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The contribution of the medical history for the diagnosis of simulated cases by medical students

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Abstract

Objectives: The case history is an important part of diagnostic reasoning. The patient management problem method has been used in various studies, but may not reflect the actual reasoning process because a list of choices is given to the subjects in advance. This study investigated the contribution of the history to making the correct diagnosis by using clinical case simulation, in which students obtained clinical information by themselves.

Methods: A prospective study was conducted. Ninety-four fifth-year medical students from Chiba University who underwent supervised clinical clerkships in 2009 were surveyed. Each student randomly selected 1 of 4 test cases and attempted to make a diagnosis through medical interview, physical examination, and laboratory tests, while the teacher acted as a patient. The student ranked the disease(s) diagnosed at each stage of the process. Diagnostic accuracy rates were compared using analysis of the $\chi 2$-test.

Results: Sixty students (63.8%) made a correct diagnosis, which was based on the history in 43 students (71.7%), physical findings in 11 students (18.3%), and laboratory data in 6 students (10.0%). Compared with students who considered the correct diagnosis in their differential diagnosis after taking a history, students who failed to do so were 5.0 times (95%CI = 2.5-9.8) more likely to make a final misdiagnosis ($\chi 2_{(1)} = 30.73$; $p<0.001$).

Conclusions: History taking is especially important for making a correct diagnosis when students perform clinical case simulation. To improve the diagnostic reasoning skills, medical students should be trained in methods for inferring the correct diagnosis from the case history.

Keywords: Diagnostic reasoning, case history, medical student, simulation

Introduction

Previous research has shown that physicians make a diagnosis from the patient's history in 70-90% of cases, i.e., while medical student consider the correct diagnosis based on the chief complaint or the history in 70% of cases.[1-3] This indicates that history taking is the most important part of the diagnostic process for both physicians and medical students. In those studies of physicians, actual cases or standard patients were used. In contrast, patient management problem (PMP) method has been used in various other studies of medical students, although it may not reflect the actual clinical reasoning process. With the PMP method, multiple options (20-30 options in one study and 15-40 options in another) for narrowing down the disease or for differential diagnosis are presented with respect to the case history, physical examination, and laboratory tests.[3,4] Thus, the actual diagnostic reasoning process, in which options must be generated by the doctor or study, may not be reflected. Research has shown a weak positive correlation among the processes of data inquiry, data interpretation and integration, and diagnosis elaboration, raising the issue of interdependence between these skills.[5] In order to assess actual problem-solving and information-gathering skills, clinical simulation tests that involve role-playing or tests using simulated patients are believed to be more appropriate.[6] Clinical case simulation involves a test in which a physician plays the role of a patient and simultaneously makes an assessment, allowing us to directly assess the student's clinical decision-making patterns as can be done with standard patient method. In fact, clinical simulation is used in the College of Family Physicians of Canada Certification Exam.[7] It allows testing to be done in a low-cost and simple way, because there is no need for an actor to play the

role of the patient, a separate observer to assess performance, or video recording of the process.

However, there have been no investigations in which the diagnostic process of medical students (history taking, physical examination, and laboratory tests) was analyzed by clinical case simulation. Accordingly we undertook the present study to elucidate the following: (1) which information from the history, physical findings, and laboratory data led to a diagnosis, (2) the difference of the diagnostic accuracy rate between students who considered the correct diagnosis after taking the history or performing physical examination and those who failed to do so, and (3) to what extent the possibility of misdiagnosis increases when students fail to obtain the correct diagnosis after history taking and/or physical examination.

Methods

Participants

A prospective study was conducted at Chiba University, Japan. The participants were 94 fifth-year medical students who underwent supervised clinical clerkships at the Department of General Medicine in 2009.

Instrument

Each student randomly selected 1 of 4 prepared cases by taking a card with a case number on it from an envelope, and made a differential diagnosis on the basis of the case history, physical findings, and laboratory data to provide simulated medical care with a teacher playing the role of the patient. The history was provided by the teacher in response to the student's questions using a scenario prepared beforehand. With regard to physical findings and laboratory data, the student asked the teacher about examinations and tests that were considered necessary and the teacher orally communicated the physical findings and test results. The student recorded the probable diagnosis/diagnoses in rank order at the end of each stage of the diagnostic process from history taking and physical examination to laboratory tests. For each student, a list of diagnostic hypotheses was generated and analyzed after all diagnostic processes. The primary hypothesis was regarded as the diagnosis at each stage of the process. The final diagnosis was considered correct if the diagnosis made after obtaining laboratory data matched the case's diagnosis. Lack of any diagnosis was defined as misdiagnosis. The student was defined as having made a correct diagnosis at the point when the diagnosis was first considered. Then we determined the diagnostic accuracy rate and the information (history, physical findings, and laboratory data) that led to a correct diagnosis. We also compared the final diagnostic accuracy rate and relative risk of misdiagnosis between the students who considered the correct diagnosis after history taking or physical examination and those who failed to do so. The diagnostic accuracy rate was also compared among the four cases and between the stages of clinical clerkship.

In order to prevent leakage of the test details, students who had completed the test were not told the correct final diagnosis and were cautioned not to discuss the cases with other students.

Cases

The four test cases presented with signs and symptoms that are encountered relatively frequently in general outpatient clinics and each scenario was constructed by multiple teachers. Cases of hypothyroidism, infectious mononucleosis, migraine, and carpal tunnel syndrome were used in this study (Table 1). At this point in their education, the students had received lectures about the symptoms and diagnostic processes for these diseases. During the one-year study period, students were undertaking "Bedside Learning" (BSL), mainly with general medicine and general surgery patients, as well as a range of specialties at Chiba University Hospital.

Table 1. The four test cases

(Case 1) Hypothyroidism
A 76-year-old woman presented with the chief complaint of malaise for 3 months. She had gained weight, but did not have exertional dyspnea. The physical findings consisted of thinning of the eyebrows, an enlarged thyroid gland, and nonpitting edema of the legs. The chest X-ray film showed no abnormalities and laboratory tests revealed no inflammation. Her hematology tests, renal function tests, and hepatic function tests were normal, but the level of thyroid stimulating hormone (TSH) was high.
(Case 2) Infectious mononucleosis
A 19-year-old man presented with the chief complaint of a sore throat for 10 days. His temperature was persistently in the 37°C range. He had no history of contact with children. The physical findings were enlargement of the tonsils, tongue fur, enlarged posterior cervical lymph nodes, and mild splenomegaly. With regard to laboratory data, tests for hemolytic streptococcus and adenovirus (rapid diagnostic test) were negative, but he had mild hepatic dysfunction and atypical lymphocytes. Viral antibody tests revealed acute infection with Epstein-Barr virus (EBV), while there was no evidence of human immunodeficiency virus or cytomegalovirus (CMV) infection.
(Case 3) Migraine
An 18-year-old woman presented with the chief complaint of headache that had persisted since the morning. She had a throbbing headache in her left temporal region. The pain was accompanied by nausea, hyperacusia, and photosensitivity, and was exacerbated by motion, but she did not have an aura. On physical examination, her blood pressure and body temperature were normal, as were the neurological findings. Blood tests and cerebrospinal fluid examination revealed no abnormalities, and a CT scan of the head was also normal.
(Case 4) Carpal tunnel syndrome
A 50-year-old woman presented with numbness of the left hand that had persisted since the morning of the same day. She had occasionally noted similar numbness in the morning before. Physical findings included mildly abnormal sensation of the first three digits and the radial half of the fourth digit of the left hand. Tinel's sign and Phalen's sign were positive, while the neck compression test was negative. No neurological abnormalities were noted in the face or lower extremities and cranial nerve findings and tendon reflexes were normal. Blood tests revealed no abnormalities, while a cervical spine X-ray film, head CT scan, and head MRI were all normal. A nerve conduction velocity study revealed prolonged latency of the median nerve compound muscle action potential and delayed sensory nerve conduction.

Procedure

In this study, each participant was identified by a number and approval was obtained from the Ethics Committee of Chiba University Graduate School of Medicine.

Data analysis

Differences of the diagnostic accuracy rate were investigated among the four test cases, as well as between the first and second stages of clinical clerkship, and the final diagnostic accuracy rate was compared between students who considered the correct diagnosis after taking a history or after performing physical examination versus those who failed to do so. These analyses were done with the $\chi 2$-test. In the past, relative risk has been used as a measure of association between the early consideration of a diagnostic hypothesis and the correctness of the final diagnosis.[3,8] In this study, the relative risk was calculated to assess the extent to which failing to include the correct diagnosis in the list of differential diagnoses made from the history or physical findings increased the possibility of misdiagnosis. The 95% confidence interval of the relative risk was calculated to assess the possibility of a final misdiagnosis when a student had not considered the correct diagnosis at a particular time versus the possibility when a student had done so. All statistical analyses were conducted with the SPSS statistics software, version 17.0.

Results

Diagnostic accuracy rate and information leading to a diagnosis

Of the 94 students, 60 (63.8%) finally made a correct diagnosis. There were no significant differences of the final diagnostic accuracy rate among the four test cases (72.0%, 56.0%, 61.9%, and 65.2%; $\chi 2_{(3)}$=1.39; p = 0.71) or between the stages of clinical clerkship (65.2% and 62.5%; $\chi 2_{(1)}$=0.075; p = 0.784) (Table 2). Across all four cases the correct diagnosis was made after obtaining the history in 43 students (71.7%), while it was made after physical examination in 11 students (18.3%) and after obtaining laboratory data in 6 students (10.0%).

Table 2. Number and percentage (in parentheses) of students making a correct diagnosis of each test case stratified by their clinical clerkship stage (N=94)

Clerkship stage	All cases	Hypothyroidism	Infectious mononucleosis	Migraine	Carpal tunnel syndrome
Entire 1-year period	60/94 (63.8)	18/25 (72.0)	14/25 (56.0)	13/21 (61.9)	15/23 (65.2)
First stage	30/46 (65.2)	11/13 (84.6)	6/11 (54.5)	6/9 (66.7)	7/13 (53.8)
Second stage	30/48 (62.5)	7/12 (58.3)	8/14 (57.1)	7/12 (58.3)	8/10 (80.0)

$\chi 2_{(3)}$=1.39; p=0.71: comparison among the four cases for the entire 1-year clerkship period.
$\chi 2_{(1)}$=0.075; p=0.784: comparison between each stage of clinical clerkship.

When the individual cases were compared, the percentage of students who reached a diagnosis on the basis of laboratory data was significantly higher for the case of hypothyroidism. For the cases of infectious mononucleosis or carpal tunnel syndrome, in contrast, none of the students used laboratory data to make a diagnosis (27.8%, 0%, 7.7%, and 0%; $\chi 2_{(3)}$ = 8.37; p = 0.039) (Table 3).

Table 3. Number and percentage (in parentheses) of correct diagnoses based on each type of information (N=60)

Information	All cases	Hypothyroidism	Infectious mononucleosis	Migraine	Carpal tunnel syndrome	p value
Case history	43/60 (71.7)	11/18 (61.1)	9/14 (64.3)	11/13 (84.6)	12/15 (80.0)	p=0.511
Physical examination	11/60 (18.3)	2/18 (11.1)	5/14 (35.7)	1/13 (7.7)	3/15 (20.0)	p=0.555
Laboratory tests	6/60 (10.0)	5/18 (27.8)*	0/14 (0)	1/13 (7.7)	0/15 (0)	p=0.039

Comparison of the diagnostic accuracy

The final diagnostic accuracy rate showed a significant difference between the 57 students who listed the correct diagnosis among their differential diagnoses by the end of history taking and the 37 students who failed to do so, with the rates being 86.0% (n = 49) and 29.7% (n = 11), respectively ($\chi 2_{(1)}$ = 30.73; p<0.001). The corresponding rates for the 65 students who listed the correct diagnosis among their differential diagnoses after taking a history and performing physical examination and the 29 students who failed to do so were 84.6% (n = 55) and 17.2% (n = 5), respectively ($\chi 2_{(1)}$ = 39.43; p<0.001).

Relative risk of misdiagnosis

When the students who failed to list the correct diagnosis after taking the case history were compared with students who did so, the relative risk of final misdiagnosis was very high at 5.0 (95%CI = 2.5-9.8). When students who failed to list the correct diagnosis after taking the history and performing physical examination were compared with those who did, the relative risk of misdiagnosis was increased to 5.4 (95%CI = 3.0-9.7) (Table 4).

Discussion

In the present study conducted over 1 year, the final diagnostic accuracy rate was about 60%, which was lower than that shown by a previous study employing PMP.[3] When diagnostic accuracy was compared between a case vignette containing all of the required diagnostic information versus the chief complaint format in which questions were asked to obtain information needed to make the diagnosis, there was a significantly lower accuracy rate with the chief complaint format.[9] In the present study, we used the latter format and students had to obtain data themselves, so the accuracy rate may have been lower. In addition, there was no difference of diagnostic accuracy between the first and second stages of

clinical clerkship. This may have been because typical outpatient cases were selected for this study that could have been difficult for students whose training was oriented towards inpatients. In fact, there are few chances to study diagnostic reasoning during clinical clerkship at our medical school because students spend most of their time with inpatients for whom a diagnosis has already been established.

Table 4. Relative risk of final misdiagnosis based on consideration of the correct diagnosis after history taking or physical examination (N=94)

Correct diagnosis considered	Final correct diagnosis		Relative risk (confidence interval)
	Yes	No	
After history taking			
Yes	49	8	5.0 (2.5-9.8)
No	11	26	
After physical examination			
Yes	55	10	5.4 (3.0-9.7)
No	5	24	

*The relative risk is the extent to which failing to consider the correct diagnosis in differential diagnosis after taking the history or performing physical examination increased the possibility of final misdiagnosis.

Of the students who made a correct final diagnosis, 70% did so after taking a history, while the findings obtained by physical examination and laboratory tests each added another 10-20%. These results are similar to those of previous research on physicians, so the importance of taking a good history and clinical reasoning was confirmed in our students.[2] Comparison among the four test cases showed that the percentage of students who only reached a diagnosis based on laboratory test results was highest for the case of hypothyroidism, while none of the students employed laboratory data for diagnosis of the cases of infectious mononucleosis and carpal tunnel syndrome. The present findings also suggest that students who suspected thyroid disease in the hypothyroidism case made their diagnosis on the basis of laboratory data because it is well known that measurement of TSH is useful (89-95% sensitivity and specificity) for diagnosing this condition.[10] In the cases of infectious mononucleosis and carpal tunnel syndrome, on the other hand, the tests/examinations that are helpful for making a definite diagnosis (such as EBV antibody measurement and nerve conduction velocity testing) may not have been sufficiently understood by the students. Although there was this difference between cases in the contribution of laboratory test results to making the diagnosis, the most students reached a correct diagnosis after taking a history in all cases, suggesting that the history is always the most important factor in the diagnostic process.

Students who made the correct diagnosis at the end of history taking accounted for over 80% of those with a correct final diagnosis. Conversely, students who failed to consider the correct diagnosis after obtaining the history were 5.0 times more likely to misdiagnose the case than those who considered it. Research using the PMP method has revealed that students making the correct diagnosis at the end of history taking are from 12 times (95%CI= 3-46) to 33 times (95%CI= 5-218) more likely to reach a correct final diagnosis than those who fail to do so.[3] These results are similar to ours in indicating that a correct diagnosis after history taking contributes to making an accurate final diagnosis. Research has shown that diagnostic accuracy is improved by early and thorough problem representation, which is defined by a degree of abstraction from actual findings.[11,12] A study of medical students indicated that faulty diagnostic decisions resulted from a failure to gather critical data.[9] In the present study, there was little difference of the relative risk of misdiagnosis when student did not consider the correct diagnosis after taking a history versus after performing physical examination. This suggests that failure to consider the correct diagnosis based on the history may also contribute to failure to perform a pertinent physical examination and laboratory tests in clinical case simulation.

Limitations of the study

In actual medical practice, a diagnosis may be inferred from easily recognizable physical findings or nonverbal information such as the voice and facial expression. In this study, however, the available information was limited to a case history and verbal reports on the results of physical examination and laboratory tests requested by the student. This situation makes inference from physical findings more difficult than in actual medical practice. Restriction on the order of information access may be another limitation, since real world physicians can switch freely between the history, physical examination, and laboratory tests while gathering information. Moreover, the present study only assessed four cases, which prevents generalization of our results. A prospective study that included 5-10 cases for each student would be required to improve the generalizability of results.[7,13] Finally, the 4 test cases were selected from among those frequently encountered at outpatient clinics, and no emergency cases were included. In the hospital ward or emergency room, the physical findings and laboratory test results are likely to be more important than in the general clinic. Thus, further studies are needed to cover a wider variety of cases, including patients with severe illnesses from various medical fields.

Conclusions

These findings indicate that considering the correct diagnosis at the stage of history taking is especially important for making a correct final diagnosis among students performing clinical case simulation. To improve the diagnostic

reasoning skills of medical students, they should be trained in methods for inferring the correct diagnosis from the case history.

Conflict of Interest

The authors declare that they have no conflict of interest.

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