

THE PHYSICIAN VERSUS THE SCIENTIST

An essay on differences between the medical practitioner and the biomedical researcher in their professional aims, methods, conceptual reasoning and mission

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received: 15.9.2018;

revised: 30.10.2018;

accepted: 12.11.2018

SUMMARY

The physician is the central figure in practical medicine. The biomedical researcher is the central figure in scientific investigation of biomedical phenomena. Both sides contribute to understanding of physiology of health and disease. In this paper, several epistemological, value-related attitudes, ethical and pragmatic differences between the two sides are outlined. Distinguished professional features stem out of differences in respective missions, education, methodology, ethical concerns and ways of reasoning. Clinical expertise is driven by benefits of the patient, whereas researcher expertise is driven by scientific curiosity towards more reliable knowledge. The eight operational and four cognitive/epistemological differences of scientific versus clinical expertise are shortly discussed. Those pairs of differences are not necessarily reducible to each other. Better understanding of these standpoints may be important for closer communications of two sides and their contributions to applicative and cognitive advancements of human physiology.

Key words: practical medicine - physician - deontology - researcher - cognitive procedure - observation - experimental approach - fuzzy logic - holistic approach - reductionistic approach

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INTRODUCTION

Contemporary understanding of a nature of health and disease has become increasingly dependent on understanding technology, computation, and principles mathematical reasoning. Recent advances of molecular omics' technologies have enabled the rapid and massive collection of molecular data with a potential relevance to patients' physiology. Information managing systems have acquired the unprecedented capacities of storage/retrieving of data, computing performance and interactive presentation. The completion of the human genome project in the year 2003 has marked the start-up of a new era in human biology and medicine. A new impetus towards more complete understanding of intricate bio-complexity of human body physiology and pathophysiology has become a working reality. The new visions and quests for a prospective integral understanding and knowledge practical application have become an immediate academic and practical agenda. Classical medical horizons and some aspects of clinical reasoning have been re-adjusted and re-shaped with the advent of molecular data plethora and expanded theoretical frameworks. Several powerful technological advancements have entered into clinical diagnostics, therapy and patients' management. A conversion of dominantly reactive medicine into more proactive system has been launched as a broader societal undertaking (Hood 2012). Such demands are heavily dependent on theoretical and broader cognitive shifts in understanding of life complexity in health and disease (Joyner 2011, Islam 2016).

It is a fact that the unprecedented advancements of molecular research during last three decades have not been paralleled with a similar pace in practical medicine. Presently, there is a "dramatic disproportion" in between the quantity of measurable and accumulated data and a degree of their expected applications in medicine. Integrative physiology and pathophysiology have been struggling with putting together a comprehensive and usable working expertise that would be more efficient in clinical usage of big molecular data sets. Various methodological approaches have been developed to reduce the chasm and to improve integral understanding. The principles of the system biology have been applied in the system medicine approach (Vandamme 2013, Kirschner 2018); translational medicine movement facilitates a closer collaboration of basic and clinical research led by the applicative agenda (Cerami 2014, Schwaiger 2016); algorithmic and clustering networking analysis and re-synthesis offers a new vision and practice of pathophysiology reasoning (Kovač 2014, 2015); evidence based medicine enforces "explicit, conscious and judicious use of the best current evidence" to the benefit of patient (Kovač 2012, Heneghan 2017, Horwitz 2017); personalized/precise medicine imposes the individualized approach to the patient and to the diseases (Aronson 2015, Sagner 2017, Haendel 2018); etc. These approaches are not necessarily mutually exclusive. It seems all these approaches are faced with the same cognitive problem hidden behind the scene of the human brain functioning and clinical/basic science methodologies applied. This paper outlines several constitutive

differences between the scientists and the physicians which can be distinguished in their respective professional roles in medicine, and ways of reasoning.

OBSERVATIONAL AND EXPERIMENTAL NATURE OF EMPIRICAL KNOWLEDGE AND PROFESSIONAL REASONING

Classical medical education, training, university curricula and daily physician practice has dominantly been based on empirical knowledge. Such knowledge has been a cumulative wisdom of experience of the past. Throughout the centuries the observation and careful recording of noted phenomena were habituated principles of the physicians' expertise. The future medical practitioners were prepared, coached and up-dated in the same way. Medical books, teaching materials and study methodology has been led by a traditional expert-based knowledge transfer. Doctors' professional formation is primarily shaped through apprentice-like strategy. The students imitate their professors/teachers in their practical methodology, clinical reasoning and professional standards. A student has been thought and coached to be a doctor by acting as his/her teachers' assistant. They adopt professional doctrines as a formal thinking, useful in everyday practice (Rall 2016). During their professional life physicians additionally enrich and strengthen their expertise based on daily elaboration of the patient problems. Physicians' empirical reinforcement has step-by-step lead to a professional doctrine in a form of "medical common sense knowledge" and "common sense reasoning". The persistence of such empirical, mainly observational, approach through a long history of medicine has proved its fundamental validity, and nowadays medicine uses it as her constitutive approach. The empirical principle has been equally applied in preventive, curative and palliative medicine (Kovač 2017). In contemporary medicine prevailing policy of specialization and sub-specialization is designed according to same empirical principle. In addition, pharmacological industries have contributed significantly to empirical knowledge which has been infused through myriads of capillary communications to doctors, and *vice versa*.

Starting with Claude Bernard (1813-1878) the experimental approach in medicine was introduced as the source of more reliable knowledge. The system of medicine had started a long journey towards adopting the experimental paradigm and related cognitive strategic approach. In last century and half physicians and professional researchers in biomedicine have been faced with a tantalizing self-imposed task to convert the medicine into the experimental body of knowledge. The new cognitive quality and methodology had opened a bran new horizon in medicine. It looked like a promising avenue of coming closer to a chemical and physical state-of-art exactness and technological applications. Such agenda has additionally been intensified in the postgenomic era (Kovač

2017). It has become increasingly clear that empirical observational and experimental strategies are not necessarily reducible to each other, but rather mutually complementary and supportive sources of information and methodology. Contributions of both sides have advanced the understanding of practical and theoretical physiology and pathophysiology as well as the practice. By doing together both sides became the two founding pillars for the new avenues in medicine (like, transplantation medicine, gene therapy, stem cell physiology, etc). Through the time, the intrinsic differences, both advantages and limits, became more-and-more visible. The constitutive features of the two procedures, conceptual frameworks and philosophical underpinnings have crystallized out, and sometimes produced miscommunications and a certain degree of conceptual confusion.

Scientific experimental paradigm comprises the analytic and synthetic approach which tends to convert information into numbers (Figure 1). This methodological procedure is inclined to reduce complexity to simplified models. General concepts of „from larger to smaller“ and „ever simpler and more tractable units“ as a model - enrich the research procedure with a higher reliability, controllability and reproducibility. Mathematical crisp reasoning and elaboration of acquired data solidifies conclusions into convincing interpretation of considered phenomena. It is widely accepted notion that such science strongly contribute to the „objective knowledge“ (i.e. the knowledge with high certainty, close to the truth). Its primary value is the increasing the certainty of understanding. Yet, on the other side, such simplification into a "reduced reality" of given experimental model and its outcome, imposes the cognitive and epistemological limits on conclusions. The solidity of respective scientific conclusions is valid for applied conditions of the experiment. It is not necessarily valid for a whole body conditions. A potential validity and functionality of discovered elementary fact and related claims should be re-tested within the integral system, whenever possible. Failure and/or ignorance of such demand may lead to a cognitive error.

DISTINGUISHING WORKING FEATURES OF SCIENTIFIC VS CLINICAL EXPERTISE

Differences of observational and experimental strategies in medicine stems out of the differences in types of reasoning, a quality of information (data), an axiology of the two professions and operative approach between the scientists, etc. These fundamental differences in attitudes and reasoning are excerpted and summarized in Figure 1 and Table 1. Clinical reasoning includes a qualitative dimension in patients' medical history and dynamic alterations of the status praesens. Due to empirical medical heritage, physician is prone to use a deductive and formal reasoning in their dealing with large quantities information. In addition, practicing physician,

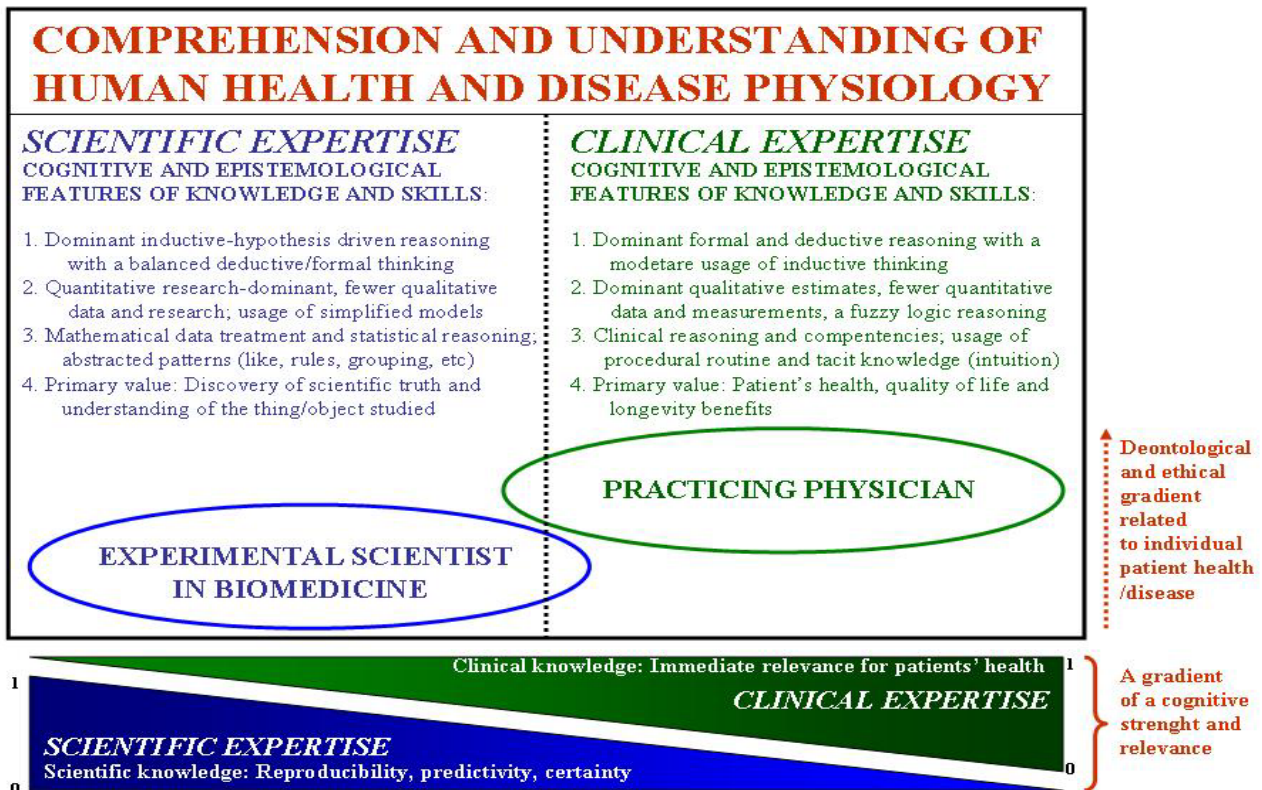


Figure 1. Short summary of difference between the clinical and the scientific expertise. The understanding of integrative pathophysiology and physiology is founded and continuously enriched through clinical and scientific expertise and practice. Between the two resourceful approaches there are epistemological, methodological, ethical and reasoning differences. Biomedical researcher and physician mutually complement each other in their respective comprehensions and visions. They share variable degrees of overlapping knowledge, competencies and broader views in dealing with given common problem

teachers and student of medicine often use fuzzy logic reasoning. It is approximative, neither strict nor exact way of reasoning (Phuong 2001, Jordan 2015). This intellectual activity is somewhat similar natural human language. Fuzzy logic is said to be close to a way of human brain spontaneous performance. Unlike digital logic of arithmetics, fuzzy logic is based on the "degrees of truth" not on the "true or false" categories (i.e. „1 or 0“ in computer operations). Therefore, a fuzzy logic reasoning does not operate in binary terms. It operates with sets of identified events recognized as a partial truths. Such partial truths can aggregate into higher truths, when certain thresholds are exceeded. Essential nature of underlying phenomenon for these „categories of truths“ and „thresholds“ remains to be explored. On the other side, the binary reasoning may be simply considered as a special case of fuzzy logic, the one out of many possible. At any step of practical medicine the fuzzy logic reasoning contributes to a flexibility of clinical reasoning. Even more, the well established expert knowledge in medicine inherently contains this cognitive dimension of partiality. That reasoning is led by the clinical benefits as the major professional landmark and often relays on a tacit knowledge (a hidden component of understanding in a form of intuition or a subroutine) encoded as the product of a working experience.

At operational level of profession and way of performance the eight distinguishing features between the researcher and the physician can be identified as in Table 1. Physician is under pressure of the time of action that is „enforced“ by the disease kinetics itself. The natural kinetics imposed and makes real difference. For example, the ventricular fibrillation will cause immediate death of patient, unless the timely correction of hearth rhythm is done. Under such circumstances, physician-in-charge does not have a freedom to think broadly about the problem, his primary mission forces him to do the appropriate curative procedure in a short period of time. He acts in accordance with principle of a good clinical practice and empirical guidelines. Physician always keeps in mind deontological framework when he/she deals with the sick patient as the „object“ of the research diagnostics and therapy procedure. These are unique features of medical profession. At the same time that „holistic“ approach is the important source of integrative knowledge of complex conditions. In cases when a dominant etiopathogenesis can be reduced to a given single causing factor (like, a bone fracture, or a single microorganism causing infectious disease) clinical expertise uses efficiently the reductionism of experimental approach. Targeted correction of respective etiopathogenetic pathway leads to a straightforward benefit to the patient.

Table 1. The eight distinguishing aspects of scientific versus practical medicine

Distinguishing criteria	Experimental researcher	Practicing physician
Compulsatory time framework of activity	“Endless”, it can be easily modified, repeated, adjusted, extended, etc	Patients’ disease kinetics dictates a working time to be, some things can not be, and must not be postponed
The primary mission	Scientific discovery, improvement of scientific knowledge and understanding	The improvement of patients’ health - curative, preventive, paliative and the prologation of life
A degree of freedom in working procedure	High, limited by ethical concerns of a life research (e.g. animal and human samples managing, etc)	Low, highly restricted by patients’ dignity, autonomy, reasoning, consent and deontological standards
Quantity of information critical for a decision making	The principle “a maximal quantity of data leads to a minimal conclusion“ - increases a certainty	Relatively small quantity of diagnostic data are sufficient for a “maximal conclusion” i.e. therapy decision, diagnostic procedure, preventive actions, etc
The internal check-ups of the procedure applied	Highly internally controlled system of experimental settings, “the more controls - the more solid science”	Internally uncontrolled procedure; historic and statistical controls apply (experience, normal values, etc)
The scope and horizon of the profession	Limited to the experimental model; The principle “the simpler the better” increases reliability; Tested variable often fit the crisp criteria of causality	Integral complexity of patient’s pathophysiology (body and mental ones) and broader related problems; Clinical quanta of information are “approximate one”, dealing often with the whole body sets of descriptors
A plasticity of the “object studied” induced by the study itself	No or minimal changes; Properly designed experimental model (the object studied) reduces reactive alterations	Placebo/nocebo effects in patients contribute to variability of the “object studied” i.e. the patients’ response to the clinical elaboration of his/here condition
Standard starting points and endpoints of study activities	Previous knowledge designed hypothesis and a model selection – “if the system works – it is a beginning of research”	Patient complains to doctor with experienced symptoms; In principle “if the therapy works - it is the end of doctors activity” - holds true

On the other side, experimental biomedical researcher, in principle, has much broader academic freedom and adjustable time schedule of research procedure. He/she makes experimental planning and sets conditions and controls in advance. Hypothesis driven research under controlled experimental research design (experimental settings and conditions) gives the insight into mutual causations of events. Under such conditions one or more variables are manipulated to determine their effect on a dependent variable. The controlled read-out of the procedure gives the clear causality or non-causality between the manipulated and dependent variable. It is the source of the unique power of experimental approach which exceeds other types of approaches in scientific cognitive cycle and clinical expertise. This and other operational difference between scientific and clinical expertise are specified in Table 1. The freedom of research and quantities of data considered are much higher in experimental sciences. The primary mission of clinical expertise is practical application of science and broader knowledge, where as the experimental expertise is targeted towards academic interests of establishing the “scientific truth”, with high reproducibility, high predictive power and thus certainty of such knowledge.

Both sorts of expertise share a certain degree of overlapping area of professional activity. Nowadays physicians and scientific researchers act in close relations in dealing with the same problem. Tentative „usage“ of

reasoning mode, cognitive methodology of the „opposite side“ is indicated in lower part of Figure 1. In scientific clinical experiments research the scientific plan and reasoning features are applied to patient population as “the investigation object”. Randomization, double blinded and defined end points (etc) are to be pre-defined, and thus to satisfy a scientific professional criteria. At the same time, participating physicians, along with fitting with those standards, actually continue to obey the clinical principles at the same time.

CONCLUSION – HOW TO BRIDGE THE GAP BETWEEN THE TWO SIDES

Both sides, the physicians with clinical expertise, and the researcher with the experimental expertise, generate relevant knowledge. Both sides are important contributors of facets of biomedical knowledge. Both sides have been trying to improve the understanding of physiology/pathophysiology of the patient problem and a nature of transitions in between the health and disease, as well as, between the life and death. There is a common sense agreement in professional and general public that more efficient progression and advancement in medicine may be improved by narrowing/closing the gap between the two sides. Academic policy makers having been aware of the problem tend to enforce curricular adjustments to meet shortages and to apply advantages of both sides.

Several types of institutional approaches have been developed to bridge the epistemological and operational chasms. Some medical schools have been practicing the MD-PhD programs. Many research institutes have postdoctoral experimental studies for physicians and advanced types of specialized education for scientists are in medical schools. Research consortia recruit the heterogeneous teams of both sides and translational medicine programs and platforms has been proclaimed and practiced as a priority by funding institutions.

Clinical epidemiology has been practiced as the strict scientific evaluation of clinical performance (Gamulin 2015). Efficiency of clinical procedures, outcomes, and economical aspects of practical medicine are targeted aspects of such epidemiological investigation. Teaching/learning methods of algorithmic integration and etiopathogenetic clusters catalyze the efficient fusion of clinical and scientific expertise, in both cognitive and educative sense (Kovač 2012, 2014, 2015).

Continental European, Asiatic and Latin American curricular course of (General) Pathophysiology facilitates integration of both sides and „...brings together clinical and preclinical knowledge ...“ (Churilov 2015). On the other side, the North American university tradition introduced a translation medicine at the end of 20th century, which can be considered as a „...nothing else, but Clinical Pathophysiology armed with modern cellular and molecular methods...“ (Churilov 2015).

Acknowledgements: None

Conflict of interest: None to declare.

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