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EDITORIAL AND COMMENT

Artificial Intelligence and Clinical Reasoning—a Way to Walk to Harrison's

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Almost thirty years apart, both editorialists started going to Morbidity and Mortality (M&M) conferences during our third-year internal medicine rotations. We became enthralled by the excitement of unlocking the mystery of an unknown case. M&M conferences highlighted incredible diagnosticians with advanced illness scripts gleaned over years of patient care combined with dedicated in-depth reading focused on clinical practice. We often called the M&M discussants "Walking Harrison's" in honor of the popular medicine textbook and their apparent encyclopedic funds of knowledge. As internal medicine residents, we quickly realized that few could become a "Walking Harrison's" and develop mastery over the vast (and rapidly growing) body of knowledge that encompasses internal medicine. We recognized these rare internists as heroes, but their mastery remained largely out of reach.

Over the last twenty years, research in the fields of clinical reasoning and meta-cognition (i.e., thinking about thinking) has identified strategies for trainees and practicing clinicians to build the skills that came naturally to our diagnostic heroes. Condensing large amounts of clinical information into an organized problem representation,[1,2] sorting knowledge into illness scripts,[3] consciously thinking fast or slow,[4] and bunching manageable amounts of information into diagnostic schema[5] are just a few of the ways that we are better equipped today to process the masses of data needed to develop diagnostic expertise. These cognitive and meta-cognitive strategies help clinicians in refining not just *what* they think (i.e., the acquisition and retention of knowledge) but also *how* they think (i.e., the application of knowledge). Translating this clinical reasoning theory to practice requires intentional efforts from curriculum designers, clinical teachers, and front-line clinicians. Luckily, there is an ever-growing number of resources utilizing different platforms to help support clinical reasoning skill acquisition, including the Exercises in Clinical Reasoning (ECR) series in *JGIM* and the popular podcast, the Clinical Problem Solvers.

In this edition of *JGIM*, Zack and colleagues take a novel approach to fostering expertise in clinical reasoning development.[6] The authors applied natural language processing to create a "reasoning-encoded" database comprised of common signs, symptoms, laboratory tests, and diagnoses[5] utilizing published Clinical Pathological Conferences (CPCs) from the *New England Journal of Medicine*. These CPCs elevate meta-cognitive strategies by highlighting the thought process of an expert clinician analyzing a sequentially presented case. During a CPC, the discussant shares their differential diagnosis and outlines an argument for their final diagnosis. The natural language program was able to link the diagnostic data from the CPC discussion to symptoms, topics, or diagnoses in a 3D frequency diagram. The result is an innovative platform that catalyzes access to CPCs and offers a searchable database of cases that include advanced clinical reasoning discussions.[7] Trainees, clinician-educators, and practicing clinicians facile with computer interfaces will find this new resource to be a useful tool for advancing clinical reasoning instruction, integrating expert knowledge into their day-to-day clinical work, and facilitating lifelong learning through deliberate practice.

Historically, medical education has drawn on instructional methods rooted in apprenticeship-based teaching, which prioritizes providing opportunities for learners to observe expert performance.[8] In traditional apprenticeship models (e.g., a baker), these observation opportunities are readily available because the target skills are often tangible or visible (e.g., the apprentice can feel the texture of a well-made crust or watch the expert baker knead dough).[8] However, many of the cognitive skills in clinical practice, such as clinical reasoning, are invisible. Providing medical learners opportunities to observe these tacit cognitive skills requires expert clinicians to externalize their internal cognitive processes as they think through a case. Implementing this cognitive apprenticeship model presents a substantial challenge for clinical reasoning instruction as there is a paucity of experts who feel comfortable narrating their meta-cognition. Furthermore, important educational resources in the medical literature, such as published case reports, seldom incorporate experts' reasoning strategies. Therefore, CPCs offer a particularly valuable tool for clinical reasoning instruction because they incorporate an expert discussants' cognition as they reason to a final diagnosis. The inclusion of how the discussant frames the case and weighs clinical data provides a rich opportunity for learners to demystify the cognitive processes of an expert clinician.

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However, in keeping with the variety and unpredictability of clinical practice, CPCs necessarily follow a stochastic publication pattern. One week, a case may focus on a pulmonary fungal infection, the next, a gastrointestinal malignancy, and the next, an autoimmune connective tissue disease. The work by Zack and colleagues enables clinician-educators to create series of reasoning-rich teaching cases focused on symptoms (e.g., dyspnea) or diagnoses (e.g., granulomatosis with polyangiitis) without combing through decades of published CPCs. The ease with which educators can curate cases will allow learners to more efficiently access and study expert cognition.

One need not be a clinician-educator to benefit from this searchable database of clinical cases; clinicians can use it to support their own reasoning in daily practice. When faced with a challenging case, practitioners may turn to Google to search the salient features of a case (e.g., fever, lymphadenopathy, and abdominal pain) with the aim of better understanding what diseases can cause such a constellation of symptoms. While this practice can augment a clinician's differential diagnosis or refine their illness scripts, it fails to support a key step of the reasoning process: illness script comparison. Zack and colleagues' innovation fills this gap. Rather than reviewing search engine results of case reports that discuss diagnoses in isolation, clinicians can now discover how experts compare and contrast these diagnoses in the context of a real case. Type those same symptoms (fever, lymphadenopathy, and abdominal pain) into Zack and colleagues' database and clinicians have multiple similar CPCs at their fingertips that can help them apply clinical reasoning strategies utilized by an expert.

Finally, physicians interested in improving their reasoning skills will find this tool also supports lifelong learning strategies. Research in the fields of cognitive psychology and expertise has consistently demonstrated that years of experience are not enough for professionals to develop expert performance.[9,10] Instead, acquisition of expertise relies on *deliberate practice*, which requires self-study, reflection, feedback, and repeated exposure to a specific task.[9,10] After a clinician recognizes and works to address limitations in their approach to a clinical dilemma, it may be weeks or months before they have an opportunity to apply this new knowledge to a similar patient. While targeted reading can help to bridge the gap between distant repetitions, combing the archives of published cases is time consuming and inefficient. Zack and colleagues solve this problem for busy clinicians by facilitating access to cases on specific clinical topics, allowing them to invest their time *engaging* in deliberate practice, rather than *preparing* for it.

Artificial intelligence in medicine could bring up a dystopian world where physicians are replaced by computer algorithms making diagnoses. The work by Zack and colleagues helps dispel this fear by creating a tool that facilitates education, clinical application, and deliberate practice of diagnostic expertise, providing another resource for those interested in cultivating clinical reasoning skills. We look forward to the application of Zack and colleagues' tool to include other clinical reasoning cases in their database and would be excited to include *JGIM*'s ECR series. Their important work uses artificial intelligence to make it easier for all of us to become "Walking Harrison's"—or at least give us another resource to "walk to Harrison's"—through more easily searching and accessing published paradigm CPCs.

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