



The Role of Biomedical Knowledge in Clinical Reasoning: Bridging the Gap between Two Theories

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Theoretical Study

Abstract

There has been a long-lasting debate on the role of biomedical knowledge in physicians' clinical reasoning. There are two major views. The two-worlds theory assumes that biomedical knowledge and clinical knowledge are two different worlds and that biomedical knowledge is not involved in clinical reasoning of expert doctors. However, according to the knowledge encapsulation view, biomedical knowledge still has an influential role in doctors' clinical reasoning and medical problem solving. Based on the illness script theory, it can be concluded that these two views have two different definitions for basic science. In the knowledge encapsulation theory, pathophysiology stands for basic science, while in the two-worlds theory, basic science is equal to normal body function and structure. This is because illness script theory clearly highlights the primacy of practice in medicine, and according to this theoretical framework, bridging the gap between two theories becomes possible.

Keywords: Biomedical knowledge, Clinical reasoning, Two-worlds theory, Knowledge encapsulation theory, Illness script theory

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Introduction

There has been a long-lasting debate on the role of biomedical knowledge in medical education. Especially within the literature, there is a debate about the role of biomedical knowledge in the physician's clinical reasoning. There are two major views on the role of biomedical knowledge: The knowledge encapsulation view and the two-worlds view (Schmidt & Boshuizen, 1993a; Schmidt & Boshuizen, 1993b; Schmidt & Boshuizen, 1992; Schmidt, Boshuizen, & Hobus,

1998; Schmidt, Norman, & Boshuizen, 1990; Rikers, Schmidt, & Boshuizen, 2002a; Rikers, Schmidt, & Boshuizen, 2002b; Rikers, Loyens, & Schmidt, 2004; Rikers, Loyens, Winkel, Schmidt, & Sins, 2005; Van de Wiel, Boshuizen, & Schmidt, 2000; Patel, Arocha, & Zhang, 2005; Patel, Evans, & Groen, 1989a; Patel, Evans, & Groen, 1989b; Patel & Kaufman, 1995; Patel, Arocha, & Kaufman, 1994). In general, the two-world view assumes that biomedical knowledge and clinical knowledge are two different worlds and that biomedical knowledge is not involved in the clinical reasoning of expert doctors. However, according to the knowledge encapsulation view, biomedical knowledge still

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has an influential role in doctors' clinical reasoning and medical problem solving.

In the present article, the two theories are briefly defined, and then, by introducing illness script theory and making distinction between basic science and pathophysiology, the role of biomedical knowledge in clinical reasoning is investigated in a comprehensive mode. The aim of this study was to resolve the controversy between these two views based on the illness script theory.

Knowledge encapsulation theory

The knowledge encapsulation theory posits that through courses in the basic sciences at the first stages of their medical training, medical students would acquire a network of causal knowledge. Therefore, in order to make sense of patient information, they will use their detailed, elaborated pathophysiological knowledge. Because of this detailed processing and lack of relevant clinical knowledge, the medical student will experience more difficulty in providing an accurate diagnosis. Gradually, by encountering many different patients, the mental structure of the medical student changes and gains more organized knowledge. On the other hand, doctors no longer explicitly refer to the biomedical concepts in their clinical reasoning. An examination of doctors' clinical reasoning process shows that a few clinical concepts like *forward failure* or *venous congestion* were used to explain the case of congestive heart failure (CHF). These concepts are sufficient to understand all relevant signs and symptoms without the need to engage in a detailed biomedical mode as most students do. This is why doctors hardly use any biomedical concepts, and mainly use clinical concepts. As mentioned before, Schmidt and Boshuizen have called these concepts "encapsulated" because they summarize such biomedical knowledge under diagnostic labels (e.g., forward failure and pulmonary edema), which are simplified causal models that explain signs and symptoms (Schmidt & Boshuizen, 1993a; Schmidt &

Boshuizen, 1993b; Schmidt & Boshuizen, 1992; Schmidt et al., 1998). These encapsulated concepts develop as a result of extensive application of biomedical knowledge and especially through encountering patient problems in medical diagnostic situations (Schmidt & Boshuizen, 1993a; Schmidt & Boshuizen, 1993b; Schmidt & Boshuizen, 1992; Schmidt et al., 1998; Schmidt et al., 1990; Rikers, Schmidt, & Boshuizen, 2002a; Rikers, Schmidt, & Boshuizen, 2002b; Rikers, Loyens, & Schmidt, 2004; Rikers et al., 2005). The studies by Boshuizen and Schmidt (1992, 1993a, 1993b) showed that although encapsulated knowledge is important in developing clinical reasoning skill, only 10% of what internists remember after reaching clinical diagnosis (regarding case description) is pertinent to encapsulated knowledge. Similarly, Rikers et al. (2004) have shown that the recollection of knowledge of basic sciences among cardiologists was 17%, and consequently, this means that 83-90% of their clinical reasoning is related to clinical sciences instead of pathophysiology. To sum up, knowledge encapsulation theory claims that biomedical concepts, in terms of pathophysiology, play a minor role in expert doctors' clinical reasoning.

Two-worlds theory

The two-worlds view, on the other hand, assumes that biomedical knowledge is not involved in the clinical reasoning of expert doctors, as basic science and clinical science are two different worlds (Patel et al., 2005; Patel et al., 1989a; Patel et al., 1989b; Patel & Kaufman, 1995; Patel et al., 1994). This view has questioned the role of well-developed encapsulated knowledge structures in doctors' knowledge based on the misconception of physicians' biomedical explanations. In this sense, clinical knowledge is more likely based on signs and symptoms of diseases; however, basic sciences are made of principles and rules of how the body normally works. Based on the studies by Patel et al., it could be concluded that clinical

medicine and biomedical sciences constitute two distinct and not completely compatible worlds with distinct modes of reasoning and quite different ways of structuring knowledge (Patel et al., 2005; Patel et al., 1989a; Patel et al., 1989b; Patel & Kaufman, 1995; Patel et al., 1994).

Illness script theory

Illness script theory assumes that medical practice-based knowledge is organized in a disease-oriented structure and contains all information needed for patient diagnosis and management.

Based on the illness script view, knowledge encapsulation is not the last stage in the progression towards expertise. Having encapsulated concepts, such as forward failure, is not enough to enable doctors to deal with real patients (Charlin, Tardif, & Boshuizen, 2000; Charlin, Boshuizen, Custers, & Feltovich, 2007; Custers, Boshuizen, & Schmidt, 1998; Custers, Boshuizen, & Schmidt, 1996; Monajemi & Rikers, 2011; Monajemi, Rikers, & Schmidt, 2007). Instead of using biomedical knowledge, the features that characterize the clinical presentation of a disease become the anchor points of reasoning for experts. An expert's knowledge is much richer than encapsulated knowledge, and it contains much more information about all the different facets of diseases; about how diseases are acquired, how they manifest in patients, and which risk factors predispose them. All the information that doctors have about diseases is organized in a structure called the *illness script*. It is an integrated knowledge structure consisting of at least three parts: *faults*, *consequences*, and *enabling conditions* (Charlin et al., 2000; Charlin et al., 2007; Custers et al., 1998; Custers et al., 1996). Faults are pathophysiological malfunctions that constitute the biomedical core of the disease and are usually subsumed under a diagnostic label (e.g., right-sided heart failure and pulmonary edema). Consequences are about the clinical manifestations of a disease such as complaints, signs, and symptoms (e.g., chest pain, dyspnea,

and fatigue). Finally, enabling conditions are the patient's background information (e.g., age, sex, medical history, drug history, family history of diseases, occupation, and living environment) that generally make the occurrence of a certain disease more or less likely (Charlin et al., 2000; Charlin et al., 2007; Custers et al., 1998; Custers et al., 1996; Monajemi & Rikers, 2011; Monajemi et al., 2007).

Illness scripts and encapsulated knowledge are formed during the course of years of training and practice; hence, they differ strongly between students and doctors (Charlin et al., 2000; Charlin et al., 2007; Custers et al., 1998; Custers et al., 1996). In the early stages of medical expertise development, biomedical knowledge plays an important role in constructing scripts for diseases. As students begin to practice with actual patients, their biomedical knowledge becomes encapsulated and will be reorganized into illness scripts (i.e., fault section). In this phase, the newly formed illness scripts consist of signs, symptoms, and complaints (i.e., consequences) that are held together by a network of biomedical explanations (Custers et al., 1996). With increasing expertise, the role of biomedical knowledge becomes less important, while, simultaneously, the role of clinical science becomes more important. The integration of clinical science into illness scripts is a consequence of a long period of clinical practice with real patients (Charlin et al., 2000; Charlin et al., 2007; Custers et al., 1998; Custers et al., 1996).

Conclusion

If we take a closer look at the definition of biomedical science or basic science in these two views, i.e. knowledge encapsulation and two-worlds views, it could be concluded that these two views have two different definitions for basic science. In the knowledge encapsulation theory, pathophysiology stands for basic science, while in the two-worlds view, basic science is equal to normal body function and structure, i.e. anatomy, physiology, and etcetera. Basic science like physiology, anatomy, and biochemistry is

the study of normal, healthy bodily function and structure (Whitcomb, 2006). Pathophysiology, on the other hand, is the study of the changes of normal mechanical, physiological, and biochemical functions, either caused by a disease or resulting from an abnormal syndrome. This type of knowledge plays a role in clinical reasoning and is integrated into illness script structure as the fault component. Illness script structure serves as a basis to link these two opposing theories. In most medical schools, medical students usually learn the basic science about a normal and healthy body in the first two years of their education, and after that, pathophysiology becomes the focus of their education. Medical students progress through different stages of knowledge restructuring (i.e., *encapsulation* and *illness script*) in which their knowledge is finely tuned towards practical situations. The integration of the two types of knowledge leads to a more holistic approach to case processing, focusing mainly on the clinical presentation of patients.

Illness script theory clearly highlights the primacy of practice in medicine. According to Schmidt and Boshuizen (1993a, 1993b) the experts' biomedical knowledge has become fully integrated with their clinical knowledge as a result of repeated exposure to a large number of real patients. Consequently, patient encounter, and in other words, clinical practice frames the doctors' knowledge structure and determines the role of basic science. This is why medical students mainly use their extended biomedical knowledge to explain case data, leading to elaborate and detailed case processing. In contrast, biomedical knowledge only plays a minor and implicit role in experts' clinical reasoning.

This primacy of clinical practice in medicine vividly shows that it is not possible for medicine to be grounded only in pure science (Lock, 1990). Medicine remains fundamentally grounded in the meeting between doctor and patient. As the need for this meeting begins with

the first acknowledgement by the patient that something is wrong, in each theory about clinical reasoning, the role of patient-doctor encounter must be prominent and this insight must be continuously worked through the process of diagnosis and management (Lock, 1990). Illness script theory not only correctly highlights the primacy of clinical practice, but also shows how this practice frames both the structure of medical knowledge and the role of basic science in clinical reasoning. It seems that besides having knowledge of the diagnosis of the illness and the way it should be managed, clinical practice is the heart of medicine; something that future research may shed further light on.

Conflict of Interests

Authors have no conflict of interests.

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