

## **CHAPTER 3: LITERATURE REVIEW**

### **Introduction**

Professional judgment and decision making are inexact sciences that require basic knowledge, reflective practice and clinical reasoning. A subcommittee (Appendix II) was charged with reviewing the literature. The focus of this literature review was to identify relevant literature on theories and models of clinical reasoning, curricular and course models, instructional strategies to enhance clinical reasoning, and assessment methods. Multiple databases were searched from 1978 – 2008 using appropriate subject headings and key words. Inclusion criteria limited the search to peer-reviewed articles, books, monographs and dissertations. See Table 3.1 for a list of databases and subject headings/key words.

**Table 3.1: Databases and Subject Headings/Key Words**

| Databases   | Sample of Subject Headings/Key Words   |
|---|--|
| CINAHL Plus<br>ERIC<br>Index to Chiropractic Literature (ICL)<br>PsychINFO<br>PubMed<br>TimeLIT | Assessment Methods<br>Basic Education<br>Clinical Competence<br>Clinical Expertise<br>Clinical Judgment<br>Clinical Reasoning<br>Cognition<br>Competency-Based Education<br>Curriculum<br>Decision Making<br>Diagnosis<br>Diagnosis Differential<br>Education, Medical<br>Education, Nursing<br>Educational Measurement<br>Health Sciences Education<br>Judgment<br>Knowledge<br>Novice to Expert Reasoning<br>Problem-Based Learning<br>Problem Solving<br>Research<br>Teaching Methods |

### **Theories and Models of Clinical Reasoning**

Clinical reasoning is a complex process that brings together multidimensional components of knowledge and skill in order to achieve effective care, and it forms a central component of physician competence (Norman, 2005). It includes “the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and

community being served”(Epstein & Hundert, 2002). Synonyms associated with clinical reasoning include problem solving, decision making, and judgment.

Over the past three decades, clinical reasoning has been focused mainly on diagnosis, cognitive processes, and knowledge-based structures that distinguish between experts and novices (Papa & Harasym, 1999). Early cognitive theories of expertise development suggested that simple knowledge expansion is responsible for expert status. Subsequent research has modified this stance to theorize that expertise is related to shifts in knowledge or knowledge restructuring (Schmidt & Rikers, 2007). Theories that have been used to explain clinical reasoning and the differences between experts and novices deal with analytic processes and non-analytic resources (Moulton, Regehr, Mylopoulos, & MacRae, 2007).

Early clinical reasoning research led to the development of a clinical problem-solving model referred to as the hypothetico-deductive method (Norman, 2005). This approach relates to the way a doctor processes patient-relevant information. These analytic processes require greater mental demand and increased cognitive load. Hypothesis generation in clinical reasoning is theorized to be related to the directionality of inference. Forward reasoning is defined as hypothesis generation based upon the data presented in a clinical problem. Backward reasoning is defined as data generation on the basis of a hypothesis. Using the hypothetico-deductive method, an expert uses forward reasoning while a novice uses backward reasoning (Patel, Groen, & Arocha, 1990; Schmidt & Rikers, 2007).

Subsequent research into the hypothetico-deductive method gave rise to other phenomena related to diagnostic accuracy referred to as ‘content specificity’ or ‘case specificity’ (Bordage, 2007; Norman, 2005). Content specificity observes that the successful solving of one specific clinical problem does not accurately predict the successful solving of another clinical problem, even within an area of specialization (Eva & Norman, 2005). Conversely, diagnostic accuracy is strongly related to the context in which a clinical problem is being addressed. Context specificity relates to the environment (context) in which the clinical cases occurred and the number of cases encountered in that environment. Context specificity in clinical reasoning requires the student to build an adequate database, through many clinical examples, to engage in problem solving. These examples should represent a variety of specific condition presentations (Eva, 2005).

Non-analytic resources are automatic and are associated with pattern recognition, heuristics, encapsulation and scripts. Experts use these mechanisms daily with minimal mental demand or cognitive load (Moulton et al., 2007).

Pattern recognition represents a non-analytical resource related to clinical reasoning and improved diagnostic accuracy. It is derived from clinical knowledge accumulated from multiple past instances or examples (Papa, Shores, & Meyer, 1990). Research has shown improved differential diagnostic accuracy with instruction focused on pattern recognition when compared to traditional classroom instruction (Papa, Oglesby, Aldrich, Schaller, & CIPHER, 2007). Akin to pattern recognition, prototype theory focuses on the organization of memory around representative cases. The use of clinical cases exhibiting prototypical signs and symptoms of a disease (typical) combined with more difficult cases (atypical) leads to improved diagnostic accuracy (Bordage, 2007).

Heuristics, used in information processing, allow clinicians to “estimate the degree that signs/symptoms match prototypical signs/symptoms in a given disease category” (Papa et al., 2007). Heuristics are shortcuts to reasoning. As the use of heuristics evolves, they have been seen to yield better clinical reasoning outcomes in some instances (Eva, Neville, & Norman, 1998).

In the course of their training, students develop mental structures that explain disease causes in terms of general biology or pathophysiological processes (Schmidt & Rikers, 2007). As they start their clinical learning journey, students engage in error-prone processes that focus on isolated signs and symptoms rather than symptom patterns. Through repetition and application of acquired knowledge, their knowledge structures change. Detailed causal, pathophysiological knowledge becomes encapsulated (Schmidt & Rikers, 2007). Encapsulated knowledge reorganizes into ‘illness scripts’ as students practice with actual patients. Illness scripts contain relatively little knowledge about pathophysiological causes of symptoms but are rich with clinically relevant information about the disease (Irby, 1994; Schmidt & Rikers, 2007). Scripts develop from repeated experiences with real clinical problems resulting in specific organization of clinical information (Charlin, Boshuizen, Custers, & Feltovich, 2007).

When considering the appropriate approach for our QEP, it was determined that the methodology should easily integrate into the existing curricular plan as set out in “The TCC Graduate: An Educational Blueprint for the 21<sup>st</sup> Century”. This document was developed as a plan to guide the College’s doctoral curriculum and was heavily influenced by the cognitive science research literature in health education. Literature focused on the contextual approach to clinical reasoning was also reviewed. The contextual approach is referred to as tacit, imagistic and a “deeply phenomenological mode of thinking”. The focus is not on disease but on the “human world of motives and values and beliefs”, or the “illness experience” (Mattingly, 1991). Additional favorable factors in selecting the cognitive approach were the existing knowledge base of the faculty, previous experience with instructional strategies, and the availability of educational resources.

### **Curricular and Course Models of Clinical Reasoning**

A key goal in the early stages of health professions education is integration of clinical information into basic science courses. Recent research (Woods, 2007) has demonstrated the importance of basic science knowledge in the development of clinical reasoning skills. The ability to use basic science to explain the causal relationships and explanatory pathways for clinical features is essential for the clinical novice (Woods, Brooks, & Norman, 2007). Curricular models such as Problem-Based Learning (PBL), Case-Based Learning (CBL), Clinical Presentation Curriculum, Application-Oriented Curriculum, An Integrated Medical Encounter (AIME), and Team-Based Learning (TBL) provide opportunities for integration.

#### **Problem-Based Learning (PBL)**

Following the lead of cognitive science, medical curriculum has been reorganized around the context of clinical problems. PBL was pioneered by Dr. Howard Barrows and McMaster’s University in the 1970’s (Papa & Harasym, 1999). In PBL, students are presented with a case or a problem that they might encounter in their daily practice, and they establish objectives that will help them achieve their learning goals. The primary

educational objectives of PBL are the acquisition of an integrated body of knowledge to the problems, and the development of problem-solving skills (Mandin, Jones, Woloschuk, & Harasym, 1997). The PBL environment is designed to help students construct an extensive and flexible knowledge base, become effective collaborators, develop self-directed learning skills, develop effective problem-solving skills and become intrinsically motivated to learn (Loyens, Rikers, & Schmidt, 2006).

### Case-Based Learning (CBL)

CBL is a relatively new variation of PBL in health professions education. As with PBL, learners in CBL are presented with a clinical problem and are provided time to define and resolve the problem (Slavin, Wilkes, & Usatine, 1995). CBL can be utilized to assist students in both attaining requisite knowledge and enhancing clinical reasoning skills. The benefits of CBL include: 1) contribution to students' appropriate organization of information for retention and later use in clinical reasoning situations; 2) generation of experiences that students would not otherwise have; 3) increased visibility of students' clinical reasoning processes; and 4) enhancement of student confidence (Thomas, O'Connor, Albert, Boutain, & Brandt, 2001)

There are important differences between CBL and PBL. First, in CBL students are required to do some advance preparation on the topic prior to the discussion. This may entail reading general articles on the topic, or some students may be asked to read specific articles to facilitate the encounter. Second, the facilitator in CBL plays a more active role in keeping the discussion on track and for making sure that the students are correctly answering the objectives. Finally, there typically is very little post-session work to be performed by the students. CBL is considered by many to be a 'guided inquiry approach' and PBL is considered an 'open inquiry approach' (Srinivasan, Wilkes, Stevenson, Nguyen, & Slavin, 2007).

Both the University of California, Los Angeles and the University of California, Davis changed their curriculums from PBL to CBL between 2001 and 2004. Students in that time frame were exposed to both forms of learning and the overwhelming majority of students preferred the CBL format over the PBL format. The students at both institutions felt that CBL was a better use of time, that they had fewer tangents to deal with, and that it decreased the amount of outside work and busy work associated with the PBL format. Additionally, the learners felt they had more time to problem-solve (Srinivasan et al., 2007).

### Clinical Presentation Curriculum

In the mid 1990s the University of Calgary Medical School modified its curriculum to what is called a "Clinical Presentation" curriculum. The first iteration was administered in the fall of 1994 (Woloschuk, Harasym, Mandin, & Jones, 2000). This model organized teaching around 120 common clinical presentations seen by physicians. These Clinical Presentations could take the form of historical points (e.g. chest pain), physical examination signs (e.g. hypertension), or laboratory abnormalities (e.g. elevated serum lipids) (*University of Calgary Faculty of Medicine: Operating philosophy*, 2008). Each presentation is organized according to a variable number of causal diagnostic categories. Each category is prototypical and exhaustive lists of differential diagnoses for each category are avoided (Mandin et al., 1997).

### Application-Oriented Curriculum

Literature reviews performed by Papa have shown that two major themes appear in medical education: 1) expertise tends to be task- and problem-specific, so it is dependent on the development of the task- and problem-specific knowledge base; and 2) the development of expertise depends upon the student receiving enough focused practice. But expertise is also about how the knowledge is integrated and organized by the learner; thus, a successful medical curriculum must emphasize gaining knowledge, practicing skills, and integration and organization of material around specific problems (Papa, 2008). One way to achieve this is for faculty to place greater import upon comprehension and application-oriented instruction. This reduces the time spent on information acquisition, allowing for greater time on task-focused, deliberate practice. By working through multiple cases, the students use prior knowledge gained from previously solved problems when solving new problems.

Application-Oriented Curriculum is based on several elements: 1) the development of clinical competencies as a progression of intellectual processes and knowledge-based capabilities; 2) the use of Bloom's conceptualization of information acquisition, comprehension and application as both the core objectives of preclinical instruction and the order by which to sequence preclinical instruction; and 3) the adoption of emerging, evidence-based learning theories and instructional methodologies demonstrating ways to improve information acquisition, comprehension and application-oriented activities (Papa, 2008).

### An Integrated Medical Encounter (AIME)

AIME was developed at Johns Hopkins University School of Medicine in 2003 to teach the students communication and clinical reasoning skills in an integrative format. The curriculum's objectives were for students to demonstrate strategies for patient-centered communication, demonstrate strategies for clinical reasoning, understand the link between communication and clinical reasoning, and appreciate both biomedical and psychosocial issues in patient care (Windish, Price, Clever, Magaziner, & Thomas, 2005). The clinical reasoning aspect of the curriculum was focused on developing a patient-specific problem list and differential diagnosis.

### Team-Based Learning (TBL)

Team-based learning is a specialized, in-depth approach to the use of small groups in teaching. It calls for restructuring a course in a way that facilitates the development of newly formed groups into teams and then challenges those teams with complex learning tasks. As members of a team, individual students commit to a higher level of effort in their learning, and learning teams are able to solve problems beyond the capabilities of the individual team members (Michaelsen, Knight, & Fink, 2004).

There are three keys to using learning teams effectively (Michaelsen et al., 2004). The first key is promotion of ongoing accountability. TBL holds both individuals and groups accountable for learning and performance through the use of the individual and group Readiness Assessment Test (RAT). The second key is the use of linked and mutually reinforcing cases. These clinical cases are related to the concepts that were assessed in the RAT. The third key is the group discussion as a vehicle for both individual and team expression of ideas and opinions regarding the cases.

Challenging instructional situations, such as large class size, high level of student diversity, and courses that emphasize thinking skills, can be helped through TBL. Practical application of previously gained knowledge is another advantage of TBL (Michaelsen et al., 2004).

In summary, aspects of CBL, TBL and Application-Oriented Curriculum have been incorporated into the College's curricular approach to enhance clinical reasoning. These curricular models were chosen because of a greater emphasis on structured active learning. Additionally, research has shown greater student satisfaction with these methods.

### **Instructional Strategies to Enhance Clinical Reasoning**

There are many studies that advocate teaching of various clinical reasoning strategies, including specific types of knowledge representation, schema, algorithms and disease patterns (Ark, Brooks, & Eva, 2006; Bowen, 2006; Eva et al., 1998). A major factor in successful teaching of clinical reasoning is the difficulty of recognizing and applying relevant knowledge learned in a situation to other similar situations, i.e., analogic transfer (Eva et al., 1998). Two approaches appear effective to facilitate transfer: the use of multiple cases, and deliberate practice (Ericsson, 2007; Eva, 2005). As Norman suggests, "Focusing instruction on one processing strategy or another may be less important than engaging students with many problems which are carefully sequenced to optimize learning and transfer" (Norman, 2005).

There are a variety of instructional strategies that can be applied to the curricular models TCC is adopting. Written cases can be analyzed by individual learners or by small groups with either verbal or written discussion. Standardized patient cases can take place with live interviews or video-recorded viewing. Web-based cases are interactive and can link to multiple resources.

An example of a web-based case resource for teaching clinical reasoning is the Knowledge Based Inference Tool (KBIT). KBIT simulates the differential diagnostic performance of clinicians by creating knowledge-based structures and decision-making processes used by clinicians (Papa, Stone, & Aldrich, 1996). KBIT uses artificial intelligence algorithms to:

- transform an expert's knowledge-base for a given problem and its associated disease differential into a web-based instructional tool.
- construct and present disease prototypes as well as numerous samples and practice cases for the problem and differential at hand.
- assign a typicality estimate to all constructed cases.
- use those typicality estimates to sequence the order of each disease case presentation.
- construct and deliver pattern-recognition-oriented feedback that addresses each student's specific diagnostic error.

A recent study demonstrated students' enhanced ability to perform a differential diagnosis using KBIT (Papa et al., 2007).

Reflective practice has been suggested to be an important instrument in improving clinical judgment and developing clinical expertise. Reflective practice is defined as the

ability of clinicians to think critically about their own reasoning and decisions (Mamede & Schmidt, 2004). The construct of reflective practice is largely influenced by the work of Schön (Schön, 1987). Reflective clinicians demonstrate a willingness and ability to reflect about their own thinking processes and to critically examine conclusions and assumptions about a particular clinical problem. Reflective practice had a positive effect on diagnosis of complex, unusual cases. Non-analytical reasoning was shown to be as effective as reflective reasoning for diagnosing routine clinical cases. The findings of Mamede's study in 2008 support the idea that reflective practice may particularly improve diagnoses in situations of uncertainty and uniqueness, reducing diagnostic errors (Mamede, Schmidt, & Penaforte, 2008).

A learner-centered model of clinical education has been developed based on cognitive learning and reflective practice that focuses on a collaborative model for case presentations in the clinical outpatient setting (Wolpaw, Wolpaw, & Papp, 2003). This model links learner initiation and faculty facilitation in an active learning conversation. A mnemonic for this model called SNAPPS consists of six steps:

- S - summarize briefly the history and examination findings.
- N - narrow the differential diagnosis to two or three relevant possibilities.
- A - analyze the differential list by comparing and contrasting the possibilities.
- P - probe the learner by asking questions about uncertainties, difficulties or alternative approaches.
- P - plan management for the patient's health related issues.
- S - select a case-related issue for self-directed learning.

Teaching students to present cases in this SNAPPS format encourages them to reflect on the clinical problem and possible solutions before questioning the faculty supervisor. It appears to be a useful way to promote higher-level clinical reasoning skills.

### **Assessment Methods**

Assessment influences students' learning processes (Newble & Jaeger, 1983). Health professions educational programs use many different methods to meet their various assessment needs. A commonly used approach for assessment of clinical reasoning is the use of an authentic clinical scenario as a stimulus format, usually in the form of a simulation. This simulation is accomplished, most commonly, through the use of standardized patient encounters and written simulation. The literature also identifies various methods of written assessment effective for evaluation of clinical reasoning. These written assessments include extended matching questions (EMQ), key features questions, and script concordance questions.

Extended Matching Questions (EMQ) (Case & Swanson, 1993) are a form of multiple choice questions that are widely used because they are highly reliable, easy to score and offer broad sampling. In a recent study, EMQ provided higher scores for pattern recognition than hypothetico-deductive reasoning (Beullens, Struyf, & Van Damme, 2005). The authors concluded that EMQ could be used to assess cognitive skills because the participants who scored the most correct responses were more likely to demonstrate forward reasoning. In other words, the students are working from the data to a diagnostic hypothesis. A year later, the same investigators compared EMQ and the Diagnostic Thinking Inventory (DTI). They reported that there was a relationship between those assessment tools and reported that the EMQ could be used to assess clinical reasoning ability (Beullens, Struyf, & Van Damme, 2006).

Bordage and Page (Page & Bordage, 1995) developed key features problems that test clinical decision-making skills by focusing on only the critical steps of each decision. These steps are divided into two types. The first type is a step in the decision-making process that is essential for an accurate diagnosis. The second type is a step that focuses on an area where common errors related to the case would be made. This assessment approach can test a large number of clinical problems in any one examination with acceptable reliability and validity.

The Script Concordance Test (SCT) (Charlin, Roy, Brailovsky, Goulet, & Van Der Vleuten, 2000) is based on the illness scripts theory of clinical expertise development (Schmidt, *et al.*, 1990); (Charlin, Tardif, & Boshuizen, 2000) and is designed to assess the extent of knowledge organization by measuring the level of script development. The SCT consists of short clinical scenarios, each containing all the relevant clinical information needed to respond to sets of test items designed to assess the diagnostic, investigative or therapeutic knowledge of the subject. Each item posits several diagnostic hypotheses. New information is presented that may validate or alter the hypothesis. The examinee selects the likelihood of changing his/her hypothesis and that selection is compared to the selection of a panel of experts. Each item is scored using a five-point Likert scale that prevents cueing. Thus, the SCT focuses on the interpretation of clinical information as part of the clinical reasoning process. It is easily administered with a consistent and straightforward scoring system, and is reliable and valid (Carriere, Gagnon, Charlin, Downing, & Bordage, 2008).

Case-based Discussion (CbD), or chart-stimulated recall, uses the patient's health record to assess clinical judgment and reasoning (Norcini & McKinley, 2007). CbD enables a faculty rater to assess a student's rationale for diagnostic and treatment decisions. The CbD has acceptable reliability and validity (Goulet, Jacques, Gagnon, Racette, & Sieber, 2007).

In addition to all the assessment tools mentioned above, Bordage, *et al.* developed the Diagnostic Thinking Inventory (DTI) in 1990 to provide insight into the clinical reasoning process (Bordage, Grant, & Marsden, 1990). The DTI is designed to evaluate reasoning style and attitudes and assumes that skill in diagnosis is related to these characteristics. A major advantage of this instrument is that it is independent of textbook knowledge. Thus, it is able to provide direct insight into the nature of the subject's clinical reasoning process. The DTI is a self-evaluation questionnaire of 41 items, each intended to assess one of two aspects of diagnostic thinking: 1) flexibility of thinking, or 2) knowledge organization. All items consist of two opposing statements separated by a six-point semantic scale representing a continuum between the two statements. The DTI has been shown by its developers and others (Jones, 1997; Rahayu & McAleer, 2008; Round, 1999) to have acceptable reliability and validity.

The Health Sciences Reasoning Test (HSRT) was developed for use by educators to assess the critical thinking skills of health sciences students and professionals. The HSRT is comparable to other widely used critical thinking skill tests. It consists of 33 multiple-choice questions that target those core critical thinking skills regarded to be essential elements in a health science educational program. No discipline-specific health sciences content knowledge is presumed on the HSRT. The primary use of the HSRT is to gather valid and reliable data about group baseline, entrance- or exit-level critical thinking skills. This measurement tool appears to have acceptable reliability and

validity. It can also be used in program evaluation with focus on effectiveness (Facione & Facione, 2006).

Objective Structured Clinical Evaluations (OSCE) are a commonly used form of assessment in health professions education. These assessments use standardized patients (SP) to present life-like case scenarios in a clinical context and/or written stations in order to assess knowledge and decision making (Harden & Gleason, 1979). An SP is a person trained to enact a case scenario, or an actual patient using his/her own history and physical exam findings, for the instruction, assessment, or practice of communication, examination and decision making. OSCE formatted assessments provide a platform to observe clinical decisions in a controlled environment. Stations can be designed to lead the examinee to a crossroad at which point a clinical decision is required through employment of reasoning skills. It has been demonstrated that repeated exposure to clinical decision making and reasoning scenarios in OSCE format assessments increases the ability and desire of students to problem solve (Durak, Caliskan, Bor, & Van Der Vleuten, 2007).

### **Summary**

Sound clinical reasoning is a vitally important requirement for clinical expertise, which is a fundamental component of clinical competence. This literature review presents current theories and models of clinical reasoning; curricular and course models to facilitate clinical reasoning; effective instructional strategies that increase clinical reasoning ability; and multiple assessment methods that, when applied appropriately, can provide insight into the clinical reasoning process.