

The Philosophy of Advanced Medical Imaging: Mapping the Field

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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 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), overtreatment, 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 Kirsten 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 Annamaria Carusi analysed the diagnosis of Pulmonary Hypertension, including the role of advanced imaging, as a case of distributed epistemic responsibility among clinicians of various expertise and technologists, involving relations of trust (van Baalen et al. 2017; van Baalen 2019).

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The section “Social Epistemology” of this volume includes three chapters, two from leading researchers in the nuclear medicine community, and one by experts of Artificial intelligence. Rodney Hicks and collaborators, in Chap. 5, “On the Inclusion of Specialists as Authors in Systematic Reviews”, address the issue of the conflict, within the Evidence-based Medicine paradigm, between methodologists and clinicians in the authorship of systematic reviews. The topic is vital because systematic reviews are at the top of the hierarchy of evidence, and they provide the basis for recommendation and guidelines. Methodologists argue that clinicians are subject to self-interest as providers of healthcare services, and therefore cannot be trusted to provide unbiased guidance to either patients or policymakers. Clinicians, conversely, question whether guidelines can be formulated by individuals with neither specific expertise in medical research, nor practical experience in clinical care. They defend the reasons for clinicians with principled arguments.

John Babich and Uwe Haberkorn’s Chap. 6 is on “Development of novel radiopharmaceuticals: problems, decisions and more problems”.

Radiopharmaceuticals or tracers are essential to the PET technique. The research on new molecules is fast-pacing and very complex. The two authors illustrate its epistemic difficulties and practical pitfalls, highlighting the choices or

“Buridan’s dilemmas” that the researcher is faced with, some of which are drastically underdetermined by the evidence.

The role of Artificial Intelligence and Deep Learning in advanced imaging is illustrated and assessed by Luca Casini and Marco Roccetti in Chap. 7, “Medical Imaging and Artificial Intelligence”. After providing the basic notions and state of the art, Casini and Roccetti argue that Artificial intelligence and big data “open up a Pandora’s box” of potential issues, including privacy and the actual responsibility of AI decision. In their conclusions, they suggest a collaboration between AI and human professionals that can leverage the best characteristics of both: “the capacity of harnessing unmanageable amounts of data to gather new insights of AI and the flexibility and specificity of the human intellect” (ibid.).

1.4. Ethical Issues in Advanced Diagnostic Imaging

Medical ethics is a vast field of study, with a long and complex tradition. Medical ethics provides normative guidance for research and clinical medicine by arguing from (ideally) universally accepted principles, such as Non-maleficence and Beneficence, Autonomy, the Utilitarian Principle, etc. In this, it is different from medical deontology, which relies on specific codes of behaviour and laws (Beauchamp and Childress 2013). Among the most discussed topics nowadays (excluding end of life and abortion) are the doctor-patient relation and the crisis of trust, the principles of Autonomy versus Paternalism, the privacy of personal data, issues related to palliative care, ethical concerns about overuse of treatments and diagnostic tests, and the ethics of communication of diagnosis (Arras 2016).

The application of ethical questions to the specific field of advanced medical imaging is to be found mostly under the label “ethics of radiology”, and sample research suggests that publications tend to be in medical rather than philosophical journals (See, e.g. Barron and Kim 2003; Malone 2013). The critical questions in the ethics of radiology literature are clear once we accept that “each examination should, in theory, provide a diagnostic benefit, whether performed in the west, the developing world, the public sector or the private domain. However, each examination also represents a monetary cost and a risk, both in terms radiation exposition and other collateral damages, including the possible distress caused by an uncaredful diagnosis report (IAEA 2011; Malone 2013, 108). What is the proper balance between the Principle of Beneficence and the Principle of non-Maleficence, regarding radiation exposition, and imaging testing in general? What counts as overutilisation of imaging procedures, and why is it ethically wrong? What are the ethical responsibilities of an imaging specialist in communicating a diagnosis?

This volume includes two chapters on the ethics of advanced imaging. Chapter 8 is Kirsten Bakke Lysdahl and Bjorn Hofmann's "Overutilisation of imaging tests and healthcare fairness".

Overutilisation of imaging procedures is a well-known and expanding phenomenon, to be analysed not only in terms of appropriateness and cost-effectiveness but also in ethical terms. In Chap. 8, the authors define the notion, then provide a clear account of why overutilisation of diagnostic imaging is incompatible with fairness, after considering the egalitarian, the utilitarian and the contractarian notions of fairness. They also assess some potential solutions to overutilisation, including educational strategies, reinforcement of appropriateness criteria, and assigning more discretionary power to imaging specialist – which they favour as the most promising.

The last chapter of the volume is about the last passage of a medical imaging diagnostic procedure, but arguably the most crucial, namely the communication to the patient. Laetitia Marcucci and David Taieb (two professional nuclear medicine physicians) explain that there is a paucity of educational curricula on interpersonal and communication skills in imaging. Research is needed to establish ideal methods to educate professionals on communicating diagnostic imaging results, that would take into account the patients' right to decide whether they wish to receive such information or not and their right to autonomy, with personalised approaches to better integrate their capacity and vulnerability. They suggest in the conclusion that role-play scenarios could represent a solution, requiring integration of medical and philosophical expertise.

1.5. Concluding Remarks

The map of the possible exploration of the territory of intersection between advanced medical imaging and philosophy sketched so far is obviously incomplete. We are at the dawn of a new research field, and there is undoubtedly much more to come. New questions and topics of discussions will come both from philosophers to medical specialists – in order to find examples of their theorisations – but, above all, we hope, from medical specialists to philosophers, in view of human health, and of science, which requires different skills.

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