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Clinical Reasoning in Manual Therapy
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Clinical Reasoning in Manual Therapy

Clinical reasoning refers to the cognitive processes or thinking used in the evaluation and management of a patient. In this article, clinical reasoning research and expert-novice studies are examined to provide insight into the growing understanding of clinical reasoning and the nature of expertise. Although hypothetico-deductive methods of reasoning are used by clinicians at all levels of experience, experts appear to possess a superior organization of knowledge. Experts often reach a diagnosis based on pure pattern recognition of clinical patterns. With an atypical problem, however, the expert, like the novice, appears to rely more on hypothetico-deductive clinical reasoning. Five categories of hypotheses are proposed for physical therapists using a hypothetico-deductive method of clinical reasoning. A model of the clinical reasoning process for physical therapists is presented to bring attention to the hypothesis generation, testing, and modification that I feel should take place through all aspects of the patient encounter. Examples of common errors in clinical reasoning are highlighted, and suggestions for facilitating clinical reasoning in our students are made. [Jones MA. Clinical reasoning in manual therapy. Phys Ther. 1992;72:875–884.]

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There is an increasing demand for accountability of physical therapists from within the profession as well as outside, including funding agencies, competing health practitioners, and the increasingly more health conscious consumer. This demand is met in part by the profession's ongoing efforts to teach and conduct scientific inquiry with the aim of improving and validating physical therapy practice. Equally important, physical therapists must apply the methods of scientific inquiry to the examination and management of patient problems. Accountability suffers when therapists unquestioningly follow examination and treatment routines without considering and exploring alternatives. Scientific reasoning often includes the hypothetico-deductive method, in which hypotheses are generated from observations and the hypotheses are then tested through subsequent data collection and modified as a result of the outcome of the test. Similarly, physical therapists should be taught to use clinical reasoning skills in their examination and management of patients. But what reasoning skills should we teach? And how should this be balanced against the teaching of knowledge? Understanding the cognitive components of clinical reasoning and in particular the differentiating features between experts and novices should enable us to critically evaluate our own reasoning and design educational activities to facilitate improved reasoning.

Although theoretical discussions and educational suggestions on aspects of clinical reasoning in physical therapy are increasing,[1–5] research in clinical reasoning within physical therapy is still sparse.[6–8] Considerable research, however, has been conducted in the area of thinking/reasoning and the nature of expertise in such diverse fields as medicine, nursing, psychology, artificial intelligence, programming, law, mathematics, engineering, and physics.[9–13] This article will briefly highlight research findings that provide insight into the growing understanding of clinical reasoning and the nature of expertise relevant to physical therapy. Although further research is needed to clarify the nature of clinical reasoning, the majority of clinical reasoning literature suggests that expert clinicians have a highly developed organization of knowledge and use a hypothetico-deductive method in their clinical reasoning.[14] A model of a clinical reasoning process for physical therapists is presented that emphasizes a hypothesis testing approach to clinical reasoning. Clinical reasoning that is

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hypothetico-deductive will assist clinicians in avoiding common errors of reasoning and enhance their recognition of clinical patterns and organization of knowledge.

Clinical Reasoning

Clinical reasoning can be defined as the cognitive processes, or thinking used in the evaluation and management of a patient. Other terms including "clinical decision making,"[1] "clinical problem solving,"[8] and "clinical judgment"[10] also appear in the literature and frequently are used interchangeably. Clinical decision making and clinical judgment focus on the diagnostic decision-making aspect of the clinical reasoning process, whereas problem solving typically refers to the steps involved in working toward a problem solution. Problem solving also infers the therapist's aim is to solve the patient's problem. Some patient problems, however, are "unsolvable." Our profession's aim is to evaluate the patient problem, identifying factors amenable to physical therapy to effectively manage the problem. The term "clinical reasoning" has broader connotations and is used in this article to refer to the cognitive processes used in achieving this aim of evaluating and managing the patient's problem.

Clinical Reasoning in Medicine: A Universal Process

A summary of findings from early medical education research in clinical reasoning highlights some universal aspects of clinical reasoning and the significance that the organization of one's knowledge has to the differentiation of expert clinicians and novices. Early medical education studies analyzed clinicians' thoughts (eg, perceptions, interpretations, plans), either retrospectively as the clinicians thought aloud while being prompted by a video or audio playback of a patient examination just completed or concurrently as the clinicians read a patient's unfolding clinical history. In a review of research in medical clinical reasoning, Feltovich and Barrows[15] described hypotheses and data gathering that were considered in the clinical reasoning studies. The variables affecting hypothesis generation included the percentage of patient data items or the time it took to creation of the first hypothesis. The total number of hypotheses considered and number of hypotheses actively considered at any one time were also studied. There was no difference in any of these variables across different specialties or across different levels of experience within the same specialty. Although these hypothesis-related variables are common to all clinicians, their importance to effective clinical reasoning was unclear, as none were consistently predictive of the quality of outcome (eg, correct diagnosis and management plan).

The data-gathering variables centered on the general themes of thoroughness, efficiency (ie, important to nonimportant information collected), activeness (ie, extent to which data collected are evaluated in relationship to hypotheses being considered to test appropriateness of hypotheses), and accuracy in interpretation (ie, correctness of interpretations as supporting or not to hypotheses). The value of the data-gathering measures to reveal important aspects of clinical reasoning were also questionable, as they did not discriminate among clinicians from different specialties or clinicians with different levels of experience or peer-judged proficiency. The importance of these data-gathering variables to the products of the reasoning process was also questioned. With the exception of "accuracy in interpretation,"[16] no other data-gathering variable correlated with quality of diagnosis and management plan.

The best indicator of the correctness of diagnosis and management plan was the quality (as judged by expert standards) of hypotheses considered.[17–20] If the appropriate hypotheses were not considered from the start, the clinician's subsequent inquiries would presumably be misdirected. This finding of the importance of good hypotheses highlights the crucial role the clinician's knowledge base has in the clinical reasoning process. The importance of knowledge and its organization are also reflected in the seminal work of Elstein and colleagues,[16] in which clinical reasoning performance was shown to vary greatly across cases. That is, clinical reasoning is specific to one's area of work (eg, orthopedics, neurology, and so forth), dependent on the clinician's organization of knowledge in the particular area.

These early medical studies provide an overall picture of a clinical reasoning process that is hypothetico-deductive and universally applied by clinicians at all levels of experience. The process involves collecting and analyzing information, generating hypotheses concerning the cause or nature of the patient's condition, investigating or testing these hypotheses through further data collection, and determining the optimal diagnostic and treatment decisions based on the data obtained.

The Nature of Expertise

"Experts" in the early medical education research were typically those selected by peer nomination, whereas "novices" were usually students at varying levels of their education.[16–20] Patel and Groen[21] have suggested that expertise be considered along the dual continuum of both generic and specialized knowledge. They define a *novice* as an individual who has the prerequisite knowledge assumed by the domain. A *subexpert*, according to Patel and Groen, is an individual with generic knowledge, but inadequate specialized knowledge of the domain, and an *expert* is defined as an individual with specialized knowledge of the domain. These definitions provide sufficient distinctions for interpreting the expert-novice literature cited in this article. Although I will not suggest my own expert-novice distinction for physical therapy, I do feel the full range of competencies inherent to physical therapy including knowledge, interpersonal, manual, and clinical reasoning skills should be incorporated into any expert-novice distinction.

Expert clinicians have a superior organization of knowledge and use a combination of hypothetico-deductive reasoning and pattern recognition or forward reasoning.[16,21,22] Support for the importance of one's organization of knowledge is available from the literature of cognitive psychology.[23,24] Experts acquire efficient ways of representing information in their working memory. Studies of problem solving and expert-novice differences in fields other than medicine have pointed to the importance of an individual's problem representation for guiding reasoning and determining successful problem solution. A problem representation is the solver's internal model of the problem, containing the solver's conception of the problem elements, his or her knowledge of those elements, and the relationship the different problem elements have to each other.[25] The depth and organization of knowledge between novices and experts has consistently been found to differ.

Chess experts recognize patterns reflecting areas of strategic strength and vulnerability and positions supporting maneuvers of attack and defense. Although the chess expert can replicate a chessboard when viewed for only 5 seconds, there is a dramatic drop-off in this ability below the level of chess master. No differences, however, are found when the chess pieces are randomly arranged, demonstrating the chess master's superior ability to perceive patterns in chess positions.[26,27] Expert physics problem solvers represent problems as instances of major laws of physics applicable to the specific situation in which novices' problem representation are more literal, fragmented, and tied to overt features of the problem such as the use of a spring or a pulley.[25] Similar results demonstrating experts' recognition of patterns have been replicated in several other domains such as in the game of GO, in reading circuit diagrams, in reading architectural plans, and in interpreting radiographs.[28] This superior ability to see meaningful patterns is not the result of superior perceptual or memory skills; rather it reflects a more highly organized knowledge base.[28]

These representations of the problem will in turn influence the subsequent search for a solution. The expert chess player's conceptualization of the game into strengths and vulnerabilities lessens the number of appropriate moves to consider. When the physicist characterizes a problem as an example of a physics law, the law itself substantially directs the form and application of equations that will be used. Similarly, the physical therapist's representation of the problem (as determined by each individual's personal perspective and organization of knowledge) will influence the subsequent reasoning and search for a solution. For example, physical therapists who adhere to the concept of "adverse neural tissue tension" as described by Elvey[29] and Butler[30] will conceptually approach the examination and treatment of a patient differently than therapists without this particular organization of knowledge. Recognition of the continuity of the nervous system[29,30] will influence therapists' attention and weighting of patient clues and their subsequent search for supporting and negating data.

Using a method of propositional analysis to determine a clinician's mental representation of a case, Patel and colleagues[31–37] have found analogous results when comparing medical clinicians at various levels of expertise. Typically, subjects are presented with a written patient description and then asked to recall the facts in writing, followed by their explanation of the patient's underlying pathophysiology and lastly their diagnosis. Propositional analysis is a system of noting and classifying the clinician's observations, findings, interpretations, and inferences derived from the information contained in the text. These studies consistently demonstrated differences between experts' and novices' conceptualization of a problem, with experts possessing a superior organization of knowledge. Experts make significantly more inferences about clinically relevant information and chunk information into recognizable patterns.[32] Novices make more verbatim recall of the surface features of a problem and have less developed and fewer variations of patterns stored in their memory. For example, a novice may recall the specific, yet superficial, detail that the patient's shoulder hurt with attempted elevation in early activities. Further details such as the exact site of pain and position of the patient's neck, shoulder, and arm may not have been sought or attended to if the clinical patterns implicated by this additional information were not known to the student. The novice must rely on black and white textbook patterns and lacks information on the relationships and shared features across different clinical patterns.[38] This creates difficulty for the novice when confronted with irrelevant and unrelated information or patient presentations containing overlapping problems and gray, nontextbook variations.

An example of the novice's risk of missing overlapping problems is the patient whose lateral elbow pain is aggravated by resisted extension of the wrist. The novice may recognize this typical feature of injury to the common extensor origin yet fail to exclude (through inquiry and physical tests) other potentially coexisting disorders that may share or predispose to this clinical presentation (eg, involvement of C5-6 musculoskeletal structures, adverse neural tissue tension, radiohumeral joint and local radial nerve entrapment).

Bordage and colleagues[39,40] have demonstrated other more qualitative differences in the organization of novice and expert knowledge. Whereas the novice's knowledge is centered purely on disjointed lists of signs and symptoms, the stronger diagnosticians make use of abstract relationships such as proximal-distal, deep-superficial, and gradual-sudden, which assist to categorize similar and opposing bits of information in memory.

One's organization of knowledge not only appears to determine what labels are given to recognizable patterns of information, but also includes "production rules," which specify what actions should be taken in different situations.[23,32,41] Experts are thought to have a large number of such rules specific to their area of experience.

The end result of the expert's superior organization of knowledge is the ability to reason inductively in a forward manner from the information presented and to achieve superior diagnostic accuracy. That is, when confronting a familiar presentation, experts can utilize rules of action found reliable in their own clinical experience to reach a diagnosis based on pure pattern recognition. When faced with an atypical problem or a problem out of their area of expertise, however, experts, like novices, must rely more on the hypothetico-deductive (ie, hypothesis testing) method of reasoning.[22,42,43]

The organization of knowledge relevant to clinical manual therapy would include the facts (eg, anatomy, pathophysiology, and so forth), procedures (eg, examination and treatment strategies), concepts (eg, instability, adverse neural tissue tension), and patterns of presentation. This knowledge is utilized with the assistance of rules or principles (eg, selection of the grade of passive movement and technique) to acquire, interpret, infer, and collate patient information.

Clinical Reasoning in Physical Therapy

Whereas research in medical education has emphasized diagnosis, I believe that physical therapists must be concerned with additional categories of hypotheses in order to deliver physical therapy effectively and safely. Therapists with different training will ask different questions and perform different tests in accordance with the significance they give to the subjective and physical information available from the patient. I propose, however, that despite these differences, the aims of therapists' inquiries are similar. That is, in an attempt to understand and manage the patient's problem, I contend that therapists obtain information regarding the following five categories of hypotheses: (1) source of the symptoms or dysfunction, (2) contributing factors, (3) precautions and contraindications to physical examination and treatment, (4) management, and (5) prognosis.

These hypothesis categories are not peculiar to any particular approach or philosophy of manual therapy. Any clinician who uses hypothetico-deductive clinical reasoning should be considering hypotheses within each of these categories.

"Source of the symptoms or dysfunction" refers to the actual structure from which symptoms are emanating. "Contributing factors" are any predisposing or associated factors involved in the development or maintenance of the patient's problem, whether environmental, behavioral, emotional, physical, or biomechanical. For example, a subacromial structure may be the source of the symptoms, whereas poor force production by the scapular rotators may be the contributing factor responsible for the development or maintenance of an "impingement" syndrome.

Hypotheses regarding "precautions and contraindications to physical examination and treatment" serve to determine the extent of physical examination (ie, whether specific movements are performed or taken up to or into ranges of movement in which pain is provoked and how many movements are tested), whether physical treatment is indicated, and, if so, whether there are constraints to physical treatment (eg, the use of passive movement without provoking any discomfort versus passive movement that provokes the patient's pain).

Hypotheses regarding "management" include consideration of whether physical therapy is indicated and, if so, what means should be trialed. If manual therapy is warranted, it must be decided whether treatment should be directed at the source of the symptoms or toward contributing factors. If passive movement is used, examples of considerations include whether physiological or accessory movements are used; whether pain should be provoked or avoided; and what direction, amplitude, speed, and duration of movement should be applied.[44]

Whereas epidemiological studies provide insight into the probable course of different diseases and injuries,[45] physical therapists should be able to inform patients to what extent their disorder appears amenable to physical therapy and to give an estimate of the time frame for which recovery can be expected. Hypotheses regarding "prognosis" in this sense can only be made on the basis of each patient's individual presentation.

Information leading to the different hypothesis categories is obtained throughout the subjective and physical examination, with any single piece of information often contributing to more than one hypothesis category. A more detailed discussion of what information can be considered for the different categories of hypotheses is available in Jones[5] and Jones and Jones.[46]

Rothstein and Echternach[3,47] have proposed a useful hypothesis-oriented algorithm for clinicians. In highlighting the all-too-frequent occurrence of clinicians carrying out routine treatment plans that are unrelated to the preceding patient examination, these authors make a case for the need for physical therapists to acquire clinical reasoning skills. They provide a clear set of steps that appropriately highlight the importance of utilizing data from the patient interview to generate a problem statement and establish measurable goals. The algorithm continues with the physical examination and the generation of hypotheses about the cause(s) of the patient's problem. They note that testing criteria for each hypothesis should be considered and that all treatments should relate to the hypotheses made. The second part of their hypothesis-oriented algorithm provides an or-

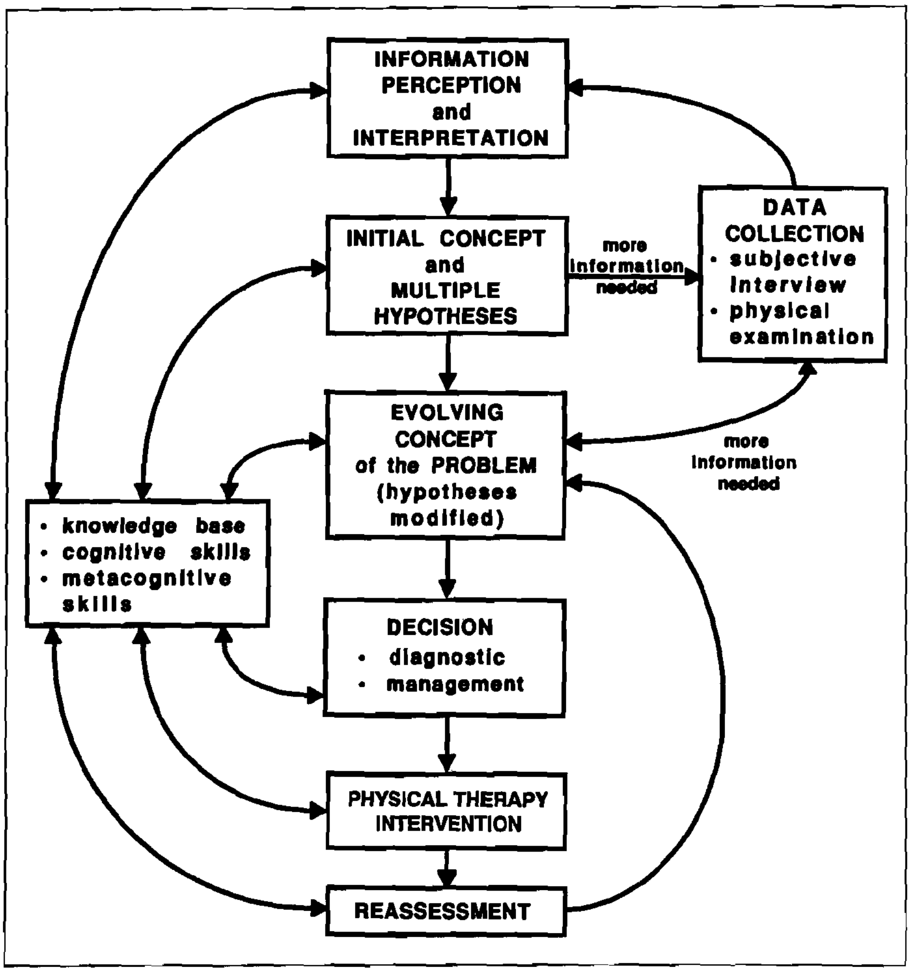

Figure. *Clinical reasoning model for physical therapists. (Adapted from Barrows and Tamblyn.[48])*

dered series of steps for reassessing the effects of the treatment implemented. This algorithm is useful in teaching the hypothetico-deductive method of clinical reasoning and assisting clinicians in recognizing when their actions have not been logically formulated.

I have adapted a diagram from Barrows and Tamblyn[48] to depict the clinical reasoning process of physical therapists (Figure). This is not a substitute for the hypothesis-oriented algorithm of Rothstein and Echternach.[3,47] Rather, this model is presented to bring attention to the hypothesis generation, testing, and modification that I feel should take place through all aspects of the patient encounter including the interview, physical examination, and ongoing management. I have also attempted to depict the cyclical character of the clinical reasoning process and to highlight key factors that influence the various phases of clinical reasoning. The process begins with the therapist's *observation and interpretation* of initial cues from the patient. Even in the opening moments of greeting a patient, the therapist will observe specific cues such as the patient's age, appearance, facial expressions, movement patterns, resting posture, and any spontaneous comments. These initial cues from the patient should cause the therapist to develop an *initial concept* of the problem that includes *preliminary working hypotheses* for consideration through the rest of the examination and throughout ongoing management of the patient. For example, if the patient shows obvious difficulty in removing his or her arm from a jacket, the therapist will already be forming initial hypotheses or working interpretations regarding the source of the problem and degree of involvement. Further information (ie, *data collection*) is then sought throughout the subjective and physical examination with these working hypotheses in mind.

Although certain categories of information (eg, site, behavior, and history of symptoms) are scanned in all patients, the specific questions pursued are tailored to each patient and the therapist's evolving hypotheses. For example, when the patient with difficulty removing the jacket describes an area of ache in the supraspinous fossa and an area of pain in the anterior shoulder just lateral to the coracoid process, the initial hypothesis of a "shoulder problem" is already modified. For me, two different symptoms, an ache and a pain, are indicated, each warranting consideration and further inquiry. I would consider both local and spinal structures as potential sources or contributing factors. The patient's response to open questions regarding what aggravates and what eases the pain should then be interpreted with these hypotheses in mind.

Maitland[44,49] uses the phrase "make the features fit" to encourage therapists to inquire in the mode described here where information is interpreted for its support or "fit" with existing information (ie, working hypotheses). When features do not fit, or in this terminology your hypothesis is not supported by the new information, further inquiry is needed. For example, an impingement of either contractile or noncontractile structures may be considered in the patient I have described. If further questioning revealed that the patient had no difficulty lifting any weight below 90 degrees while movements across the body into horizontal flexion were limited by the anterior pain, this would not, in my view, support a contractile tissue lesion but would implicate an impingement of noncontractile structures or an acromioclavicular source to this pain. I would question and reason in this manner to assess the involvement of other structures in the anterior pain, such as cervical structures and neural tissues, and I would pay equal attention to the ache.

Similarly, the physical examination is not simply a routine series of tests. There may be specific physical tests that are used for different areas, but these should be seen as an extension of the data collection and hypothesis testing performed through the subjective examination.[46] For example, reports of painful "clicking" in the shoulder and sensations of apprehension indicate the need for instability and labral integrity testing, but these tests may not be warranted in the next patient who has similar symptoms.

This process of data collection continues as hypotheses are refined and reranked and new ones considered in the therapist's "evolving concept" of the problem. The clinical reasoning through the patient examination continues until sufficient information is obtained to make a *"diagnostic" and management decision.*

The clinical reasoning process does not stop at completion of the patient examination. Rather, the therapist will have reached the management decisions of whether to treat or not treat; whether to address the source(s) or contributing factor(s), or both, initially; which mode of treatment to use initially; and, if passive movement treatment is to be used, whether to provoke symptoms and the direction and grade of movement. Every treatment, whether it is hands-on or advice, should be a form of hypothesis testing. Continual reassessment is essential and provides the evidence on which hypotheses are accepted or rejected. *Reassessment* should contribute to the therapist's evolving concept of the patient's problem. When treatment has not had the expected effect, the therapist's concept of the problem and its management may be altered, leading to a change in treatment or further inquiry (eg, reexamination, additional examination, reanalysis of data obtained, referral to another health care practitioner).

Factors Influencing Clinical Reasoning

The clinical reasoning process is influenced by the therapist's *knowledge base, cognitive skills* (eg, data analysis and synthesis),[16,42,50] and *metacognitive skills* (ie, awareness and monitoring of thinking processes).[51] These factors influence all aspects of the clinical reasoning process and can themselves be improved when therapists consciously reflect on the supporting and negating information on which their inquiries and clinical decisions are based. For example, consideration of the features of the patient's presentation that fit and do not fit existing patterns recognized by therapists will enable therapists to learn about different clinical patterns and their variations and to broaden their knowledge base. I contend that therapists with good clinical reasoning skills will reflect as they interact with the patient, improvising their actions in accordance with the unfolding patient findings much like a musician adjusts his or her performance when participating in an improvisational session with other musicians.[52]

As reasoning is only as good as the information on which it occurs, any factor influencing the reliability and validity of information obtained (eg, communication/interpersonal and manual skills) will also influence the effectiveness of one's clinical reasoning. For example, leading questions in a patient interview often elicit responses that support the examiner's assertion. Other less tangible factors influencing clinical reasoning include environmental contingencies such as group norms and time constraints.[41] That is, working environments of overextended case loads and peer or self-imposed pressure to exclusively adopt the latest treatment fad are not conducive to clinical reasoning that is hypothesis oriented.

Errors of Clinical Reasoning

Successful management of a patient's problem requires a multitude of skills. Working from the patient's account of the problem, the therapist must be able to efficiently observe and extract information, distinguish relevant from irrelevant information, make correct interpretations, weigh and collate information, and draw correct inferences and deductions. Errors of reasoning may occur at any stage of the clinical reasoning process including errors of perception, inquiry, interpretation, synthesis, planning, and reflection. Application of hypothesis-oriented clinical reasoning as encouraged by the clinical reasoning model portrayed in the Figure and the hypothesis-oriented algorithm described by Rothstein and Echternach[47] should assist clinicians in avoiding errors of reasoning.

Examples of reasoning errors extrapolated from Nickerson et al[51] are given below with the physical therapy applications derived by this author.

1. *Adding pragmatic inferences.* Making assumptions is an error of reasoning. For example, a patient with pain in the supraspinous fossa will often describe this as "pain in my shoulder." It is a misrepresentation of the facts to assume the patient's "shoulder pain" is actually within the shoulder itself without specific clarification of the site.

2. *Considering too few hypotheses.* By prematurely limiting the hypotheses considered, discovery of the correct hypothesis may be missed or delayed. This can occur when inquiries and physical tests are only directed to the local sources of a patient's symptoms, as with the patient reporting "shoulder pain with any lifting." To interpret this automatically as a shoulder problem or, worse yet, a "frozen shoulder" without considering other hypotheses is an error of reasoning.

3. *Failure to sample enough information.* It is an error to make a generalization based on limited data.

This is seen in judgments regarding the success or failure of a particular management approach based on only a few experiences. Closely linked to this error is the failure to sample information in an unbiased way. Although this is typically controlled for in formal research, the practicing therapist will rely on memory of previous experiences as the sample on which views are based. The error occurs when only those cases are recalled that support one view while confounding evidence is forgotten.

4. *Confirmation bias.* Another error of reasoning related to a biased sample of information occurs when therapists only attend to those features that support their favorite hypotheses while neglecting the negating features. This can lead to incorrect clinical decisions and hinder the therapist's opportunity to learn different variations of clinical patterns. For example, a presentation of central low back pain aggravated by slouched sitting may be quickly interpreted by some therapists to be a "diskogenic" disorder. Further clarification that the patient's pain provocation was not time dependent and that movement from a sitting to a standing position was not hindered, regardless of the speed at which it was performed, could represent negating features to the "diskogenic" diagnosis. Attention to such variations in presentation will assist therapists' recognition of clinical variations within the same diagnosis, which in turn should lead to recognition of optimal treatment strategies for the respective presentations.

5. *Errors in detecting covariance.* To make a judgment about the relationship of two factors requires understanding of how the two factors covary with one another. It is an error to make this judgment based solely on one combination of covariance. For example, knowing that the patient's medial scapular pain is experienced at the same time as a central neck pain is insufficient to judge the relationship of these symptoms. A full understanding of the relationship between these two symptoms requires inquiry of when both occur together, when the neck pain occurs without the scapular pain, when the scapular pain occurs without the neck pain, and when neither neck nor scapular pain are occurring.

6. *Confusing covariance with causality.* When two factors have been found to covary, it is an error to deduce the factors are necessarily causally related. For example, if the scapular pain in the above example only occurs when the cervical pain is present, this does not prove the two symptoms are from the same source (eg, cervical disk). Although this is a reasonable hypothesis, another possibility is that two different structures (eg, cervical and thoracic) are simultaneously stressed by the same activity or posture.

7. *Confusion between deductive and inductive logic.* Deductive reasoning involves logical inference. One draws conclusions that are a logical, necessary consequence of the premises without going beyond the information contained in the premises. Correct deductive reasoning is independent of the truth of the premises or the conclusion. In contrast, inductive reasoning involves going beyond the information given. Every time we make a generalization based on specific observations, this is an induction. A valid form of deductive reasoning states: If A, then B; A, therefore B. For example, if you have an acromioclavicular joint problem, horizontal flexion is likely to be symptomatic. It is a deductive error to reason: If A, then B; B, therefore A. For example, if you get pain with horizontal flexion you have an acromioclavicular joint problem. This may be inductively reasonable based on past experience; however, it is deductively wrong, as other structures may be responsible. Similarly, with rotator cuff lesions, there will typically be pain on resisted isometric testing; however, this does not mean that all painful resisted isometric tests are necessarily intrinsic rotator cuff lesions.

   A second form of deductive reasoning states: If A, then B; not B, therefore not A. For example, if you have shoulder pain referred from the cervical spine, you will have cervical signs; if you do not have cervical signs, it is not cervical referred shoulder pain. It is a deductive error to reason: If A, then B; not A, therefore not B. For example, if you have shoulder pain referred from the cervical spine, you will have cervical signs; if there is no cervical referred shoulder pain, there will not be cervical signs.

8. *Premise conversion.* It is a deductive error of reasoning to reverse a statement of categorization. That is, all A are B does not mean all B are A. For example, all shoulder impingements are subacromial (or subcoracoid) does not mean all subacromial pains are impingements.

These examples represent only a sample of the reasoning errors a therapist can make. Errors in reasoning are also not confined to the less experienced, as even "experts" have been shown to overemphasize positive findings, ignore or misinterpret negative findings, deny findings that conflict with a favorite hypothesis, and obtain redundant information.[16,52–54] The As and Bs of logic may appear to be nothing more than semantics. If the inductive generalizations prevalent in manual therapy are not recognized for what they are, however, therapists are prone to accept these generalizations as fact and fail to look for alternative explanations.

Bordage and colleagues[40,55–57] suggest that most diagnostic errors are not the result of inadequate medical knowledge as much as an inability to retrieve relevant knowledge already stored in memory. That is, the amount of knowledge appears less relevant than the organization of that knowledge. When knowledge is not organized in clinically relevant patterns, it becomes less accessible in the clinical setting.

Having given the impression that good clinical reasoning will assist therapists in recognizing clinical patterns, a word of caution regarding excessive attention to clinical patterns is needed. Clinical patterns are at risk of becoming rigidly established when the patterns themselves control our attention. I believe this leads to errors of limited hypotheses and insufficient sampling where anything that has any resemblance to a standard pattern will be seen as that pattern. For example, the information that a patient has pain in the area of the greater trochanter aggravated by functional movements involving flexion or adduction of the hip may cause some therapists to hypothesize the existence of a "hip joint" disorder. Limiting one's hypotheses to what may appear to be the most obvious hypothesis without pursuing additional supporting or negating evidence prevents the therapist from ever learning the pattern of other disorders that may share features with a disorder of the hip (eg, lumbar spine, sacroiliac joint, adverse neural tissue tension) or the full range of presentations a hip joint disorder can manifest.

Implications for Physical Therapists

Physical Therapy Research in Clinical Reasoning

Consideration of the clinical reasoning literature outside of physical therapy assists in developing an understanding of this topic while providing educational and clinical extrapolations to our profession. Debate continues in the medical literature, however, regarding the nature of expertise and the appropriate methodology to use in research.[40,58–63] Although some evidence does exist suggesting that medical and physical therapy clinical reasoning processes are similar,[6–8] the potential differences in medical and physical therapy organization of knowledge necessitates further investigation of potential differences in clinical reasoning and associated factors.

Facilitating Clinical Reasoning in Our Students

As physical therapists have taken greater responsibility in patient management, especially with the increased autonomy associated with first-contact practice, physical therapy education has responded with efforts to produce more "thinking" therapists. Although attention to clinical reasoning skills has presumably always been inherent in our physical therapy education, there has been a more recent interest in providing more formal and focused learning experiences specifically aimed at facilitating clinical reasoning in physical therapy students.[4,5,64–69]

Facilitating students' clinical reasoning requires making them aware of their own reasoning process and designing learning experiences that promote all aspects of the clinical reasoning process while exposing the errors in reasoning that occur. This requires access to students' thoughts and feedback on thinking processes. That is, students should be taught to think and to think about their thinking.[70] This can be achieved by promoting students' use of reflection to encourage awareness and promote integration of existing versus new knowledge. When combined with a better awareness of one's own cognitive processes (ie, metacognition), the students' processing of information is enhanced and clinical reasoning is facilitated. Learning experiences to facilitate clinical reasoning using both reflection and metacognition are described elsewhere.[5,71]

The process of reasoning should not, in my view, be addressed to the neglect of knowledge. Rather, facilitating the clinical reasoning process will assist the students' acquisition of knowledge. In turn, good organization of knowledge leads to better clinical reasoning. The importance of one's organization of knowledge is closely linked to the accessibility of one's knowledge. Knowledge that is acquired in the context for which it will be used becomes more accessible.[72,73] Although clinical knowledge is typically presented in the context of patient problems, this is less commonly the case with the basic sciences (eg, pathophysiology). Approaches to physical therapy education in which the acquisition of knowledge is facilitated by teaching centered on patient problems provide, in my opinion, the ideal environment for building an accessible organization of knowledge and fostering clinical reasoning skills.[67,68,74–81]

Learning the hypothesis testing approach also enables students to continue to learn beyond their formal education. Rather than relying on a text or more experienced colleague to learn new clinical patterns, the therapist who actively reasons through and reflects on patient problems will continually challenge existing patterns and in the process acquire new ones.

Summary

Early research in medical education provided a picture of a clinical reasoning process that was hypothetico-deductive and universally applied by clinicians at all levels of experience. The differentiating feature of expert diagnosticians and novices appears to lie in their organization of knowledge. Experts have a superior organization of knowledge that enables them to reason inductively in a form of pattern recognition. When confronted with unfamiliar problems, the expert, like the novice, will rely on the more basic hypothesis testing approach to clinical reasoning.

Research to better understand the clinical reasoning and nature of expertise in physical therapy can assist us in designing learning experiences to facilitate clinical reasoning. Clinical reasoning is now being given specific attention in some physical therapy education programs. The aims of these programs should be to increase students' awareness of their clinical reasoning and to foster development of both reasoning and knowledge through learning experiences centered on patient problems. This requires accessing students' thoughts during and after a patient encounter and providing feedback on errors of reasoning that emerge. Teaching students skills of reflection and metacognition should improve their clinical reasoning now and equip them with the means to continue learning from future patient problems. Therapists can improve their own clinical reasoning by stopping at various points through a patient examination and the ongoing management period to consciously reflect on hypotheses being considered, implications of those hypotheses, and, in hindsight, where errors of reasoning occurred. Clinical reasoning that is hypothesis directed and open-minded can add to our organization of knowledge and enhance the quality and accountability of our patient care.

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