

Can *Think Aloud* Be Used to Teach and Assess Clinical Reasoning in Graduate Medical Education?

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Clinical reasoning may be defined as the cognitive processes involved in arriving at a diagnosis or treatment plan.¹ It is central to effective medical practice, yet it remains elusive and continues to present a challenge to clinical teachers and learners.² The antemortem misdiagnosis rate at autopsies and audits of adverse events in hospitals attest to the continuing importance of clinical reasoning, despite the introduction of guidelines and advances in technology.^{3,4} The level of quality and accuracy of the clinical reasoning that underlies diagnostic and management decisions is the difference between trainees and expert clinicians. The process of learning clinical reasoning may be assisted by using *think aloud*.

Think aloud is a research method used to study cognition and is considered the optimal method to capture thought processes.⁵ Cognitive psychologists view thinking as a temporal sequence of mental states. Each state contains information retrieved from long-term memory, perceptions from the environment, and the inferences generated from the recovered information. *Think aloud* occurs when individuals verbalize their thoughts while performing a task. It is our view that during *think aloud* individuals do not describe or explain what they are thinking; they simply verbalize how they are using the available information to generate a solution to a problem.⁵ For example, when asked to multiply 17 by 13, an individual might say, “17 × 10 is 170 and 17 × 3 is 51; adding these gives the answer 221.” When people verbalize how they are thinking as they perform a task, the sequence of thoughts is not changed by the added instruction to “think aloud.”⁵

Expert clinicians gather and use clinical information to generate accurate diagnoses. However, this is usually done in an implicit and frequently automatic

process. *Think aloud* is a method of making clinical reasoning processes more explicit, so that inexperienced clinicians are able to learn from these processes. *Think aloud* methods provide explanations and descriptions of complex information, and parallels the clinical reasoning process. *Think aloud* explicitly allows trainees to see how high-content knowledge is used by expert clinicians, who are able to select the important information and generate links and associations to organize this information. Research has shown how trainees and expert clinicians are able to identify important pieces of information for a diagnosis.⁶ However, only expert clinicians are also able to identify and organize the important information to generate a correct diagnosis. *Think aloud* allows trainees to hear how expert clinicians selectively organize information to solve a patient problem, and it also allows supervising clinicians to understand the way trainees are thinking when using *think aloud* to explain their developing reasoning process. It transforms the thought processes of expert clinicians, which are otherwise automatic and implicit, into explicit and concrete explanations. Instead of learning how to deal with complex cases merely by exposure to many cases, *think aloud* provides a systematic way for trainees to develop their clinical reasoning skills for complex cases.⁷

Evidence to support *think aloud* as a way to capture thought processes comes from task analysis and functional magnetic resonance imaging studies.^{5,8} In task analysis, an individual’s thought processes and his or her steps used to solve a problem are made explicit.⁵ The contention that verbalization accurately reflects the thought processes is supported by the fact that verbalized thoughts are consistent with the sequence of intermediate steps used to solve a problem, and other sequences of verbalized thoughts are used to generate correct answers. Laboratory analyses of recordings of reaction times, error rates,

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TABLE
Trainee's Presentation and Supervisor's *Think Aloud*

Presentation of Patient by Trainee	Think Aloud by Supervisor
Robert—10-mo-old child. Referred because of bouts of abdominal pain, vomiting, and diarrhea.	P A U S E <i>Presentation most commonly due to gastroenteritis. Other serious conditions, particularly surgical problems, present in a similar way.</i>
Robert—youngest of 3 children. Siblings (ages 3 y and 5 y) have been well recently. Attends day care, but none of the children there have been sick. Normal vaginal delivery without any complication or resuscitation needed. He is growing (weighs 20 lbs.) and developing normally. Fully immunized and has no known allergies.	P A U S E <i>Absence of a history of contact with a child with diarrhea doesn't exclude the possibility of infectious gastroenteritis, but together with the fact that he is immunized, it makes it less likely.</i>
Vomiting in the last 12 hours. Vomit is now a green color, but there is not as much volume as initially and not projectile. Mother has noted that Robert has been very irritable and looking like he is in pain at times. He has been drawing up his legs and screaming on occasions. Some lightly blood-tinged diarrhea noted the last 3 h.	P A U S E <i>Green vomitus is a significant sign because it is often a manifestation of intestinal obstruction. I am worried about a surgical condition—malrotation, intussusception (he is in the right age group for this because it peaks 6–18 mo). Appendicitis is a little less likely because he hasn't been febrile. Summary: Acute onset of bile-stained vomiting in a 10-mo-old infant with irritability and bloody diarrhea is very suggestive of intussusception.</i>
Any fluids taken this morning have been vomited. Not eaten for 8 h. Difficult to ascertain the number of wet diapers with the diarrhea. Robert's mother says he is now looking listless and tired.	P A U S E <i>This information of very poor oral intake suggests he is at risk of becoming dehydrated and may need intravenous fluids.</i>

patterns of brain recordings, and sequences of eye fixations add further support to the contention that verbalization during *think aloud* reflects thought processes.⁵ Functional magnetic resonance imaging shows how brain activity differs when physicians answer a question, and when they *think aloud* about how they arrive at their chosen answer.⁸ These findings add further evidence that *think aloud* is a measure of the process of critical cognition. In *think aloud*, it is the thinking processes involved that are important. How we arrive at an answer is what is instructive, rather than just focusing on the answer itself.⁵

Much of expert clinicians' reasoning is based on pattern recognition, which is implicit.⁹ Pattern recognition occurs very quickly and without deliberation. We suggest that teachers retrospectively consider why they arrived at a particular diagnosis based on pattern recognition. Was this based on experience with a similar case previously, or was it that the constellation of symptoms and signs were characteristic or pathognomonic of a particular condition? Most experienced clinicians who are aware of the

danger of premature closure when using pattern recognition would seek immediate confirmatory evidence from further history and physical examination to support their intuition or diagnosis based on pattern recognition. The reason for the pattern recognition, and how to avoid the associated risk of premature closure, can be demonstrated to trainees. *Think aloud* reveals steps in the reasoning process and makes explicit how decisions are made—outlining the process of making the diagnosis, rather than just focusing on the diagnosis. All thinking processes involved in clinical reasoning shown in BOX 1 can be captured during *think aloud*. *Think aloud* shows that clinical reasoning is an iterative process in which the repetition of collecting and analyzing data continues until a final diagnosis is made.¹⁰

How can *think aloud* be used in graduate medical education to learn and assess clinical reasoning? We suggest that trainees be encouraged to pause intermittently as they present their clinical findings to their peers or supervisors, and use *think aloud* to explain what and how they are thinking. This can be done in small group teaching sessions or when they are

BOX 1 Cognitive Processes Involved in Clinical Reasoning

Intuition and hypothetical deduction

- How data are analyzed as they are collected and aggregated
- How this analysis is used to support diagnoses
- How the preliminary analysis is used to collect further highly relevant, specific data
- How possible diagnoses are compared and contrasted
- How tentative diagnoses are reviewed as new data emerge
- How additional data are collected for clarification when information is encountered that does not support the tentative diagnosis
- How clinicians regulate judgments and minimize errors and biases

presenting their findings to a supervisor (best done without the patient being present). When trainees do this, their clinical reasoning can be assessed and common errors can be remedied.¹¹ If their supervisors explain how they themselves are thinking as part of this session, trainees can learn how an expert thinks. The TABLE shows an outline of how *think aloud* can be used.

While there are a number of ways to teach and learn clinical reasoning, *think aloud* has unique advantages.¹² Based on our experience of including anecdotal feedback from clinical teachers following training in the *think aloud* technique, advantages of this approach are shown in BOX 2.

We have conducted workshops at 2 international conferences where clinicians were instructed in how to use *think aloud*.^{13,14} The feedback was very positive. Attendees agreed that *think aloud* is a useful technique to teach and assess clinical reasoning in clinical practice, and it provides an actual teaching strategy for what is a complex process.

To better understand the value of the *think aloud* technique for teaching and learning clinical reasoning,

BOX 2 Advantages of the *Think Aloud* Technique

- It occurs in real time during patient management
- It requires minimal teacher training
- All intermediate and critical steps used in clinical reasoning are made explicit
- It demonstrates the use of intuitive and hypothetical deductive processes
- It is useful for both teaching and assessment
- It is incorporated into clinical practice without significantly slowing down clinical activity

well-designed research such as comparing the effect of using teach aloud to other methods of teaching clinical reasoning, qualitative research to establish themes on what aspects of *think aloud* are effective, and a longitudinal study to assess the long-term effects of introducing teach aloud on clinical practice will be key next steps.

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