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Philosophy of Advanced Medical Imaging



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Philosophy of Advanced Medical Imaging

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Preface

This volume is a genuinely interdisciplinary work. Five of the contributors are medical doctors, specialists in nuclear medicine, five are philosophers, and two are Artificial Intelligence specialists. We, the volume editors, are a philosopher and a nuclear medicine physician. This distribution reflects our idea of what philosophy of medicine can and should be, namely, a reflection on common problems with different kinds of expertise. The risk is some heterogeneity of style in the chapters of this book, but we hope it is balanced by the interest of the contents.

We regret that for this time, we had to leave out the big topic of medical imaging and brain disorders, as we concentrated mostly on diagnostic imaging for the diagnosis of cancer.

We wish to thank all the contributors and the editorial team at Springer for their enthusiasm for this first volume on the philosophy of advanced medical imaging.

Bologna, Italy

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Bologna, Italy
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Chapter 1

The Philosophy of Advanced Medical Imaging: Mapping the Field



Elisabetta Lalumera and Stefano Fanti

Abstract The philosophy of advanced medical imaging is a new research field. Here we map the terrain with a provisional division between classical epistemology, social epistemology and ethics of advanced medical imaging. For each broad topic, we indicate what the most important questions are likely to be, review relevant samples of the existing publications, and describe the new contributions contained in this volume.

Keywords Epistemology · Ethics · Medical imaging · Diagnosis

1.1 Introduction

In the last decades, medicine has been revolutionised by advanced imaging technologies, which provided better tools for research and improved the accuracy of diagnoses. Computed tomography (CT) uses a computer to acquire a volume of X-ray based images, then reconstructed as three-dimensional pictures of inside the body, which can be rotated and viewed from any angle, providing anatomical “slices”. Nuclear medicine tests such as PET use very small amounts of radioactive materials (called radiopharmaceuticals or radiotracers) to evaluate molecular, metabolic, physiologic and pathologic conditions of organs, and they can identify abnormalities very early in the progress of a disease and assess treatment response. Magnetic resonance imaging (MRI) uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, and bones. Fusion imaging may combine two imaging techniques in order to allow

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information from two different sources to be viewed in a single set of images, such as for PET/CT. Such techniques are now widely utilised to diagnose and manage the treatment of cancer, heart disease, brain disorders such as Alzheimer's and Parkinson's disease, gastrointestinal disorders, lung disorders, bone disorders, kidney and thyroid disorders (SNMMI 2019).

What has this to do with philosophy? In fact, quite a lot. More specifically, there is a range of philosophical questions that arise in connection with advanced imaging, with diagnosis, and with the practice of radiology and nuclear medicine. The next three sections of this chapter will be aimed at mapping this terrain. Our map of the field will show three main areas – (classical) epistemology, social epistemology, and ethics – with the proviso that borders are, at least to some extent, conventional, and migration of questions from one area to the other is unavoidable. Moreover, our map will be largely one of an unexplored territory, as the interest of philosophers in advanced imaging and diagnosis is very recent, dating back one decade at most (Delehanty 2005, 2010; Lysdahl and Hofmann 2009; Hofmann 2010; Fangerau et al. 2012 with a historical perspective). In addition to the previously published literature, which is sparse, we will, therefore, refer to the chapters included in this volume, and briefly illustrate their content.

The new-born philosophy of advanced imaging can be seen as a product of diverse trends. First, recent handbooks, journal papers and edited volumes show a tendency of the philosophy of medicine of analytic tradition to move from general conceptual issues – traditionally the nature of health and disease – to special fields, such as the philosophy of evidence-based medicine, of epidemiology, pharmacology, immunology, and healthcare, to mention just a few recent examples (Solomon et al. 2016). Second, philosophers of medicine came to realise that diagnosis, in general, has been under-discussed, when compared to topics such as RCTs, placebo, or the hierarchy of evidence, and there is a research gap to be filled in this area (Stegenga et al. 2017). Finally, from the medical community, there is a request of clarification and discussion of concepts which are intrinsically value-laden and call for philosophical analysis, such as appropriateness (of a test or treatment), over-treatment, and overdiagnosis. The discussion about “Too much medicine” promoted by the British Medical Journal is an example in this sense. It brought to the forefront of the debate the need for thinking about aims and values of clinical practice when issues cannot be settled by evidence alone (BMJ 2019). In general, it is increasingly recognised that philosophers can bring a kind of expertise or skill that can be applied to questions outside traditional bioethics. Nonetheless, medical specialists call for philosophical expertise when specific ethical problems arise in everyday contexts, like the communication of a bad prognosis to an oncologic patient (Gonzalez et al. 2018).

1.2 Advanced Diagnostic Imaging and Epistemology

The main question of epistemology is: what counts as knowledge? The standard answer is the justified-true-belief account, dating back to Plato, and discussed and criticised in many ways – given a content p , a person knows that p if and only if she believes that p , she has a reason for believing that p and p is true. Epistemology of advanced diagnostic imaging turns the question to the specific domain of imaging.

Suppose a doctor reports the following, after a PET-CT scan of the patient: There are multifocal diffuse scattered hypermetabolic predominantly osteosclerotic lesions throughout the axial and proximal appendicular skeleton, compatible with widespread osseous metastases. At what conditions can we say that the doctor knows the content of the report? Her evidence is what she saw on the screen, and she formed a belief based on such evidence. When can we say that it was good, sufficient evidence? Moreover, suppose the patient reads the scan. What, if anything, counts as knowledge of the content of the report, from the patient's part? This simple example helps us introduce some broad issues in the epistemology of advanced diagnostic imaging.

1.2.1 *Images as Evidence*

Advanced imaging gives the illusion to see through the body. *Prima facie*, they provide observational evidence for a diagnostic claim. In her PhD Dissertation and a later article, Megan Delehanty (2005, 2010) investigates the peculiar nature of such observational evidence. Though they look like naturalistic images, she argues, these are rather mathematical objects, as they require several layers of mathematical and statistical processing. Her point is that the knowledge one can acquire from, say, a PET scan can qualify as knowledge from observation only if we take into account the characteristics of the technology. It is their means of production, not their similarity to body parts, what makes these images evidence. She concludes that advanced imaging – PET in particular – makes us rethink the philosophical notions of observation and empirical knowledge. Lalumera et al. (2019) elaborate on Delehanty's conclusion. They take PET as a case study and argue that it is a highly theory-laden and non-immediate knowledge procedure, despite the photographic-like quality of the images it delivers. They tackle the more general issue of what is for an advanced imaging diagnostic test to count as a reliable knowledge procedure, to which the point that follows is also related.

1.2.2 *The Skill of Readers*

In the sketchy example above, the doctor reports that there are lesions throughout the patient's skeleton, and these lesions are likely metastases. After investigating what is for an image counts as evidence, we need to raise the question of what makes the doctor in the position of appraising such evidence. What kind of skill or expertise does the doctor have in order to deliver the report from the image? Empirical studies in the field of medical vision tell us that expert radiologists and nuclear medicine physicians often report the sensation of knowing that a particular image contains a lesion before with a sudden "Gestalt" impression, rather than with a conscious search. On the other hand, they undergo years of intensive training that involves reading many thousands of images and learn that some areas of an organ are more likely to contain a lesion than others. Thus, eye movement recordings show that novice readers search in a relatively haphazard fashion when looking for lesions, while experienced ones tend to exhibit more concise eye movements, with fewer fixations needed to extract information (Drew et al. 2013; Friis 2017; Samei and Krupinski 2009).

Epistemology can redescribe the empirical findings with the traditional dichotomy between procedural knowledge, or knowing-how, and propositional knowledge, or knowing-that. The first is mainly unconscious and arguably direct, i.e. non-mediated by beliefs, while the latter is based on other beliefs and can be explicitly reconstructed by the knowing agent (Fantl 2017; Ryle 1971). Also, the Gestalt component of the reader's experience can be analysed by the notion of seeing-as, discussed by Ludwig Wittgenstein (2009), and a key theme in the philosophy of perception. From the epistemic point of view, these kinds of knowledge have different conditions of correctness. Once spelt out, such conditions would give a clearer picture of what counts for a doctor to know the content of a report, and the difference in performance between novice and expert readers.

1.2.3 *Diagnostic Uncertainty*

Even when a complete conceptual analysis of what counts as knowledge of the content of a report from the doctor's part is carried out, we still have to deal with the *de facto*, actual phenomenon of diagnostic uncertainty. What does it mean that the report that the doctor in our initial example communicates to the patient is uncertain? Despite the conspicuous sociological and medical literature on the topic, the concept of diagnostic uncertainty itself requires clarification (Kennedy 2017). Is uncertainty eliminable? Can there be uncertainty in the absence of error? How many kinds of uncertainty are involved in a doctor-patient encounter, in the case of advanced medical imaging?

This volume contains three original contributions by leading philosophers of medicine on diagnostic uncertainty. They are included in Part 1 of the book,

“Epistemology”. In Chap. 2, “Types of diagnostic uncertainty – defining them and addressing them”, Bjorn Hofmann and Kristin Bakke Lysdahl illustrate how diagnostic uncertainty can be classified according to what it is about, who experiences or scrutinises it, and which task or part of the (diagnostic) process it deals with. In conclusion, they suggest some basic rules for limiting uncertainty in practical contexts.

Ashley Graham Kennedy, in Chap. 3 (“Imaging, representation and diagnostic uncertainty”) starts with arguing that medical imaging is a form of indirect observation, as we remarked above. Because of that, she argues, using an example, an image must be interpreted in the clinical context by appealing to other forms of evidence. Such an evidential pluralist strategy can mitigate the negative effects of diagnostic uncertainty.

Chapter 4, “Screening, scale and certainty”, focuses on diagnostic uncertainty in screening programmes, a hotly debated topic in recent years. Stephen John uses the example of CT-based screening for lung cancer, argues that there is an epistemologically and ethically significant distinction between “individual-level” and “population-level” uncertainties, and suggests that population-level analysis should not be overlooked.

1.3 Social Epistemology of Advanced Diagnostic Imaging

Social epistemology of medicine analyses medical knowledge as a collective achievement, involving diverse subjects, institutions, scientific groups and practices. It broadens the focus of classical epistemology. A notable example of this kind of approach is Miriam Solomon’s work on group decision and consensus conferences in medicine, and her book on the making of medical knowledge (Solomon 2007, 2015). This is a field where the interdisciplinary collaboration of philosophers and doctors can be particularly fruitful, as doctors have a first-person insight on the dynamics of their profession, especially if they are research leaders – for example, on the role of guidelines, of experts’ meetings, on the research on radiopharmaceuticals (in nuclear medicine), on the problems of test evaluation and reliability enhancement of test, and the use of Artificial Intelligence.

Here are some examples of published literature. Lalumera et al. (2019) argued, among other points, that consensus conferences of the kind described and evaluated by Solomon are ineliminable in advanced imaging, in all those cases where the semantics of an image – the standard of interpretation – needs to be fixed. Lalumera and Fanti (2019) also illustrated the problems of evaluating the accuracy of advanced imaging diagnostic tests via randomised controlled trials, because of the nature of radiotracers, which are different from other drugs, and because RCTs inevitably end up assessing the test-plus-treatment pair, rather than the test alone. They also investigated the topic of guidelines following, by conducting qualitative research on the views of imaging experts involved in a consensus conference (Fanti et al. 2019). Finally, on the topic of shared decision making in imaging, Sophie van Baalen and