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THE ASSESSMENT OF CLINICAL REASONING IN PRECEPTORS ACROSS THE ATHLETIC TRAINING PROFESSION

by

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ABSTRACT

THE ASSESSMENT OF CLINICAL REASONING IN PRECEPTORS ACROSS THE ATHLETIC TRAINING PROFESSION

Gary Wayne Cohen Jr.
Old Dominion University, 2021
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Clinical reasoning (CR) is defined as a complex multi-factorial metacognitive process for diagnosis formulation. Clinical reasoning begins as a student and develops over a career. Students are typically taught an analytical approach defined as hypothetico-deductive reasoning (HDR). Expert clinicians use a non-analytical approach defined as the Knowledge Based Model (KBM) of CR. It is accepted that clinicians use the KBM with cases that they have more experience to streamline the evaluation process. Unfortunately, because of the nuance of CR there have been limited investigations within athletic training to evaluate CR outside of the student population.

The overarching purpose of this dissertation was to investigate CR in athletic training preceptors. To achieve this purpose, three interrelated projects were conducted. The first project involved a systematic review to investigate the use of the Diagnostic Thinking Inventory (DTI). The second project assessed clinical reasoning using the Diagnostic Thinking Inventory for Athletic Trainers (DTI-AT) in athletic training preceptors. The second project was guided by the Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning to establish appropriate demographic questions associated with CR development. The final project explored preceptors' perceptions of CR in athletic training.

The systematic review confirmed that the DTI was a valid, reliable, and widely used instrument to assess CR in healthcare professions. The instrument was used in medicine,

physiotherapy, and athletic training. Project II indicated that the athletic training preceptors studied scored higher on the DTI than the averages of all other professions assessed in the literature, however, all other professions included both students and professionals. Professional sociability was found to be the only demographic factor related to higher scores on the DTI-AT. This finding contrasted with the Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning. Project III identified that CR processes in athletic training are highly variable between individual clinicians based on their experiences, confidence, patients, and external factors. Findings from these three projects indicate the importance of continued CR assessment of athletic training professionals, inclusion of soft skills in athletic training education, and encouraging professional sociability both inter- and intraprofessionally.

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This dissertation is dedicated to my family for their love and support. To my girlfriend Jamie Legner, my best friend Bailey Jones, and my mentors Bonnie Van Lunen, Julie Cavallario, Luzita Vela, and Rob Cramer who literally and figuratively carried me through physical, mental, and emotional challenges to achieve success. To all the people who have struggled and continued to persevere and move towards success inch by inch without giving up.

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CHAPTER I

INTRODUCTION

Background

Clinical reasoning (CR) finds its' roots in medicine where it has been investigated for over forty years.[1,2] Clinical reasoning is defined as a multi-factorial and complex mental process inclusive of multiple methods for diagnosis formulation.[3] Novice clinicians favor a hypothetico-deductive reasoning (HDR) approach to clinical reasoning where they propose plausible diagnoses, and attempt to prove or disprove each hypothesis through evaluation techniques.[4] Hypothesis generation is rooted in the clinician's existing knowledge, associations, and experience relative to the case.[2,5] Expert level clinicians favor the knowledge based model (KBM) of clinical reasoning which has been attributed to more efficient methods of cognitive organization that result in a streamlined evaluation approach called case pattern recognition.[4,6-10] Case pattern recognition is characterized by identifying relevant information for a diagnosis, and arriving at a working diagnosis based on the clinicians prior experiences with similar cases that facilitate the development of accessible array of case patterns.[4] The ability of an expert clinician to recall and organize information from prior experiences and access their array of case patterns is a result of structure of memory which is established as an important subcategory of clinical reasoning.[10] If features are identified that do not fit with an expert clinician's prior experiences or they are evaluating a novel condition they may use a dual process technique characterized by reverting back to HDR to diagnose their patient.[11] The switches between the KBM and HDR methods demonstrate flexibility in thinking which has been identified as a key subcategory to whether a clinician is a novice or an expert.[4,10] Clinicians develop over their careers from students to novice clinicians, and finally content experts in their own domains of exposures.

It is widely accepted that clinical reasoning development occurs naturally throughout experiences and exposure to clinical practice over time.[1,4,12] This notion is guided by the Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning developed in the field of nursing to explain how students develop from memorizing classroom knowledge to novice clinicians using predominantly a HDR approach, and, lastly, to expert clinicians who demonstrate a KBM approach to clinical reasoning.[13] This framework articulates that it takes up to three years of autonomous clinical practice in a specialized area to become an expert clinician within your specialty. However, central to the ability of student clinicians to improve clinical reasoning is the receipt of constructive feedback from preceptors.[4] Feedback should challenge students' ability to access, organize, and apply classroom knowledge to clinical cases within their experiences. This role is fulfilled in athletic training by preceptors. Preceptors are an integral member of athletic training education but empirical research has not been directed at understanding athletic training preceptors' ability to perform the clinical reasoning tasks that they are expected to foster in students. Assessment of preceptor clinical reasoning, using the diagnostic thinking inventory (DTI) and qualitative interviews that contextualize lived experiences with clinical cases, can provide programs and the profession with a better understanding of how well preceptors clinically reason using the HDR and KBM approaches to diagnosis.[10]

Diagnostic Thinking Inventory

The DTI is a self-reported instrument originating in physician practice developed to evaluate the clinical reasoning of students and practicing clinicians. It serves to measure a clinician's flexibility in thinking and structure of memory as subcategories of clinical reasoning. Flexibility in thinking determines the clinician's ability to use multiple methods of investigation

and analysis while allowing for considerations of differential diagnoses when conflicting or absent key features arise.[10] An example of flexibility in thinking is a clinicians ability to be responsive towards a patient's line of thought where they are explaining symptoms as opposed to hearing one symptom and needing to evaluate it right away. Structure of memory refers to the availability and ready access to accumulated knowledge from previous clinical experiences.[10] An example of structure of memory is that the patient reports, "I went to make a cut but I felt my knee shift and I heard a pop" and the clinician reports thinking, "ACL tear" (recognition of a forceful feature) or the clinician reports, "I seem to have come up with a lot of ideas but I can't quite figure out what this is" (dispersed knowledge).[10] Responses to the DTI are based on a Likert scale where clinicians report how they would approach a clinical prompt. Their responses correspond to a score for their flexibility in thinking and structure of memory that arrives at their total clinical reasoning score. Higher scores indicate a preference towards KBM reasoning and lower scores a preference towards HDR. The DTI is scored using a 6-point Likert scale with responses totaling a maximum score of 126 for flexibility in thinking, and 120 in structure and memory. The maximum total score is 246 points. Eighteen of the 41 questions are left-handed responses. Left-handed responses are questions in which the highest value Likert scale response is on the left side of the scale. The DTI has been adapted to different languages and to different healthcare professions, including athletic training. This version (DTI-AT) has undergone changes in the wording of questions to represent the scope of practice of athletic trainers, and the adaption of an orthopedic case prompt.[14] The instrument has remained psychometrically sound for its' use in evaluating clinical reasoning throughout each of its adaptations.[10,14-17]

Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning

The longitudinal framework for fostering critical thinking and diagnostic reasoning has been developed in nursing to explain clinical reasoning development throughout a clinical career. The framework contains three levels associated with experience ranging from undergraduate or professional education, beginning clinician (0-3 years of experience), and experienced clinician (beyond 3 years of experience). Within the levels of experience, knowledge acquisition, knowledge storage and utilization, and reasoning styles are described.[13] Students acquire knowledge from didactic curriculum and are exposed to cases that require and application of specific classroom knowledge to understand. Students then develop a rule-based reasoning approach based on the didactic material and as they have clinical experiences, they begin to develop an outline presentation of what the didactic case looks like in a real patient. Their diagnosis methods at this stage of development are rule-based reasoning processes. In the first three years of clinical practice clinicians develop practical signs and symptoms in real life circumstances based on repetition. Reasoning transitions away from a rule-based model towards an analytical approach (HDR)[10] where clinicians gather case information, logically deduce the information to create a judgement or diagnosis. Beginning clinicians are aware of their deliberate thinking and their own limitations. Experienced clinicians have been exposed to many different cases and developed an understanding of case patterns. In addition to the case patterns, experienced clinicians have an effective organizing system and an acuity for recognizing key features associated with the cases. Intuitive processing (KBM)[10], characterized by a rapid holistic approach based on key features identified, is used by the experienced clinician for cases that fit their domain specific knowledge, and an analytical approach (HDR) is used for cases outside of

their domain specific knowledge. Reasoning is contingent upon the clinician's knowledge, and the nature of the case.

The Problem

Clinical reasoning is defined as a multi-factorial and complex mental process inclusive of multiple methods for diagnosis formulation.[3] One of the first exposures to clinical reasoning for athletic training students is through their preceptors in their clinical experiences. However, clinical reasoning ability has gone unstudied in the preceptor population. Most preceptor selection is done through a qualitative assessment of readily available candidates to choose who will serve in this role.[18,19] It is imperative to understand how athletic training preceptors clinically reason within their clinical practice where students are placed. Using the DTI-AT, and qualitative interviews, may allow for a better understanding of the level at which preceptors use the two prevailing models of clinical reasoning in their practice. Measuring clinical reasoning grounded in the longitudinal framework for fostering critical thinking and diagnostic reasoning may provide foundational level evidence to improve athletic training student clinical experiences.

Purpose

There were four purposes of this dissertation which aims to critically examine clinical reasoning in athletic training and athletic training preceptors. The first purpose was to systematically review the literature to determine how the DTI has been used and adapted since its inception. The second purpose was to evaluate the clinical reasoning ability of professional master's level athletic training preceptors using the DTI-AT. The third purpose of this study was to understand the lived experiences of preceptors in their application of clinical reasoning as they evaluate and treat their patients. The fourth purpose of this study was to apply the Longitudinal

Framework for Fostering Critical Thinking and Diagnostic Reasoning[13] to athletic training preceptors.

Experimental Aims and Hypotheses

Aim 1: Understand the use of the DTI and its different iterations in healthcare education and practice.

Hypothesis for Aim 1: The DTI will be used to assess clinical reasoning broadly in different healthcare professions, but primarily in students.

Aim 2: Assess the clinical reasoning abilities of athletic training preceptors using the DTI-AT.

Hypothesis for Aim 2 (A): Athletic training preceptors with more years of experience will score higher on the DTI-AT.

Hypothesis for Aim 2 (B): Athletic training preceptors will score comparatively on the DTI-AT to physicians' scores on the DTI based on years of experience.

Aim 3: To explore athletic training preceptors' perceptions on their clinical reasoning application in their clinical practice.

Hypothesis for Aim 3 (A): Athletic trainers will use a KBM approach to diagnosis associated with less challenging cases.

Hypothesis for Aim 3 (B): Athletic trainers will use a HDR approach to diagnosis associated with more challenging cases.

Aim 4: Evaluate trends in clinical reasoning of athletic training preceptors with the Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning.[13]

Hypothesis for Aim 4: Athletic training preceptors beyond 3 years of experience will exhibit traits associated with experienced diagnostic reasoning including a favorability towards the KBM of clinical reasoning.

Clinical Implications

Growth and development as a clinician in athletic training has been perceived as a gradual improvement over time based on exposure and clinical experience. The results of these studies completed within this project may lead to a transformation in how athletic training preceptors are clinically assessed, trained, and compare to professionals in other healthcare professions. These findings may improve educational outcomes for athletic training students and improve the quality of care for patients. The DTI-AT can be implemented to assess preceptors prior to their appointment and used as a pretest evaluation prior to preceptor training initiatives. The instrument can be used to explain the success of a training program in improving clinical reasoning within preceptors. Once scores are recorded, athletic training students can be paired with preceptors that are more proficient in complimentary clinical reasoning strategies to what the student exhibits in their didactic curriculum. Strategic professional socialization for students may allow them to become better clinicians equipped to diagnose most conditions that are presented to them in their career. An accurate diagnosis may improve treatment and patient outcomes that minimize the burden on the healthcare system. The reduction of resource allocation needed to diagnose, treat, and rehabilitate injuries and illnesses that athletic trainers are exposed to may have a positive effect on the healthcare system through a cost savings model.

Conceptual Definitions

Athletic Training Student: A person who is enrolled in an accredited athletic training education program that functions under the direct supervision of a certified/licensed professional and is not yet a certified athletic trainer.[20]

Preceptor: A certified/licensed professional who teaches and/or evaluates students in a clinical setting using an actual patient base.[21]

Clinical Reasoning (CR): Cognitive processes, decision-making, problem-solving, or focused thinking used in the evaluation and management of a patient.[22]

Knowledge Based Model of Clinical Reasoning (KBM): Evaluation model characterized by recognition of meaningful information, definition of clinical data, and access to knowledge structures in memory.[10]

Hypothetico-deductive Model of Clinical Reasoning (HDR): Evaluation model characterized by data acquisition, hypothesis generation, data interpretation, and hypothesis evaluation.[10]

Assumptions

For Chapter III

1. Subjects were current and active preceptors to entry-level Master of Athletic Training students.
2. Subjects were honest and accurate when reporting information on all questionnaires and scales.
3. Subjects clearly understood the content of the questionnaires and scales.

For Chapter IV

1. Subjects were current and active preceptors to entry-level Master of Athletic Training students.
2. Subjects honestly reported their attitudes and beliefs towards how they clinically reasoned through their prior patient cases.
3. Subjects clearly understood the content of the questions asked

Limitations

For Chapter III

1. Subjects self-reported preference on clinical case evaluation methods

2. The scales used were validated on an athletic training student population

3. Participants were self-selected based on individual participant

For Chapter IV

1. Subjects self-reported evaluative thought processes and skills performed in prior cases

2. The study sample consisted only of preceptors that self-selected into participation and completed the preliminary demographic questionnaire

Delimitations

For Chapter III

1. Subjects were entry-level Athletic Training program preceptors

For Chapter IV

1. Subjects were entry-level Athletic Training program preceptors

CHAPTER II

REVIEW OF THE LITERATURE

PROJECT I: A SYSTEMATIC REVIEW ON THE USE OF THE DIAGNOSTIC THINKING INVENTORY IN HEALTHCARE

Introduction

Clinical reasoning (CR) has been studied over the past four decades originating from physician practice.[1,2] Higher levels of CR have been linked to more efficient, and timelier methods of cognitive organization, leading to more efficient and accurate diagnoses.[4,6-10] Healthcare providers must make accurate diagnoses before implementing safe and effective plans of care, and CR serves as a foundational component of clinical expertise in evidence-based practice.[23]

A strong foundation of clinical expertise facilitates strong diagnostic accuracy and a streamlined patient encounter. Diagnostic accuracy is an important measure to be able to treat injury and illness. In the United States of America there are 883.7 million physician visits yearly that require a healthcare provider to accurately diagnose and provide treatment to a patient.[24] These physicians undergo different stages of their CR development that can be assessed through developed instrumentation.[10] One of these instruments is the diagnostic thinking inventory (DTI).

The DTI was developed and has been adopted throughout multiple professions.[16,17] The instrument examines flexibility in thinking and structure of memory subcategories. Flexibility in thinking determines the clinician's ability to use multiple methods of investigation and analysis while allowing for considerations of a differential diagnosis when conflicting or absent key

features arise.[10] Structure of memory refers to the availability and ready access of accumulated knowledge from previous clinical experiences.[10]

The DTI has stood up to psychometric analysis throughout its iterations. It is scored using a 6-point Likert scale with responses totaling a minimum of 41 and a maximum of 246 points. The scores represent 126 points measuring flexibility in thinking, and 120 points measuring structure and memory. Eighteen of the 41 questions are left-handed responses which place the less desirable choice first in the scale.[25] Left-handed responses were included in the development of this instrument to minimize a right-handed response bias.[10] Cronbach α was strong and was found for the total scores ($r(41)=0.83$), with an acceptable reliability for flexibility in thinking ($r(21)=0.72$) and structure of memory ($r(20)=0.74$).[10] Test-retest reliability was assessed using a correlation coefficient calculated for each set of scores that was significant with p values of less than 0.002.[26] More experienced clinicians scoring significantly higher than students.[10,26] Content validity was obtained through qualitative analysis with participants and experts who agree that the instrument measures CR.[10,14,26] The adaptation to the instrument for different healthcare professions has not diminished the instrument psychometrically and the tool has been found to be both valid and reliable.[10,14-17,26]

Though the DTI has been used broadly, it's application and findings have yet to be comprehensively investigated. The purpose of this systematic review is to examine the scores associated with the DTI, in what fields it has been adapted to, and the different adaptations it has undergone to be used globally. This is important to establish within healthcare professions to create an interprofessional CR assessment method as a standard of comparison across the professions.

Methods

Information Sources and Search

A computerized literature search was completed using EBSCO (CINAHL, MEDLINE, SPORTDiscus), PubMed, and ERIC from inception through March 1, 2020. The Boolean term used was “Diagnostic Thinking Inventory” OR “DTI”. The primary author reviewed the articles obtained for inclusion. Titles and abstracts of all articles were screened using the inclusion criteria below. If the authors were unable to determine eligibility from abstracts the full text was screened. A hand search was performed on reference lists of all screened articles.

Eligibility Criteria

Studies were included in the systematic review if they used the DTI or any of its variations to assess healthcare professionals or students, and if they were written in English. Studies were excluded if they assessed non-healthcare professionals, did not use the DTI or any of its variations, were not written and published in English, or were conference proceedings or review articles.

Study Selection and Data Extraction

Studies were included for assessment if the variables of interest for this systematic review were present: DTI scores, professions using the DTI, and participants scores on the DTI. Publications were listed alphabetically by first author surname, and each reviewer was assigned a different place to start on the list to prevent bias resulting from reviewer fatigue. Each reviewer independently reviewed and rated the publications, and a total rating score was calculated for each article. The reviewers preliminarily assessed two quantitative and one qualitative study to compare scoring scheme and ensure agreement. Once agreement was achieved the reviewers reviewed all the remaining articles. Articles with scores greater than a 5-point range were

individually discussed to reach agreement. All rating scores were entered into a spreadsheet using Microsoft Excel 2010 (Microsoft Inc., Redmond, WA). Using each reviewer's total rating score for each article, a rank list of quantitative studies and a rank list of qualitative studies were created for each reviewer. The rankings were then averaged among both reviewers to prevent overvaluing any one reviewer's scoring. The a priori criteria for quantitative studies to be featured as exemplary were that the average of both reviewers' rankings of an article were greater than or equal to 20. The lack of qualitative studies involving the DTI required that only the highest-ranking article was considered exemplary. Data were further analyzed using IBM SPSS 26.0 (Armonk, NY) for internal consistency and interrater reliability with Cronbach's alpha and intraclass correlation coefficients (ICCs) using absolute agreement, respectively. The scores reported on the DTI were reported using descriptive statistics.

Data Synthesis and Analysis

The Educational Research Scoring Sheet (ERSS) was used to assess the methodologic quality of included studies. The ERSS was selected based on the educational grounding of the studies included in this review and having been validated for use with both quantitative and qualitative methodologies.[27] Studies were first assigned to a category of methodology (quantitative, qualitative, mixed methods). Based on their research design the appropriate version of the ERSS was used to assess the studies. Those studies that were of mixed methodological design were assessed using both instruments respective of their methods.

The quantitative scoring instrument (Appendix A) was adapted from a 2009 version created by the Society for Academic Emergency Medicine.[28] The instrument scores quantitative studies in nine domains on a 25 point scale. The domains include the following: introduction (0-3 points), measurement (0–4 points), data collection (0–4 points), data analysis (0–3 points),

discussion (0–3 points), limitations (0–2 points), innovation (0–2 points), generalizability (0–2 points), and clarity of writing (0–2 points). Each of the domains were scored based on predefined criteria to make scoring as objective as possible.[27]

The qualitative scoring instrument (Appendix B) was developed based on accepted recommendations for qualitative methodology and includes nine parallel domains to those applied to the quantitative studies for a maximum total score of 25 points.[29] These also include the domains of measurement, data collection, and data analysis criteria, as defined specifically for high-quality qualitative research.[27]

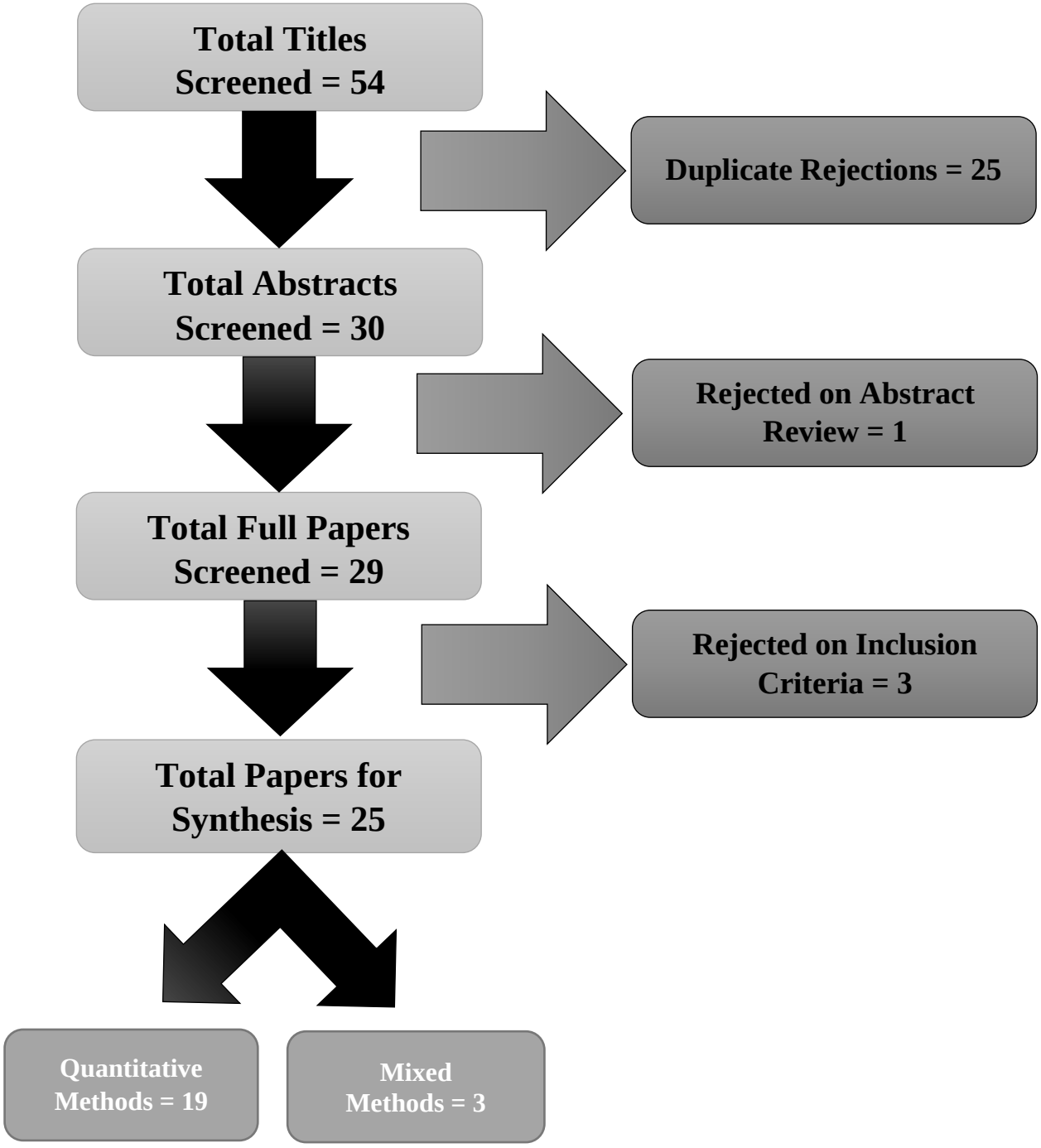
Results

Trial Flow

The initial search strategy retrieved 54 articles (Figure 1). Of the 54 articles assessed for eligibility, 25 articles met the inclusion criteria for this systematic review.[10,12,14,26,30-50] Of the 54 articles, 25 duplicate articles were excluded, 1 article was excluded because it was a commentary publication, and 3 articles were excluded because they did not use or report the findings of any version of the DTI. The 25 studies were classified into the following categories based on methodological design: qualitative, quantitative, or mixed methodological. In 22 studies a quantitative study design was used,[10,30-48,50] and in 3 studies a mixed methodological design was used.[12,14,49] Additional article information can be found in Appendix C.

Figure 1.

Systematic Review Search Strategy and Study Selection Process



Methodological Quality

The two reviewers agreed on 81.54% (375/455) of the items on the Educational Research Scoring Sheet (Quantitative and Qualitative)[27,28] across all the studies included (Appendix D). A high degree of reliability was found between the two reviewers. The average measure ICC was 0.909 with a 95% confidence interval from 0.804 to 0.958 ($F(27,27) = 11.020$, $p < .000$). Cronbach's alpha was reported to be 0.909 between the two reviewers and any disagreements were resolved by discussion. Overall, quality scores for the studies ranged from 12 to 22, with 7 exemplary studies (19.5+), and 18 inadequate studies (<19.5).

Scores Associated with the DTI

Of the 25 studies included, there were 37 total DTI, 25 structure of memory, and 25 flexibility in thinking scores reported. The studies reported the mean of the total scores as 165.91 ± 14.55, flexibility in thinking as 86.41 ± 3.31, and structure of memory as 82.50 ± 3.001. The scores ranged between 115.48 and 195.00, 81.19 and 92.41, and 77.77 and 88.53 for total, flexibility in thinking, and structure of memory scores, respectively. Accounting for professions, total scores reported were as follows: medicine 168.43±9.09 (n=3,255), athletic training 137.36±33.44 (n=51), and physiotherapy 178.11±0.48 (n=48).

Professions That Have Used the DTI

Of the 25 studies included, there were 22 that used the DTI to assess CR in medicine, 1 in physiotherapy, and 2 in athletic training. Medicine represented 88% of the total studies included in this systematic review. Of the participants in the studies analyzed, 2991 participants were students, and 363 were professionals. Furthermore, 2914 of the students were training to practice medicine, 51 athletic training, and 26 physiotherapy. Of the professionals, 341 were medical doctors, and 22 were physiotherapists.

Geographic Regions That the DTI Has Been Used Within

Geographic regions for the purpose of this systematic review were defined as the country of origin for which the study took place. There were twelve difference countries that the DTI was used to study CR in. The top three countries using the DTI, in order from most to least, were the United States of America (8), Australia (7), and the United Kingdom (3). These are all English language speaking countries, however, non-English speaking countries (9) had translated and adapted the DTI for use.

Discussion

In this study, available literature was systematically reviewed for the use of the DTI and characteristics associated with its use. The main findings of this review indicate the DTI is used around the world in different healthcare professions to quantify the scores of practicing clinicians and students. Clinical reasoning is a concept that is difficult to measure and, despite the many tools developed to attempt to assess components of CR, the DTI has been adopted interprofessionally and internationally.

The DTI was used to quantify CR within different healthcare professions, and at different levels of experience within those professions. The DTI scores that were reported varied based on control groups within the study, pre- and post-testing based on intervention administration, and total or subcategory of interest. When the instrument was used to assess the efficacy of a CR intervention, it was administered prior to and post intervention to measure the change in CR characteristics.[30,39-43,46-49] It was also used to capture the success of educational programs in which students were assessed throughout their academic training to measure progress.[12,33,35-38,45] Since the DTI has been found to be valid and reliable in measuring small changes in CR, the application of the instrument in serial assessments within the same subjects makes it useful as

another tool to determine the change in mental processes throughout a career or academic curriculum.[10,14-17,26] The findings of the validation and revalidation studies consistently found that the instrument was interprofessionally reliable and valid for assessing the CR of participants.[10,12,14,15,17] These findings have facilitated the use of the DTI as the foundational level instrument to assess and compare scores against for new CR assessment measures.[32,51]

The DTI was first validated for use in medicine where it was used to assess students, residents, and practicing physicians of different experience levels.[10] It was found to be able to discriminate between those students from different years, and physicians with different levels of experience.[10,15] Since then, the DTI has been used throughout medicine with mostly students to better understand their performance in their medical curriculum, and the success of CR interventions on improving CR.[30,33,38,40,42,43,45-49,51,52] The DTI has more recently been adapted to, and for use in, physiotherapy and athletic training.[14,17,26] Both adaptations occurred in 2016 and required questions to be adjusted for the scope of practice of those professions. The change in questioning did not diminish the reliability and validity of the instrument as their validation studies concluded similar results to those found in medicine.[14,17]

The DTI has been implemented internationally, and with geographical diversity. English speaking countries represent the largest sample of studies that have adopted its use.[10,12,14,26,31,32,34-39,41,42,47,50] There were nine non-English speaking countries that have used the DTI to assess the healthcare providers in their country.[12,30,33,43-46,49] Clinical reasoning appears to be a common denominator in healthcare practice that is present in driving clinical decisions for professionals. The DTI was validated across different languages to be used in some of the non-English speaking countries including a German and Indonesian version that were validated for

use with medical students.[12,15] The constructs of the DTI to assess CR were valid and reliable in different languages, geographical regions, and countries.[10,14,15,26]

There were several possible limitations within this study. The first is that the search strategy was limited to articles published in English which may have failed to capture the true dispersion of the DTI's use in different countries or with different translations. Second, studies that were limited to conference abstracts or commentary pieces were not included. This limitation may have failed to capture the most accurate scores reported for the use of the DTI and prevented a larger sample size of total DTI scores assessed. The primary limitation of this study was the overall quality of the studies included. Only 28% of the studies included were of exemplary methodological quality and none of the qualitative studies met exemplary quality cutoffs. Only four of the 25 studies included an experimental and control group with random assignment to those groups. Lastly, many of the studies included in this review that assessed students were from researchers with a long history of publications in medical education and CR with the assessment occurring within the host institution of the researcher. This may limit the findings of these individual studies and scores reported because of a focus on curricular content that fosters and supports CR.

Conclusions

The findings of this study suggest that the DTI is a valid and reliable tool to measure CR in healthcare professions. This tool is a CR assessment measure used to assess and monitor CR ability longitudinally, and pre- and post-intervention and within practicing professionals. Further research should focus on using the DTI with greater numbers of practicing professionals to understand comprehensive levels of CR and how those levels change over time. This will help

further the understanding of quantifiable differences amongst healthcare professionals inter- and intraprofessionally.

Appendix A

EM Education Research Scoring System: Quantitative Research[28]

Domain	Item	Item Score	Maximum Domain Score
Introduction: Give 1 point for each criterion met			3
	Appropriate description of background literature	1	
	Clearly frame the problem	1	
	Clear objective/hypothesis	1	
Measurement: Give 0 or 1 point for each criterion met			4
1. Methodology			
	Has no pretest or posttest	0	
	Has a posttest only	1	
	Has a pretest and posttest	1	
2. Groups			
	Both experimental and control group	1	
	Random assignment to groups	1	
Data Collection: Give 0 or 1 point for each criterion met			4
1. Institutions			
	Single institution	0	
	At least two institutions	1	
	More than two institutions	1	
2. Response rate			
	Response rate < 50% or not reported	0	
	Response rate ≥ 50%	1	
	Response rate ≥ 75%	1	
Data Analysis: Give 0 or 1 point for each criterion met			3
1. Appropriateness			
	Data analysis inappropriate for study design and type of data	0	
	Data analysis appropriate for study design and type of data	1	
2. Sophistication			
	Descriptive analysis only	0	
	Beyond descriptive analysis	1	
	Includes power analysis	1	
Discussion: Give 1 point for each criterion met			3
	Data support conclusion	1	
	Conclusion clearly addresses hypothesis/objective	1	
	Conclusions placed in context of literature	1	
Limitations: Assign a single best score			2
	Limitations not identified accurately	0	
	Some limitations identified	1	
	Limitations well addressed	2	
Innovation of Project: Assign a single best score			2
	Previously described methods	0	
	New use for known assessment	1	
	New assessment methodology	2	
Relevance of Project: Assign a single best score			2
	Impractical to most programs	0	
	Relevant to some	1	
	Highly generalizable	2	
Clarity of Writing: Assign a single best score			2
	Unsatisfactory	0	
	Fair	1	
	Excellent	2	
Total			25

Appendix B

EM Education Research Scoring Sheet: Qualitative Research[29]

Domain	Item	Item Score	Maximum Domain Score
Introduction: Give 1 point for each criterion met			3
	Appropriate description of background literature	1	
	Clearly frame the problem	1	
	Clear objective/hypothesis	1	
Measurement: Give 1 point for each criterion met			3
1. Methodology			
	Appropriate for study question	1	
2. Sampling of participants			
	Appropriate study population	1	
	Enrolled full range of cases/settings beyond convenience	1	
Data Collection: Give 0–1 point for each criterion met			3
1. Institutions			
	Single institution	0	
	At least two institutions	1	
	More than two institutions	1	
2. Sample size determination			
	Appropriate sample size determination	1	
Data Analysis: Give 1 point for each criterion met			5
	Clear, reproducible "audit trail" documenting systematic procedure for analysis	1	
	Data saturation through a systematic iterative process of analysis	1	
	Addressed contradictory responses	1	
	Incorporated validation strategies (e.g., member checking, triangulation)	1	
	Addressed reflexivity (impact of researcher's background, position, biases on study)	1	
Discussion: Give 1 point for each criterion met			3
	Data support conclusion	1	
	Conclusion clearly addresses hypothesis/objective	1	
	Conclusions placed in context of literature	1	
Limitations: Assign a score			2
	Limitations not identified accurately	0	
	Some limitations identified	1	
	Limitations well addressed	2	
Innovation of Project: Assign a score			2
	Previously described methods	0	
	New use for known assessment	1	
	New assessment methodology	2	
Relevance of Project: Assign a score			2
	Impractical to most programs	0	
	Relevant to some	1	
	Highly generalizable	2	
Clarity of Writing: Assign a score			2
	Unsatisfactory	0	
	Fair	1	
	Excellent	2	
Total			25

Appendix C

Study, Study Design, Population, Sample Size, Profession, DTI Score, and Country of Origin of Studies Included

					DTI Scores			
Study	**Study Design**	**Population**	**Sample Size**	**Profession**	**Total**	**Flexibility In Thinking**	**Structure of Memory**	**Country of Origin**
Beullens et al 2006	Quantitative	Final (7th) year medical Students	70	Medicine	Pre 168.13 Post 172.10	85.89 87.00	82.24 85.10	BEL
Bordage et al 1990	Quantitative	Medical practitioners including students and physicians	60 Students 210 Physicians	Medicine	170.29	87.7	82.52	GBR
Durning et al 2016	Quantitative	Internal medicine physicians with faculty appointments	17	Medicine	161.94	81.41	80.53	USA
Findyartini et al 2016	Mixed Methods	Medical Students from the University of Melbourne and the University of Indonesia	69 Semester Six 97 Semester Six 75 Semester Six 128 Semester Twelve	Medicine	161.17	83.37	77.77	AUS IDN
Gehlhar et al 2014	Quantitative	Three German Medical Schools with students in their 5th through 9th semesters	42 Fifth Semester 42 Sixth Semester 42 Seventh Semester 42 Eighth Semester 187 Ninth Semester	Medicine	164.35	N/A	N/A	DEU
Groves et al 2003	Quantitative	General practice Physicians with an average of 20 years' experience	21	Medicine	191.05	N/A	N/A	AUS
Groves 2005	Quantitative	Medical Students enrolled in years 2-4 of at the Universities of	189	Medicine	161.64	N/A	N/A	AUS

		Queensland and Sydney							
Groves et al 2007	Quantitative	First year medical students Universities of Queensland	115	Medicine	171.53		89.09	82.30	AUS
Groves et al 2003	Quantitative	Three successive medical school cohorts at Universities of Queensland	290	Medicine	168.55		87.3	81.15	AUS
Groves et al 2002	Quantitative	Medical students at the Universities of Queensland and general practice physicians	35 Second Years 33 Third Years 24 Final Years 22 Physicians	Medicine	Students Physicians	168.27 195.0	N/A	N/A	AUS
Heinerichs et al 2013	Quantitative	Undergraduate athletic training students from 3 different CAATE accredited athletic training education programs	38	Athletic Training	Pre Post	115.48 120.75	N/A	N/A	USA
Jerant et al 2004	Quantitative	Third year students enrolled in a primary care clerkship at the University of California at Davis	89	Medicine	169.85		87.25	82.6	USA
Jones 1997	Quantitative	Physiotherapists in the South Wales area and students at the Cardiff School of Physiotherapy	22 Physiotherapists 26 Physiotherapy Students	Physiotherapy	Pre Post	177.77 178.45	91.5 92.41	86.27 86.23	GBR
Kicklighter et al 2016	Mixed Methods	Senior Level Athletic Training students in a CAATE accredited	13 Quantitatively 3 Qualitatively	Athletic Training	175.85		89.54	86.31	USA

		undergraduate program							
Kiran et al 2016	Mixed Methods	Internal Medicine Post Graduate Students	24	Medicine	Pre Post	162.26 177.92	81.19 89.39	81.08 88.53	IND
Lee et al 2010	Quantitative	Fourth-year medical students at The Chinese University of Hong Kong	53	Medicine	Pre Post	161.65 162.8	82.95 83.15	78.75 79.65	CHN
Peahl et al 2019	Quantitative	Third year Ob/Gyn Clerkship Students	78	Medicine	Pre Post	160.3 166.95	82.05 85.2	77.85 81.9	USA
Round 1999	Quantitative	Fourth year medical students	186	Medicine	Pre Post	161.4 167.8	N/A	N/A	GBR
Schaye et al 2019	Quantitative	First year Residents at New York University Internal Medicine	71	Medicine	Pre Post	165.4 173.23	84.93 88.67	80.43 84.53	USA
Sobocan et al 2017	Quantitative	Third year Undergraduate medical students	34	Medicine	Pre Post	163.5 176.75	82.55 91.3	80.95 85.45	SVN
Sobral 1995	Quantitative	Students enrolled in the internal medicine clinical clerkship at the University of Brasilia Medical program over a 4-year period.	180	Medicine	163.45		84.21	79.25	BRA
Sobral 2000	Quantitative	Third term students over three years in the University of Brasilia 6-year medical program	195	Medicine	171.9		88.6	83.25	BRA
Stieger et al 2011	Quantitative	Fifth year medical students at the University of Vienna	398	Medicine	Pre Post	165.1 176.4	84.5 89.1	80.6 87.3	AUS
Windish et al 2005	Quantitative	Second Year Medical Students at Johns Hopkins	121	Medicine	Pre Post	147.3 164.7	N/A	N/A	USA

		University School of Medicine							
Yousefichaijan et al 2016	Quantitative	Students at the Arak University of Medical Sciences	42	Medicine	Pre Post	157.65 175.94	N/A	N/A	IRN

Appendix D

Article Appraisal using the Educational Research Scoring Sheet[27,28]

Study	Reviewer 1 Score	Reviewer 2 Score	Average Score	Exemplary (Yes/No)
Assessed using The Educational Research Scoring Sheet for Quantitative Studies				
Beullens et al (2006)[30]	17	17	17.0	No
Schaye et al (2019)[31]	19	20	19.5	Yes
Bordage et al (1990)[10]	21	21	21.0	Yes
Durning et al (2016)[32]	17	17	17.0	No
Findyartini et al (2016)[12]	19	19	19.0	No
Gehlhar et al (2014)[33]	18	16	17.0	No
Groves et al (2003)[34]	13	12	12.5	No
Groves (2005)[35]	14	15	14.5	No
Groves et al (2007)[36]	15	17	16.0	No
Groves et al (2003)[37]	19	17	18.0	No
Groves et al (2002)[38]	18	15	16.5	No
Heinerichs et al (2013)[39]	21	20	20.5	Yes
Jerant et al (2004)[50]	18	16	17.0	No
Jones (1997)[26]	18	18	18.0	No
Kicklighter et al (2016)[14]	19	18	18.5	No
Kiran et al (2016)[49]	21	19	20.5	Yes
Lee et al (2010)[40]	19	18	19.0	No
Peahl et al (2019)[41]	22	19	20.5	Yes
Round (1999)[42]	19	20	19.5	Yes
Sobocan et al (2016)[43]	19	17	18.0	No
Sobral (1995)[44]	16	16	16.0	No
Sobral et al (2000)[45]	19	18	19.0	No
Stieger et al (2011)[46]	17	15	16.0	No
Windish et al (2005)[47]	22	19	20.5	Yes
Yousefichaijan et al (2016)[48]	15	14	15.0	No
Assessed using The Educational Research Scoring Sheet for Qualitative Studies				
Findyartini et al (2016)[12]	15	15	15.0	No
Kicklighter et al (2016)[14]	14	13	13.5	No
Kiran et al (2016)[49]	17	14	15.5	No

CHAPTER III

PROJECT II: OBJECTIVE MEASUREMENT OF CLINICAL REASONING IN ATHELTIC TRAINING PRECEPTORS, LINKING THE LITERATURE TO CLINICAL PRACTICE

Introduction

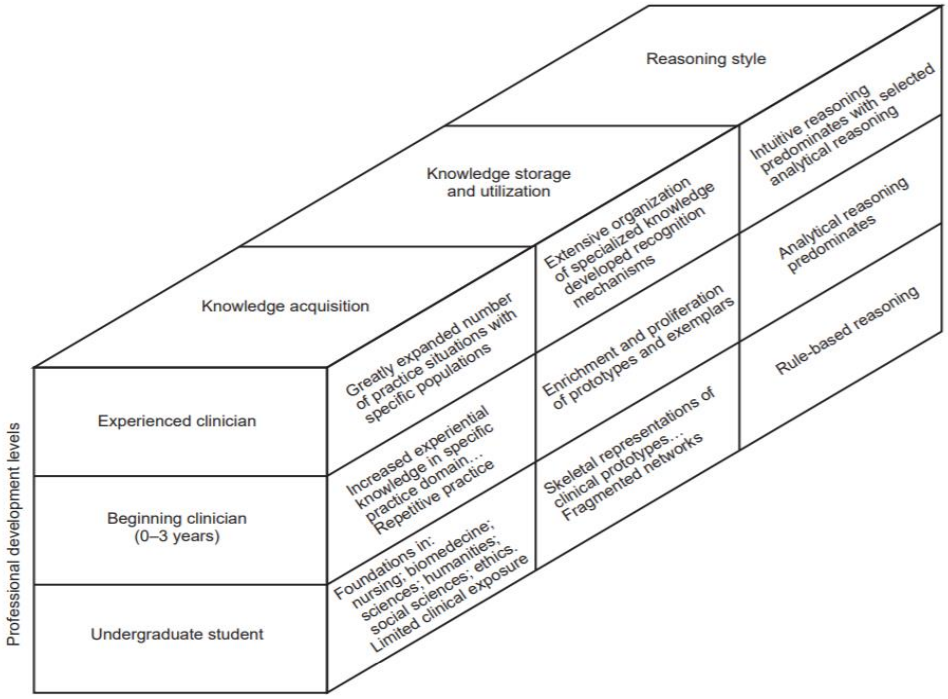
Clinical reasoning has been defined as a branch of critical thinking where medical practitioners use a varied and nuanced thought process to make clinical decisions.[53] In athletic training, Geisler and Lazenby[4] defined clinical reasoning as, "the cognitive processes, decision making, problem solving, or focused thinking used in evaluation and management of a patient." Although there is consistency in definition across professions, it has been difficult to understand the best methods to promote, teach, and evaluate its presence in clinicians.[53-55] Clinical reasoning seminars and workshops have been constructed to help foster a foundational level understanding of core concepts and application to clinical scenarios.[39,40,48] However, once the participants were evaluated for changes in their clinical reasoning ability they varied in their success to induce a change.[39,40,48]

It is widely accepted that clinical reasoning development occurs naturally throughout experiences and exposure to clinical practice over time.[1,4,12] Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning (Figure 2)[13] will guide this study. It was developed in the field of nursing to explain how students develop from memorizing classroom knowledge to novice clinicians, using predominantly a hypothetico-deductive reasoning approach, and, lastly, to expert clinicians who demonstrate a knowledge based model approach to clinical reasoning.[13] This framework articulates that it takes up to three years of autonomous clinical practice in a specialized area to become an expert clinician within your

specialty. However, central to the ability of student clinicians to improve clinical reasoning is to receive constructive feedback from mentors.[4] Feedback should challenge student's ability to access, organize, and apply classroom knowledge to clinical cases within their experiences. Student mentorship is fulfilled, in athletic training, predominantly by preceptors.

Figure 2.

Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning[13]



This assertion can be supported by the 2020 Commission on Accreditation of Athletic Training Education (CAATE) standards for accreditation of professional athletic training programs.[20] The definition of supervision, provided by the CAATE as "occurring along a developmental continuum that allows a student to move from interdependence to independence…"[20(p21)] supports the vital role of the preceptor as the gatekeeper from dependence to independence. However, clinical reasoning ability, to the best of our knowledge, has not been formally assessed in athletic training preceptors.

The Diagnostic Thinking Inventory was developed in medicine and has since been adapted and validated for use in athletic training to assess the core components of CR.[10,14] The instrument examines flexibility in thinking and structure of memory subcategories. Flexibility in thinking determines the clinician's ability to use multiple methods of investigation and analysis

while allowing for considerations of differential diagnoses when conflicting or absent key features arise.[10] The structure of memory refers to the availability and ready access to accumulated knowledge from previous clinical experiences.[10]

Therefore, the purpose of our study was to assess preceptors clinical reasoning scores using the DTI-AT and determine if there was a relationship between age, years of experience, professional sociability, and preceptorship status on DTI-AT scores. We selected age, years of experience, professional sociability, and preceptorship status because of literature supporting these demographics as major contributing factors to clinical reasoning development.[10,13,23] Specifically, we hypothesized that more years of professional and preceptor experience, and higher levels of professional sociability would be positive predictors of clinical reasoning ability and that preceptors would score similarly to physicians based on years of experience.

Methods

Study Design

This study was a cross-sectional online survey (Qualtrics, Provo, UT) developed to examine the relationships between years of experience, years of preceptorship, volume of preceptorship and professional sociability among preceptors as it relates to clinical reasoning ability. Approval was awarded by the Old Dominion University College of Health Sciences Human Subjects Review Committee prior to data collection.

Participants

Thirty-eight (12 men, 31.58%; 26 women, 68.42%, 12.68 ± 10.04 years of experience) ATs currently serving as preceptors for post-baccalaureate athletic training programs participated in our study. The inclusion criterion was serving as a preceptor for a at least one post-baccalaureate athletic training education program in good standing with the Commission for

Accreditation in Athletic Training Education (CAATE). Preceptors to only baccalaureate athletic training education programs, post-professional athletic training education programs, and those programs not in good standing with the CAATE or seeking accreditation were excluded from participation.

Instrumentation

The survey instrument (Appendix 1) was entered into Qualtrics and consisted of a demographic section and the Diagnostic Thinking Inventory for Athletic Trainers (DTI-AT).[14] The demographic section gathered information regarding participant age, sex, race/ethnicity, years of experience, credentials, practice setting, years of preceptorship, preceptorship volume, professional sociability, and preceptor training experience. Years of experience was defined as years certified, years of preceptorship was total number of years as a preceptor with an accredited program, preceptorship volume was defined as the number of students served, and professional sociability was defined as the number of other healthcare providers interacted with on a weekly basis.

The Diagnostic Thinking Inventory (DTI) was originally developed as a quantitative measure of clinical reasoning ability in medicine.[10] The DTI-AT is scored using a 6-point Likert scale with responses totaling a maximum score of 126 for flexibility in thinking, and 120 in structure and memory. The maximum total score is 246 points. Eighteen of the 41 questions are scored in reverse order.

The DTI-AT total scores, flexibility in thinking, and structure of memory subcategories were calculated using a Cronbach α. A strong reliability was found for the total scores (r(41)=0.846, power=0.99), and an acceptable reliability for flexibility in thinking (r(21)=0.731, power=0.85) and structure of memory (r(20)=0.771, power=0.92).[14] These findings were slightly

higher than the values reported by Bordage et al.[10] in the validation of the original version of the instrument. Content validity was obtained through interviewing study participants for clarity and understanding of questions asked, inventory, and the introductory scenario in which 100% of respondents responded positively.[14]

Procedures

Public records were collected for post-baccalaureate athletic training program directors e-mail addresses based on the CAATE database of programs in good standing that were currently accredited. The CAATE provided clinical education coordinators' e-mail addresses for follow-up contact with the same programs. Of the 216 post-baccalaureate institutions,154 were eligible to participate. An invitation e-mail was sent to the 154 eligible programs to return their preceptor contact information. Of the 154 eligible programs, 7 elected to provide preceptor contact information and an additional 3 programs elected to distribute the survey link directly to their preceptors. An invitation e-mail was sent to 231 potential participants containing the hyperlink to the survey and an additional 81 participants received the hyperlink directly from their affiliated program. The survey was open for a total of 180 days, and 5 reminder e-mails were sent to all participants, 2 weeks after the initial and every 2 weeks for the next 7 weeks after the initial request for participation. After the initial 90 days, social media solicitations were used to recruit participants through Facebook, Twitter, and Instagram. These participants were required to self-select and consent to participation within the inclusion criteria. Settings were established in Qualtrics that limited responses to one survey entry per internet protocol address to avoid duplicate responses. At the end of the 180-day collection period, all surveys were reviewed to examine completeness, duplications, and inclusion criteria. At the close of the data collection period, 87 survey responses were recorded. A total of 49 responses were removed because of

incomplete responses, resulting in 38 completed surveys. The recorded completion rate for this instrument was 55.88%.

Data Analysis and Management

The independent variables derived from the survey responses were years of experience, years of preceptorship, volume of preceptorship and professional sociability. The dependent variables were DTI-AT scores. We set the a priori level at $P > .05$. Data were downloaded from the Qualtrics Web site into an Excel spreadsheet, which was then converted to an SPSS (version 22.0; IBM Corporation, Armonk, NY) worksheet. The data were cleaned (responses were listwise deleted if a participant did not complete the survey questions) before analysis. Likert responses for the DTI-AT were summed to provide a total professional development score for each participant, as well as the associated questions were summed to provide flexibility in thinking and structure of memory subscale scores. A simple linear correlation was conducted to determine the relationship between DTI-AT scores and our independent variables. Statistical analysis was dictated by the participant sample size. All descriptive and significance testing was completed using SPSS.

Results

Participants were certified by the Board of Certification for 12.68 ± 10.04 years (range, 43 years n=37) and served as a preceptor for 7.87 ± 6.17 years (range, 25 years, n=38). Respondents indicated serving as a preceptor for 2.54 ± 2.12 students annually (range, 8 students, n=35) and had weekly professional sociability with 5.63 ± 5.08 other healthcare providers (range, 22 healthcare providers, n=38). Demographic data reported based on number of respondents (n) who answered representative demographic questions. Additional demographic data can be found in Table 1. Total DTI-AT scores from 147 to 221, with the average DTI-AT

score being 186.82 ± 16.98 with a median value of 186. Flexibility in thinking scores ranged from 67 to 110, and structure of memory scores ranged from 79 to 112. The average flexibility in thinking score was 93.66 ± 9.81 with a median value of 92.5, and the average structure of memory score was 93.16 ± 8.65 with a median value of 92.

Table 1.

Participant Demographic Information

Demographic Variable	No. (% of Sample)
Sex	
Male	12 (31.58)
Female	26 (68.42)
Race/Ethnicity	
Hispanic/Latino	3 (7.89)
Asian/Pacific Islander	1 (2.63)
Caucasian/White	34 (89.47)
Credentials	
ATC	38 (100)
EMT	3 (6.7)
Physician Assistant	1 (2.2)
Physical Therapist	1 (2.2)
Strength and Conditioning Certified	5 (11.1)
Other	2 (4.4)
Formal Preceptor Training	
Yes	33 (86.84)
No	3 (7.89)
Unsure	2 (5.26)
Have they taken this instrument before	
Yes	2 (5.3)
No	34 (89.5)
Unsure	2 (5.3)
Clinical practice Setting	
Clinic	2 (5.26)
College/University	13 (34.21)
Secondary School	21 (55.26)
Other	2 (5.26)

Correlation coefficients were calculated to understand the relationship between DTI-AT scores and the independent variables of interest. There were no significant findings between age, years of experience, years as a preceptor, number of students served, and DTI-AT scores. There was a significant, medium, positive relationship between the amount of interprofessional interactions on a weekly basis and DTI-AT scores (r (36) = 0.33, $p < 0.05$). Correlations for all the dependent variables can be found in Table 2.

Table 2.

Correlation Matrix Between the Dependent Variable and All Independent Variables

	DTI-AT (sig)	Professional Sociability (sig)	AT Experience (sig)	Preceptor Experience (sig)	Student Volume (sig)
DTI-AT		**.330 (.023)**	.141 (.203)	.045 (.396)	-.027 (.437)
Professional Sociability	**.330 (.023)**		-.008 (.482)	.147 (.193)	.332 (.022)
AT Experience	.141 (.203)	-.008 (.482)		.742 (.000)	-.129 (.223)
Preceptor Experience	.045 (.396)	.147 (.193)	.742 (.000)		.170 (.157)
Student Volume	-.027 (.437)	.332 (.022)	-.129 (.223)	.170 (.157)	

Discussion

We aimed to assess athletic training preceptors clinical reasoning scores using the DTI-AT and determine if there was a relationship between age, years of experience, professional sociability, and preceptor experience on DTI-AT scores. Our results revealed that professional sociability was the only significant predictor of higher scores on the DTI-AT, meaning that clinicians that interacted with more healthcare providers on a weekly basis exhibited higher clinical reasoning scores. The absence of significant relationships between the DTI-AT scores and selected independent variables may indicate that clinical reasoning in athletic training matures differently than previously established in other healthcare professions and other factors should be considered and explored regarding clinical reasoning development.

The use of the DTI has uncovered clinical reasoning scores in medicine, physiotherapy, and athletic training students. The average combined overall scores in medicine (n=3255) were 168.07±9.09, in physiotherapy (n=48) were 178.11±0.48, and in previous studies of athletic

trainers (n=51) were 137.36±33.44. The findings of this study, 186.82 ± 16.98, suggest that the preceptors in this study are higher level clinical reasoners than students in the same profession, and those found in medicine and physiotherapy. These findings may suggest that there is something unique about athletic training practice that results in higher levels of clinical reasoning. These findings may also suggestion that there could be a possible ceiling effect with the DTI-AT that may be challenging for experienced clinicians to significantly increase their scores. If further investigation supports a ceiling effect with the DTI-AT it may be imperative to evaluate CR in experienced clinicians through patient outcomes and experiences.

These findings are both consistent and inconsistent with previous literature exploring demographic factors associated with clinical reasoning development in other healthcare professions. Age has been found to have no association with clinical reasoning scores in other professions.[37,56,57] This is consistent with our findings and can be explained through academic research on problem solving. Conclusions have been drawn that heuristics coincides with the emergence of formal reasoning during early adolescence and tend to become resistant to age and instruction influences.[58,59] Within our athletic training preceptor population studied, it is likely that age is not a factor in reasoning approaches as supported by some of the literature.

However, the nature of clinical practice requires experienced clinicians to be older which has led to older providers exhibiting higher levels of CR.[10] In the extremes, providers that are more senior may experience a cognitive decline leading to decreased levels of CR.[60] Athletic training is a young profession with the oldest athletic trainers in their 60s, and the majority of athletic trainers between the ages of 22 and 47 that may insulate the profession against the impact of age on CR.[61]

Years of experience has had a positive association with higher levels of clinical reasoning in nursing[13] and medical education.[8] The Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning was built around the principal of knowledge acquisition over time through clinical experiences.[13] The three years of specialized clinical practice proposed by the authors of the framework fails to explain the findings of our study which showed a very small relationship between experience and clinical reasoning ability.[13] However, athletic training practice varies from nursing based on injured patient load, and specificity of clinical cases evaluated and diagnosed. Athletic trainers typically see many patients with varying conditions and may have concentrated areas of expertise that do not broadly translate into robust clinical reasoning strategies in all areas of their practice.

Professional sociability has been identified as a key component in clinical reasoning development throughout healthcare professions starting as a student and sustaining its importance in professional practice.[62-65] Within physician practice, both novice and expert clinicians indicated the importance of mentorship and professional sociability on development and maintenance of clinical reasoning.[62] However, experts emphasized this theme more often than their novice counterparts.[62] Professional sociability promotes an environment for metacognition, and remediation to create educative experiences to foster clinical reasoning.[66] Within athletic training, preceptors have indicated a perception that professional sociability improves their clinical reasoning ability.[23] Although this study did not comprehensively investigate professional sociability, consistent interactions with other professionals may result in many of the positive outcomes associated with professional sociability. The findings within other healthcare professions are consistent with the findings of this study that there is a positive relationship between professional sociability and clinical reasoning. Athletic trainers work under

the direction of, or in collaboration with, a physician and could leverage that relationship to create educative experiences to improve and maintain their clinical reasoning ability.

Preceptorship is predominantly investigated from the student perspective to determine how preceptorship impacts student development. However, what we can glean from these studies is that in nursing, most preceptors have been professional practicing clinicians for greater than 3 years.[67] However, in athletic training there is no consistent threshold of years of experience for preceptorship.[23,68] Nursing consistently adheres to The Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning in their preceptorship demographics.[13,67] Whereas athletic training preceptors perceive that lack of experience is a barrier to clinical reasoning development.[23] However, the findings of this study do not support these traditions founded in clinical experience. Overlap exists between years of experience as a clinician and years of experience as a preceptor. Existing literature suggests that as preceptors become more experienced clinicians and are exposed to preceptor development through their institutional relationships, their clinical reasoning scores may improve.[63,69]

Preceptorship across most healthcare professions varies in the ratio of preceptor to student. However, the evidence supports that a 1:2 preceptor to student ratio is most likely to successfully balance the needs of all stakeholders.[70] Preceptorship load in athletic training most commonly falls below a 1:4 ratio of preceptors to students but, in some cases can be as high as 1:15 preceptors to students.[71] Lack of time and formal training in education for athletic training students can exacerbate the extra strain of preceptorship.[19,23,68] The larger load seen in athletic training may lead to worse clinical reasoning ability through an increased workload that detracts from time that would be used for metacognition. However, the volume of students that are served

requires further investigation to determine the factors that enhance or stunt clinical reasoning development specifically to preceptorship load.

In this study, we examined the impact that age, years of experience, professional sociability, and preceptor experience had on DTI-AT scores. Given the existing body of literature in athletic training and other professions, our findings are inconsistent and emphasize that there are nuances of athletic training clinical practice and preceptorship that may create differences when compared to other healthcare professions. Therefore, we should assume that there are other factors, such as athletic training's immediate transition to autonomous practice, that contribute to the development and maintenance of clinical reasoning in athletic training which warrant further investigation.

Limitations and Future Research

Although our study extends current knowledge about clinical reasoning in athletic training and serves to inform future research germane to clinical reasoning in athletic training, it is not without its limitations. These limitations include the sampling process, sample size, and inherent biases in survey research. Due to the small sample size, caution should be taken when generalizing results. Additionally, as with most survey methods, our study is susceptible to a self-selection bias.

Further research should evaluate clinical reasoning objectively amongst educators and practicing clinicians to complete a comprehensive understanding of the clinical reasoning landscape within athletic training. Additionally, further investigation into clinician and preceptors should focus on the first three years of clinical practice as this may be where the development of clinical reasoning skills primarily occurs. Future research should include

additional demographic questions to better understand what contributing factors are associated with different levels of clinical reasoning.

Conclusions

This survey is the only known report to objectively measure clinical reasoning exclusively in the athletic training preceptor population. This information is important to consider for preceptor selection, evaluation, and training. Deliberate effort should be made to promote professional socialization of preceptors, and for athletic training education program administrators to be mindful of the strain that preceptorship has on a clinician. Objective measures of clinical reasoning can be used to better understand the abilities and needs of preceptors within an institutional system. Our findings stand as the beginning of a standard of comparison for clinical reasoning ability within athletic training starting at the preceptor level.

Appendix A

Diagnostic Thinking Inventory for Athletic Trainers[14]

INSTRUCTIONS: This inventory contains 41 items concerning your diagnostic thinking. Each item contains a stem, two accompanying statements and a rating scale. The scale refers to a continuum between the two statements. Please indicate the answer that best describes your position on the continuum. Do not try to work out any underlying meaning to each item; there is no right or wrong answer. Only the sum of the items will have a significance. Simply respond as spontaneously as you can by indicating how you actually diagnose and not how you think you should (even for those with little clinical experience). You will often find that you actually do things associated with both statements for a given item; your answer should indicate which one you do more often. Opt for the statement which describes what you do most often. It will take you about 15 to 20 minutes to complete the inventory.

Consider this case as you answer the questions in this assessment:

A 19-year-old volleyball player presents with right shoulder pain that has been present over about 2 weeks. The patient denies any previous history of right shoulder injury or trauma and is unable to specify a specific mechanism of injury. She primarily notices a mild, sharp pain when serving, blocking, and spiking that progressively worsens as practice progresses and is uncomfortable at night

When the patient presents symptoms,

	1	2	3	4	5	6	
I think of the symptoms in the precise words used by the patient	○	○	○	○	○	○	I think of the symptoms in more abstract terms than the expressions actually used (eg, '4-day duration' becomes 'acute'; 'two-hands' becomes bilateral)

In considering each diagnosis,

	1	2	3	4	5	6	
I try to evaluate their relative importance	○	○	○	○	○	○	I try to give them equal importance or weighting

In thinking of diagnostic possibilities,

	1	2	3	4	5	6	
I think of diagnostic possibilities early on in the case	○	○	○	○	○	○	First I collect the clinical information then I think about it

When I am interviewing a patient,

	1	2	3	4	5	6	
I often seem to get one idea stuck in my mind about what might be wrong	○	○	○	○	○	○	I usually find it easy to explore various possible diagnosis

Throughout the interview,

	1	2	3	4	5	6	
If I follow the patient's line of thought, I tend to lose my own thread	○	○	○	○	○	○	I can still keep my own ideas clear even if I follow the patient's line of thought

When it comes to making up my mind about a diagnosis,

	1	2	3	4	5	6	
I do not mind postponing my diagnostic decisions about a case	○	○	○	○	○	○	I feel obliged to go for one diagnosis or another even if I am not very certain

Once the patient has clearly presented their symptoms and signs,

	1	2	3	4	5	6	
I think about them in my mind in the patient's own words	○	○	○	○	○	○	I translate them in my mind into medical terms (eg, 'numbness' becomes 'paresthesia' or 'paralysis')

In relation to the routine history,

	1	2	3	4	5	6	
I often feel that I did not sufficiently cover the routine history	○	○	○	○	○	○	I usually cover the routine history to my satisfaction

As the patient tells their story and the case unfolds,

	1	2	3	4	5	6	
I often find it difficult to remember what has been said	○	○	○	○	○	○	I can usually keep track in my mind of what has been said

During the course of the interview, I find that,

	1	2	3	4	5	6	
Some key pieces of information seem to leap out at me	○	○	○	○	○	○	It is often difficult to know which items of information to latch on to

When I cannot make sense of a patient's symptoms,

	1	2	3	4	5	6	
I move on and gather new information to trigger new ideas	○	○	○	○	○	○	I ask the patient to define those symptoms more clearly

In considering diagnostic possibilities,

	1	2	3	4	5	6	
I often come up with unlikely diagnoses	○	○	○	○	○	○	I am usually in the right area

While I am collecting information about a patient,

	1	2	3	4	5	6	
The various items of information usually seem to group themselves together in my mind	○	○	○	○	○	○	I often have difficulty seeing how the pieces of information relate to each other

When the diagnosis becomes known and I realize that I have missed it initially,

	1	2	3	4	5	6	
It is often because I knew the disease but failed to think about it	○	○	○	○	○	○	It is often because I did not know enough about the disease

During the clinical interview,

	1	2	3	4	5	6	
I cannot bring myself to dismiss some information as irrelevant	○	○	○	○	○	○	I am quite happy to dismiss some information as irrelevant

When I cannot make sense of the patient's symptoms and signs,

	1	2	3	4	5	6	
I move on to get new information and a new perspective	○	○	○	○	○	○	I look at them from a different perspective before moving on

When I consider a number of possible diagnoses,

	1	2	3	4	5	6	
The diagnoses tend to be related to one another	○	○	○	○	○	○	The diagnoses tend to be scattered

When a possible diagnosis comes to my mind,

	1	2	3	4	5	6	
I usually find myself anticipating possible abnormal signs and symptoms that go with that diagnosis	○	○	○	○	○	○	Quite often, it does not help me to decide what to ask the patient next

When I know very little about a particular type of injury or condition,

	1	2	3	4	5	6	
I can still usually come up with a diagnosis	○	○	○	○	○	○	I have great difficulty in reaching a diagnosis

In considering the patient's signs and symptoms,

	1	2	3	4	5	6	
I think about each in absolute terms as stated by the patient	○	○	○	○	○	○	I think of them in terms of possible opposites (eg, progressive vs. sudden; unilateral vs. bilateral; spastic vs. flaccid)

When I know a lot about a particular type of injury or condition and have to make a diagnosis,

	1	2	3	4	5	6	
I find it relatively easy to pin down a diagnosis	○	○	○	○	○	○	I often seem to be all over the place and have difficulty pinning down a diagnosis

As the history progresses and I already have some ideas about the possible diagnosis(es),

	1	2	3	4	5	6	
New information often makes me have more ideas	○	○	○	○	○	○	New information does not often make me have more ideas

When I am taking a history, I find that,

	1	2	3	4	5	6	
I can get new ideas just by going over the existing information in my mind	○	○	○	○	○	○	I need to have new information to make me have a new idea about the case

When patients use imprecise or ambiguous expressions,

	1	2	3	4	5	6	
I let them go on to maintain the flow of the interview	○	○	○	○	○	○	I make them clarify precisely what they mean before going on

After an interview with a patient,

	1	2	3	4	5	6	
I rarely think of other things that I should have asked in relation to the patient's disorder	○	○	○	○	○	○	I often think of other things that I should have asked in relation to the patient's disorder

When a piece of information comes along and makes me think of a possible diagnosis,

	1	2	3	4	5	6	
It often makes me go back to the previous information to see if things fit together or not	○	○	○	○	○	○	It rarely makes me review the information that I have gathered previously

In relation to the diagnosis I eventually make,

	1	2	3	4	5	6	
I usually have very few doubts	○	○	○	○	○	○	I often feel too uncertain for my own comfort

In making a diagnostic decision,

	1	2	3	4	5	6	
I decide by considering each possible diagnosis separately on its own merits	○	○	○	○	○	○	I decide by comparing and contrasting the various possible diagnoses

When I know a lot about a particular type of disease and have to make a diagnosis,

	1	2	3	4	5	6	
I check up on most possibilities before reaching a decision	○	○	○	○	○	○	I often have lots of ideas that I don't explore further

As the case unfolds,

	1	2	3	4	5	6	
I do not find it useful to summarize as I go along	○	○	○	○	○	○	I periodically take stock of the data and my ideas

When I reach my diagnostic decisions,

	1	2	3	4	5	6	
There is often left-over information I have just forgotten about	○	○	○	○	○	○	I usually will have considered all the information

When I have got an idea about what might be wrong be the patient,

	1	2	3	4	5	6	
I feel most comfortable if I can follow it up without being diverted	○	○	○	○	○	○	I feel happy to go off on another track and come back to my original ideas later

When I come up with a broad idea as to what might be wrong with the patient,

	1	2	3	4	5	6	
I can usually proceed to a specific diagnosis	○	○	○	○	○	○	I find it difficult to put it into specific terms

Throughout the interview,

	1	2	3	4	5	6	
I manage to test my ideas even if I let the patient control the interview	○	○	○	○	○	○	I am only successful if I can control the direction of the interview

In relation to choosing from among the diagnostic ideas that I have,

	1	2	3	4	5	6	
I am usually not capable of wholly ruling out any of the ideas I have had	○	○	○	○	○	○	I am capable of ruling out most of my ideas completely

Once I have made up my mind about a patient,

	1	2	3	4	5	6	
I am prepared to change my mind	○	○	○	○	○	○	I really do not like to change my mind

When I consider my diagnostic ideas, I do so on the basis of,

	1	2	3	4	5	6	
The case as a whole so far	○	○	○	○	○	○	A few outstanding symptoms or signs

If I do not know what to make of a clinical interview,

	1	2	3	4	5	6	
I can readily see the information in new ways	○	○	○	○	○	○	I find it difficult to see the information in new ways

When I determine which diagnostic tests (eg: MRI, CT scan, ultrasound) I would like ordered,

	1	2	3	4	5	6	
I do it as part of the routine clinical investigation	○	○	○	○	○	○	I do it expecting specific information or supporting evidence

In considering diagnostic possibilities,

	1	2	3	4	5	6	
I compare and contrast the possible diagnoses	○	○	○	○	○	○	I consider each diagnosis separately on its own merits

In terms of the way I conduct an interview,

	1	2	3	4	5	6	
I usually cover the ground that I need to during the interview	○	○	○	○	○	○	Quite often I do not ask all the questions that I should at the time

End of Block: DTI-AT

Start of Block: Demographics

Age

_____

Sex

- ○ Female
- ○ Intersex
- ○ Male
- ○ Transgender
- ○ Prefer not to respond

Ethnicity

- ☐ Hispanic or Latino
- ☐ Non-Hispanic (White)
- ☐ Prefer not to respond

Race

- [ ] Asian
- [ ] White
- [ ] American Indian and Alaska Native
- [ ] Black or African American
- [ ] Native Hawaiian and Other Pacific Islander
- [ ] Mixed Race
- [ ] Prefer not to respond

Which of the following credentials do you currently hold? (Check all that apply)

- [ ] Athletic Trainer (ATC)
- [ ] EMT
- [ ] Nurse
- [ ] Occupational Therapist
- [ ] Physician (MD, DO, DC)
- [ ] Physician Assistant
- [ ] Physical Therapist
- [ ] Strength and Conditioning, Certified
- [ ] Other _____

How many years have you been practicing as an athletic trainer?

_____

What is your clinical practice setting?

- ○ Amateur/Recreational/Youth Sports
- ○ Business/Sales/Marketing
- ○ Clinic
- ○ Health/Fitness/Sports Performance Enhancement
- ○ College/University
- ○ Hospital
- ○ Professional Sports
- ○ Public Safety
- ○ Secondary School
- ○ Other _____

How many years have you been a preceptor for athletic training students?

_____

How many students do you serve as a preceptor for on a yearly basis?

_____

In your professional practice, how many other healthcare providers do you interact with on a weekly basis?

_____

Have you received formal preceptor training?

- ○ Yes
- ○ No
- ○ Unsure

Have you taken an inventory similar to this before?

- ○ Yes
- ○ No
- ○ Unsure

Thank you for your participation. Please indicate if you would like to participate in a follow-up study pertaining to the results of this instrument.

- ☐ Email Address _____
- ☐ I would like to participate in a follow-up study
- ☐ I would NOT like to participate a follow-up study

CHAPTER IV

PROJECT III: PRECEPTORS PERCEPTIONS OF CLINICAL REASONING IN ATHLETIC TRAINING PRACTICE

Introduction

Medical education researchers have spent the last four decades investigating the multi-factorial and complex mental processes used for establishing a clinical diagnosis.[1-3] Novice clinicians favor an analytical process that is stepwise, developing a suspected diagnosis, and using their evaluation skills to determine if their suspicions are founded in what is termed hypothetico-deductive reasoning (HDR).[4] Hypothesis generation using HDR is rooted in the clinician's existing knowledge, associations, and experience relative to the case.[2,5] Expert clinicians favor a non-analytical approach which has been attributed to more efficient methods of cognitive organization that result in a streamlined evaluation approach called case pattern recognition using a knowledge based model (KBM) of CR.[4,6-10] Case pattern recognition is when a clinician recalls stored information from prior experiences to work through potential diagnoses and attribute the key features of the case to a specific diagnosis.[4] Structure of memory is exhibited through the clinicians organization and recall of information from prior experiences and serves as a subcategory of CR.[10] If features are identified that do not fit with an expert clinician's prior experiences or they are evaluating a novel case they may revert back to HDR to diagnose their patient. The switches between the HDR and KBM models demonstrate flexibility in thinking, another important subcategory to whether a clinician is a novice or an expert.[4,10] Switching between methods of evaluation is indicative of dual-process theory where clinicians self-regulate based on the case to use the best evaluation technique to properly evaluate their patients.[11] Clinicians typically develop over their careers from students, to novice clinicians, and

finally content experts in their own domains of exposures that dictate which models are used for diagnosis and evaluation.[13]

The development of clinical reasoning begins to take shape in clinical education that is necessary in the preparation of healthcare providers.[72] During clinical education experiences, students apply knowledge, and skills learned didactically to gain patient care experience under the supervision of a licensed professional.[73,74] The preferred model for clinical education in healthcare is preceptorship.[75-78] A preceptor is a certified and/or licensed professional who teaches and/or evaluates students in a clinical setting using an actual patient base.[21] Preceptor selection in athletic training follows a convenience model that incorporates preceptor training programs based on individual preceptor and programmatic needs.[18,19,79] Preceptors more broadly have identified a need for training to prepare them with the tools to develop students' critical thinking skills, and teaching clinical decision making.[68] However, the clinical reasoning ability of preceptors has not been investigated to understand their mastery of critical thinking skills and clinical decision making that they desire training to teach. Therefore, the purpose of this study was to explore athletic training preceptors' perceptions of their evaluation and diagnosis mental processes. The following research questions guided this investigation:

1. How do athletic training preceptors organize their thoughts while making clinical decisions during patient encounters?
2. What are the changes in preceptors' evaluation techniques based on the perceived difficulty of the case?
3. Do preceptors identify a preference in clinical reasoning models when evaluating patients?

Methods

The design of this study was modeled after the consensual qualitative research (CQR) approach. The CQR tradition focuses on the use of multiple researchers, the process of reaching a consensus, and a methodologic approach to constantly and repetitively analyze multiple cases to reach a comprehensive representation of the results.[80] We selected the CQR approach for this qualitative study to explore the perceptions of athletic training preceptors in different clinical reasoning models associated with injury and illness evaluation.

Given the consensual process of CQR, multiple researchers are essential to the construction of a solid research team. As complex issues arise within qualitative data, multiple perspectives, opinions, and levels of awareness are needed to increase the approximation of truth and simultaneously diminish researcher bias.[80] The research team for this study consisted of 4 athletic trainers: (AAA, BBB, CCC, DDD) with various levels of CQR experience. One member of the research team (DDD) also served as the internal auditor. Auditors often participate within CQR to verify the interpretations made by the research team and to provide continual appraisal during each stage of data analysis.[80] They must ensure the data were closely and appropriately analyzed and multiple perspectives were considered and discussed before consensus was reached.[80]

Participants

We aimed to solicit between 8 and 15 participants, as consistent with the CQR methodology, that self-selected their interest to participate in a qualitative study from a previous survey study to assess the clinical reasoning skills of athletic training preceptors. To reach participant numbers required for data saturation, snowball sampling, and social media solicitation were used to bolster participation in this study. The inclusion criteria for this study

required that participants were serving as preceptors to athletic training students and were licensed and/or certified athletic trainers. All self-selected participants were originally contacted requesting voluntary participation in the study; the first 10 to respond that they were willing to participate in this study were included. However, out of the 10 self-selected participants, only 9 confirmed their availability to schedule interviews. Data saturation was achieved following individual interviews with these 9 athletic training preceptors.

Instrumentation

Due to the lack of a preexisting interview protocol to address the guiding research questions of this study, the researchers developed a semi-structured interview protocol. The interview protocol consisted of 12 open-ended questions (Table 3). The interview protocol was assessed by four athletic training researchers using a 4-point Likert scale content validity index (CVI) to determine the quality of questions. The scale-level CVI for universal agreement (S-CVI/UA) is the level of agreement that the raters report a question as relevant or representative of the construct being measured.[81] There was a high level of agreement between the raters that the instrument was valid (S-CVI/UA = 88%). As part of the emergent design of this study, the interview protocol was flexible to allow for the questions to evolve throughout the study and within each interview.[80,82] The semi-structured nature permitted the principal investigator (AAA) to ask each participant probing questions during the interview to explore their responses and clarify certain points. To ensure face validity the interview protocol was pilot tested with a preceptor that met our inclusion criteria and participated in a previous study. The pilot-interview did not yield any additional changes to the instrument and was included for final analysis. The interview protocol was developed based on existing literature related to clinical reasoning in athletic training and medicine. Key areas within the interview protocol were focused on

assessment, diagnosis, treatment, and self-confidence. The gap in literature between other healthcare professions and athletic training was taken into consideration.

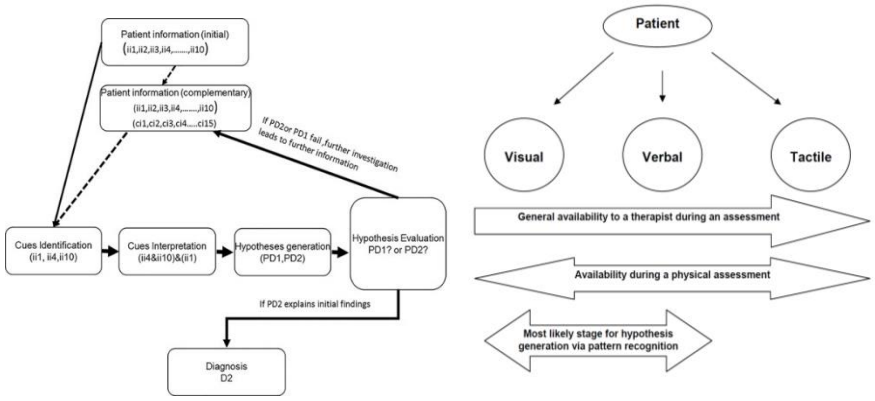
Table 3.

Semi-structured Interview Protocol

Focus of Research	Sub Focus of Research	Questions
Rudimentary Case	**High Self-Perceived Case Competence**	Please describe your thought process as you worked through a recent patient case that was easy for you to assess and diagnose? • **Probing Question:** Tell me about the aspects of that case that stood out to you. For example, this can include a set of words that the patient used or things that you noticed right away about the case based on the patient's presentation
	DDx Development	Please walk me through the process you used to develop a differential diagnosis for this case. • **Probing Question:** What were your differentials?
	Assessment	Can you describe the process of how you narrowed down the differential diagnoses to a primary diagnosis? • **Probing Question:** How did you select which evaluation skills to use for your assessment?
	Plan	How did your differential diagnoses affect your intervention plan? • **Probing Question:** Please describe how and if the treatment options you chose addressed multiple conditions associated with your differential diagnoses?
	Overall CR Self-perception	How would you rate your clinical decision-making processes in this case on a scale of 1-5? One being the worst possible and five being the best possible clinical decision-making processes. • **Probing Question:** How did you decide on this rating? If you had to use one word to describe your clinical decision making in this case, what would it be? Why?
Challenging Case	**Low Self-Perceived Case Competence**	Please describe your thought process as you worked through a recent patient case that was difficult for you to assess and diagnose? • **Probing Question:** Tell me about the aspects of that case that stood out to you. For example, this can include a set of words that the patient used or things that you noticed right away about the case based on the patient's presentation
	DDx Development	Please walk me through the process you used to develop a differential diagnosis for this case. • **Probing Question:** What were your differentials?
	Assessment	Can you describe the process of how you narrowed down the differential diagnoses to a primary diagnosis? • **Probing Question:** How did you select which evaluation skills to use for your assessment?
	Plan	How did your differential diagnoses affect your intervention plan? • **Probing Question:** Please describe how and if the treatment options you chose addressed multiple

Table 3. Continued

		conditions associated with your differential diagnoses?
	Overall CR Self-perception	How would you rate your clinical decision-making processes in this case on a scale of 1-5? One being the worst possible and five being the best possible clinical decision-making processes. • **Probing Question:** How did you decide on this rating? If you had to use one word to describe your clinical decision making in this case, what would it be? Why?
Model Selection	**Self-Perceived Preference in CR model**	*Show two models below to interviewee in alternating order between participants* **Left:** "Information is received from the initial patient encounter, particular information is identified by the clinician as a cue for a suspected diagnosis, cues are interpreted to form a hypothesis, a hypothesis is formed, evaluation skills are used to confirm the hypothesis. If the hypothesis explains the findings, then the diagnosis is confirmed, if hypotheses fail to explain the findings, then complementary information is gathered, and the process is repeated." **Right:** A clinician is presented with visual and verbal information from the patient about their chief complaint. They use this information to generate a hypothesis based on previous knowledge associated with other cases they have evaluated which is the arrow on the bottom of the diagram. Then tactile evaluative tools are selected to confirm that diagnosis which is represented in the top arrow. During the physical examination, represented by the middle arrow, more visual and verbal information is gathered to confirm the initial case pattern that the clinician is evaluating for. Which of these two models do you think you use more frequently in your evaluative process? • Why?



Procedures

Prior to data collection, the Old Dominion University human subjects review committee approved this study. The principal investigator contacted the potential participants via e-mail after individuals who met the inclusion criteria were identified. The e-mail included the purpose of the study, contact information, and a request for their voluntary participation. After the initial email solicitation, the purpose of the study, contact information, and a request for voluntary participation was posted on social media, and emailed out to clinical coordinators for all CAATE accredited professional level athletic training programs. Given the various locations and individual situations of the athletic trainers participating in this research, the primary mode of data collection was via teleconferencing. After an individual agreed to participate, an individual 30 to 45-minute interview was scheduled, and the participant completed a brief demographic questionnaire via e-mail. Participants did not receive the interview protocol in advance of their interview to limit any premeditated responses. All interviews were conducted by the principal investigator. All participants provided verbal consent to have their interview audio recorded.

Each individual interview was audio recorded via Zoom software (version 5.3.0; zoom.us, San Jose, CA). Once the interview was completed, an audio file of that interview was automatically saved to the principal investigator's Zoom cloud storage database. Each audio file was transcribed verbatim through the automatic transcription feature on Zoom and reviewed by the principal investigator for accuracy. All personal identifying information (eg, name, place of employment) was deleted from each transcript to ensure participant confidentiality. Once the de-identified transcript was completed, the audio file remained on a secure server at Old Dominion University protected with two-factor authentication and network encryption. The transcript was sent to the participant via e-mail to ensure the information was accurate through a member

check. During the member check, each participant was provided the opportunity to provide clarifications or additional information.

Data Analysis and Management

The data analysis process occurred in 4 progressive stages: (a) identifying initial code domains, (b) extracting core ideas from each domain, (c) cross-analysis of multiple participant interviews via development of categories, and (d) establishing the frequency of data presented in the determined categories. Throughout data analysis, several strategies (ie, member checks, triangulation) were used to ensure trustworthiness of the data and reduce potential researcher bias. Once 3 participants' interviews were transcribed and returned from member checks, three members of the research team (AAA, BBB, CCC) determined initial code domains. The domains were used to group data about similar topics.[80,82] Once the initial domains were deployed and agreed upon, each research team member individually coded the first transcript and placed the data in a domain as they saw fit. From there, three members of the research team (AAA, BBB, CCC) reconvened to discuss their coding decisions until a consensus was reached about the placement of the transcribed information. The internal auditor reviewed the final codebook for accuracy. Upon internal auditor approval, a consensus version of the domains was used to recode the initial transcript as well as the transcripts that followed.[80,82] The remaining six transcripts were divided amongst three research team members (AAA, BBB, CCC) to reach consensus between at least two researchers. At least two members of the research team were engaged in each phase of data analysis, and an internal auditor provided additional perspectives to confirm that multiple viewpoints were deliberated.[80] Generally, with the CQR process, it is beneficial to code the data into domains for several transcripts before progressing to the next step of the data

analysis process. Coding multiple transcripts will allow the research team to get a clearer sense of the content that will represent each domain.[80,82]

The next stage of data analysis involved constructing core ideas from the data in each domain. This process is called abstracting[83] and essentially involves summarizing what the participant has said in each domain in a more concise manner.[80,82] Each of the three team members (AAA, BBB, CCC) extracted core ideas independently, and then gathered to discuss the abstracting process until a consensus was reached.

The third stage of data analysis involved constructing cross-analyses of multiple participant interviews. Three of the research team members (AAA, BBB, CCC) looked for relationships, similarities, and differences that emerged from the interviews when they were examined together. Cross-analysis allowed the research team (AAA, BBB, CCC) to distinguish categories in which the core ideas can be placed.[80,82] Categories can be developed in 2 manners: (a) each team member independently creates categories to cluster the core ideas, and then the research team reaches a consensus on the various categories, or (b) the research team brainstorms potential categories together.[80,82] The research team (AAA, BBB, CCC) in this study developed categories by independently creating categories and then meeting to reach a consensus of the identified categories. The categories were discovered based on the data provided and were not established from the literature or preconceived ideas.[80,82] Additionally, it was important to understand that core ideas could be placed in several categories if necessary, and categories could be modified as the research team became more familiar with the data.[80,82] The internal auditor reviewed the final consensus of categories to confirm that multiple viewpoints were deliberated.[80]

The internal auditor provided continual appraisal during each stage of the data analysis to ensure reliability. The final stage of data analysis consists of frequency counting. More specifically, frequency counting allows the research team to determine how often each category is applied across the whole sample, which will therefore provide a sense of representativeness of the entire sample.[80,82] Frequency of the categories is most often broken into components: (a) general, (b) typical, (c) variant. A category is considered general if it applies to all cases, typical if it applies to as least half of the cases, and variant if it applies to less than half the cases, but minimally appear in at least 2 cases.[80,82]

Results

Four main themes, 12 categories, and 20 sub-categories emerged from the semi-structured interviews. The main themes were (1) Diagnostic Reasoning, (2) Therapeutic Reasoning, (3) Metacognition, and (4) Influences. Representative participant quotes were included for each category. Frequency counts per theme and category are displayed in Table 4.

Table 4.

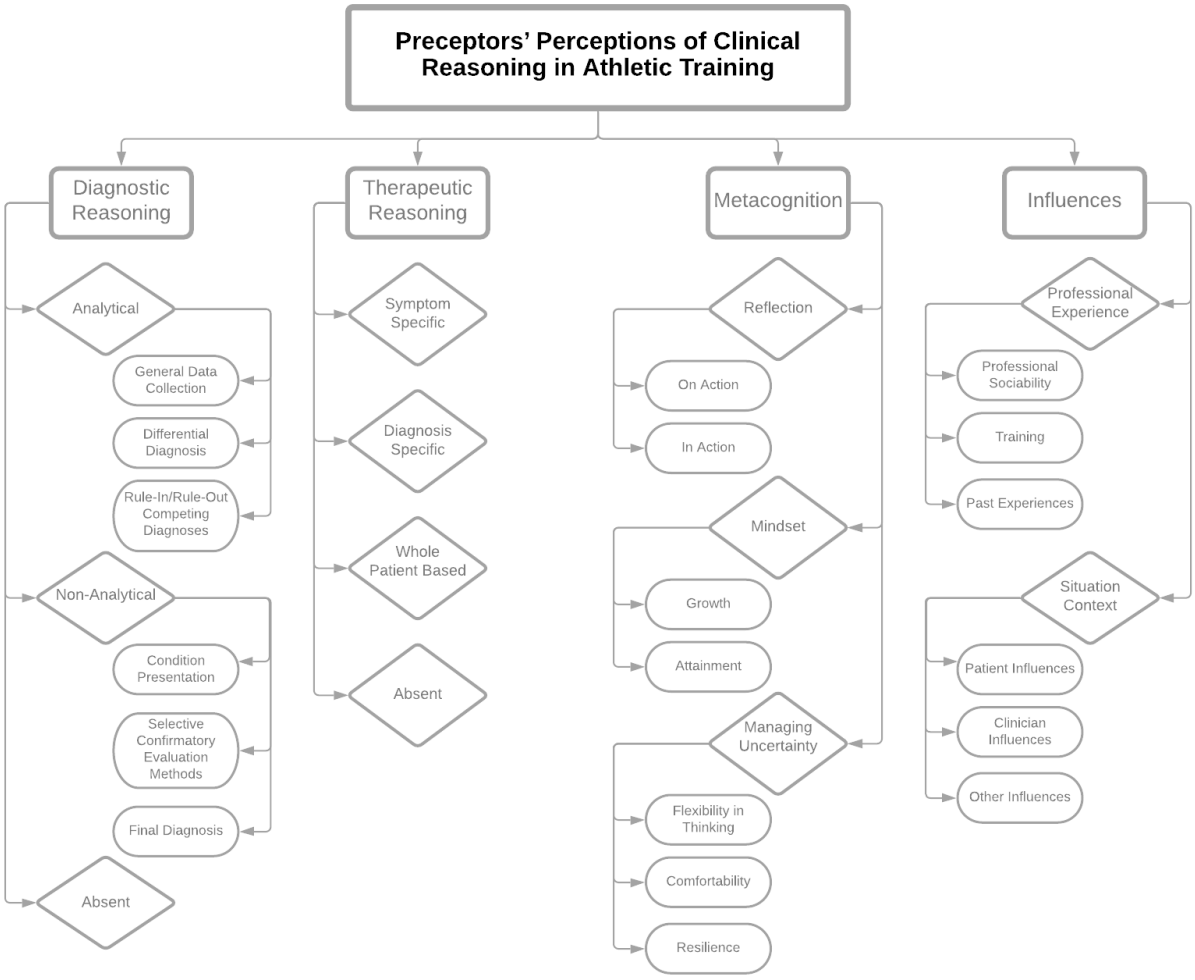
Frequency of Participant Cases per Category and Sub-Category

Theme, Category, or Sub-Category	Frequency	No. Cases per Domain
Diagnostic Reasoning		
Analytical		
General Data Collection	General	9
Differential Diagnosis	General	9
Rule In/Rule Out Competing Diagnosis	General	9
Non-Analytical		
Condition Presentation	General	9
Selective Confirmatory Evaluation Methods	Typical	8
Final Diagnosis	Typical	6
Absent	Rare	3
Therapeutic Reasoning		
Symptom Specific	Typical	8
Diagnosis Specific	General	9
Whole Patient Based	Typical	7
Absent	Variant	4
Metacognition		
Reflection		
On Action	Typical	7
In Action	General	9
Mindset		
Growth	Typical	8
Attainment	Typical	8
Managing Uncertainty		
Flexibility in Thinking	Typical	9
Comfortability	Typical	9
Resilience	Typical	6
Influences		
Professional Experience		
Professional Sociability	Typical	7
Training	Typical	7
Past Experiences	General	9
Situational Context		
Patient Influences	General	9
Clinician Influences	Typical	7
Other Influences	Typical	7

Figure 3 shows the conceptual framework resulting from the data analysis. Participants are identified with their pseudonym throughout the remainder of the results to contextualize similarities and differences in responses based on participant.

Figure 3.

Qualitative Conceptual Framework



Diagnostic Reasoning

Participants commonly identified concepts that contributed to successfully evaluating and diagnosing patients throughout the interview process. Three categories emerged from the discussion: analytical evaluation methods, non-analytical evaluation methods, and absence of an evaluation process. Within these three categories six sub-categories emerged from the discussion: general data collection, differential diagnosis, ruling-in/ruling-out competing

diagnoses, condition presentation, selective confirmatory evaluation methods, and final diagnosis. Quotes supporting each category are provided in Table 5.

Analytical Evaluation Methods

As participants described their evaluation process, the existence of an analytical process facilitated establishing a diagnosis. Especially, in cases that were perceived to be more challenging. General data collection, establishing a differential diagnosis, and ruling-in and ruling-out competing diagnoses characterized their analytical process.

General Data Collection

Participants identified that, if they were unfamiliar with a case, or it presented in a way that they did not expect they were likely to collect a lot of general information to help them develop a differential diagnosis. Participants, even when identifying a primary diagnosis, also identified a preference towards collecting additional general information to avoid missing anything. Participants also described general data collection to identify and understand contributing factors to the injury and at different segments in the system from what they had diagnosed.

Differential Diagnosis

When participants were considering different diagnoses, it was common for them to report their top potential diagnoses. Participants described using the generalized information to work backwards from to identify what conditions could explain the general data that was initially collected. Some participants also included less likely diagnoses into their differential diagnosis to avoid missing a potential issue in the area that they were evaluating. Participants described using this process to narrow down their suspicions into a few potential diagnoses that they could use their evaluative skills to determine which would become their final diagnosis.

Rule-in/Rule-out Competing Diagnoses

To reach a final diagnosis the participants reported narrowing down their differential diagnoses by ruling-in and ruling-out their competing diagnoses. Participants described using their own clinical evaluation skills to help them rule-in and rule-out potential diagnoses, but they also described using diagnostic imaging to investigate their suspicions more accurately. Participants shared an emphasis on ruling out conditions and making a diagnosis by exclusion.

Non-Analytical Evaluation Methods

Participants that described their diagnosis strategies for cases that they felt a greater mastery in the management of, called upon a non-analytical process to establish a diagnosis. Condition presentation, selective confirmatory evaluation methods, and affirming their final diagnosis characterized their non-analytical process.

Condition Presentation

Participants described a process where they identified key features that led them to select a diagnosis to streamline their evaluations. Previous experience in the management of conditions was reported as a contributing factor associated with identifying different condition presentations. Participants spoke about symptoms that specified tissue type involved in the injury, situational context that led them to suspect specific conditions, and subjective information associated with conditions they had greater familiarity with.

Selective Confirmatory Evaluation Methods

The participants that used a non-analytical evaluation method called upon specific evaluation methods to rule-in their suspected diagnosis. Participants called upon clinical prediction rules, special tests, subjective information, and their physical exam skills to confirm their suspected diagnosis. In addition to selecting the methods to rule-in the condition,

participants described a deliberate exclusion of some evaluation methods that were perceived as unnecessary. Participants felt that performing these skills would not provide any additional information that would change the final diagnosis.

Final Diagnosis

Participants articulated that once they used their confirmatory methods in their non-analytical evaluation process that they would come to a final diagnosis for the patient. Participants described being able to process the information from their evaluative measures and attributing those findings to a specific diagnosis to come to their final diagnosis. Participants described their prior experience and familiarity with the diagnosis as the mechanism to correctly attribute their evaluative findings to the proper condition.

Absence of an Evaluation Process

Some participants did not report using any method to diagnose their patients. This process of evaluation resulted in an evaluation that included a predetermined evaluation process regardless of the injury presentation, inability to reach a diagnosis, or using many evaluative measures searching for useful findings. Participants attributed their absence of an evaluative process to lack of time, knowledge, or information.

Table 5.

Results: Participant Quotes to Support the Diagnostic Reasoning Theme

Diagnostic Reasoning						
Analytical			Non-Analytical			Absent
General Data Collection	Differential Diagnosis	Rule-In/Rule-Out Competing Diagnosis	Condition Presentation	Selective Confirmatory Evaluation Methods	Final Diagnosis	
"He's conscious, I can see that by him moving his feet. One of the questions I asked him, I said, 'Do you have any numbness or tingling in your legs or arms?' He said, 'No'. I go through the whole history of what's going on. Do you have any neck pain? None. Do you have any soreness your neck? None. Try to think what else I asked them initially. No headache? No headache. Now, I think the kid is lying to me. I said, 'Nothing hurts?' He said No. I said, 'All right, can you sit?' We had to move his arms and legs. He said, 'Yep.' Then we got him off the bench, or I'm sorry. Off the ice to the bench. Then once on the bench, I do the same things. Now I know, I'm	"It's a funnel. You funneled down to it, so by the time I get to using special tests, I better have a small number of differential diagnoses. Otherwise, I'm just like, slapping people with special tests." ~Ruby	"…make sure you do all these quick joint assessments joint integrity assessments to rule out this rule out that, like I said, bony tenderness. Make sure there's no bony tenderness going on. And if I look at it as if you've ruled all these other things out then, most likely, this is what's going on." ~Chester	"I had someone come in yesterday they pulled, they strained their back. For me, it was pretty easy. Just to see where he pointed, the length and location of where the muscle was and then the actions that he did, pain on the stretch and then pain on the contraction of the muscle. It was pretty easy for me just from him telling me." ~Sophie	"The deformity was there. Just looking at it palpated for, really lightly, and then felt no need to palpate after that. Didn't even feel any reason to do any range of motion things. It's pretty evident, pretty easy to see." ~Bruce	While working track and field and diagnosing a hamstring strain, Jack reported, "…track and field athlete male sprinter was running, felt a sharp pain in the backside of his leg, and can no longer really run or walk very well…" ~Jack	I especially for like an on-field evaluation. I do like the quick, I always start with the patella because their leg is usually straight. I can rule that out pretty quickly. If it's going to hurt to like bend or straighten out their knee. I use the patella apprehension and the patella glides as a quick assessment. I usually just have like a set standard for like a quick evaluation. Then the Lachman's, anterior drawer. Then, like the MCL, LCL, posterior drawer if it's if the mechanism is there.

Table 5. Continued

sorry. On the ice. I palpated as well. There was no pain along any the cervical vertebrae. No pain along any of the landmarks, no shoulder pain on either side. Again, he denied his headache on the ice, off the ice, and on the bench…" ~ Bruce						Then if those come up with nothing. I'll then do like the meniscus. If that's not really showing anything, then I'll go to like manual muscle test to see if anything there shows up. ~Sophie
"Going through the second evaluation, or reevaluation at that point. I had to go through everything again, see what symptoms were there, see what he could actually do. It was a different approach, I had to be very thorough. I had to look over everything in terms of if he was sleeping, what was he eating, hip range of motion, abdominal feel, going over general GI and GU issues, I'm going over general range of motion, when he felt that trigger and dysfunction…He described the symptoms differently. He felt that this one was a cramp or a spasm, he told	"Differentials would have been fibular fracture. Lateral ankle sprain of any of the three lateral ligaments. Cuboid injury, either subluxation of the bone itself or damage to ligamentous structures or even a fracture there. Just to check the other cardinal points" ~Maya	"We had x-rays on the hip and lumbar spine, MRIs and arthrogram to look at the labrum, and we also had a couple DEXAs as well as part of our imaging studies for this athlete." ~Jack	"Sharp stabbing will generally be like bone or nerve, if it's shooting. Sharp pinching is almost always some kind of joint capsule. Whether it's a facet dysfunction or it's a plica. That capsule, for whatever reason, feels distinctly pinchy when it's getting irritated. He said that the location of pain, and the dorsiflexion deficit. That kind of like got me to there because there just wasn't anything else really floating to the top to kind of	"There's pretty clear evidence [Added from MC: indicative of the fracture], I mean palpating the base of the fifth is part of the Ottawa ankle rules" ~Maya	"I diagnosed a fracture, and then, obviously, our physician that was at the game did as well." ~Bruce	"I don't think I had a specific differential diagnosis at that point more-so these are the cluster of symptoms that I think could be related. Here or there or I think this is a piece that is less contributing to the issue, or this is a big factor in the symptoms that he's experiencing. I don't think I ever came to true differential diagnoses." ~Maya

Table 5. Continued

me he felt like a muscle pulled on him. I'm looking at all of these things in terms of his tone, strength, range of motion." ~Maverick			compete with it." ~Ruby			
As I evaluate further away, and my objective ideas I go to hands, and I go to shoulders, and I go to raise one shoulder versus the other shoulder. Due to again, being the handedness of the person. ~Hank	"When a kid goes into the boards like that. I'm thinking, I kind of always try to work my way back, is this a C spine injury? Paralysis? Fracture, sprain, or strain? Then again, for me, concussion? Some kind of head injury?" ~Bruce	"Joint line palpation was a big one in there. Eventually this person did some diagnostic testing was done later and x-ray and MRI are also included. Hop test. We did one of those just general stability, I think I said Lachmann's, early on." ~Hank	"I was really concerned about the heat at first because he was kind of acting like that. You look at the easiest thing first." ~Grace	"I already did posterior glide; I did mobilizations to see how the shoulder is. He's already painting a picture of pain with elevation, he can't even get into some of these positions, so there is no need to make it hurt more. Even when I'm doing external rotation passively that's already going to give him discomfort." ~Maverick	"I mean, based on that mechanism and all signs are kind of pointing to 'Yes' (it's a lateral ankle sprain), at that point." ~Ruby	"When you have that kid that's like, 'It hurts here.' I just end up doing all of them (special tests)." ~Ruby

Therapeutic Reasoning

Participants identified concepts that were specific to how they thought about and approached their treatment process throughout the semi-structured interviews. Four categories emerged from the interviews: symptom specific treatment, diagnosis specific treatment, whole patient-based treatment, and the absence of a therapeutic reasoning process. Quotes supporting each category are provided in Table 6.

Symptom Specific Treatment

Participants described providing treatment to their patients that addressed symptoms that were presented to them in their evaluations. These treatments were geared towards either increasing function, improving symptoms to progress into other therapeutic interventions, or as a means to limit further injury. Participants identified treating symptoms as a direct means to a desired outcome such as returning to play.

Diagnosis Specific Treatment

Participants shared how they addressed specific diagnoses with rehabilitation and treatment plans that were designed specifically for those injuries. Some participants described using protocols that were structured and specific to the injury they were treating. Protocols were implemented for post-surgical and common injuries that are well understood. Participants also described treating a particular diagnosis more functionally to address the stress that the injured tissue is under during the desired activity.

Whole-Patient Based Treatment

Participants described using whole-patient treatment methods as a means to treat the person from multiple aspects outside the physical manifestations of the injury they had sustained. These methods included using the biopsychosocial model where considerations in treatment were made towards team involvement and psychological challenges that may arise from the injury process. Participants described a focus on maintaining social support structures and helping to supplement social support structures as a part of their treatment plans.

Absence of a Therapeutic Reasoning Process

Participants also described situations where their treatment plans were absent a thought process towards the interventions, or absence of interventions were administered. Participants

described not treating specific injuries. Participants also shared how they did not see improvements in their patients but continued to administer treatments hoping for a positive effect. Lastly, participants described using any and all treatment methods that they had available to them in the hopes that something would work for their patient in improving their functionality and sport performance.

Table 6.

Results: Participant Quotes to Support the Therapeutic Reasoning Theme

Therapeutic Reasoning			
Symptom Specific	Diagnosis Specific	Whole Patient Based	Absent
"Some neural flossing stretching techniques that can help with like the sciatic symptoms." ~Jack	"I use the PATS protocols for hamstring stuff. So, they use a lot of glute involved in some or lateral and nonlinear motions and movements. Not just forwards and backwards planes, but some of the lateral sides that helps with some glute weakness or inefficiencies as well." ~Jack	"I'm working to address the functional deficits because no matter what the injury is I have to treat the guy; I have to treat the person." ~Maverick	"Well, we have not done the rehab. I was like, 'We'll cross that bridge if it happens.'" ~Sophie
"…We had gotten to the point where we had found a tape job that significantly decreased his pain." ~Ruby	"We did have a protocol. The protocol is really, really standardized and only in the beginning, in terms of like weight bearing status or bracing. The restrictions really start to come off and you can start to be a lot more creative around three months, but we work directly with that surgeon often so anything that we wanted to do, we could incorporate in." ~Maya	"The kid was okay with it, and he wasn't ostracized from the team. You always worry about that part too. It's that you get this new kid coming in, and we want them to play, but we're also holding them back so, then the kids are like, 'Why? What's going on with him? Why does he get this treatment?' That kind of stuff has to play into the decision of when do we hold him out. What team bonding stuff are they doing? We worked on lots of stuff with him not just cardiac." ~Grace	"I tried to combine a whole bunch of stuff I knew that he would be on the wide receivers, so I tried to work on balance with him. If he was going up for a catch like jumping up in the air, how is he going to land? He's not going to land on two feet he's going to land on one and he's probably going to get hit, so you need to have balance. Need to work on some core strength." ~Grace
"I gave him one of our stiff collared neck braces. I'm like, 'Put this on it will pry help you sleep a little bit if you're stiff' and I said, 'If it's too much in it bothers you too much, I'm okay with you taking it off, but I'd rather have you wear it if you could.' That's basically what he did. I saw him the next day, and he was still wearing it. He goes, 'Yeah, feels better being in this.'" ~Bruce	"The first part of my other rehab it was heavy hinging progression, making sure that I can educate him on hinging." ~Maverick	"Getting him involved in like injured athletes' groups. Both my coworker and I had worked at a college before and knew of groups that athletes from there that have had career ending or long injuries. We got him involved in some of those [Added from MC: groups for injured athletes] and keeping him involved with the team. There were a lot of factors in that too.	"At that point, we were just kind of holding Humpty together. We started really focusing on what's going to help him feel good during a game situation. Messing around with different tape variations to find something that was going to prevent him from getting in that position that caused him pain. He wasn't having any continual deficits, I guess

Table 6 Continued

	Keeping him from not just dealing with the knee itself but dealing with the loss of two and a half years in any sort of athletic activity in the middle of high school was tough too." ~Maya	it wasn't progressive. Although, he wasn't really seeing a lot of improvement." ~Ruby

Metacognition

Participants described their mental processes pertaining to their clinical reasoning and processing the results of their actions. Three categories emerged from the discussion: reflection, mindset, and managing uncertainty. Several sub-categories emerged within these three categories: Reflection on action, reflection in action, growth mindset, attainment mindset, flexibility in thinking, comfortability, and resilience. Quotes supporting each category are provided in Table 7.

Reflection

Participants described an internal thought process both within the moment of the management of the case, and after the management of the case. These thought processes were expressed after the fact on actions that the participants took and expressed from within the moment that the actions were taking place. They are articulated as reflections on action and in action.

Reflection On Action

Participants described reflecting on patient cases in the past in various ways. Some participants described aspects of their case management that they could have improved upon, some described justifications for case outcomes, and others reflected on their level of perceived difficulty when managing a case. Participants tended to focus on negative aspects of their case

management and areas for improvement. Reflecting on action was perceived as an exercise in becoming a better clinician and learning from previous experiences.

Reflection In Action

Participants described reflecting on immediate feedback in their case management to help dictate how they would proceed. Participants described self-talk that provided a sense of perceived competence with cases where they would actively consider the information to separate aspects of the case presentation that they understood from aspects they did not. Participants shared how they reflect on evaluative findings when they do not match their expected findings and persistence of features that do not fit with their primary differential diagnosis. Lastly, participants spoke about how they reflect on evaluative findings to help determine what therapeutic interventions to administer.

Mindset

Participants described their clinical reasoning approaches from a perspective of learning and developing as clinicians from their experiences or transitioning their reasoning processes towards outcomes. These two concepts were expressed in either a growth or attainment mindset.

Growth Mindset

Participants described their role as a preceptor as a mechanism for growth and a growth mindset. There was an emphasis on becoming better clinicians, better preceptors, and learning from mistakes in the past. Participants recalled replaying the events of their experiences and critiquing their own performance to think about how they could improve their patient care. Positive or negative outcomes were not described as considerations when participants spoke about learning from their experiences. Lastly, participants emphasized the role of clinical

experience on their growth as a clinician where they hoped to learn and improve from each of their encounters.

Attainment Mindset

Participants described how they felt about their clinical reasoning based on the outcomes that followed their decisions. Participants spoke about evaluation skills and their perception that the success of their patient was a direct result of their own performance. Other participants described a return to participation as the only outcome that mattered from their interactions with their patients. Lastly, participants expressed frustration with an inability to resolve the patients' complaint. These participants felt that the irresolution or lagging of a patient case was attributed to their abilities as a clinician.

Managing Uncertainty

Throughout the evaluation and treatment process, participants described how they managed situations that they were unsure of. These discussions gave rise to strategies to manage uncertainty that included flexibility in thinking, comfortability, and resilience. Participants described changing their mental approach, how comfortable they were with the decisions they were making based on the information they had, and how they actively confronted and worked through their uncertainty.

Flexibility in Thinking

Participants described choosing the mode that they would evaluate their patients with based on the situation and their familiarity with the case. Participants spoke about how they would use a non-analytical process initially and then incorporate an analytical process as way to prevent errors. Even though the participants were almost certain of the diagnosis they would change modes to prevent themselves from missing another potential diagnosis. Participants

described how additional information would change their mode of evaluation. Lastly, participants shared how different modes of evaluation change with experience and that, in their role as a preceptor, they notice the difference between students and experienced clinicians. They described an emphasis on simultaneous evaluation methods that are adapting to the scenario as it unfolds.

Comfortability

Participants described how they would justify their clinical reasoning decisions or be able to manage uncomfortable clinical scenarios that arose due to the uncertainty of the diagnosis or management of the condition. Participants described being uncertain of a diagnosis but feeling comfortable with the athlete participating if they could functionally meet the demands of their activities. Other participants described low levels of comfortability with management of cases that they believe they lacked training in. Lastly, participants described being comfortable with misdiagnoses and poor outcomes if they did their due diligence to refer patients to their supervising physician.

Resilience

When confronted with challenges, participants described how they overcame them. Participants described overcoming knowledge deficits that impacted their confidence with their evaluations by seeking external educational resources. Participants also shared that they overcame uncertainty by using a focused approach where they reflected on the case presentation to deduce the most likely diagnosis. Participants shared how they overcame uncertainty in their final diagnosis by incorporating a rehabilitation plan that would address multiple different suspected diagnoses.

Table 7.

Results: Participant Quotes to Support the Metacognition Theme

Metacognition						
Reflection		Mindset		Managing Uncertainty		
On Action	In Action	Growth	Attainment	Flexibility in Thinking	Comfortability	Resilience
"I didn't see that one, but I'm like, well, she also went to the doctor, and he didn't catch it either. We'll we got her through her senior year." ~Sophie	"…in the moment. I'm thinking to myself, what in the world is going on with this kid and the fact that I wasn't able to have a true understanding of exactly what was going on…" ~Chester	"I think I've been in situations in the past, especially as a young clinician where I took care of a situation, the outcome ended up positive. But then, it's kind of like self-teaching and going back. You think, 'How could I have approached this differently?' And you think, like, 'Oh, I did this and thankfully, nothing happened. But, let's not do this, the next time around type deal.' I think you really have to look at both approaches, because you could be almost naive to how you approach the situation at the end of the day, the	"When you do a history, whether it's on the ice or off the ice is to do a thorough history and it's all about asking the right question. You know, my mistake, if you want to call it that, was, this kid who had the fracture." ~Bruce	"It's like that's what I see is kind of like what we teach them in this stepwise progression of try this, listen to these things, do this, that didn't work, go back, find the thing. Do it again. Get to an answer and then it's like, once they figured that out, they jump over here, but I think the model on the right [Knowledge Based Model of Evaluation] is functionally how people actually evaluate. Once you've been doing it and you kind of have the foundation in, 'This is what an eval looks like', it's a little more organic, is a good way to put it. Things are happening simultaneously" ~Ruby	"She said it still felt a little weird but I'm like, 'As long as you protect yourself and do everything without issue, I'll let you go back in.'" ~Sophie	"It's a situation where you might not understand what's going on but not trying to get too out of the box, reflect on what's exactly in front of you, and try to use that information that's there." ~Chester

Table 7. Continued

		kid was fine. Nothing happened. But maybe you just got lucky. And if you're not doing that self-reflection and you're not saying, 'Hey! What did I do wrong here? What could I have done better? Should I have checked this before I did that? Could I have missed something?' I think that's important for everyone because if you're not going through your mind and you're not working through the scenario again or a couple times after it's happened. I don't think that helps you in the long run…" ~Chester				
"Probably, legitimately my most challenging case ever in the eleven years of me doing this." ~Jack	"I'm thinking the same thing. Like, man, he really got wrenched. We now had video of the of the hit and looking at it,	"I mean there's always improvement, and then obviously, if I have another dislocation hopefully	"I couldn't fix it and it was really bothering me because I've had like four or five cases of anterior impingemen	"I know that 'Okay, this is what I'm pretty sure I'm pretty much thinking this is.' 99% it's going to be this, but I need to know a little bit more about	"That's one of those things that I think that as an athletic trainer I wasn't taught about that. That's not something that's in your wheelhouse.	"I did use all the resources that I had and all the evidence from the patient themselves and then

Table 7. Continued

	like, Man, oof, I said 'you're, so NOTHING, really?' I just wanted to cross the fracture part off my list or something weird that I'm missing. Like, 'hey, is there something in there or not?'" ~Bruce	not this kid. Would I treat them differently?" ~Grace	t and it's a long process, but we get them there. This kid just wasn't getting there." ~Ruby	the kid. What's their health history, what else has happened to them, have they hurt themselves doing something else?" ~Grace	It's something that's totally out of the realm and it makes you feel uncomfortable." ~Grace	global evidence about pathologies related to that type of knee injury." ~Maya
"I didn't do imaging. I didn't get a diagnostic ultrasound which would be really nice to have here. Be super helpful with a lot of things, explaining things to people and all that. I don't know actually what's going on with the tissue. I didn't get far enough away, probably, into regional interdependenc y approaches to like I said I probably should have done a little bit more with shoulder. Looking back at it now I should have made more of a plan that actually helps this guy get	"Even then, I'm making sure I'm ruling out other pathologies like impingement or secondary issues going on. There's going to be inflammatio n and swelling, inhibition. So, I'm making sure that I'm avoiding frozen shoulder. I need to see how he's moving and how he's able to tolerate the movement. I'm also cognizant of the emotional and mental health aspect associated with injury because it	"I considered being a preceptor and the opportunities that I have to help make sense of what I'm doing to someone else an opportunity to improve the care for a patient but also just to improve on how I am providing care so that I can explain, I can understand, what I'm doing. Then, hopefully I can share and let somebody else understand what I'm doing. That's a pretty good opportunity. " ~Hank	"Maybe it's only a day or two off, if that, taping as needed. And that's a big thing for me is trying to get them to get back to participatio n without the need of taping I refer to that as like putting a Band-Aid over the true problem." ~Chester	"Initially were just kind of working through that and then when the anorexia history came out, we had to go another route. We started looking more into bone density, mass, all that. From there, as we got imaging, and we're going through that, we found nothing in the hip. We decided to start looking up and down the kinetic chain to see if there was something that was causing the referred pain." ~Jack	"I also sent her to the doctor. Then the doctor diagnosed it the same, so I'm like, 'Well, she went and saw the doctor.'" ~Sophie	"These are all aspects that I'm going to be hitting through my rehab and that may include an impingemen t labral pathology. I'm going to be addressing all of the potential diagnoses." ~Maverick

Table 7. Continued

better overall and not just beat things with hammers." ~Hank	can be pretty traumatizing. I'm making sure that I'm checking these boxes for range of motion, strength to rule out these other pathologies. Based on your overall evaluation and the questions like you're asking in terms of the symptoms and how he's feeling after the subluxation." ~Maverick

Influences

Participants described different influences that impacted their clinical reasoning decisions and abilities. The two categories that emerged from discussion were professional experiences and situational context. Quotes supporting each category are provided in Table 8.

Professional Experiences

Participants described how their different professional experiences impacted their clinical decision making. The participants specifically spoke about their interactions with other providers, their education and training, and how previous clinical experience impacted their decisions in the moments they described. They also provided contextual information from the patient, themselves, and general contextual information that affected their decision making. The subcategories that emerged in these interviews were professional sociability, training, past experiences, patient influences, clinician influences, and other influences.

Professional Sociability

Participants described professional sociability from varying perspectives. Some participants described being an advocate for their patients to ensure that clinically relevant information was received by other providers. Participants spoke on their reflection and mentorship relationships with other healthcare providers. They described learning different evaluation techniques and learning from clinical experiences through debriefs. Lastly, participants described real-time communication with other healthcare providers to facilitate proper management of preexisting conditions.

Training

Participants shared how their training in diagnostics dictated their choice in evaluative tools. Participants cited research articles for their perceived quality of the diagnostic tests that they used, and they spoke about how continuing education was incorporated into their clinical practice. Participants described how their formal training and schooling provided them with the tools to determine how to, and which tools to select for their evaluative measures.

Past Experiences

Participants shared how the volume of injuries that they manage impacts their approach to similar cases. They spoke about their confidence and ability to quickly recognize and develop a differential diagnosis for those cases that they have a lot of experience with. Participants described how negative previous experiences were contributing factors to their approach to current cases. Participants described being thorough in their evaluations to prevent missing a diagnosis that could result in negative professional consequences. Lastly, participants shared how the outcomes of previous cases effected their mindset when evaluating similar cases.

Situational Context

Contextual influences were described by the participants as influencing factors associated with their clinical reasoning choices. Influences that emerged in the discussion were associated with patients, clinicians, and other influences.

Patient Influences

Participants described patient influences that impacted their clinical decision making. Participants described patient non-compliance as an influencing factor on their therapeutic reasoning. Participants shared instances that miscommunication influenced therapeutic reasoning where patients became aggressive towards the clinicians when they felt that their expectations were not being met. Lastly, participants described instances where guardians of adolescent patients requested evaluation methods and specific treatments. Some participants described how these patient influences took an emotional toll on them.

Clinician Influences

Participants described how their perception of legal action influenced their clinical reasoning. Participants emphasized expanding the scope of their evaluation to avoid missing a potential diagnosis that could lead to legal action against them. Participants also spoke about making referrals as a mechanism to avoid legal action when managing a challenging case. Lastly, participants described a more conservative approach to evaluation and management when confronted with a case that they perceived to be unfamiliar with.

Other Influences

Participants described how the patient care environment, which included factors outside of their control such as finances, resources, time, and environmental considerations, contributed to the management of their patients. Participants shared how COVID-19 has influenced how they

interact with patients to manage injuries in a telehealth format. In addition to the pandemic, participants described limited resources as an influence that they took into consideration in their clinical decision making. Some participants described improvising to create evaluative tools for gait analysis while others described an inability to perform certain special tests because of a lack of physical space.

Table 8.

Results: Participant Quotes to Support the Influences Theme

Influences					
Professional Experiences			Situational Context		
Professional Sociability	Training	Past Experiences	Patient Influences	Clinician Influences	Other Influences
"When I went to the appointment with him the doctor was saying, 'You know, that could be a situation. Why don't we get him tested for sickle cell?'" ~Chester	"I know tuning forks are not very sensitive, but they are pretty specific; and from my experience they are even more specific in pediatric patients and on smaller fractures or joints [fingers, avulsion fractures, etc.]" ~Maya	"I see shoulders every day, and the amount of shoulder subluxations and dislocations that I've seen it's a lot. I will already know what it looks like after somebody does that. It sucks. So, I already have a good idea about what that athlete's going to look like in their presentation. This experience allows me to put them in a category where I know what they're going to look like right after their injured, one week out, two weeks out, and so on. I know what they're gonna look like whether it was a complete dislocation, a subluxation or just an injury to that shoulder." ~Maverick	"Non-compliance is an issue with this athlete. Also, the fact that their later, as we're working on this, history of anorexia comes out. As well as low bone density." ~Jack	"I always say it's like, 'Make sure we don't get sued.' But that's not what I actually mean. I mean, just make sure you're not missing a really important or potentially dangerous pathology." ~Maya	"COVID happened. Everybody got sent home and we've been trying to tele-health it with our physicians and with some other specialists as well." ~Jack
"I only found out about this question later on from the neurologist that he saw asked him, 'Did you ever have any numbness or tingling since the injury?' And he said, 'Well, yeah. As soon as it happened. I had numbness and tingling that went down my arm 'til	"I feel pretty good about how Thessaly's is graded. Specificity and sensitivity kind of standpoint." ~Hank	"We just had someone else who tore their ACL. Not at work but brought this in and presented it to me and I did not go to an ACL as quickly as I should have, in that one. I carried that into this case." ~Hank	"…This kid as an expectation of treatment and he has other people coming into play like his dad that is telling him what he should be doing and what he should be getting. All of these are variables that are impacting his expectation for the treatment paradigm." ~Maverick	"I decided I needed to refer it after the first two weeks when we're having some non-compliance issues. Getting the team physician involved just to help document, CYA policies." ~Jack	"Did not do McMurry's, because I didn't have a table like that." ~Hank

Table 8 Continued

Bruce got there.'" ~Bruce					
"I called his pediatrician and let pediatrician know what I found this is what I found before you cleared him. This is what I'm finding now. I know that we're working hard today but it's really not that hot outside, and this is what's going on. The pediatrician is like, 'That's fine. Maybe we'll get him to see a pediatric cardiologist.'" ~Grace	"I worked my previous two years with an orthopedic surgeon who specializes in, he usually does like High School and athletes, knee surgeries. Plicha and ACL. We went to a symposium, and he was telling us the research that the three main injuries that happen to minors' knees in sports are those three. He said patella subluxation and dislocation actually being number one from their research as orthopedics, so that's very interesting. He told me, keep it in the back of my brain. If someone hears a pop in their knee, and he's like, it's not always ACL. He's like, these are the other two to think of." ~Sophie	"I do make sure because I, when I first started early on my career, I was burned a couple times by doing one of those quick assessment evaluations that this is the case. I really do make sure that I've covered my bases." ~Chester	"He and his guardian read it [the clearance note] as cleared to participate in the game. …They were extremely upset with me. They said, well, 'Why did you even rush us to get to this doctor and get us evaluated if you're not gonna allow him to play.' This and that. So, that was a rough day, rough night with the student athlete and the guardian. But eventually, they kind of got over it and we went through the proper progressions." ~Chester	"I restricted him more, because I did not feel comfortable, even though I didn't do the procedure. He understood and I felt like I could be quite honest with the kid and I'm like, 'Look I've never dealt with this before. You're my first but I need to make sure that you end up out of here and I want it to be in four years and not 20 minutes from now.'" ~Grace	"I don't have pressure plates, it would be wonderful, but in the high school that's never going to happen. I make his feet wet, and I make him walk on some rubber mats in our weight room because I want to see if it really is a structural problem." ~Grace

Model Selection

Interestingly, when presented with the HDR and KBM models and asked to indicate their preference towards which model they use in clinical practice, the participants were evenly split between the two models with four preceptors preferring HDR and four preceptors preferring KBM. One preceptor indicated a preference towards the flexibility in thinking approach and described clinical scenarios that would indicate the use of both models using HDR to prevent

overlooking conditions that may not have been evaluated for using KBM. There was no demographic data that could be linked to a preference in model usage.

Discussion

Diagnostic Reasoning

We examined preceptors aligned with professional athletic training programs because of their role in socializing and familiarizing athletic training students into their future professional roles through clinical experiences.[63,84] The perceived level of CR and factors associated with clinical decision making was examined from the preceptor perspective. This evidence suggests that preceptors believe that CR is a dual processing construct where they choose between a non-analytical and analytical approach based on contextual and situational factors.

The non-analytical and analytical approach fit the two primary types of CR in the medical education research; KBM CR and HDR, respectively.[55] Preceptors shared their experiences using KBM in self-perceived easier cases that they felt they understood better and had more experience with. However, participants spoke about how they may initially use a KBM approach and then change to an HDR approach if their initial suspicions were not confirmed by their evaluations. What preceptors were describing is dual-process theory where clinicians vacillate between KBM and HDR methods of evaluation.[11,85] The participants showcased a practical application of flexibility in thinking which is a key component of CR.[4,10] Preceptors described a preference towards HDR approaches for cases that were novel and perceived as more difficult. The information gathering associated with this evaluation process gave preceptors the ability to use external educational sources such as publications and specialist referrals to diagnose and manage these cases more accurately. Again, these perceptions and accounts reinforce the idea that CR is a dual processing construct balancing non-analytical and analytical approaches that reflect the

reality of the complexity of clinical decision making.[86] Reinforcement of a dual processing construct may help educators link KBM and HDR to break down preceptors' and students' perception that CR is a dichotomy. Breaking down the dichotomy of clinical reasoning may improve metacognition so that clinicians can determine which mode of CR will be most advantageous to their current clinical scenario.[11]

Preceptor confidence and perceived diagnostic accuracy dictated how they treated their patients. If they felt that they were experienced and were able to eliminate diagnostic uncertainty they would describe being more aggressive and creative with treatment protocols. However, if they perceived themselves to be a novice, they would rely on treatment guidelines from referrals, and even be increasingly cautious with the management plan. This finding is consistent with the literature that has shown that clinical uncertainty can have negative effects on patients.[87] Patients interpret their healthcare experience based on clinician confidence and bedside manner which has been found to enhance a clinicians self-perceived competence.[88,89] Our findings suggest that preceptors flow between their diagnostic reasoning patterns and are constantly assessing situational factors and self-confidence to appraise the accuracy of their final diagnosis, risk of their treatment plans and success of their patient interactions.

Preceptors in Clinical Education

The role of a preceptor in athletic training is to supervise athletic training students in the role of a mentor. This assertion can be supported by the 2020 Commission on Accreditation of Athletic Training Education (CAATE) standards as stated in Standard 40.2. The definition of supervision, provided by the CAATE as "occurring along a developmental continuum that allows a student to move from interdependence to independence…"[20(p21)] supports the vital role

of the preceptor as the gatekeeper from dependence to independence. Therefore, the findings of this study should be considered through the lens of student impact.

Mentors are central to student clinicians' ability to improve CR through constructive feedback.[4] Mentorship within athletic training professional education is provided by preceptors who function to supervise, instruct, and mentor students during clinical education in accordance with the program's policies and procedures.[20(p33)] Preceptors in our study spoke about how they work with students and how their CR processes are explained as learning opportunities. Preceptors should be approachable, open, and take time to actively instruct their students on CR as its occurring, when appropriate, and after the fact when not appropriate.[18]

Preceptors explained processes of metacognition for growth and development of their clinical skills. Metacognition took place both in the moment of the clinical scenario and when reflecting on previous scenarios. These findings are consistent with the literature further supporting metacognition as a means of self-regulation to know when, why, and how to apply different cognitive strategies to solve different types of problems.[90] Self-regulation is a skill that preceptors may develop to improve their CR and model self-regulation behavior for students.[90,91] Preceptors mentor students through healthcare delivery experiences, and the reality of clinical practice, establishing a connection between didactic material and the real world demands of clinical practice.[92-95] Self-reflecting on previous clinical cases has been found to be a way in which a clinician can enhance their clinical skills and self-learning.[96] Therefore, preceptors self-perceived proficiency should be considered when aligning students with their clinical sites based on programmatic milestones and individual student competency.

Athletic training education programs should give preceptors tools to foster metacognitive skills to include into their clinical practice and preceptorship. Some tools may include a pathway

to mentorship or professional socialization, targeted CR preceptor training, and administrative support new preceptors. Preceptors can deploy these tools to educate students on how they are thinking, how they consider past experiences, and how they arrive at their final diagnosis through a dynamic approach to their patient interactions. Therefore, metacognitive self-awareness will help guide preceptors to accelerate student development in practical application of diagnostic reasoning.

Situational Factors Associated with Clinical Decision Making

Preceptors often described how their training and clinical experiences were called upon and referenced for how to handle their clinical decision-making processes. These findings are consistent with structure of memory, a key component of CR, which is a stored and organized accumulation of knowledge from reflective experiences.[10] Preceptors reported their annual preceptor training mandated by the CAATE accreditation standards[20] as being administered in an online or in-person format. Preceptors recalled instances from their own clinical education that influenced their current practice including evaluation methods, and condition specific symptoms. These findings indicate that preceptor training and clinical education have a trickle-down effect by influencing how preceptors practice alongside students.

Preceptors reported many influences on their CR processes. Patients, parents, and coaches were identified as key stakeholders that were regularly involved in management of the patient. Preceptors shared how the presence and actions of these stakeholders influenced their management of their patient. Preceptors reported being more conservative and thorough in their processes when considering fear of litigation even if they felt confident in their initial findings. However, fear of litigation may be supported by parents' lacking appropriate knowledge of athletic training scope of practice.[97] Also, parents' lack of knowledge was supported by

preceptors who spoke about how parents were dissatisfied with clinical uncertainty and return to play decisions. However, a mitigating factor that preceptors in this study spoke about were positive relationships with external support systems such as coaches and supervising physicians. Positive relationships, communication, and clear rationale for clinical decisions were found to be mitigating factors of the negative effects of professional pressures that preceptors in this study confirmed.[98] Preceptors should look to strengthen relationships with key stakeholders to build a support network that compliments the evaluation and diagnosis process. In addition, athletic training education programs could look to include soft skill development, such as effective communication, conflict resolution, adaptability, and problem-solving, into preceptor training programs. Soft skill development would improve the clinical decision-making process and could positively impact students who rely on preceptor communication to learn.

Preceptors also spoke about external influences outside of their control. Resources for evaluation and rehabilitation space, funds for purchasing equipment, and human resources to complement their medical team were part of the preceptor experience. Access to resources has been identified as a potential barrier to athletic training practice based on financial resources and clinical setting.[99] However, some preceptors shared their experiences with their directing physicians and access to rapid consultation as positively complementing their clinical decision making. Access to collaborative practice may increase the diagnostic accuracy of athletic training evaluations when combined with physician direction.[100] Professional socialization for preceptors typically focuses on instruction and the educators perspective, however, mentorship and clinical professional socialization may lead to improved preceptor CR.[63,101] Incorporating soft skill development and fostering positive professional sociability opportunities may help preceptors create real world learning opportunities for their students. Learning opportunities may

help students navigate conversations with stakeholders, mentors, other clinicians, and create a culture of continued clinical improvement.

Limitations and Future Research

During the interviews, we assumed that participants were truthful in their answers to the interview questions, but the study's self-reported nature could be a limitation. Participants were asked to describe previous experiences that could have led to recall bias. Lastly, recruiting preceptors to participate in a 1-hour interview proved challenging and may have resulted in a self-selection bias. Future research should investigate practicing clinicians who are not preceptors and investigate professional socialization. Professional socialization has been found to increase clinical reasoning and was described as having a mitigating effect on negative influences in the CR process within our study.

Conclusions

Our study’s findings highlight the complexities and nuance of clinical decision making. When clinical cases aligned with clinical experience, in a confident clinician, non-analytical diagnostic approaches were preferred. However, more complex cases or those that preceptors were not confident evaluating resulting in the application of an analytical approach. Most times preceptors used a combination of the two approaches based on situational context and metacognitive processing. Preceptors should foster a culture of self-reflection on clinical experiences and incorporate those practices into learning activities with students. Athletic training programs should leverage preceptor training opportunities to help educate preceptors on CR and tools to deliberately improve students’ CR.

CHAPTER V

CONCLUSIONS

The overall purpose of this dissertation was to better understand clinical reasoning (CR) assessment and to explore factors associated with the clinical decision-making process in athletic training. The overall purpose of this dissertation was accomplished through a series of three studies. The first study was a systematic review to assess the evaluation of CR and the use of the diagnostic thinking inventory (DTI) in healthcare. The DTI is used to assess CR in medicine, physiotherapy, athletic training, and has maintained acceptable psychometrics in each iteration and in different languages. The second study evaluated diagnostic reasoning in athletic training preceptors using the diagnostic thinking inventory for athletic trainers (DTI-AT). Athletic training preceptors were found to score higher on the DTI-AT if they had higher levels of professional socialization, and lower levels of professional strain. The third study investigated the beliefs and perceptions of athletic training preceptors on their clinical decision-making process. Preceptors described their clinical decision-making process as a dynamic internal mental process that evolves over the course of the clinical case and is subject to both internal and external influences.

This dissertation was the first to investigate the DTI interprofessionally, CR objectively within athletic training preceptors, and glean preceptors' perceptions of CR. Previous literature has focused on CR in professional education within mostly student populations. However, preceptors serve as the clinical link from didactic educational content to clinical practice. Preceptors mentor and develop students into practicing clinicians and do so from their own clinical practice and skillset. Therefore, the focus on preceptors in this dissertation is a logical next step in understanding CR in the athletic training profession.

The second study in this dissertation applied The Longitudinal Framework for Fostering Critical Thinking and Diagnostic Reasoning[13] to athletic training practice. The theory serves to explain how CR is developed from student, to novice, and to experienced clinicians. The model focuses on didactic concepts, applying them to clinical experiences, and after three years of focused clinical experience clinicians exhibit high levels of CR. However, this model did not hold up when applied to athletic training. Experience did not influence scores on the DTI-AT in the study sample. Experience included years as a certified athletic trainer and years as a preceptor. Professional sociability was defined as the number of contacts with other healthcare professionals on a weekly basis. Professional sociability was the only factor that was correlated to scores on the DTI-AT. Preceptors who had higher levels of professional sociability scored higher on the DTI-AT. Future research should focus on exploring additional factors that may prove to influence CR in athletic training practice.

This dissertation highlighted how athletic training compares to other professions in terms of CR. The findings of the systematic review showed that athletic trainers scored lower on the DTI instrument than their counterparts in medicine and physiotherapy. However, the athletic training sample size was very small. Of the 3354 total participants to be assessed using the DTI, 51 were athletic trainers or athletic training students. The second study found that athletic training preceptors scored higher, on average, than their counterparts in medicine and physiotherapy with an average DTI-AT score of 186 (n=38).

Historically, CR is thought to be naturally developed over time based on clinical experiences. Clinicians start as hypothetico-deductive reasoners (HDR) and transition towards knowledge-based model (KBM) clinical reasoners. The HDR model is characterized by generating a hypothesis and testing that hypothesis until the assessment findings are explained by

a clinicians' hypothesis of the condition presented. The KBM of CR is characterized by an experienced clinician recognizing key features of a specific diagnosis and then using their assessment methods to confirm that diagnosis in a streamlined and direct diagnostic approach. Project three was aimed towards discovering the beliefs and perceptions of CR by athletic training preceptors in difficult and easy cases.

Preceptors consistently shared that they transition between the two established models of CR based upon their unique circumstances. They identified internal and external factors that influenced their evaluative decisions, and deployed mitigating methods to maneuver through their evaluations. Preceptors spoke about previous experiences playing a role in how they assess patients and how they have grown over time as a clinician. In easy cases preceptors were more likely to use a non-analytical KBM approach to diagnosis, and in difficult cases they applied a more analytical, HDR approach. They described, even when using a KBM approach, still using elements of HDR to avoid negative outcomes associated with missing a potential diagnosis. Preceptors shared how they managed uncertainty using their mental thought processes to mitigate external factors influencing their decisions. The nature of athletic trainers' frequent interactions within their prospective patient population serves as a unique variable that is incorporated into the evaluation and management of their patients. Athletic trainers build personal relationships with and know their patients when they are healthy prior to injury. Unique factors of athletic training practice may explain the discrepancy in previously established findings associated with clinical reasoning development.

Future research should investigate practicing clinicians and educators using the DTI-AT to assess key components in athletic training education and practice. Situational context should be further investigated to determine its impact on CR for athletic trainers who practice under

unique circumstances with many stakeholders present throughout the evaluation and management process. The intersection of evidence-based practice and patient desires should be investigated to determine their impact on which model of CR an athletic trainer may use. Lastly, further investigation into the CR abilities of autonomous practicing clinicians may explain demographical differences between the findings of this dissertation and the literature in other professions.

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Doctor of Philosophy	**Old Dominion University,** Norfolk, VA Major Area: Health Services Research Dissertation: *The Assessment of Clinical Reasoning in Preceptors Across the Athletic Training Profession*	August 2021
Master of Science	**A.T. Still University,** Mesa, AZ Major Area: Athletic Training Thesis: *Athletic Trainers' Perceived Challenges Toward Comprehensive Concussion Management in the Secondary School Setting*	June 2016
Bachelor of Science	**Ithaca College,** Ithaca, NY Major Area: Athletic Training Minor Area: Sport and Exercise Psychology	May 2014

Publications

Welch Bacon CE, **Cohen GW**, Kay MC, Tierney DK, Valovich McLeod TC. Athletic trainers' perceived challenges toward comprehensive concussion management in the secondary school setting. *Int J Athl Ther Train*. 2018; 23(1):33-41.

Professional Presentations

Cohen GW, Nelson E, Wathen HM, Welch Bacon CE, Cavallario JM. *Educator and Preceptor Roles in Athletic Training Student Development.* National Athletic Trainers' Association Virtual Meeting Free Communications. 2020. Peer Reviewed Poster Presentation

Cohen GW, Medina R, Hoffman E, Paladin S, Clines S, Welch Bacon CE, Eberman LE, Cavallario J, Van Lunen BL. *The Role of Academic Debt and Benefits to the Profession on the Interest of Professional Post-Baccalaureate Athletic Training Students' in a Doctor of Athletic Training Degree.* National Athletic Trainers' Association Meeting Free Communications. Las Vegas, NV, 2019. Peer Reviewed Oral Presentation