short, convention generally dictates that the radiology report should include the name of the examination, a brief statement of relevant clinical information and any specific clinical questions, reference to comparison examinations, a brief description of the procedural technique, a description of the findings, and a concluding summary or impression statement. The conclusions should support the conclusions. The concluding section should address any specific clinical questions and should include the radiologist’s expert opinion of how the findings likely relate to the working diagnosis given the clinical information.

**Key Interactions: Teamwork, Collaboration, and Collegiality in Radiology**

As the complexity of health care has expanded, diagnosis has increasingly become a group effort [1]. The working diagnosis is thus shared among group members, rather

**TABLE 2: Examples of Information Provided by the Clinical Team to the Radiology Team That Meet and Do Not Meet the What-When-Where-Concern for (WWW-C) Criteria to Be Considered a Satisfactory Clinical History**

<table>
<thead>
<tr>
<th>Examination Ordered</th>
<th>Information Provided</th>
<th>Length</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT of abdomen and pelvis</td>
<td>History of umbilical hernia repair 2 months ago, now with increased swelling and pain at surgical site for 1 day. Ddx: Recurrent hernia with or without incarcerated bowel.</td>
<td>28 words</td>
<td>Meets all WWWC criteria</td>
</tr>
<tr>
<td>Chest radiograph</td>
<td>History of HTN, CAD. Presents with left side chest pain for 2 days after fall. Evaluate for ptx or rib fx.</td>
<td>21 words</td>
<td>Meets all WWWC criteria</td>
</tr>
<tr>
<td>Chest radiograph</td>
<td>Hx of lung ca. Presents with cough/sob for 2 days. Concern for pna.</td>
<td>13 words</td>
<td>Meets all WWWC criteria (site of abnormality is not applicable)</td>
</tr>
<tr>
<td>CT of abdomen and pelvis</td>
<td>History of metastatic colon cancer, right hemicolectomy. Abdominal pain with vomiting. Rule out obstruction vs colitis.</td>
<td>16 words</td>
<td>Does not include duration of symptoms; meets other criteria</td>
</tr>
<tr>
<td>Knee radiograph</td>
<td>Presents with knee pain for 1 day after knee gave out playing tennis. Concern for fracture or dislocation.</td>
<td>18 words</td>
<td>Does not specify side; meets other criteria</td>
</tr>
<tr>
<td>CT of head</td>
<td>PMH lupus, known ICA aneurysm. Presents with dizziness and HA for 1 day.</td>
<td>13 words</td>
<td>Does not specify concern or differential diagnosis; meets other criteria</td>
</tr>
</tbody>
</table>

Note—Ddx = differential diagnosis, HTN = hypertension, CAD = coronary artery disease, ptx = pneumothorax, fx = fracture, Hx = history, ca = cancer, pna = pneumonia, Abd = abdominal, PMH = past medical history, ICA = internal carotid artery, HA = headache.

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than existing solely in the mind of a single individual. This necessitates a high degree of effective coordination among those involved.

Over the past century, the complexity and sophistication of health care has driven continued specialization in two dimensions: role and medical specialty [28]. Examples of specific roles within a clinical team include physician, advance practice provider, nurse, medical assistant, administrative leader, and unit secretary. Examples of specific roles within a radiology team include radiologist, technologist, nurse, medical assistant, administrative leader, informatics specialist, and administrative assistant. Because of the increasing demand for professional services to be available every day at all hours, professional colleagues commonly work in group practices to provide continuous coverage [29].

Because diagnosis has become a group effort, interpersonal dynamics play a critical role in communication and in the diagnostic process in general. We divide these interpersonal interactions into teamwork, collaboration, and collegiality (Fig. 4), all three of which are critical to the diagnostic process.

**Teamwork**—A team can be defined as “a small number of people with complementary skills [and roles] who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable” [30]. We define teamwork as the ability of such teams to work together effectively to achieve their common goals (Fig. 4A).

Health care teams tend to consist of individuals with very different backgrounds and medical training, often with large differences in formal authority and status [31]. Medical teams also tend to work in high-stress environments in rapidly unfolding situations. Such teams are prone to breakdowns in communication that can have devastating consequences [32]. A dedicated field of study has emerged to understand these dynamics, including techniques known as crew resource management, which focuses on how team members can effectively overcome barriers inherent to established hierarchies [32, 33].

**Collaboration**—We define collaboration as the ability of individuals who are on separate teams or in different organizational units to work together effectively toward a common goal [34] (Fig. 4B). Collaboration differs from teamwork in several ways. Although teamwork involves repeated frequent interactions sustained over time, collaborative interactions tend to be brief and infrequent. Teams are typically held accountable collectively, whereas accountability between teams tends to be a much more diffuse. Although team members’ roles tend to be well defined, roles in collaborative interactions typically are more informal.

Communication breakdowns between team members tend to occur differently than between members of different teams, for several reasons. Organizational structures tend to highlight unit performance rather than interactions between units; these units often have different and potentially conflicting goals and priorities [34]. Cross-unit processes and systems are often less well developed than those within units. Furthermore, behavioral standards are often less well established and harder to enforce between units than within units.

In addition, members of the same profession and same organizational unit tend to identify more strongly with their profession and their unit than with the organization as a whole [35, 36]. These affinities resemble tribal allegiances, which can foment rivalry and distrust between groups. These counterproductive tendencies are often reinforced by the infrequent and transactional nature of interactions between individuals in different groups [37].

Overcoming obstacles to collaboration typically requires deliberate sustained efforts on the part of senior organizational leaders to break down traditional barriers between units to more resemble effective teams [38]. Such efforts may include identification and reinforcement of a shared vision, frequent organization-wide briefings, creation of cross-unit teams, and reinforcement of collaborative behavior [39]. Collaboration should be carefully managed, however, because too much time spent in collaborative activities can distract and overwhelm individuals, detracting from their core focus [40].

**Collegiality**—We define colleagues as individuals within a group who play the same role on a team or set of similar teams. We de-
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fine collegiality as the ability of colleagues to work together cohesively, often reflected in the ability of a team to smoothly transition from one colleague to another without disrupting the team's operations (Fig. 4C). We consider critical elements of collegiality to include the ability to agree on and abide by technical and behavioral standards and to teach, learn from, and support one another in a positive manner [41].

This specific definition of collegiality is not as well established as more general concepts of teamwork and collaboration. Traditionally, the concept of colleagues has been applied most often to professionals such as physicians, who have traditionally been self-governed, with little hierarchical authority [42]. Strategies to enable independent individuals to reach agreement on difficult topics can be found in concepts of fair process [43], and models for supportive interpersonal interactions between colleagues can be found in concepts of organizational learning [44]. For example, Davies and Nutley [45] define eight cultural values for continuously learning health care systems that also reflect the professional ethos: celebration of success, absence of complacency, recognition of mistakes as opportunities to learn, belief in human potential, recognition of tacit knowledge, openness, trust, and outward-looking orientation.

Application to the diagnostic process—Effective teamwork is needed to perform tasks that are performed primarily by either the clinical or radiology teams. Collaboration is especially needed for activities that are shared by the clinical services. For example, the clinical team typically selects a modality when ordering an imaging examination. That order is typically also reviewed by the radiology team and may be questioned if the requested imaging examination does not seem appropriate for the given clinical scenario.

Structural elements that overlap both clinical and radiology processes should be developed collaboratively with input from both parties, including decision rules for determining imaging appropriateness [46], communications processes and systems [19], and balancing priorities such as turnaround time versus degree of radiology subspecialization versus cost [9]. Collegiality is needed to develop standard methods, conventions, and processes that all team members and other party members can rely on without having to adjust to arbitrary preferences of every professional in the group [47]. Collegiality also contributes to the health of the organization by encouraging individuals to support one another and to continuously learn and improve [41], especially as physician burnout becomes an increasingly pervasive problem [48].

Trust

Trust is a qualitative and subjective concept, but it plays a major role in the diagnostic process. Information is almost never 100% reliable, including in diagnostic radiology. Not only do imaging modalities and examinations have inherent limitations, but because image interpretation and communication skills vary, the accuracy and helpfulness of interpretations also vary accordingly. Clinicians who do not trust the radiologist’s interpretation tend to discount it, which compromises its usefulness. It matters little whether the radiology team believes itself to be trustworthy; the recipient of the information, not the provider, is the arbiter of the information’s trustworthiness [49]. It is up to the radiology team to earn that trust.

Trust tends to be strongest when it is based on individual relationships [50]. When clinicians know the radiologists personally, trust is developed at the level of the individual professional. Highly skilled and helpful radiologists tend to be trusted and highly valued, whereas unhelpful radiologists tend to be mistrusted and ignored. In larger systems, referring clinicians tend not to have an individual relationship with each radiologist in a practice. In that setting, clinicians must rely on their experience with the group or with the specialty as a whole. This increases the likelihood of misaligned incentives, in which individual radiologists or radiology team members may not invest adequate time and effort to maintain high levels of skill or strong relationships with their referring clinicians. Without appropriate management, this misalignment can engender a vicious cycle that may compromise the reputation of the entire practice or even the entire specialty in the eyes of clinicians [51].

Challenges and Opportunities in the Modern Health Care Environment

Radiology has evolved significantly over the past few decades, which has created both challenges and opportunities. Advances in information technology have enabled rapid transfer of images and other information between technologists, radiologists, and clinical teams, reducing radiologists’ face-to-face interactions with all other members of the radiology and clinical team [19, 52]. This almost certainly has weakened interpersonal relationships, which are critical for facilitating teamwork, collaboration, and collegiality.

Ironically, these advances in information technology often impede effective and reliable information flow between individuals involved in the diagnostic process. For example, a clinical team routinely will provide a brief history and framing of the question when reviewing a case with a radiologist in person. Yet such context is not reliably provided through asynchronous electronic communication channels [25]. The evolution of decision making in medicine from individual expert opinion toward evidence-based guidelines and increasingly automated decision algorithms [53] could isolate individuals even further. Paradoxically, interpersonal coordination and communication become more important as specialization and fragmentation occur within a field, yet increased specialization and geographic isolation tend to reinforce a silo mentality as individuals increasingly do not identify with members of the other specialized groups [38].

Information technology has the potential to both facilitate and undermine productive and efficient communication. The large-scale transition to the electronic medical record [54, 55] provides many examples of unintended detrimental effects when such subtle qualitative elements are not well recognized and protected by system designers [52].

A deliberate effort is needed to overcome this self-imposed isolation, including strategies to enhance interpersonal communication and relationships. For example, the known value of effective communication in the diagnostic process should prompt additional research to find ideal content, format, and methods of such communications.

Increasing attention has been paid to the concept of value in health care in general, including in diagnostic radiology, with a desire to frame value in terms of health outcomes [56, 57]. Although outcomes can be used as a measure of value for the entire clinical process, they are difficult to apply to individual subprocesses such as radiology, because the diagnostic process is at least two steps removed from health outcomes (Fig. 3), treatment decisions are not controlled by the radiology team, and overlap between the clinical and radiology teams make it difficult to attribute responsibility to an individual person or subunit.

Rather, if the value of diagnostic radiology were to be distilled to a single measure, perhaps the best candidate would be the help-
fulness of the radiology team to the clinical team in efficiently and accurately establishing a diagnosis [9]. Perhaps the focus of efforts to measure value in diagnostic radiology should be to quantify a long-held informal maxim, which states that the helpfulness of any consultant can be distilled to three general qualities—availability, affability, and ability [58]—which capture notions not only of diagnostic acumen, but also of timely and accessible communication.

Principles

We propose the following 10 principles to facilitate effective information flow in the diagnostic process.

**First principle**—Needed information should always be provided to individuals and teams answering important questions and making important decisions in the diagnostic process. Professionals providing such information should work to genuinely understand the context of the information that is useful to the other parties. Specifically, the clinical team should provide adequate information regarding the clinical scenario to the radiology team so the radiology team can confirm the appropriateness of imaging, protocol the examination correctly, and interpret the imaging findings in the clinical context. Radiology teams should provide adequate information regarding the imaging interpretation for the clinical teams to effectively integrate the results and accurately refine the working diagnosis.

**Second principle**—Individuals should take the extra time to provide information that is valuable to others in the diagnostic process, especially when it is relatively easy to do so.

**Third principle**—Information should be structured in the manner that is most useful to the recipient, not necessarily in the way that is most convenient for the sender. For example, because clutter is costly, individuals should strive for succinctness in reporting.

**Fourth principle**—When providing information, individuals should share both their current thinking and the rationale behind that thinking to help the recipient better understand the context of the information provided. For example, clinicians should provide a brief statement of relevant medical history, salient findings of the history of the present illness and physical examination, the working diagnosis, and any specific clinical questions. Radiologists should provide a report that contains a succinct summary and interpretation, including a statement of findings that clearly states the rationale for that conclusion.

**Fifth principle**—Because additional discussion may be warranted to clarify standard communications, members of the clinical radiology teams should make themselves accessible for discussion of relevant imaging cases.

**Sixth principle**—Information that is not in the hands of the decision maker loses its value with time, especially in emergent or urgent situations. Therefore, timeliness is an essential measure of quality.

**Seventh principle**—Effective communication often depends on subtleties that are not as richly conveyed through structured communication. Therefore, structural elements such as pick lists and standard codes should be imposed on communication processes with caution [59].

**Eighth principle**—Decision rules and algorithms are most useful in routine cases. Clinical and radiology teams should work together to standardize and automate decisions for routine cases, on the basis of the evidence, and reserve skilled professionals’ time for more complex cases [47].

**Ninth principle**—Interpersonal behavior has a significant effect on communication and thus on diagnosis when diagnosis is a group activity. Organizations should define behavioral standards that promote effective communication and hold individuals accountable for abiding by them.

**Tenth principle**—Radiology and clinical teams should view one another as collaborative partners rather than as rivals and actively seek to break down silos. This effort should be manifested in tangible ways, such as infrastructure development, daily interpersonal interactions, and even in private discussions regarding other groups and individuals.

Conclusion

We have provided a framework for understanding the role of diagnostic radiology in the context of the diagnostic process, with an emphasis on information, communication, and interpersonal interactions. Many of the unintended consequences of modern electronic health systems came about because system designers did not appreciate critical but difficult-to-measure elements such as interpersonal relationships [52, 55]. Although interpersonal interactions are difficult to specify and quantify, they are critical to the effective flow of information, which itself is critical to the diagnostic process as it is increasingly performed within and among professional teams. As the complexity of medical practice increases and as systems and organizations evolve according-ingly, the core elements of teamwork, collaboration, collegiality, and trust, which led to the founding of our specialty in the first place, are critical to its enduring relevance.

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