



# The epistemology of imaging procedures and reporting

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As imaging professionals, we are used to solving everyday complicated problems of interpretation of findings, but we rarely have time to dedicate to the roots of imaging itself, namely the epistemology of our procedures. THE guiding idea of this editorial is that there are questions at different levels that need to be addressed if we are after a philosophical understanding of diagnostic medical imaging [1]. In contemporary epistemology, reliabilism is the view that knowledge is the output of a reliable process, that is, a process that is relatively free from errors. It is usually opposed by internalist views, according to which to know is to be able to give reasons for what you judge or explain how you got there. In the terminology of reliabilism, there are other processes to consider, in addition to image construction, that of course remains the first process of imaging procedures. The second process (or series of processes) is social and cognitive, and its output is a radiological report, possibly including a diagnosis (for example, suspected tumoral lesion in the patient's lung). Imaging procedures are ubiquitous in medicine; studies in the social epistemology of clinical decision-making emphasize the essential contribution of imaging tests and reports [2]. Work that focuses on the epistemology of imaging procedures per se, however, is scarce; therefore, what follows will not be a synthesis of the state of the art, but rather an indication of areas that can be explored.

Our proposal is that the good epistemic standing of imaging procedures is in turn epistemically complex, as it involves three levels of normative assessment. First, it depends on rules and conventions about how to read images (**the “semantics” of imaging**); second, on how these rules and conventions are applied by the individual reader (either

radiologist or nuclear medicine expert) in the specific case (usually called **“reading”**); and third, on how the reading is conveyed in a written report (**“reporting”**). That imaging involves conventions may appear controversial (there is an element of arbitrariness in conventions, and what could be arbitrary in the fact that a focal hot spot in a [18F]-FDG PET image of the lung should be read as cancer?). We will consider this in more detail below, with particular emphasis on reporting.

In order to obtain good evidence for a report we need a good-quality image from the scan and a relatively error-free reading by the imaging specialist. Let us now consider the imaging report. The importance of radiological reports lies in the fact that what the imaging expert reads is not evidence that can be acted on (clinically relevant evidence), until it is communicated to the relevant stakeholders in the diagnostic process, that is, the referring physician, and possibly the patient. Reports are therefore part of what we have called the imaging procedure, and from this, they earn their epistemic relevance. What makes a radiological report epistemically good? More precisely, in the case of a good-quality image, and a good reading, what conditions does the reporting process add to the epistemology of radiology?

The medical literature on good imaging reporting is vast [3]. This is because there can be no clinically relevant evidence from medical imaging without reports—as said, they are as epistemically relevant as images themselves to obtaining medical knowledge. Radiological reports are documents, they are part of the patient's records, they are stored in databases, and they can be accessed at any time. The main theme that emerges from the literature is that a good radiological report is such that one who reads it—the referring physician, a specialist, the family doctor, or the patient and family—knows what to do after reading it [4]. Therefore, we may pretend that good reporting is action-guiding reporting. Back in 1923, a leading expert criticized radiologists who “describe in detail all that the roentgenologist sees in the film or on the screen but does not tell what he thinks about it, what conclusions he draws from it, and what it means to him” [5]. In other words, a good report should include a diagnosis

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whenever possible, and a clearly understandable one. An expert opinion published in 2000 makes it explicit that

radiologists should minimize, if not eliminate altogether, the use of such phrases as “if clinically warranted,” or “if clinically indicated may be of value,” when assessing abnormal radiographic findings. Because radiologists are acknowledged to possess radiologic expertise derived from training and experience, they should not relinquish to nonradiology physicians the responsibility of evaluating the potential significance of a purely radiographic finding that is unexpected or unusual [6].

For a radiological report to be good in the sense of being adequate as a basis for action, it should also be readable for its intended target. Studies show that referring doctors do not understand abbreviations used by radiologists, and (more relevantly) they often assign meanings to terms conveying uncertainty (such as “suspicious for” and “consistent with”) that do not coincide with those intended by reporting radiologists [7]. Readability is even more important, and difficult to achieve, as increasingly more often the patient, and not only the referring doctor, is a reader of the report, in a patient-centered model of care [8]. Easy accessibility of radiological reports by patients has been described as disruptive by imaging specialists, for it forces a radical change in a profession that traditionally did not include a direct relation with patients and caregivers [9].

How radical should be the change in reporting? The threshold set by the requirements of clarity and simplicity is interesting to discuss. A study of quantitative analysis of the readability of radiological reports in the USA concludes that fewer than 4% of all reports in the sample were at the eighth-grade reading level of the average U.S. adult, and therefore they were classified as difficult to understand by patients and caregivers [10]. The problem here is whether and how precision of imaging data stored in reports, which are essential to patient care and to medical research, can be achieved without employing technical terms (or terms that are not understandable by an 8th grader). Would a simplification of language in medical imaging reporting bring about a loss of essential concepts, as in the Newspeak dystopia of George Orwell’s famous novel? [11]. It appears that a (philosophical) question about patient-centered radiology, or patient-centered care in general, needs to be addressed.

Discussion of what counts as good imaging reports have included proposal of methods of standardization since the early days of radiological diagnosis. Standardization is proposed in the form of templates or lists of questions for the radiologist to fill in (structured reporting), and more recently in the form of software for reports. For example, a structured report of an abdominal CT contains subheadings that describe each of the anatomic areas examined, such as the liver, spleen, pancreas,

and kidneys. Structured reporting could also be intended in a stronger sense as including explicit rules for the use of terms [12]. Ideally, structured reporting should improve the completeness of information as well as readability; it is indicated as a goal by scientific societies, such as the European Society of Radiology [13].

Difficulties for implementing structured reporting in imaging, however, appear to be prohibitive when compared to other medical specialties, such as pathology and surgery [14]. Some resistance may come from a sort of professional pride of old-style radiologists, who see standardization as a threat to their authority in performing what they consider their main professional task (arguably, surgeons do not consider reporting as their main professional task) [11]. But economic factors are surely relevant. Studies found that standardized reporting systems are costly in terms of money and time (productivity), especially for private practice radiologists. As a commentator writes in an academic radiology journal,

In the world outside of medicine, what would a manufacturer do when customers require a product that costs more to create? Corporate petulance would dictate one of two responses—decrease manufacturing cost or increase price. In medicine, we are constrained by third parties with downward pressure on any price adjustments [15].

To sum up, what may be of philosophical interest, epistemic properties of imaging reports depend on features that account for their efficacy as communicative acts—apparently, a case where pragmatics of communication grounds epistemology. This might be contingent and temporary, as standardization tools may gradually take over. But, at present, it is a relevant feature of contemporary medical practices. Moreover, discussions of readability thresholds stimulate reflections on patient-centered care, and the difficulty of implementing structured reporting touches on the big issue of costs of healthcare.

## Declarations

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**Informed consent** Not applicable.

**Conflict of interest** The authors declare no conflicts of interest.

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