

Please refer to: Baalen, S.J. van, and Boon, M. (2017). *Evidence-based Medicine versus Expertise - Knowledge, Skills, and Epistemic Actions*. Chapter 2 in: *Knowing and Acting in Medicine*. Robyn Bluhm (ed.). Rowman & Littlefield, 21-38.

Chapter 2

Evidence-based Medicine versus Expertise

Knowledge, Skills, and Epistemic Actions

Sophie van Baalen and Mieke Boon

Since its inception in the early 1990s, evidence-based medicine (EBM) has been promoted as a way to make clinical practice more scientific, though its epistemology has been criticized on many grounds, for example, for being based on a narrow view of science, which focuses on quantitative, clinical evidence and rule-following instead of basic science, theories, and judgments (Loughlin 2008, 2009; Tonelli 1998; Worrall 2002; Wyer and Silva 2009). This chapter will focus on another line of critique, to wit, EBM's disregard of "expert opinion," in particular the role of physician's expertise in clinical decision-making.

Very shortly after EBM was announced as a "new paradigm for medicine" (Evidence-based Medicine Working Group 1992), Sandra Tanenbaum pointed out some of its philosophical challenges, among which is a misrepresentation of clinical reasoning: "In an act of *interpretation*, not *application*, physicians make clinical sense of a case, rather than placing it in a general category of cases. As interpreters, physicians draw on all their knowledge, including their own experience of patients and laboratory-science models of cause and effect" (Tanenbaum 1993, p. 1269, our emphasis). She argues that clinical medicine inherently has to deal with the uncertainty of a situation and with incomplete information. For physicians to make wise decisions requires them to necessarily rely on "personal knowledge," including experience and sensory input.

In a similar fashion, Mark Tonelli (1998) defended "expert opinion" by first arguing that expertise is wrongfully put on the lowest rung in the "hierarchy of evidence" ladder because it is different *in kind* rather than *in degree* from the other types of evidence that EBM ranks. According to him, expert opinion is crucial to overcome the *epistemic* gap between the outcomes of population-based clinical trials and those of the individual patient, as well as

the *normative* gap between what is regarded as the “best” treatment according to EBM (i.e., the treatment that gives the best outcome to a group of patients with a particular disease in a clinical trial) and what will be the “best” treatment for an individual patient. With a clinical case description, Tonelli illustrates how an experienced physician uses “all relevant kinds of medical knowledge, along with patient goals, values and preferences, in order to reach the best possible decision for the patient-at-hand” (Tonelli 2006, p. 73). The role of expertise in such decision-making requires a physician to be aware of the strengths and weaknesses of each kind of medical knowledge and to cope with the fact that evidence derived from clinical research cannot be prescriptive but still requires experience and pathophysiological knowledge.

One of EBM’s initial aims was to improve the quality of clinical decision-making by minimizing bias, subjectivity, and uncertainty through statistical evidence and rule-based reasoning (Guyatt, Cairns, and Churchill et al. 1992). As Tanenbaum (1993) and Tonelli (1998, 2006) argue, EBM falls short in its initial aims when neglecting the crucial role of expert opinion in making clinical decisions about individual patients. Together with other critiques, this has led proponents of EBM to ask whether it is “a movement in crisis” and to contend that “evidence based medicine has not resolved the problems it set out to address (especially evidence biases and the hidden hand of vested interests)” (Greenhalgh, Howick, and Maskrey 2014, p. 5). Trisha Greenhalgh et al. (2014) argue that in order for EBM to overcome this crisis, it needs to refocus its attention on training doctors to use intuitive reasoning based on experience, followed by formal EBM methods to “check, explain, and communicate diagnoses and decisions” and to share uncertainty with patients. Furthermore, they argue that drawing on a “wider range of underpinning disciplines,” including qualitative research, would enrich the field.

In other words, EBM proponents admit that EBM falls short as a guiding principle for clinical decision-making. Tonelli, in turn, admits that the danger of overly relying on the authority of medical experts is that experts may become “authoritarian,” rigid, and not receptive to new evidence and insights. In addition, expert opinion does not necessarily provide good grounds for decision-making, as experts can disagree or have biased opinions. Thus, opponents and proponents of EBM are showing signs of rapprochement in the sense that both sides acknowledge that evidence from clinical research alone is not sufficient to make diagnosis and treatment decisions for individual patients, whereas reliance on expert opinion holds the danger of an unwanted return to “authority-based” decision-making. The challenge that is raised by this rapprochement is to develop an epistemology of clinical decision-making that acknowledges the central role of medical expertise in decision-making, but at the same time allows us to assess the quality of knowledge and reasoning in these practices.

In view of this dilemma, the aim of this chapter is to explicate what aspects of medical expertise allow doctors to make sound clinical decisions. It will be argued that medical expertise does not consist only of formal knowledge, practical skills, or experience (or any combination of these traits), but should also include *cognitive skills*. In other words, medical expertise also involves the ability to perform the *epistemic activities* needed to produce adequate knowledge about individual patients, by combining knowledge and experience from different sources fitted to the specific situation of that patient. Therefore, becoming an expert involves learning to *use* scientific knowledge and medical evidence in clinical decision-making. This is not, however, simply something that is tacitly learned by being immersed in the tradition and authority of existing medical practice. Instead, expertise means that clinicians can actually justify and thus be held accountable for their decisions. This requires, as we will argue, that experts can justify *how* they reach their decisions, in other words, for the underlying reasoning processes. Yet, this idea is seemingly at odds with authors who, when defending the importance of expertise in clinical decision-making, emphasize the role of *tacit knowledge* in these reasoning processes (Henry 2010; Malterud 2001). Our point will be that tacit knowing and reasoning in these accounts are regarded as inarticulate and therefore inaccessible. As a consequence, clinical decision-making remains a mysterious and vague process that cannot be reflected on, running into the danger that the original problem of tradition and authority-based expertise will persist. In order to address this problem, we will analyze the notion of tacit knowledge and its role in expertise by starting from Collins and Evans's (2007) skill-based account of expertise. Next, in order to open up and evaluate the tacit dimension in their notion of expertise, we will revisit Polanyi's (1958) original account of tacit knowing. As we will show, Polanyi's more subtle notion allows for better understanding how clinicians can indeed be held accountable for their decisions. As well as an epistemological dimension, "being held accountable for decision-making in diagnosis and treatment" involves an ethical dimension. Therefore, we have dubbed this type of accountability the *epistemological responsibility* of clinicians (van Baalen and Boon 2015), which we consider an inherent aspect of an enriched understanding of medical expertise. Based on our analysis of the role of tacit knowledge in expertise, we are in a position to explain in more depth the meaning of epistemological responsibility of clinicians that aims to overcome the dangers of tradition and authority-based notion of expertise. Finally, we believe that the proposed account of expertise in terms of epistemological responsibility is relevant for two reasons: first, in understanding how the quality of clinical decision-making can be accounted for and, second, in specifying learning-aims of the education of medical students.

EPISTEMOLOGICAL RESPONSIBILITY IN CLINICAL PRACTICE

Recently, we have argued that medical doctors have a professional responsibility to come up with the best possible diagnosis and treatment plan for individual patients, by generating knowledge about the disease of a particular patient (van Baalen and Boon 2015). To meet this responsibility, the key epistemological challenge of doctors involves gathering and integrating all relevant yet heterogeneous sources of information, including not just scientific-medical knowledge of diseases and treatments, and diagnostic data on the patient, but also contextual information (e.g., the patient's situation, goals and values, the availability of specific medical equipment and expertise, and the constraints of the medical system) so as to construct a coherent "picture" of the patient's disease and its possible treatments. In addition, this "picture" must be constructed so that it can be used as an *epistemic tool* for reasoning in clinical decision-making. The notion of "epistemic tools" for reasoning about a target-system was coined by (Boon and Knuuttila 2009; Knuuttila and Boon 2011). They propose the notion of scientific models as epistemic *tools* as an alternative to a generally held *representational* notion of scientific models. The analogy we wish to draw is between scientific models and the "picture" of a patient. In their notion of scientific models as epistemic tools, Knuuttila and Boon claim that the process of constructing scientific models (the modeling) is already part of the *justification* of the model, because constructing a model—or in our case the "picture" of the patient—involves *justification of the information* that is built into this "picture" (e.g., information on the individual patient and more general theoretical and clinical information need to be *relevant* as well as *reliable*) and requires that these heterogeneous bits of information are *coherently tied together*. In the vocabulary of our chapter, one could say that modelers have the expertise—knowledge, experience, and cognitive skills—to build models that are at least partly correct about the specific target-system for which the model is constructed. When translated to the medical context, the scientific model (the "picture") constructed by the modeler (a medical doctor) is about a specific target-system (an individual patient) and functions as an epistemic tool that allows for scientific reasoning about the target-system. Hence, instead of truly representing the target-system, the scientific model is a tool that allows for scientific reasoning about the system. Similarly, instead of finding objective "truth" about the individual patient by scientific approaches such as EBM, "pictures" of individual patients constructed by medical experts allow for reasoning about the patient in clinical decision-making, for instance, in formulating relevant and testable questions and hypotheses that eventually guide toward proper diagnoses and predicting which cure may work as part of the treatment plan, or in explaining why a

treatment causes side effects. In clinical practice, the concept “model” has a different connotation; therefore, the word “picture” is used to characterize similar epistemic processes.

We have argued that the epistemological challenge for which doctors bear responsibility is how they build up the “picture” of each patient individually. This epistemic tool should therefore be evaluated in relation to relevant epistemic criteria, such as logical consistency and coherence with relevant knowledge. Another important epistemic criterion is utility for a specific situation. Therefore, contextual and personal information, such as the availability of a certain device in a hospital, a doctor’s experience, and a patient’s preferences, are all relevant in the epistemic activities of generating and using this “picture” toward diagnosis and treatment, because this information has an impact on how to make the best possible diagnosis and treatment decision for the individual patient in a *specific* situation.

Due to the heterogeneous character of the various aspects playing a role in the construction of an epistemic tool, it is not possible to construct this tool by means of rule-based reasoning only. Instead, constructing an epistemic tool (the “picture” of a patient) requires complex reasoning and assessment of evidence. Therefore, we have proposed that, instead of deferring responsibility to general clinical guidelines, as at least some interpretations of EBM seem to suggest, doctors should consider themselves *epistemologically responsible* for producing good quality diagnosis and treatment. In other words, by introducing the concept of epistemological responsibility, we allow for a richer and less rigid epistemology of clinical decision-making that leaves space for alternative modes of reasoning better suited to the epistemological challenges of clinical decision-making. However, in spite of the space for personal judgments by medical experts defended here, we wish to avoid a return to the justification of decisions on the basis of cognitively empty authority or “professional opinion.” By introducing the notion of epistemological responsibility, we point at specific responsibilities of clinicians toward the best possible execution of *epistemic activities* in diagnosis and treatment and at the accountability of clinicians for the quality of their decisions. Specific skills are required to perform epistemic activities responsibly, and these skills are an important aspect of medical expertise. A further characterization of these skills will therefore help clarify what it means for a clinician to be epistemologically responsible and to help assess the quality of expert decision-making.

Lorraine Code introduces the concept of epistemic responsibility as a “potential new focal point for theory of knowledge” (Code 1984, p. 29). Code draws analogies between ethical and epistemological reasoning processes to show how an epistemological inquiry can be approached by a study of intellectual virtues, instead of searching for foundations as in traditional foundationalism. Important for our argument is Code’s insight that, first, cognitive

agents (such as doctors) have an important degree of choice when it comes to reasoning, and second, they are accountable for these choices.¹ Therefore, in contrast to passive information-processers that are at best *reliable*, these agents should be evaluated in terms of responsibility. Following Code, we argue that the epistemological tasks of doctors involve a considerable amount of choice, deliberation, and justification, for which they are held responsible in our account of medical decision-making. By introducing these two notions, “epistemological responsibility” and “knowledge of a specific patient as an epistemic tool for reasoning,” we have shifted the focus from “epistemic truth” and passive rule-following to “epistemic use” and active knowledge-construction. Within the epistemological responsibility framework of medical decision-making, it makes sense to focus on what doctors actually do when they generate knowledge of a patient and make diagnostic and treatment decisions, in other words to the *epistemic activities* they perform.

In short, we have argued that clinicians are epistemologically responsible for constructing a “picture” of each individual patient from heterogeneous sources of evidence and using that “picture” as an epistemic tool for clinical reasoning. However, expecting doctors to bear responsibility for the execution of epistemic activities requires a detailed account of how competence in these actions is developed, how epistemic activities relate to medical expertise, and how they can be assessed, in order for doctors, students, and policy makers to know what a clinician’s accountability involves. Our framework provides useful leads for developing such an account: by shifting the attention from *what is known* to the *knower*, we return to a more doctor-centered account of clinical decision-making, and by focusing on *epistemic tools*, *epistemic use*, and *epistemic activities*, we point out that what matters for clinical decision-making is not only the knowledge and information that is used, but also *what a doctor does* with it, in other words, how that knowledge and information are used in the reasoning process to reach clinical decisions. Performing actions and using tools *well* require skills that are developed as a part of a professional’s *expertise*. In explicating how clinical expertise is developed and what it means to develop skills in performing epistemic activities, we will first evaluate Collins and Evans’s skill-based account of expertise.

MEDICAL EXPERTISE

Collins and Evans have developed a view of expertise in which expertise is not solely defined by the amount of formal knowledge possessed by individuals, but as something *practical*:² “something based in what you can do rather than what you can calculate or learn” (Collins and Evans 2007, p. 23). Central to their thesis on expertise is an immersion within a certain society, which

is necessary in order to gain expertise. They distinguish between two levels of specialist expertise, *interactional* and *contributory* expertise. They define interactional expertise as “expertise in the *language* of a specialism, in the absence of expertise in its *practice*” (ibid, p. 28). In other words, only immersion in the world of language is needed to acquire this kind of expertise, which requires only a “minimal body” that fulfills only the requirements that are necessary to learn a language. This is what they call “the minimal embodiment thesis” (ibid, p. 79). In contrast, they define contributory expertise as “enabling those who have acquired it [contributory expertise] to *contribute* to the domain to which the expertise pertains: contributory experts have the ability to *do* things within the domain of expertise” (ibid, p. 24). According to Collins and Evans, this requires full embodiment³ and immersion in a social group of experts of a domain.

Collins and Evans point out that all specialist expertise (interactional as well as contributory) involves a great deal of *specialist tacit knowledge*,⁴ defined by them as “things you know how to do without being able to explain the rules for how you do them” (ibid, p. 13). Therefore, in order to acquire any degree of specialist expertise requires interactive immersion in a specialist culture or *enculturation* “because it is only through common practice with others that the rules that cannot be written down can come to be understood” (ibid, p. 24). For medical specialists, this would mean that to master medical expertise requires to be immersed in the culture of day-to-day medical practice. An endorsement of this idea is the extensive system of apprenticeship teaching in the education of medical professionals: a large part of what a clinician learns is learned by “doing” in internships, residencies, and fellowships. Collins and Evans present a five-stage model of acquisition of contributory expertise—adopted from Dreyfus and Dreyfus (1986)—in which successive steps (from *novice* to *expert*) represent an increasing internalization of physical skills, exemplified by the process of learning to drive a car (ibid, pp. 24–25). This process hinges on the acquisition and mastering of skills, unselfconsciously recognizing contexts, and unselfconsciously acting accordingly. This unselfconscious decision-making in response to a certain context is what is considered as “tacit knowledge” by Collins and Evans. In addition, Collins and Evans emphasize that to understand expertise, one should focus on what experts *do* instead of what they *know*.

In short, in Collins and Evans’s account of what makes somebody an expert in a certain specialism involves—besides being familiar with the epistemic content—skills and enculturation, which in the case of high-level experts are largely tacit. Their account presents important reasons for the crucial role of (medical) expertise, but may unintentionally vindicate nontransparent authority-based reasoning in medical decision-making. Therefore, in our view, it has two shortcomings. First, it does not address acquisition and cultivation

of *cognitive skills* required to perform *epistemic actions*, and second, it does not provide an adequate account of tacit knowledge to analyze the quality of medical reasoning.

In everyday clinical practice, doctors are continuously performing epistemic actions, for example, hypothesizing which treatments will be beneficial, predicting the risk of adverse effects, or adjusting treatment plans and interpreting new information in light of what is already known about a patient. Collins and Evans focus mainly on the acquisition of physical skills and on enculturation (i.e., understanding and use of language and unwritten social rules) into the relevant group practices. Although we agree with them that in medical practice skills (such as surgical skills and communication skills), epistemic content (such as basic biomedical knowledge, knowledge of treatments, and up-to-date knowledge of clinical science) and acquaintance with the medical (hospital) culture (e.g., traditions, hierarchy, and behavioral etiquette) are all highly important, our point is that focusing on these aspect of expertise leaves out another aspect that is particularly crucial for clinical decision-making, which is the ability to perform specific epistemic actions related to medical reasoning at an expert level. Epistemic actions are similar to physical actions in that they generate a transformation from the initial state to another—for epistemic actions this concerns a change in an agent’s mental state, whereas a physical action results in the change of an actor’s environment. Furthermore, both epistemic and physical actions are temporarily confined and are directed toward achieving some goal (Neth and Muller 2008).⁵ Just as expertise in a certain specialism involves a specific set of physical actions that a person should master, it also involves a set of epistemic actions that experts are able to perform skillfully. Consequently, Collins and Evans’s ideas about the acquisition of expertise through experience and apprenticeships should be extended to include the acquisition and deployment of *cognitive skills*.

The second shortcoming of Collins and Evans’s account of expertise is their notion of tacit knowledge. They assign a pivotal role to tacit knowledge in expertise, for example, by describing expertise as an ability to tacitly make decisions in response to a certain situation or context. However, in their definition, tacit knowledge is inarticulate and therefore inaccessible for inquiry and evaluation. As a consequence, their account obscures an analysis of what it involves to make these decisions and what it means to be an expert in that respect. The problem with thinking about the skillful execution of epistemic actions in this way seems to be that expert decision-making and the knowledge used in the process become increasingly inaccessible to others, which increases the likelihood of referring to authority rather than epistemic quality in clinical decision-making.

In contrast, a fruitful interpretation of “tacit knowledge” in clinical reasoning for diagnosis and treatment would focus on *what kind* of knowledge is

used and *how* reasoning is performed tacitly, so that its strength, relevance, and application can be evaluated. For example, Michael Loughlin (2010) argues that “features of our knowledge that function tacitly in many contexts can, without contradiction, be made the object of explicit attention in others” (Loughlin 2010, p. 298). Loughlin argues that it is a mistake to assume that tacit knowledge is completely inarticulate in all situations. Stephen Henry (2010), analyzing how a physician in a neurological exam focuses on observing neurological symptoms while being tacitly aware of a patient’s body part, writes: “Whether information is tacit or explicit has less to do with its content than it does with how it functions in a particular situation” (Henry 2010, p. 294). In other words, tacit knowledge is not essentially different from explicit knowledge, and therefore, knowledge that functions tacitly in one situation can be reconstructed in another situation to study how it informs clinical decision-making. Hence, an account of tacit knowledge in medical reasoning need not be implicit and mysterious.

Summing up, Collins and Evans show that tacit knowledge plays a pivotal role in expertise, but their view of tacit knowledge as inarticulate does not clarify how to evaluate the reasoning process. Referring to inarticulate tacit knowledge as a justification of clinical decisions and actions is not enough to hold clinicians accountable for the decisions they make. In order to ensure the quality of clinical decision-making for diagnosis and treatment, a better understanding of tacit knowledge is needed, which is why we will revisit the original definition by Michael Polanyi.

TACIT KNOWLEDGE

Michael Polanyi first introduced the concept “tacit knowledge” in his book *Personal Knowledge: Towards a Post-Critical Philosophy* (1958) and further explicates this notion in *The Tacit Dimension* (1966). His idea has been widely taken up to make sense of situations in which experience, know-how, and practice play important roles. For example, the notion of tacit knowledge has been important in the (sociological) analysis of scientific practices, such as gravitational physics labs, and the realization that in such practices, in addition to knowledge, theories, and concepts, skills and personal contacts are crucial (for example, see Collins 2001). However, over the years, tacit knowledge has come to mean “inarticulate,” and therefore as not transferable and inaccessible by others. This conception of tacit knowledge leads to obfuscating and mystifying expertise and is therefore seemingly unsuitable as a concept to clarify expert knowing. In contrast, Polanyi’s original notion is much more detailed and refined and therefore appears to be very helpful in better understanding expertise.

In Polanyi's epistemology, knowing comprises two types of awareness: the *subsidiary* and the *focal* (Polanyi 1958, p. 57; also see Mitchell 2006, p. 71). Focal awareness is the conscious object of our awareness, whereas subsidiary awareness includes a variety of background clues that enable focal awareness. An example to understand these two kinds of awareness is the recognition of somebody's face: "We know a person's face, and can recognize it among a thousand Yet we usually cannot tell how we recognize a face we know" (Polanyi 1966, p. 4). Polanyi goes on to explain that faces consist of a collection of particular physiognomics such as a nose, a mouth, eyes, ears, etc. In recognizing a face, we are not consciously aware of all the particulars of a face, but rather by integrating our awareness of its particulars, as subsidiaries, in order to recognize the whole, the face that is our focal awareness. This is, according to Polanyi, "the outcome of an active shaping of experience performed in the pursuit of knowledge" (ibid, p. 6). Therefore, in tacit knowing, the *knower* is the third essential element. These three elements make up a *from-to* relationship: the knower "attend[s] *from* the subsidiaries *to* the focal target" (Mitchell 2006, p. 73).

According to Polanyi, the *use of tools* (e.g., technological instruments such as a probe) also involves "incorporation" in our subsidiary awareness. He calls this process, in which the use of a tool moves from focal to subsidiary awareness, "indwelling." For example, when an ultrasound is made, a doctor dwells in the probe to observe organs that remain otherwise unseen: "It is not by looking at things (particulars), but by dwelling in them that we understand their joint meaning" (Polanyi 1966, p. 20). As we have characterized the picture doctors develop of their patients as *epistemic tools*, we can understand the use of these tools in a similar fashion. The use of epistemic tools or theories become part of our subsidiary awareness; it is "interiorized" to understand something, extending the cognitive apparatus of the knower. It is, however, important to note that subsidiary awareness is *not necessarily* unconscious awareness, because the use of the tool, such as the ultrasound apparatus or the epistemic tool, can always be brought back to the focal awareness, for instance when inspecting its proper functioning or adequateness. But this is at the cost of focal awareness of the observed object. When one draws their attention away from the focal attention to the subsidiaries, the conception of the entity—which is recognized or understood through the subsidiary use of technical or epistemic tools—is destroyed, in the same way as a pianist who, when turning her attention from the music to the separate notes and the movement of her fingers, will likely become confused and cease to play (ibid, p. 73).

In other words, part of the "triad" will remain unspecifiable, as it is impossible to focus one's direct attention on it. In summary, Polanyi recognizes that although during the act of knowing, it is impossible to articulate which

particulars make up the background clues of the subsidiary awareness, it is very well possible to make a reconstruction (although this is usually not a complete account of how knowledge is perceived). Furthermore, Polanyi explicates the relationship between what is tacitly known and what is consciously known.

We will now apply Polanyi's original conception of tacit knowing to analyze skillful execution of epistemic actions in clinical decision-making. Conversely, this analysis serves as an illustration of Polanyi's understanding of tacit knowledge. Within our framework of epistemological responsibility in clinical decision-making, epistemic actions can be divided into three broad activities. First, the gathering and critical assessment of relevant information, second the *construction* of a coherent "picture" of the individual patient from these heterogeneous pieces of information, and third the application and adaptation of this "picture" (van Baalen and Boon 2015). Being competent in these specific epistemic activities is an important aspect of the expertise of doctors, which allows them to face the main epistemological challenges of clinical practice responsibly.

Gathering and Assessment of Information

Physicians need to gather relevant information by searching the literature and textbooks, by ordering lab tests and images, by physical examination of the patient, and by taking the patient's medical history. In all of these situations, the *relevance* and *utility* of the information for the particular patient needs to be assessed—for example, in the case of a literature search. As the clinical encounter usually commences with the question "what brings you here today?" (Montgomery 2006), the first set of information that doctors collect is a patient's account of their symptoms. While searching the scientific literature and textbooks, the particular signs and symptoms of a patient function as tacit knowledge, residing in a clinician's *subsidiary awareness*, from which clinicians are able to direct their *focal awareness*, to the question to be answered, thereby assessing the relevance of the information that is coming across. In short, deciding on what information to use in a particular case, which is an *epistemic action*, relies on the tacit use of knowledge of particular aspects of a patient. Conversely, when doctors attend to their patients to gather information through physical exam and medical history taking, theoretical information functions as *subsidiary awareness*, as background information about possible diagnoses and pathophysiological mechanism that cause the symptoms, from which clinicians direct their *focal awareness* to the conversation with the patient and the proceedings of the exam. As such, the subsidiary information functions as a conceptual and theoretical framework that allows coming up with and asking the right questions, interpreting the

answers, and subsequently following up on them. Thus, in contrast to the appraisal of textual information, the gathering of particular patient information requires the subsidiary use of theoretical knowledge while directing one's focal awareness to performing epistemic activities such as prioritizing certain questions and interpreting answers in light of prior knowledge.

As Collins and Evans contend, the subsidiary information that experts use tacitly is often selected unselfconsciously. However, it is a mistake to conclude, as they seem to suggest, that subsidiary information cannot be identified and evaluated and that choices that were made unselfconsciously are unjustifiable. It is possible to check, for instance, whether the theoretical information used in clinical decisions was up-to-date and relevant for the specific case at hand. Examples of such inquiries are: Is the information based on good quality science, and if such scientific support is not available, what else warrants the use of that piece of information? When the patient's story is subsidiary, which information is given priority and for what reason? Did the physician obtain the story firsthand? Is the patient considered to be a trustworthy source? Did the patient provide enough information? These examples illustrate that, although knowledge is used tacitly and involves a considerable amount of choice and variability, physicians can be held accountable for the quality of knowledge they use and how they use it.

Constructing the Epistemic Tool in the Sense of a "Picture" of the Patient

In order to construct a useful epistemic tool (i.e., the "picture" of an individual patient), it is necessary that the information gathered by a clinician—the written, scientific, or general knowledge as well as patient-specific evidence such as lab results, imaging, and clinical history—is comprehensive, relevant, and up-to-date. Subsequently, the construction and use of such an epistemic tool involves tacit knowledge and epistemic activities. For example, in fitting the different pieces of information together, these pieces need to be weighted and mutually adjusted, which requires epistemological choices and an active involvement of the epistemic agent. Tacitly, thus in their subsidiary awareness, prior experience with similar patients is used to draw analogies with the current patient. Through the subsidiary awareness of biomedical knowledge, the relevance of certain signs or symptoms can be assessed and weighted in relation to others. By subsidiary awareness of results from earlier tests, the results of new tests can be interpreted and fitted in with what is already known. When a disease develops over time, an up-to-date picture of a patient is obtained through subsidiary awareness of the prior instances of the disease in that patient. Such uses of tacit knowledge allow doctors to fit together relevant information (the "particulars") according to epistemic criteria, such

as internal logical consistency, coherence with background knowledge, and comprehensiveness of information, thus directing their focal awareness to “whole,” the resulting “picture” that is under construction.

The Adaptation and Application of a “Picture” of the Patient

The resulting “picture” functions as an epistemic tool that allows epistemic actions, such as further reasoning, hypothesizing, and making diagnostic and treatment decisions.⁶ In these cases, the epistemic tool, similar to physical tools, is used tacitly, focusing the attention on the *goal* of performing epistemic action (e.g., to draw up a possible diagnosis). In Polanyi’s words, talking about physical tools in quite similar ways as Collins and Evans, “We are attending to the meaning of its impact on our hands in terms of its [the physical tool’s] effect on the things to which we are applying it” (Polanyi 1966, p. 13). The use of such a tool requires *skills*. Mastering cognitive skills in clinical practice is in that sense on the same footing as physical skills, as also recognized by Polanyi: “The art of the expert diagnostician ... we may put it in the same class as the performance of skills, whether artistic, athletic or technical” (Polanyi 1966, p. 6). In other words, the cognitive skills that enable a medical expert to perform diagnosis are similar to the skills of painters handling their brush and paint, a football player skillfully passing his opponent with a ball, or a surgeon closing a wound with sutures. And, similar to other skills, different levels of mastery can be obtained, from novice to expert level, through practice and experience. Analogous to the responsibility of clinicians to ensure their competence in physical skills,⁷ doctors have a responsibility to develop and cultivate their cognitive skills, which is part of their *epistemological responsibility*.

Finally, Polanyi’s notion of tacit knowledge enables us to better understand two other important aspects of medical expertise playing a role in the three epistemic activities just listed, which set experts apart from novices. First, the ability of experts to deploy large amounts of information, including text-book knowledge and experience in their subsidiary awareness while focusing their attention on the patient at hand. When faced with cognitive tasks, a range of earlier acquired knowledge and information is tacitly invoked through which experts focus on the epistemic action. In contrast, novices still need to direct their focal attention to particulars such as theoretical information while talking to the patient or focus on patient particularities while searching for information. Analogous to the piano player who becomes confused when focusing on separate notes or finger movements, this focusing of attention impedes the execution of epistemic actions. Thus, similar to the mastery of *physical skills*, doctors and other experts master cognitive skills through practicing and improving their epistemic actions, being able to include more and more knowledge tacitly while being focused on the specific action.

A second aspect that sets experts apart from novices is the tacit recognition of relevant patterns. By having gained experience from diagnosing and treating many patients, expert clinicians have collected a wide range of exemplary cases including signs and symptoms, the diagnosis that followed, the choice of treatment, and the clinical outcome. Clinicians are able to group these cases together according to similarities and differences between cases and distill what combination of signs and symptoms, measurements, and other evidence suggests that a case belongs to a certain group. In interaction with patients or evidence, these patterns enable to recognize possible diseases and direct courses of action. Tacit pattern recognition can be compared to chess grandmasters—an example used by Polanyi—who recognize patterns in the way the pieces are positioned on the board without having to assess the position and possible course of each individual piece and who can act accordingly. Such a catalogue of patterns is build up through practice and from prior experience. Important to our argument is that, very similar to theoretical knowledge acquired in formal education, this catalogue of patterns operates as subsidiary awareness, allowing physicians (and chess grandmasters) to recognize what is going on and how to handle it. This is not to say that pattern recognition is a justification for a medical decision at the same level as theoretical and evidence-based knowledge. Instead, it is an indispensable mechanism that fills the gaps not yet covered by formally tested knowledge. Furthermore, pattern recognition enables physicians to direct their reasoning and search for further information. Although patterns are recognized tacitly, instantly, and unselfconsciously, they are open to evaluation, and physicians are responsible for the conclusions they reach on the basis of a recognized pattern.

EPISTEMOLOGICAL RESPONSIBILITY OF EXPERTS IN CLINICAL DECISION-MAKING

One of the main criticisms against the epistemology of EBM is that it wrongly assumes that the role of expertise in medical decision-making can and should be reduced in order to increase objectivity and quality. Nevertheless, EBM has rightfully challenged “authority-based” decision-making, by demanding quality in accordance with scientific standards. In this chapter, we have reconciled EBM’s call for quality decision-making with medical expertise. We have argued that what seems to be missing in current accounts of medical expertise is an understanding of the role of the reasoning process in medical decision-making about individual patients. Therefore, we have argued that a more detailed analysis of what medical expertise entails is needed. We have first turned to Collins and Evans, who have highlighted

that expertise is about what experts can do rather than primarily about what they know and who have pointed out that tacit knowledge is a central trait of experts. In addition to their analysis, which focuses on cultural integration, mastering physical skills, and epistemic content, we have argued that an understanding of expertise must also include the role of cognitive skills. Furthermore, it should include an explanation of *how* tacit knowledge allows experts to practice their expertise. Michael Polanyi's original notion of tacit knowledge is richer and more detailed than that usually put forward by authors defending medical expertise. Polanyi describes tacit knowing as a triad consisting of three components: the knower, their subsidiary awareness, and their focal awareness. This triadic conception allows for a more fine-grained analysis of the epistemic actions that make up decision-making for diagnosis and treatment, and of how tacit knowledge is a specific trait of experts in comparison to novices.

An important result of elucidating the role of tacit knowledge in expertise is that it clarifies how medical experts can be held accountable for epistemic activities in medical decision-making. We have argued that cognitive skills and competence in epistemic actions are considered to be crucial aspects of medical expertise and doctors have a responsibility to develop, acquire, and cultivate these skills and competence in a similar way as they have a responsibility to develop, acquire, and cultivate physical skills such as surgical skills. We follow Collins and Evans in their claim that tacit knowledge plays a pivotal role in expertise, but we refuse to regard it as inarticulate and therefore hidden from evaluation. Rather, by referring to Polanyi's original conception of tacit knowing, we showed that there is a distinction between subsidiary and focal attention and that knowledge in one's subsidiary awareness can be opened up to scrutiny, so that doctors can be held accountable for what information is used tacitly, be it textbook knowledge, outcomes from RCTs, or experience. What information is used, in either one's subsidiary or focal awareness, should be justifiable by the knower. By giving an account of how medical experts employ tacit knowledge and how they become skilled in performing epistemic activities, we have detailed what the epistemological responsibility of doctors entails.

In conclusion, a crucial aspect of medical expertise is competence in performing epistemic activities, which requires cognitive skills, and similar to physical skills, mastering cognitive skills entails internalization, or tacit knowledge. Doctors can and should be held accountable for how well they perform epistemic activities in decision-making. This means that they can be held responsible for acquiring, developing, and maintaining competence in cognitive skills, and also that they bear responsibility for the quality of the knowledge and reasoning processes. This is what we have called their "epistemological responsibility."

NOTES

1. Code argues that this epistemology would parallel an ethics based on moral virtues, and hence investigates which *intellectual virtues* an epistemologically responsible agent should possess. In order to connect to theories of expertise, we will focus on skills rather than virtues, but still similar to Code, emphasize the importance of *cognitive skills*.

2. Collins and Evans introduce this “wisdom-based or competence-based model” as an alternative to the way that expertise has been understood, which has developed over the last half-century, inspired by phenomenological philosophers such as Heidegger and Merleau-Ponty, and ideas from philosophers like Polanyi and Wittgenstein.

3. One thing that might be argued for medical expertise is that only a minimal body is required for epistemic action, and therefore, people with only *interactional medical expertise* are capable of performing clinical judgment. However, the point that we want to make in this chapter is not that medical expertise is a particular kind of expertise that can be fully characterized by considering the relevant epistemic activities. Rather, we argue that, in order to fully explicate medical expertise, our account of expertise should be widened to include, besides knowledge and physical skills, also cognitive skills.

4. Collins and Evans contrast “specialist expertise” to “ubiquitous expertise,” the latter including “all the endlessly indescribable skills it takes to live in a human society” (Collins and Evans 2007, p. 16). They argue that ubiquitous expertise requires *ubiquitous* tacit knowledge, which is acquired through immersion in society in general, whereas specialist tacit knowledge requires immersion in a community of specialists.

5. Neth and Muller distinguish between *practical* versus *theoretical* action because earlier work in cognitive science used *epistemic actions* to describe “physical actions that improve cognition by facilitating or reducing the need for internal computations” (Neth and Muller 2008, p. 994). We adopt the term “epistemic action” to emphasize the relation with the two other notions introduced to account for the cognitive side of “expertise,” *epistemic tools* and *epistemological responsibility*.

6. It is important to note that an epistemic tool is a “tool in its own making” (Knuutila and Boon 2011, p. 318): as it is being used to formulate questions and hypotheses, it is adapted to newly gained insights. In other words, it *develops* through its use, in an interaction between tacitly held knowledge, experience, explicit reasoning, in consultation with others, and by including new information. In addition, the epistemic criteria mentioned above (consistency, coherence, specificity, and comprehensiveness) remain continuously relevant, in both the construction and use of an epistemic tool. Thus, although the epistemic actions differ between construction and use of an epistemic tool, a distinction between the two are analytical rather than being two consecutive, distinct steps in the diagnostic process.

7. In the Dutch health care law, doctors carry a personal responsibility to develop and cultivate their competence in medical procedures (“geneeskundige handelingen”) that are reserved to be solely performed by professional clinicians.

REFERENCES

- Boon, Mieke, and Tarja Knuuttila. 2009. "Models as Epistemic Tools in Engineering Sciences: A Pragmatic Approach." In *Philosophy of Technology and Engineering Sciences*, edited by Anthonie Meijers, 687–720. North Holland: Elsevier Science & Technology.
- Code, Lorraine. 1984. "Toward a Responsibilist Epistemology." *Philosophy and Phenomenological Research* 45:29–50.
- Collins, Harry, and Evans, Robert. 2007. *Rethinking Expertise*. Chicago, London: The University of Chicago Press.
- Collins, Harry M. 2001. "Tacit Knowledge, Trust and the Q of Sapphire." *Social Studies of Science* 31(1):71–85.
- The Evidence-Based Medicine Working Group. 1992. "Evidence-Based Medicine: A New Approach to Teaching the Practice of Medicine." *JAMA* 268(17):2420–2425.
- Greenhalgh, Trisha, Jeremy Howick, and Neal Maskrey. 2014. "Evidence Based Medicine: A Movement in Crisis?" *BMJ* 348. doi: 10.1136/bmj.g3725.
- Knuuttila, Tarja, and Mieke Boon. 2011. "How Do Models Give Us Knowledge? The Case of Carnot's Ideal Heat Engine." *European Journal for Philosophy of Science* 1(3):309–334.
- Loughlin, Michael. 2008. "Reason, Reality and Objectivity—Shared Dogmas and Distortions in the Way Both 'Scientific' and 'Postmodern' Commentators Frame the EBM Debate." *Journal of Evaluation in Clinical Practice* 14(5):665–671.
- Loughlin, Michael. 2009. "The Basis of Medical Knowledge: Judgement, Objectivity and the History of Ideas." *Journal of Evaluation in Clinical Practice* 15(6): 935–940.
- Loughlin, Michael. 2010. "Epistemology, Biology and Mysticism: Comments on 'Polanyi's Tacit Knowledge and the Relevance of Epistemology to Clinical Medicine'." *Journal of Evaluation in Clinical Practice* 16(2):298–300.
- Mitchell, Mark T. 2006. *Michael Polanyi: The Art of Knowing*. Wilmington, Delaware: ISI books.
- Montgomery, Katherine. 2006. *How Doctors Think: Clinical Judgment and the Practice of Medicine*. New York: Oxford University Press.
- Neth, Hansjörg, and Thomas Muller. 2008. "Thinking by Doing and Doing by Thinking: A Taxonomy of Actions." *Paper presented at the 30th Annual Meeting of the Cognitive Science Society*, Austin, TX.
- Polanyi, Michael. 1958. *Personal Knowledge: Towards a Post-Critical Philosophy* (1974 ed.). Chicago and London: The University of Chicago Press.
- Polanyi, Michael. 1966. *The Tacit Dimension*. Chicago and London: The University of Chicago Press.
- Tanenbaum Sandra J. 1993. "What Physicians Know." *New England Journal of Medicine* 329(17):1268–1271.
- Tonelli, Mark R. 1998. "The Philosophical Limits of Evidence-Based Medicine." *Academic Medicine* 73:234–240.
- Tonelli, Mark R. 2006. "Evidence Based Medicine and Clinical Expertise." *JAMA* 8(2):71–74.

- van Baalen, Sophie, and Mieke Boon. 2015. "An Epistemological Shift: From Evidence-Based Medicine to Epistemological Responsibility." *Journal of Evaluation in Clinical Practice* 21(3):433–439.
- Worrall, John. 2002. "What Evidence in Evidence-Based Medicine?" *Philosophy of Science* 69(S3):S316–S330.
- Wyer, Peter C., and Suzana A. Silva. 2009. "Where is the Wisdom? I—A Conceptual History of Evidence-Based Medicine." *Journal of Evaluation in Clinical Practice* 15(6):891–898.