The Process of Clinical Reasoning among Medical Students

O processo de raciocínio clínico de estudantes de medicina

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PALAVRAS-CHAVE:

– Resolução de problemas,

– Diagnóstico,

– Pensamento, Estudantes

RESUMO

Introdução: *As pesquisas no campo de raciocínio clínico têm colaborado no entendimento do processo de raciocínio dos estudantes. As estratégias nesse processo são relacionadas ao sistema analítico [hipotético-dedutivo (HD)] e ao não analítico [esquema-indutivo (SI) e reconhecimento de padrão (PR)].*

Objetivos: *Explorar o processo de raciocínio clínico de estudantes quinto ano de medicina ao final do ciclo clínico do internato médico, identificar as estratégias utilizadas na elaboração de hipóteses diagnósticas e analisar a organização e conteúdo do conhecimento.*

Método: *Estudo qualitativo conduzido em 2014 numa universidade pública brasileira com estudantes do internato médico. Este estudo utilizou-se do método Stamm, em que um caso clínico de medicina interna foi elaborado baseando-se na teoria dos protótipos (Grupo 1 = 47 internos), em que os estudantes listam, sob suas percepções, os sinais, sintomas, síndromes e doenças mais típicas da clínica médica. Esse caso foi então utilizado na avaliação do processo de raciocínio clínico do Grupo 2 (30 estudantes aleatoriamente selecionados da amostra inicial) por meio da técnica "think aloud". As verbalizações foram transcritas e avaliadas por meio da análise temática proposta por Bardin. A análise de conteúdo foi validada por dois especialistas da área no início e ao final de todo o processo.*

Resultados: *Os internos elaboraram 164 hipóteses primárias e secundárias durante a rosolução do caso clínico proposto. O SI foi a estratégia mais utilizada, com 48,8%, seguida de PR (35,4%), HD (12,2%) e mista (1,8% cada: SI + HD e HD + PR); Os estudantes construíram 146 eixos semânticos distintos, resultando numa média de 4,8/participante; Durante a análise, eles realizaram 438 processos de interpretação (média de 14,6/participante) e 124 processos de combinação (média de 4,1/participante).*

Conclusões: *As estratégias não-analíticas prevaleceram, com PR a mais utilizada no desenvolvimento de hipóteses primárias (46,8%) e a SI para as hipóteses secundárias. Os internos demonstraram uma rede semântica sólida e realizaram três vezes e meia mais processos de interpretação do que combinação, o que reflete uma organização e conteúdo de conhecimento menos aprofundada quando comparados com médicos experientes.*

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– Diagnosis;

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– Problem Solving.

ABSTRACT

Introduction: *Research in the field of medical reasoning has shed light on the reasoning process used by medical students. The strategies in this process are related to the analytical [hypothetical-deductive (HD)] and nonanalytic [scheme-inductive) (SI)] systems, and pattern recognition (PR)].*

Objective: *To explore the clinical reasoning process of students from the fifth year of medical school at the end of the clinical cycle of medical internship, and to identify the strategies used in preparing diagnostic hypotheses, knowledge organization and content.*

Method: *Qualitative research conducted in 2014 at a Brazilian public university with medical interns. Following Stamm's method, a case in internal medicine (IM) was built based on the theory of prototypes (Group 1 = 47 interns), in which the interns listed, according to their own perceptions, the signs, symptoms, syndromes, and diseases typical of internal medicine. This case was used for evaluating the clinical reasoning process of Group 2 (30 students = simple random sample) obtained with the "think aloud" process. The verbalizations were transcribed and evaluated by Bardin's thematic analysis. The content analysis were approved by two experts at the beginning and at the end of the analysis process.*

Results: *The interns developed 164 primary and secondary hypotheses when solving the case. The SI strategy prevailed with 48.8%, followed by PR (35.4%), HD (12.2%), and mixed (1.8 % each: SI + HD and HD + PR). The students built 146 distinct semantic axes, resulting in an average of 4.8/participant. During the analysis, 438 interpretation processes were executed (average of 14.6/participant), and 124 combination processes (average of 4.1/participant).*

Conclusions: *The nonanalytic strategies prevailed with the PR being the most used in the development of primary hypotheses (46.8%) and the SI in secondary hypotheses (93%). The interns showed a strong semantic network and did three and a half times more interpretation than combination processes, reflecting less deep organization and content of knowledge when compared with experienced physicians.*

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INTRODUCTION

Clinical reasoning is a still that should be taught at medical schools; however, diagnostic error still shows rates of 10 to 15 %[1], the majority of which are related to problem solving[2].

Research in this field began about 40 years ago, and supported our understanding of the way doctors and medical students think. Presently, it is integrated into the dual process theory, two opposing cognitive systems proposed by Epstein[3] and Hammond[4] in the 1990s. The first, called system 1 or intuitive system, originates in the ancient parts of the brain[1, 5, 6] as it is processed automatically, quickly and unconsciously. Because it is based on low scientific rigor and subject to changes in emotions, the diagnostic hypotheses formulated or tested based on this system have a relatively high error rate[7].

Pattern recognition (PR) – whereby diagnosis is sometimes arrived at by a single look – is the most common strategy of the intuitive system[5]. The quick formulation of hypotheses during the first meeting – known as the *gestalt* effect[8, 9] – is possible because the clinical cases are repetitive. Diseases are organized and encapsulated in the form of scripts until they are retrieved from the long-term memory when needed[10]. In general, this method is used successfully by experts, but it can be disastrous for beginners, because less experience is assumed in determining the best plausible explanation to the pattern presented. Other weaknesses include the overestimation of irrelevant information[11] and, especially, the atypical presentation of a clinical picture[7]. A study of acute coronary syndrome, for example, showed a diagnostic error rate ten

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times higher among patients who did not present any chest pain as a cardinal symptom[12].

In turn, the scheme-inductive model (SI) uses inference as the methodological basis, and its application produces a truth constructed from a limited number of single data – assumptions – to reach a conclusion; for this, heuristic tools and mental shortcuts are used[13]. It is considered a weak method due to the lack of logical justification for relying on the first intuitive impressions[14], the result of usually premature interpretations, or any combinations of data when formulating diagnostic hypotheses. With a single piece of information, such as chest pain, the physician immediately formulates the hypothesis of acute myocardial infarction.

Contrary to the intuitive system, system 2 or the analytic method is conscious, controlled, and of high scientific rigor. As it is only subjected to minor influence of emotions, it rarely induces the physician to create a wrong hypothesis[7]. Studies using functional magnetic resonance imaging show an association between the analytical method and the anterior cingulate cortex – responsible for reflective thinking – which is able to monitor and control conflicting information[2, 15]. Deduction is its methodological basis – constructed from the interpretation and combination of the assumptions present in a clinical picture – producing a conclusion by applying the rules of logic. Errors related to this strategy occur if it is applied incorrectly or under conditions detrimental to a good performance of the cortical activity, such as cognitive overload, fatigue, or sleep deprivation[1]. The model that represents this system is the hypothetical-deductive model.

Ideally, medical schools prioritize the analytical model when teaching clinical reasoning[16]; however, the decision-making process during this learning phase usually tends to the intuitive method[16]. Therefore, the students' reasoning should be tested and new methods developed to ascertain whether there is consonance between what is considered ideal and what is actually learned and practiced[17].

The primary objective of this study was to identify the process of clinical reasoning used by medical students at the end of the clinical cycle in medical internship, as well as the organization and content of knowledge during the resolution of a clinical case prototype in internal medicine.

METHOD

Study with qualitative epistemological basis applying the method of Stamm[182015]. The project was approved by the Ethics Committee on Research with Humans of the institution where it was conducted at a public university in southern Brazil and was registered under number CAAE 20897413.2.0000.0121.

Survey participants were students from the fifth year of medical school at the end of the clinical cycle of medical internship, based on the assumption that by this phase of their medical training they have already acquired theoretical and practical knowledge in internal medicine.

Upon initial contact with the participants, an informative document was delivered explaining the purposes of the research. A group of forty-seven students (group 1) participated in phase 1. From these, thirty were selected (group 2), by simple random sampling, for phase 2.

In phase 1, the students in group 1 were invited to list, in descending order of importance in their understanding, five to ten signs, symptoms, syndromes, and diseases in internal medicine. This prototype formulation served to build a case-problem – the basis of the experiment – with its elements coming from the common knowledge of all participants. In that way, it was possible to avoid constraints and to facilitate verbalization of the reasoning when applying the think aloud technique (phase 2).

In the second phase, a questionnaire with semi-open and closed questions was applied to obtain the profile of the participants in Group 2. Each participant was subsequently invited by one of the researchers to appear on a pre-established date and time for a meeting in a comfortable room, free from external interference, located at the Didactic-Pedagogical Unit of the university teaching hospital (TH). There, the student received a printed case history and was instructed to verbalize their clinical reasoning process (think-aloud technique) while developing the diagnostic hypotheses and reading the case. If they remained silent for more than ten seconds, they were encouraged by the researcher (who was present but outside the participant's field of view), with the phrase "keep thinking out loud." The session was recorded on a tape recorder.

In the third and final phase, the text obtained with the verbalizations of each participant was transcribed in separated tables with a column for the verbalized text, another for coding and categorization and a third column for the categories of clinical reasoning strategies. A second researcher then revised all the tables.

Thematic analysis was used[19] to evaluate the content of the verbalization column and, after an initial reading, the text was classified as "general context unit" (for text evaluation as a whole) and "specific context units" (formed by a sentence or set of sentences, connected by the same meaning), for better understanding of the analysis units. To transform the raw data and reach the nuclei of text understanding, we used the coding [18] system as proposed by Bardin[19] and Minayo[20], which allowed for description of the content characteristics. Rating

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of the tool - prototype case - was conducted in similar manner to Bordage and Lemieux[21] in the field of structural analysis of diagnostic thinking, with the text fragmented into constituent, morphological units and cognitive process (intellectual operation itself).

The clinical reasoning strategies column was categorized into "hypothetical-deductive" (HD), "scheme-inductive" (SI), "pattern recognition" (PR)[22] and "mixed", the latter when the interns used more than one strategy at the same time (deductive and inductive) – whether scheme-inductive (mixed SI) or pattern recognition (mixed-PR).

Secondly, the semantic structure was analyzed by recognizing the processes of abstraction (interpretation) or association (combination), which allowed identification of knowledge organization and content[23], respectively. As noted by Bordage[23], knowledge becomes meaningful by the network of relationships represented by dichotomous axes.

The diagnostic hypotheses raised by the students were categorized into primary principal diagnostic hypotheses (PPDH), secondary principal diagnostic hypotheses (SPDH), and secondary diagnostic hypotheses (SDH). The two researchers involved in the study subsequently agreed with the analytical description, and the analysis validation was conducted by two experts in semiotics and medical reasoning.

RESULTS

Most participants who developed the clinical reasoning process of a prototype case were male (73.3% vs 26.7% women) with a mean age of 25.7 years (SD ± 2.82). The weekly time spent on individual study ranged from 4–10 h (56.7%), to 1–3 h (30%) and >10 h (13.3%). Extracurricular activities are developed by most participants (96.7%) – such as participation in academic leagues or other extension and/or research activities – with more than half (58.6%) being related to internal medicine. Self-evaluation regarding each participant's dedication to the medicine program was considered good or regular by the majority (53.3% and 36.7%, respectively), followed by excellent (6.7%) and poor (3.3%). The mean time for resolution of the case was 08'38'' (SD ± 02'27 '').

One hundred and twenty-four principal diagnostic hypotheses (primary and secondary) were created, with prevalence of the PR strategy (46.8%), followed by SI (34.7%) and HD (14.5%). The mixed strategies (PR and SI) were scarcely used (2.4% and 1.6%, respectively). Regarding the secondary diagnostic hypotheses, 40 were prepared, with a prevalence of SI (93%), followed by HD (5%), and mixed SI (2%). In this case, the PR strategy was not covered. In solving the case as a whole, 164 hypotheses were built, with SI (48.8%) being the prevalent strategy, followed by PR (35.4%), HD (12.2%), and mixed (PR and SI, with 1.8% each). (Diagram 1)

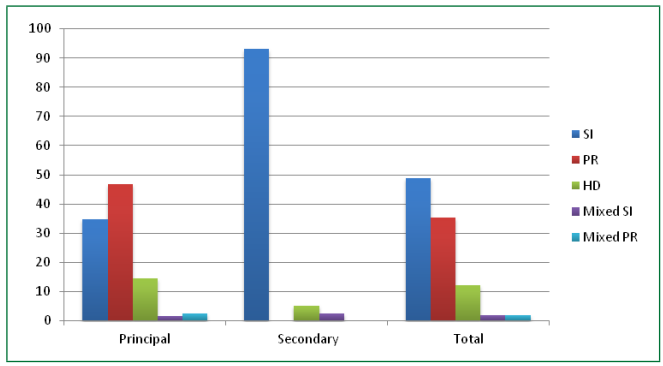

Diagram 1 - Frequency of reasoning strategies in the development of principal and secondary diagnostic hypotheses in solving a case prototype in internal medicine by medical students.
Legend: SI (scheme-inductive); PR (pattern recognition); HD (hypothetical-deductive); mixed SI (starting with SI + HD) and mixed PR (starting with PR + HD)

Participants built 146 semantic axes during the resolution of the clinical case prototype, most of which were related to factual data (24%), followed by axis related to symptoms (22%), signs (20.5%), diseases (18.5%), syndromes (8.9%), and process (6.1%). The semantic network was formed by a mean of 4.8 (SD ± 5.83) semantic axes per participant.

The organization of knowledge within the semantic subcategory was represented by the semantic axes and by the 438 interpretation processes (abstraction) with a mean of 14.6 (SD ± 7.56) per student. Knowledge content within the subcategory form was represented by the semantic axes and the creation of 124 combination processes (association), with a mean of 4.1 (SD ± 2.55) per participant.

DISCUSSION

In the forty years of research on clinical reasoning, there has been significant progress in making thought understandable in the process of reaching a diagnosis, thus enabling teaching and reflection on this ability. However, there is still disagreement on the best method doctors and students should use when building and testing diagnostic hypotheses[5, 6, 16]. This study aimed at demonstrating this process with medical students at the end of the clinical cycle of medical internship, by identifying the strategies adopted and knowledge organization and content.

Developed in the field of cognitive psychology, the think-aloud technique or "thinking aloud", is widely used in qualitative research to evaluate the medical reasoning process[22].

When analyzing the results obtained with this tool, there is a prevalence of non-analytical strategies (system 1) – both

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primary and secondary – in building diagnostic hypotheses, while the analytical strategy (system 2) was hardly considered. The impact of using non-analytical strategies in this process remains controversial. While some authors suggest that they should be avoided by students – due to the potential of "dire consequences"[16] – others point out their relationship with improved diagnostic accuracy[17]. Within what was observed in this study, it can be inferred that the students built the reasoning based on previous experiences and first impressions, rather than following logical rules applied to the clinical case discussions, and dialogued "theoretical and practical" classes in internal medicine, present in the activities of the educational institution to which they belong. The premature closure of diagnostic hypotheses, which prevents them from considering other possibilities when establishing the initial diagnosis, is another phenomenon that may be associated with this outcome. This inhibits the deductive (analytical) reasoning and increases the chance of failure due to cognitive error[24], since the hypotheses constructed are not tested.

The clinical case prototype constructed from signs, symptoms, syndromes, and diseases as perceived by the students themselves may also have inhibited the analytical method, which appears in more complex situations and in ambiguous, atypical or poorly[25] defined clinical situations, encouraging the use of inductive strategies.

When constructing the principal diagnostic hypotheses, the most widely-used was PR, indicating that students recognized the diseases present in the case – infection of the upper airways, pneumonia, and chronic obstructive pulmonary disease – from their classic descriptions. A third of them were built using the SI strategy, probably due to lack of verbalization in the "think aloud" process or by inferring the diagnosis by extrapolation of a single information[22]. The HD strategy, which is based on the correct interpretation and combination of data, and follows a logical line of reasoning to explain the facts, was used in only 14.5% of the cases, while mixed strategies occurred at an insignificant rate (2.4% for mixed PR and 1.6% for mixed SI).

Concerning the secondary diagnostic hypotheses – which are part of the case, but are not the most relevant ones in a patient with more than one morbid condition – the SI strategy prevailed (93%). Although part of the problem, they do not require a complex construction of the history of these diseases, and are not directly part of the current illness. These considerations also make the lack of the PR strategy understandable – simply because there is no pattern to be recognized – as well as the negligible rate of the HD (5%) and mixed SI (2.5%) strategies.

When we observe the case-solving process as a whole, we credit the prevalence of the SI strategy (48.8%) to the impact of using this strategy in preparing the SDH while the PR strategy (35.4%) continues to indicate its importance in formulating the principal diagnostic hypotheses (PPDH) by students in a case prototype in internal medicine. The use of the HD strategy in 12.2% of the cases also resulted from building the hypotheses (PPDH), while the mixed strategy remained negligible (1.8%, for both mixed PR and mixed SI strategies).

Regarding knowledge organization and content, represented by the semantic axes and the interpretation (abstraction) and combination (association) processes respectively, we observed a strong semantic network and organization of thought (15.6 semantic axes and 14.6 abstractions per participant), but shallower content (15.6 semantic axes, but only 4.1 associations per participant).

In a previous study using the same method, conducted with teaching physicians[19], a greater number of semantic axes (mean of 11.9 axes per participant) was observed; these were predominantly related to the clinical features of the case (34% to signs, 19.6% to the process, 16.3% to syndrome, 14.8% to symptoms, 11.8% to diseases, and 3.7% to factual data), while in this study they were related mainly to factual data (24%) concerning epidemiology and risk factors. Students formed 3.5 times more abstractions than associations (14.6 abstractions and 4.1 associations per participant) , while the rate amongst teaching physicians[18] was 1.7 times (17.2 abstractions and 9.7 associations per participant), pointing to the dense semantic network of these professionals, as well as to their organization of knowledge and depth of thought content.

CONCLUSIONS

These data allow us to infer how medical school students absorb the learning of clinical reasoning. The hypotheses were constructed from a strong semantic network, with a dominance of the interpretation process, and the prevalent strategies were PR for the primary hypotheses, and SI for the secondary hypotheses. Apparently, construction of the hypothesis is not only due to the strategy used, but also results from the semantic network that supports the reasoning process, and from the organization and content of knowledge.[18]

Because diagnostic reasoning is complex, it must be accompanied by metacognition – which is the act of thinking about our own thoughts and emotions[3, 7, 26] – which can contribute to improving the process as a whole.

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CONTRIBUIÇÃO DOS AUTORES

Gustavo Henrique Bregagnollo participou da coleta de dados, análise dos resultados e revisão bibliográfica. Bruna Morais Barbosa colaborou na coleta de dados, revisão gramatical, transcrição dos arquivos de áudio e revisão bibliográfica. Ana Maria Nunes de Faria Stamm é a idealizadora do método e orientação em toda pesquisa científica.CONFLITO DE INTERESSES : Não há conflitos de interesses,

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