Clinical reasoning in osteopathy – An investigation of diagnostic hypothesis generation for patients with acute low back pain

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Declaration

Name of candidate: Simon Ashley Roots

This Thesis/Dissertation/Research Project entitled 'Clinical reasoning in osteopathy – An investigation of diagnostic hypothesis generation for patients with acute low back pain' is submitted in partial fulfilment for the requirements for the Unitec degree of Master of Osteopathy

Candidate's declaration:

I confirm that:

- This Thesis Project represents my own work;
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.
  Research Ethics Committee Approval Number: 2013-1028

Candidate Signature: ……Date: ……

Student number: 1347402

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Preface

Clinical reasoning in the health professions has evolved significantly since the seminal works in medicine by Elstein, Shulman, and Sprafka (1978). Although researchers in the medical profession were the key instigators of clinical reasoning research, allied health professions such as nursing, occupational therapy and physiotherapy have also contributed significantly to the current understanding of clinical reasoning (Higgs, Jones, Loftus, & Christensen, 2008). The knowledge derived from research in each of these professions has altered the way clinical reasoning is understood both in totality, and with respect to each respective healthcare profession. One particular area of research interest is the utilisation of clinical reasoning strategies, which may refer to the methods, approaches, structures and organisations selected to guide the process of clinical reasoning (Fleming, 1991). Clinical reasoning strategies have been well established in the aforementioned professions of medicine, nursing, occupational therapy and physiotherapy. In contrast, clinical reasoning in osteopathy has not seen a wealth of research. Whilst clinical reasoning can be pragmatically acknowledged as an inherent component to any health professional's decision making, there still largely remains an 'unknown' or 'presumptive' label of why, when, what or how osteopaths clinically reason. Researchers have advocated the importance of characterising the clinical reasoning of osteopaths, noting that the credibility of osteopathy may be challenged without a research developed 'bridge' between knowledge and practice (Thomson, Petty, & Moore, 2011).

The aim of this study was to investigate the processes of clinical reasoning utilised by osteopaths in the diagnostic hypothesis generation for patients with acute low back pain. Exploring the nature of diagnostic hypothesis generation was carried out due to its relative importance in the process of clinical reasoning. Diagnostic reasoning is well-established in healthcare (Higgs et al., 2008) and is the way in which health professionals reach diagnoses. As diagnostic reasoning is a somewhat 'generic' approach to clinical reasoning, the researcher determined that investigating these processes that lead to a diagnosis, or diagnostic hypothesis generation, would be beneficial to further develop the preliminary understanding of clinical reasoning in osteopathy. Furthermore, low back pain was chosen as a reference point to assess clinical reasoning as it is the most common complaint seen by manual healthcare professionals in New Zealand (Scarrott, 2009).

This thesis is arranged into four sections. Section 1 is a review of the literature regarding clinical reasoning in the health professions, the development of expertise in practice, low back pain in healthcare and the use of video analysis as a research tool. Section 2 contains a comprehensive description of the methodology and methods which were condensed for the manuscript. One of the two methods, 'consultation mapping', was a novel approach to content analysis which has been described in further depth to help fortify its understanding. Section 3 contains a manuscript that reports an investigation into the clinical reasoning during diagnostic hypothesis generation by osteopaths consulting patients with acute low back pain. The manuscript is formatted in accordance with the submission requirements to the *International Journal of Osteopathic Medicine* (IJOM) (See Appendix I for the guidelines for authors). Section 4 (appendices) contains additional material supplementary to this thesis.

Section 1: Literature Review

Introduction

Clinical reasoning is said to be the foundation of all health related practice (Higgs & Jones, 2000). A conventional understanding of clinical reasoning in osteopathy has only recently seen close attention from researchers. Namely, Oliver Thomson has completed a number of clinical reasoning-related studies in osteopathy through the employment of grounded theory. These studies have provided a coherent representation of several areas of osteopathic clinical reasoning; however, further research is necessary to complement Thomson's findings in order to fortify the early understandings of osteopathic clinical reasoning.

Furthermore, research in osteopathy currently lacks the depth of knowledge to describe the use of clinical reasoning strategies. Without added documentation of the clinical reasoning strategies used, and the reasoning behind clinical decisions, osteopathy may struggle to define and justify its perspective on diagnosis, treatment, prognosis and management. "Once clinical reasoning models are established for osteopathy, this will help to describe the profession in terms of the competing areas of practice" (Thomson, Petty, & Moore, 2011, p. 75). Research may provide an opportunity to add further layers to the empirical background of osteopathy, introducing a broader scope of evidence based practice. As it becomes increasingly important to detail the reasoning behind decisions in healthcare, osteopaths must also learn to make explicit their process of clinical reasoning (Thomson et al., 2011).

In this literature review there are seven main sections which include an overview of clinical reasoning within and external to osteopathy, the development of expertise in practice, touch and palpation, video recording and analysis, and low back pain. The first section will define clinical reasoning, the nature of health profession specificity and how in comparison, osteopathy has little supportive clinical reasoning research, along with the development of clinical reasoning research. Section two will describe three clinical reasoning strategies in detail: hypothetico-deductive reasoning, pattern recognition and collaborative reasoning. An introduction to clinical reasoning in osteopathy, medicine, nursing, occupational therapy and physiotherapy will then follow in section three, with particular attention to the existing clinical reasoning strategies and their application in the named health professions. Section four will describe the development of expertise in healthcare, including the differences between expert and novice practitioners. Section five will provide a description of the importance of touch and palpation in the practice of osteopaths. Section six will cover an overview of video recording and analysis in healthcare for research, education and development purposes. Finally, in section seven, a recent definition of low back pain is offered with overviews of how it has been previously approached in osteopathy and the aforementioned health professions.

Part One: Clinical Reasoning- What is it? A body of work

Defining clinical reasoning

Higgs and Jones (2000) describe clinical reasoning as an internalised process reliant on clinical experience and education; as such, reasoning may vary significantly between practitioners with

different professional experience and who are from diverse educational backgrounds. Several authors have offered perspectives, explanations and characterisations of clinical reasoning and its theoretical make-up. For the purpose of this literature review, a single definition of clinical reasoning is presented to avoid any ambiguity behind its meaning within the context of this research project. Higgs and Jones (2000) define clinical reasoning as "a process in which the clinician, interacting with significant others (client, caregivers, healthcare team members), structures meaning, goals and health management strategies based on clinical data, client choices, and professional judgement and knowledge" (p. 11). Any reference to the definition of clinical reasoning within this literature review will correspond to this description.

Referenced extracts from the above paragraph, including the definition, stem from the knowledge and experiences of Joy Higgs and Mark Jones. Higgs, an experienced physiotherapist and Jones, a psychiatrist with a background in manual therapy, are two authors who have played a significant role in defining clinical reasoning in the health professions over the past 25 years (Higgs & Jones, 2000). Together, an amalgamation of their research has established a key portion of the current understanding of clinical reasoning. Although Higgs and Jones are only two of several researchers who have contributed to the growing body of clinical reasoning research, their work is some of the most respected and sought out. On this premise, references from each of these authors will be used throughout this literature review. With respect to the offered definition of clinical reasoning, different parallels inherent to modern osteopathic practice may be recognised (Thomson et al., 2011). Three of these parallels have been discussed below to illustrate this relationship.

Firstly, the ability to synthesise meaning, goals and management strategies from several forms of clinical evidence fully encapsulates the necessary cognitive processing of an osteopath during a consultation. Acknowledging multiple sets of clinical evidence within a patient's context is an important skill, and one which develops progressively throughout professional life. Banning (2008) supports that clinical reasoning "focuses on the assimilation and analysis of health care evidence… differentiated according to its usefulness, efficacy and application to a selective group of patients" (p. 177). An osteopath will commonly utilise clinical information to shape their perspective and understanding of a patient's context, enabling each patient to be considered as an individual.

Secondly, the importance of interacting with patients, caregivers and healthcare team members should be highlighted. Osteopaths are known to spend extended periods of time with their patients in clinical practice. The lengthened patient-practitioner encounter facilitates a collaborative nature within the osteopathic reasoning process, where patients, caregivers or other persons of interest may have input into their recovery process. As described in physiotherapy and relevant to the context of osteopathy, incorporating a collaborative nature to reasoning allows for the dynamic interplay between patient and practitioner perspectives, creating a mutual understanding of the respective case (Edwards, Jones, Higgs, Trede, & Jensen, 2004). Additionally, a collaborative approach aids in

empowering patients to fully engage with the necessary steps of their recovery, thus complementing the osteopath, their set goals and management strategies.

Thirdly, the 'structuring' aspect of the above definition suggests that numerous thought processes are associated with developing goals, strategies and other conclusions. Assembling, analysing and evaluating patient information relative to its significance will facilitate an exploration of different clinical actions and their respective value (Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003). It has already been acknowledged that different forms of clinical evidence are gathered in the context of an osteopathic consultation; however, in order to filter, collate and then present the given information, thousands of small decisions are made which effectively conclude in a clinical decision. These decisions may be experience or intuition based and will help to dictate the course of decisions made with respect to patient management (Benner, 1984). The offered definition, as derived from Higgs and Jones' physiotherapy background, can therefore be seen to correspond with at least three parallel areas of osteopathic practice.

Profession and professional specificity

In the past 25 years, clinical reasoning has been researched extensively in different professions including medicine, nursing, occupational therapy and physiotherapy (Norman, 2005). Although the nature of this research has more fully characterised the process of clinical reasoning, the understanding that existed around its definition has since shifted (Simmons, 2010). Factors which appeal to the clinical reasoning of some professions do not necessarily translate into others, leaving a diverse interpretation and understanding between health professions. For example, if a patient consulted both a doctor and an occupational therapist for the same problem, their aims, focuses and goals would contrast one another (Fleming, 1991a), resulting in different clinical reasoning processes. As aforementioned, clinical reasoning differences between health professions may be because of their previous experience, clinical or otherwise, combined with the teachings and education from their given profession (Tanner, 2006). A combination of experience and education will shape a professional's competency in generating diagnostic conclusions, forming management plans and the recognition of familiar patterns from the patient's presentation.

Contrasting differences between health professions and their respective protocols have led not only to profession specific interpretations of clinical reasoning, but also to the coining of several terms to describe essentially the same idea. As research continues to broaden the scope of a profession's clinical reasoning, it appears that tailoring not only meaning, but also terminology to that given profession will act as a method of individualising their ideas. Specifically, amidst this growing interest of clinical reasoning, synonymous labels including clinical processing, critical reasoning, decision-making and clinical problem-solving have become interchangeable with the term 'clinical reasoning' (Simmons, 2010; Thomson et al., 2011). Utilising a range of terms to denote the process of clinical reasoning is not necessarily a negative; it does however provide researchers or readers from outside a given field with an element of confusion when trying to distinguish their respective meanings.

Research in clinical reasoning

Clinical reasoning research in the health professions

Clinical reasoning is a cognitive process which predominantly exists as an implicit and tacit phenomenon. For this reason, authors have described the difficulty in characterising the processes of clinical reasoning in the research environment (Higgs & Jones, 2000). Logically, when confronted with clinical information, a multitude of links are made within the brain, retrieving knowledge to inform the process of clinical reasoning. There is no single method robust enough to quantify all of these links, thereby illustrating the impossibility of providing a complete account of the clinical reasoning process. Instead, researchers have endeavoured to describe concepts, theories and strategies in various health professions in order to better understand the process of clinical reasoning.

Approaches to clinical reasoning research have evolved significantly since the psychometric simulation origins of the 1950s-1970s (Patel & Arocha, 2000). Early studies, such as that carried out by Barro (1973), sought to describe the diagnostic reasoning skills of medical practitioners by using a simulation of real clinical encounters. Although conceptualisations of clinical reasoning were derived from such investigations, the specificity was questioned for its true clinical applicability and transferability (Norman, 2005). Despite this, the collective work of Elstein, Shulman, and Sprafka (1978), which involved actors learning how to recreate pain behaviours and therefore 'simulate' diagnostic situations for participating doctors, is widely recognised to have inspired several of the modern approaches to clinical reasoning research. Elstein et. al's 1978 study contrasted the clinical reasoning processes undertaken by expert and novice medical practitioners and as Patel and Arocha (2000) point out, the investigation was a 'legacy' derived from areas of non-health related practice (physics and chess). Attention then shifted from an interest in clinical reasoning research methods to the process of clinical reasoning itself, opening the door to several new approaches to clinical reasoning research. Specifically, the role of knowledge and clinical adaptability in the cognition of expert practitioners gained significant interest (Norman, 2005).

Now a pluralistic approach, clinical reasoning research is open to multiple methods which have been explored and tested in various health professions (Norman, 2005; Patel & Arocha, 2000). The two research paradigms through which these methods may be categorised are quantitative and qualitative. A discussion of each of the documented methods is beyond the scope of this review; however, particular acknowledgement has been made toward the effectiveness of video-analysis in the investigation of clinical reasoning (Kamin, O'Sullivan, Deterding, & Younger, 2003; Patel & Arocha, 2000; Unsworth, 2005). "Observation of the patient encounter, either directly in person or indirectly via the use of video recording, is a valuable tool in clinical reasoning research, producing 'rich' data on specific aspects of practice" (Thomson et al., 2011, p. 75). Video-playback enables an observing practitioner to view their actions in real-time, thereby helping to retrospectively trigger thought processing from situations as seen on video. As a powerful research tool (Pelaccia et al., 2014) and an effective approach to enhance the validity of an investigation (Laitinen-Väänänen,

Talvitie, & Luukka, 2008), video-recording has been employed in this research project and is discussed in further depth in subsequent sections.

Dreyfus Model of Skill Acquisition

Aside from interest in the health professions, research into several different fields has contributed to the overall understanding of skill acquisition and decision-making. Dreyfus and Dreyfus (1986) investigated the skill-acquisition processes of chess players, adults learning a second language, automobile drivers and airplane pilots. Emerging from their study pertaining to airplane pilots (and later observed as a common pattern between the aforementioned fields e.g. chess players) was the Dreyfus model of skill acquisition (Dreyfus & Dreyfus, 1980; Dreyfus & Dreyfus, 1986). The model acknowledges experience and implicit, intuitive and tacit knowledge in the development of expertise, identifying five stages through which a pilot (or person in a given field) may transition from novice to expert (Dreyfus & Dreyfus, 1986; Peña, 2010). The five stages of skill acquisition as recognised by Dreyfus and Dreyfus (1986) include: novice, advanced beginner, competent, proficient and expert. A key factor in pilots progressing through these stages was the lessened dependency on abstract principles and analytical thinking, with experience and intuition instead replacing the need for systematic thought processing (Dreyfus & Dreyfus, 1980).

Benner (1984) similarly carried out an investigation of expertise and the development of skill acquisition with a focus instead with nurses. In her 1984 interpretive investigation, Benner adapted the Dreyfus model to characterise nursing expertise through the five aforementioned stages. Despite the models of Dreyfus and Dreyfus (1986) and Benner (1984) receiving criticism (Gobet & Chassy, 2008; Purkis, 1994; Rudge, 1992), they are both considered integral in the foundations of expertise research. In relation to clinical reasoning in the health professions, Benner's theory of expertise is appreciated as an influential (Gobet & Chassy, 2008) and key piece of literature in the early understanding of clinical expertise. Being that the descriptions of Benner (1984) were revised from Dreyfus and Dreyfus (1980), a model developed from outside of healthcare, the importance of non-healthcare orientated research should therefore be acknowledged in the development and present understanding of expertise in healthcare.

Part Two: Clinical Reasoning Strategies

Overview

Clinical 'reasoning strategies' has been defined in occupational therapy as the "methods or approaches to reasoning or the selection of a structure or organization for one's reasoning process" (Fleming, 1991a, p. 989). Studies have been carried out with the intention of identifying clinical reasoning strategies in nursing, occupational therapy and physiotherapy. Out of these studies have emerged various titles and categories which may be used to classify clinical reasoning in the context of clinical practice. Thomson et al. (2011) comprehensively detail eight strategies of clinical reasoning from the aforementioned professions, citing the importance of not only practitioner but also patient contributions to the reasoning process. These clinical reasoning strategies include: diagnostic

reasoning, narrative reasoning, procedural reasoning, interactive reasoning, collaborative reasoning, reasoning about teaching, predictive reasoning and ethical reasoning (Thomson et al., 2011). Predominantly, these reasoning strategies were formed out of observational studies and grounded theory based interviews to try and characterise the cognitive processing of the practitioners in question. Although not included in this list, the central clinical reasoning approach employed in medicine is diagnostic reasoning (comprised of hypothetico-deductive reasoning and pattern recognition reasoning strategies) (Eva, 2005; Norman, 2005; Schwartz & Elstein, 2008).

For the purpose of this review, hypothetico-deductive reasoning, pattern recognition and collaborative reasoning have been described in depth as they were recognised to pertain most closely to the clinical reasoning of osteopaths. Additionally, each of the aforementioned clinical reasoning strategies highlighted by Thomson et al. (2011) has been described in the subsequent section titled 'Clinical Reasoning in the Health Professions'. In doing so, an understanding of each clinical reasoning strategy within the context of its respective health profession can be better appreciated.

Hypothetico-Deductive Reasoning

Origins

Conceptualisations of the hypothetico-deductive model pre-date modern healthcare-related descriptions, such as those provided by Elstein et al. (1978). The premise of hypothetico-deductive reasoning stems from the scientific method, a process of observation, hypothesis generation, empirical hypothesis testing, and the adaptation or revision of hypotheses (Flowerdew, 2009). The true origin of the scientific method is thought to date back to Parmenides and Aristotle (Popper, 1998; Pozzo, 2004), with additional philosophers, theorists and researchers testing and adapting the method over time, progressively leading toward its modern understanding.

Description of process

The process of hypothetico-deductive reasoning recognised in clinical reasoning literature is largely based upon Elstein and colleagues' original investigation of how expert medical practitioners solve problems. Elstein et al. (1978) described a process involving cue acquisition, hypotheses generation, cue interpretation and hypotheses evaluation, all of which contribute to the formulation of a diagnostic conclusion. Practitioners form hypotheses from cues obtained during their clinical interaction; they can then acquire further cues to support or refute their hypotheses, working in a backwards fashion to further synthesise, deduce and isolate one or many hypotheses (Lawson & Daniel, 2011; May, Greasley, Reeve, & Withers, 2008; Norman, Young, & Brooks, 2007). The nature of this cognitive processing requires a practitioner to use analytical thinking, characterised by rational and deliberate thinking through multiple evaluations of the different cues acquired (Pelaccia, Tardif, Triby, & Charlin, 2011). To minimise confusion, it is important recognise that hypothetico-deductive has garnered synonymous titles such backward reasoning and deductive reasoning (Case, Harrison, & Roskell, 2000; Jones, 1995). These terms represent part of the hypothetico-deductive reasoning process and do not characterise a different reasoning strategy.

Novice and experts using Hypothetico-Deductive Reasoning

"Hypothetico-deductive reasoning represents a generic approach that can be utilised in the absence of organized knowledge structures, permitting diagnosis when medical problems reside outside the area of expertise of the problem solver" (Coderre, Mandin, Harasym, & Fick, 2003, p. 700). The premise of hypothetico-deductive reasoning can therefore be seen as crucial to both experienced and inexperienced practitioners seeking a diagnostic conclusion. It is widely acknowledged that hypothetico-deductive reasoning is employed more so by novices than experienced practitioners; this is primarily due to the novice practitioners' lack of experience and inability to readily retrieve knowledge from previous encounters (Doody & McAteer, 2002; Norman et al., 2007). When expert practitioners are confronted with unfamiliar or undifferentiated problems, they seek to reduce their level of uncertainty through the generation of hypotheses (Jones, 1995; Norman et al., 2007). In doing so, a hypothetico-deductive approach, which is informed by an extensive knowledge bank, is employed to reach a diagnostic conclusion.

Pattern Recognition

Origins

With the analytical nature of hypothetico-deductive reasoning well acknowledged in literature, medical researchers sought to investigate other approaches to clinical reasoning, focussing on the differences of novice and expert medical practitioners. Groen and Patel (1985) described a process of 'pattern recognition', where medical experts called upon previously obtained clinical information to inform their current clinical situation. The retrieval of this clinical information was seen in non-problematic situations, and contributed to the development of hypotheses through the recall of similar past encounters (Groen & Patel, 1985). Pattern recognition is often recognised by its rapid and automatic nature (Higgs, Jones, Loftus, & Christensen, 2008).

Description of process

Pattern recognition is often described as the most common approach to non-analytical processing (Pelaccia et al., 2011). When confronted with familiar clinical information, practitioners may subconsciously make a link between their present situation and memory patterns stored in their extensive knowledge bank (Groen & Patel, 1985; Heemskerk et al., 2008; Jones, 1995). In effect, the 'recognition' of a clinical pattern may fast-track practitioners into developing, refining and concluding hypotheses. As practitioners are not required to deductively reason, or work backwards as described in hypothetico-deductive reasoning, pattern recognition has often been referred to as inductive or forwards reasoning (Case et al., 2000; Higgs & Jones, 2000; Jones, 1995). Akin to the synonyms described above in hypothetico-deductive reasoning, these terms are the equivalent of pattern recognition and should not be used to separate the process into different strategies.

The greatest strength of pattern recognition of unconscious, rapid processing is also its most significant weakness. Patel and Kaufman (2000) explain that because forward reasoning is based on domain knowledge (expert knowledge organised to facilitate the recognition of problem

features/clinical cues), it is highly prone to error when this knowledge base is not well-developed. Without an adequate level of domain knowledge, practitioners may fall into the 'trap' of forcing clinical cues to fit given patterns outside of their normal context. Inductive approaches to clinical reasoning do not contain built-in-checks of legitimacy to monitor the validity and reliability of inferences made (Cuthbert et al., 1999; Patel & Arocha, 2001). In effect, the absence of these reasoning checks can prevent practitioners from correcting mistakes which could potentially compromise reaching a safe and accurate diagnosis. There is also a danger in the reliance on authority and the failure to consider that a patient, their presentation and unique context, can exist outside of the norm.

Novice and expert use of Pattern Recognition

Case et al. (2000) postulates that the cognitive mechanisms used for the retrieval and storage of knowledge are better refined in expert practitioners. Harjai and Tiwari (2009) add that the "expert clinician is also able to quickly locate relevant parts of the knowledge store, using… recognition between observations and their knowledge base often and at very high speeds". Expert practitioners become more familiarised with patterns of clinical cues, their relative importance and how they may interact together with respect to their patient. In comparison, novices do not have the richness and depth of knowledge with which to recognise patterns from past encounters. They lack the rapid recall abilities exhibited by expert practitioners and are not able to access their knowledge as readily (Benner, 1984). For this reason, pattern recognition is acknowledged as a characteristic clinical reasoning strategy which fundamentally pertains to the cognition of expert practitioners (Groen & Patel, 1985; Tanner, Padrick, Westfall, & Putzier, 1987).

The Dual-Process Theory with respect to hypothetico-deductive reasoning and pattern recognition

Hypothetico-deductive reasoning and pattern recognition are recognised as diagnostic clinical reasoning strategies (Croskerry, 2009; Elstein, 2009; Patel & Groen, 1986). Both approaches to clinical reasoning are commonly discussed in relation to the dual-process theory, a method which consists of two cognitive systems that parallel these two strategies in their modus operandi (Croskerry, 2009; Marcum, 2012). Pelaccia et al. (2011) discussed that system 1 is known as 'non-analytical' processing and is characterised as automated, tacit and intuitive; system 2 is recognised as 'analytical', with deliberate thought processing taking place in contrast to the unconscious nature of non-analytical thinking. When presented with clinical information, practitioners will be seen to recognise it as either familiar or as unfamiliar. "If it is recognized, the parallel fast, automatic processes of System 1 engage, whereas if it is not, the slower, analytical processes of System 2 engage instead" (Croskerry, 2009, p. 30). Pattern recognition and hypothetico-deductive are therefore seen to correspond with non-analytical and analytical processing respectively (Marcum, 2012; Pelaccia et al., 2011).

Some authors have acknowledged the logicality of utilising both System 1 and System 2 interchangeably, tailoring their application to different clinical situations (Ark, Brooks, & Eva, 2006;

Eva, 2005; Pelaccia et al., 2011). With respect to clinical reasoning and diagnostic error, Norman et al. (2007) discusses the apparent importance of utilising both approaches to reduce mistakes in the reasoning process. By relying solely on System 1 pattern recognition and similarity-based conclusions, diagnostic errors may eventuate due to the absence of critical and reflective thinking (Norman et al., 2007). On this premise, it can be recognised that when seeking safe, accurate and correct diagnoses from the clinical information presented in practice, employing both pattern recognition (System 1) and hypothetico-deductive (System 2) reasoning strategies can help to minimise diagnostic error.

Collaborative Reasoning

Origins

Research has illustrated that collaboration in healthcare enhances a practitioner's ability to grasp a patient's problem, thereby potentiating the improvement of patient outcomes (Edwards, Jones, Higgs, et al., 2004; Jones, 1995; Resnik & Jensen, 2003). Although some may argue that interactions between patient and practitioner are collaborative (to various extents) by nature, it is important to acknowledge the pragmatic significance that joint approaches in healthcare can produce. An early notion of collaboration as a component of clinical reasoning in healthcare was described by Jones (1995), who posited that through "a process of explanation, reassurance and shared problem solving, the 'enlightenment' of the therapist regarding diagnosis and management of a problem is paralleled by the 'enlightenment' of the patient regarding his or her own problem or situation and ability to do something about it" (p. 21). Additional authors who began to define collaboration in the clinical reasoning process of health professionals were Mattingly and Fleming (1994), Jensen, Gwyer, Hack, and Shepard (1999) and Resnik and Jensen (2003).

Ian Edwards further developed the concept of collaboration in clinical reasoning through its existence as a clinical reasoning strategy. Edwards, Jones, Higgs, et al. (2004) define collaborative reasoning as "the nurturing of a consensual approach towards the Interpretation of examination findings, the setting of goals and priorities, and the implementation and progression of treatment" (p. 73). Edwards also discusses three types of knowledge accessed in the process of collaborative reasoning, drawing upon his unpublished thesis: (1) approaches to collaboration where decision making is informed by the practitioner's knowledge, employing an empirico-analytical method to reasoning; (2) approaches to collaboration where decision making is informed by the patient's knowledge, thereby reasoning with an interpretive framework; (3) situations where collaborative approaches generate new knowledge for the practitioner and patient, reasoning within a critical framework (Edwards, 2000; Edwards, Jones, Higgs, et al., 2004). Logically, these three knowledge types will be present to varying extents in each consultation, producing an individualistic nature to collaboration in practice. Collaborative reasoning has primarily been described in literature in the context of physiotherapy; to date, there are no identifiable studies in osteopathy that reference the employment of collaborative reasoning.

Expert practitioner use of Collaborative Reasoning

In a grounded theory investigation of physical therapists' expertise in clinical practice, Resnik and Jensen (2003) found that the "practitioners classified as expert…were distinguished by a patient-centred approach to care, which is characterised by collaborative problem solving, patient empowerment through education, and cultivation of the patient-practitioner relationship" (p. 1105). Demonstrating these traits may be seen to parallel the characteristics of collaborative reasoning illustrated above. Promoting patient empowerment and a shared approach to clinical reasoning naturally encourages patient involvement thereby facilitating collaboration between patient and practitioner. In addition, experts in Resnik and Jensen's (2003) study also displayed an advanced ability to self-reflect upon their clinical actions, continuously reassessing their practice decisions. The process of thinking and reflecting about thinking, also known as metacognition (Marcum, 2012; Simmons, 2010), is a hallmark of expertise in practice, and will be discussed in a subsequent section. On this premise, Resnik and Jensen's (2003) investigation advocates the utilisation of collaborative reasoning by expert practitioners.

Part Three: Clinical Reasoning in the Health Professions

It is widely recognised that there is no *single* clinical reasoning strategy or approach to be learned; rather, *multiple* generalised strategies can be learned which allow a clinician to utilise reasoning approaches in the context of each individual patient (Jones & Rivett, 2004a). As there may be several viable paths to a successful diagnosis and treatment approach, the skill of clinical reasoning lies in selecting methods appropriate to a given situation (Higgs & Jones, 2000). On this premise, a well-integrated application of clinical reasoning strategies and approaches is required by healthcare professionals to accommodate all presenting patients. In the sections below, clinical reasoning in osteopathy will be discussed, followed by a brief summary of the clinical reasoning seen in medicine, nursing, occupational therapy and physiotherapy to provide a reference for comparison.

Clinical reasoning in Osteopathy

Overview

For a long time, clinical reasoning in osteopathy has been 'black-boxed' as a poorly understood (Thomson et al., 2011) yet pragmatically accepted process. It can be acknowledged that early ideas of thinking in osteopathy were derived from A. T. Still's osteopathic principles and Thomson, Petty, and Moore (2014d) support that "osteopaths have relied upon the philosophical and theoretical foundations upon which the profession was built to guide clinical practice" (p. 37). Although it may be argued by some within the profession of osteopathy, relying on historical and philosophical pragmatism will no longer be sufficient to explain what, why and how osteopaths practice.

Clinical reasoning research in Osteopathy

Despite still being in its relative infancy, research into the clinical reasoning of osteopaths has begun to confirm the empirical and pragmatic understandings from which practice was built. "Research is necessary to provide an understanding of the nature and scope of clinical reasoning used by

osteopaths, giving an important and much needed insight into aspects of osteopathic practice" (Thomson et al., 2011, p. 74). Researchers have started to investigate osteopaths' conceptions of clinical practice (Thomson, Petty, & Moore, 2014a, 2014c; Thomson et al., 2014d), clinical reasoning education and assessment (Fryer, 2008; Lalonde, 2013; Moore et al., 2014; Stone, Boud, & Hager, 2011), the application of clinical reasoning strategies (Thomson, Petty, & Moore, 2014b) and the role of palpation (Browning, 2014; De Jesus Esteves, 2011; Esteves & Spence, 2014). Each of the aforementioned studies was completed within the last six years, reiterating the emerging nature of clinical reasoning research in osteopathy.

Another recent study has seen researchers endeavouring to outline the componentry of osteopathic thinking. In a recent critical discussion, Thomson, Petty, and Moore (2013) explained that the osteopathic reasoning process may involve a patient-centred, practitioner-driven or collaborative approach which is sometimes biomedical and at other times disease centred, together accommodating the biopsychosocial aspects of a patient and their environment. When amalgamated, these components suggest that osteopathic clinical reasoning could encompass a dynamic, holistic and multifaceted consideration of patients and their reported signs, symptoms and environmental contexts (De Jesus Esteves, 2011; Thomson et al., 2011, 2013; Ward, 2003). Future research may look to better understand the importance of each these components and their true meaning within the osteopathic context.

Clinical reasoning strategies in Osteopathy

Overview

As noted earlier, the utilisation of clinical reasoning strategies in osteopathy has not been widely researched. Identifying the clinical reasoning strategies in any health profession helps to better characterise the thought processing of its practitioners, and thus, to explain the different stages of reasoning toward diagnosis (Higgs & Jones, 2000; Jones & Rivett, 2004a). Various clinical reasoning strategies and their respective meanings have been described in the existing body of clinical reasoning research. Presently, this body of work does not include a sufficient level of osteopathic literature, providing an opportunity for the present study to take advantage of this literature 'gap'.

In a recent grounded theory study, Thomson et al. (2014b) investigated the diagnostic reasoning of 12 experienced osteopathic practitioners. The results concluded that an interplay of both hypothetico-deductive reasoning and pattern recognition were utilised, depending on the level of complexity and unfamiliarity of the presented case (Thomson et al., 2014b). Although hypothetico-deductive reasoning and pattern recognition are the two most well established foundations of diagnostic clinical reasoning (Doody & McAteer, 2002; Higgs & Jones, 2000; May et al., 2008; Tanner et al., 1987), the rationale behind their application in osteopathy is only beginning to be understood. Whether there is a predominance of hypothetico-deductive approaches or pattern recognition is logically a consultation specific finding; however, mapping the employment of these clinical reasoning strategies may help to better understand the aforementioned interplay described by Thomson et al. (2014b).

Hypothetico-deductive reasoning in novice and experienced osteopaths

Hypothetico-deductive reasoning has been acknowledged, albeit briefly, in literature as occurring in both educational and professional practice contexts of osteopathy. In education, students are encouraged to initially utilise a hypothetico-deductive approach to clinical reasoning in order to make decisions (Esteves, 2004). In doing so, the process of acquiring cues, generating hypotheses, interpreting cues and evaluating hypotheses (Elstein et al., 1978) may be carried out in a slow, but methodical way when learning clinical reasoning skills. Looking to professional practice, Thomson et al. (2014b) reveal that hypothetico-deductive reasoning may be invoked when patient presentations are not clear, and there is a requirement to delve deeper into the reasoning process. Ascertaining the frequency and depth of hypothetico-deductive reasoning used by osteopaths may help to better characterise its place within the osteopathic reasoning process.

Pattern recognition in novice and experienced osteopaths

The presence of pattern recognition is typically present to a lesser extent in novice osteopaths when compared to hypothetico-deductive reasoning (De Jesus Esteves, 2011; Esteves, 2004). Naturally, pattern recognition develops over time and from repeated exposure to clinical encounters, through which, a broad knowledge bank is developed (Gobet & Chassy, 2008; Higgs & Jones, 2000; Norman et al., 2007). It is reasonable to assume that although novice osteopaths may begin to grasp the concepts of diagnosis, their ability to identify diagnostic patterns is not as proficient as experienced practitioners. Thomson et al. (2014b) note that experienced osteopaths appear to recognise relationships between groups of cues, enabling diagnostic verification, and confirmation, to occur in less time and with more efficiency. Acknowledging relationships between clinical cues is therefore suggestive of pattern recognition, where knowledge is drawn upon from previous clinical encounters to inform the present context (Norman et al., 2007; Thomson et al., 2014b).

Clinical reasoning in Medicine

Clinical reasoning in medicine is frequently discussed synonymously with diagnostic reasoning. As such, the principal focus of clinical reasoning orientated research in medicine has been centred around diagnostic reasoning (Schwartz & Elstein, 2008). It is from this research that both hypothetico-deductive reasoning and pattern recognition (as described in earlier sections) were conceived. Fundamental research to the original understanding of these reasoning strategies was, as previously noted, completed by Elstein et al. (1978) for hypothetico-deductive reasoning and Groen and Patel (1985) for pattern recognition. Several references acknowledge the employment of these strategies in the context of expert and novice physicians, detailing the differences between strategy application and the importance that each has in medicine (Coderre et al., 2003; Elstein, 2009; Eva, 2005; Norman & Eva, 2010; Pelaccia et al., 2014; Schwartz & Elstein, 2008). Clearly, clinical reasoning has seen extensive research in medicine, establishing an advanced grasp on the gap between novice and expert cognition.

The combined utilisation of multiple reasoning strategies, such as hypothetico-deductive reasoning and pattern recognition, has been strongly advocated in medicine (Eva, 2005; Norman, 2005; Schwartz & Elstein, 2008). In a study of 256 physicians, Eva, Link, Lutfey, and McKinlay (2010) acknowledged the importance of recognising that non-analytical (pattern recognition) and analytical (hypothetico-deductive reasoning[1]) thought processes are not 'mutually exclusive', and that both processes may be seen to work most efficiently in unison. Croskerry (2009) adds that there is often a need for physicians to blend these two approaches together for the sake of time, resources and the optimal calibration of clinical situations. It is a physician's recognition of when to engage with these thought processes and, importantly, when to take the time to deliberately analyse clinical evidence utilising past experience that distinguishes expertise in medicine (Marcum, 2012).

Clinical reasoning in Nursing

Overview

The definition of clinical reasoning in nursing has seen several variants and contrasting propositions. Gordon, Murphy, Candee, and Hiltunen (1994) defined the clinical reasoning of nurses into a sequence of stages including the formulation of diagnostic hypotheses, the search for additional information to confirm or refute the hypotheses, the attainment of a diagnostic conclusion and the determination of actions based of the conclusion. The clinical reasoning process of nurses described by Gordon et al. (1994) can be seen to align with the process of hypothetico-deductive reasoning, in that deductive reasoning is taking place through a series of stages. Although this acknowledges the presence of a diagnostic reasoning strategy (hypothetico-deductive) in the decision making of nurses, it does not recognise the necessity to appreciate patients, their respective data and contexts which is a key notion inherent to nursing literature (Fonteyn & Ritter, 2008; Tanner, 2006). A consequence of detailing a staged process, as described by Gordon et al. (1994), is that it may lead to an oversimplified conceptualisation, therefore contributing to an understatement of its complexity and overall, a superficial understanding of clinical reasoning.

In another light, Fonteyn and Ritter (2008) define clinical reasoning in nursing "as the cognitive processes and strategies that nurses use to understand the significance of patient data, to identify and diagnose actual or potential patient problems, to make clinical decisions to assist in problem resolution, and to achieve positive patient outcomes" (p. 236). As a definition which acknowledges diagnosis, problem resolution, patient data and positive outcomes, this description better encapsulates the reasoning processes of nurses. In addition, some authors discuss the importance of metacognition, experience, intuition or domain-specific knowledge (Banning, 2008; Benner, 1984; Benner & Tanner, 1987; Claxton, Sculpher, & Drummond, 2002; Simmons et al., 2003; J. E. White, Nativio, Kobert, & Engberg, 1992). In addition, Tanner (2006) notes that the clinical reasoning of a

[1] Analytical thinking was not directly referred to as 'hypothetico-deductive reasoning' in this study; however, as described in the previous section 'The Dual-Process Theory with respect to hypothetico-deductive reasoning and pattern recognition', hypothetico-deductive reasoning is an approach to analytical thinking.

nurse must arise from a concerned stance that relates to the patient and their situation, be informed by both rational processes and knowledge, and never exist objectively or in disconnection from the patient's concerns. On the premise of the offered definitions, clinical reasoning in nursing can be perceived as a multifarious process involving several different components.

Heuristics and Nursing

Fonteyn and Grobe (1993) have showed that most of a nurse's reasoning processes are not directed toward hypothesis generation and the attainment of a diagnostic conclusion. Evidently, this contrasts the previously described clinical reasoning of a physician, which is aimed predominantly at the processes of diagnosis. A strategy of interest in the reasoning process of nurses is the utilisation of heuristics in the clinical reasoning process. Several authors, including Fonteyn and Grobe (1993), have contributed a description of heuristics in the nursing. Heuristics are a decision-making strategy employed in periods of clinical uncertainty (Tversky & Kahneman, 1973, 1974) which enable nurses to make inferences (Cioffi, 1997) from data received. Derived from prior encounters and clinical experience, heuristics are an approach to clinical reasoning which do not rely on analytical or deliberate thinking (Kahneman & Tversky, 1982; Tversky & Kahneman, 1973, 1974). They are often referred to as cognitive 'rules of thumb' and are readily accessible to the user (Fonteyn & Grobe, 1993; Pearl, 1983). Heuristics can therefore be recognised as an important clinical reasoning approach to the nurse, informing reasoning processes in the presence of doubt and clinical uncertainty. The references provided in this paragraph were derived from both propositional studies and investigative research.

Ethical Reasoning

Nurses are confronted with decisions everyday which are informed by, and grounded in, ethics (Goethals, Gastmans, & de Casterlé, 2010; Numminen & Leino-Kilpi, 2007). The unpredictability of nursing in any environment, from private practice to the emergency department, requires nurses to make quick, ethically informed decisions often for the patient's benefit. "As ethical reasoning is embedded in the personal relationship between a patient and a nurse, the patient's and nurse's personal qualities influence the ethical decision-making process" (Goethals et al., 2010, p. 644). Ethical issues may arise in variety of situations such as confidentiality, informed consent, decisions regarding patient autonomy, practitioner-patient relationships and inter-professional relationships (Jones & Rivett, 2004b). It is the recognition of these issues and the moral behaviours taken by the nurse (Numminen & Leino-Kilpi, 2007) that characterises ethical reasoning.

Goethals et al. (2010) note that nurses must "consider the values and expectations of patients, patients' families, and others, in addition to the rules and routines of their ward and institution" (p. 646). In light of these values and expectations, nurses are exposed to perspectives which may hamper thinking and have a confounding influence on their reasoning outcomes (Goethals et al., 2010). As such, several factors outside of the nurse's own personal subjectivity and bias can be acknowledged to affect the ethical reasoning in nursing practice. The clinical reasoning processes of

a nurse might therefore be conceptualised as a balancing act, where professional judgement is called upon to weigh the respective benefits and or detriments of a situation, based on personal values and those imposed from other parties, in the context of each patient. If nurses are aware and conscious of their practice, then they can be confident in their decision making, for which they are ethically accountable for (Cooper, 2012).

Clinical reasoning in Occupational Therapy

Overview

Utilised either individually or in unison, clinical reasoning strategies are employed by occupational therapists to define, sense and resolve problems in a patient's occupational status (Mattingly & Fleming, 1994; Rogers & Holm, 1991; Unsworth, 2001). Throughout the last 25 years, knowledge of clinical reasoning and the strategies used by occupational therapists has broadened significantly. Although several researchers have contributed to the current understanding of clinical reasoning in occupational therapy, the backbone has largely been formed by early descriptions from Maureen Fleming, who characterised a three staged process. These stages are based on the application of three key clinical reasoning strategies; interactive, procedural and conditional reasoning, together referred to as the 'three track-mind' (Fleming, 1991b; Thomson et al., 2011). The following paragraphs describe the three aforementioned strategies which shape the 'three track-mind' and how each may fit into an occupational therapist's reasoning process.

Interactive Reasoning

Mattingly and Fleming (1994) define interactive reasoning as a form of reasoning employed by therapists who take an interest in their patient's perspective, and own perception of their problem, as a method to better understand each individual patient. The idea that a practitioner may take interest in a patient, beyond their physical manifestations, is a key factor in understanding a patient's presenting behavioural as well as environmental contexts. Liu, Chan, and Hui-Chan (2000) support that a therapist who uses interactive reasoning will acknowledge patients to the extent that they are not viewed or perceived by the level of their disability; instead, they are viewed as real people and not simply as a client.

Interactive reasoning may be knowingly utilised to benefit both the practitioner and the patient. As described by Fleming (1991b), interactive reasoning may be applied as a tool to receive patient feedback on treatment to aid in tailoring specific techniques to a patient, to express interest in the patient's understandings or concerns about their problems and to engage a patient in the overall consultation. Researchers add that interactive reasoning develops progressively and is more commonly employed by experienced therapists who have encountered similar patients before, or, who have experienced enough patients to recognise and thus tailor their questioning and reasoning approaches (Fleming, 1991b; Mattingly & Fleming, 1994; Unsworth, 2001).

Procedural Reasoning

Occupational therapists have been described as utilising a similar clinical reasoning strategy to hypothetico-deductive reasoning (Unsworth, 2005). Through the formulation of multiple hypotheses, a therapist may seek to test those hypotheses against each other, ultimately shaping the diagnostic outcome and subsequent treatments. Fleming (1991b) termed this strategy procedural reasoning, an approach where therapists were rationalising disease or disability against relevant treatment 'procedures' which could be utilised to remediate a patient's functional problems. Procedural reasoning may be characterised as the process of problem definition, or simply, identifying the problem which the patient has presented with. In contrast to interactive reasoning, novice therapists are proven to employ procedural reasoning more frequently than expert therapists, who will often bypass the staggered phases of hypothesis generation through the recognition of patterns (Fleming, 1991b; Mattingly & Fleming, 1994).

Conditional Reasoning

The third strategy of reasoning described in the 'three track-mind' is conditional reasoning, a multidimensional process involving therapist reflections on the failures and successes of the clinical encounter, namely the interactive and procedural standpoints with an amalgamation of the two (Fleming, 1991b). In the context of occupational therapy, the term 'conditional' does not refer to provisions or situations subject to condition as its dictionary definition suggests; instead it refers to a reflective process that is centred on the patient and the outcomes of the clinical encounter. Conditional reasoning allows for therapists to consider the impact of a client's problem on broader temporal and social contexts, imagining possible future revisions and changes to treatment or the condition title (Liu et al., 2000; Schell & Cervero, 1993; Unsworth, 2001). Reasoning conditionally is therefore a skill developed over a long period of time, where multiple clinical encounters may culminate to form a breadth of knowledge which is alterable to any given client presentation. As acknowledged by Thomson et al. (2011), conditional reasoning has also be referred to as predictive reasoning in physiotherapy (Edwards, Jones, Carr, Braunack-Mayer, & Jensen, 2004) and nursing (Fisher & Fonteyn, 1995).

Pragmatic Reasoning

In addition to the 'three track-mind', pragmatic reasoning (a strategy which parallels conditional reasoning) has been described to address the thought processes undertaken by occupational therapists regarding their personal contexts and practice, and how these influence therapy (Mattingly & Fleming, 1994; Schell & Cervero, 1993; Unsworth, 2005). Personal context as described by Schell and Cervero (1993) may encompass negotiation skills, therapy skill repertoire, personal motivation and a therapist's capacity to read and thus understand the practice culture. Unsworth (2005) notes that "procedural, interactive, and conditional reasoning all appear to be client driven forms of reasoning, pragmatic reasoning appeared driven by the therapeutic context" (p. 36). As also recognised by Thomson et al. (2011), pragmatic reasoning has been similarly described as ethical reasoning in physiotherapy (Edwards, Jones, Carr, et al., 2004) and nursing (Gordon et al., 1994).

Clinical reasoning in Physiotherapy

Overview

Early research into the clinical reasoning processes of physiotherapists were generally modelled on established medical research. For example, innovative work carried out by Payton (1985) in the field of physiotherapy was largely developed from the basis of Barrows and Tamblyn (1980) and the previously discussed work by Elstein et al. (1978). Findings from Payton's study indicated a correlation between both medicine (Barrows & Tamblyn, 1980; Elstein et al., 1978) and physiotherapy, indicating that practitioners from both health professions employed a hypothetico-deductive approach in their clinical reasoning. In this light, Payton suggested that physiotherapy education might accommodate this notion, by ensuring the problem-solving techniques concluded be taught to students through the approaches suggested by Barrows and Tamblyn (1980). Knowledge of clinical reasoning in physiotherapy was, therefore, initially derived from research in medicine and directed toward diagnosis.

However, as research has continued to evolve, so too has the understanding of clinical reasoning in physiotherapy. Studies characterising the clinical reasoning processes and strategies undertaken by physiotherapists have moved away from a purely diagnostic focus, acknowledging the importance clinical reasoning during treatment and management (Doody & McAteer, 2002; Jones, 1992). Additionally, recent research has started to emphasise clinical reasoning strategies outside of pattern recognition and hypothetico-deductive reasoning, both of which are well established clinical reasoning strategies in physiotherapy (Doody & McAteer, 2002; Plummer, Morris, Hurworth, & Dunai, 2006; Rivett & Higgs, 1997).

Of particular note, Edwards, Jones, Carr, et al. (2004) investigated the clinical reasoning of 6 expert physical therapists over a period of at least 2 days in their normal working environment. The conclusions drawn by Edwards, Jones, Carr, et al. (2004) suggested that physical therapists employ several clinical reasoning strategies in practice to complement diagnostic approaches. Eight strategies were described which have been the subject of this literature review as modelled by, and adapted from, Thomson et al. (2011). Specifically for the purpose of reiteration, these strategies include diagnostic reasoning, narrative reasoning, procedural reasoning, interactive reasoning, collaborative reasoning, reasoning about teaching, predictive reasoning and ethical reasoning (Edwards, Jones, Carr, et al., 2004). All but narrative reasoning and reasoning about teaching have been acknowledged in this literature review and as such, are described below.

Narrative Reasoning

As informed by the writings of Mattingly (1991) M. White and Epston (1990), Edwards, Jones, Carr, et al. (2004) describe narrative reasoning in physical therapy[2] to concern "the understanding of patients' stories in order to gain insight into their experiences of disability or pain and their subsequent beliefs,

[2] Physiotherapy is labelled as 'physical therapy' in America; therefore the two are synonymous in this literature review. It important to ensure this is clear to avoid any confusion.

feelings, and health behaviours" (pp. 314-315). Narrative reasoning encompasses a view of patients in their psychological and functional contexts, with practitioners seeking to understand the meaning of a patient's given situation (Edwards, Braunack-Mayer, & Jones, 2005; May et al., 2008). Listening to patient narratives provides an effective way to engage with patients through a demonstration of interest and awareness of the patient's perspectives. Amalgamating these perspectives into the process of clinical reasoning may enable a practitioner to combine context-specific patient narratives with case history data, thereby recognising not only the physical, but also the emotional and spiritual domains.

Reasoning about Teaching

Edwards, Jones, Carr, et al. (2004) define reasoning about teaching as the "thinking directed to the content, method, and amount of teaching in clinical practice, which is then assessed as to whether it has been effectively understood" (p. 322). Reasoning about teaching can also be seen to involve the careful planning, implementation and evaluation of content-sensitive teaching which is individualised to each patient (Jones, Jensen, & Edwards, 2008). The extent of teaching and education of patients varies from practitioner to practitioner, as does the forms of advice given. Pragmatically speaking, engaging with patients through teaching may be more effective when it is well structured and teaching objectives are co-created with the patient. Sluijs (1991) adds that the education of patients is generally more effective when conveyed systematically. Ultimately, this finding may give credence to the need for clear, coherent and organised teachings in practice, enabling patients to respond and repeat what they have learned in order to validate the practitioner's teachings.

Part Four: Clinical Reasoning: Knowledge and Expertise

Expertise is highly sought after by health practitioners in their given field (Benner, 1984; Doody & McAteer, 2002; Higgs et al., 2008; Marcum, 2012; Ramsburg & Childress, 2012). The pathway along which a novice health professional transitions into an expert is multifarious and dependent on each individual's experiences. Characteristically, this pathway is largely authenticated by the influence of education and personal experience which translates into solidified knowledge over time (Benner, 1984). Understanding the importance of knowledge in the context of clinical reasoning skill development allows the differences between novice and expert health practitioners to be seen.

There are numerous classifications of knowledge presented in literature. Three of these classifications, as presented by Higgs and Titchen (1995), pertain closely to the knowledge base that develops in the minds of healthcare professionals in clinical practice. Knowledge is constructed through an individual's interpretation of experience; propositional, professional (craft) and personal knowledge together recognise the importance of these experiences, amalgamating knowledge from within, and external to, clinical practice (Higgs & Titchen, 1995; Jensen, Gwyer, & Shepard, 2000). Propositional knowledge can be understood as research orientated knowledge which has been endorsed by the respective profession (Higgs & Titchen, 1998). In osteopathy, an example of

propositional knowledge may be identified as the effectiveness that osteopathic technique can have on patients complaining of low back pain.

Professional (craft) knowledge is a tacit and intuitive integration of practice knowledge (obtained from clinical experiences) and specific knowledge (which relates to a particular patient or clinical context) (Higgs & Titchen, 1995; Jones & Rivett, 2004a). Logically, this form of knowledge is unique as it will inevitably contain subtle nuances which pertain to each respective health profession and its professional understandings. It is important to recognise that the field of practice knowledge is examined in several domains of research such as psychology, philosophy and other health practice disciplines. The views offered in this review represent only a small segment of the latter, framing a health-orientated context.

Higgs and Titchen (1995) define personal knowledge as "the unique frame of reference and knowledge of self which is central to the individual's sense of self" (p. 528). Sweeney (1994) adds that personal knowledge is denoted by the person's perception and understanding of active comprehension, rational intuiting, appraisal, human and environmental interaction and personal judgement. Each person is shaped by their upbringing, values, beliefs and experiences, all of which will rationally contribute to the development of personal knowledge. Derived empirically through practical engagement, professional (craft) and personal knowledge are collectively known as non-propositional knowledge (Higgs & Titchen, 1995, 1998; Jones & Rivett, 2004a).

Clinical reasoning: Novice to expert

"Knowledge development in an applied discipline consists of extending practical knowledge… through theory-based scientific investigations and through the charting of the existent "know-how" developed through clinical experience in the practice of that discipline" (Benner, 1984, p. 3). All previous experiences collectively guide the construction of situational or contextual representation; these representations can be dependent on both positive and negative experiences which result in the development and refinement of knowledge. Jensen et al. (2000) discuss that the utilisation of personal knowledge coupled with a collaborative consideration of the patient's knowledge represents clinical expertise. Amalgamating patient and practitioner knowledge was labelled as a critical focus of the assessment process, distinguishing novice practitioners who conversely, depended mostly on their own thinking (Jensen et al., 2000). Evidently, literature supports the marked differences between novice and expert practitioners, with research continuing to reveal the broad range of potential directions taken in the process of developing expertise (Case et al., 2000; Curran, Campbell, & Rugg, 2006; Doody & McAteer, 2002; Unsworth, 2001).

Novice practitioners in practice

The irresolute nature of novice-orientated cognition can be recognised as the starting point from which health professionals embark on the path toward clinical expertise. Upon entering the uncontrolled environment of healthcare e.g. an osteopath transitioning from a student clinic to private

practice, the predominance of obtained knowledge is propositional and personal, or that derived from education and personal experience. Unsworth (2001) explains that novice practitioners have knowledge of principles, specific patient attributes and existing theories. Typically rigid in their application of this knowledge base, novice practitioners lack the fluidity and efficiency of knowledge recall that is observed with clinical expertise (Unsworth, 2001). In effect, the organisation of knowledge and its subsequent presentation is a key distinguishing factor between novice and expert practitioners (Case et al., 2000).

Novices are less structured and defined in their practice, with a weaker ability to respond to clinical information which they may have previously encountered (Case et al., 2000; Robertson, 1996). The inability to swiftly recognise patterns of clinical information is well established as a hallmark of novice-orientated practice. Consequently, the most common clinical reasoning strategy employed by novice practitioners is hypothetico-deductive reasoning (Higgs et al., 2008). Although hypothetico-deductive reasoning is described in subsequent sections, the rationale behind its use by novice practitioners may understandably come in response to the aforementioned deficit in professional (craft) knowledge. Testing hypotheses to fortify diagnostic certainty inevitably occurs with both expert and novice practitioners; however, the extent of depth and ability to recall relevant information can be seen to distinguish the two (Higgs et al., 2008).

Expertise in clinical practice

Knowledge may be progressively compounded by experience after extended periods of time in clinical practice; time to learn and experience the reality of clinical practice is key in the development of expertise (Benner, 1984; Jensen et al., 2000). As such, the process of acquiring clinical expertise is not directed by a set number of steps, exchanges or clinical experiences. The base of knowledge which is added to, subtracted from and adapted through repeated clinical interactions allows practitioners to develop a familiarity with patterns observed from previous experiences. Benner (1984) adds that "experience… results when preconceived notions and expectations are challenged, refined, or disconfirmed by the actual situation" (p. 3). In contrast to novice practitioners, pattern recognition (as described in a subsequent section), or forward reasoning, is considered a distinguished attribute of clinical expertise and experience (Higgs et al., 2008). Research has thus far ascertained several components of clinical expertise including metacognition, professional artistry and intuition, all of which are inherent to the cognitive processing of expert practitioners (Levett-Jones et al., 2010; Schön, 1987; Thomson et al., 2011).

Metacognition

Metacognition is broadly defined as 'thinking about thinking' (Marcum, 2012). As discussed in literature, this overly simplified definition extends to thinking about features which limit thinking and the avenues to explore when resolving these features (Marcum, 2012; Semerari et al., 2012; Thomson et al., 2011). As a continuous open-ended process, metacognition accommodates repetitive feedback loops which synergistically enhance thinking (Marcum, 2012). These feedback

loops enable a practitioner to acknowledge their mistakes or diagnostic inaccuracies, acting as a learning tool to minimise the likelihood of repeating these problems. In effect, a summation of mistakes processed through metacognitive thinking will contribute to a practitioner's ability to recognise previously encountered clinical cues.

Acquiring time in the relevant environment, although not the only factor in the development of expertise, will naturally assist in providing more clinical experience. Through an increase in exposure to clinical experiences, an awareness of cognitive bias develops, helping to solidify knowledge by self-monitoring and self-evaluating experiences (Cutrer, Sullivan, & Fleming, 2013; Jones & Rivett, 2004a). As these processes simultaneously/inevitably add to a practitioner's body of professional knowledge, metacognition justifiably contributes to the development of clinical expertise. The cyclical process of reflection is a key characteristic of clinical experts, who can actively 'step back' and assess features of their own thinking (Cutrer et al., 2013). In effect, metacognition may broaden the professional knowledge base as the practitioner "consciously reflects on the process by which a correct diagnosis was made, thereby reinforcing prior patterns, scripts, schema or categories" (Marcum, 2012, p. 957).

Building on the aforementioned conclusions of increased patient cue recognition and the reinforcement of identified patterns, metacognition can be seen as a practice through which clinical progress is made. Clinical experience, although pivotal in professional development, does not directly equate to the advancement expertise in practice (Marcum, 2012). Engaging in metacognitive self-reflection gives purpose to experience, through which cognitive changes (conscious or unconscious) may alter lines of thinking. As Benner (1984) describes, past situations are remembered because they have altered the practitioner's [nurse's] perception. These experiences will thus help to guide an expert's perceptions and accommodate a fast perceptual grasp of situational variables in practice (Benner, 1984). Clinical experience coupled with metacognitive processing can therefore be regarded as a key contributing factor to the development of clinical expertise.

Clinical Intuition

Automatic and instinctive decisions in clinical practice are a common occurrence displayed by expert practitioners. When asked to articulate these decisions of tacit and implicit nature, practitioners often have trouble verbalising their cognition retrospectively or otherwise (Levett-Jones et al., 2010; Peña, 2010). The massive bank of professional knowledge associated with expertise invariably leads to adaptive and rational cognition, where a clinically intuitive approach to reasoning is taken (Gobet & Chassy, 2008; Peña, 2010). The application of clinical intuition, as the title suggests, is arguably not decision based. Levett-Jones et al. (2010) discuss that intuitive processing may develop from repeated practice, owing to faster and more efficient cognitive methods of memory retrieval. These methods effectively lead to the bypassing of normal processing, with clinical responses determined largely through memory retrieval (Levett-Jones et al., 2010).

Expert practitioners may refer to their rapid clinical decisions as subconscious, only aware of their conclusions once reached. Compounding experience into knowledge with a gradual evolution from the rigid procedures of novice practitioners sees the development of know-how (Benner, 1984; Peña, 2010). Often coupled with clinical intuition, know-how is a form of implicit knowledge that transcends conscious thought processing (Peña, 2010). When experts are confronted with routine situations, intuitive knowledge is drawn upon allowing for a rapid consideration of previous clinical encounters (Gobet & Chassy, 2008). These encounters will naturally provide a broad range of clinical information which helps to shape clinical know-how and intuition. Benner and Tanner (1987) add that "intuitive judgement is what distinguishes expert human judgement from the decision or computations that might be made by a beginner or by a machine" (p. 23). Although the descriptions of intuitive judgements are fairly logical and probable, they include assumptions that cannot be tested. The reality of intuition is that researchers do not know exactly what a person, health professional or otherwise, is doing in terms of thought processing. It is therefore important to acknowledge that the mechanisms described in this section are proposed, and perhaps, not currently able to be truthfully tested.

Professional Artistry

Professional artistry is described as an individual's unique and meaningful expression, embracing uncertainty, exceptional skill, behaviours and actions of a creative and expert (Gobet & Chassy, 2008; Robertson, 2012; Thomson et al., 2014d). The flexibility and adaptability of a professional artist may be perceived through their ability to utilise superior knowledge and skill sets to quickly navigate past unfamiliar presentations. Gobet and Chassy (2008) describe professional artistry to be a blend of practitioner qualities (for example, connoisseurship, self-attunement and emotional, spiritual and bodily intelligence), practice skills (such as expert critical appreciation, metacognitive skills to balance professional (craft) knowledge within each patient-practitioner interaction and to find equilibrium between intuition, reasoning and the various forms of practice) and creative imagination processes (for example, visualising how as people we can create strategies to subsequently transmute ourselves, others, professions, organisations plus the outcomes of given interventions). The aforementioned metacognitive and intuitive processes can therefore be seen to play a role in the characterisation of professional artistry.

Exhibiting a level of mastery which recognises each individual's physiognomies alongside the research and lived experience which pertains to a given situation epitomises the professional artist. Robertson (2012) highlights several key characteristics including a heightened awareness of practice performance, heightened receptivity in the access of clinical information, advanced degrees of critical thinking and professional judgment and the capacity to explicitly share practice knowledge amongst other behaviours. Within the osteopathic context, Thomson et al. (2011) add that an integration of research with knowledge of different types which is then tailored toward each patient constitutes professional artistry. These characteristics "are built up through extensive introspective and critical reflection upon, and review of, practice" (Gobet & Chassy, 2008, p. 275). It is not one characteristic in

isolation that defines professional artistry; instead, the significance lies in a practitioner's ability to amalgamate together the acknowledged qualities, processes and skills that are effectively synonymous with the title 'expert' (Schön, 1987).

Part Five: Touch

"Touch is a perception that is emergent from neural activity in a complex network that includes the somatic sensory system as well as portions of many cortical regions in the cerebrum" (Willard, Jerome, & Elkiss, 2011, p. 221). As one of the five senses, touch is the tactile perception used to interact with the environment and other human beings. As a sense intrinsic to human existence, touch enables humans to physically engage, both consciously through purposeful judgment (e.g. picking up a pair of shoes) and reflexively (e.g. the reflexive response to touching a hot stove), with the processes that contribute to existence. In particular, touch acts a form of communication, facilitating the perception of emotion between two people (Hertenstein & Keltner, 2011).

Touch is a highly contextual and emotive tool, conveying different sentiments with different pressures and forms of contact. Although emotion is largely substantiated through facial expression (Stouten & De Cremer, 2010) and verbal interaction (Scherer, 2003), touch can produce strong emotional reactions in the absence of these visual and verbal communications. Hertenstein, Keltner, App, Bulleit, and Jaskolka (2006) describe that touch can communicate either positivity such as warmth and intimacy or negativity such as pain and discomfort. Along this positive and negative spectrum of influence, "touch is thought to be an intensifier of emotion related communication" (Hertenstein et al., 2006, p. 528). The reciprocal nature of touch invokes a response from both the person touching, and the person being touched, where both parties feel more connected (Goman, 2014). Evidently, the significance of touch in everyday human life is enormous; whether touch instigates verbal conversation or helps to identify an object through tactile discrimination, it is of critical importance to engage with others and the environment.

Touch for osteopathic practitioners

Like its inherence to human life, touch plays a pivotal and almost ubiquitous role in each phase of osteopathic practice. These roles may range from the common handshake between an osteopath and patient upon meeting, to potential hands-on clarification by the osteopath during case history questioning, to the procedures of examination that lead to a diagnosis, to treatment procedures and even the presentation of management strategies by the osteopath. Barrington (2014) supports that "touch is used to communicate throughout the osteopathic consultation, and to signal stages of the process to the patient" (p. 37). Each of these roles of touch requires a different mode, displaying the need for osteopaths to have an adaptability to their employment of touch which is dependent on the given situation. Touch may be "seen as the cornerstone of osteopathic practice" (Gale, 2011, p. 240), with numerous resources advocating the importance of touch and palpation in osteopathy (DiGiovanna, Schiowitz, & Dowling, 2005; Kuchera & Kuchera, 1994; Masters, 1988; Parsons & Marcer, 2006; Ward, 2003).

In a phenomenological study conducted by Consedine (2007), the role of touch was strongly advocated to play a key role in the enhancement of the osteopath-patient therapeutic relationship. Conveying therapeutic goals, reinforcing communication and legitimising therapeutic interaction, Consedine (2007) illustrated that osteopathic touch engenders trust between the patient and practitioner. Building strong relationships in healthcare can be heavily influenced by trust; whether it is the trusting of a practitioner to offer appropriate treatment, or a practitioner's willingness to trust their patient to take medication or carry out exercises, the outcomes will be affected by the condition of the therapeutic relationship. The presence of confidence, and assurance, in the therapeutic relationship will naturally promote the development of trust between patient and practitioner. Trust is a product of physical and verbal dialogue constructed over time (Consedine, 2007). Mediating the balance between these two dialogues will naturally help osteopaths to build rapport, patient confidence and consequently, trust in the therapeutic relationship. Touch may therefore be appreciated as not only a remedial tool in osteopathy, but also a connection which enables trust, security and the sense of care to shape the therapeutic relationship (Barrington, 2014).

The development of palpation and expertise

Palpation is a key component of an osteopath's diagnostic tool kit (Esteves & Spence, 2014). The diagnosis of musculoskeletal ailments is often made directly through, or in conjunction with, palpation of the patient's tissues. Some authors discuss the difficulty of teaching and subsequently learning palpatory skills (Aubin, Gagnon, & Morin, 2014; Browning, 2014), suggesting that the acquirement of palpatory competence should be associated with the development of clinical reasoning (Esteves & Spence, 2014). Understandably, an osteopath's ability to recognise and 'interpret' palpatory findings is not perfected in the early stages of practice life. Instead, knowledge of palpation is enriched following repeated hands-on experience and self-reflection in clinical practice. Willard and Jerome (2011) add that "all of palpatory diagnosis is predicated on previously formed tactile memories; acquiring these memories is a process critical to the development of skills in the osteopathic physician-in-training" (p. 54). The development of palpatory knowledge and expertise may therefore be likened to the aforementioned discussion of expertise and clinical reasoning, where time, experience and logically, metacognitive self-refection plays a key role.

The hands of an osteopath may be regarded as their tools for practice, similar to a builder whose use of a drill enables the undertaking of construction work. Osteopaths utilise their hands multifariously (such as the back of the hands, palms, thenar eminences and hypothenar eminences) in order to ascertain different characteristics of the body's tissues. In addition, particular focus is directed toward the finger pads due to their highly receptive nature. DiGiovanna et al. (2005) supports that the "touch receptors such as Merkel's disks and Meissner's corpuscles are most numerous in the pads of the fingers, making these the most sensitive areas" (p. 64). Repetitive activation of these receptors through the palpation of various tissue texture types will help to shape an osteopath's palpatory knowledge bank. Continually challenging this knowledge bank aids in the progressive refinement of palpatory awareness, the understanding of tissues and their significance within a given context, the

potential cause and effect links between case history and palpatory findings and importantly, the development of palpatory expertise.

Palpation and somatic dysfunction

One of the traditional diagnostic goals of utilising palpation in osteopathy is to identify the presence of somatic dysfunction. As a historical concept in osteopathy, somatic dysfunction has been acknowledged by some authors to require further empirical validation (Esteves & Spence, 2014). Despite this, it remains an accepted component of osteopathic diagnosis, receiving endorsement from the World Health Organisation (Esteves & Spence, 2014; World Health Organisation, 2010). The Educational Council on Osteopathic Principles (2011) define somatic dysfunction as the "impaired or altered function of related components of the somatic (body framework) system: skeletal, arthrodial and myofascial structures, and their related vascular, lymphatic, and neural elements" (p. 53). Somatic dysfunction is usually diagnosed through criteria which vary depending on the osteopathic text consulted. For the purpose of this review, one criteria, that described by DiGiovanna et al. (2005), will be offered in order to frame a diagnostic reference for the reader.

Traditionally, the acronym 'TART' had been used to represent four different characteristics of somatic dysfunction. T represents tissue texture changes and includes a range of palpable deviations from the normal texture of skin, fascia or muscle; A signifies asymmetry which may include a comparative difference in muscle atrophy or hypertrophy between the left and right sides of the body; R signifies a restriction in the physiological range of a joint's motion; T represents tenderness (a non-objective finding) of the tissues which is typically absent in patients with no somatic dysfunction (DiGiovanna et al., 2005). In addition, Parsons and Marcer (2006) note that palpatory findings of each characteristic may indicate the age (acute, sub-acute or chronic) of the somatic dysfunction. Findings of acuteness or chronicity may then be used to inform treatment approaches. Kuchera and Kuchera (1994) confirm that palpation offers essential clinical data for structuring a rational and total treatment program.

Part Six: Low Back Pain

Overview

"There are over 500 randomised controlled trials published on interventions commonly used in acute low back pain in primary care" (Penney, 2009, p. 63). The volume of research behind low back pain (LBP) is continuing to grow as it remains the most common presenting complaint to the professions of manual healthcare in New Zealand (Scarrott, 2009). To investigate the number of professions who successfully treat LBP is beyond this review; however, osteopathy, chiropractic medicine, physiotherapists, manual therapists, general practitioners and acupuncturists have provided significant evidence to support the effectiveness of their treatment (Penney, 2009). Although these modalities have established themselves at the forefront of LBP intervention, no single treatment approach has emerged as significantly more effective than the other.

Defining low back pain

Similarly to clinical reasoning, low back pain has multiple definitions and interpretations of what it is and what it is not (Bogduk, 2012; Brownhill, 2007; Griffith et al., 2007; Hoy, Brooks, Blyth, & Buchbinder, 2010). With reference to the International Association for the Study of Pain and Nikolai Bogduk's written definition, low back pain can be identified as two musculoskeletal regions; lumbar spinal pain:

> "pain perceived within a region bounded laterally by the lateral borders of the erector spinae, superiorly by an imaginary transverse line through the T12 spinous process, and inferiorly by a line through the S1 spinous process" (Bogduk, 2012, p. 174);

And sacral spinal pain:

> "pain perceived within a region overlying the sacrum, bounded laterally by imaginary vertical lines through the posterior superior and posterior inferior iliac spines, superiorly by a transverse line through the S1 spinous process, and inferiorly by a transverse line through the posterior sacrococcygeal joints" (Bogduk, 2012, p. 174).

Together these two definitions outline the borders for which pain may be characterised in the region of 'low back'. Structures within these borders may lead to the perception of noxious stimuli or may be recipients of referred pain from structures outside of the low back.

Osteopathy and low back pain

Amongst the research into LBP, intervention studies of osteopathic manipulative treatment (OMT), isolated manipulation and various other treatment approaches have been tested. The current available research suggests that osteopathy is an effective therapy for patients with back pain (Penney, 2009). Caragan et al. (2008) conducted a pilot study to investigate the effects of OMT in 11 pregnant women with acute low back pain. The treatments were carried out three times each week for four weeks and involved standardised OMT technique to the lumbar, sacral and pelvic regions to resolve muscular/soft-tissue and vertebral restriction (Caragan et al., 2008). Results showed an immediate improvement of visual analogue scale measured back pain following each treatment session and an improvement of the functional capacity and relative burden of the low back pain after the weekly sessions (Caragan et al., 2008). In a recent randomised control trial, Vismara et al. (2012) investigated whether OMT combined with specific exercises was more effective than specific exercises alone in the treatment of 19 obese patients with chronic LBP. Results suggested that combining specific exercises and OMT was effective in reducing disability, pain and improving thoracic spine flexion kinematics (Vismara et al., 2012). These examples are two of many osteopathic investigations that indicate OMT is an effective treatment approach for low back pain.

Part Seven: Video Analysis

Origin and application

It is thought that the introduction of video analysis in healthcare was pioneered by Patrick Byrne at the University of Manchester in the early 1970s (Heath, Luff, & Svensson, 2007). This introduction was later amplified in the following decade, becoming a key facet of learning and retrospective clinical analysis in primary healthcare (Heath et al., 2007). Professions such as occupational therapy, physiotherapy and medicine have since employed video analysis as a method of clinical assessment (Heath et al., 2007; Noll, Key, & Jensen, 2001; Unsworth, 2005). Despite its introduction almost 40 years ago, there continues to be "a growing interest in using video, particularly audio-visual recordings, to undertake naturalistic analysis of talk and interaction" (Heath et al., 2007, p. 110). Seeing, hearing and acknowledging clinical competency in healthcare through video analysis aids in depicting strengths and weaknesses, which ultimately assist in the clinical development of practitioners.

A learning tool

Video analysis and observation has become a key method by which learner clinicians can assess and evaluate themselves on the basis of clinical competence, clinical reasoning and an outlet by which to receive feedback through observation. Kogan, Conforti, Bernabeo, Iobst, and Holmboe (2011) support that "accurate observations and high-quality feedback about clinical skills are requisite for the development of expertise" (p. 1049). The process of developing clinical competency can lead to difficulties in accepting areas of weakness when the learner has neither seen nor heard the actual problem. Observation through video enables a student to understand and thus explicate the specific procedures or aspects of their clinical competency that require attention (Heath et al., 2007). It is through analysing real-time actions that beginner clinicians can fully engage with their clinical development, contributing to a clearer picture of what is and what is not required in their respective health profession.

Video analysis in the research setting

Researching cognitive phenomena

Conducting research based on cognitive and internalised thought approaches is one of the most challenging; the difficulty lies in confidently ensuring the data collected is truthful and unbiased. A central problem faced by researchers investigating cognitive phenomena is the challenge of measuring in a consistent and reproducible manner. In this light, various methods have been tested and tried in studying a person's thoughts, although it is argued that few have adequately represented the full picture (Higgs & Jones, 2000; Thomson et al., 2011). An example is the use of retrospective interviewing: on its own, interviewing is merely a momentary judgement or opinion and is not linked as close to the phenomena in question as think-aloud interviewing (Simmons, 2010). However, thinking aloud 'in the moment' of the phenomena can compromise that person's judgement, thought processing and influence the given context of a phenomena. It is important to note that a disadvantage of retrospective interviewing, especially those associated with the specific recall of

specific events, is the possibility of both non-intentional and intentional alteration. Specifically, without a method to prompt recall, there is a bigger chance that thoughts and events may be changed from their original occurrence. Methodological combination such as triangulation has been suggested, but one of the most effective research methods for studying cognitive phenomena currently appears to be video analysis (Kamin et al., 2003; Noll et al., 2001).

In a problem based learning study conducted by Kamin et al. (2003), the clinical reasoning of 128 third-year medical students was assessed utilising three different methods: face-to-face groups with a text/paper case, face-to-face groups with a video case, and virtual groups with a digital video case. Results from this study concluded that groups who were presented with a video case engaged more in explaining their thought processing such as problem description, integration and applicability (Kamin et al., 2003). In a similar study to the proposed research project, Noll et al. (2001) investigated the clinical reasoning of a single physiotherapist using video analysis and follow-up discussions to characterise the clinical reasoning process. The physiotherapist was videoed during consultations with six different patients, all of whom had presented with low back pain (Noll et al., 2001). A working model of the physiotherapist's clinical reasoning and the strategies employed during the consultations were identified in similar fashion to the proposed research project. The authors concluded that with the ability to confirm observations through video analysis, the credibility and dependability of data was better assured as retrospective recall was assisted. These two studies support the effectiveness of video recording in the research of cognitive phenomena, with both indicating the value of retrospective recall with assistance of video.

Research, video analysis and healthcare

Within healthcare, clinicians are known for their quick thought processing and ability to form hypotheses based on a patient and their symptomology. This process of reasoning clinically is not easily externalised and thus not easily recorded or measured. Utilising video recording to capture a clinician's external processing is an effective method to also analyse the cognitive nature of clinical reasoning. Higgs and Jones (2000) note that video analysis provides "a better characterisation of cognitive processing by providing extra nonverbal information, such as gestures, movements and gazes, which complements the information obtained from the subjects' verbal protocols" (p. 87). Kamin et al. (2003) adds that the use of video data enhances critical thinking; thus, as reference point, reviewing video data allows a practitioner to better recall their clinical reasoning, acting as a prompt. Logically, a crucial advantage of these visual and verbal prompts is the clear picture practitioners gain, resulting in a decreased possibility of 'guess work' when thinking retrospectively about decisions made.

The intricate cognitive nature of clinical reasoning requires an intense holistic investigation to adequately engage with a clinician's processing (Higgs & Jones, 2000). Observing a clinician in their professional environment through video analysis enables researchers to collect rigorous clinical reasoning data. Unsworth (2005) supports that "video-assisted recall is argued to be the best

retrospective method of eliciting reasoning since the therapist can rely on a sequential video image to prompt recall of reasoning" (p. 34). Having access to observations better informs the use of clinical reasoning strategies by a clinician; for example, a clinician's use of examination and special tests can be verbally and visually observed as a method of hypothetico-deductive problem solving. Simpson (2011) highlights that "the researcher can begin to explore how people use space and their bodies, how people interact with space, understand where and how they look, and ultimately gain a far more nuanced idea of how participants derive meanings through movement" (p. 333). Collected video data can be used to support hypotheses made from both visual and verbal data, therefore facilitating a holistic exploration into clinical reasoning (Higgs & Jones, 2000).

Conclusion

Clinical reasoning has become an important way in which healthcare professions distinguish themselves from one another. Varying levels of clinical experience and broad educational backgrounds contribute to the diverse inter-profession application of clinical reasoning strategies. Research into osteopathic clinical reasoning has only recently gained widespread interest. The importance of explaining the reasoning behind clinical decisions has become an integral part of healthcare, a manner to explain why consultation procedures occur as they do. Clinical reasoning strategies have been identified in many healthcare professions, helping to characterise the different areas of a clinician's thought processing. Identifying the clinical reasoning strategies utilised in the osteopathic consultation will help to better describe the thought processes of osteopaths and thus, explain the various stages toward diagnosis, treatment, prognosis and management.

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Section 2: Methodology to Method

Note: This section provides a review of methodology in support of the methods reported in Section 3 (Manuscript). In addition, it provides a more fulsome description of the methods and procedures of thematic analysis and content analysis. Some of this content overlaps with Section 3, but is provided to give a more comprehensive overview.

Methodology to Method

The following chapter outlines the research methodology and methods utilised in investigating the way by which osteopaths arrive at diagnostic hypotheses when consulting patients with acute low back pain. An explanation of why the chosen methodology was employed is provided in order to identify its appropriateness within the context of this study. A detailed account of the research methods and their implementation follows the methodology.

Methodology

The study of clinical reasoning has been carried out using largely qualitative research approaches which have aimed to elucidate a clinician's way of thinking (Banning, 2008a, 2008b; Higgs, Jones, Loftus, & Christensen, 2008; Unsworth, 2005). The clinical reasoning process is considered to be unique to each practitioner due to their diverse educational backgrounds and life experiences (Higgs & Jones, 2000). In order to make this process explicit, the perceptions and experiences of 3 osteopaths were investigated through an interpretive hermeneutic phenomenological inquiry.

Quantitative and Qualitative Research

All research is a venture of exploration which may seek to describe, explain, test or predict the outcomes of a related question. Confirmation or affirmation can represent a conclusion based on the question's meaning within the context of that research project. In order to investigate a research question, different methods of enquiry may be utilised. Quantitative and qualitative investigations, the two key paradigms of modern research, are often considered markedly diverse in their theoretical underpinnings and approaches (Duffy & Chenail, 2008). Quantitative research produces numerical summaries in a clear and persuasive way whilst reliably asserting cause and effect relationships among constructs; these constructs may be then used to form models and theories which broaden the generalizability of collected data (Fassinger & Morrow, 2013; Thomas & Magilvy, 2011). Researchers note that the focus of quantitative investigation is to obtain information quickly from a sample population of multiple data points, thus accommodating the extension of conclusions to a larger or entire population (Duffy & Chenail, 2008; Frels & Onwuegbuzie, 2013; Thomas & Magilvy, 2011).

Conversely, qualitative research focusses on the richness and depth of subjective realities which are shaped by lived experiences (Thomas & Magilvy, 2011). Qualitative data are collected without specific control of variables (as is seen in quantitative research) in order to seek maximum variation and accommodate the opinions led by subjectivity (Erlingsson & Brysiewicz, 2013). Personal biases, assumptions and topic orientated stand-points are made explicit by qualitative researchers, allowing for complete immersion and engagement in the understanding of data collected (Duffy & Chenail, 2008; Thomas & Magilvy, 2011). The application of a research paradigm is often directed by the nature of both research question and aim. In the instance of this research project, the aim was to describe the clinical reasoning process, therefore a qualitative research approach was utilised.

Hermeneutic Phenomenology

Humans are idiosyncratic beings who, although sharing opinions, emotions and even genetic similarities, are unique in their thought processing and perception of experiences. In the context of social environments, common traits and personal actions are inevitably interpreted in a way that relates to each human's perspective and previous life encounters. In the research setting, these diverse perspectives may call for the application of hermeneutic phenomenology, a methodological approach that acknowledges a participant's lived experiences and thoughts on given phenomena (Annells, 1996; Walker, 2011). The central purpose of hermeneutic phenomenology is to describe, identify and interpret lived experiences in a specific context; the conclusions derived from describing, identifying and interpreting these experiences seek to discover meaning and understanding of a given phenomenon (Walker, 2011).

Benner (1985) states that "hermeneutics, or interpretive methodology, is a holistic strategy because it seeks to study the person in the situation rather than isolating person variables and situation variables and then trying to put them back together" (p. 1). The nature, therefore, of hermeneutic enquiry is to investigate phenomena as a whole, where a non-reductionistic approach to research is taken in order to understand a phenomena as a complete unit. Benner's use of the word 'holistic' lends itself toward the belief that the components of an interpretive research investigation are interrelated, and together, exist purposefully within the context of that investigation.

In order to build and subsequently fortify the understanding of phenomenology presented above, the well-established theoretical understandings of Max van Manen may be consulted. van Manen (1990) describes phenomenology as a method "to gain insightful descriptions of the way we experience the world pre-reflexively, without taxonomizing, classifying, or abstracting it" (p. 9). As a process of thoughtful reflection, hermeneutic phenomenology explores the experiential significance of a phenomenon, existing (*for the most part)* free of prejudicial, theoretical, and suppositional intoxications (Dowling, 2007; Kafle, 2011; van Manen, 1990). Truly understanding phenomena will therefore require a researcher to become fully immersed in their subject of question, exploring the context by which the research is carried out.

Notably, van Manen (1997) suggests that there is no acknowledged/fixed set of methods that must be used when conducting hermeneutic phenomenological research. The opportunity is therefore presented to the researcher to employ multiple tools in the process of data collection such as observation, interviews or other associated protocols (Kafle, 2011; van Manen, 1997). Coupled with the rich, intuitive and experiential inquiry that hermeneutic phenomenology provides, a multiple method approach to data collection justifiably lends itself to the research of clinical reasoning. Higgs and Jones (2000) support that one method of data collection is not enough to provide the detail necessary to characterise the complexities of clinical reasoning. As a subconscious and intrinsic process, clinical reasoning research is well suited to phenomenology as it attempts "to explicate the meanings as we live them in our everyday existence" (van Manen, 1997, p. 11).

Similarly, Husserl's account of phenomenology is shaped by the rigorous and equitable study of phenomena as they appear within their respective context; the purpose for this approach is to determine an understanding that truly represents human consciousness and experiences (Dowling, 2007; Husserl, 1983). It was Husserl's belief that consciousness was the location for experiences and intuition to 'act out their part' (Husserl, 1983). Translating this idea into the context of cognition and clinical reasoning demonstrates the need for a robust and specific approach to research. Using a hermeneutic phenomenological approach that is rooted in the interpretive paradigm can allow practitioner clinical reasoning, thus intuition and experience, to be more coherently characterised.

The aim of this research project was to investigate the clinical reasoning processes undertaken by an osteopath in the diagnostic hypothesis generation of patients with acute low back pain. Investigating these processes encompassed a deep investigation into how and why standard physical examinations, case history questions and thus diagnoses were concluded. Employing hermeneutic phenomenology was determined as an appropriate research methodology to study clinical reasoning. The holistic and interpretive research process was used to frame the participating osteopath's contextual thought, allowing for experiences and perceptions to guide the clinical reasoning process.

Overview of the Research Process

In this study, the clinical reasoning of three osteopaths was investigated. The subject of clinical reasoning was directed toward the processes of thinking associated with patients complaining of acute low back pain. In total, two of the osteopaths consulted two patients each with the third osteopath consulting three patients. The case history questioning and examination procedures were video recorded using a GoPro camera[3] with the remainder of the consultation (i.e. treatment and relevant management discussions) completed without video. Each osteopath was provided with a pro forma case history form to write their notes on. The pro forma had section headings to write case notes (see Appendix E).

The case history and examination procedures parallel the conventional 'SOAP note' structure described by Cameron and Turtle-Song (2002). SOAP stands for subjective, objective, assessment and plan (Cameron and Turtle-Song, 2002), and is a method for documentation used in healthcare. In the context of this study (and generic healthcare practises), the 'SOAP note' structure aligns with the case history ('subjective') and examination ('objective' and 'assessment'). The 'SOAP note' structure is referred to in the manuscript, with its introduction and acknowledgement here aiming to frame the context for its inclusion.

Following the conclusion of six of the seven consultations, the osteopath in question gave a verbal commentary assisted by a review of the consultation video (described as a video-assisted

[3] The camera utilised in this research project was the high-definition HERO3+ Black Edition (GoPro Inc., San Mateo, CA, USA). The GoPro camera was approximately (length x height x depth = 55 x 40 x 22mm) and during video recording was encased in a small plastic skeleton for stability. This form of camera was chosen to provide a minimally invasive approach to video recording.

commentary). One practitioner commentary was delayed for two days due to time constraints; no patients were seen during this time by the osteopath. The practitioner commentaries were carried out to discuss the osteopaths' clinical reasoning displayed during the consultation. A review of the consultation video was utilised to enable the osteopaths to comment on their reasoning i.e. why they performed particular examinations or asked specific questions. An audio recording was taken and later transcribed from each of the practitioner commentaries along with transcriptions of the video recording.

Methods

It is important to make explicit that the initial intent of data analysis was directed toward a thematic analysis. Following the identification of a cross-over between the themes and 3 literature accepted clinical reasoning strategies, a process of content analysis was also employed to characterise clinical reasoning strategy application. In Section three (Manuscript), the methods section is restricted due to the word count which pertains to the journal *(International Journal of Osteopathic Medicine)* format. In this section, the steps of thematic analysis and content analysis have been described to a fuller extent. As the process of content analysis utilised in this study ('consultation mapping') was a novel approach, it was deemed important to add further detail to the steps carried out.

Thematic Analysis

A process of reflexivity was employed through the utilisation of thematic analysis akin to the content described by Braun and Clarke (2006). The researcher also used a progression of writing, reflecting and re-writing during the process of thematic analysis. The transcriptions taken from each osteopath's clinical reasoning descriptions (as made explicit via discussion of the videoed case history and examination procedures) were first read alongside the respective audio recordings. This was carried out two times to ensure no mistakes were present and to become deeply immersed in the data. Transcripts were also read through without the audio recording three times before commencing analysis.

"Thematic analysis is a method for identifying, analysing, and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 6). The formulation of themes can be seen as both a simplification and representation of key findings from the collected data. Themes are intransitive, and are the result of capturing the phenomenon in question through various means (van Manen, 1997). Researchers have identified two key approaches to carrying out a thematic analysis; inductive or 'bottom-up' and deductive (theoretical) or 'top-down' (Boyatzis, 1998; Braun & Clarke, 2006; Crabtree & Mill, 1999). An inductive approach involves the creation of themes which are strongly linked to the data with assumptions being driven by the data (Boyatzis, 1998). Deductive approaches are, however, driven by theories and are generally less descriptive with analysis limited by pre-conceived ideas (Crabtree & Mill, 1999). In this research project, an inductive approach was utilised as the identified themes were created without explicitly attempting to fit them into a pre-existing framework. That being said,

the coded extracts and thematic outcomes were considered alongside clinical reasoning strategies which are evident in current research in order to answer the research question.

Description of Thematic Analysis Process

Through the progression of identifying themes, an iterative process of 'dipping in and dipping out' was utilised which enabled the researcher to step back and recognise the importance of each theme and each code, and how it fit within the study's context. van Manen (1997) notes that repeating this process accommodates a balancing of the research context, where all themes, codes and related summaries are considered holistically and with equal importance. Braun and Clarke (2006) add that "analysis involves a constant moving back and forward between the entire data set, the coded extracts of data that you are analysing, and the analysis of the data that you are producing" (p. 15). Applying this iterative and holistic approach prevented the development of themes in isolation, or those which pertained to 'hoped' or 'favoured' conclusions. The following paragraphs detail the process of thematic analysis employed in this research project as suggested by Braun and Clarke (2006).

Familiarising yourself with your data

Although it was initially proposed to have the transcriptions completed by an external party, a decision was made to self-complete the transcriptions for the purpose of better understanding and engaging with the data. "The time spent in transcription is not wasted, as it informs the early stages of analysis, and you will develop a far more thorough understanding of your data through having transcribed it" (Braun & Clarke, 2006, p. 18). The strength which completing the transcriptions added to the development of preliminary codes and themes was enormous, with broad categories of interest being acknowledged at an early stage.

A reflective journal was kept throughout the entirety of the research process extending back to submission of the research proposal. Ortlipp (2008) details that keeping a reflective journal contributes to paradigmatic consistency and methodological rigour whilst also facilitating researcher reflexivity. Before the formal process of data analysis started, each transcript was read twice along with and without the video recording to check for errors and also help to familiarise the researcher with the collected data. Moving into the next step of analysis, the reflective journal helped to spark previously conceived ideas and prompt the researcher to recall the reasoning behind key research decisions (Borg, 2001).

Generating initial codes

The process of generating initial codes "begins when you have read and familiarised yourself with the data, and have generated an initial list of ideas about what is in the data and what is interesting about them" (Braun & Clarke, 2006, p. 18). Codes are effectively labels that represent a basic element or a segment within the data such as a word, a sentence or a paragraph; these labels can then be evaluated for significance and meaning within the context of the researched phenomenon (Boyatzis,

1998; Fade & Swift, 2011). For this clinical reasoning investigation, codes were identified based on the researcher's evolved perception of their relevance and importance in the data.

The coding process was carried out manually using physical copies (highlighting, note taking and post-it note commenting). Manual coding was employed as a means to build on the interest and understanding of the collected data. As suggested by Braun and Clarke (2006), the data were worked through in a systematic fashion, giving equal attention to each data item in order to recognise repeated patterns (themes). Each transcript was read through at least three times by the researcher to ensure codes were checked for their relevance. Preliminary codes and ideas were discussed with experts and colleagues to further develop research ideas and conclusions.

Searching for themes

Subconsciously, the preliminary development of themes may occur during the coding of data; when the process of coding is complete, sorting relevant extracts into themes can be formally carried out. Braun and Clarke (2006) discuss that this phase has a broader focus directed toward theme generation, where researchers begin to consider how the coded extracts may together or in isolation form an illustrative theme. Relevant codes are then collated within each theme to form a representation of the data; representations may stem from a single code or an amalgamation of multiple extracts (Braun & Clarke, 2006; Fade & Swift, 2011).

For the purpose of both characterising and understanding the data outside of purely written transcriptions, flow charts and diagrams were drawn concurrently during the process of theme searching (see Appendix B and C). Utilising visual representations provided an efficient and alternative method to theme development, helping the researcher conceptualise the quality of each theme and how it made the phenomenon (clinical reasoning) what it was (Braun & Clarke, 2006; van Manen, 1997). Discussions regarding the review and definition of each theme occurred between 3-5 times each month over a six month period.

Reviewing themes

Themes identified from the aforementioned processes were then reviewed and refined in order to determine their overall coherency and meaning. As Braun and Clarke (2006) describe, the reviewing process involved two main levels:

- Level One encompassed a review of the coded data extracts. This process involved reading the extracts which pertained to each theme, followed by an evaluation to determine whether they fit within the context of that theme via a coherent pattern. A thematic map, or diagrammatic illustration of the themes, was produced from this level to visually showcase the themes (See Appendix A).
- Level two involved essentially the same process, only with focus directed toward the entire data set. A consideration of the themes and their validity within the context of the data occurred as well as an examination of the thematic map. This was carried out to ensure that

the themes displayed on the map truthfully reflected the meanings found within the entire data set.

Defining and naming themes

Once a 'satisfactory' thematic map is completed, a process of defining, refining and naming of the themes that will guide data analysis is carried out (Braun & Clarke, 2006). Defining and refining includes determining what portion/s of the data each given theme captures and what it may represent in that given research context (Braun & Clarke, 2006).

These processes were undertaken by the researcher to ensure no thematic overlap was present. In effect, this helped to enhance the researcher's knowledge of the individual meanings of each theme prior to analysis, specifically with respect to the research question and aim (Braun & Clarke, 2006; van Manen, 1997). Each theme was repeatedly examined with the aforementioned process of 'dipping in and dipping out' utilised to gather a stronger appreciation of how each theme was shaped from the overall data set.

Producing the report

Producing the report is relatively self-explanatory with the researcher utilising the identified and fully explained themes to complete the final analysis. Referencing each theme to its data extracts and relevant narrative arguments is important in providing a concise, logical and interesting account of the data obtained (Braun & Clarke, 2006). In the current project, the researcher identified 3 themes which were: Theme 1- Implicit cognitive evaluations not apparent to an external observer; Theme 2- Iterative processing of cues assembled through clinical interactions; and Theme 3- Collaborative interaction between patient and practitioner. Each of these themes was found to broadly represent an existing clinical reasoning strategy which informed the process of content analysis described below.

Content Analysis

Content analysis involves a non-linear process of examination, where textual data is studied for characteristics and patterns that emerge as key features to the researcher; categories are then developed and further aggregated into distinct constructs, through which meanings are derived (Gray & Densten, 1998; Polit & Beck, 2004; Shoemaker & Reese, 1996; Vitouladiti, 2014). Identifying characteristics from the data enables researchers to make valid inferences which assist in the conceptualisation of important features from the data (Elo & Kyngäs, 2008; Weber, 1990). As a research method open to interpretation and application, content analysis can be applied to both qualitative and quantitative data sets (Elo & Kyngäs, 2008; Harwood & Garry, 2003). For this reason, it is considered a flexible approach to analysis of visual and verbal data (Harwood & Garry, 2003), which, in the context of this study, was a necessary accommodation with consultation videos.

Similarly described above with respect to thematic analysis, both deductive and inductive approaches can be taken in content analysis. Deductive content analysis involves an operationalized structure to analysis, where approaches are based on the testing of established theories or models (Burns & Grove, 2005; Elo & Kyngäs, 2008). In deductive approaches, researchers start with predetermined variables, categories and key words which are used to 'sift' through the data (Kondracki, Wellman, & Amundson, 2002). Conversely, Elo and Kyngäs (2008) describe that inductive content analysis is employed when theories, concepts and models are formed originally from the data, contrasting the deductive approach. Utilising inductive content analysis has been recommended when knowledge of the phenomenon in question in fragmented, or when there is an absence of related studies from which to inform analytical methods (Elo & Kyngäs, 2008).

In the context of this research investigation, an inductive approach to content analysis was initially utilised as there is only a small amount of research pertaining to osteopathic clinical reasoning. After repetitive analysis of the data, the researcher recognised that the findings (themes) were closely aligned with existing clinical reasoning strategies. In response, a clinical reasoning strategy framework was created in order to guide a deductive approach to content analysis. Kondracki et al. (2002) support that "inductive and deductive approaches are not mutually exclusive, and it is often useful to apply both" (p. 225). A closer breakdown of the content analysis processes utilised by the researcher has been described below.

Description of Content Analysis Process

Step One

The process of content analysis utilised in this study involved a novel approach to the interpretation of each osteopath's transcript. Over a 6-month period, the researcher met regularly in person with colleagues and experts (3 to 5 meetings per month), discussing the codes and themes emerging from the data. From these meetings, the concept of 'consultation mapping' was developed in response to attempts to develop schematics of the findings that were emerging from the data. Through this process, also one of writing, reflecting and re-writing, the researcher developed a strong sense of the

clinical reasoning processes undertaken by the participating osteopaths. The three identified themes which broadly represented existing clinical reasoning strategies were then used to guide the process of 'consultation mapping'.

In order to validate and define the clinical reasoning strategies evident in the data, a contextualised representation of each apparent clinical reasoning strategy was compiled into a framework (see supplementary material S2). The three reasoning strategies of pattern recognition, hypothetico-deductive reasoning and collaborative reasoning, were arranged in the framework alongside an explanation of their problem complexity, an approximated relationship with time, a description of their accepted literature definitions, additional criteria specific to this investigation, key words and extracts from the data.

Importantly, hypothetico-deductive reasoning was categorised into three different sub-types: 'light, moderate and heavy'. The reasoning behind doing so was to illustrate the varied nature of the osteopaths' application of hypothetico-deductive reasoning.

Step Two

The researcher then utilised the established clinical reasoning strategy framework to identify the clinical reasoning strategies from each of the transcribed commentaries. Each transcript was analysed 3 times to ensure the identification process was consistent in each case. The clinical reasoning strategies were assigned a highlighter colour in order to distinguish their placement in each practitioner comment on review. In order to avoid confusion with the thematic analysis, clinical reasoning strategy notes were made in the right hand column and theme-related notes were made in the left hand column.

Step Three

During the audio-recorded video-assisted commentary, any comment made by the practitioners was given a time-stamp by the researcher in accordance with the video recording. The clinical reasoning strategies identified in the transcripts could then be linked to a particular time-stamp.

Step Four

The time-stamped clinical reasoning strategies were then organised into a timeline which was specific to each individual consultation. The timeline is presented longitudinally, enabling the researcher to 'map' the clinical reasoning strategies in a coherent order. The consultation maps (as seen in the manuscript and supplementary materials S3 and S4) illustrate a pattern of clinical reasoning strategies utilised by the respective practitioner. As there were instances of multiple reasoning strategies at each time-stamp, a number value was given to illustrate the order each reasoning strategy was used e.g. 1, 2, 3.

Step Five

In order to further validate the identification of each clinical reasoning strategy in the data, illustrative extracts were added. This enables the corresponding timestamp to be matched to the direct quote as given by the respective practitioner.

Procedures

The information presented in this sub-section provides an overview of the ethical considerations, sample selection and recruitment and participant inclusion, exclusion and withdrawal criteria

Ethical Considerations

Ethical consent was granted for this study in June 2013 (see Appendix H). The areas of ethical consideration in the proposed research project are noted below:

Informed consent

- Before any data were collected, written informed consent was obtained from the participating osteopaths and patients. The written consent form outlined the research process, purpose and intended use of the collected data. In particular, it was essential that all participants being videotaped were fully informed and understood the intended implications of having their voice and body images captured on video (Powell, Francisco, & Maher, 2003).

Confidentiality

- The video recording was viewed only by the researcher, participating osteopath and supervisor/s. Videos were stored on a secure flash-drive and hard-drive accessible to only the researcher and supervisor.
- The osteopaths were allocated a letter to ensure confidentiality. A single number was given to each patient when referenced in the research context.

Examination video

- In the instance of clothing removal, draping was carried out by the osteopaths to ensure the patient remained covered and comfortable during examination. In all facets of the consultation, the patient's wishes were followed.
- Faces and body markings such as tattoos, visible scars and moles evident in the video recordings were pixelated to prevent the identification of both patients and osteopaths. The videos were pixelated after the osteopaths gave their commentary on the consultation. The reason for this was because it was not feasible to assume adequate pixelation could be carried out in the short period between the video recording being stopped and the osteopath watching the video after the consultation.
- The patients and osteopaths were given the opportunity to procure a copy of the videoed consultation footage.

Retention of video data

- The videoed footage will be retained for 10 years according to the New Zealand Health (Retention of Health Information) Regulations (1996). During this 10 year period, the footage will be stored on one flash-drive and one hard-drive; both copies of the video data will be locked away in separate locations.

- During the 10 year withholding period, only the researcher and research supervisors will have access to the video recordings unless permission is granted from the participants.
- Following this, the videos will be destroyed to ensure that the videoed evidence is kept entirely confidential.

On-going care

- After the patients received their treatment, they were booked in to the tertiary teaching clinic for follow up visits. Re-booking ensured that full care and follow up checks were carried out, furthering monitoring that each patient was safe and recovering well.

Cultural/personal beliefs

- There were no instances of a patient participant's beliefs or culture interfering with the research process.

The participants were provided with the contact details of the principal researcher and associated supervisors in the event that follow up questions or complaints were made. No questions or complaints were made.

Sample Selection and Recruitment

Two separate processes of recruitment were necessary for this research investigation due to the involvement of both osteopaths and patients. The following paragraphs describe the sample selection and methods of recruitment:

Osteopaths:

Three osteopathic practitioners were recruited from a single tertiary teaching clinic through convenience sampling due to logistical and traveling constraints. Initially, an email outlining the study was sent to the osteopaths who worked as part-time clinic tutors in the teaching clinic. The respondents were screened with the inclusion and exclusion criteria in order to narrow the sample size to three tutors. Following recruitment, the three tutors received a detailed explanation of the research process, what it entailed and the commitment they were making; before data collection was carried out, the osteopaths signed a written consent form.

Patients:

The seven patients were sampled from respondents who expressed interest from word of mouth and the answering of fliers distributed on local community notice boards and osteopathy clinics. The respondents who expressed interest in the participating were formally interviewed by telephone to discuss their eligibility, the research process and a preliminary briefing of what the intentions of their data would be. Appointment times were then made, where a face-to-face interaction took place between the respondent/s and the researcher. Respondents were briefed again on the research process, provided the opportunity to ask questions before providing written consent. Prior to the consultations were carried out, the patients were introduced to their osteopath. Patients were consulted by an osteopath (clinic tutor) for their first presentation only. Following this consultation, patients were booked in with a 5th year osteopathy student who subsequently consulted them for ongoing clinical management.

Inclusion, Exclusion and Withdrawal Criteria

Practitioner Criteria

Inclusion Criteria:

- The osteopathic practitioners must be clinic tutors from the single osteopathic tertiary teaching clinic.
- The osteopathic practitioners must be New Zealand registered and hold an Annual Practising Certificate.
- The osteopathic practitioners must understand the research process and consent to video recording.
- The osteopathic practitioners must have at least 5 years of clinical experience. This time period will provide a satisfactory level of clinical experience from which reasoning can be adequately assessed.
- The osteopathic practitioners agree to carry out their consultations at the single osteopathic tertiary teaching clinic, and not in their own private clinic external to this environment.

Exclusion Criteria:

- The osteopathic practitioner(s) does not have the clinical experience to successfully contribute to this research project.

Withdrawal Criteria:

- Osteopaths may withdraw their own data (two or three video recordings and accompanied commentaries) from the study up to five working days after their final video and consultation commentary is recorded.

Note: The 3 participating practitioners completed the 'practice style' questionnaire described by Wittwer Blaser (2009). All practitioners were identified as preferring the 'practice style' which has been informally described in osteopathy as 'structural osteopathy' (Thornton-Smith & Rajendran, 2010). The outcomes of this questionnaire are provided in Appendix D.

Patient Criteria

Inclusion Criteria:

- Seven patients of any gender between the ages of 20-50.
- The patients must understand the research process and give informed consent to video recording.
- The patients must have had low back pain for no more than 4 weeks and without pain referral or motor and sensory (neurological) signs. The 2003 ACC guidelines for acute low back pain note that "manipulation of the spine by trained practitioners using appropriate techniques is safe and effective in the first 4-6 weeks" (2003, p. 14). As manipulation was a chosen

treatment method by the osteopathic practitioners, it was important to ensure the safety of its use with acute patients.

Exclusion Criteria:

- Red flags including sudden onset of a severe headache, vomiting, disturbed consciousness, severe and debilitating pain.
- Participants who do not consent to video recording and the intentions of the videoed data.

Withdrawal Criteria:

- Patients may withdraw their own data (single video recording) from the study up to five working days after their video is recorded.

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Section 3: Manuscript

Note: The manuscript presented here is intended for submission to the *International Journal of Osteopathic Medicine* (IJOM) but rather than the referencing style specified in the IJOM guidelines for authors, the referencing style follows the American Pyschological Association ("APA"). Elsevier's initiative 'Your Paper, Your Way' (www.elsevier.com/yourpaperyourway) now permits manuscripts submitted using other referencing formats and APA was selected because it is easier to follow authors' names in the text. Consistent with the recent IJOM initiative to adhere to standards for reporting being adopted in the rehabilitation literature (Chan, Heinemann, & Roberts, 2014), the manuscript is presented together with a COREQ checklist (see supplementary material S5).

Investigation of clinical reasoning during diagnostic hypothesis generation by osteopaths consulting patients with acute low back pain: A qualitative case study approach

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Abstract

Investigation of clinical reasoning during diagnostic hypothesis generation by osteopaths consulting patients with acute low back pain: A qualitative case study approach

Background The clinical reasoning strategies employed in healthcare have been well established in a wide range of health professions. Currently, there is little literature pertaining to the diagnostic process of osteopaths and the clinical reasoning strategies utilised in osteopathy.

Aim To investigate the processes of clinical reasoning utilised by osteopaths in the diagnostic hypothesis generation for patients with acute low back pain.

Methods Two methods were employed: a thematic analysis in conjunction with content analysis which involved a novel 'consultation mapping' approach. Three osteopaths were video recorded taking a case history and performing examination procedures. Following conclusion of each consultation, participants viewed a video recording of the consultation, and provided a commentary which was audio recorded. All audio and video recordings were later transcribed for analysis.

Results Three themes were identified from the data which broadly represented three existing clinical reasoning strategies: Implicit cognitive evaluations not apparent to an external observer (pattern recognition); Iterative processing of cues assembled through clinical interactions (hypothetico-deductive reasoning); Collaborative interaction between patient and practitioner (collaborative reasoning). Each consultation was then 'mapped', and content analysis showed dynamic transitioning between three levels of pattern recognition ('light', 'moderate', 'heavy') of hypothetico-deductive reasoning. Collaborative reasoning occurred consistently at the commencement and conclusion of each consultation.

Conclusions The clinical reasoning strategies employed by osteopaths in this study were pattern recognition, hypothetico-deductive reasoning and collaborative reasoning. Each strategy was characterised by a theme which described its meaning.

Key words: Acute low back pain, clinical reasoning, osteopathy, video analysis

1. INTRODUCTION

Clinical reasoning is an essential component of clinical practice that focusses on the cognitive decision making processes concerned with patient evaluation and management (Banning, 2008; Edwards, Jones, Carr, Braunack-Mayer, & Jensen, 2004; Jones, 1992; Thomson, Petty, & Moore, 2011). It is widely accepted that an individual health professional's thought processing encompasses multiple factors which collectively form the process recognised as clinical reasoning (Higgs & Jones, 2000; Jones & Rivett, 2004; Mattingly & Fleming, 1994). More formally, clinical reasoning has been defined as "a process in which the clinician, interacting with significant others (client, caregivers, healthcare team members), structures meaning, goals and health management strategies based on clinical data, client choices, and professional judgement and knowledge" (Higgs & Jones, 2000, p. 11). Elstein et al.'s patient simulation study, which investigated the diagnostic clinical decision making of doctors (Elstein, Shulman, & Sprafka, 1978), was the seminal work on clinical reasoning in healthcare, and generated substantial early interest in clinical reasoning in medicine (Barrows & Tamblyn, 1980; Groen & Patel, 1985; Patel & Groen, 1986), and other allied health including nursing (Benner, 1984, 1985; Benner & Tanner, 1987), occupational therapy (Fleming, 1991a, 1991b; Mattingly & Fleming, 1994; Rogers & Holm, 1991) and physiotherapy (Jones, 1992; Payton, 1985). However, in comparison to other allied health, there has been little investigation of clinical reasoning in osteopathy, with only a small volume of recently emerging research on aspects such as osteopaths' conceptions of clinical practice (Thomson, Petty, & Moore, 2014a, 2014c, 2014d), clinical reasoning education and assessment (Fryer, 2008; Lalonde, 2013; Moore et al., 2014; Stone, Boud, & Hager, 2011), the application of clinical reasoning strategies (Thomson, Petty, & Moore, 2014b), and the role of palpation (Browning, 2014; Esteves & Spence, 2014).

Evidence-based medicine is the integration and application of the best available research, especially that which is patient-centred, with clinical expertise and the thoughtful consideration of each individual patient's values and expectations (Sackett, Rosenberg, Muir Gray, Haynes, & Richardson, 1996; Sackett, Straus, Richardson, Rosenberg, & Haynes, 2000). Jensen, Resnik, and Haddad (2008) note that decision making and clinical reasoning is both an intricate and essential dimension of expertise. Improvements in understanding of both clinical interactions and decision-making between patient and practitioner would therefore be useful to inform the clinical expertise limb of evidence-based practice.

Research into the clinical reasoning of osteopaths might therefore be considered a contributor to improving clinical expertise in osteopathy.

The main focus of the wider clinical reasoning literature has been on diagnostic reasoning (Coderre, Mandin, Harasym, & Fick, 2003; Croskerry, 2009; Elstein, 2009), and a range of clinical reasoning strategies have been described including hypothetico-deductive reasoning (Elstein et al., 1978), pattern recognition (Groen & Patel, 1985), collaborative reasoning (Edwards, Jones, Higgs, Trede, & Jensen, 2004) and procedural, interactive and conditional reasoning (Fleming, 1991b). Of these strategies, it has been recognised that osteopaths utilise the clinical reasoning strategies of hypothetico-deductive reasoning and pattern recognition (Sprafka, 2003; Thomson et al., 2014b). However, the extent to which these strategies are used, the relationship between the two, and the presence of other processes in the clinical reasoning of osteopaths have not been extensively investigated. Therefore, the aim of this study was to investigate the processes of clinical reasoning utilised by osteopaths in the diagnostic hypothesis generation of patients with acute low back pain.

2. METHODS

2.1 Study design

A multiple case study approach (Carter, Lubinsky, & Domholdt, 2011) informed by the interpretive paradigm was utilised in this qualitative research investigation. Case studies provide a credible, original and creative approach to research and are a valuable method in developing the theories and hypotheses required to generate the evidence base necessary for healthcare practice (Anthony & Jack, 2009; McGloin, 2008; Wisdom, Cavaleri, Onwuegbuzie, & Green, 2012). The depth and complexity of clinical reasoning cannot be well defined through a single investigation such as a lone interview or questionnaire (Unsworth, 2008). A rigorous inquiry into clinical reasoning by osteopaths was therefore well accommodated by the depth available within the case study design (McGloin, 2008). The reporting of this study follows the consolidated criteria for reporting qualitative research (COREQ) (Tong, Sainsbury, & Craig, 2007) – see supplementary material S5 for compliance with COREQ requirements.

2.2 Participants

2.2.1 Recruitment

Three osteopaths were recruited through convenience sampling from a single tertiary teaching clinic in New Zealand using email invitation. All osteopaths taught part-time in the same teaching clinic and all were graduates of the same UK based school. In accordance with the 'practice style' questionnaire of Wittwer Blaser (2009), all three osteopaths were identified as preferring the use of a 'practice style', informally described within osteopathy as 'structural osteopathy' (Thornton-Smith & Rajendran, 2010). A summary of practitioner characteristics is presented in Table 1.

A total of seven patients complaining of acute low back pain were recruited through word of mouth and distribution of fliers on local community notice boards and osteopathy clinics. Respondents to advertising, who showed interest in the study, were formally interviewed by telephone to discuss the research process, review eligibility criteria, and undertake a preliminary briefing. An appointment time was then established where respondents were briefed further and given the opportunity to have questions answered. Participants then gave written informed consent and were enrolled in the study, before being introduced to the practitioner. Each practitioner consulted two patients, except for

Practitioner A, who consulted three patients. A summary of patient characteristics is presented in Table 2.

Table 1 Characteristics of the participating osteopaths

Practitioner	Gender	Years of clinical experience	Education[a]	Practice Style[b]
A	Male	22	UK	Structural
B	Male	7	UK	Structural
C	Female	10	UK	Structural

Notes: a = 'education' refers to the country in which the practitioner's registrable qualification was awarded; b = 'practice style' was based on responses to a practice style questionnaire developed by Wittwer Blaser (2009). The term 'Structural' is an informal description in common use in the osteopathy community (Thornton-Smith & Rajendran, 2010).

Table 2 Characteristics of the participating patients

Patient	Gender (y)	Age	Onset of pain episode[a]	Occupation
1	Female	22	4 weeks	Student
2	Female	21	2 weeks	Student
3	Male	33	10 days	Massage Therapist
4	Female	28	4 weeks	Violin Teacher
5	Male	22	3 weeks	Student
6	Female	25	4 days	Student
7	Male	30	3 weeks	Statistical Analyst

Notes: a = 'onset of pain episode' refers to the time between the patients' involvement in this investigation and their first experience of the current episode of low back pain.

2.2.2 Inclusion criteria

In order to be included in this study, practitioners were required to fulfil the following criteria: (1) hold registration with the Osteopathic Council of New Zealand, and hold a current Annual Practising Certificate; and (2) have at least 5 years of clinical experience.

For inclusion, patients were required to satisfy the following criteria: (1) be aged between 20-50 years; (2) be experiencing, at the time of consultation, an episode of back pain which had lasted for no longer than 4 weeks. Patients were not eligible to participate if they exhibited any 'red flags' (such as sudden onset of a severe headache, vomiting, disturbed consciousness, severe and debilitating pain). Patients were offered the opportunity to withdraw their own data (single video recording) from the study up to five working days after their video was recorded.

2.3 Ethical considerations

Ethical approval for all procedures was granted by the Unitec Research Ethics Committee (UREC Approval No.: 2013-1028). The main ethical considerations were anonymisation, confidentiality and aspects of privacy related to video recording. All practitioners and patients gave written, informed consent to be video recorded and were offered the opportunity to withdraw their video for up to 5 working days post recording.

2.4 Procedures

The order of procedures carried out in this research investigation involved the following steps: (1) the patient and practitioner entered the consultation room, followed by an independent research assistant who turned the camera on and started the recording. The independent research assistant then left the consultation room; (2) the case history and examination procedures were video recorded. The osteopaths were provided with a pro forma case history form which had section headings to write case notes; (3) when completed, the practitioner knocked on the consultation room door to signal the research assistant to enter, turn off and remove the camera; (4) the video recorded file was then exported from the camera to a notebook computer; (5) practitioner then completed the consultation, providing osteopathic treatment and any relevant management advice; 6) the patient were then re-booked with a senior student osteopath in the tertiary clinic for ongoing care; (7) the practitioner then met the researcher in a separate and quiet room where the video recording was played and an audio-recorded, video-assisted commentary was carried out with the practitioners. Practitioners were encouraged to comment on their clinical reasoning at any stage while they viewed the video. The practitioners would signal when they had a comment to make regarding what they had seen, heard or recalled from the video, at which point, the researcher paused the video and verbally noted the time (time-stamp) at the end of the practitioners' comments; 8) the researcher also paused the video at different times to ask the practitioners question/s informed by predetermined prompts; 9) the audio-recorded commentaries were transcribed verbatim for further analysis.

2.5 Equipment and procedure (Data Collection)

Video recordings of the case history and examination procedures of each consultation were completed at a tertiary teaching clinic in New Zealand. An image of the room set up is provided in Figure 1. Consultation videos lasted between 25 and 42 minutes and were recorded on a high-

definition HERO3+ Black Edition (GoPro Inc., San Mateo, CA, USA) camera. The camera was contained in a skeleton case which permitted its attachment to a tripod stand. Video recordings were made using a narrow field of view setting, a video resolution of 1080p with a frame rate of 30 FPS, and 16:9 aspect ratio.

After the conclusion of the consultation, in six of the seven consultations, the participating osteopaths gave an immediate video-assisted commentary of their consultation. In one case, the commentary was undertaken two days after the consultation, between which the practitioner did not engage in any clinical practice. The video-assisted commentaries involved both practitioner free speech and prompts offered by the researcher (Table 3). Prompts included phrases adopted from those described by Thomson et al. (2014a) and Thomson et al. (2014d).

Table 3 List of prompts

1. What information did you gather from that clinical interaction?
2. What are your thoughts and feelings about the patient at this stage?
3. What was your reasoning behind doing 'X'?
4. What were you able to learn from the examination procedure?

2.6 Data Analysis

Two methods were employed: firstly, a thematic analysis informed by the approach described by Braun and Clarke (2006); and secondly, in conjunction with the thematic analysis, content analysis of the consultation was undertaken using a novel documentation technique ('consultation mapping') developed within the current investigation. All practitioner commentaries were transcribed verbatim and anonymised prior to data analysis.

2.6.1 Thematic Analysis

Each of the practitioner transcripts were read through once initially to enable the researcher gain a preliminary understanding of the practitioners clinical reasoning. A minimum of three further reviews of each transcript were then carried out by the researcher order to become familiarised with the data. Initial codes were then generated through highlighting, and note taking on each transcript.

Preliminary themes were then derived from the codes and reviewed by the researcher, highlighting different areas of interest which were discussed with the supervisors. Themes were then consolidated, defined and named by the researcher through an iterative process of writing, reflecting and re-writing; the process of theme development involved discussions with the research supervisors which occurred between three and five times each month over a three month period.

The three identified themes were not predetermined or deliberately sought out from the data; however, the themes were found to be consistent with clinical reasoning strategies identified in current literature. In effect, this matching allowed for an interrelation of both the identified themes (hermeneutic phenomenological inquiry) and the consultation maps (content analysis). Participating osteopaths were provided with a copy of their commentary transcripts prior to data analysis for the purpose of checking accuracy, and to add or clarify any additional comments in response to the transcripts.

Figure 1: A screen-shot from the GoPro video recording during a consultation. The image illustrates the room set up during the video recorded consultations. The case history was first taken with both the osteopath and patient/s seated to the right at a desk (as indicated by the pixilated area).

2.6.2 Content Analysis

Over a 6-month period, the researcher met regularly in person with supervisors (3 to 5 meetings per month) to discuss the findings and relevant analysis processes. From these meetings, the concept of consultation mapping was developed in response to attempts to develop schematics of the processes that were emerging from the data. Generation of a consultation map involved several stages: Firstly, as detailed above, each transcript was read through once initially, followed by at least three further reviews by the researcher. Through this process, the researcher became immersed in the transcripts, enabling the developed of a clinical reasoning strategy framework (see supplementary material S2) which reflected the clinical reasoning strategies undertaken by the participating osteopaths. Secondly, the clinical reasoning strategy framework was then used to identify the clinical reasoning strategies from each of the transcribed commentaries. Each comment from the osteopaths' commentaries was analysed three times to ensure the identification process was consistent in each case. Thirdly, when the osteopaths commented on their clinical reasoning, a time-stamp was made by the researcher. The identified clinical reasoning strategies in the transcripts could then be matched to their respective time-stamp. In effect, this enabled a link to be made between the osteopaths' clinical reasoning commentaries (informed by the video recordings) and the corresponding time-stamp. Fourthly, the now time-stamped clinical reasoning strategies were organised on a timeline specific to each observed consultation. Generation of a timeline for when each strategy was used enabled the researcher to 'map' the osteopaths' consultations, thereby illustrating a pattern of the clinical reasoning strategies used by each osteopath.

3. FINDINGS

Three key themes were extracted from the data: Theme 1 – Implicit cognitive evaluations not apparent to an external observer; Theme 2 – Iterative processing of cues assembled through clinical interactions; and Theme 3 – Collaborative interaction between patient and practitioner. Each theme will be presented in relation to four clinical phases (a to d) observed in each consultation: (a) pre face-to-face, and face-to-face, (b) structured case history, (c) structured examination, (d) combination phase. Figure 2 is a schematic diagram of these four diagnostic phases in an osteopathic

consultation (excluding treatment or management procedures as these were beyond the scope of this study) and acts as a framework through which the themes are described. The discussion of each theme is supported by one or more illustrative extracts from the commentary transcripts. A table of additional extracts is provided in S1 of the supplementary material.

3.1 Theme 1: Implicit cognitive evaluations not apparent to an external observer

Implicit cognitive evaluation is characterised by a practitioner's cognitive processing that is implicit and partially unknown to an external observer. As a process of implicit cognition (be it conscious or sub-conscious), implicit cognitive evaluations involve acquiring and processing of clinical information, followed by actions that appear to be informed by previously obtained knowledge.

3.1.1 Pre Face-to-Face Evaluation

Theme 1 – Phase 'A' Relationship of implicit cognitive evaluation to the pre face-to-face evaluation

Pre face-to-face evaluations represent the phase before face-to-face interactions between the practitioner and patient. Evaluations carried out by each participating osteopath during the pre face-to-face phase were, in this study, based upon the following factors:

- Practitioner knowledge that patients were presenting with acute low back pain
- Practitioners were given a page to write their notes on which basic patient details (age, gender and occupation) were pre-recorded

Practitioners acknowledged that these factors had an influence on their initial thoughts regarding patient presentation. Informed by previous experience and knowledge of these factors, the practitioners reported synthesising early hypotheses before face-to-face contact.

> *"With you having indicated that it would be acute low back pain, I'd already been starting to think of the classic list of acute low back pain differentials…"* [Practitioner B].

3.1.2 Face-to-Face Evaluation

Theme 1 – Phase 'B' Relationship of implicit cognitive evaluation to the structured case history: "Talking"

The structured nature of conversation has been highlighted in Figure 2 to best represent verbal communication. The participating osteopaths utilised both conversational (verbal) and observational (visual) cues to fuel their clinical reasoning with all practitioners initially directing their focus to 'ruling out' serious pathologies using what appeared to be active searching for the presence of clinical features associated with pathology.

> *"Serious back pain, in terms of structural damage to any of the structures in the lumbar spine, or pelvis, or any kind of pathology, were fairly down my list very early on… there wasn't an early on pathological picture of unrelenting pain disassociated with any kind of mechanical factors…"* [Practitioner B].

Assembling and recognising cues together evidently helped the practitioners to justify their diagnostic hypotheses.

> *"When justifying a sacro-iliac ligament sprain] Again mode of onset makes me believe that, in terms of having treatment performed through it which has upset it; the fact that she does a fair bit of yoga, so she's probably quite flexible so it makes it a little bit more prone to injury; the location of it, where she's feeling it would make me think that"* [Practitioner C].

Theme 1 – Phase 'C' Relationship of implicit cognitive evaluation to the structured examination: "Doing"

During the video-assisted debrief, it was evident that all of the participating osteopaths utilised observation to inform their examination procedures. It appeared that observational cues obtained through standing (static), directed active movement, and passive movements of the patient were evaluated concurrently throughout these procedures. In Figure 2, the label 'Doing' is a reference to the mode through which the osteopaths physically carried out their structured examination procedures.

Panel of a Nominal Consultation Structure

Pre Face-to-Face Evaluations	Face-to-Face Evaluations			
	Case History *(Subjective)*	**Examination** *(Objective/assessment)*	**Treatment** *(Plan)*	**Reassessment/Management** *(Plan)*

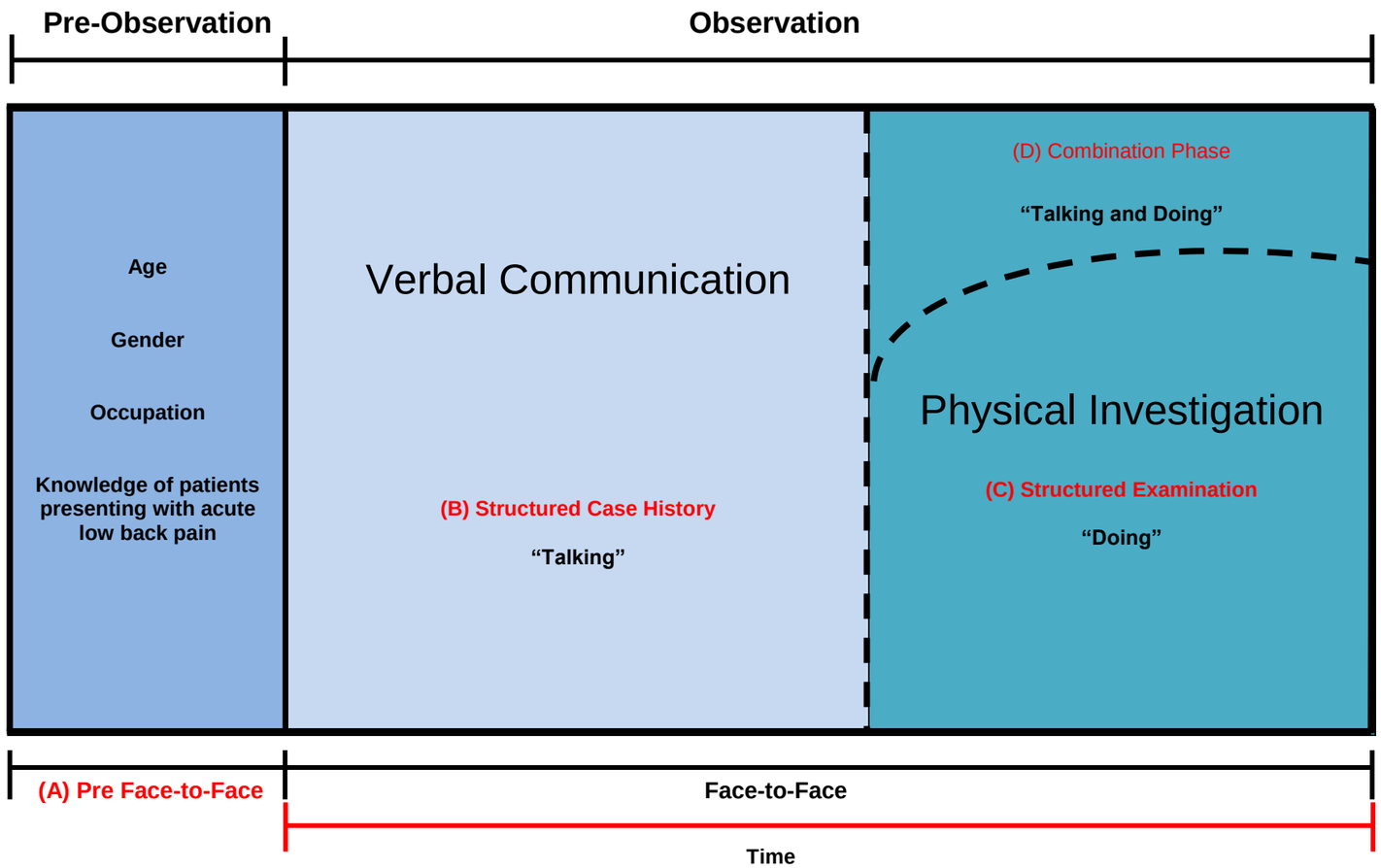

Figure 2: Schematic diagram of the initial diagnostic phases in an osteopathic consultation. The nominal consultation structure shown in the upper panel is intended to orient and emphasise the phases illustrated in the lower, larger panel below. Three phases have been colour coded in the nominal consultation structure panel to correspond with the larger panel. These three coloured phases represent the observed phases in this research investigation, which parallels the conventional 'SOAP note' structure as described by Cameron and Turtle-Song (2002). The length of the upper panel is nominal and not representative of any specific dimension of time length. Pre face-to-face evaluations do not feature in the SOAP note structure, but have been included in the nominal consultation structure as they were identified as a key part of the findings.

There are four phases (a to d) of evaluative processing illustrated in the larger panel provided above: (a) pre-face-to-face, and face-to-face: (b) structured case history, (c) structured examination, (d) combination phase evaluations. Collectively, the four phases align to form the time frame in which the research investigation took place. Pre face-to-face evaluations are described as the phase prior to face-to-face interactions, where the practitioner may start to generate a 'picture' based on initial patient descriptors e.g. age and gender. The structured case history phases involved the patient and practitioner exchange of verbal communication (i.e. "Talking") observed during initial questioning. The structured examination encompassed the procedures associated with physically carrying out (i.e. "Doing") patient-orientated examination. The combination phase amalgamated both the "Talking" and "Doing" elements from the aforementioned phases with general patient-practitioner conversation. Osteopaths utilised the combination phase to seek new information and revisit details obtained from earlier in the consultation.

The key words ‘seen’ and ‘see’ were identified in each practitioner’s examination-related descriptions. These words indicate the utility of visual stimuli and the recognition of familiar visual cues.

> *“What I’ve also seen whilst he’s doing that is that left side of his innominate is posterior and he’s got an adaptation in the way in which he does that movement which is highlighted again when he goes into extension”* [Practitioner A].

Theme 1 – Phase ‘D’ Relationship of implicit cognitive evaluation to the combination phase: “Talking and Doing”

The ‘combination phase’ refers to the presence of examination procedures, case history questioning and general conversation occurring concurrently. During this phase, the participating osteopaths sought additional new information, or revisited details to further inform their hypothesis generation.

> *“Whilst I was examining I was asking further questions in order to clarify my findings throughout the exam and also to back-track back to the case history and again just confirm my hypotheses and my findings”* [Practitioner C].

3.2 Theme 2: Iterative processing of information assembled through clinical interactions

Iterative processing is characterised by the participating osteopaths’ ability to dynamically alter their thinking in response to clinical information as it was received. Assembling this clinical information, be it familiar or non-familiar, was used by the participating osteopaths to synthesise and then ‘test’ hypotheses.

3.2.1 Pre Face-to-Face Evaluation

Theme 2 – Phase ‘A’ Relationship of iterative processing to the preface-to-face evaluation

In the described phase of pre face-to-face evaluation, iterative processing was not evident.

3.2.2 Face-to-Face Evaluation

Theme 2 – Phase 'B' Relationship of iterative processing to the structured case history: "Talking"

Instead of remaining fixed on a given question, examination finding, sign, symptom or diagnostic hypothesis, all participating osteopaths appeared to remain, to some extent, open to and comfortable with uncertainty in their reasoning. Iterative processing was observable in each consultation and was used to incorporate new clinical information as it became available.

> *"You'll hear in a minute she says something about pins and needles in her hands and so on, so I'm suddenly sort of thinking oh hang on this is not as clean cut as I first thought. So [I'm] going back from postural to neurological type thoughts"* [Practitioner A].

Theme 2 – Phase 'C' Relationship of iterative processing to the structured examination: "Doing"

During physical examination, iterative processing appeared to be used when testing hypotheses through the addition of various physical examination procedures. Amalgamating these tests and the related clinical information enabled the osteopaths to refine, accept and discard hypotheses.

> *"There was what seemed to be a superiorised left innominate when he was standing which was then perfectly fine sitting and then there again lying down with no noticeable leg length [discrepancy], which is also why I checked the SI joints as they didn't feature at all in my original examination plan"* [Practitioner B].

When the case history did not reveal enough information for the practitioners to reach confident differential diagnoses, palpation was often utilised as a diagnostic method alongside orthopaedic or special testing.

> *"So I'm happy to now rely a lot more heavily on my palpatory and movement interpretation side of things. I haven't got enough out of this history to be able to really nail what it is I'm likely to be looking at…"* [Practitioner A].

Palpation appeared to play both a diagnostic, and confirmatory, role in the examination process. This was observed through the assembling of clinical information and the testing of hypotheses.

"So even with his knees up and his lumbar spine in flexion, his psoas was very easily palpable through his abdomen. So I think that's hanging around, and kind of pulls my number three diagnosis [psoas spasm] up a little higher really. So it ends up being 1-3-2 rather than 1-2-3" [Practitioner A].

Theme 2 – Phase 'D' Relationship of iterative processing to the combination phase: "Talking and Doing"

During physical examination, osteopaths were observed to gather additional verbally-oriented clinical information which subsequently informed the examination procedures in an iterative process.

"With the comment about the weird spacing there, just brought me back to my original thought about a spondylolisthesis which is why I'm checking the lumbar spine at the moment. [I'm] just looking at SPs, looking at any kind of rotation or side-bending through it and any vertebra or whether there was a step" [Practitioner B].

3.3 Theme 3: Collaborative Interactions between the patient and practitioner

Collaborative interaction has been defined in this study as communication based on the consensual involvement of both patient and practitioner which may include the development of rapport, reassurance, education, shared management strategies and patient empowerment.

3.3.1 Pre Face-to-Face Evaluation

Theme 3 – Phase 'A' Relationship of collaborative interaction to the pre face-to-face evaluation

During the phase of pre face-to-face evaluation, collaborative interaction was not evident.

3.3.2 Face-to-Face Evaluation

Theme 3 – Phase 'B' Relationship of collaborative interaction to the structured case history: "Talking"

When first engaging with the patient, Practitioner A placed a great deal of importance on establishing rapport and advising what the consultation process would involve.

"So the scene setting side of things is quite an important phase in my opinion, simply because it allows the patient to have a sort of context as to what's happening next all the time. And if they know where the break points are and where they can either get out of the situation or how much information is required, then I think they give you more" [Practitioner A].

All three participants emphasised the role of reassurance and the careful use of language. Patients were observed to express relief when reassured by practitioners that their complaints were likely to respond to osteopathic care. Therefore, reassurance is a key component to acknowledge when identifying the characteristics of collaborative interaction.

"You don't want to scare patients off with potential things like 'bulging discs' and things like that so I'm just reassuring the patient… I'm trying to make the patient feel quite secure because obviously there is treatment available and there are things that you can help with" [Practitioner C].

Theme 3 – Phase 'C' Relationship of collaborative interaction to the structured examination: "Doing"

During the phase of structured examination, collaborative interaction was observed as co-operation. Patients used words such as "yes" and "ok" when carrying out physical examination procedures, co-operating and subsequently following the practitioner's instructions.

Theme 3 – Phase 'D' Relationship of collaborative interaction to the combination phase: "Talking and Doing"

Education was identified by all three osteopaths as a method to promote involvement of patients in their own recovery. By incorporating lifestyle factors such as physical activity into their discussion, practitioners used education to further collaborate with their patients on an individualised level.

"Together we were both reassured they weren't painful, later talking about how we could eventually use more yoga to strengthen her core" [Patient C].

Collaborative interaction between osteopath and patient around therapeutic management was a strongly apparent observation, with each practitioner identifying patient involvement as critical to the recovery process.

> *"We've got to do a bit of a combination of just me working through the muscles to try and release the tension and then having [the patient] doing some exercises to help stretch the muscles on a more regular basis which is just going to help improve the support through [the patient's] back"* [Practitioner C].

One aspect of the collaborative process was that practitioners emphasised during the video-assisted commentary was the importance of empowering the patient. Illustrating to patients that the recovery process can be positive was a method by which practitioners strengthened their collaborative interactions.

> *"I try to put more of a focus on what the positive things are that they can do in the first treatment session rather than telling them off… It's really important to make the patient feel empowered so that there are things that they can do to help themselves out"* [Practitioner C].

3.4 Consultation Mapping

The existing clinical reasoning strategies of pattern recognition (Groen & Patel, 1985), hypothetico-deductive (Elstein et al., 1978) and collaborative reasoning (Edwards, Jones, Higgs, et al., 2004) were identified in each of the seven observed consultations. Figure 3 is an example of one consultation map which represents a single consultation undertaken by Practitioner A. The map illustrates the consistent presence of pattern recognition and three levels of hypothetico-deductive reasoning (light, moderate and heavy). These three levels were identified as practitioners appeared to use hypothetico-deductive to different extents depending on the complexity and familiarity with the clinical information. When there was evidence of the practitioners recognising clinical information, this was documented as pattern recognition. Similarly, hypothetico-deductive reasoning was seen in varied extents of practitioner uncertainty. Collaborative reasoning was evident at the commencement of the interaction, and was dispersed throughout the consultation and was, in every case, present in the final minutes of the observed consultation phases. Classifications of each reasoning strategy are provided in the supplementary material (see S2).

The findings demonstrated in Figure 3 are broadly consistent across the three osteopathic practitioners and seven cases observed (see supplementary material S3 and S4 for additional consultation maps which support this finding).

- "…taking the word 'bar-work' generates a certain picture in my head.
-"I'm trying to clarify whether I've got the right picture of not- if she's standing behind a bar pouring pints, that's quite different to working in a waitressing situation or a silver servicing or something along those lines."
-"I just wanted to clarify whether she was on her feet all the time or whether she was able to sit down on a bar stool (or something) and relieve her back from pressures."

- "It's a functional problem, in terms of joint quality of movement and muscular spasm that's been established through this incident, or series of incidents perhaps."
- "I'm interested now in the quality and range of movement, what she finds difficult rather than what she can or can't do."

- "So again confirming the idea that it's movement related- when she lies down and takes herself off of weight bearing, she feels change. So it's got a weight component to it- she gets relief."

- "I was just looking for tethering in case there was some old disc injury underneath there or neurological restriction, range of movement and so on that I would have encountered first in bias in the use of the pelvis."
- "… it was really just a case of trying to find out where the worst of the tension in the hamstring was- whether it was more medial or lateral."

Clinical Reasoning Strategies		Time (Minutes)																							
		1:01	2:41	3:48	6:18	6:35	7:20	7:55	8:58	9:43	11:20	15:26	18:21	18:51	19:25	20:55	21:17	23:02	23:52	26:20	27:32	30:12	32:53	35:33	37:20	37:50
Pattern Recognition			1		1,2			2,3,5,6			1,2			1								1				
Hypothetico-Deductive Reasoning	Light		2,3					1						2							2					
	Moderate	2		2	3			4	1,2												1					
	Heavy																									
Collaborative Reasoning		1		1																		2				

- "So again I've got a motivational aspect there as well so in the future we can talk about perhaps improving her netball performance, improving her training regimes and so on in order to achieve higher honours at netball, because it's an aim that we can go for."
- "What I'm aiming to get out of it at this stage is less about specifics of a particular position that she might play or something along those lines, much more about the amount of energy being consumed and the amount of jumping around that's required."

- "…for completeness as much as anything else, just to make sure I've got enough of the relevant timeline and if she wants to add more in and say "oh no I had a car crash 6 weeks before I took up tennis" then there is an opportunity for her to say so.

- "…internal/external rotation is also trying to find out whether there was bias in the piriformis as sometimes when they internally rotate like that, the piriformis pulls the pelvis off to one side and they rotate as well. So if the pelvis is rotated in space I know that some of it's coming from her hips."

- "So the word 'jarred' there is a relevant word for me, she didn't talk about spraining it, she didn't talk about progression. It sounds like an acute onset locking kind of scenario where she just jarred and can't do something, like something's suddenly happened. So it infers all sorts of locking questions in my mind."

- "Can you see that? Similar distance, so the hands don't go flat to the floor so I know the hamstrings are too tight."

- "…if I can get a better picture of how the system needs to be manipulated, for lack of a better word, to improve it, and I can explain that in lay terms to the patient, then I can get them to sign off on the consent and we move into the treatment process from there."

Figure 3: Illustrative consultation map of one practitioner (Practitioner A). Three clinical reasoning strategies were identified from the data: pattern recognition, hypothetico-deductive reasoning and collaborative reasoning. The strategies were identified through a clinical reasoning strategy framework (see supplementary material S2) derived from the practitioner's commentary transcripts. When a strategy was recognised, the corresponding timestamp (as made during the video-assisted debrief) was highlighted. The highlighted strategies correspond to the yellow, blue and green coloured boxes, thus representing when each strategy was apparent in the data. Timestamps with multiple strategies shown are numbered to represent the order in which strategies were seen to be employed, illustrating a 'dynamic transition' between clinical reasoning strategies (see discussion for further details). The arrowed boxes outside of the table provide illustrative extracts from the transcripts in relation to each strategy.

4. DISCUSSION

4.1 Main findings

The aim of the study was to investigate the processes of clinical reasoning utilised by a small sample of osteopaths during diagnostic hypothesis generation for patients with acute low back pain. The main finding of this study was the identification of three themes: 'implicit cognitive evaluations', 'iterative processing', and 'collaborative interaction'. Each of these themes has a close association with three identified clinical reasoning strategies present in the literature. The theme 'implicit cognitive evaluations' observed in this study were most consistent with the existing strategy of 'pattern recognition' (Groen & Patel, 1985). Participating osteopaths appeared to recognise and draw on information from prior clinical experiences during both case history and examination procedures in order to justify hypotheses. Drawing on their recollection of knowledge organised from previous encounters to inform their present consultations, characteristic of clinical expertise, and was demonstrated by all participants (Benner, 1984; Feltovich, Prietula, & Ericsson, 2006; Jensen et al., 2008; Norman, 2005).

The second theme of 'Iterative processing' aligned most closely with the well-known strategy of hypothetico-deductive reasoning as first described in healthcare by Elstein et al. (1978). When the participating osteopaths appeared to experience diagnostic uncertainty, they engaged in an iterative process in which they gathered clinical information, formulated hypotheses, interpreted clinical information and tested these hypotheses (Elstein et al., 1978). The process of refining, accepting and discarding hypotheses evident in this study is consistent with hypothetico-deductive reasoning approaches described in a wide range of other health professions including: medicine (Coderre et al., 2003; Heemskerk et al., 2008), physiotherapy (Edwards, Jones, Carr, et al., 2004; Smith, Higgs, & Ellis, 2008) and osteopathy (Sprafka, 2003; Thomson et al., 2014b). The application of both pattern recognition and hypothetico-deductive reasoning together is consistent with diagnostic reasoning literature in medicine (Coderre et al., 2003; Elstein, 2009; Schwartz & Elstein, 2008) and physiotherapy (Doody & McAteer, 2002; Edwards, Jones, Carr, et al., 2004; May, Greasley, Reeve, & Withers, 2008).

As a component of diagnostic reasoning, palpation was utilised by the participating osteopaths, especially during periods of uncertainty to complement physical assessment procedures (such as orthopaedic and special testing). Findings from palpation were used to test hypotheses and assist in the ranking of their respective importance in the context of each case. Palpation therefore played a key role in the clinical reasoning processes of osteopaths in this investigation. This finding supports the claim of Esteves and Spence (2014, p. 53), who suggest that "palpation plays a central role in osteopathic clinical decision making". Furthermore, this finding is consistent with models of diagnosis described in osteopathy textbooks which emphasise the role of palpation in the diagnostic process (Kuchera & Kuchera, 1994; Ward, 2003).

The third theme, 'collaborative interaction', aligns with the clinical reasoning strategy of collaborative reasoning, as first described in physiotherapy (Edwards, Jones, Carr, et al., 2004; Edwards, Jones, Higgs, et al., 2004; Jensen, Gwyer, Hack, & Shepard, 1999). Osteopaths in this study placed care and importance on the nature of language extended to patients as part of the process of reassurance. It is well known that reassurance can positively influence a patient's perception of their low back pain (Accident Compensation Corporation, 2003; Darlow et al., 2013). The nature of language in a consultation can also negatively influence outcomes, for instance, in a recent New Zealand study of patients with acute and chronic low back pain, Darlow et al. (2013) found that practitioners who offered negative explanations ("what patients should not do") contributed to the development of patient's avoidance beliefs and maladaptive behaviours. Darlow et al. (2013) argues that maladaptive patient behaviours such as worry, frustration, increased vigilance and guilt may be 'protection strategies' that patients adopt to protect their back.

The findings from this study indicate that participants viewed collaborative management, patient education and patient empowerment as critical components of their therapeutic communication. These collaborative, educational and empowerment traits parallel two of the three 'conceptions of practice' identified in a grounded theory study of clinical reasoning in osteopathic practitioners (n=12) by Thomson et al. (2014a). Specifically, in the present study all three participants exhibited characteristics of Thomson's 'communicator' and 'educator' conceptions. These conceptions were consistent with the theory of clinical decision-making offered by Thomson et al. (2014a), who

describes a willingness to facilitate a shared approach to management and to guide the learning and education of their patients.

In a recent grounded theory investigation, Thomson et al. (2014b) describes the use of hypothetico-deductive reasoning and pattern recognition in the diagnostic reasoning process of osteopaths. An "interplay" of both of these strategies was observed, where the perceived degree of complexity and familiarity determined which strategy would be used (Thomson et al., 2014b). In the context of the current study, findings from the consultation maps identified that all participating osteopaths predominantly utilised hypothetico-deductive reasoning and pattern recognition, transitioning dynamically between both strategies during the observed clinical encounters. This transitioning is consistent with the work of Thomson et al. (2014b) and, to our knowledge, is the second study to illustrate the dynamic use of both diagnostic reasoning strategies in an osteopathic consultation.

Another finding from the consultation maps was the identification of collaborative reasoning. Collaborative reasoning is a clinical reasoning strategy that involves a consensual approach to goal setting, interpretation of findings from the examination, development, and implementation of treatment between patient and practitioner (Edwards, Jones, Carr, et al., 2004; Edwards, Jones, Higgs, et al., 2004). Collaborative reasoning may be empirically and pragmatically recognised by many osteopaths as an inherent component to their clinical practice. In the context of this study, the mapping of collaborative reasoning provides direct evidence of its application in osteopathy. Surprisingly, this investigation appears to be the first to formally acknowledge the presence of collaborative reasoning within a reasoning process undertaken by osteopaths.

Patient-centred care has been described as a process that involves skilled therapeutic communication and patient empowerment, whereby, patients make informed decisions (Stewart, 2005). Despite the assumption that osteopathy is patient-centred, there is little available evidence from direct observation in the literature to support this claim. The idea of collaborative clinical reasoning is strongly associated with patient-centred care. One of the main findings from the consultation maps in this investigation was the confirmation of collaborative reasoning at the commencement, during, and conclusion of the interaction. In effect, this finding provides preliminary support for the claim that patient-centred, collaborative care occurs in osteopathy.

The use of video in the current study offered three main advantages: (1) the researcher was able to observe the consultations without being present in the room, which is advantageous in reducing "Hawthorne Effects" inherent in observation (Croskerry, 2009). The video camera used was small and minimally obtrusive which, in comparison to the presence of a third party, was less disturbing for the participants (patient and practitioner); (2) Video enabled the researcher an opportunity to undertake a post-consultation debrief with the respective osteopath, while watching the recording. The osteopath could then use the video as a prompt to explain what they were thinking at any point of interest, even in the absence of verbalisation on the recording. Comparably, this prompt to explain thinking wouldn't be as obvious using audio recording alone. (3) Video recording enabled the researcher to undertake multiple reviews of a consultation while concurrently reviewing the debrief transcripts and added a further dimension to data analysis compared with isolated review of the interview and written transcripts. A second strength was the development of consultation mapping as a novel approach to illustrate the utilisation of clinical reasoning strategies. The consultation map, essentially a modified timeline schematic, enabled visualisation of the types of clinical reasoning strategies employed, and their temporal organisation. To our knowledge, this is the first study of clinical reasoning to map clinical reasoning strategies *vs*. time using this format.

4.2 Limitations

Clinical reasoning is an internalised cognitive process (Higgs & Jones, 2000), and due to its implicit nature, many components of clinical reasoning are unobservable to anyone other than the practitioner (Thornton-Smith & Rajendran, 2010). For this reason, and in common with all attempts at observational research in clinical reasoning, there applies a general caveat that the accuracy of findings is at least partly dependent on the participating osteopaths' capacity to verbalise their clinical reasoning with clear and appropriate language.

The osteopaths in this study were provided with a pro forma history form which included section headings. The pro forma may have influenced the participants' clinical reasoning processes by introducing a process of note-taking outside of their norm. Although participants were all familiar with this pro forma in their teaching roles, the use of their own preferred method of case history note taking would have been preferable and improved the representativeness of the interaction to their own typical behaviours and processes.

The three osteopaths who participated in this study were a sample of convenience, recruited from a single tertiary teaching clinic in New Zealand. Furthermore, the osteopaths were graduates from one UK based school and all taught on a part-time basis as clinical tutors in the same teaching clinic. In their own private practices outside of their teaching roles, all of the practitioners recorded, using the 'practice style' questionnaire described by Wittwer Blaser (2009), a preference towards the use of manual therapy techniques informally described as 'structural osteopathy' within the osteopathy community (Thornton-Smith & Rajendran, 2010). This small, relatively homogenous sample, cannot represent the apparent diversity of clinical approaches used by practitioners in osteopathy. Further research needs to be conducted with a broader range of osteopaths from diverse backgrounds to develop the level of generalizability to the wider profession.

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Supplementary Material: S1 Table of additional verbatim quotes to support themes

Theme	Phase	Illustrative Extract
Theme One- Implicit Cognitive Evaluations	Phase One	*"I think given that I already knew that the general complaint would be orientated around low back pain, I used that to guide my initial thoughts…"* [Practitioner A].
		"Before I had met the patient I was thinking of potential causes given her occupation, gender and age…" [Practitioner C].
	Phase Two	*"I'd already sort of decreased the likelihood of it being anything 'bad' in terms of an acute disc or an acute muscle spasm or anything that would cause any kind of pain modification behaviour"* [Practitioner B].
		"So there doesn't seem to be any observable signs of an acute disc radiation. It seems to be more that there's a lot of tension there through the hamstrings which is potentially creating a little bit more of a neural stretch so I'm not worried about having to refer this patient immediately. There are no real significant red flags that are showing up" [Practitioner C].
		"I'm sort of reassured that the standing and the posture seems to be the major part of it and so I don't think I am looking at anything too serious, obviously she's fit and young so the likelihood is pretty low" [Practitioner A].
	Phase Three	*"So because I've had a funny result with the slump I've gone for an SLR just to corroborate and again I'm not expecting to be any positives here, and there wasn't"* [Practitioner A].

"I was expecting it to be pretty much the same finding and it was. And so again it was 25 degrees, patient had the leg completely relaxed so there was no, there was no tension held on there" [Practitioner C].

"With the original ligament presentation I'd been expecting the right side that would have been way more mobile than the left, and it was the opposite. So I then wondered whether the hip joint itself was involved which is why I tagged it on to my examination at that point" [Practitioner B].

"So I've already seen it, I've already seen the crest height problem and the rotation. As soon as she's standing there you can see that it faces one way" [Practitioner A].

"I've got my hand on his hip and through his legs, so in a way I'm actually interested in getting tissue feedback and doing very specific you know, passive examinations of individual segments to see what's going on there and I can feel it's all just tight and it's all locked up" [Practitioner C].

"All the other movements had been very very stable, very controlled as, as befitting somebody of that stature and with that kind of muscle definition" [Practitioner B].

"In my own picture in my head, I can already see that he's really tight through the hamstrings and through the hips and probably not very flexible at all. So I'm already forming a bit of an opinion in my head in terms of what I'm going to be expecting to see in my examination" [Practitioner C].

	Phase Four	*"So I'm just asking a couple of screening questions to see if there's anything else that has cropped up and she then does say something about her thorax, so I end up having a little light review of her thorax"* [Practitioner A]. *"I was just going back to a few questions we had talked about earlier"* [Practitioner B].
Theme Two- Iterative Processing	Phase One	*Not applicable.*
	Phase Two	*"That essentially kind of made me not do a complete U-turn, but revert the order of my differentials in terms of importance. Violin not being an aggravating factor at all makes it highly unlikely that it was due to that posture"* [Practitioner B]. *"What she said at the very beginning does not really lead me to believe it's anything gastro-intestinal related, but I'm asking the questions just to be sure"* [Practitioner B].
	Phase Three	*"How the body is feeling, how the tissues are moving, what the joints are doing- but it's mostly about tissue. So it's about muscle and fibrotic tissue etc. and just getting back positive feedback in terms of, you know, how it's all moving"* [Practitioner C]. *"That's where sort of follow your fingers to some extent in terms of finding out which tissues are responding better, which are still sticking around, which ones aren't responding and the case history won't give you that"* [Practitioner B]. *"I think without the palpation I would have not picked up on the psoas, I would not have picked up on the degree of lumbar hypertonia asymmetry"* [Practitioner A].

	"I am feeling for reaction of the muscles, how acute they are, feeling for any kind of spasm or like severe muscle rigidity, fluidity of movement, ease of movement, those sorts of things really" [Practitioner C].
	"So I think the quality of the feedback in palpation was absolutely fundamental to picking up on that [hypertonic musculature and joint restriction] because from an orthopaedic point of view all those tests were negative" [Practitioner A].
	"From an orthopaedic perspective they just would not have picked up on any of the stuff I just picked up on. They would say your discs are sound, your joints are sound, there's nothing wrong, go away and get fit. That grey area of understanding of how the body is starting to break down can only be found through palpation in my opinion" [Practitioner A].
	"There were facet restrictions in the lumbar spine on compressive side-bending bilaterally but there was also increased muscle tone bilaterally which was found to be preventing those movements from happening" [Practitioner C].
Phase Four	*"I investigated that a little bit, he was saying that a lot of the treatment was done with very strong muscle energy technique which I took to be PNF stretching to increase the range of motion, and that tempered the way in which I was going to approach his back and pelvis from here on in because I didn't want to upset something"* [Practitioner A].
	"After those comments from the patient, I decided to have a closer look at the thoracic spine" [Practitioner C].

Theme Three- Collaborative Interaction	Phase One	Not applicable.
	Phase Two	*"So that scene setting aspect of things is, if you are able to get them to relax in that scenario then you get more information and then if it's all very stilted and doctor-y"* [Practitioner A]. *Because you haven't met them before that instance, you start to develop a bit of a practitioner-patient rapport which is important to make the patient feel comfortable cause most of the time they're in quite a significant amount of pain"* [Practitioner C]. *"It's always good to be careful about the words you use to describe the patient's problem"* [Practitioner A]. *"I find it's important to talk to the patient in a language they can understand, both in terms of lay-terms and also anatomical language"* [Practitioner B]. *"I try and always, I don't like to scare my patients so it's something that I just try and make them feel a little bit calmer about it and you know try to assure them that there is a way forward. I think also for the fact that you know you'd want to think about the outcome of the treatment session and you want them to sort of feel quite positive about the experience so I think positive reassurance is really important in terms of a therapy perspective as well"* [Practitioner C]. *"So with what we [osteopaths] do, their [the patient's] reaction to that and their involvement in it will be a fairly major determinant in whether or not the practitioner and the patient establish good rapport which is then going to be very determinant on whether or not the patient gets better"* [Practitioner B].

	Phase Three	Not applicable.
	Phase Four	*"If I can enlighten people to the areas that need to be addressed in some way, it's then up to them how they get it done"* [Practitioner A]. *"I tend to see myself quite a bit as a preventer/educator"* [Practitioner B]. *"I think it's very important to educate the patient, so if there's something that they could be doing in a slightly different way then you know you need to educate them in that. And potentially, possibly also their role in how the problems come about- that's important as well"* [Practitioner C]. *"If they've got the right motivation towards getting themselves better and I can help steer them in the right direction then we'll both get there"* [Practitioner A]. *"It's a two way street in terms of treatment and management"* [Practitioner C]. *"We've got to do a bit of a combination of just working through the muscles to try and release the tension, and get him doing some exercises to help stretch the muscles on a more regular basis which is just going to help improve the support through his back"* [Practitioner C].

Clinical Reasoning Strategy		Problem Complexity[4]	Time[5]	Definition	Criteria	Key Words	Extract Examples
Hypothetico-Deductive Reasoning	Light	Simple	Period of consideration tends to be quite short	A process involving cue acquisition, hypotheses generation based on clinical data and knowledge, cue interpretation and hypotheses evaluation through further inquiry (Elstein, Shulman, & Sprafka, 1978, 1990). The three categorisations (light, moderate, and heavy) involve the same process of hypothetico-deductive reasoning. The observed differences are based upon the increasing complexity of the problem in question and the depth of thinking required.	Evidence of two or more hypotheses being considered/ruled out, associated with problems that are less complex. Seeking information to determine a yes/no answer or familiar simplicity.	No set key words, instead sentence structure is commonly based on a list or series of components which are being considered.	- "It was really just a case of trying to find out where the worst of the tension in the hamstring was- whether it was medial or lateral" (Practitioner A). - "So here again I'm trying to establish whether getting in and out of the car is relating to the sacro-iliac joint, which it isn't" (Practitioner C).
	Moderate	Medium	Period of consideration tends to be longer than that observed in Light Hypothetico-Deductive		Evidence of multiple hypotheses being considered/ruled out, associated with problems of increased complexity. Clinical uncertainty is not explicitly marked. Complexity	No set key words, instead sentence structure is commonly based on a list or series of components which are being considered.	- "…Bowel, bladder, gynae scanning checks more than specifics to see if there's any themes in there that might suggest referred pain" (Practitioner A).
	Heavy	High in complexity	Period of consideration tends to be longer than that observed in Moderate Hypothetico-Deductive		Evidence of uncertainty with further depth of thinking observable. Clinical uncertainty may be explicitly marked.	"Unsure**"** **"**Uncertain**"** **"Unconvinced" "Battling"**	- "At this point I'm **unconvinced** of my findings" (Practitioner A). - "I'm still **battling** a little bit here; I haven't got a **clear** idea of what I'm going to be looking at" (Practitioner A).

[4] Problem complexity is a broad term used to encapsulate the apparent difficulty of a problem. It may also represent the depth of thinking required to reach a conclusion.

[5] Time is relatively self-explanatory. Each problem that is encountered may warrant short or long thought processes depending their complexity.

Pattern Recognition	Varied complexity, based upon the recognition of a pattern	Period appears to be much faster	Expert clinical reasoning in non-problematic situations where situations may resemble pattern recognition or the retrieval of knowledge from previous experiences. New cases may be categorised based on similarities to previous patient presentations (Groen & Patel, 1985).	Evidence of drawing on previous experience, practitioner acknowledgement of identifying familiar signs, symptoms, outcomes and contexts based on previous encounters.	"Indicates/Indicator" "**Suggests**" "Expect"	- "The left shoulder blade was protracted and elevated which was normal for a violinist, which is also why I'd asked about the chin rest before hand" (Practitioner B) - "So the muscular bracing presumably was slightly asymmetrical which **suggests** to me that normally she would be slightly rotated with her spine on her pelvis" (Practitioner A)
Collaborative Reasoning	Not defined by problem complexity or time duration.	Not defined by time period.	"The nurturing of a consensual approach towards the Interpretation of examination findings, the setting of goals and priorities, and the implementation and progression of treatment" (Edwards, Jones, Higgs, Trede, & Jensen, 2004, p. 73).	Evidence of joint aims being set, inclusive language utilised, patient presented opportunity to provide their own opinion, given options about management preferences, practitioner consideration of patient and their understanding of the problem and consultation process.	**"We"** "Together" "Collectively" "Aim"	- "I'm sort of thinking right ok… there's a lot **we** can do in terms of actually treating it [the patient's problem]" (Practitioner C). - "I've got a motivational aspect there as well so in the future **we** can talk about perhaps improving her netball performance" (Practitioner A).

Supplementary Material: S2 Clinical Reasoning Strategy Framework.

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- "Having met the patient and then seen the walk into the room- young, no antalgic posture, no apparent pain sitting down, no discomfort, I'd already recognised and decreased the likelihood of it being anything 'bad' in terms of an acute disc or an acute muscle spasm or anything that would cause any kind of pain modification behaviour."

- "It's rarely as clear-cut, but after a chat we both found it quite reassuring that the two relieving factors that the patient had were exactly the opposite of the aggravating factors."
- "As soon as she put her tissues in the reverse position, her symptoms went away, and that to me…strongly suggested that it was more a postural component."
- "Because of that, I then went on to the next question which was more about neurological symptoms in the upper extremity to see how much of the neck was involved and which tissues I could then start looking at individually."

- "Palpation showed that yes, there was some increased tone through those muscles- there was a little bit of tissue feel that I'd normally associate with semi-chronicity…"
- When the patient was lying on the table, whilst there was rotation of the left lower limb, the right was neutral which made me think that there wasn't a huge amount of pull through that right gluteal area."

- "Especially having just identified that a golf ball in the piriformis area seemed to help a lot, I wanted to make sure there wasn't something akin to piriformis syndrome or some kind of sciatic nerve contribution and that seemed the easiest way to figure that out."

- "…at this point I've started to think of prognosis and now is when I'm thinking this isn't going to get better instantly because there are various processes interacting together."

Clinical Reasoning Strategies		Time (Minutes)																										
		0:25	0:30	3:00	3:50	4:43	5:08	6:22	7:24	8:05	8:34	9:40	10:08	10:45	12:23	12:44	15:41	20:53	21:30	24:35	26:44	27:55	34:53	35:21	35:38	35:48	38:08	41:09	42:26
Pattern Recognition								2,3			1,3		1,2	2	2				2,4		1,2				1,2				1
Hypothetico-Deductive Reasoning	Light							1						1					3										
	Moderate										2				3														
	Heavy																		1										
Collaborative Reasoning															1														2

- "…the main relieving factor was something that correlated to muscle function given my differentials in terms of muscles being included in the pain generating process."

- "…when I've come across these kinds of changes in other patients, the level of stress they describe is generally much higher and it seems to fit quite well: stressed up to the eye balls and their menstrual cycles have changed."

- "I think a lot of the time, especially nowadays with so much information being freely available, if you can reassure a patient and say what's wrong with them, then you can alleviate quite a lot of apprehension or fear."

- "…with the pain having been present in the lateral thigh I'm starting to think of the list of either referred pain or thigh pain causing structures in terms of the muscles around the pelvic girdle, obviously lateral femoral cutaneous nerve of the thigh, SI and hip joint as well as lower back to a lesser degree in terms of referral pain patterns…"

- "With that initial description I essentially had a list of differentials that spanned neck, (grossly speaking) neck, upper rib cage, scapulo-thoracic and GH joint as well as the upper arm- both in terms of the symptoms described and how to make them worse as well as the patient's occupation."

- "I'd noticed just standing at neutral there was a little bit of a rotation right through [the patient's] spine, not by much, only about 5 degrees overall which I thought was quite interesting because in all the violinists that I've seen before, the spine is rotated the other way. When they're right handed it is rotated left."
- "The left shoulder blade was protracted and elevated which was normal for a violinist, which is also why I'd asked about the chin rest before hand."

Supplementary Material: S3 Illustrative consultation map of one practitioner (Practitioner B).

- "I got the patient to clarify and explain in her own words exactly where she was feeling the pain and she was pointing directly over the sacro-iliac joint area."
- "Getting that kind of referred pain into the hip made me think immediately that there could have been a sacro-iliac ligament sprain/irritation."

- "So again, very typical that that specific exercise puts one of the greatest loads on the lower lumbar discs because there is no support whatsoever apart from the abdominal muscles... So it's a huge overloading on her discs by doing that."

- "I'm just letting the patient describe in her own words how she feels about it. And so the choice of words is very important as well in terms of coming to a little bit more of a conclusion as to what I think the diagnosis is."
- "Those words 'I feel very nervous around it', 'I feel like I can't trust it', or 'I feel like it's going to give way', they tend to make me feel that there's a bit of an instability there and again of very much a discal picture."

- "Here I'm trying to establish whether this potentially is a nerve root irritation or a referral pattern."

- "I was testing function, I wanted to assess a little bit of foot function and also just check to if power was present and equal both sides."

Clinical Reasoning Strategies		Time (Minutes)																								
		1:03	2:08	2:36	3:09	4:23	6:44	8:03	9:46	9:55	10:39	11:47	12:41	14:09	14:28	16:01	17:11	18:03	18:39	21:34	23:06	23:48	25:33	26:09	29:48	30:52	31:52
Pattern Recognition		1,2		2		1,3	1,2					1		1,2		2	2		1,2,3					1			1
Hypothetico-Deductive Reasoning	Light											2				1										1	
	Moderate																										
	Heavy					2																		2			
Collaborative Reasoning				1													1									2	2

- "So the fact that she's had soft tissue work done that helped to relieve the pain again goes back to the muscle spasm because obviously having the soft tissue release, the muscle spasm will feel better."

- "So here again I'm trying to establish whether getting in and out of the car is relating to the sacro-iliac joint, which it isn't."
- "She's had some pressure on her lower back from sitting and driving so again pushes me to think that it's maybe a little bit more of a discal issue."

- "I did a standard rebound test just to see if there was any abdominal tenderness. There wasn't."
- "Together we were both reassured they weren't painful, later talking about how we could eventually use more yoga to strengthen her core."

- "In terms of immediately talking about that sort of sharp intense pain, makes me think some kind of muscle spasm has happened and that there's been potentially a bit of force going through the area."
- "…it's obviously high intense sharp pain so as you know, acute spasm/inflammation potentially around the lower back and SI area."

- "Trying to again illicit any kind of clue as to whether it's again more specifically relating to a disc or any kind of neurological symptoms that might give us an idea in terms of what else is happening. More on a deeper level."

- "She had quite a bit of pain at about 25 degrees and that was on the right side as well which was the non-affecting side; makes me more likely to believe again that it's potentially a posterior disc irritation."

Supplementary Material: S4 Illustrative consultation map of one practitioner (Practitioner C).

Supplementary Material S5:

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care, 19*(6), 349–357. doi: 10.1093/intqhc/mzm042

The criteria has been formatted as: Item number – Guide questions/description

DOMAIN 1: RESEARCH TEAM AND REFLEXIVITY

Personal Characteristics

1. Interviewer/facilitator – Which author/s conducted the interview or focus group?

Principal researcher (Simon Roots)

2. Credentials – What were the researcher's credentials? E.g. PhD, MD

BAppSc (Human Biology), Master of Osteopathy student.

3. Occupation – What was their occupation at the time of the study?

Student

4. Gender – Was the researcher male or female?

Male

5. Experience and training – What experience or training did the researcher have?

Two years of personal clinical experience in osteopathy; no previous research training

Relationship with participants

6. Relationship established – Was a relationship established prior to study commencement?

The researcher had spent time with the participating osteopaths during time in the tertiary teaching clinic and osteopathy undergraduate program.

7. Participant knowledge of the interviewer – What did the participants know about the researcher? e.g. personal goals, reasons for doing the research.

All osteopaths and patients recruited understood that the researcher was completing this study to partially fulfil the requirements for the Master of Osteopathy degree.

8. Interviewer characteristics – What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic

The researcher developed an interest in the topic of clinical reasoning during the clinical component of his masters degree.

DOMAIN 2: STUDY DESIGN

Theoretical framework

9. Methodological orientation and Theory – What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis

Hermeneutic phenomenology

Participant selection

10. Sampling – How were participants selected? e.g. purposive, convenience, consecutive, snowball

Convenience sampling.

11. Method of approach – How were participants approached? e.g. face-to-face, telephone, mail, email

Practitioners: Email invitations
Patients: Word of mouth, fliers on community notice boards and local osteopathy clinics. This was followed up with a formal telephone conversation.

12. Sample size – How many participants were in the study?

Practitioners: n=3
Patients: n=7

Total: n=10 participants

13. Non-participation – How many people refused to participate or dropped out? Reasons?

No participants refused to participate or dropped out

Setting

14. Setting of data collection – Where was the data collected? e.g. home, clinic, workplace

A single tertiary teaching clinic

15. Presence of non-participants – Was anyone else present besides the participants and researchers?

An independent research assistant who gave their consent to participate

16. Description of sample – What are the important characteristics of the sample? e.g. demographic data, date

New Zealand European between the ages of 21 and 33 years old

Data collection

17. Interview guide – Were questions, prompts, guides provided by the authors? Was it pilot tested?
The prompts were piloted prior to data collection using two postgraduate student osteopaths not involved in the study.

18. Repeat interviews – Were repeat interviews carried out? If yes, how many?

No repeat interviews were carried out.

19. Audio/visual recording – Did the research use audio or visual recording to collect the data?

Both audio and video recording was used to collect the data.

20. Field notes – Were field notes made during and/or after the interview or focus group?

Brief field notes were made by the researcher following the video-assisted commentaries.

21. Duration – What was the duration of the interviews or focus group?

Audio recorded video-assisted commentaries lasted between 40 and 60 minutes.

22. Data saturation – Was data saturation discussed?

Following the conclusion of Practitioner A's 3 patient consultations, the researcher and supervisors discussed data saturation. It was decided that the richness of the data obtained from 3 patient consultations was sufficient to achieve the research aim. On this premise, 2 instead of 3 patients were consulted by the remaining 2 practitioners.

23. Transcripts returned – Were transcripts returned to participants for comment and/or correction?

Yes – Transcripts were returned to the participating practitioners.

DOMAIN 3: ANALYSIS AND FINDINGS

Data analysis

24. Number of data coders – How many data coders coded the data?

One data coder- the principal researcher (SR)

25. Description of the coding tree – Did authors provide a description of the coding tree?

A description of the coding tree is not present in the manuscript.

26. Derivation of themes – Were themes identified in advance or derived from the data?

Themes were derived from the data; however, although not the initial intent, the themes were later matched to clinical reasoning strategies present in literature.

27. Software – What software, if applicable, was used to manage the data?

No software was used.
28. Participant checking – Did participants provide feedback on the findings?

Yes- the researcher provided practitioners an opportunity to give feedback

Reporting

29. Quotations presented – Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? e.g. participant number

Yes- Quotations were extracted from the data and referenced to each practitioner e.g. Practitioner A

30. Data and findings consistent – Was there consistency between the data presented and the findings?

Yes.

31. Clarity of major themes – Were major themes clearly presented in the findings?

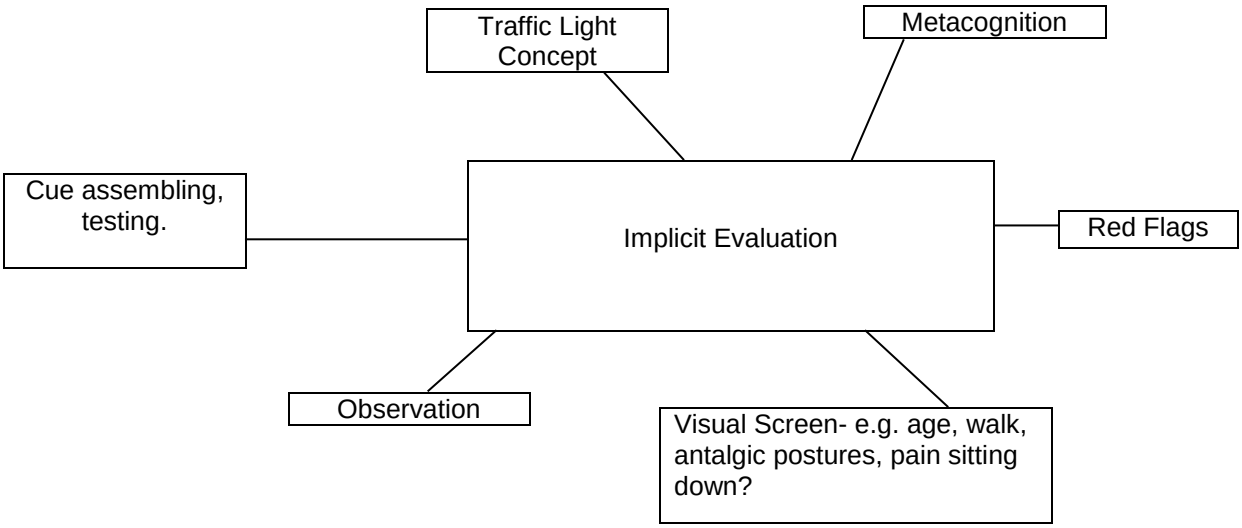
Yes.

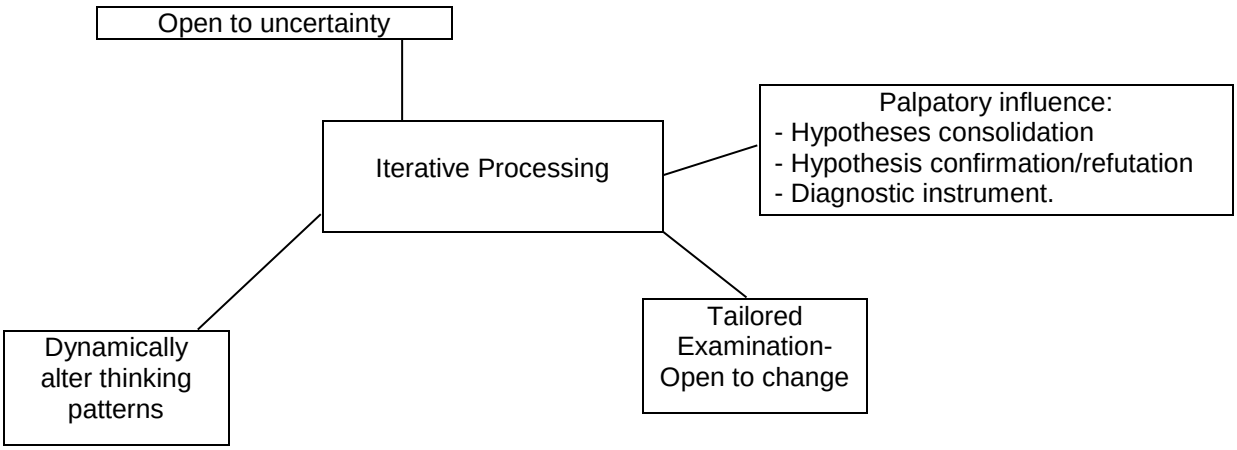
32. Clarity of minor themes – Is there a description of diverse cases or discussion of minor themes?

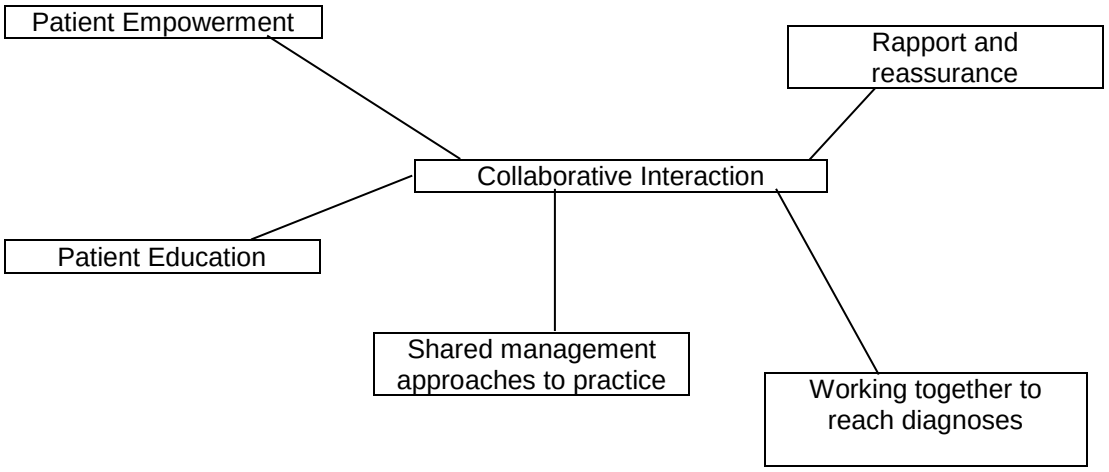
Yes- the three major themes were discussed. There were no minor themes identified.

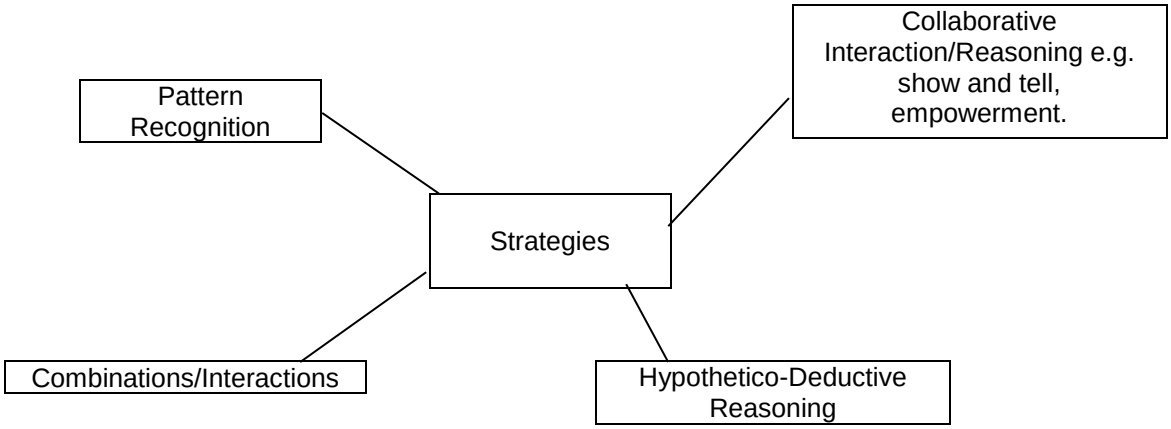
Section 4: Appendices

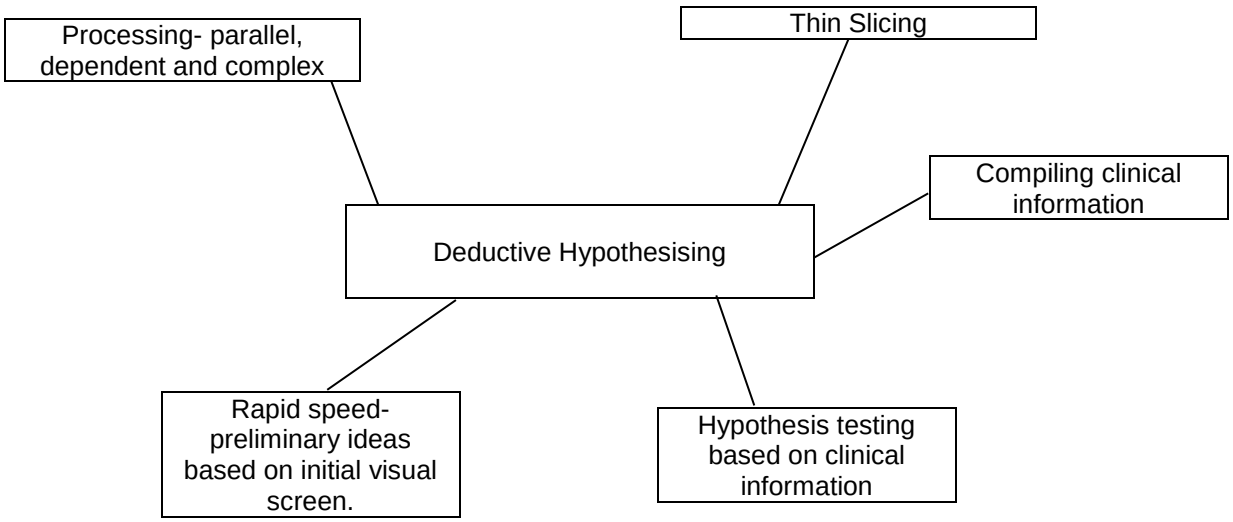
Appendix A: Thematic Maps


Traffic Light Concept
Metacognition
Cue assembling, testing.
Implicit Evaluation
Red Flags
Observation
Visual Screen- e.g. age, walk, antalgic postures, pain sitting down?


Open to uncertainty
Iterative Processing
Palpatory influence:
- Hypotheses consolidation
- Hypothesis confirmation/refutation
- Diagnostic instrument.
Dynamically alter thinking patterns
Tailored Examination- Open to change


Patient Empowerment
Rapport and reassurance
Collaborative Interaction
Patient Education
Shared management approaches to practice
Working together to reach diagnoses



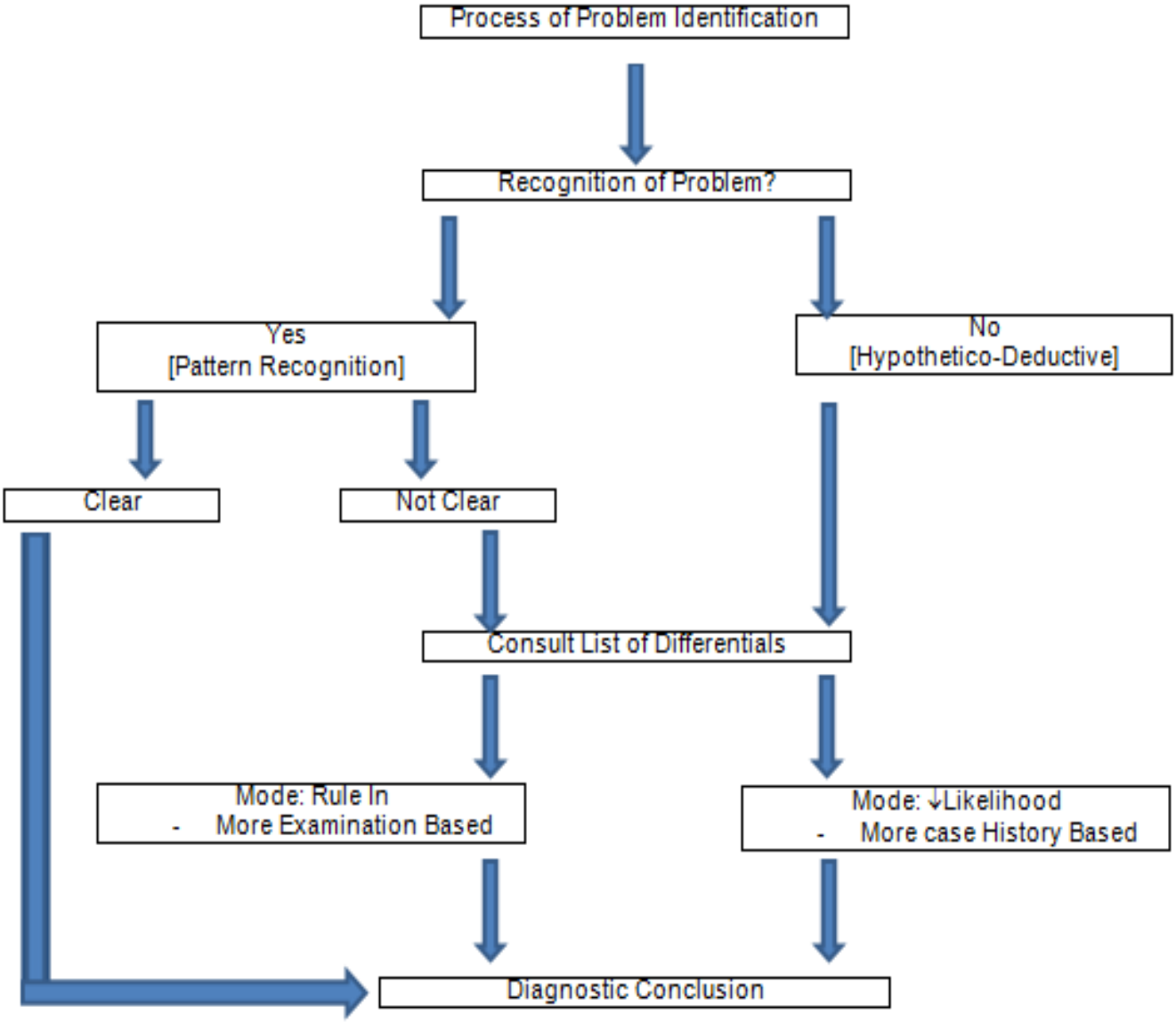


Three themes and two additional points of interest are illustrated in the theme maps above. The codes stemming from each of the three identified themes (shown on page 116) were established through a process of writing, reflecting and re-writing in conjunction with supervisor discussions. The box shown at the top of this page (page 117), 'Strategies', eventually contributed to the development of the consultation map. In addition, 'Deductive Hypothesising' was evaluated closely, later going through a process of refinement before it was amalgamated into the second theme of iterative processing. Iterative processing, as discussed, aligned closely with hypothetico-deductive reasoning which therefore warranted the consideration, and inclusion, of 'Deductive Hypothesising'.

Appendix B: Consultation Map Development

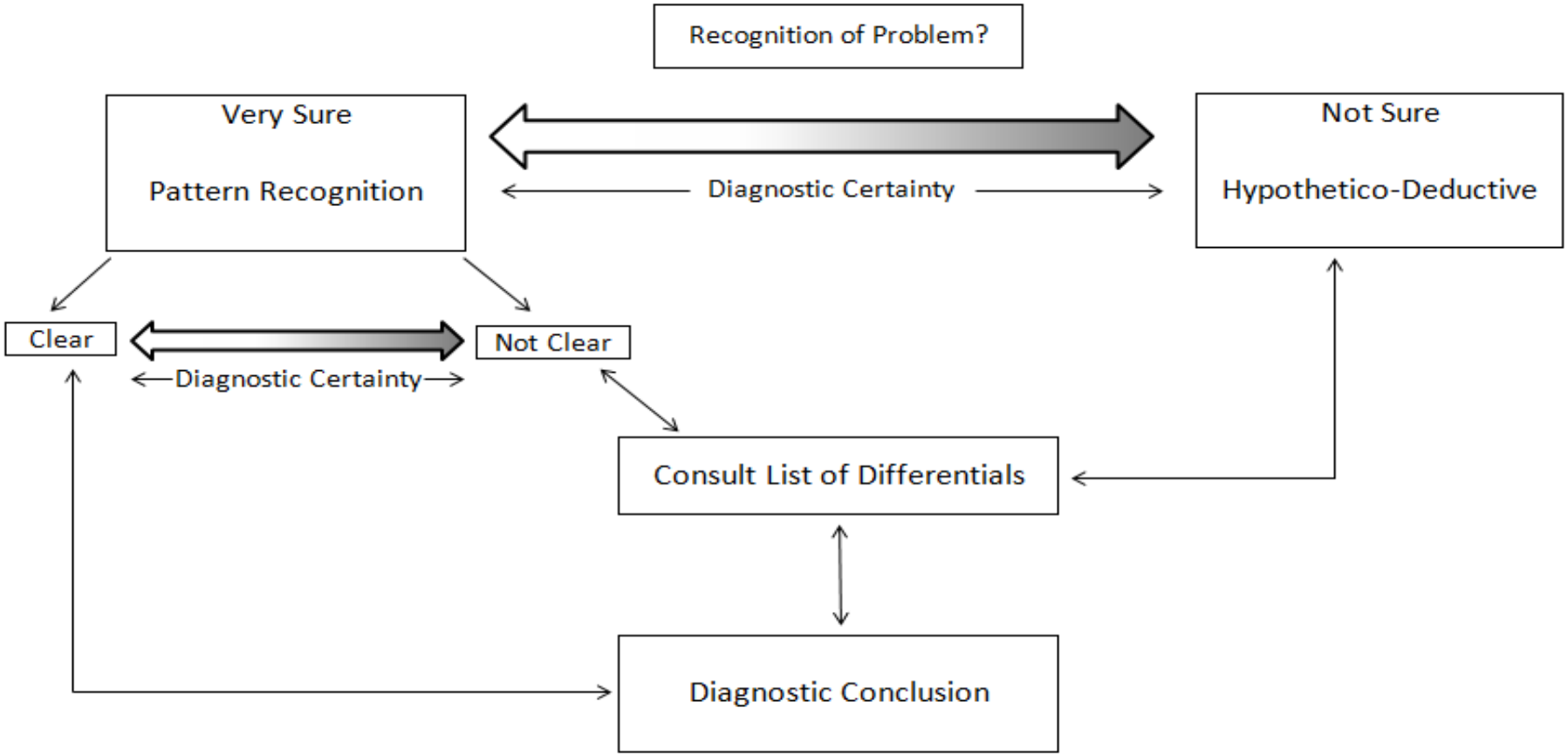
Note: There are four consecutive diagrams presented in this section. The order of these diagrams, labelled Stage 1-4, is to illustrate the progression and development of the ‘consultation map’.

Clinical Reasoning Process- Forming a Diagnostic Conclusion- Stage 1



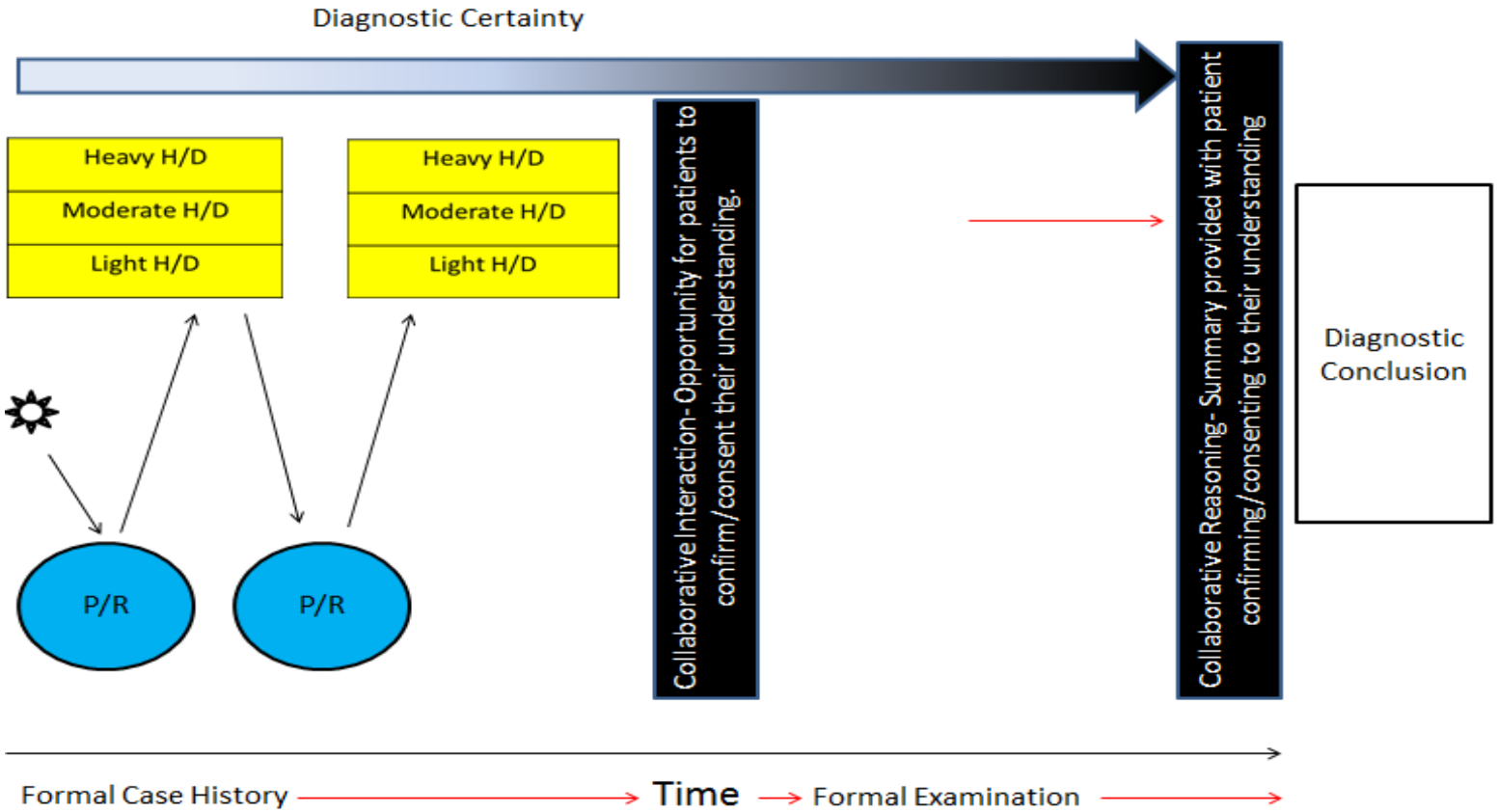
Schematic of the first stage of consultation map development. The premise of this diagram was to illustrate the employment of pattern recognition, hypothetico-deductive reasoning and the steps undertaken to reach a diagnostic conclusion. The diagram was seen to be too linear and not represent any extent of diagnostic certainty. Also, the dichotomous nature of the diagram suggested that the processing of clinical reasoning was black and white, rather than a complex interplay of the different reasoning strategies and thought processes.

Clinical Reasoning Process- Forming a Diagnostic Conclusion- Stage 2



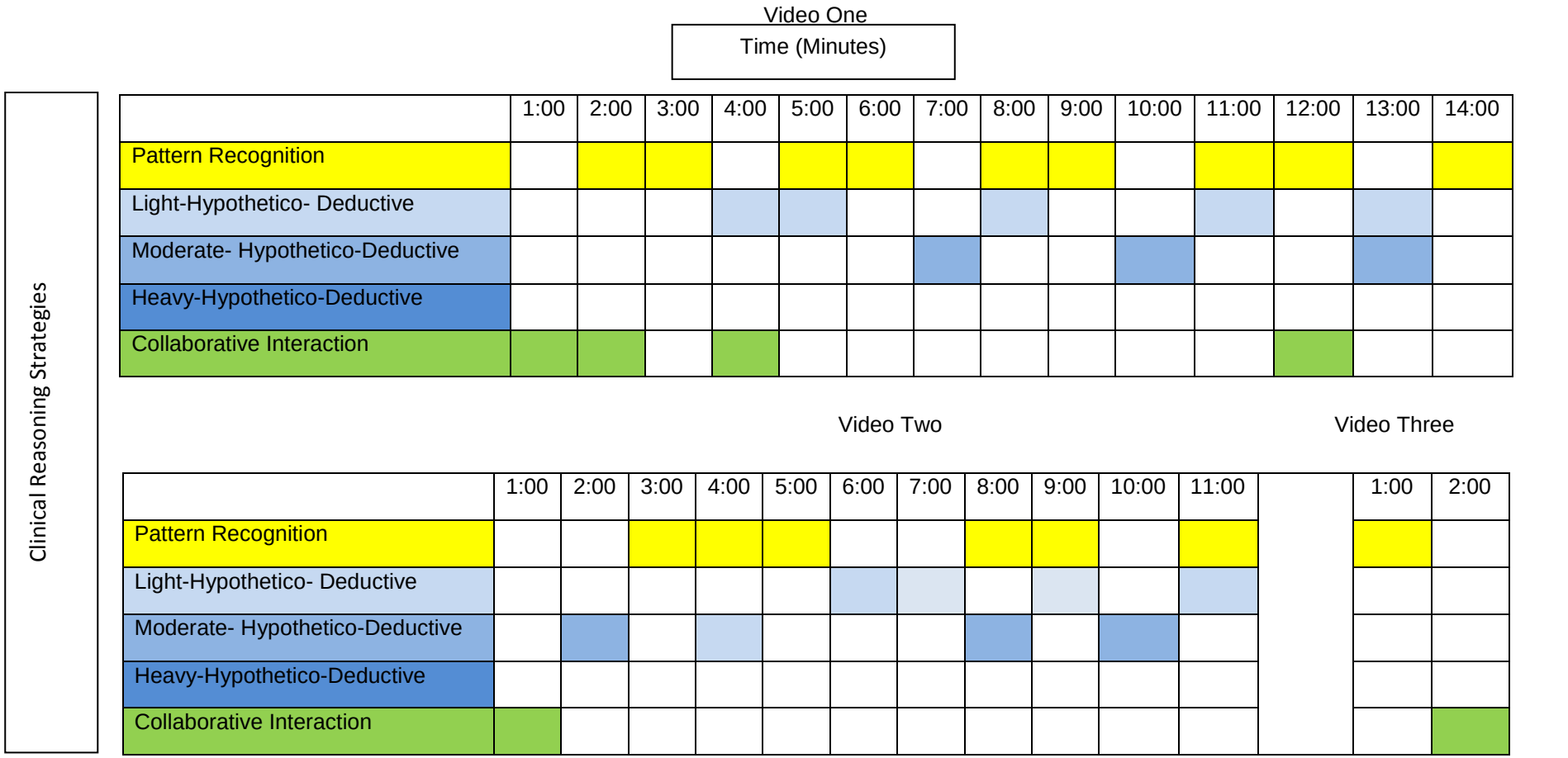
Schematic of the second stage of consultation map development. The diagram included a continuum to represent diagnostic certainty in order to decrease the dichotomous and linear nature of clinical reasoning shown in the first stage of development. Although small changes were made, the diagram still did not clearly illustrate the interplay between clinical reasoning strategies identified in this study. A further limitation was that collaborative reasoning was not included; this meant that the clinical reasoning strategies were not fully characterised and their usage could not be understood outside of the over-simplified steps shown above.

Clinical Reasoning Process- Forming a Diagnostic Conclusion- Stage 3



Schematic of the third stage of consultation map development. This diagram was favoured over the initial two as it acknowledged all three reasoning strategies identified in this study. The star represents the practitioner's line of thought, which is seen to bounce in between three levels of hypothetico-deductive reasoning and pattern recognition. Collaborative reasoning was recognised in the middle and at the end of the observed process which was an improvement on stage 2; however, although the dynamic transitioning of strategies was demonstrated more clearly, it was not found to be specific to each practitioner. This weakness lead to the recognition that it was necessary to use a method that could be applied to each individual interaction observed in this research investigation.

Clinical Reasoning Process- Forming a Diagnostic Conclusion- Stage 4

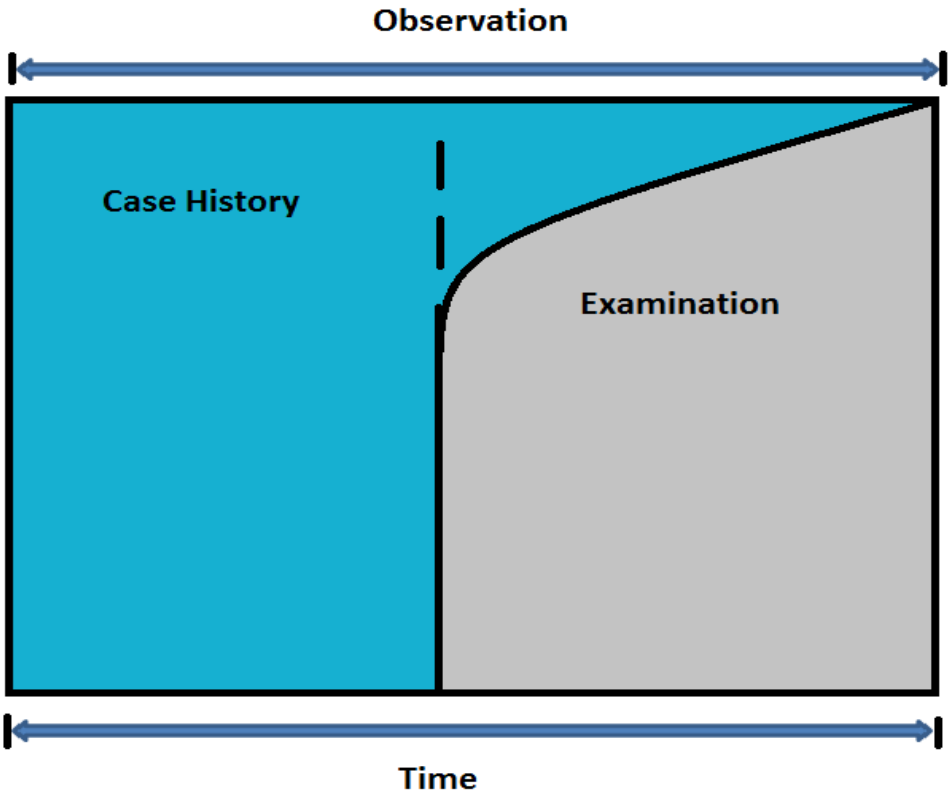


Schematic of the fourth stage of consultation map development. It was decided that utilising a linear diagram to describe the clinical reasoning processes of osteopaths in this study was not sufficient. This is the last developing stage of the consultation map, with each reasoning strategy (including the three observed levels of hypothetico-deductive reasoning) assigned a colour. The time periods of this map are not specific to any of the observed consultations. Limitations observed in this diagram include the nature of separating the map into three sections (as the videos were only a maximum of 17:25 minutes long, multiple video files were made to accommodate this) and therefore the loss of conceptualising the full diagnostic process, the lack of room to include supporting extracts and the question of how to represent multiple clinical reasoning strategies within one time-stamp.

Appendix C: Development of the schematic diagram of the initial diagnostic phases in an osteopathic consultation

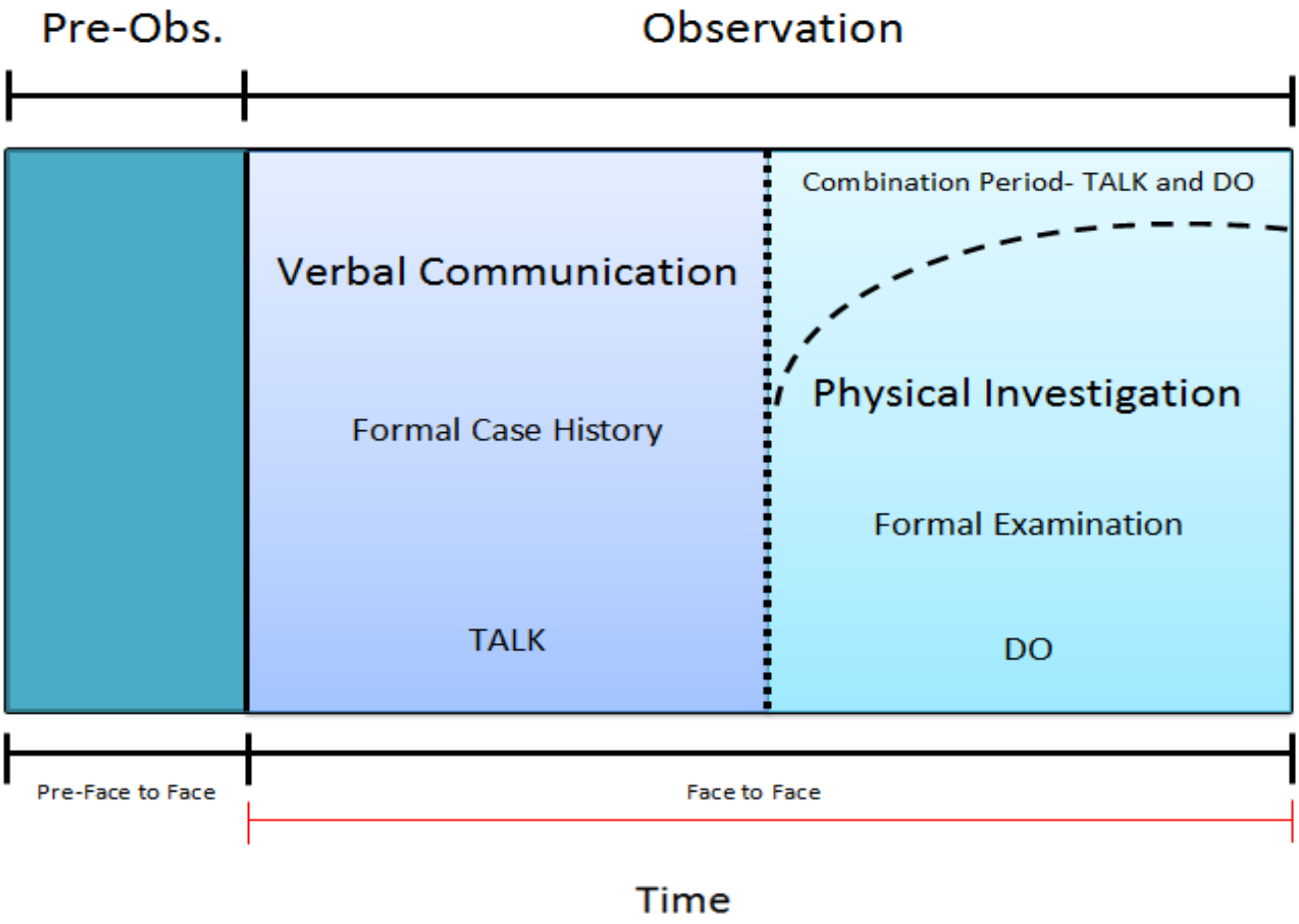
Note: Two stages illustrated in this section to show the progression of development for the ‘schematic of the initial diagnostic stages’ diagram.

Schematic of the initial diagnostic stages in an osteopathic consultation- Stage 1



Schematic of the first stage of the diagram illustrating the diagnostic stages observed in this research investigation. This diagram was an over-simplified representation of the two phases investigated in the research process. Limitations observed were a lack of acknowledgement for pre-face to face evaluative processing, the absence of a brief characterisation for each phase i.e. as a stand-alone piece, what occurred during each of these evaluative phases (later described as talking and doing etc.) and the acknowledgement of a combination period during the examination process.

Schematic of the initial diagnostic stages in an osteopathic consultation- Stage 2



Schematic of the second stage of the diagram illustrating the diagnostic stages observed in this research investigation. This diagram aligns most closely with the figure provided in the manuscript. The pre-face to face section has been added but does not contain a brief characterisation as the other two other phases do.

Appendix D: Outcomes of the ‘Practice Style’ Questionnaire

Practitioner A: Practice Style Questionnaire

How would you describe your practice style?

Please select a single response per technique that best represents your style

	Most of my patients	75% of my patients	50% of my patients	25% of my patients	Hardly any of my patients
High Velocity Low Amplitude (HVLA)		✓			
Dry Needling/ Acupuncture					✓
Functional Technique			✓		
Muscle Energy MET)		✓			
Osteopathy in the Cranial Field (OCF)					✓
Soft Tissue	✓				
Fascial Unwinding			✓		
Articulation/Joint Mobilisation (without cavitation)	✓				
Visceral				✓	
Balance Ligamentous Tension				✓	
Strain Counterstrain &/or Positional Release		✓			
Other Technique	✓				
Other Technique (Please Specify)	Combinations of the above categories: Breathing retraining, isometric exercises, stretch exercises, sustained traction.				

Practitioner B: Practice Style Questionnaire

How would you describe your practice style?

Please select a single response per technique that best represents your style

	Most of my patients	75% of my patients	50% of my patients	25% of my patients	Hardly any of my patients
High Velocity Low Amplitude (HVLA)		✓			
Dry Needling/ Acupuncture					✓
Functional Technique			✓		
Muscle Energy MET)	✓				
Osteopathy in the Cranial Field (OCF)				✓	
Soft Tissue	✓				
Fascial Unwinding			✓		
Articulation/Joint Mobilisation (without cavitation)	✓				
Visceral				✓	
Balance Ligamentous Tension			✓		
Strain Counterstrain &/or Positional Release			✓		
Other Technique			✓		
Other Technique (Please Specify)	Muscle stretching (various).				

Practitioner C: Practice Style Questionnaire

How would you describe your practice style?

Please select a single response per technique that best represents your style

	Most of my patients	75% of my patients	50% of my patients	25% of my patients	Hardly any of my patients
High Velocity Low Amplitude (HVLA)			✓		
Dry Needling/ Acupuncture					✓
Functional Technique			✓		
Muscle Energy MET)			✓		
Osteopathy in the Cranial Field (OCF)			✓		
Soft Tissue	✓				
Fascial Unwinding			✓		
Articulation/Joint Mobilisation (without cavitation)		✓			
Visceral				✓	
Balance Ligamentous Tension				✓	
Strain Counterstrain &/or Positional Release				✓	
Other Technique					✓
Other Technique (Please Specify)	Not applicable				

Appendix E: Case History Pro Forma

NEW PATIENT CASE HISTORY FORM

TUTOR:	STUDENT:	TEAM:	DATE:	FEE:($)
NAME:			DOB:	
ADDRESS:			CHILDREN?	
PHONE: DAY (0)		MOBILE: (0)		
GP NAME & ADDRESS:				
ACC NUMBER: *(Please attach ACC45 form or relating documents)*……. **Read Codes:** …….. **Trigger Number:** …… **Visit Number:** ……/……				
OCCUPATION	EXERCISE / SPORT	HOBBIES / INTERESTS		
PRESENTING COMPLAINT				
GENERAL HEALTH:				
Smoker? Hx?	Allergies:			

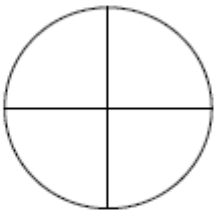
Height: Change in weight/time: Weight: BMI:	Current Medication:	Med. Details: (Rx, S/E)	Investigations Required?

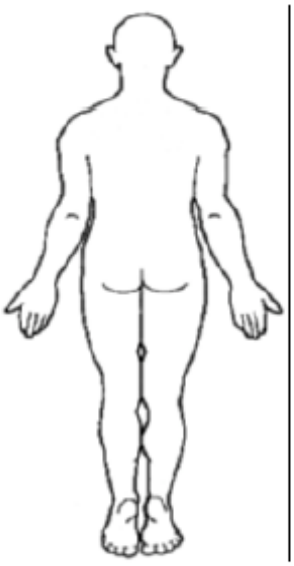
ANY FLAGS:	

PROVISIONAL HYPOTHESES / DIFFERENTIALS	*JUSTIFICATION*
1.	
2.	
3.	

KEY EXAMINATIONS TO BE PERFORMED TO SUPPORT DIFFERENTIATION:	
Clinic Tutor Signature:	Student Signature:

Active Movements





Passive ROM Findings

Palpatory Findings

Special Tests

Respiration

Provisional Diagnosis, justification and first treatment aims

Treatment plan, prognosis and diagnosis as explained to Patient:	**Patient consent to outlined management:**

Initial Treatment (including advice) and patient response

Clinic Tutor Signature:	**Student Signature:**

PATIENT EVALUATION AND MANAGEMENT SUMMARY	
Special Precautions:	**Further Osteopathic Examinations to be performed:** ***Other Medical Tests:*** **Findings** entered **on follow up appointment dated:**

Predisposing & Maintaining Factors, Aetiology, Physical Factors	***Perceived Emotional/Stressor Factors & remedial actions suggested (if appropriate)***

Summary of Diagnosis:

Patients View of problem and expectations:

Management Plan and Outcome Measures (eg ADL's, VRS, PSFS, etc)
Short Term:
Medium Term:
Long Term:

Expectations: Symptomatic Relief	***Functional Changes:***

To be re-evaluated after _____ treatments

Clinic Tutor Signature:	Student Signature:

Appendix F: Participant Information Sheet

Information sheet for practitioners

Video analysis and investigation of osteopathic clinical reasoning in the diagnostic hypothesis generation of patients with acute low back pain: A feasibility study

About this research

You are invited to take part in a research project investigating the clinical reasoning of osteopaths. The study involves videoing the case history and examination phases of an osteopathic consultation with a patient complaining of acute low back pain. Following the videoing and completion of the consultation, you will be asked to replay the video and give a running commentary on why you have asked particular questions, performed specific examinations and come to diagnoses. Providing a commentary on your diagnostic process will enable the researcher to follow the clinical reasoning process and subsequently identify clinical reasoning strategies. Literature indicates that experienced practitioners have developed effective strategies of clinical reasoning; these are the processes that we are most interested in, and it is hoped that research will help in surfacing these reasoning strategies.

The project aims to involve three osteopaths, with each practitioner asked to carry out three patient consultations and therefore provide commentary for the three interactions. Although the research project is an investigation of clinical reasoning, the process of commenting on reasoning and clinical judgements is not something often carried out by health professionals. In this light, the research project provides an opportunity to gain insight into your own clinical reasoning and how you may come to diagnostic conclusions in practice.

A conventional understanding of clinical reasoning and the strategies employed by osteopaths has not been well researched. As it becomes increasingly important to detail the reasoning behind decisions in healthcare, osteopaths must also learn to make explicit their process of clinical reasoning. Through research in the osteopathic clinical setting, I hope to begin to describe what reasoning strategies are used in the diagnostic hypothesis generation of patients complaining of acute low back pain. Furthermore, from the collected data I am aiming to discuss why these strategies may have been used and how their application may fit in the context of the presenting patient.

If you are expressing interest in the research project, the researcher will discuss the inclusion and exclusion criteria with you to ensure that you are eligible to participate in the study.

What will happen in this research?

You are invited to take part in a research case study involving three patients with acute low back pain:

- Firstly, patient/s will present to Clinic 41 who are expressing interest in this study; you will be asked to discuss the inclusion/exclusion criteria with the patient/s to determine their eligibility. From here, you will be asked to invite the patients to participate in the research project.
- As would be in a normal osteopathic consultation, you will then be responsible for gaining consent from the patient before the consultation begins. This will involve signing of a written consent form by the patient.
- Following this step, you will be asked to carry out a consultation with a new (and not pre-existing/known) patient complaining of acute low back pain. The case history and examination phases of the consultation will be videoed on a small go-pro camera (size of around 2 match boxes). At the beginning of the consultation, you will be asked to show the patient where the camera is to ensure to patient is comfortable with the location.

- After these two phases have been videoed, a research assistant will enter the room, turn off the video, and exit the room with the go-pro camera. You will then be asked to complete the consultation with treatment and/or education as you see necessary.
- You will then be asked to move into another (separate) room and provide a running audio commentary of the videoed consultation. The video will be played through the mac application 'i-movie' which will allow the recording of audio commentary underneath as the video is played back. The video will be watched twice to allow you to observe and comment on different facets of the case history/examination processes.
- This process of consulting a patient with acute low back pain will occur three times; therefore, you will see three new (and not pre-existing/known) patients.
- The researcher will carry out data analysis of each consultation by viewing the video recording, reading the case history notes (as these may inform strategies of clinical reasoning), listening/reading your verbal commentaries and effectively cross referencing these three data sources.
- As patients are in effect (already experiencing acute low back pain), a passive part of this study, their consent relates to the confidentiality of their information- a normal part of an osteopathic consultation. On this premise, after screening and recruitment, you will be responsible for gaining consent from patient- i.e. a signing of the consent form with any further necessary discussion.

Prior to the first consultation, the researcher will explain the purpose of the research again and answer any questions you may have. You will then be asked to read and sign an informed consent form. It is intended that the video and commentary will be saved to the researcher's personal flash-drive and hard-drive in a password protected file. The original file will then be deleted. The commentaries will then be transcribed by an external party not directly related to the research project. You will have an opportunity to see the commentary transcript if you wish, and the principal researcher will contact you following the conclusion of the three patient consultations to make this opportunity available.

Information about withdrawing from the study

You may withdraw your own data (three video recordings and accompanied commentaries) from the study up to five working days after your final video and consultation commentaries are recorded.

We treat your personal information confidentially

Your name and information will be kept strictly confidential. All information will be stored on a password protected file on the researcher's personal laptop. Simon Roots and his supervisors will be the only ones to have access to this information in order to complete the analysis. A copy of the research findings can be sent to you at the conclusion of the study if you wish.

Who can I contact with any further questions?

If you have any further questions about this research please feel free to contact one of us:

Principal Researcher:
Simon Roots
Tel: 021 112 6609
Email: simonroots23@gmail.com

Research Supervisors:
Dr Elizabeth Niven
Tel: 021 654 935 or 09 815 4321 ext 8320
Email: eniven@unitec.ac.nz

Rob Moran
Tel: 021 073 9984
Email: rmoran@unitec.ac.nz

Information sheet for patients

Video analysis and investigation of osteopathic clinical reasoning in the diagnostic hypothesis generation of patients with acute low back pain: A feasibility study

About this research

You are invited to take part in a research project investigating the clinical reasoning of osteopaths. Clinical reasoning is the process that a health professional may go through in order to make a decision and is an area of growing interest in osteopathy. In order to participate in this study, you must be experiencing acute low back pain, which is pain experienced in the low back for no longer than 4 weeks. The study involves videoing the case history (or questioning/conversation between you and the osteopath) and the examination (which involves a physical assessment of body areas related to your low back) procedures of your consultation with the osteopath. Following these procedures, the video recording will be stopped and the osteopath will carry out their treatment and explain to you the relevant management plan. This consultation with a qualified osteopath is completely free; this is therefore a great opportunity to receive free treatment from an experienced health professional.

A conventional understanding of the clinical reasoning carried out by osteopaths has not been well researched. On this premise, I hope to begin to describe the clinical reasoning used by osteopaths through video analysis and verbal commentaries alongside the video recordings. Only a single video recording will be carried out per patient with this study aiming to involve 9 patients altogether.

The video recording will last from between 15-30 minutes and will be viewed by the researcher, your osteopath and the principal supervisor, no one else. Upon entry to the consultation room, the osteopath will show you where the camera is sitting to ensure you are aware of the location. Your face, anybody markings such as tattoos, visible scars and moles will be pixelated to maintain anonymity when the videos are viewed by the researcher and associated supervisors.

If you are expressing interest in the research project, a participating osteopath will discuss the inclusion and exclusion criteria with you to ensure that you are eligible to participate in the study. Due to the current and acute nature (up to 4 weeks) of your back pain, discussion of these criteria will occur at first contact (between you and the participating osteopath) to determine your eligibility; this is to ensure you are consulted as soon as possible after first contact. After the criteria discussion and your recruitment, the osteopath who will consult you will be responsible for gaining consent- this will be carried out through the signing of a consent form and answering any further questions.

It is intended that the video recording will be saved to the researcher's personal flash-drive and hard-drive in a password protected file. The original file will then be deleted. You will have an opportunity to see the video recording if you wish, and the principal researcher will contact you to make this opportunity available.

Information about withdrawing from the study

You may withdraw your own data (single video recording) from the study up to five working days after your video is recorded.

We treat your personal information confidentially

Your name and information will be kept strictly confidential. All information will be stored on a password protected file on the researcher's personal laptop. Simon Roots and his supervisors will be the only ones to have access to this information in order to complete the relevant analysis. A copy of the research findings can be sent to you at the conclusion of the study if you wish.

Who can I contact with any further questions?

If you have any further questions about this research please feel free to contact one of us:

Principal Researcher:
Simon Roots
Tel: 021 112 6609
Email: simonroots23@gmail.com

Research Supervisors:
Dr Elizabeth Niven
Tel: 021 654 935 or 09 815 4321 ext 8320
Email: eniven@unitec.ac.nz

Rob Moran
Tel: 021 073 9984
Email: rmoran@unitec.ac.nz

Appendix G: Participant Consent Form

Practitioner Consent Form

Video analysis and investigation of osteopathic clinical reasoning in the diagnostic hypothesis generation of patients with acute low back pain: A feasibility study

Participant name: _____

I have seen the information sheet about this study. I have read and understand the information sheet given to me. I have had the opportunity to discuss any queries or concerns regarding this study with the principal researcher, Simon Roots, and am satisfied with the explanations given.

I understand that taking part in this project is my own choice. I don't have to be part of this if I don't want to and I understand that I may withdraw from this study during the research process- this includes consenting to three video recordings, giving two verbal commentaries for each video recording. I acknowledge that I may withdraw my own data (three video recordings and accompanied commentaries) from the study up to five working days after their final video and consultation commentaries are recorded. I understand that I will have the opportunity to see a copy of the commentary transcript if I wish, and the principal researcher will be in contact following data collection to make this opportunity available. I have been provided with the principal researcher's details as well.

I understand that anything I say or do during the video recording and commentaries will be completely confidential, and that the only persons who will have access to my videos/commentaries are the principal researcher (Simon Roots) and his associated supervisors.

I understand that the videos and commentary recordings will be stored securely on the principal researcher's flash-drive and hard-drive which will be stored in safe and separate locations. I acknowledge that the video data will be retained for a period of 10 years, kept in a locked cabinet at Unitec, after which time they will be destroyed. Any information reported will not identify me in any way. I give permission for the analysed findings published from this research project to be potentially drawn upon and utilised as a platform to inform future research cycles. I also give permission for anonymised data to be used in any future publications of this research project.

I understand that I can see the finished research document.

I have had time to consider everything and I give my consent to be a part of this project.

I know whom to contact if I have any questions or concerns about this project.

The principal researcher is:
Simon Roots

Simonroots23@gmail.com
Tel: 021 112 6609

Participant Name: ……..

Participant Signature: …….. **Date:** ……
Project explained by: ……..

Patient Consent Form

Video analysis and investigation of osteopathic clinical reasoning in the diagnostic hypothesis generation of patients with acute low back pain: A feasibility study

Participant name: _____

I have seen the information sheet about this study. I have read and understand the information sheet given to me. I have had the opportunity to discuss any queries or concerns regarding this study with the principal researcher, Simon Roots, and am satisfied with the explanations given. I understand that taking part in this project is my own choice. I don't have to be part of this if I don't want to and I understand that I may withdraw from this study during the research process described on the information sheet; specifically, I may withdraw my own data (single video recording) from the study up to five working days after my video is recorded. I understand that my face, anybody markings such as tattoos, visible scars and moles will be pixelated to maintain anonymity when the videos are viewed by the researcher and associated supervisors. I understand that I will have the opportunity to see a copy of the video recording if I wish, and the principal researcher will be in contact following data collection to make this opportunity available. I have been provided with the principal researcher's details as well.
I understand that anything I say or do during the video recording will be completely confidential, and that the only persons who will have access to my videos are the principal researcher (Simon Roots) and his associated supervisors.

I understand that the video recordings will be stored securely on the principal researcher's flash-drive and hard-drive which will be stored in safe and separate locations. I acknowledge that the video data will be retained for a period of 10 years, kept in a locked cabinet at Unitec, after which time it will be destroyed. Any information reported will not identify me in any way. I give permission for the analysed findings published from this research project to be drawn upon and utilised as a platform to inform future research cycles.

I understand that I can see the finished research document.

I have had time to consider everything and I give my consent to be a part of this project.

I know whom to contact if I have any questions or concerns about this project.

The principal researcher is:
Simon Roots

Simonroots23@gmail.com
Tel: 021 112 6609

Participant Name: ……..

Participant Signature: …….. **Date:** ……
Project explained by: ……..

Signature: …….. **Date:** ……

Thank you for participating in this research.

Research Assistant Consent Form

Video analysis and investigation of osteopathic clinical reasoning in the diagnostic hypothesis generation of patients with acute low back pain: A feasibility study

Research Assistant name: _____

You are invited to take part in a research project investigating the clinical reasoning of osteopaths. The study involves videoing the case history and examination phases of an osteopathic consultation with a patient complaining of acute low back pain. The project aims to involve three osteopaths, with each practitioner asked to carry out three patient consultations. In total, this amounts to nine patient-practitioner encounters and thus nine video recordings. The particular role you are invited to fill is that of a research assistant to retrieve the video recording device once the videoing is completed. The osteopathic consultations will be videoed on a small GoPro camera, and only cover the case history and examination procedures (amounting to approximately 20 minutes). Following these two procedures, you will be asked to enter the consultation room, remove the camera and then bring the camera directly to the principal researcher who will be waiting in a separate room.

You will be asked to carry out the camera retrieval nine times (once per consultation); you will not be asked to be present/participate in any further components of this research study. You are asked to sign this consent form and keep any details of patient identity, practitioner identity or related information from this research project confidential.

I have read and understood the information written above. I have had the opportunity to discuss any queries or concerns regarding this study with the principal researcher, Simon Roots, and am satisfied with the explanations given. I understand that taking part in this project is my own choice; I don't have to be part of this if I don't want to and I have been provided with the principal researcher's details if further questions should arise.

I understand that I am only retrieving the camera from the osteopath's consultation room and not participating in any other facets of the research project.

I have had time to consider everything and I give my consent to be a part of this project.

I know whom to contact if I have any questions or concerns about this project.

The principal researcher is:
Simon Roots

Simonroots23@gmail.com
Tel: 021 112 6609

Participant Name: ……..

Participant Signature: …….. **Date:** ……
Project explained by: ……..

Signature: …….. **Date:** ……

Thank you for participating in this research.

Appendix H: Ethics Approval Letter

Simon Roots
60 Asquith Ave
Mount Albert
Auckland

20.6.13

Dear Simon,

Your file number for this application: **2013-1028**
Title: **Video analysis and investigation of osteopathic clinical reasoning in the diagnostic hypothesis generation for patients with acute low back pain: A feasibility study.**

Your application for ethics approval has been reviewed by the Unitec Research Ethics Committee (UREC) and has been approved for the following period:

Start date: 6.6.13
Finish date: 6.6.14

Please note that:

1. The above dates must be referred to on the information AND consent forms given to all participants.

2. You must inform UREC, in advance, of any ethically-relevant deviation in the project. This may require additional approval.

3. Organisational consent/s must be cited and approved by your primary reader prior to any organisations or corporations participating in your research. You may only conduct research with organisations for which you have consent.

You may now commence your research according to the protocols approved by UREC. We wish you every success with your project.

Yours sincerely,

pp

Gillian Whalley
Deputy Chair, UREC

cc: Elizabeth Niven
Cynthia Almeida

Appendix I: International Journal of Osteopathic Medicine: Guidelines for Authors

The Editors of the Journal welcome contributions for publication from the following categories: Letters to the Editor and Editorials, Reviews and Original Research articles, Commentaries, Clinical Practice articles (Case Studies) with educational value and Protocols.

The Guidelines are separated into the following sections:

A Online Submission

B Types of Contributions

C General Guidance

D Preparation of the Manuscript

E Specific Guidance for Original Research Articles

F Specific Guidance for Protocols

G Post Acceptance

(A) ONLINE SUBMISSION

Submission to this journal proceeds totally online at (http://ees.elsevier.com/ijom). You will be guided stepwise through the creation and uploading of the various files. The system automatically converts source files to a single Adobe Acrobat PDF version of the article, which is used in the peer-review process. Please note that even though manuscript source files are converted to PDF at submission for the review process, these source files are needed for further processing after acceptance. All correspondence, including notification of the Editor's decision and requests for revision, takes place by e-mail and via the Author's homepage, removing the need for a hard-copy paper trail.

The above represents a very brief outline of this form of submission. It can be advantageous to print this "Guide for Authors" section from the site for reference in the subsequent stages of article preparation.

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the Publisher.

(B) TYPES OF CONTRIBUTIONS - word limits exclude tables, figures and reference list.

Letters to the Editor (up to 1,000 words)

As is common in biomedical journals the Editorial Board welcomes critical responses to any aspect of the journal. In particular, letters that point out deficiencies and that add to, or further clarify points made in a recently published work, are welcomed. The Editorial Board reserves the right to offer authors of papers the right of rebuttal, which may be published alongside the letter.

Reviews and Original Articles (2,000 - 5,000 words)

These should be either (i) reports of new findings related to osteopathic medicine that are supported by research evidence. These should be original, previously unpublished works; or (ii) a critical or systematic review that seeks to summarise or draw conclusions from the established literature on a topic relevant to osteopathic medicine.

Short review (1,500-3,000 words)

The drawing together of present knowledge in a subject area, in order to provide a background for the reader not currently versed in the literature of a particular topic. Shorter in length than and not intended to be as comprehensive as that of the critical or systematic review paper. These papers typically place more emphasis on outlining areas of deficit in the current literature that warrant further investigation.

Research Note (up to 1,500 words)

Findings of interest arising from a larger study but not the primary aim of the research endeavour, for example short experiments aimed at establishing the reliability of new equipment used in the primary experiment or other incidental findings of interest, arising from, but not the topic of the primary research. Includes further clarification of an experimental protocol after addition of further controls, or statistical reassessment of raw data.

Preliminary Findings (1,500-2,500 words)

Presentation of results from pilot studies which may establish a solid basis for further investigations. Format similar to original research report but with more emphasis in discussion of future studies and hypotheses arising from pilot study.

Commentaries (up to 2,000 words)

Includes articles that do not fit into the above criteria as original research. Includes commentaries and essays especially in regards to history, philosophy, professional, educational, clinical, ethical, political and legal aspects of osteopathic medicine.

Clinical Practice

Authors are encouraged to submit papers in one of the following formats: Case Report, Case Problem, and Evidence in Practice.

i. Case Reports - usually document the management of one patient, with an emphasis on presentations that are unusual, rare or where there was an unexpected response to treatment (e.g. an unexpected side effect or adverse reaction). Authors may also wish to present a case series where multiple occurrences of a similar phenomenon are documented. Preference will be given to reports that are prospective in their planning and utilise Single System Designs, including objective measures.

ii. The aim of the Case Problem is to provide a more thorough discussion of the differential diagnosis of a clinical problem. The emphasis is on the clinical reasoning and logic employed in the diagnostic process.

iii. The purpose of the Evidence in Practice report is to provide an account of the application of the recognised Evidence Based Medicine process to a real clinical problem. The paper should be written with reference to each of the following five steps: 1. Developing an answerable clinical question. 2. The processes employed in searching the literature for evidence. 3. The appraisal of evidence for usefulness and applicability. 4. Integrating the critical appraisal with existing clinical expertise and with the patient's unique biology, values, and circumstances. 5. Reflect on the process (steps 1-4), evaluating effectiveness, and identifying deficiencies.

Protocols (1,500 - 2,000 words)

The IJOM accepts the submission of protocols of randomised interventions, systematic reviews and meta-analyses, observational studies, and selected phase I and II studies (novel intervention for a novel indication; a strong or unexpected beneficial or adverse response; or a novel mechanism of action), with the overall aim to encourage good principles in clinical research design.

The editors are looking for studies that will appeal to a wide general readership. The question being addressed and the planned design and analysis will need to be as original as possible, topical, and valid. All protocols will be subject to the journal's usual peer review process.

New section - Osteopathic Education:

Papers which focus on osteopathic education in the clinical/practice environment and in academia are welcomed for a new section of the International Journal of Osteopathic Education. Papers from academics involved in the teaching of students in the classroom are welcomed alongside those from clinical staff involved in the education of osteopaths in practice, through post-qualifying education and training initiatives. It is essential that the evidence-base to education is developed and this is reflected in papers submitted for publication. In alignment with the journal's overall Aims and Scope, papers submitted for consideration of publication should be relevant to an international audience, even if they

are national in scale of study. The editorial team wish to encourage submission of papers that demonstrate:

• Innovation and development of education

• Creativity in teaching and learning strategies

• Evaluation and quality assurance of academic standards

• Advancement of practice-based education

• Collaborative interdisciplinary education initiatives

• Delivery and evaluation of education within osteopathic and related services.

AudioSlides

The journal encourages authors to create an AudioSlides presentation with their published article. AudioSlides are brief, webinar-style presentations that are shown next to the online article on ScienceDirect. This gives authors the opportunity to summarize their research in their own words and to help readers understand what the paper is about. More information and examples are available at http://www.elsevier.com/audioslides. Authors of this journal will automatically receive an invitation e-mail to create an AudioSlides presentation after acceptance of their paper.

(C) GENERAL GUIDANCE

Submission Declaration

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the copyright-holder.

Ethical considerations

Human subjects. Work on human beings that is submitted to The International Journal of Osteopathic Medicine should comply with the principles laid down in the declaration of Helsinki; Recommendations guiding physicians in biomedical research involving human subjects. Adopted by the 18th World Medical Assembly, Helsinki, Finland, June 1964, amended by the 29th World Medical Assembly, Tokyo, Japan, October 1975, the 35th World Medical Assembly, Venice, Italy, October 1983, and the 41st World Medical Assembly, Hong Kong, September 1989. The manuscript should contain a statement that the research has been approved by the appropriate ethical committees related to the

institution(s) in which it was performed and that subjects gave informed consent to the work. Studies involving experiments with animals must state that their care was in accordance with institution guidelines. Patients' and volunteers' names, initials, and hospital numbers should not be used. In a case report, the subject's written consent should be provided. It is the author's responsibility to ensure all appropriate consents have been obtained.

Patient anonymity. Studies on patients or volunteers require ethics committee approval and informed consent which should be documented in the manuscript.

Patients have a right to privacy. Therefore identifying information, including patients' images, names, initials, or hospital numbers, should not be included in videos, recordings, written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and you have obtained written informed consent for publication in print and electronic form from the patient (or parent, guardian or next of kin where applicable). If such consent is made subject to any conditions, Elsevier must be made aware of all such conditions. Evidence of written consent must be provided to Elsevier on request.

Even where consent has been given, identifying details should be omitted if they are not essential. If identifying characteristics are altered to protect anonymity, such as in genetic pedigrees, authors should provide assurance that alterations do not distort scientific meaning and editors should so note.

Authors submitting manuscripts as Case Reports, Case Problems, and Evidence in Practice should ensure that they have received consent from patients who are the subject of such reports. A statement to this effect should be included in the manuscript.

If such consent has not been obtained, personal details of patients included in any part of the paper and in any supplementary materials (including all illustrations and videos) must be removed before submission.

Role of the funding source

You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication. If the funding source(s) had no such involvement then this should be stated. Please see http://www.elsevier.com/funding .

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Acknowledgments

In the appendix one or more statements should specify (a) contributions that need acknowledging, but do not justify authorship (b) acknowledgments of technical support (c) acknowledgments of financial and material support, specifying the nature of the support. Persons named in this section must have given their permission to be named. Authors are responsible for obtaining written permission from those acknowledged by name since readers may infer their endorsement of the data and conclusions.

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has changed. Also accessible from here is information on copyright, frequently asked questions and more.

Contact details for questions arising after acceptance of an article, especially those relating to proofs, will be provided by the publisher.

(D) PREPARATION OF THE MANUSCRIPT

Submitted papers should be relevant to an international audience and authors should not assume knowledge of national practices, policies, law, etc. Authors should consult a recent issue of the journal for style if possible. Since the journal is distributed all over the world, and as English is a second language for many readers, authors are requested to write in plain English and use terminology which is internationally acceptable.

Abbreviations - Avoid the use of abbreviations unless they are likely to be widely recognised. In particular you should avoid abbreviating key concepts in your paper where readers might not already be familiar with the abbreviation. Any abbreviations which the authors intend to use should be written out in full and followed by the letters in brackets the first time they appear, thereafter only the letters without brackets should be used.

Statistics - Standard methods of presenting statistical material should be used. Where methods used are not widely recognised explanation and full reference to widely accessible sources must be given.

Manuscript Layout

The manuscript with a font size of 12 or 10 pt double-spaced with wide margins (2.5 cm at least) and number pages consecutively beginning with the Title Page. Depending on the paper type (see above) this should include the title, abstract, key words, text, references, tables, figure legends, figures, appendix. Microsoft Word or similar programme should be used.

Please check your typescript carefully before you send it off, both for correct content and typographic errors. It is not possible to change the content of accepted typescripts during production.

To facilitate anonymity, the author's names and any reference to their addresses should only appear on the title page. Please check your typescript carefully before you send it off, both for correct content and typographic errors. It is not possible to change the content of accepted typescripts during production.

Papers should be set out as follows, with each section beginning on a separate page:

Title page

To facilitate the blinded peer-review process, two title pages are required. The first should carry just the title of the paper and no information that might identify the author or institution. The second should

contain the following information: title of paper; full name(s) and address(es) of author(s) clearly indicating who is the corresponding author; you should give a maximum of four degrees/qualifications for each author and the current relevant appointment only; institutional affiliation; name, address, telephone, fax and e-mail of the corresponding author; source(s) of support in the form of funding and/or equipment.

Keywords

Include four to ten keywords in alphabetical order, which accurately identify the paper's subject, purpose, method and focus. These should be indexing terms that may be published with the abstract with the aim of increasing the likely accessibility of your paper to potential readers searching the literature. Therefore, ensure keywords are descriptive of the study. Use the Medical Subject Headings (MeSH®) thesaurus or Cumulative Index to Nursing and Allied Health (CINAHL) headings where possible (see http://www.nlm.nih.gov/mesh/meshhome.html).

Abstract

Both qualitative and quantitative research approaches should be accompanied by a structured abstract of no more than 250 words. Commentaries and Essays may continue to use text based abstracts of no more than 150 words. All original articles should include the following headings in the abstract as appropriate: Background, Objective, Design, Setting, Methods, Participants, Results, and Conclusions. As an absolute minimum: Objectives, Methods, Results, and Conclusions must be provided for all original articles. Abstracts for reviews of the literature (in particular systematic reviews and meta-analysis) should include the following headings as appropriate: Objectives, Data Sources, Study Selection, Data Extraction, Data Synthesis, Conclusions. Abstracts for Case Studies should include the following headings as appropriate: Background, Objectives, Clinical Features, Intervention and Outcomes, Conclusions.

Text

The text of observational and experimental articles is usually, but not necessarily, divided into sections with the headings; introduction, methods, results, results and discussion. In longer articles, headings should be used only to enhance the readability. Three categories of headings should be used:

• major headings should be typed in capital letter in the centre of the page and underlined (i.e. INTRODUCTION)

• secondary ones should be typed in lower case (with an initial capital letter) in the left hand margin and underlined (i.e. Participants).

• minor ones typed in lower case and italicised (i.e. questionnaire).

Do not use 'he', 'his' etc. where the sex of the person is unknown; say 'the patient' etc. Avoid inelegant alternatives such as 'he/she'.

Statement of Competing Interests

When submitting a manuscript you will need to consider if you, or any of your co-authors, are an Editor or Editorial Board member of the International Journal of Osteopathic Medicine. If this is the case you will need to include a section, at the end of your manuscript immediately before the reference section, called "Statement of Competing Interests". Example statement, which may require editing, is as follows: {Name of author} is an Editor of the Int J Osteopath Med; {Name of author} is a member of the Editorial Board of the Int J Osteopath Med but was not involved in review or editorial decisions regarding this manuscript.

References

Responsibility for the accuracy of bibliographic citations lies entirely with the authors.

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Text: Indicate references by superscript numbers in the text. These should generally appear at the end of the relevant sentence and should be directly after punctuation. The actual authors can be referred to, but the reference number(s) must always be given.

List: Number the references in the list in the order in which they appear in the text.

Examples:

Reference to a journal publication:

1. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. J Sci Commun 2000;163:51-9.

Reference to a book:

2. Strunk Jr W, White EB. The elements of style. 3rd ed. New York: Macmillan; 1979.

Reference to a chapter in an edited book:

3. Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, editors. Introduction to the electronic age. New York: E-Publishing Inc; 1999, p. 281-304

For journal articles, the abbreviated title of the journal should be used. Authors should refer to the National Library of Medicine database for journal abbreviations (http://www.ncbi.nlm.nih.gov/nlmcatalog/journals).

Note shortened form for last page number. (e.g., 51-9), and that for more than 6 authors the first 6 should be listed followed by "et al." For further details you are referred to "Uniform Requirements for Manuscripts submitted to Biomedical Journals" (J Am Med Assoc 1997;277:927-934) (see also http://www.nejm.org/general/text/requirements/1.htm).

Web references - As a minimum, the full URL and access date should be given. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be provided. Web references should be included in the reference list.

Tables, Illustrations and Figures

Tables, illustrations and figures should be placed on separate pages as separate electronic files and not placed within the manuscript. Each table, illustration or figure should be accompanied by a number (e.g. Table 1) and a brief description of the content of the table, figure or illustration, below the table, illustration or figure. All tables, illustrations or figures should be referred to in the manuscript.

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• Make sure you use uniform lettering and sizing of your original artwork.

• Save text in illustrations as "graphics" or enclose the font.

• Only use the following fonts in your illustrations: Arial, Courier, Times, Symbol.

• Number the illustrations according to their sequence in the text.

• Use a logical naming convention for your artwork files.

• Provide captions to illustrations separately.

• Produce images near to the desired size of the printed version.

• Submit each figure as a separate file.

A detailed guide on electronic artwork is available on our website: http://www.elsevier.com/artworkinstructions

Please do not:

• Supply embedded graphics in your word processor (spreadsheet, presentation) document.

• Supply files that are optimised for screen use (like GIF, BMP, PICT, WPG); the resolution is too low.

• Supply files that are too low in resolution.

• Submit graphics that are disproportionately large for the content.

Appendices - Ordinarily there should be no appendices although in the case of papers reporting tool development or the use of novel questionnaires authors must include a copy of the tool as an appendix unless all items appear in a table in the text. Appendices may be published as online supplementary files to which a reference should be made in the printed article.

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At submission stage, authors of reviews and original research articles are required to provide three to four bullet points outlining the manuscript implications for clinical practice.

(E) SPECIFIC GUIDANCE FOR ORIGINAL RESEARCH ARTICLES

The text of original research for a quantitative or qualitative study is typically subdivided into the following sections:

Introduction

State the purpose of the article. Summarise the rationale for the study or observation. Give only strictly pertinent references and do not review the subject extensively. Do not include data or conclusions from the work being reported.

Materials and Methods

Describe your selection of observational or experimental participants (including controls). Identify the methods, apparatus (manufacturer's name and address in parenthesis) and procedures in sufficient detail to allow workers to reproduce the results. Give references and brief descriptions for methods that have been published but are not well known; describe new methods and evaluate limitations.

Indicate whether procedures followed were in accordance with the ethical standards of the institution or regional committee responsible for ethical standards. Do not use patient names or initials. Take care to mask the identity of any participants in illustrative material.

Results

Present results in a logical sequence in the text, tables and illustrations. Do not repeat in the text all the data in the tables or illustrations. Emphasise or summarise only important observations.

Discussion

Emphasise the new and important aspects of the study and the conclusions that follow from them. Do not repeat in detail data or other material given in the introduction or the results section. Include implications of the findings and their limitations, and include implications for future research. Relate the observations to other relevant studies. Link the conclusion with the goals of the study, but avoid unqualified statements and conclusions not completely supported by your data. State new hypothesis when warranted, but clearly label them as such. Recommendations, when appropriate, may be included.

Conclusion

A summary of the pertinent findings and, relevance of the study and implications of the study for future research.

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AB conceived the idea for the study. AB and CD contributed to the design and planning of the research. All authors were involved in data collection. AB and EF analysed the data. AB and CD wrote the first draft of the manuscript. EF coordinated funding for the project. All authors edited and approved the final version of the manuscript.

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