

Investigating the reliability of Contemporary Chinese Pulse Diagnosis as a diagnostic tool in Oriental medicine.

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Certificate of Authorship/Originality

I certify that this thesis has not previously been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

A handwritten signature in dark ink, appearing to read 'Jon Sut', is written on a light gray background.

Signature of Candidate

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Abstract

Introduction

Few studies have evaluated the reliability of pulse diagnosis clinically despite it being a fundamental part of Oriental medicine diagnostics. The objective of this study was to determine the levels of intra-rater and inter-rater reliability of practitioners using an operationally defined method, Contemporary Chinese Pulse Diagnosis™ (CCPD), to evaluate the radial pulse of volunteer subjects.

Methods

The study utilised a real-life design to investigate CCPD in a clinical setting. Fifteen volunteer subjects and six testers skilled in the CCPD method were recruited. Two episodes of data collection were conducted 28 days apart as a practical test and retest. For each subject, four pulse rates and 30 pulse categories defined by the CCPD system were assessed and reassessed by the same four testers during both phases of testing. All assessments were conducted according to the CCPD method.

Intra rater reliability was measured by comparing individual tester results on day one with day two, while inter rater agreement and reliability were determined by comparing all testers across both days. Rates were analysed using ANOVA, while the remaining data employed Cohen's kappa coefficient. Kappa values were interpreted according to previous clinical studies and parameters considered acceptable when using a tool such as CCPD to assist in clinical diagnosis. Cross-referencing percentage agreement with the appropriate kappa results rated individual pulse quality dependability.

Results

Of the 11760 kappa calculations excellent to good agreement ($\kappa \geq 0.60$) in 67% of intra rater and 44.1% of inter rater calculations indicated CCPD to be a reliable method of pulse diagnosis. Unacceptable agreement ($\kappa \leq 0.40$) in 14.3% of intra rater and 30.5% of inter rater calculations correlated most profoundly to CCPD pulse category/position and to several subjects. Reliability of individual pulse qualities depended on the location of the quality, the complexity of the sensation description and the classification or grouping to which the quality belonged.

Conclusions

The results confirmed the findings of earlier studies that when the system of pulse diagnosis is operationally defined, acceptable levels of reliability can be achieved. Additionally bilateral methods of palpation were identified as more reliable than those that assessed pulse positions using a single finger.

Unacceptable reliability for the *Combined Complementary Positions* suggested imprecise descriptions, wording or language for accessing the *Pleura*, *Esophagus* and *Diaphragm Positions* may exist within the CCPD operational definitions. Further any uncertain terminology needs revision as the data indicated this might have contributed to variance within the testers' techniques. Also the pulse qualities Muffled, Change of Amplitude, Blood Heat, Blood Thick, and Flooding Deficient, while not shown to be unreliable, had comparatively lower reliability suggesting the definitions for these qualities may also need modification. If variance continues following review, then the reliability within a clinical context of these positions and qualities needs to be re-evaluated entirely.

Chapter 1

1 INTRODUCTION

The medical tradition of assessing arterial impulses, most commonly at the radial artery, is ubiquitous throughout human history. Consistently across different times and civilizations the pulse has been palpated in an effort to determine the physiological functioning or health of the individual. As a result different systems of pulse diagnosis were developed and refined at distinct times in history in various geographical locations. (Balick M, De-Gezelle J et al. 2008)

Ancient cultures who incorporated methods of pulse diagnosis into their medical practices include the Egyptian, Greek, Unani (Greco-Persian), Indian (Ayurvedic), Mayan, Tibetan, as well as the Chinese, who ultimately influenced the medical theories and practices of Korea, Vietnam and Japan. (Steiner RP 1987; Amber R and Babey-Brooke AM 1993; Kuriyama S 1997; Hall T 2001; Balick M, De-Gezelle J et al. 2008) (For an elaboration of pulse diagnosis specific to these cultures see Appendix 1) Some of these ancient methods have survived the test of time and are still used today within the practices of the various medical paradigms that gave rise to their development. This is exemplified by Chinese, Ayurvedic and Mayan medicine where pulse diagnosis plays a significant role in diagnosing the patient condition and therefore remains a current topic of discourse within these particular medicines. (Balick M, De-Gezelle J et al. 2008)

Of particular interest is the tradition of pulse diagnosis with regard to the modern practice of Chinese medicine. Despite its prevalence in the traditional medical model for millennia, its clinical execution in the modern context is obfuscated (Turner F 2007) due to a range of commonly accepted conjectures within the profession that have little basis in fact. (Walsh S and King E 2008) The most notable of these is the assumed 'correctness' of the historical Chinese medical pulse literature as a reliable means for the diagnostic interpretation of pulse findings within clinical practice. (Veith I 1972)(1949); Yang S 1997; Kuriyama S 1999; Ramholz J 2001) The classic texts have been shown under a range of experimental conditions (Cole P 1977; Kass R 1990; Craddock D 1997; King E 2001; King E, Cobbin D et al. 2002; Walsh S 2003) to be ambiguous and inadequate for this task therefore discounting this long held presumption. Accordingly, some authors (Ramholz J 2001; Hammer L 2005¹; Walsh S and King E 2008) advocate the classic literature as the starting point for further study and research so as to expand our existing knowledge.

In formulating a diagnosis, practitioners today still depend upon the classic literature to assist and guide their classification of a pulse as healthy or not. (Cole P 1977; Kass R 1990; Craddock D 1997; King E 2001) Given the obscurity of these sources and the subjective nature of pulse diagnosis in general, reports (anecdotal and in the current literature) of practitioners' having reduced confidence in pulse diagnosis to contribute meaningful information to diagnosis (Bilton K 2006; Walsh S and King E 2008) are not surprising. For this reason there has been resurgence in systems of pulse diagnosis based on traditional texts and theoretical knowledge that have been further developed. Such systems have been refined by clarifying the problems of ambiguity contained in the classic literature to allow practitioners more

accessibility to the knowledge while still remaining clinically relevant to current methods of practice. (Shen JHF 1980; Kass R 1990; Ramholz J 2001; Hammer L 2005¹; Walsh S and King E 2008) One such system is Contemporary Chinese Pulse Diagnosis™ (CCPD).

This thesis intends to explore the use of pulse diagnosis within the modern practice of Chinese medicine by investigating the reliability of practitioners using CCPD in the clinical setting. More specifically the study aims to demonstrate if acceptable levels of agreement or reliability can be achieved within the same and between different practitioners assessing the radial artery of subjects according to the CCPD method.

1.1 THESIS FORMAT

1.1.1 CHAPTER 1: INTRODUCTION

This chapter presents the background for the study; the aim of the study and outlines the thesis format.

1.1.2 CHAPTER 2: SYSTEMATIC LITERATURE REVIEW

This chapter reviews the published research concerning the reliability of using manual methods of pulse diagnosis to assess the radial artery within the field of Chinese medicine. It discusses the advances that research to date has made, the shortcomings of these studies and presents directions for further research and therefore the rationale for undertaking the present study.

1.1.3 CHAPTER 3: CONTEMPORARY CHINESE PULSE DIAGNOSIS™

This chapter offers a detailed description of Contemporary Chinese Pulse Diagnosis™ (CCPD) the method of pulse diagnosis that is the subject matter of the study. It includes information regarding the history, influence of the classic literature on the development of CCPD and the specifications or operational definitions of the system.

1.1.4 CHAPTER 4: METHODOLOGY OF THE STUDY

This chapter describes the process that was implemented for collecting, handling and analysing the data. It presents the study's aims and objectives; the design; the methods for data collection including the test – retest procedure, pulse categories assessed and variables included; the methods of data management and analysis including storage of data, transcription of the raw data to electronic format, the statistical methods used to analyse the data and the entry of these processed calculations to Excel for ease of managing the results.

1.1.5 CHAPTER 5: RESULTS

This chapter presents the study results in terms of levels of agreement of the testers rating the subjects' pulses. Results are structured according to pulse rates, kappa analysis and reliability of pulse qualities, and report intra rater reliability (agreement within a tester) and inter rater reliability (agreement between testers). Overall levels of agreement and reliability are presented according to testers, subjects and days of testing. More specific results are also reported including reliability with reference to pulse positions, pulse qualities as well as the large and small segment of the pulse or those pulse categories assessed using bilateral versus unilateral palpation of the radial artery.

1.1.6 CHAPTER 6: DISCUSSION

Here the methods of analysis and the major findings of the results are discussed in light of issues raised in the systematic literature review. These include how operationally defining the system allows acceptable levels of agreement to be achieved within and between raters, however despite this, a portion of pulse diagnosis remains subjective. Additionally, this chapter adds to current theories regarding variance of reliability and considers its dependency in terms of testers, subjects, pulse positions, pulse qualities and whether single or bilateral methods of palpation affect agreement. Further the complicated matter of individual pulse quality reliability is considered with regard to the complexity of the pulse quality sensation, the strength of the impulse and the position in which it is found.

1.1.7 CHAPTER 7: IMPLICATIONS OF THE STUDY

This chapter presents the conclusions of the study and recommendations for future research based on the findings of this study.

1.1.8 REFERENCES

1.1.9 APPENDICES

Chapter 2

2 SYSTEMATIC LITERATURE REVIEW

2.1 RELIABILITY OF MANUAL METHODS OF PULSE DIAGNOSIS

Within the field of Chinese medicine there are relatively few studies that evaluate how reliably practitioners can apply diagnostic techniques within the clinical setting. Pulse diagnosis, a method commonly included in the extant practice of Chinese medicine, contributes significantly to the palpation component of the 'four diagnostic methods' (questioning, listening, observation and palpation). Accordingly pulse descriptions are widely held to reveal important diagnostic information and often accompany patient presentations reported in the acupuncture and Chinese medicine literature. Despite this, there is little evidence that demonstrates the repeatability or reliability of techniques such as pulse diagnosis to gather diagnostic information.

This primarily unsubstantiated status is surprising and has far reaching implications for the profession. Most significantly, the questions thus raised concerning the validity of results obtained in studies conducted on acupuncture or Chinese medicine using untested methods of assessment. Without evidence that demonstrates the clinical dependability of the diagnostic methods used, it is not possible to have confidence in assertions concerning information gained from unverified techniques such as pulse diagnosis. (King E, Cobbin D et al. 2002)

Accordingly, evaluating the dependability of Chinese medicine practitioners to apply the diagnostic methods clinically is vitally important. As such, a systematic review of the existing literature reporting levels of agreement or reliability of practitioners using pulse diagnosis to assess the radial artery will determine their limitations and direct the current study on the reliability of Contemporary Chinese Pulse Diagnosis™ (CCPD).

2.2 METHODS OF LITERATURE REVIEW

To investigate the demonstrated reliability of clinicians implementing methods of pulse diagnosis, studies that examined agreement of testers using manual palpation techniques to assess the radial pulse were analysed.

2.2.1 ELIGIBILITY CRITERIA

Types of Studies: Those that were published in English and investigated manual pulse taking procedures were included. There were no date, or publication status restrictions imposed.

Types of pulse testers: Studies utilising all types of pulse testers whether students or practitioners of Chinese medicine were considered.

Types of subjects: Studies that recruited both healthy and ill subjects were included.

Method of pulse diagnosis: Those that investigated methods of manual pulse diagnosis applied by human testers were included while studies that used electronic or mechanical devices to assess the radial artery were excluded.

Types of outcome measures: Primary outcome measures were the reported levels of intra rater (same tester assessing the same subject on separate occasions) and inter

rater (different testers assessing the same subject on the same/different occasions) agreement for defined attributes rated on the radial pulse of subjects.

2.2.2 DATABASE SEARCH AND INFORMATION SOURCES

Studies were identified by searching electronic databases, scanning reference lists of articles and consultation with experts in the field. No limits were applied for the date of publication and all relevant papers published in English were considered. The search was applied to Medline, PubMed, CINAHL(EBSCO), ProQuest Central and Google on August 5, 2010. Additionally the reference lists of papers returned from electronic sources were hand searched for appropriate studies.

The following search terms were used to search the electronic databases 'pulse diagnosis', 'reliability', 'rater agreement', 'Chinese medicine', 'Oriental medicine' and 'acupuncture'.

2.2.3 STUDY SELECTION

The author performed all eligibility assessments of the studies returned from the database and hand search. The titles and abstracts of the identified records were screened for relevance. Those that potentially suited the eligibility criteria underwent a further full text screening before being included in the systematic review.

2.2.4 DATA COLLECTION PROCESS

A data extraction sheet (See Table 2-1) was developed based on the Cochrane Consumers and Communication Review Group's data extraction template. (Cochrane Consumers and Communication Review Group 2009)

2.2.5 DATA ITEMS

The following information was extracted from each study: (1) the number of subjects included; (2) the location of the study; (3) the characteristics of the subjects (including health, age, sex), and the studies inclusion and exclusion criteria; (4) the testers (including practitioner, student) and the studies inclusion and exclusion criteria; (5) method of pulse palpation used; (6) the study design; (7) the methods of statistical analysis used; (8) reported outcomes (levels of agreement, reliability).

2.2.6 SUMMARY MEASURES

Levels of intra rater (within practitioner) and inter rater agreement (between practitioners) were the primary measure of reliability.

2.2.7 LIMITATIONS AND RISK OF BIAS ACROSS STUDIES

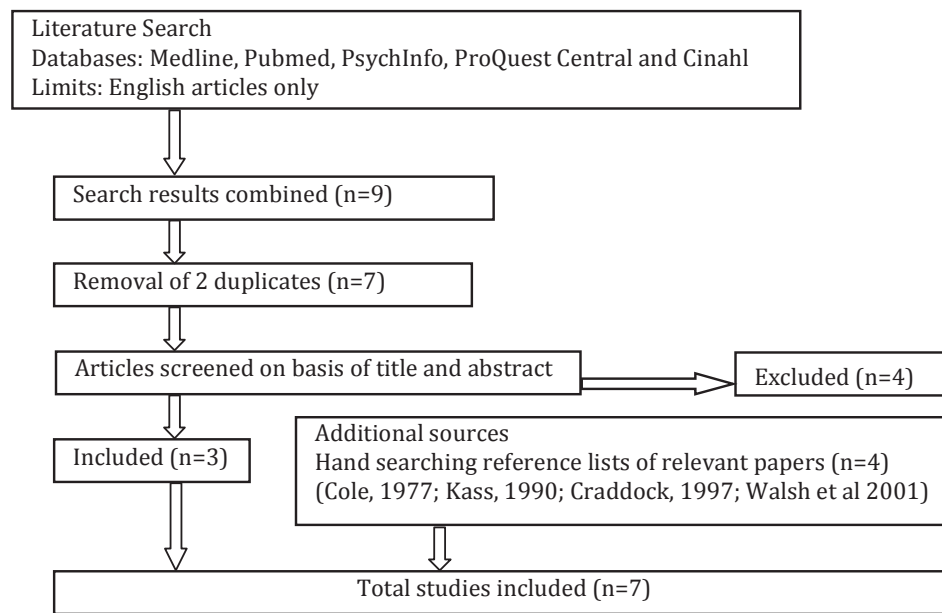
The methodology and results from the available studies were explored for factors limiting the conclusions and also clues that suggested missing data or selective reporting bias.

2.3 STUDIES INCLUDED IN LITERATURE REVIEW

A total of seven studies were identified for inclusion in the review. The Medline, Pubmed, PsychInfo and Cinahl databases conducted on August 5, 2010 returned a total of nine citations. After adjusting for duplicates seven remained. Of these, four studies were discarded on reviewing the titles and abstracts when it was obvious that these papers did not meet the stated standards. An additional four studies that satisfied the inclusion criteria were identified by checking the references of located,

relevant papers and searching for studies that have cited these papers. The process for data collection is outlined in the following diagram Figure 2-1.

Figure 2-1: Flow diagram of included studies



2.3.1 THE STUDIES ANALYSED

Seven studies were finally selected that in some way investigated the reliability of manual methods of pulse diagnosis. These are summarised in Table 2-1 and included:

Study 1 (Cole, P. Pulse diagnosis and the practice of acupuncture in Britain. [PhD]. Sussex: University of Sussex; 1977);

Study 2 (Kass, R. Traditional Chinese Medicine in San Francisco: Reliability of traditional Chinese pulse diagnosis. Social Welfare Department, University of California, Berkeley, 1990);

Study 3 (Craddock, D. Is Traditional Chinese Medical pulse reading a consistent practice? A comparative pilot study of four practitioners. College of Acupuncture, Sydney: UTS; 1997);

Study 4 (Walsh S, Cobbin D, Bateman K, Zaslowski C. Feeling the pulse: trial to assess agreement level among TCM students when identifying basic pulse characteristics. Eur J Orient Med 2001; 3(5): 25-31);

Study 5 (King E, Cobbin D, Walsh S, Ryan D. The reliable measurement of radial pulse characteristics. Acupuncture Med 2002;20:150–159);

Study 6 (King E, Cobbin D, Walsh S, Ryan D. The Testing of Classical Pulse Concepts in Chinese Medicine: Left- and Right-Hand Pulse Strength Discrepancy Between Males and Females and Its Clinical Implications. J Alt Comp Med; 2006;12(5):445-450);

Study 7 (O'Brien K, Abbas E, Zhang J, Guo ZX, Luo R, Bensoussan A, Komesaroff P. Understanding the Reliability of Diagnostic Variables in a Chinese Medicine Examination. J Alt Comp Med 2009;15(7):727–734).

During the study selection process a previous journal article was located that reported the reliability of 'Traditional East Asian Medicine' diagnoses. (O'Brien K and Birch S 2009) It reviewed studies that investigated the reliability of many of the Chinese medical diagnostic and treatment methods (pulse diagnosis, tongue diagnosis, other clinical observations, pattern diagnosis, eight guiding principals and TCM treatments). However, the reviews of the studies on pulse diagnosis are inadequate. Very little, incomplete and even misleading information (in reference to Cole, 1977; Walsh S, Cobbin D et al, 2001; and Kass R, 1990) is offered regarding the subjects, observers, design, methodology and conclusions of the included studies.

Further the reviewed studies are presented in a table that only briefly summarised each, and omitted some data.

Within this article, the discussion on factors that affect reliability addressed all modalities collectively. In doing so little information regarding the individual components was provided, each of which may be expected to exhibit various and specific procedural difficulties. The conclusion that future researchers develop strategies to improve reliability did not suggest specific guidance for the individual methods, beyond what was offered by the original studies. The following literature review concentrates solely on manual methods of pulse diagnosis and aims to overcome these shortcomings.

Table 2-1: Summary of included studies evaluating the reliability of manual methods of pulse diagnosis

Author	Number of subjects	Subject characteristics	Pulse testers	Method of pulse palpation used	Study design	Statistical analysis	Outcomes
Cole P, 1977							
Intra rater A	Retested 5 of 29 subjects	Hospital patients.	1 acupuncturist (18 years experience)	6 traditional pulse positions ascribed by Wang Shu He.	Repeat practical test retest; testers blinded to subjects; no verbal communication; data recorded on standard pulse map using ++, +, 0, -- notation (+ yang, - yin). Intra rater reliability calculated	Spearman Rank correlation	1 subject identical pulse maps; 3 of 5 Spearman Rank correlation > 0.5. Possible for stable information to be obtained from a pulse, however not achieved on all occasions.
Intra rater B	Retested 4 of 49 subjects	Hospital staff and patients.	1 acupuncturist (20 years experience)	As for intra A with addition of 7 pulse qualities.	As for intra A.	As for intra A.	Spearman Rank correlation for the repeated pulse maps 0.56, 0.31, 0.24 and 0.53. Showed varied intra rater reliability.
Intra rater C	Retested 2 of 10 subjects	Subjects of mixed health, age 18 to 56.	1 acupuncturist (18 years experience) same as A.	As for A.	As for intra A.	As for intra A.	Spearman Rank correlation for the repeated pulse maps, 0.93 and 0.96. Indicated pulse findings reproduced reliably.
Intra rater D	12 subjects	Healthy male medical students.	1 acupuncturist (14 years experience)	As for intra A.	As for intra A.	Spearman Rank correlation; Wilcoxon test.	Spearman Rank correlation 0.9, 0.9, 0.6, 0.5, 0.5, -0.1, 0.1, 0.7, 0.9, -0.5, 0.7 and 0.5; Wilcoxon two-tailed test verified values unlikely due to chance (p <0.01). Indicated significantly similar pulse patterns for the same individuals were reported on two occasions.
Intra rater over time	5 subjects	Hospital patients.	1 acupuncturist (20 years experience) same as B.	As for intra A.	As for intra A. In addition 2 subjects retested 5 times, 3 retested 3 times.	Kendall coefficient of concordance	Kendall concordance coefficients were 0.7, 0.95, 0.5, 0.3 and 0.4. Showed to some extent, stable pulse patterns reported. 81% of variance in correlation was accounted for by physical and projected stereotyped components.

Inter rater 1	12 subjects	Acupuncture patients.	3 testers: 1 acupuncturist (same as B) and 2 of his students.	As for intra A. Also both students were trained by the acupuncturist and presumably using the same technique.	Practical test: blinded to subjects; no verbal communication; data recorded on standard pulse map using ++, +, 0, -, -- notation. Inter rater reliability calculated.	Spearman Rank	Range for Spearman correlation -0.80 to 0.9 (with most being low). Indicated low inter rater reliability for the blinded conditions. Kendall coefficients of 0.2, 0.3 and 0.4; showed testers not generating stereotyped pulse patterns.
Inter rater 2	12 subjects	Healthy medical students; 9 male, 3 female	2 acupuncturists (same as D) 14 years experience and 11 years experience.	As for intra A.	As for inter rater 1 but open testing, testers not blinded to subjects.	Spearman Rank	Range for Spearman correlation -0.8 to 0.8; showed varied inter rater reliability for open conditions. Kendall coefficients 0.3 and 0.2; testers did not stereotype pulse patterns. Combined inter rater 1 and 2 showed one tester could agree with himself but disagree with another tester; thus the testers perceived their own gestalt in the pulses (recorded what they expected to feel) independent of being blinded to the subjects or not.
Kass R, 1990	10 subjects	Gender not specified. Mean age 80.5 years, all with medical conditions.	2 TCM practitioners 1 manual palpation 1 electronic device	Not specified. Assessed 3 depths in 3 pulse positions (R) and (L) side. 31 pulse patterns used.	Practical test, all subjects. Data recorded on forms with 3 sections; <i>general, individual positions and pulse sub type (qualities)</i> . Compared manual palpation to electronic assessment.	Normal	<i>General and individual positions</i> sections manual and electronic responses matched 79% and 70% ($\alpha = 0.0001$). <i>Pulse sub type (qualities)</i> had matches significant ($\alpha = 0.05$) in < 50% of groupings. Reliability decreased as levels of distinction became subtler.
Craddock D, 1997	8 subjects	4 males, 4 females. Healthy subjects.	4 TCM practitioners	Not specified	Practical test-retest. Testers assessed 12 subjects; 4 had repeat test; rated 7 pulse categories. Data recorded on standard form; testers blinded. Intra and inter rater reliability calculated.	% Agreement	Across all 7 categories average agreement: inter rater = 63%, intra rater = 56.1%. Lowest inter/intra rater agreement found in category <i>Individual Qualities</i> . Inter/intra rater reliability decreased as pulse quality complexity increased.

Walsh S, Cobbin D, et al. 2001	18 subjects total. Collection 1, 35 female Collection 2, 29 Collection 3, 20	44% male, 56% female	TCM students	Not specified. Cun, guan and chi positions assessed.	Practical lineal test, 3 data collections (pulse diagnosis class; C1 week 1, C2 week 14 C3 1 year after); no repeat test on any subjects. Rated 12 categories on pulse (total of 72 categories/collection); data recorded on a standard form. Inter rater reliability calculated.	Chi χ^2 , ($\alpha = 0.05$)	Collection 2 inter rater agreement greater than chance in 31 of 72 sets of data ($\alpha = 0.05$, $\chi^2 = 0.046$). Collection 2 and 3 agreement no different to chance alone. Low inter rater agreement due to the inadequacies of the pulse literature versus ability of students to learn pulse diagnosis.
King E, Cobbin D, et al. 2002	Collection 1, 27 males, 39 females 66 Collection 2, 30 13 males, 17 females	27 males, 39 females 13 males, 17 females	2 TCM practitioners	Researchers developed operational definitions and a standardised manual palpation method. Definitions provided.	Practical test-retest method; no apparent repeat test on any subjects. Rated 16 categories on pulse; data recorded on a standard form. Inter rater reliability calculated.	Chi χ^2 , ($\alpha = 0.05$) % Agreement	Mean % agreement for C1 and CII >80%. Agreement in C1, 13 of 16 categories >70% (10 > 80%); in CII >80% for 11 categories. With operationally defined pulse method acceptable levels of inter rater reliability achieved.
King E, Walsh S, et al. 2006	65 subjects	27 males, 38 females. Healthy subjects.	2 TCM practitioners same as in King E, Cobbin D, et al 2002.	Cun, guan and chi positions assessed. Same method as in King E, Cobbin D, et al 2002.	Practical test. Testers rated all subjects' pulses in respect to dominant left-right balance; data recorded on a standard form.	Chi χ^2 , ($\alpha = 0.05$) % Agreement	Inter rater agreement 86% in rating the relative strength of the subjects' pulses. Gender related right-left pulse strength differences not supported.
O'Brien K, Abbas E et al. 2009	45 subjects	Subjects with hypercholesterolemia. Age range 20-75 years.	3 TCM practitioners	Not specified. Presumably testers did not use a constant method, as it is not stated otherwise.	Part of larger study to assess the efficacy Chinese herbal medicine. Included of 3 of the 4 methods of diagnosis in Chinese medicine. Rated 3 categories on pulse; data recorded on a standard form. Inter rater reliability calculated.	Kappa Coefficient	Agreement between 2 practitioners > than agreement between all 3. Location: all 3 testers slight agreement (K=0.15); 2 of 3 testers perfect agreement (K=1.0). Force: all 3 testers fair agreement (K=0.29); 2 of 3 testers almost perfect agreement (K=0.86). Speed: Compared assessment by breath (2 testers) to rate by electronic device (1 tester); K=0.72 and 0.86 (substantial and near perfect agreement)

2.3.1.1 STUDY 1 (COLE P 1977)

This extensive research was the first of its kind and investigated the use of pulse diagnosis by acupuncturists within the United Kingdom (UK). There were 16 small studies conducted by Cole that contributed to the final PhD thesis. These included a questionnaire sent to the 350 registered acupuncturists practicing in the UK at the time; observation of two experienced acupuncturists using pulse diagnosis to treat patients; various trials comparing health descriptions of patients as described by a western doctors and acupuncturists diagnosing by pulse only (each of which involved a retest of some subjects serving as preliminary trials of intra rater reliability); assessments of bladder fullness made by western doctors using heart rate and blood pressure and acupuncturists using pulse diagnosis alone (again involving a retest of some subjects to assess intra rater reliability); intra rater reliability over time; inter rater reliability with the testers blinded and then unblinded to subjects; rating the pulses of subjects before and after acupuncture treatment; and both novice and skilled practitioners detecting contours on a mechanical pulse simulator. Only the relevant component studies are included in this systematic literature review. There was no mention of ethical considerations in this study.

Study Location

The studies and thesis were completed as requirements for the Doctor of Philosophy (PhD) program at the University of Sussex, UK.

Subjects

There is varying information provided across the studies regarding the subjects' gender, age, ethnicity and state of health. Also methods of subject selection, consent and issues of de-identifying data and confidentiality are not described.

Preliminary intra rater reliability (A): (Recorded in the original text as Study 1, page 177). Retested five of 29 subjects (hospital patients).

Preliminary intra rater reliability (B): Recorded in the original text as Study 2, page 192. Retested four of 49 subjects (hospital staff and patients).

Preliminary intra rater reliability (C): Recorded in the original text as Study 3, page 206. Retested two of ten subjects (mixed health, age 18 to 56).

Preliminary intra rater reliability (D): Recorded in the original text as Study 7, page 249. Subjects were twelve volunteer, healthy male, medical students.

Intra rater reliability over time: Recorded in the original text as Study 8, page 254. Included five subjects that were hospital patients at the time.

Inter rater reliability (1): Recorded in the original text as Study 10, page 260. Twelve patients who were attending Mr Van Buren's clinic were tested.

Inter rater reliability (2): Recorded in the original text as Study 11, page 264. Subjects were twelve healthy medical students, nine male and three female.

Pulse Testers

Preliminary intra rater reliability (A): One acupuncturist, 18 years experience.

Preliminary intra rater reliability (B): One 'world-renowned' acupuncturist, Mr JD Van Buren with 20 years experience, who at the time was the head of the International College of Oriental Medicine.

Preliminary intra rater reliability (C): Same acupuncturist as preliminary intra rater reliability (A).

Preliminary intra rater reliability (D): One acupuncturist, 14 years experience, who was at the time teaching at the College of Acupuncture.

Intra rater reliability over time: Same acupuncturist as preliminary intra rater reliability (B).

Inter rater reliability (1): Same acupuncturist as preliminary intra rater reliability (B) plus two of his students who had been practicing acupuncture for three years, and were instructed daily by Mr Van Buren in the technique of pulse diagnosis.

Inter rater reliability (2): Two acupuncturists with similar experience and who were both teaching at the College of Acupuncture, one with eleven years, and the other with 14 years was the same as preliminary intra rater reliability (D).

Method of Pulse Palpation Used

Preliminary intra rater reliability (A): The traditional 28 qualities as cited in Mann (Mann F 1971) are mentioned but were not included in the study methodology, while the six traditional pulse positions ascribed by Wang Shu He (Yang S 1997) were included in the standardised pulse map used during the pulse palpation.

Preliminary intra rater reliability (B): As for preliminary intra rater (A) with the addition of seven pulse qualities as cited in Chan (Chan J 1960).

Preliminary intra rater reliability (C) and (D): As for preliminary intra rater reliability (A).

Intra rater reliability over time: As for preliminary intra rater reliability (A).

Inter rater reliability (1) and (2): As for preliminary intra rater reliability (A).

Study Design

Although the design of each of the component studies was well described, there were no specific details provided for the methods of handling and storing the data after it was collected.

Preliminary intra rater reliability (A), (B), (C) and (D): used a practical test and retest design with testers blinded to subjects (visual and auditory), and verbal communication forbidden. Information from the subjects' pulses was recorded on the standardised pulse map using ++, +, 0, -, -- notation meaning very yang, moderate yang, balanced, moderate yin and very yin respectively.

Intra rater reliability over time: Same as intra rater (A), (B), (C) and (D) with the additional goal of testing all subjects five times. However, only two subjects were examined all five times, the remaining three were only tested three times each as they found the procedure too tiring.

Inter rater reliability (1): Testing conditions consistent with the preliminary intra rater studies, however, there were no retests. Instead two separate trials were conducted where two testers (acupuncturist and one student) assessed six subjects, using the same acupuncturist on both occasions but different students.

Inter rater reliability (2): This study was conducted under standard open conditions, where talking was not allowed and subjects were in view of the testers. The subjects were presented to the two acupuncturists who were blinded to each other's results.

Statistical Analysis

Preliminary intra rater reliability (A), (B) and (C): test and retest were compared using the Spearman Rank correlation test where the two pulse maps generated for

each subject were converted into numbers so that each organ was represented by its ranked value, rather than its yin/yang value. Thus the ranks attributed to each organ on the first occasion of pulse diagnosis could be compared with those on the second occasion.

Preliminary intra rater reliability (D): As for the preliminary intra rater trials with the addition of the Wilcoxon test applied to the Spearman Rank correlation scores to assess the significance of some results.

Intra rater reliability over time: The Kendall coefficient of concordance was applied (scores range from 0 [no agreement] to 1 [complete agreement]). (Seigel S and Castellan Jr N 1988) This was calculated for each of the subjects, and assessed the overlap of pulse maps in terms of constant physical versus stereotyped components projected onto the pulse by the acupuncturist.

Inter rater reliability (1): Spearman Rank coefficient was applied as in previous tests, also the Kendall coefficient of concordance was calculated for each practitioner across all subjects as a measure of the possibility that they generated stereotyped pulse patterns, rather than basing their findings on physical attributes they felt in the pulses.

Inter rater reliability (2): As for intra rater reliability over time.

Outcomes

Preliminary intra rater reliability (A): In one subject the two pulse maps generated were identical and in three of five they showed a Spearman Rank correlation coefficient >0.5 . Cole thus suggested it was possible for stable information to be obtained from a pulse, however she noted that the acupuncturist did not manage to do so on all occasions.

Preliminary intra rater reliability (B): The Spearman Rank correlation coefficients derived for the repeated pulse maps were 0.56, 0.31, 0.24 and 0.53 respectively. Cole suggested these were lower than expected considering the claim of the tester that he believed pulse diagnosis to be an objective technique.

Preliminary intra rater reliability (C): The Spearman Rank correlation coefficient for the two repeated pulse maps, 0.93 and 0.96, indicated that tester was able to reproduce pulse findings reliably.

Preliminary intra rater reliability (D): The correlation coefficients obtained were 0.9, 0.9, 0.6, 0.5, 0.5, -0.1, 0.1, 0.7, 0.9, -0.5, 0.7 and 0.5, while the Wilcoxon two-tailed test verified these values were unlikely due to chance ($p < 0.01$). Cole thus suggested the acupuncturist was able to report significantly similar pulse patterns for the same individuals on two occasions.

Intra rater reliability over time: Kendall coefficients of concordance for the five subjects were found to be 0.7, 0.95, 0.5, 0.3 and 0.4. This corroborated the preliminary findings that showed to some extent, stable pulse patterns were reported over the course of a day, and further, that 81% of the variance in pulse map correlation was accounted for in terms of constant physical and stereotyped projective components.

Inter rater reliability (1): Spearman Rank coefficients ranged from -0.80 to 0.9 (with most being low) indicated low inter rater reliability for the blinded conditions. The Kendall coefficients of 0.2, 0.3 and 0.4 suggested that neither the students nor Mr Van Buren were simply generating a stereotyped pulse pattern. Cole concluded that despite the likelihood both students used a similar technique due to their learning pulse diagnosis under the guidance of Mr Van Buren, they were not able to report

pulse findings that correlated highly with his. Cole thus queried to what extent did the testers project their expected pulse picture onto the reported information?

Inter rater reliability (2): The range of Spearman Rank coefficients for each pair of pulse maps (-0.8 to 0.8) again showed low inter rater reliability for the open conditions. The Kendall coefficients of concordance for the two acupuncturists (0.3 and 0.2) indicated it was unlikely they generated repeated stereotyped pulse maps for all subjects. Cole thus concluded that even if the same tester recorded repeated 'objective' physical patterns on different occasions, different testers did not detect these similarly within the same subject. She further suggested individual 'subjective' influences were projected onto the same subjects' pulses by different acupuncturists.

Intra rater reliability over time, Inter rater reliability (1), and (2): The combined outcomes of these studies suggested that although one tester could report relatively constant patterns in the same subjects' pulse at different times, two testers did not report the same patterns in the same individuals reliably. Further she observed that one tester could agree with himself but disagree with another tester for the same group of subjects. Thus each acupuncturist seemed to perceive their own 'gestalt' in the subjects' pulses, or record what they were expecting to feel whether they were blinded to the subjects or not.

Risk of Bias and Limitations

Although this collection of studies is very comprehensive in that it examines intra and inter rater reliability under both blind and open conditions, there are relatively small sample sizes to draw decisive conclusions from regarding the reliability of pulse diagnosis. The studies on intra rater reliability had between two and five

subjects, while the inter rater studies both included twelve subjects. The subjects for inter rater reliability study (1) were all recruited from the clinic of the primary tester in that study. In this case the results may have been influenced by the potential of prior knowledge of the subjects pulses, despite the tester being blinded.

2.3.1.2 STUDY 2 (KASS R 1990)

This study involved an evaluation of the reliability and validity of both manual and electronic pulse taking techniques. Only the section that investigated the reliability of manual pulse palpation will be included in this literature review. There is no mention of ethical considerations by this study.

Study Location

This study was conducted as part of the PhD requirements, for the Social Welfare Department, University of California, Berkeley, USA.

Subjects

Ten subjects (mean age = 80.5 years) were recruited from On Lok Senior Health Services in San Francisco on the basis of their medical file. The file was considered appropriate if it contained a relevant western diagnosis also no references to physical or physiological conditions at the radial artery or wrist (arrhythmias, hypertension, obesity, Parkinson's Disease etc) that would confound the pulse taking procedure. Identifying data was removed from all files included in the study however there is no mention of gaining consent from the subjects.

Pulse Testers

Two traditional Chinese physicians were included in the study, one using manual palpation, the other using an electronic pulse-taking device. The testers were

described as having 'extensive experience' however no further information such as the number of years is offered.

Method of Pulse Palpation Used

Although the exact method of pulse diagnosis is not stated, 31 pulse patterns cited in Porkert (Porkert M 1983) were included. Three depths were assessed at the three primary pulse positions on both wrists to give 18 locations.

Study Design

The study was set up as a practical test where the two physicians examined the pulse of the same ten subjects. The testers aimed to obtain the same pulse readings for each subject (reliability), and correctly match subjects with their corresponding medical files on the basis of pulse analysis alone (validity).

The testers were blinded to the subjects, and recorded information from the subjects' pulses on a form containing three sections (general pulse, pulse sub type and individual pulse). Eleven pulse categories were included in the general and individual pulse sections. The section pulse sub type required more detailed analysis by way of specific pulse qualities being selected for four of the eleven pulse categories in the general pulse section.

Statistical Analysis

The normal approximation to the binomial (Prazen E 1960) was employed to determine whether the results obtained were better than what chance alone would produce. A probability value of <0.05 was considered significant.

Outcomes

Significant results were obtained in both the general and individual pulse sections where manual and electronic responses were matched 79% and 70% respectively ($p < 0.0001$). These sections included general pulse characteristics such as depth, intensity, amplitude, frequency, rhythm, etc. Where specific pulse qualities were nominated, pulse sub type section, matches were significant in less than half of the groupings ($p < 0.05$). Therefore Kass suggested the reliability of pulse diagnosis decreased as more subtle levels of distinction were attempted.

Risk of Bias and Limitations

The main limitation of this study lies in the practical test design. As there was no retest done by the two physicians the results compared a manual pulse taking procedure with that of an electronic device. Without separately evaluating the repeatability of the manual and electronic methods it is impossible to draw definitive conclusions regarding the reliability of pulse diagnosis from this study. The sample size was also relatively small which further restricts the findings.

2.3.1.3 STUDY 3 (CRADDOCK D 1997)

This was conducted as a pilot study and aimed to investigate the consistency of pulse evaluation by practicing acupuncturists. Intra and inter practitioner consistencies were investigated. There was no mention of confidentiality or ethical considerations for handling the data or subject details.

Study Location

The study was an independent research project conducted as part of course requirements for an undergraduate program at Acupuncture Colleges Australia, later becoming the University of Technology, Sydney, Australia.

Subjects

There were eight volunteer subjects, selection based on their availability for inclusion in the study. One was a student at Acupuncture Colleges, and another was a member of staff, the remaining six had no affiliation with the institution. There were four female and male subjects ranging in age from 24 to 51 years.

Pulse Testers

The four pulse testers included in the study were all members of staff at Acupuncture Colleges. They had a minimum of three years full time training and five years of clinical and teaching experience.

Method of Pulse Palpation Used

There is no specific indication of the model of pulse diagnosis used for the study however Li Shi Zhen is mentioned in reference to positioning of the subjects' wrists. Beyond this there is no citation available for the source of definitions used by the testers in terms of the pulse characteristics and specific qualities assessed by the study.

Study Design

A practical test and retest was used where practitioners were required to complete twelve pulse assessments, four of which were repeated tests. They documented the subjects' pulses according to a standardised questionnaire that rated seven pulse characteristics. Testers were blinded to the subjects and verbal communication was not allowed during the trial.

Statistical Analysis

The results are reported in terms of percentage agreement however, no details were provided regarding the procedures used for managing or analysing the data.

Outcomes

The average inter practitioner agreement was reported at 63.3%. Six categories showed $\geq 56.3\%$ agreement, while the other =31.8%. Average intra practitioner agreement was 56.1%. Five categories demonstrated $\geq 58.3\%$ agreement while two were $\leq 36.5\%$. The lowest percentage agreement in both intra and inter rater comparisons occurred in the category *Individual Qualities*. Craddock thus concluded as the complexity of the assessed pulse variable increased, levels of intra and inter rater agreement decreased. He also suggested that the lack of agreement might have been due to inadequate operational definitions within the practice of pulse diagnosis.

Risk of Bias and Limitations

There is the risk of bias in that the testers may have had prior knowledge of two of the subjects' pulses, given that they were all either students or staff at the same institute. Also there is no mention of blinding the practitioner's results during the trial, or how the pulse assessment questionnaires were handled once completed. Without this information it is not possible to determine if these sources confounded the data. The sample size of eight subjects is again relatively small, thus the conclusions drawn must be held in light of this.

2.3.1.4 STUDY 4 (WALSH S, COBBIN D ET AL. 2001)

This study assessed the frequency of agreement between TCM students learning pulse diagnosis to identify simple parameters such as speed, depth, volume, length and overall quality of the pulse. There was no mention ethical considerations, or if funding was provided for the study.

Study Location

The study was conducted at the College of Traditional Chinese Medicine within the Department of Health Sciences, Faculty of Science, University of Technology, Sydney (UTS), Sydney, Australia.

Subjects

This study included 18 volunteer subjects, (44% men, 56% women). Six different subjects participated in three separate episodes of testing. It is not stated whether informed consent was gained from the subjects and their age and ethnicity was not described. Methods for de-identifying and handling the data were also not explained.

Pulse Testers

The pulse testers were volunteer TCM students at UTS. The number of pulse testers for Collection 1 was 35, reduced to 29 for Collection 2, and 20 for Collection 3, all of who participated in all three collections.

Method of Pulse Palpation Used

Although the exact method of pulse diagnosis is not described, the distal (cun), middle (guan) and proximal (chi) positions were each palpated. The included pulse

parameters were described, however the source of this information was not provided.

Study Design

The study was designed as a practical lineal test where three occasions of data collection were conducted (at week one of pulse diagnosis classes, the conclusion or week 14, and then one year later). Each collection phase lasted two to three hours. Pulse testers were divided into two groups, blinded to subjects, and then required to rate twelve pulse characteristics on three subjects randomly assigned to them (giving a total of 72 observed pulse characteristics for each collection). All responses were recorded on a standard assessment form, talking was not allowed and subjects were given instructions on conditions for eating and drinking prior to testing.

Statistical Analysis

Data was analysed using Chi square and the level of significance was set at 0.05.

Outcomes

The level of agreement in Collection 2 was significantly greater than expected by chance ($\alpha = .05$, $\chi^2 = .046$), while frequencies of agreement in Collection 1 and 3 showed no difference from that expected by chance alone. Noteworthy was the fact that the lowest reliability was recorded in Collection 3, one year after the cessation of pulse diagnosis classes. Accordingly the authors concluded the low frequency of agreement was more likely due to the inadequacies and conflicting information existing in the pulse literature rather than the ability of the student to learn pulse diagnosis. Additional findings reported the tendency for more frequent agreement (although not statistically significant) when testers palpated female subjects'

pulses, while in the *full/empty* category chi (proximal) positions showed the highest agreement followed by guan (middle), then cun (distal) positions.

Risk of Bias and Limitations

This sole purpose of this study was to investigate inter rater reliability. Although having sound design, methodology, reporting and conclusions there was no mention of intra rater reliability. Therefore it is unknown whether the same tester was able to use the method reliably on the same subject on different occasions.

2.3.1.5 STUDY 5 (King E, Cobbin D et al. 2002)

The aim of the study was to determine whether a pulse diagnosis method with concrete operational definitions, devised by the authors, could produce reliable measurement of simple pulse parameters. There was no mention of ethics approval or funding for the study.

Study Location

The study was also conducted at the College of Traditional Chinese Medicine, Department of Health Sciences, Faculty of Science, University of Technology, Sydney (UTS), Sydney, Australia.

Subjects

There were 66 subjects (27 males, 39 females) included in data collection one (CI) and 30 subjects (13 males, 17 females) in data collection two (CII). The subjects were recruited from the College of Traditional Chinese Medicine undergraduate students and Health Science staff UTS, and from the general population. However, there is no mention of the method of recruitment used or the distribution of

subjects between students, staff and general population. Ethnicity was reported at approximately 70% European and 30% of Asian background.

The inclusion criteria for the subjects were that they were free of acute illness such as respiratory tract infections. It was unclear whether the researchers obtained informed consent from the subjects.

Pulse Testers

There were two pulse testers, both graduates of UTS and educators in the College of Traditional Chinese Medicine at UTS, with five and seven years of clinical experience respectively.

Method of Pulse Palpation Used

The researchers developed operational definitions and a standardised manual palpation method for the radial artery based on literature review of pulse definitions and pulse-taking methods, and also repeated practical test and retest procedures. Definitions were given for pulse location, depth, width, force, relative force, rhythm and pulse occlusion.

Study Design

The study was designed as a practical test and retest with two separate phases of data collection. The specific requirements of the testing procedure, such as the blinding of pulse testers to others results and the subjects, were not described. The researchers rated 16 pulse characteristics on each subject and inter rater reliability was measured as percentage agreement. Pulses were rated at the same time with a tester on either the right or left wrist then changing sides. Each examination lasted approximately 30 minutes. It is unclear whether the retest included subjects from

the initial test or if they were completely different population samples. It is noted however, that there is no mention of intra rater reliability and there are nearly twice as many subjects in CI compared with CII.

Statistical Analysis

The levels of inter rater agreement for all 16 pulse characteristics were tested against the appropriate chance alone models (Chi square goodness of fit) for the number of possible combinations for each characteristic. The level of significance was set at 0.05.

Outcomes

The mean percentage agreement for pulse characteristics across both collection phases (CI and CII) was $\geq 80\%$. For CI agreement levels $>70\%$ were achieved for 13 of 16 categories with $>80\%$ agreement achieved for 10 of these categories. For CII levels of agreement were $\geq 80\%$ for 11 of the data categories. The authors therefore concluded acceptable levels of inter rater reliability can be achieved when the method employed has a standardised pulse taking procedure with concrete operational definitions.

Risk of Bias and Limitations

There is a risk of bias within this study, as it was not stated if any of the subjects had previously had their pulses rated by the testers. As the researchers were lecturers at UTS and the subjects included both students and staff of the same university, prior knowledge of the subjects' pulses may have influenced the results. The study may also be limited by the fact intra rater reliability was not investigated.

2.3.1.6 STUDY 6 (KING E, WALSH S ET AL. 2006)

This study aimed to assess whether there is a difference in force of the right and left radial artery that corresponds to gender as described by Chinese medicine theory. Part of this study reported the inter rater reliability of the testers and as such this section will be reviewed.

Study Location

Again this study was conducted at the Department of Health Sciences, Faculty of Science, College of Traditional Chinese Medicine, University of Technology, Sydney, Sydney, Australia.

Subjects

65 healthy volunteer subjects (27 men and 38 women) were recruited from UTS staff and students and the general population. Informed consent was obtained and approval for the study was gained from the UTS Human Research Ethics Committee. It was not stated if the study received funding.

Pulse Testers

Two pulse testers, who previously demonstrated high levels of inter rater reliability using an operationally defined method of pulse diagnosis (King E, Cobbin D et al. 2002) were included in this study.

Method of Pulse Palpation Used

The study reports palpation of the three traditional pulse positions, located in reference to the radial styloid, and three depths (superficial, middle and deep) to assess the overall pulse strength for each wrist. Presumably the testers were using the same pulse method described by Study 5. (King E, Cobbin D et al. 2002)

Study Design

A practical test design was incorporated. Data was collected in 20-minute sessions with subjects seated, wrists at heart level and wrists in full supination. The testers were not blinded, however subjects were not allowed to speak during testing. The cun, guan and chi pulse positions were located and marked then the two testers simultaneously palpated either the subject's right or left wrist then swapped sides, and recorded a rating of each subjects' pulse in respect to the dominant left-right balance. Following their assessment demographic information (sex, age, weight, height, blood pressure, hand dominance, mediations etc) was collected from the subjects.

Statistical Analysis

Percentage agreement was used to evaluate inter rater agreement while the Chi square test (χ^2) was used to analyse the testers rating of relative right-left side strength. The level of significance was set at 0.05.

Outcomes

While the assumption in Chinese medicine of gender related right-left pulse strength differences was not supported by the study, inter rater reliability was found to be high. There was 86% agreement between the testers in rating the relative strength of the subjects' pulses. A higher frequency of greater pulse force was recorded in the right wrist. Thus further investigation of the influence of hand dominance on this finding was recommended.

Risk of Bias and Limitations

This study incorporated dependable design, methodology, analysis, reporting and conclusions. The primary limiting factor is that prior intra rater reliability of the

diagnostic tool was not demonstrated. Also the testers and some of the subjects were recruited from UTS, thus prior knowledge of the subjects' pulses may have influenced the high level of inter rater reliability that was reported.

2.3.1.7 STUDY 7 (O'Brien K, Abbas E et al. 2009)

The aim of this study was to investigate the reproducibility of TCM diagnostic methods (inspection, palpation, and auscultation). Only the section relating to palpation or pulse diagnosis was reviewed. Ethics approval was obtained from Monash University Ethics Committee and the Alfred Hospital Ethics Committee. As it is reported that the study was part of a larger project to assess the efficacy of Chinese herbal medicine treatment for hypercholesterolemia and other cardiovascular risk factors in an Australian population (O'Brien K, Ling S et al. 2008), presumably funding was provided.

Study Location

The study was conducted in the Department of Medicine, Monash University, and the Alfred Hospital in Melbourne, Australia.

Subjects

45 subjects with hypercholesterolemia (age range 20-75 years) were recruited by newspaper advertisements and posters displayed at the Alfred Hospital. Exclusion criteria included plasma triglyceride level >10 mmol=L, established heart disease, serious medical or psychological conditions, pregnancy, and the use of vasoactive medications. Informed consent was gained from all subjects.

Pulse Testers

Three registered Chinese herbal and acupuncture practitioners were included. One had 5 years part time experience while the other two were in clinical practice for over 20 years.

Method of Pulse Palpation Used

In terms of pulse diagnosis, three basic characteristics were assessed; location (the depth at which the pulse was felt most strongly), force (the strength of the pulsation of blood in the vessel) and speed (Practitioner 1 used a timing device, the others counted by breath). A specific method of pulse diagnosis is not referred to.

Study Design

The study was conducted in two phases where Practitioner 1 completed the subjective evaluation on a standardised assessment form. Copies were passed to Practitioners 2 and 3, with all three completing the next phase, the inspection, auscultation, and palpation components of the TCM examination. The study utilised a standard assessment form, with a limited range of categorical variables in two of the three palpation categories. Testers were blinded to each others' results, data entry was completed by the research assistant and data analysis completed in a blinded fashion by Practitioner 1 at the end of the study.

Statistical Analysis

Cohen's kappa was used to measure the inter rater reliability between the three practitioners rating the selected clinical signs. The Landis and Koch (Landis JR and Koch GG 1977) interpretation of kappa values were adopted.

Outcomes

In terms of pulse location, agreement among all three practitioners was only slight (kappa 0.15) while pulse force showed fair agreement (kappa 0.29). When only two practitioners were compared, almost perfect agreement was found for pulse location (kappa 1.00) and pulse force (kappa 0.86). Agreement on pulse speed between Practitioner 2 and 3 using traditional assessment methods (counting beats/breath) was reported as moderate (kappa 0.63), while a comparison of Practitioner 1 using an electronic instrument and the traditional methods found almost perfect agreement between Practitioner 1 and 2 (kappa 0.84) and substantial agreement between Practitioner 1 and 3 (kappa 0.72).

Risk of Bias and Limitations

The main limitation of this study is the varied experience of the pulse testers and the fact that there is no apparent consistency or indication they were trained in the same method of palpation when it has already been demonstrated that this is critical to the reliable application of pulse diagnosis. This seriously questions the design and thus relevance of the pulse diagnosis portion of this study. Further interpreting the data according to the kappa ranges stated by Landis and Koch (1977) is contentious as many recent studies that judge reliability of a clinical procedure suggest that kappa values ≤ 0.40 represent poor agreement that is unacceptable in a clinical situation. (Jelles F, Van Bennekom CAM et al. 1995; Devane D 2005; Sim J and Wright CC 2006) Also the grounds for comparing manual assessment of pulse speed to that recorded by an electronic device are problematic.

2.3.2 SYNTHESIS OF RESULTS OF LITERATURE ANALYSIS

Several major realities were established by these studies regarding the reliability of manual techniques of pulse diagnosis.

- 1) It is possible for the same tester to detect similar pulse patterns on the same subject on different occasions, however this is not repeated on all occasions.
(Cole P 1977; Craddock D 1997)
- 2) Under both blinded and open conditions practitioners can agree with themselves but disagree with others when rating the same person's pulse, indicating a subjective aspect of pulse palpation exists independent of other sensory input. (Cole P 1977)
- 3) With increasing complexity of the pulse variable being detected, levels of both intra and inter rater agreement decrease. (Kass R 1990; Craddock D 1997; King E, Cobbin D et al. 2002)
- 4) Low levels of agreement between testers rating the pulse of the same subject (inter rater reliability) are due to variations in the interpretation of pulse definitions that result from the confusing and ambiguous nature of the classic texts. (Cole P 1977; Kass R 1990; Craddock D 1997; Walsh S, Cobbin D et al. 2001; King E, Cobbin D et al. 2002)
- 5) Good levels of inter rater reliability are possible when the system of pulse diagnosis is operationally defined so those who use it, implement the procedure and interpret the definitions in the same way every time. (King E, Cobbin D et al. 2002; King E, Walsh S et al. 2006)

- 6) Inter rater reliability decreases as the number of pulse testers increases. (O'Brien K, Abbas E et al. 2009) This further supports the findings of 4) above.

2.3.3 RISK OF BIAS AND LIMITATIONS ACROSS STUDIES

The literature review identified three recurrent biases or limitations that were considered in the design of the current study.

- 1) The more recent investigations did not examine intra rater reliability. Questions regarding the integrity of studies that test only inter rater reliability are thus raised.
- 2) Some studies exhibited the potential of testers having prior knowledge of subjects' pulses. If this was not the case, it was not specifically reported as such, leaving the reader to conclude this knowledge may have confounded the data and influenced the results accordingly.
- 3) Small subject sample sizes in a number of the studies limited the wider extrapolation of their results.

2.4 DISCUSSION OF LITERATURE ANALYSIS

The concept of the same tester using a method of pulse diagnosis reliably on the same subject on separate occasions has not been assailed since Craddock, 1997. Recent studies seem to label intra rater reliability as contentious (O'Brien K, Abbas E et al. 2009) and instead focus on inter rater reliability. However intra rater reliability remains particularly important to clinical practice. What use is a diagnostic procedure if a practitioner is not able to dependably implement it to assess then reassess the same patient? If the same tester cannot repeat results

reliably on the same subject at different times, then the redundancy of inter rater results become apparent. This challenges the integrity of studies that aim to investigate inter rater reliability without concurrent or prior demonstration of intra rater reliability.

The most recent study (O'Brien K, Abbas E et al. 2009) did not test intra rater reliability as it reported the results may have been influenced by observer memory (Abramson JH 1990) and also by their own suggestion that pulse characteristics may change within hours or days. Previous authors have disputed both these claims. Results for intra rater reliability can in fact be validated by reducing rater memory of the preceding test, best achieved by allowing time to pass between the test and retest procedures. (Sim J and Wright CC 2006) Similarly, the erratic nature of pulse characteristics is an unsupported assumption made by the authors and contradicts millennia of empirical medical knowledge. For pulse diagnosis to have survived several thousand years to date and developed across many different cultures, there is presumably some observed stability and consistency on which this diagnostic system is predicated. (O'Rourke MF, Kelly RP et al. 1992; Veerman D, Imholtz B et al. 1995; Schmieder R, Schbel H et al. 1996; Walsh S, Cobbin D et al. 2001)

2.5 CONCLUSIONS OF LITERATURE ANALYSIS

The results of this literature review defined the parameters affecting the design of the current study. These will be explained in detail in the appropriate chapters, Chapter 3 – Contemporary Chinese Pulse Diagnosis™ and Chapter 4 – Methodology.

Further it is recommended all future studies on pulse diagnosis take the following into consideration.

- 1) The system of pulse diagnosis under investigation must have concrete operational definitions.
- 2) Pulse testers that are included in the study must be trained in the same technique each with comparable levels of instruction so that all interpret the definitions and implement the method in the same way every time.
- 3) For integrity to the clinical setting it is essential the study test intra as well as inter rater reliability.
- 4) To extensively test inter rater reliability the number of pulse testers that evaluate each subject must be greater than two.
- 5) To optimise the results, consideration must be given to the number of subjects included in the study as well as the number of pulse attributes or categories being tested.
- 6) To ensure independent data the pulse testers included in the study must not have prior knowledge of the subjects' pulses.

Chapter 3

3 CONTEMPORARY CHINESE PULSE DIAGNOSIS™

Contemporary Chinese Pulse Diagnosis™ (CCPD) is the system of pulse diagnosis developed by Dr. John He Feng Shen OMD (Shen JHF 1980), and documented by Dr. Leon Hammer MD, in the book Chinese Pulse Diagnosis, A Contemporary Approach. (Hammer L 2005¹) This pulse system is rooted in a long history of Chinese medical knowledge and most probably represents the coalescence of several medical traditions that existed in China prior to the Communist Revolution. Typically the secrets of the historic lineages were highly prized and guarded closely by the family for reasons of success and survival. Those without direct inheritance of the oral tradition had little or no access to the information. It appears, however, in the case CCPD unusual circumstances have come to pass that have made this knowledge available to those outside the lineage.

3.1 RECENT HISTORY

3.1.1 DR. JOHN HF SHEN, OMD

Dr. Shen began his studies of Chinese medicine in the early 1930's as a formal student of the Shanghai College of Chinese Medicine, an official school operated by the Ding family physicians one of three influential lineages in Menghe medicine. (Scheid V 2007) On completion of the formal programme he apprenticed with the last inheritor of Ding knowledge (Scheid V 2007) learning a system of pulse

diagnosis dated to the 15th century, and by custom accessible only to those with birthright entitlements. (Hammer L 2012)

Several years after his graduation, the outbreak of the Chinese War of Resistance against Japan (1937) saw thousands of refugees settle the foreign concessions of inner Shanghai. Seeing an opportunity, Dr. Shen together with ten other doctors set up a hospital to provide low cost medical care for the people who lived in these crowded inner city areas. At its busiest times Dr. Shen alone would reportedly treat more than 200 people per day. (Shen JHF c. 1985) This provided him with an enormous amount of clinical experience and empirical knowledge from the very outset of his career.

During this period Dr. Shen became aware of the strengths and weaknesses of Chinese medicine and endeavoured to further develop age-old theories with relevancy to modern times. He understood that western medicine had the advantage of timely control of the disease at hand, while Chinese medicine emphasising the root cause, would take time to achieve results but inevitably result in a stronger person more resistant to illness. At the same time the traditional theory and terminology of the Five Elements and yin and yang were beyond the comprehension of the general population. Thus from that time on Dr. Shen attempted to improve the traditional way of diagnosis, to research the causes of diseases that a person might incur when subjected to unfavourable circumstances. (Shen JHF 1980)

After the outbreak of the Pacific War in 1941 Dr. Shen relocated to Hong Kong, then after the fall of Hong Kong, moved to Guilin in Guangxi Province. There he helped set up a government refuge centre, similar to what he had developed in Shanghai, and provided medical services free of charge until the end of the Second World War in 1945. (Shen JHF c. 1985)

In 1949 Dr. Shen settled in Taiwan having fled the political conditions that swept China as a result of the Cultural Revolution. He practiced Chinese medicine there for at least twelve years, endeavouring to improve the diagnostic methods, and in particular honing his skills in pulse diagnosis. By 1964 his reputation was growing and the Malaysian Chinese Medical Trade Union invited Dr. Shen to travel Southeast Asia as a visiting medical consultant. (Shen JHF c. 1985)

Whilst visiting Vietnam in this capacity, he may have encountered a family medicine tradition handed down for generations in the Mekong delta region. (Hammer L and Bilton K 2003) In his book *Fourth Uncle in the Mountain*, Quang Van Nguyen describes the tradition including a pulse method (Nguyen QV 2004) with pulse positions that closely resemble those used in CCPD. This may have been influential on Dr. Shen's later practice of pulse diagnosis.

Following seven years in this prominent position his sister sponsored his immigration to the USA. (Hammer L 2012) In 1971 he first encountered Dr. Hammer in a medical office in New York City, and for the next 25 years Dr. Shen operated clinics in Chinatown (New York City) and briefly in Boston, continuing to develop his methods of diagnosis and treatment. By the 1980's his skill as a

practitioner was world-renowned and between 1978 and 1995 he lectured extensively in Australia, the USA and Europe. Dr. Shen continued his practice of Chinese medicine in New York City until 2001, when he returned to his native city of Shanghai shortly before his death. (Hammer L 2005²; Shen JHF c. 1985)

3.1.2 DR. LEON HAMMER, MD

Dr. Hammer began his study of medicine at Cornell University Medical College in 1948. Having an interest in psychology, he spent seven years at the William A. White Institute of Psychoanalysis and Psychiatry in New York and began his medical career as a psychiatrist. Specialising in child psychiatry he directed a child guidance clinic and the Drug Abuse Councils on the Southeast Shore of Long Island. He taught at Adelphi University, and was also a Psychiatric Consultant and associate professor at Southampton College in Southampton, New York. (Hammer L 2007)

In the late 1960's following working with Alexander Lowen and Bioenergetics over a period of eight years, and with Fritz Perls and Gestalt therapy for three years, he began his study of Oriental medicine. He studied for four years in England under the guidance of Dr. Jon D van Buren (one of the practitioners recruited in the Cole study, 1977) along side Giovanni Maciocia. (Hammer L 2007)

Shortly after his return to New York City in 1971, Dr. Hammer experienced Dr. Shen's extraordinary diagnostic ability in a colleague's medical office. (Shen JHF 1980; Hammer L 2007) Committed to learning these skills, he subsequently completed eight years of apprenticeship under Dr. Shen's direct tutelage attending his Chinatown clinic daily. The mentorship concluded with Dr. Hammer's relocation

from New York City, however he maintained a close association with Dr. Shen that lasted until his death in 2001. (Hammer L 2007)

Throughout his career, Dr. Shen 'had a strong desire to improve the Chinese diagnostic techniques.' (Shen JHF 1980) This was equally matched by Dr. Hammer's determination to document a diagnostic system that from his medical perspective showed exceptional empirical integrity. (Hammer L 2005²; Hammer L 2007) During their 30 year alliance they evolved concepts based on the combined experience of their medicine, (Hammer L 2005²; Hammer L 2007) and Dr. Hammer worked closely with Dr. Shen to document the pulse system, standardising the theoretical framework of the method and terminology used within the system. (Hammer L 2005¹; Hammer L 2007)

3.2 INFLUENCE OF THE CLASSICS ON CCPD

Oriental medicine is not composed of a single theoretical system, nor is it a single system of practice. (Birch S and Felt R 1999) Many practices and theories exist within the medicine, the majority of which can be directly traced to the classics. As such there are numerous models of pulse diagnosis that exist, each employing different terminology and operating systems in terms of pulse depths, pulse positions and qualities. Each method yields a somewhat different set of information, however the common outcome of all is to provide the practitioner with diagnostic clues that are relevant to the particular paradigm of practice.

Amongst the more well known methods of pulse diagnosis are those that use two depths to assess the radial pulse (Hammer L 2005¹) and have their origins in the

Nan Jing (Unschuld P 1986) such as the method documented by Wang Shu-He. (Yang S 1997) There are also those that incorporate three depths (Hammer L 2005¹) and have their origins in the Neijing Suwen. (Ni M 1995) CCPD exemplifies the latter, and also exhibits evidence of later concepts from interpretations of the work of Li Shi Zhen (1564) and Zhang Jie-Bing (1624). (Hammer L 2005¹)

3.2.1 CCPD – A THREE DEPTH SYSTEM

CCPD is an example of a three-depth system of pulse diagnosis. Although the model formally describes eight depths, in practice three main depths are palpated. These are termed the Qi, Blood and Organ depths. (Hammer L 2005¹) CCPD also gives preference for the six principal or major pulse positions to the zang or yin organs due to their primary role in physiological function. The fu or yang organs are found in the secondary or complementary positions that are mostly located in relation to a principal position. (Hammer L 2005¹)

3.2.2 INFLUENCE OF THE NEIJING SUWEN

The arrangement of the major pulse positions in CCPD are very similar to that used in the Neijing Suwen. (Ni M 1995) This classic emphasises the importance of the storing function of the zang or yin organs compared to the transporting function of the fu or yang organs. Exception is given to the Stomach or 'the Sea of Nutrients' as it is the origin of the 'Pure Essence' of the Spleen that circulates to nourish the five zang. Therefore the yin organs, the Heart, Liver, Lung, Kidney Yin and Kidney Yang, as well as the Stomach (the only yang organ included) are seen as the significant energetic factors and are assigned the six main pulse positions. (Ni M 1995)

The Neijing also describes the radial pulse as being an anatomically correct representation of the body. The distal positions are described to reflect the chest, the middle positions the epigastrium to the abdomen, and the proximal positions the abdomen to the feet. (Ni M 1995) In doing so the pulse positions are organised according to the Triple Burner. Likewise the CCPD model retains this anatomical integrity of the homunculus at the wrists with both the principal and complementary positions each placed within the appropriate area of the Three Burning Spaces.

3.2.3 INFLUENCE OF LI SHI ZHEN

Li Shi Zhen (1564) further developed the Triple Burner model first described by the Neijing Suwen. (Ni M 1995) He elaborated this by identifying an association of the Gall Bladder with the Liver, or the left middle position; the Spleen with the Stomach, or the right middle position; and the Intestines and Bladder with the Kidney pulses, or the proximal positions. (Huynh HK and Seifert G 1981) Similarly CCPD associates these organs via the relationship between the principal and complementary positions. Li Shi Zhen also describes palpation of the superficial, middle and deep aspects of the pulse, (Huynh HK and Seifert G 1981) which is a foundation of the CCPD method.

3.2.4 INFLUENCE OF ZHANG JIE-BING

Zhang Jie-Bing (1624) expounded Wang Shu-He's two depth model (Yang S 1997) and described the placement of some additional pulse positions that show remarkable similarity to those found in CCPD. He lists the sternum as the superficial pulse in the right distal location, which has a correlation to, and suggests a prelude

to what Dr. Shen later referred to as the diaphragm position. Also Zhang Jie-Bing's notation places the Large Intestine in relationship to the left proximal, and the Small Intestine to the right proximal positions. Although these are placed at a more superficial depth, the same organs are related in CCPD by the association of the proximal and complementary positions. In another similarity suggesting the influence of Zhang Jie-Bing, Dr. Shen's positioning of the Pericardium within the left distal position is also somewhat in agreement with that of Zhang Jie-Bing. (Hammer L 2005¹)

3.2.5 THE MODEL OF WANG SHU-HE – A TWO DEPTH SYSTEM

The model described by Wang Shu-He (280 CE) (Yang S 1997) by comparison, is an example of a two-depth pulse system and is one of many first mentioned in the Nan Jing classic (200 CE). (Unschuld P 1986) Undoubtedly the most important concept transmitted by this manuscript that affected many subsequent pulse systems, is its identification of the radial artery as the predominant site for assessing a patient's pulse. The method of Wang Shu-He is what predominates in teaching institutions in Europe and the USA and is most commonly used by practitioners of these countries today. (Hammer L 2005¹)

When comparing this model with a three-depth system such as CCPD several major organisational differences become apparent. Obviously within the Wang Shu-He method two main depths of the pulse are palpated, but more significantly it exhibits a deviation from the system first mentioned in the Neijing Suwen, where organs were placed at the wrist according to their location within the Triple Burner. Instead, this model assigns pulse positions according to zang fu elemental partners

with the zang or solid organs accessed deep and the fu or hollow organs more superficially.

With this arrangement, there is no anatomical correlation of the organisation of organs on the radial pulse with that of the body. The Heart and Small Intestine, and the Lung and Large Intestine constitute the distal or cun positions, while the Kidney and Bladder, and Pericardium and Triple Heater form the chi or proximal positions. In both situations there are organs from the lower burner placed within the distal pulse positions and organs from the upper burner placed with the proximal positions, therefore removing the ability to assess the function of the Triple Burner via bilateral palpation of the principal positions.

3.3 SPECIFICATIONS OF THE CCPD SYSTEM

3.3.1 THE PRINCIPAL POSITIONS

CCPD incorporates six principal positions• all of which are located on the radial artery. (Hammer L 2005¹) The Neijing Suwen model of organ placement according to the Triple Burner is adopted and further developed. The six principal positions similarly correspond to the major yin organs, however there are some subtle differences. In the case of the right middle position soft or pliable qualities that relate to qi and yang deficiency are viewed as more indicative of Spleen pathology, while hard qualities that relate to heat and yin deficiency are more representative

• Left distal position = Heart, Left middle position = Liver, Left proximal position = Kidney Yin, Right distal position = Lung, Right middle position = Stomach or Spleen, Right proximal position = Kidney Yang or Bladder.

of Stomach pathology. Similarly, the right proximal position most commonly conveys information concerning Kidney yang, unless pathology in the Bladder causes the usually reduced pulse qualities associated with Kidney Yang to be dominated by the very robust qualities associated with infection. (Hammer L 2005¹)

In terms of actual palpation, the middle and proximal positions are palpated longitudinal to the artery with the flat pad of the middle and ring fingers respectively. The distal positions however, are felt transverse to the course of the artery at the site on the wrist where the radial artery terminates and trifurcates into smaller vessels. They are palpated by rolling the index finger distally so the radial edge of the finger lies adjacent to the superior border of the scaphoid bone. Thus the lateral side of the index finger monitors the sensation that occurs as the pulse wave disperses at this vessel partition. (Hammer L 2005¹)

3.3.2 THE COMPLEMENTARY POSITIONS

There are 22 Complementary positions within the CCPD system. (Hammer L 2005¹) These positions represent the yang organs, areas of the body or specific structures, such as the Diaphragm position. Some are located on the radial artery and are found distal or proximal to the principal positions, while others are found off the major artery and located medial or lateral to the main pulse position. Most complementary positions have a close relationship to a principal position, the exception being the Neuro-psychological position that does not exhibit this association. (Hammer L 2005¹)

The three depths do not apply in the complementary positions, as they are not part of the yin organ system. Even though various qualities may be present at different depths, these are not specifically aligned with the Qi, Blood or Organ depths. Despite this all qualities bear diagnostic significance independent of where they are found. (Hammer L 2005¹) Another characteristic is the transient or ephemeral nature of pulse qualities found in some of these positions (especially those located off the main artery such as the Neuro-Psychological and Mitral Valve positions). As a result the entire position must be explored and palpation should wait for the sensation to become apparent. (Hammer L 2005¹)

3.3.3 THE DEPTHS

Although CCPD theoretically incorporates eight depths,* three major depths (Qi, Blood and Organ depths) are palpated. When palpated bilaterally on the entire pulse they represent the overall state of the person's qi or metabolic activity, the blood and pure fluids, and the yin organs respectively. When palpated in the principal positions, the Qi and Blood depths represent the contribution of that organ to these substances within the whole organism, while the Organ depth, relates information about the state of the parenchyma of the organ represented by that position. Although these main depths provide a considerable amount of the information gained from the total pulse evaluation, all eight depths are examined briefly for relevant diagnostic indications. (Hammer L 2005¹)

* Eight depths from most superficial to deepest: [1] Above the Qi, [2] Qi, [3] Blood, [4] Qi of the Organ, [5] Blood of the Organ, [6] Yin of the Organ, [7] Firm and [8] Hidden.

3.3.4 THE PULSE QUALITIES

CCPD incorporates approximately 80 pulse qualities. (Hammer L 2005¹) These can be categorised according to either pulse dimensions or the condition that is represented by the quality. For the purposes of this study 76 of the more common pulse qualities were included. They were grouped according to dimension with the exception of the pulse qualities that represent a separation of yin and yang, termed 'Qi Wild' by Dr. Shen, and those relating to specific pulse attributes and structures such as Rhythm, Diaphragm and the Sides. The categories of pulse qualities used in the study are as follows.

3.3.4.1 CLASSIFICATION OF PULSE QUALITIES

'Qi Wild' – Separation of Yin and Yang

These qualities represent severe deficiency and chaotic qi where the normal order and flow of biological processes within the body has been disrupted. Dr. Shen described these situations as 'Qi Wild' where the operative physiological contact between yin and yang that is fundamental to survival of the organism has been interrupted, leaving the person vulnerable to serious and life threatening illness.

Volume

Volume is a reflection of metabolic activity or the strength of qi or yang heat within the body. Pulses can exhibit characteristics of either robust volume (conditions of excess, heat and stagnation) or reduced volume (conditions of qi [and blood] and yang deficient cold).

Depth

Depth provides information regarding the location and stage of the disease. Generally, the superficial pulses are associated with acute diseases involving the wei qi while the deeper pulses are a sign of more profound chronic illness.

Width

Width primarily reflects the condition of the blood. Thin pulses are associated with blood deficiency and more chronic conditions while wide pulses are associated with conditions of excess (heat, toxicity, increased viscosity) and more acute patterns.

Length

Length refers to the how far the impulse extends under or beyond the fingers. Long pulses tend to indicate plentiful or abundant qi and pulses that are short indicate deficient qi.

Shape

These pulse qualities are recognised by shape and reflect specific excesses or deficiencies of certain substances. Shape is further broken into pulse qualities that are *Fluid* (feel pliable and as though they are moving under the fingers), *Non Fluid* (feel either hard and smooth, or hard and coarse) and *Miscellaneous* (recognised by their shape but not related by any defining characteristic).

Modifiers

These qualities are used to clarify or better define the primary pulse qualities.

Anomalous

The anomalous qualities are those that under normal anatomical circumstances are not present on the radial pulse.

Waveform

The waveform is found on the entire pulse and describes how the impulse arrives at and leaves the fingers as it rises from and falls to the Organ depth. It provides information regarding the state of the qi, yang, blood, yin and the organs of the body.

Rhythm

Rhythm is the most significant measure of Heart and circulatory function. The beat of the normal pulse is consistently regular, while an arrhythmia refers to the pulse varying in rate or skipping beats, and represents a depletion of Heart substances.

Sides

The pulse characteristics associated with the left and right side are assessed while palpating both wrists simultaneously. Judgements are made on whether both sides are equal in amplitude and intensity or if one side is stronger, also the presence of differing pulse qualities side to side.

3.3.5 THE LARGE SEGMENT OR BROAD FOCUS

The large segment of the pulse refers to the broad focus and provides information regarding the all-encompassing, universal energetic patterns and state of substances of the organism. It is assessed on the entire pulse by concurrent palpation of left and right wrists with the index, middle and ring fingers of both hands. The large segment pulse categories include rate, rhythm, waveform, and uniform qualities on the entire pulse, at the Three Burners, on the left and right sides and at each of the depths. (Hammer L 2005¹)

3.3.6 THE SMALL SEGMENT OR CLOSE FOCUS

The small segment of the pulse or close focus provides information regarding the critical and dominant factors in the individual organs. The principal positions provide information regarding the function and interrelationship of the yin organs, while the complementary positions indicate the functioning of the yang organs and the association of different areas of the body. (Hammer L 2005¹)

3.4 OPERATIONAL DEFINITIONS OF CCPD

Within CCPD all the principal and complementary positions are described using standard anatomical terms that are universal within the medical field. The radial arteries are palpated both bilaterally and unilaterally with differing amounts of pressure to assess pulse qualities at the three main depths on the entire pulse and in each of the principal pulse positions. The procedure or methodology for evaluating and identifying pulse qualities is clearly explained for each of the depths and individual pulse positions. (Hammer L 2005¹)

Pulse qualities are described according to sensation and defined using terms fixed within the CCPD system in an attempt to eliminate the metaphoric ambiguity of the classical literature (Cole P 1977; Kass R 1990; Craddock D 1997; Walsh S, Cobbin D et al. 2001; King E, Cobbin D et al. 2002). In addition to this, each variable or pulse quality is given a specific diagnostic interpretation that also takes into account the implication of the location of the pulse quality. Changes that are detected in these variables are correlated within the diagnostic framework of CCPD that is then

referenced within the broader diagnostic structure of Oriental medicine for interpretation.

3.4.1 RATIONALE FOR STUDY

As the procedures, terminology and interpretations within CCPD are allegedly definitive and consistent, or, the system is operationally defined, (Hammer L 2005¹) in theory, it is feasible to undertake testing of intra rater and inter rater reliability of practitioners using this method.

Further, within CCPD the pulse is considered to represent the state of the organs, substances, pathogens and metabolic activity, or, the health of the person. (Hammer L 2005¹) Thus if health remains unchanged, the founding principles of this method indicate the basic characteristics of pulse patterns should remain accordingly stable, allowing appropriate inquiry.

Therefore a study was designed to investigate the reliability of practitioners assessing pulses using the standard operational procedures and definitions of CCPD. The specifications of the CCPD system, the depths, pulse positions, pulse taking procedures and pulse qualities helped define the design of the research. These are explained in detail in Chapter 4 – Methodology. Additionally the pulse qualities that constitute the variables in the study are described in full in Appendix 6.

Chapter 4

4 THE STUDY – METHODOLOGY

4.1 AIM AND OBJECTIVES

The aim of the study was to investigate the reliability of practitioners using CCPD to assess the radial pulse of volunteer subjects. This was achieved firstly, by examining if the same practitioner could attain acceptable levels of agreement using CCPD on different occasions in the same subject (intra rater reliability), and secondly, if acceptable agreement could be achieved by different practitioners assessing the same subject on the same as well as different occasions (inter rater reliability).

4.2 STUDY DESIGN

The study incorporated a real life design where the method employed during testing reflected that used to assess the pulse in clinical practice, using the same attendant requirements for procedure, positioning and documentation of findings. The flow chart of all processes and actions followed to implement this research is represented in Figure 4-1.

Two separate episodes of data collection were conducted at Dragon Rises College of Oriental Medicine (DRCOM) in Gainesville, Florida, as practical test and retest 28 days apart at the same time of day. This schedule was selected to replicate female subjects' menstrual cycles, control for diurnal pulse variance and to decrease the

testers' memory of the initial test. If health conditions for the subjects remained stable during the 28 days, so too should the basic parameters of their pulses. The test and retest assessments made by the testers were then compared, and levels of agreement calculated to determine the reliability of practitioners using this method.

4.2.1 PULSE TESTERS

The study incorporated a pool of six testers, two female, four male, with a mean age of 40.17 years. The inclusion criteria were that all had detailed knowledge of CCPD, were currently using the method clinically and were actively involved in maintaining familiarity with the application of the system. To fulfil the experience requirements, the testers were recruited from the Dragon Rises Seminars (DRS) list of instructors.

Of the testers selected one documented the CCPD system while the remaining received equivalent training from that tester over a period of eight to ten years. All had been DRS instructors for more than three years and their experience integrating the current standard pulse definitions and procedures of CCPD into clinical practice ranged from seven to 15 years. Additionally to match tester skills, each attended six-monthly workshops to ensure consistency in the interpretation of pulse qualities palpated. Four of the six testers were lecturers at DRCOM.

4.2.2 SUBJECTS

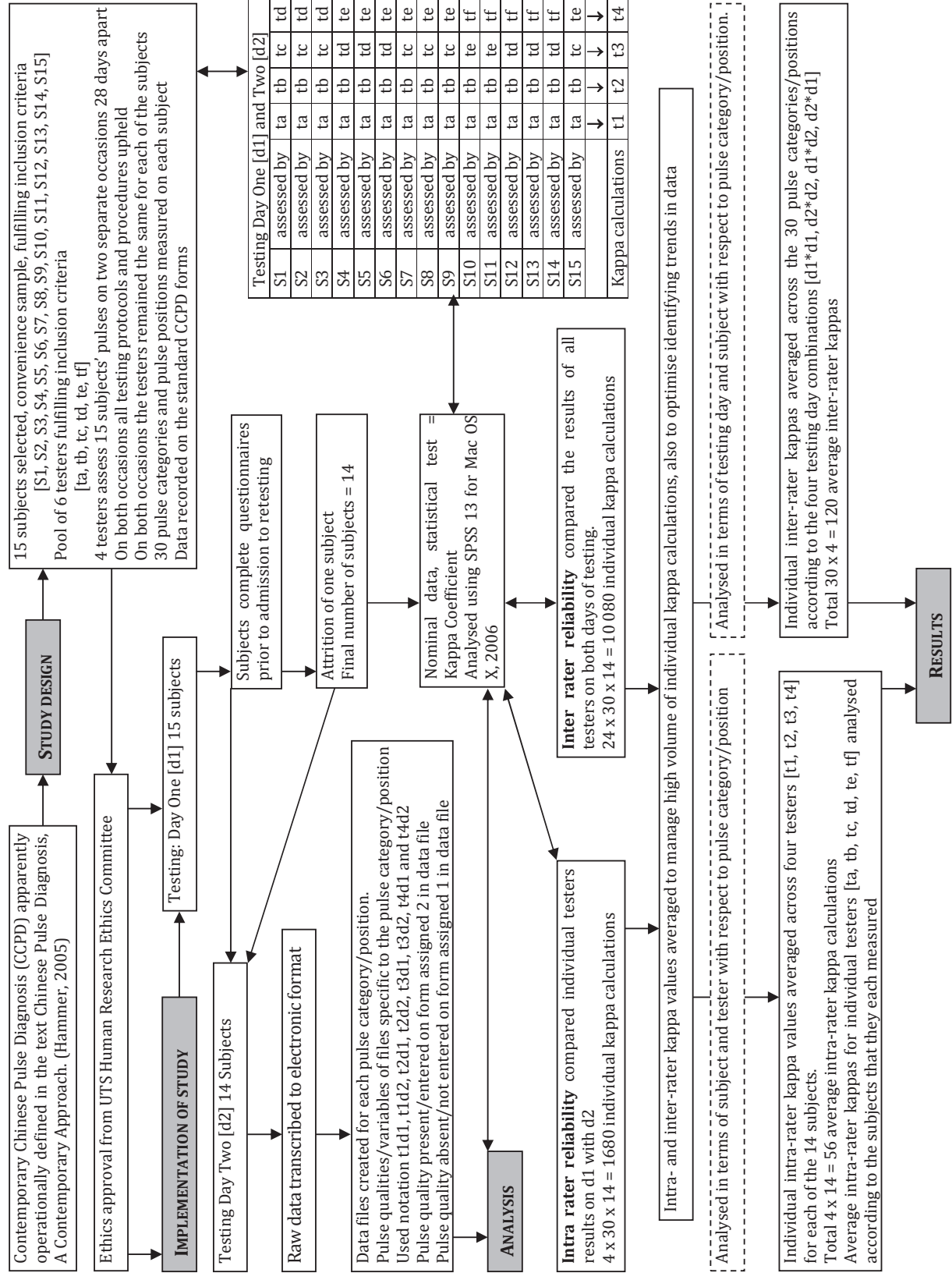
Fifteen healthy subjects were recruited as a volunteer convenience sample from the Gainesville region in Florida. The subjects had a mean age of 32.14 years; ethnicity was 13 Caucasian, two Hispanic and one Asian; genders three were male and twelve

female. Eight of the 15 were students at DRCOM, the remaining were recruited from the local community by advertising. (Appendix 2)

The inclusion criteria specified that the subjects were at least 18 years of age, had not previously completed a pulse assessment with the testers and if receiving any form of health management (E.g. acupuncture, massage, medication), it remain consistent for the duration of the testing period. Exclusion criteria included signs or symptoms consistent with a short-term acute illness (E.g. colds, respiratory or intestinal flu), febrile conditions, unexpected extraordinary stressors (E.g. death of a loved one, loss of job) or changes to health management or daily supplements. These parameters aimed to reduce influences that would alter the 'normal' pulse for the subjects and unduly affect the testing procedure.

Prior to the second stage of testing all subjects completed a questionnaire (Appendix 3) detailing their health status at the time. As none reported anything consistent with the exclusion criteria all were admitted to re-testing. Of the 15 subjects, one (subject 11) did not return for re-assessment, reducing the final number of subjects to 14, and those assessed by tester f, from five to four subjects.

Figure 4-1: Study design



4.2.3 ETHICAL CONSIDERATIONS

Ethics approval for the study was obtained prior to data collection from the Human Research Ethics Committee of the University of Technology, Sydney. All subjects were given an information sheet detailing the purpose of the study, its potential risks and benefits, an explanation of data collection procedures and the time commitment required (Appendix 1). An offer to answer any questions and an explanation that participation was voluntary and confidentiality assured was also provided. Written consent was obtained from those agreeing to participate and the researcher's contact details were also made available to the subjects. (Appendix 1)

4.3 METHODS

4.3.1 TEST – RETEST PROCEDURE

The number of testers to assess each of the subjects pulses was set at four to more rigorously test inter rater reliability of CCPD and to also generate increased data for intra rater reliability. On both days of testing, four testers from the pool of six were designated to assess each of the subjects' pulses. The combination of four testers remained the same for each subject. Testers used the standard CCPD operational evaluation procedures and all data were recorded on the standardized pulse forms. (Appendix 5)

Subjects were assessed in sitting with their arms resting on a pillow on a desk so the wrist approximated the level of the heart. During testing, talking was not allowed and the testers were blinded to each other's findings. Subjects remained in

view of the testers as it was previously established that intra and inter rater reliability varied to similar degrees independent of testers being open or blinded to subjects. (Cole P 1977) Further, open testing conditions were employed as reliability, or comparing the combination of pulse qualities entered for each pulse category/position, was the exclusive interest of the study, and not validity, the diagnostic interpretation of these qualities.

4.3.2 PULSE TAKING METHOD

The testers recorded their responses on the CCPD forms using a scale of one to five to indicate the degree or presence of variables or pulse qualities. All pulse rates (*Beginning Rate*, *End Rate*, *Exertion Rate* and *Rate Change with Exertion*) were recorded in beats per minute and counted, timed by a clock.

To start the testing procedure the large segment pulse categories (also the *Beginning Rate* counted for 60 seconds timed by a clock) were evaluated and recorded. The testers used bilateral palpation techniques or the index, middle and ring fingers of both hands at the same time to assess the left and right wrists of subjects. According to the CCPD procedures, finger positions were referenced by the index fingers contacting the superior edge of the subjects' scaphoid bones. The middle and ring fingers were then allowed to fall into place along the course of the radial artery. (Hammer L 2005¹) Each pulse tester had 15 minutes to assess the large segment of the pulse.

Next the testers evaluated and recorded the small segment pulse positions. This was achieved by using single fingers (determined by the CCPD procedures) to

palpate the six principal and 22 complementary positions in the distal to proximal direction. Concurrently two testers palpated either the left or right wrist of the subject for 30 minutes then exchanged sides for a further 30 minutes. Pulse assessments carried out under normal circumstances in the clinic involve palpation of the patients left wrist followed by the right.

Next the *End Rate* was recorded. Using all six fingers placed on both of the subjects' wrists, the testers counted for 30 seconds (timed by a watch) then multiplied the number by two to obtain the *End Rate* in beats per minute. During this time the pulse testers were allotted several minutes to re-check or clarify any uncertainties or difficult qualities they encountered during the testing procedure.

Finally the *Exertion Rate* and *Rate Change with Exertion* were recorded. The subjects were asked to vigorously rotate one arm at the shoulder for 15 revolutions, immediately after which the tester counted the rate for 10 seconds (timed by a watch) and multiplied this figure by six to get the *Exertion Rate* in beats per minute. The *Rate Change with Exertion* was calculated by subtracting the *End Rate* from the *Exertion Rate*. All *Exertion Rates* were obtained at the conclusion of testing for each subject so as not to interfere with pulse readings for subsequent testers.

This completed the testing procedure. For both test and retest, immediately after the testers completed their pulse forms, they were collected and secured independently in the DRCOM administrator's office to prevent any untoward comparisons of findings.

4.3.3 PULSE CATEGORIES AND POSITIONS ASSESSED

In addition to pulse rates (*Beginning, End, Exertion* and *Change with Exertion*) there were 30 pulse categories and/or pulse positions that were investigated in the study. These were defined by the standard CCPD pulse intake form (Appendix 5) and are a regular part of the pulse evaluation as conducted on patients in the clinic. These included eleven large segment categories, six principal positions and 13 complementary positions.

Prior to testing all pulse qualities within CCPD were discussed by the testers with reference to each pulse category/position. The rare qualities were omitted and lists for the possible qualities for each position/category were devised. See Table 4-1 for a list of each pulse position or pulse category with the number of possible variables for each.

Table 4-1: Pulse categories or pulse positions and associated number of variables

	Pulse Category or Pulse Position	Number of Variables
Large Segment of Pulse (Categories assessed by simultaneous bilateral wrist palpation)		
	1. First Impressions	41
	2. First Impressions (left side)	51
	3. First Impressions (right side)	51
	4. Rhythm	4
	5. Above Qi Depth	6
	6. Qi Depth	29
	7. Blood Depth	34
	8. Organ – Qi Depth	31
	9. Organ – Blood Depth	31
	10. Organ – Organ Depth	31
	11. Waveform	6
Small Segment of Pulse (Positions assessed by unilateral wrist palpation)		
Principal Positions	12. Left Distal Position	39
(Found on the main artery)	13. Right Distal Position	39
	14. Left Middle Position	43
	15. Right Middle Position	43
	16. Left Proximal Position	43
	17. Right Proximal Position	43
Complementary Positions	18. Left Neuropsychological Position	28
(Related to principal positions)	19. Right Neuropsychological Position	28
	20. Mitral Valve	22
	21. Left Special Lung Position	37
	22. Right Special Lung Position	37
	23. Diaphragm Position	13
	24. Gall Bladder Position	32
	25. Stomach Pylorus Extension Position	32
	26. Large Intestine Position	33
	27. Small Intestine Position	33
	28. Left Pelvic Lower Body Position	32
	29. Right Pelvic Lower Body Position	32
	30. Combined Complementary Position	11

Within the complementary positions one category named the *Combined Complementary Positions* included eleven complementary positions that are indicated on the CCPD form as either present or absent and rarely have actual pulse qualities recorded for them. Table 4-2 lists the component positions of the *Combined Complementary Positions* and the associated principal position for each of these.

Table 4-2: Component positions of the *Combined Complementary Positions*

Associated Principal Position	Variable – Complementary Position
Heart	Pericardium
	Large Vessel
	Heart Enlarged
Lung	Pleura
Liver	Distal Liver Engorged
	Radial Liver Engorged
	Ulna Liver Engorged
Stomach – Spleen	Esophagus
	Spleen Special
	Pancreas – Peritoneal Cavity
	Duodenum

4.3.4 THE VARIABLES – PULSE QUALITIES

The 76 pulse qualities or variables included in the study and their associated classification or grouping is listed in Table 4-3. Additionally the operational definition based on sensation, and the interpretation for each variable or pulse quality is described in full in Appendix 6.

Table 4-3: List of variables or pulse qualities included in the study

Pulse Quality Grouping	Variable – Pulse Quality	Variable number
Qi Wild	Empty	1
	Change in Quality	2
	Change in Amplitude	3
	Unstable	4
	Scattered	5
	Minute	6
	Leather	7
	Amplitude change side to side	8
	Qualities shifting side to side	9
Volume (Robust)	Hollow Full-Overflowing	10
	Robust Pounding	11
	Flooding Excess	12
	Inflated	13
Volume (Reduced)	Yielding Qi Depth	14
	Diminished Qi Depth	15
	Feeble at Qi Depth	16
	Spreading	17
	Reduced Substance	18
	Reduced Pounding	19
	Diffuse	20
	Deep	21
	Feeble - Absent	22
	Flat	23
	Suppressed Pounding	24
	Muffled	25
	Dead	26
	Floating Tight	27
Depth	Floating Tense	28
	Floating Yielding	29
	Floating Smooth Vibration	30
	Floating Slippery	31
	Cotton	32
	Hollow	33
	Thin	34
Width (Narrow)	Short	35
Length	Restricted	36
	Long	37
Shape (Fluid)	Slippery	38
Shape (Non-Fluid - Hard Even)	Taut	39
	Tense [Tense-Tight]	40
	Tight [Tight-Tense]	41
	Wiry	42
	Ropy	43
Shape (Non-Fluid - Hard Uneven)	Choppy	44
	Smooth Vibration	45
	Rough Vibration	46
Shape (Miscellaneous)	Biting	47
	Doughy	48
	Amorphous	49
	Hard-Leather	50
	Electrical	51
	Bean 'spinning'	52
	Split Vessel	53
	Transient	54
Modifiers	Separating	55
	Rough	56

Anomalous	Fan Quan Mai/ San Yin Mai	57
	Ganglion	58
	Local Trauma	59
Wave	Normal Wave	60
	Flooding Deficient	61
	Hesitant	62
	Suppressed	63
	[Hollow Full-Overflowing]	
	[Flooding Excess]	
Rhythm	Change in rate at rest	64
	Intermittent	65
	Interrupted	66
	Normal Rhythm	67
Width (Wide)	Blood Unclear	68
	Blood Heat	69
	Blood Thick	70
Sides (Amplitude – Intensity)	Sides Equal	71
	Left > Right	72
	Right > Left	73
Diaphragm	Inflation Equal Bilateral	74
	Inflation Left > Right	75
	Inflation Right > Left	76

For purposes of analysis only, the component positions of the *Combined Complementary Positions* (Table 4-4) and the *Pulse Rates* (Table 4-5) were assigned variable numbers that were used exclusively in reference to these pulse categories.

Table 4-4: Variables specific to the *Combined Complementary Positions*

Associated Principal Position	Variable – Complementary Position	Variable number
Heart	Pericardium	77
	Large Vessel	78
	Heart Enlarged	79
Lung	Pleura	80
Liver	Distal Liver Engorged	81
	Radial Liver Engorged	82
	Ulna Liver Engorged	83
Stomach – Spleen	Esophagus	84
	Spleen Special	85
	Pancreas – Peritoneal Cavity	86
	Duodenum	87

Table 4-5 *Pulse Rate* variables

Pulse Rates	Variable number
Beginning Rate	88
End Rate	89
Exertion Rate	90
Rate Change with Exertion	91

4.4 DATA MANAGEMENT

The test and retest phases of data collection produced a total of 116 tester responses or completed pulse forms, an example of which is included in Appendix 7. First the raw data were transcribed to electronic format. Testers responses for *Beginning Rate*, *End Rate*, *Exertion Rate* and *Rate Change with Exertion* were entered into Excel in a way that facilitated the methods of analysis (an example of this data entry is presented in Table 4-6). On transcription of the remaining data, variables or pulse qualities that were recorded by only one of the four testers, and those that were rated ≤ 1 on the one to five scales were considered anomalies and excluded.

Table 4-6 Data entry for *Rates* for Subject 1

Subject 1	Beginning	End	Exertion	Change with Exertion	Tester	Day
	70	50	78	28	1	1
	56	59	76	17	1	2
	60	50	72	22	2	1
	54	56	78	22	2	2
	56	54	72	18	3	1
	59	70	78	8	3	2
	59	54	66	12	4	1
	63	67	78	11	4	2

Next a master file was constructed for each pulse position or category that defined the range of possible qualities or variables. The results of all testers on both days were entered into these files. If a pulse quality was present, that is, entered on the pulse form by the tester, number 2 was assigned. If a pulse quality was absent, that is, not entered on the pulse form, number 1 was assigned. For each file the data were organised according to tester and day of testing using the notation t1d1, t1d2, t2d1, t2d2, t3d1, t3d2, t4d1 and t4d2 where t=tester, and d=day. In total, 30 separate files were created for all 14 subjects. The *First Impressions* category for subject 1 is presented in Table 4-7 as an example of these electronic data files.

Table 4-7: First Impressions category for Subject 1

Possible Qualities 1 st Imp.	Variable no.	t1 d1	t1 d2	t2 d1	t2 d2	t3 d1	t3 d2	t4 d1	t4 d2
Qi Wild									
Empty	1	1	1	1	1	1	1	1	1
Change in Quality	2	1	1	1	1	1	1	1	1
Change in Amplitude	3	2	2	2	2	1	2	2	2
Scattered	5	1	1	1	1	1	1	1	1
Minute	6	1	1	1	1	1	1	1	1
Leather	7	1	1	1	1	1	1	1	1
Volume – Robust									
Hollow Full-Overflowing	10	1	1	1	1	1	1	1	1
Robust Pounding	11	2	2	1	2	2	2	2	2
Flooding Excess	12	1	1	1	1	1	1	1	1
Volume – Reduced									
Yielding Qi Depth	14	1	1	1	1	1	1	1	1
Diminished Qi Depth	15	1	1	1	1	1	1	1	1
Feeble at Qi Depth	16	1	1	1	1	1	1	1	1
Spreading	17	1	1	1	1	1	1	1	1
Reduced Substance	18	2	2	2	2	1	2	1	2
Reduced Pounding	19	1	1	1	1	1	1	1	1
Diffuse	20	2	2	1	1	1	1	1	1
Deep	21	1	1	1	1	1	1	1	1
Feeble – Absent	22	1	1	1	1	1	1	1	1
Muffled	25	2	1	2	1	2	2	1	1
Depth									
Hollow	33	1	1	1	1	1	1	1	1
Width									
Thin	34	2	2	2	2	2	2	2	2
Length									
Short	35	1	1	1	1	1	1	1	1
Long	37	1	1	1	1	1	1	1	1
Shape – Fluid									
Slippery	38	1	1	1	1	1	1	1	1
Shape – Non Fluid Even									
Taut	39	1	1	1	1	1	1	1	1
Tense [Tense-Tight]	40	1	1	1	1	1	1	1	1
Tight [Tight-Tense]	41	2	2	2	2	2	1	2	2
Wiry	42	1	1	1	1	1	1	1	1
Ropy	43	1	1	1	1	1	1	1	1
Shape – Non Fluid Uneven									
Choppy	44	2	1	2	2	1	2	2	2
Smooth Vibration	45	1	2	1	1	2	2	2	2
Rough Vibration	46	1	1	1	1	1	1	1	1
Shape - Miscellaneous									
Amorphous	49	1	1	1	1	1	1	1	1
Hard-Leather	50	1	1	1	1	1	1	1	1
Split Vessel	53	1	1	1	1	1	1	1	1
Modifiers									
Transient	54	2	2	1	2	2	2	1	2
Separating	55	1	1	1	1	1	1	1	1
Rough	56	1	1	1	1	1	1	1	1
Anomalies									
Fan Quan Mai/ San Yin Mai	57	2	2	2	2	2	2	2	2
Ganglion	58	1	1	1	1	1	1	1	1
Local Trauma	59	1	1	1	1	1	1	1	1

4.5 DATA ANALYSIS

4.5.1 PULSE RATES

The data for the rate categories were analysed using ANOVA in Minitab version 15. The reliability of rate measurement by the testers was assessed where the model was subject, day and tester nested within subject, for each of *Beginning Rate*, *End Rate*, *Exertion Rate* and *Rate Change with Exertion*, with subject and tester as random factors. The level of significance was set at 0.05 and all assumptions were checked and satisfied.

4.5.2 INDIVIDUAL PULSE CATEGORIES AND PULSE POSITIONS

The remaining data were analysed using Cohen's kappa coefficient (Cohen J 1960) and Statistical Package of the Social Sciences, version 13 (SPSS 13 for Mac OS X, 2006). Kappa is the preferred measure of rater reliability for nominal types of data. (Cyr L and Francis K 1992) It measures the reliability of agreement between two or more independent raters (Cohen J 1960) using a rating scheme with mutually exclusive categories. (Cohen J 1960; Cyr L and Francis K 1992; Tooth LR and Ottenbacher KJ 2004) Kappa is an extension of simple percent agreement (Cyr L and Francis K 1992; Tooth LR and Ottenbacher KJ 2004) and corrects this for the proportion of agreement between raters that would be expected due to chance alone. (Landis JR and Koch GG 1977; Fleiss JC 1981; Maclure M and Willett WC 1987; Cyr L and Francis K 1992; Tooth LR and Ottenbacher KJ 2004) Kappa values lie between -1.00 and 1.00. Those approaching 1.00 represent perfect agreement, 0.00 represents agreement due to chance alone (Cyr L and Francis K 1992) and negative values indicate agreement less than what is expected by chance. (Ubersax J

1982; Rae G 1988) More rigid interpretations of kappa have been proposed, (Landis JR and Koch GG 1977; Fleiss JC 1981; Altman DG 1991; Cicchetti DV 1994; Jelles F, Van Bennekom CAM et al. 1995; Shrout PE 1998) however, for most purposes values ≤ 0.40 represent poor agreement, values between 0.40 and 0.75 represent moderate to good agreement and values ≥ 0.75 indicate excellent agreement. (Jelles F, Van Bennekom CAM et al. 1995) Values < 0.00 are a rare outcome as rater training usually results in a kappa value > 0.00 . (Rae G 1988; Portney LG and Watkins MP 2000)

4.5.2.1 INTRA RATER RELIABILITY

Intra rater reliability or the consistency within a tester over time (Tooth LR and Ottenbacher KJ 2004) to assess the pulse was measured by comparing the four testers results on day one, with their results on day two, for example, $t1d1*t1d2$, where t =tester and d =day. This method resulted in four kappa values for each of the 30 pulse positions or pulse categories in each of the 14 subjects, totalling $4 \times 30 \times 14 = 1680$ individual kappa calculations.

These data were then analysed in terms of tester and subject with respect to pulse position or category. For ease of managing the high volume of kappa calculations individual intra rater kappa values were averaged for the four testers across the 14 subjects. This method resulted in 56 (4×14 subjects) average intra rater kappa calculations. Additionally average intra rater kappas for each individual tester were calculated and analysed according to the subjects that they measured.

4.5.2.2 INTER RATER RELIABILITY

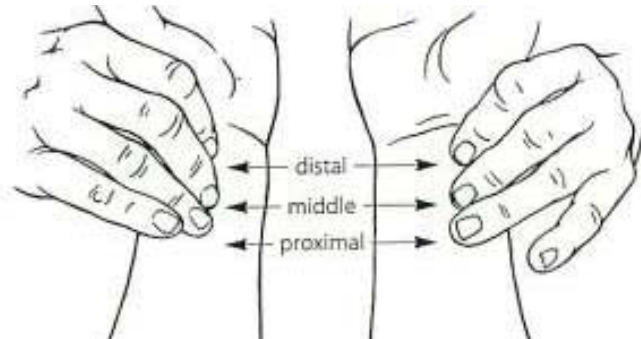
Inter rater reliability is more accurately divided into inter rater agreement (measured by comparing testers within one day) and reliability (measured by comparing testers over time or between days). (Tooth LR and Ottenbacher KJ 2004) They were determined by comparing the results of two testers at a time (ensuing six tester combinations $t1*t2$, $t1*t3$, $t1*t4$, $t2*t3$, $t2*t4$ and $t3*t4$) across both days of testing (four day combinations $d1*d1$, $d1*d2$, $d2*d2$ and $d2*d1$). This resulted in 24 kappa values for each pulse position in all subjects totalling $24 \times 30 \times 14 = 10\,080$ individual kappa calculations.

These data were analysed in terms of testing day and subject with respect to pulse position or category. Again for ease of managing and reporting the vast number of calculations, individual inter rater kappa values were averaged for each of the 30 pulse categories according to the testing day combination totalling 120 average inter rater kappas ($30 \times$ four day combinations). Kappa values within these groupings were used to identify emerging trends in the data.

4.5.2.3 RELIABILITY OF THE LARGE SEGMENT OF THE PULSE

The large segment of the pulse includes pulse categories that are assessed over the whole pulse. That is, testers employ six fingers (index, middle and ring fingers of both hands) to simultaneously palpate pulse categories on both the subjects' left and right wrists. This method of palpation is shown in Figure 4-2.

Figure 4-2 Palpation of the pulse large segment



(Hammer L 2005¹)

The large segment of the pulse comprised eleven of the total 30 pulse categories/positions included in the study. Table 4-8 lists these along with the number of variables possible for each position. The large segment was explored to ascertain the reliability of palpation methods that incorporate the bilateral use of multiple fingers at the same time.

Table 4-8 Large segment of the pulse

Pulse Category	Number of Variables
1. First Impressions	41
2. First Impressions (left side)	51
3. First Impressions (right side)	51
4. Rhythm	4
5. Above Qi Depth	6
6. Qi Depth	29
7. Blood Depth	34
8. Organ – Qi Depth	31
9. Organ – Blood Depth	31
10. Organ – Organ Depth	31
11. Waveform	6

The individual intra rater kappa values for the large segment of the pulse were averaged across each of the testers according to pulse category. Gross intra rater reliability for the large segment was calculated by averaging kappas across all testers, subjects and days according to large segment pulse categories.

Inter rater reliability of the large segment was established by averaging the individual inter rater kappa values across all subjects and combinations of testers and days with respect to large segment pulse categories.

4.5.2.4 RELIABILITY OF THE SMALL SEGMENT OF THE PULSE

The small segment of the pulse refers to the individual pulse positions, each of which is palpated separately by one finger. As an example of this Figure 4-3 shows the technique used to palpate the *Left Distal Position*.

Figure 4-3 Palpation of a small segment position (*Left Distal Position*)



(Hammer L 2005¹)

The small segment includes the principal positions, found on the radial artery, as well as the complementary positions, located in relation to a principal position. It comprises 19 of the total 30 pulse categories/positions. Table 4-9 lists these along with the number of variables possible for each position. The small segment was scrutinised to determine the reliability of single finger methods of palpation.

Table 4-9 Small segment of the pulse

Principal Positions (Found on the main artery)	Number of Variables
1. Left Distal Position	39
2. Right Distal Position	39
3. Left Middle Position	43
4. Right Middle Position	43
5. Left Proximal Position	43
6. Right Proximal Position	43
Complementary Positions (Related to principal positions)	
7. Left Neuropsychological Position	28
8. Right Neuropsychological Position	28
9. Mitral Valve	22
10. Left Special Lung Position	37
11. Right Special Lung Position	37
12. Diaphragm Position	13
13. Gall Bladder Position	32
14. Stomach Pylorus Extension Position	32
15. Large Intestine Position	33
16. Small Intestine Position	33
17. Left Pelvic Lower Body Position	32
18. Right Pelvic Lower Body Position	32
19. Combined Complementary Position	11

The individual intra rater kappa values were averaged for all testers, subjects and days according to small segment pulse positions. These were then organised according to the principal and complementary positions. The principal positions were further grouped according to the distal, middle and proximal positions. To determine the gross intra rater reliability of the principal positions versus the complementary positions the relevant kappa values were averaged. Finally gross reliability of the small segment was calculated by averaging kappas across all testers, subjects, days and small segment pulse positions.

Inter rater reliability was determined by averaging the individual inter rater kappa scores for all subjects and combinations of testers and days with respect to small segment pulse position. Again gross inter rater reliability for the small segment, as well as the principal versus the complementary positions was calculated by averaging the relevant kappa values.

4.5.2.5 RELIABILITY ACCORDING TO PULSE CATEGORY AND PULSE POSITION

The reliability of testers to measure a particular pulse attribute was determined by analysis of the kappas values across both the large segment pulse categories and small segment pulse positions. Individual intra rater kappas were averaged for specific testers according to each pulse category/position. While inter rater kappas were averaged across all testers and pulse category/positions for each of the four d*d (day*day) combinations. These data were then presented graphically to obtain a visual ranking of the reliability of all the pulse categories and positions.

4.5.3 RELIABILITY ACCORDING TO PULSE QUALITY

The reliability of individual pulse qualities were determined by investigating qualities that were selected frequently by the testers and those that were common to both large segment pulse categories and small segment pulse positions. Further, pulse qualities that were specific to only certain positions were also scrutinised to establish which pulse qualities demonstrated lesser reliability and if this was related to pulse position/category or other factors.

Each pulse quality was investigated separately for each pulse category or position by running case summaries in SPSS. These were then copied and pasted into Excel for ease of further analysis (Figure 4-4).

Figure 4-4 Excel worksheet for Choppy (44) in the *First Impressions* category of the large segment of the pulse

First Impressions: Choppy (44)													
	subject	variable	t1d1	t1d2	t2d1	t2d2	t3d1	t3d2	t4d1	t4d2	present	absent	
1	1	44	2	1	2	2	1	2	2	2	6	2	
2	2	44	2	2	2	2	1	2	2	2	7	1	
3	3	44	2	2	2	2	2	2	2	2	2	6	
4	4	44	2	2	2	2	2	2	2	2	0	8	
5	5	44	2	2	2	2	2	2	2	2	0	8	
6	6	44	1	2	1	2	2	2	1	2	5	3	
7	7	44	2	1	2	1	2	1	2	2	5	3	
8	8	44	2	2	2	2	2	2	2	1	5	3	
9	9	44	2	2	2	2	2	1	2	1	4	4	
10	10	44	2	1	2	1	1	2	2	1	4	4	
11	12	44	2	2	2	2	2	2	2	2	8	0	
12	13	44	2	2	2	2	2	4	1	2	7	1	
13	14	44	2	2	2	2	1	2	2	2	7	1	
14	15	44	2	2	2	2	1	2	2	2	7	1	
Total	N	14	14	14	14	14	14	14	14	14			
Indicates test - retest match					Indicates subjects with ≥ 3 testers in agreement								
Intra Rater Reliability					37	test - retest matches							
Inter Rater Reliability					8	subjects with agreement 3 or more testers							
Where 2=present, 1=absent													

From the Excel data the number of test – retest agreements (indicated in Figure 4-4 by cross hatching) were counted to determine intra rater reliability. There were 56 repeated tests for each pulse quality in each category or position. Pulse qualities that showed less than 70% agreement (<39 test – retest matches) were highlighted for further investigation. In the case of Figure 4-4 there were 37 repeat test agreements so the Choppy quality in the *First Impressions* category was assigned for further analysis of intra rater reliability.

Inter rater reliability was determined for each pulse quality in each category or position by calculating the number of subjects where at least three of the four testers' test-retest matches were in complete agreement. These subjects are represented in Figure 4-4 by pixelated fill. The pulse categories or positions where

agreement between three or more testers occurred in less than seven subjects were assigned for further review. In the case of Figure 4-4 there were eight subjects that showed complete agreement between three or more testers, therefore inter rater reliability for the Choppy quality in the *First Impressions* category was not subjected to further analysis.

Finally the pulse qualities that were indicated by the selection parameters to have lesser reliability were analysed in terms of pulse categories/positions and also the classification grouping of the individual pulse qualities. These results were then cross-referenced with the kappa results for the relevant pulse categories/positions to further identify possible sources of variance of intra and inter rater reliability of individual pulse qualities.

Chapter 5

5 RESULTS

To maintain consistency with the methods of data analysis described in Chapter 4, the results are set forth according to three main sections; pulse rates (5.1), kappa analysis (5.2) and reliability of pulse qualities (5.3). Both 5.2 and 5.3 present extensive intra and inter rater findings in terms of pulse large and small segments and pulse category/position. Further to this the kappa analysis (5.2) details overall or gross levels of intra and inter rater reliability in relation to subject, tester and testing day combinations.

5.1 PULSE RATES

The ANOVA results for *Beginning*, *End*, *Exertion* and *Change with Exertion Rates* are presented in Table 5-1. For each of these rate variables there was a significant difference established between subjects. There was also a significant difference between days for *End Rate* and *Exertion Rate* (where overall day 2 was higher in *End Rate* and *Exertion Rate*) but not for *Beginning Rate* and *Rate Change with Exertion*. There was no significant difference between testers for any of the rate variables.

Table 5-1 ANOVA results for *Pulse Rate* variables

Rate	Variable No.	Subject (p value)	Day (p value)	Tester (p value)
Beginning Rate	88	0.000	0.262	0.347
End Rate	89	0.000	0.000	0.720
Exertion Rate	90	0.000	0.003	0.536
Rate Change with Exertion	91	0.000	0.355	0.193

5.1.1 SUMMARY OF FINDINGS FOR PULSE RATES

These results indicated that although subjects' pulse rates varied, the raw data recorded by the testers when counting these rates did not. This demonstrated reliable assessment of pulse rate variables.

5.2 KAPPA ANALYSIS

5.2.1 GROSS INTRA RATER RELIABILITY

Of the 1680 raw intra rater kappa scores 43.2% (726) showed kappas ≥ 0.75 or excellent agreement (Jelles F, Van Bennekom CAM et al. 1995); a further 42.5% (713) scored kappas 0.41–0.74 indicating moderate to good agreement (Jelles F, Van Bennekom CAM et al. 1995); while 14.3% (241) scored kappas ≤ 0.40 showing poor agreement. (Jelles F, Van Bennekom CAM et al. 1995) In total 67% (1126) scored ≥ 0.60 .

These percentages demonstrated very good intra rater reliability, or agreement of individual tester's responses. For further analysis the averaged intra rater kappas for each tester and the subjects they assessed are shown in Table 5-2.

Four of the testers (ta, tb, tc, td) attained excellent agreement between their repeated assessments from day one to day two in at least one of the subjects they tested, while two of these (tb, td) obtained average intra rater kappa values ≥ 0.60 for all subjects tested. One tester (tf) exhibited slightly lower test-retest agreement and scored average intra rater kappas < 0.60 in all subjects tested.

Table 5-2: Intra rater reliability – average and range of kappas according to tester

Tester	No. of subjects tested	Average kappa	Range of kappa
t a	14	0.66	0.44 – 0.76
t b	14	0.72	0.65 – 0.82
t c	7	0.68	0.54 – 0.78
t d	9	0.70	0.62 – 0.78
t e	8	0.62	0.49 – 0.72
t f	4	0.52	0.45 – 0.57

Analysis of the intra rater results in terms of subjects showed generally good reliability but also revealed some interesting trends in subjects where agreement within testers was demonstrated to be less. Table 5-3 presents the 56 averaged intra rater kappas in terms of ranges for the 14 subjects.

Excellent agreement was demonstrated in the upper limit of kappa ranges for nine subjects. Six of the subjects (1, 3, 5, 6, 9 and 15) demonstrated good reliability with average intra rater kappa values ≥ 0.60 for all four testers. Intra rater disagreement was unevenly distributed with the two lowest average intra rater kappa values of 0.44 and 0.45 appearing within subject 13, and the next lowest of 0.48 in subject 10. Examination of the individual kappas for these testers and subjects showed the unusual occurrence (Rae G 1988; Portney LG and Watkins MP 2000) of negative values, or agreement less than that expected by chance, in up to seven pulse categories.

Table 5-3: Intra rater reliability – range of average kappas according to subject

Subject	Range of intra rater kappas	Subject	Range of intra rater kappas
Subject 1	0.66 – 0.76	Subject 8	0.49 – 0.78
Subject 2	0.54 – 0.76	Subject 9	0.68 – 0.74
Subject 3	0.61 – 0.78	Subject 10	0.48 – 0.70
Subject 4	0.59 – 0.77	Subject 12	0.57 – 0.70
Subject 5	0.62 – 0.75	Subject 13	0.44 – 0.78
Subject 6	0.64 – 0.77	Subject 14	0.57 – 0.82
Subject 7	0.57 – 0.74	Subject 15	0.62 – 0.73

5.2.2 GROSS INTER RATER RELIABILITY

Of the 10 080 raw inter rater kappa scores 23.5% (2366) showed kappas ≥ 0.75 or excellent agreement; (Jelles F, Van Bennekom CAM et al. 1995) 46% (4642) scored kappas 0.41–0.74 indicating moderate to good agreement; (Jelles F, Van Bennekom CAM et al. 1995) while 30.5% (3072) scored kappas ≤ 0.40 showing poor agreement. (Jelles F, Van Bennekom CAM et al. 1995) In total, 44.1% (4442) scored ≥ 0.60 .

These results demonstrated overall inter rater reliability as largely good. For further exploration of the data the inter rater kappa values averaged according to subject and testing day combinations are presented in Table 5-4.

The results for different testing day combinations (bottom row Table 5-4) were all consistent and showed moderate to good inter rater agreement (Jelles F, Van Bennekom CAM et al. 1995) with average kappa values between 0.52–0.56. In terms of the 14 subjects, average kappas for all testing day combinations (last column Table 5-4) ranged from 0.42–0.63 again indicating moderate to good agreement. (Jelles F, Van Bennekom CAM et al. 1995) Subject 13 and 14 demonstrated the two lowest scores of 0.47 and 0.42, with subject 13 reported previously as exhibiting the highest incidence of intra rater disagreement.

Further examination of the data for these two subjects, specifically the 24 averaged inter rater kappa scores for each discrete pulse category/position, showed poor agreement (kappas ≤ 0.40) in seven categories common to both subjects. Negative

inter rater kappa values were again noted amid the raw or individual scores, however they were not skewed according to pairs of testers or day combinations.

Table 5-4: Inter rater reliability – average kappas according to subject and day

	d1*d1	d2*d2	d1*d2	d2*d1	Average kappa for subject
Subject 1	0.62	0.66	0.63	0.60	0.63
Subject 2	0.46	0.53	0.47	0.50	0.49
Subject 3	0.54	0.54	0.58	0.47	0.53
Subject 4	0.56	0.58	0.58	0.57	0.57
Subject 5	0.51	0.56	0.53	0.53	0.53
Subject 6	0.59	0.62	0.51	0.64	0.59
Subject 7	0.55	0.54	0.57	0.50	0.54
Subject 8	0.51	0.57	0.52	0.52	0.53
Subject 9	0.59	0.58	0.59	0.56	0.59
Subject 10	0.47	0.49	0.53	0.47	0.49
Subject 12	0.51	0.50	0.45	0.51	0.49
Subject 13	0.44	0.58	0.40	0.43	0.47
Subject 14	0.38	0.46	0.40	0.44	0.42
Subject 15	0.56	0.56	0.52	0.58	0.56
Average K for d*d	0.52	0.56	0.52	0.53	0.55

Where d1*d1 compares the results of day 1 with day 1; d2*d2 day 2 with day 2; d1*d2 day 1 with day 2 and d2*d1 day 2 with day 1.

5.2.3 RELIABILITY OF THE LARGE SEGMENT OF THE PULSE

5.2.3.1 INTRA RATER RELIABILITY

In terms of individual kappa scores the large segment included 616 of the total 1680 raw intra rater kappa scores. Of these 56.5% (348) showed kappas ≥ 0.75 or excellent agreement (Jelles F, Van Bennekom CAM et al. 1995); a further 30.4% (187) scored kappas 0.41–0.74 indicating moderate to good agreement (Jelles F, Van Bennekom CAM et al. 1995); while 13.1% (81) scored kappas ≤ 0.40 showing poor agreement. (Jelles F, Van Bennekom CAM et al. 1995) In total 72.1% (444) individual large segment intra rater kappas were ≥ 0.60 .

These results demonstrated intra rater reliability for the large segment of the pulse as very good to excellent. The raw or individual intra rater kappas, averaged across all testers according to the large segment pulse categories are presented in Table 5-5.

Average intra rater kappas ranged between 0.63–0.88. Excellent agreement, or average intra rater kappas ≥ 0.75 , (Jelles F, Van Bennekom CAM et al. 1995) were attained in five categories (*First Impressions*, *First Impressions (right side)*, *Above Qi Depth*, *Qi Depth* and *Blood Depth*). The remaining six scored average kappas ≥ 0.63 indicating moderate to good intra rater agreement (Jelles F, Van Bennekom CAM et al. 1995). It was noted however the two categories with the least reliability, *Organ-Blood* and *Organ-Organ Depths* both scored average inter rater kappas =0.63. These were substantially lower (0.10 kappa point) than the next pulse category that scored 0.73. Gross intra rater reliability for the large segment of the pulse was found to be moderate to good with an average kappa of 0.74. (Jelles F, Van Bennekom CAM et al. 1995)

Table 5-5 Average intra and inter rater kappa scores for large segment pulse categories

Pulse Category	Average kappa all testers	
	Intra rater k	Inter rater k
First Impressions	0.75	0.65
First Impressions (left side)	0.72	0.56
First Impressions (right side)	0.77	0.58
Rhythm	0.74	0.67
Above Qi Depth	0.88	0.78
Qi Depth	0.76	0.61
Blood Depth	0.78	0.49
Organ – Qi Depth	0.74	0.58
Organ – Blood Depth	0.63	0.53
Organ – Organ Depth	0.63	0.52
Waveform	0.73	0.49
Average kappa all pulse categories	0.74	0.59

5.2.3.2 INTER RATER RELIABILITY

The large segment of the pulse comprised 3696 of the 10 080 individual inter rater kappa scores. Of these 36.6% (1351) showed kappas ≥ 0.75 or excellent agreement; (Jelles F, Van Bennekom CAM et al. 1995) 36.4% (1345) scored kappas 0.41–0.74 indicating moderate to good agreement; (Jelles F, Van Bennekom CAM et al. 1995) while 27% (1000) scored kappas ≤ 0.40 showing poor agreement. (Jelles F, Van Bennekom CAM et al. 1995) In total, 52.8% (1950) individual large segment inter rater kappas were ≥ 0.60 .

These results indicated that overall, inter rater reliability for the large segment was good. Average inter rater kappa values for the large segment pulse categories, presented in Table 5-5, ranged from 0.49–0.78. *Above Qi Depth* attained excellent inter rater agreement with an average kappa ≥ 0.75 , (Jelles F, Van Bennekom CAM et al. 1995), while the remaining ten categories showed moderate to good inter rater agreement with all average kappas ≥ 0.49 . (Jelles F, Van Bennekom CAM et al. 1995) The categories with substantially lower average inter compared with intra rater kappas were the *Blood Depth* and *Waveform*. Gross inter rater reliability for the large segment of the pulse was shown to be moderate to good with an average kappa of 0.59. (Jelles F, Van Bennekom CAM et al. 1995)

5.2.4 RELIABILITY OF THE SMALL SEGMENT OF THE PULSE

5.2.4.1 INTRA RATER RELIABILITY

In terms of individual kappa scores the small segment included the remaining 1064

of the total 1680 raw intra rater kappa scores. Of these 35.5% (378) showed kappas ≥ 0.75 or excellent agreement (Jelles F, Van Bennekom CAM et al. 1995); a further 49.5% (526) scored kappas 0.41–0.74 indicating moderate to good agreement (Jelles F, Van Bennekom CAM et al. 1995); while 15% (160) scored kappas ≤ 0.40 showing poor agreement. (Jelles F, Van Bennekom CAM et al. 1995) In total 64.1% (444) individual small segment kappas were ≥ 0.60 .

These results demonstrated very good intra rater reliability for the small segment of the pulse. For further analysis the individual intra rater kappa values averaged across all testers according to small segment pulse position are displayed in Table 5-6.

Average kappas for the small segment pulse positions ranged from 0.49–0.74 indicating moderate to good intra rater agreement. (Jelles F, Van Bennekom CAM et al. 1995) The average intra rater kappas for each of the principal positions ranged from 0.74–0.64 with the distal positions showing the greatest reliability (average intra rater kappa 0.74) followed by the middle positions (0.69) then the proximal positions (0.66). Twelve of the complementary positions attained average intra rater kappa values between 0.71 and 0.62, while one, *Combined Complementary Positions* rated considerably lower with an average intra rater kappa of 0.49.

In terms of gross intra rater reliability, the principal positions were shown to be slightly more reliable than the complementary positions with average kappas of 0.70 and 0.63 respectively. The entire small segment attained an average kappa of 0.65 (Table 5-6). All of these values indicated moderate to good intra rater

agreement. (Jelles F, Van Bennekom CAM et al. 1995)

Table 5-6 Average intra and inter rater kappa scores for small segment pulse positions

Pulse Position	Average kappa all testers	
	Intra rater K	Inter rater K
Left Distal Position (LDP)	0.74	0.64
Right Distal Position (RDP)	0.74	0.58
<i>[Average K DPs]</i>	<i>[0.74]</i>	<i>[0.61]</i>
Left Middle Position (LMP)	0.73	0.49
Right Middle Position (RMP)	0.65	0.54
<i>[Average K MPs]</i>	<i>[0.69]</i>	<i>[0.52]</i>
Left Proximal Position (LPP)	0.67	0.57
Right Proximal Position (RPP)	0.64	0.52
<i>[Average K PPs]</i>	<i>[0.66]</i>	<i>[0.55]</i>
<i>[Average kappa principal positions]</i>	<i>[0.71]</i>	<i>[0.56]</i>
Left Neuropsychological Position	0.62	0.50
Right Neuropsychological Position	0.62	0.51
Mitral Valve	0.71	0.50
Left Special Lung Position	0.64	0.53
Right Special Lung Position	0.60	0.52
Diaphragm Position	0.70	0.46
Gall Bladder Position	0.65	0.48
Stomach Pylorus Extension Position	0.63	0.49
Large Intestine Position	0.64	0.48
Small Intestine Position	0.64	0.50
Left Pelvic Lower Body Position	0.63	0.50
Right Pelvic Lower Body Position	0.64	0.51
Combined Complementary Positions	0.49	0.34
<i>[Average kappa complementary positions]</i>	<i>[0.63]</i>	<i>[0.49]</i>
Average kappa all small segment	0.65	0.51

5.2.4.2 INTER RATER RELIABILITY

The small segment of the pulse included 6384 of the 10 080 individual inter rater kappa scores. Of these 15.9% (1015) showed kappas ≥ 0.75 or excellent agreement; 51.6% (3297) scored kappas 0.41–0.74 indicating moderate to good agreement; (Jelles F, Van Bennekom CAM et al. 1995) while 32.5% (2072) scored kappas ≤ 0.40 showing poor agreement. (Jelles F, Van Bennekom CAM et al. 1995) In total, 39.0% (2492) of the individual small segment inter rater kappas were ≥ 0.60 .

These results demonstrated inter rater reliability for the small segment of the pulse to be mostly favourable. The individual inter rater kappa values averaged across all testers according to small segment pulse position are displayed in Table 5-6.

Average kappas for 18 of these 19 small segment positions ranged from 0.46–0.64 indicating moderate to good inter rater agreement for each. (Jelles F, Van Bennekom CAM et al. 1995) One of the complementary positions, the *Combined Complementary Positions*, proved to be unreliable and scored an average kappa of 0.34 indicating poor inter rater agreement. (Jelles F, Van Bennekom CAM et al. 1995) The remaining complementary positions attained moderate to good inter rater reliability (average kappas 0.46–0.53), notably however, the *Diaphragm Position* exhibited a considerably lower average inter rater (0.46) compared with intra rater kappa (0.70). For the principal positions, average inter rater kappas ranged from 0.49 to 0.64, with the distal positions again demonstrating the greatest reliability (average inter rater kappa 0.61), followed by the proximal positions (0.55) then the middle positions (0.52).

In terms of gross inter rater reliability the results replicated those for intra rater. The principal positions were shown to be slightly more reliable than the complementary positions with average kappas of 0.56 and 0.49 respectively. The entire small segment scored an average kappa of 0.51. While these values are considerably less than those calculated for the intra rater results, they still indicated moderate to good intra rater agreement. (Jelles F, Van Bennekom CAM et al. 1995)

5.2.5 RELIABILITY OF PULSE CATEGORY OR PULSE POSITION

The results for intra rater and inter rater reliability across both the large and small segment in terms of pulse category or position are presented in Figure 5-1. On this graph the y-axis indicates the gross levels of agreement or kappa values averaged across all testers and subjects, while the x-axis indicates pulse position or pulse category. Perfect agreement for all testers across all positions would be represented by a horizontal line across the top of the graph at kappa = 1.

5.2.5.1 INTRA RATER RELIABILITY

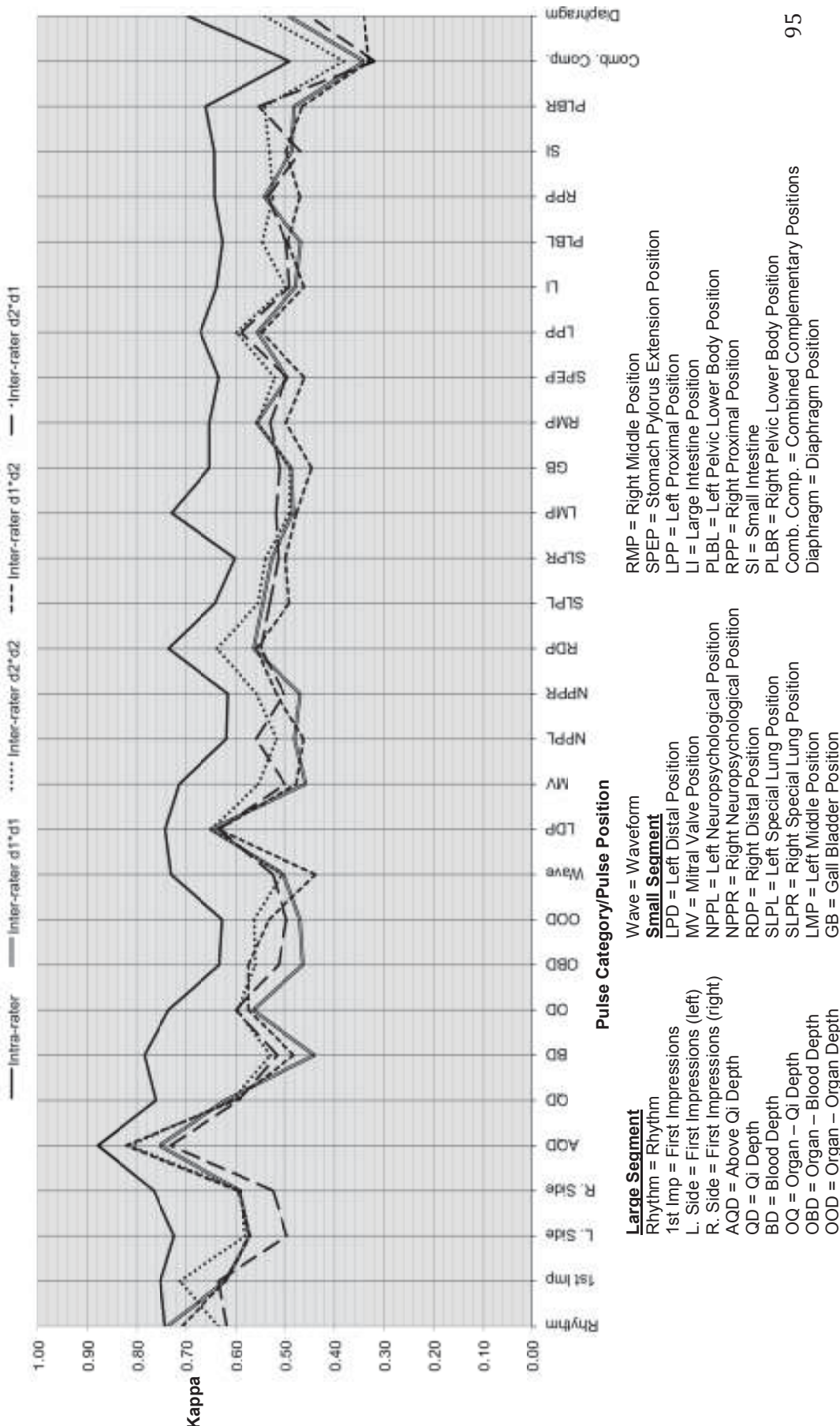
The graph visually demonstrates the very good to excellent results for intra rater reliability. As previously discussed average intra rater kappas for pulse categories/positions ranged between 0.49 and 0.88 indicating moderate to good agreement or above (Jelles F, Van Bennekom CAM et al. 1995) in all but one pulse position or category, the *Combined Complementary Positions*. The average kappa of 0.49 (confirmed by the small segment results) was considerably less than the next lowest ranking position, *Right Special Lung Position*, which scored 0.60.

5.2.5.2 INTER RATER RELIABILITY

The results for inter rater reliability are displayed on the graph according to the four different testing day combinations. The averaged inter rater kappas followed a similar pattern to those of intra rater, however they were typically 0.10 to 0.15 kappa units less. The *Combined Complementary Positions* again exhibited averaged inter rater kappas that were significantly lower than all other pulse positions and categories. In this instance however, it proved to be unreliable and rated poor

agreement (average kappa ≤ 0.40) (Jelles F, Van Bennekom CAM et al. 1995) for all four testing day combinations.

Figure 5-1: Average intra rater and inter rater kappa values according to pulse category or position



5.2.6 SUMMARY OF FINDINGS FOR KAPPA ANALYSIS

Kappa analysis demonstrated intra rater reliability to be higher than inter rater with 85.7% versus 69.5% raw kappa values indicating moderate to good agreement or above (≥ 0.40). All testers exhibited moderate to excellent test-retest agreement however one showed slightly lower levels of intra rater reliability with an average kappa 0.1 units less than the next ranked tester. Three of the subjects exhibited greater disagreement within and between testers, or higher occurrences of unacceptable intra and inter rater kappa values.

Large segment pulse categories proved more reliable than small segment pulse positions. For both segments inter rater results although 0.10 to 0.15 kappa units lower, replicated the trend of intra rater with the exception of *Waveform*, *Blood Depth* and *Diaphragm* where greater disparity existed. (See Figure 5-1) Within the small segment of the pulse principal positions were slightly more reliable than complementary, the *Combined Complementary Positions* exhibiting significantly less intra rater reliability and the only pulse position or category to demonstrate poor or unacceptable inter rater reliability.

5.3 RELIABILITY OF PULSE QUALITIES

5.3.1 QUALITIES COMMON TO PULSE LARGE AND SMALL SEGMENTS

There were 36 pulse qualities found across the pulse large and small segments that were included in the analysis. These consisted of representatives from the Qi Wild, Robust Volume, Reduced Volume, Width, Depth, Shape and Modifier groups. Only

major large segment pulse categories and small segment principal positions were included in the analysis.

5.3.1.1 INTRA RATER RELIABILITY

Large Segment

The intra rater reliability results for pulse qualities according to large segment categories is presented in Table 5-7. The Qi Wild, Robust Volume, Width, Depth and Modifier classes achieved the greatest reliability with $\geq 70\%$ test-retest agreement (≥ 39 matches of the possible 56 test-retest comparisons) in all component pulse qualities for the large segment pulse categories analysed.

The Reduced Volume classification exhibited the least reliability with $< 70\%$ test-retest agreement exhibited in two pulse qualities; Reduced Substance (35) test-retest matches in *Organ-Blood* and *Organ-Organ Depths*; and Muffled (30) in *First Impressions* category. The Shape group exhibited Choppy (37) test-retest matches in *First Impressions*, (31) in *Organ-Blood* and (30) in *Organ-Organ Depths*.

Further the data was considered via the columns of Table 5-7 to examine the relationship between reliability of qualities and pulse category. The *Organ-Blood*, *Organ-Organ Depths* and *First Impressions* both demonstrated two pulse qualities with $< 70\%$ test-retest agreements. The least reliability, or least number of test-retest matches (30) was found with Muffled in *First Impressions*, and Choppy in the *Organ-Organ depths*. When cross-referenced with the large segment kappa analysis, Table 5-5, the *Organ-Blood* and *Organ-Organ depths* rated the lowest reliability, both with average intra rater kappas = 0.63 (moderate to good agreement) (Jelles F,

Van Bennekom CAM et al. 1995), however, *First Impressions* scored 0.75 or excellent agreement. (Jelles F, Van Bennekom CAM et al. 1995)

Small Segment

The intra rater reliability results for pulse qualities according to the principal positions are also shown in Table 5-7. The Robust Volume and Depth groups achieved the greatest reliability with $\geq 70\%$ test-retest agreement or ≥ 39 matches for all component pulse qualities in the small segment positions analysed. The next reliable were the Width, Shape and Modifier groups each of which displayed only one quality narrowly outside the defined parameters with 37 to 38 test-retest matches.

The Reduced Volume and Qi Wild classifications displayed the least intra rater reliability for the small segment positions, each with two pulse qualities that demonstrated < 39 ($< 70\%$) test-retest matches. Of the Reduced Volume qualities Reduced Substance showed (31) test-retest matches in the *Right Middle Position*; and Muffled (35) *Left Distal*, (38) *Right Middle Positions*. Qi Wild exhibited Change of Amplitude (37) test-retest matches in the *Left Distal*, (32) *Right Middle Positions*; and Change of Quality (35) *Right Proximal Position*.

The qualities with the least reliability, or least number of test-retest matches, were Change of Amplitude (32) and Reduced Substance (31), both of which occurred in the *Right Middle Position*. Indicated by the columns of Table 5-7, the positions that demonstrated the most pulse qualities with $< 70\%$ test-retest matches were the *Right Middle* with (4) qualities and *Right Proximal Positions* (3). This was confirmed

by the kappa analysis (Table 5-6) where the *Right Middle* and *Right Proximal Positions* showed the lowest average intra rater kappa values for the principal positions. It was however noted, values of 0.65 and 0.64 still indicated moderate to good agreement. (Jelles F, Van Bennekom CAM et al. 1995)

Large and Small Segments

When the intra rater data was considered via the rows of Table 5-7 three qualities (Reduced Substance, Muffled and Choppy) manifested lower comparable reliability in both the large and small segments. Each of these obtained <39 (<70%) test-retest matches in several pulse categories or positions. Two (Reduced Substance and Muffled) were constituents of the Reduced Volume classification, while Choppy demonstrated the least reliability with three large segment categories and two small segment positions scoring <70% test-retest agreement.

Table 5-7 Intra rater reliability – number of test-retest agreements (56 total)

PULSE QUALITY/VARIABLE		LARGE SEGMENT PULSE CATEGORIES							SMALL SEGMENT PRINCIPAL POSITIONS						
Classification of Pulse Quality	Variable	FI	QD	BD	OD	OB	OO	No. Cat's <70% agree	LDP	LMP	LPP	RDP	RMP	RPP	No. Posn's <70% agree
Qi Wild															
Empty	1	56	xx	56	56	56	56	-	56	50	54	56	50	56	-
Change Quality	2	56	56	56	56	56	56	-	49	46	42	46	43	35	1
Change of Amp	3	43	xx	xx	xx	xx	xx	-	37	45	40	41	32	40	2
Unstable	4	xx	xx	xx	xx	xx	xx	-	56	56	56	56	56	56	-
Scattered	5	56	56	xx	xx	xx	xx	-	xx	xx	xx	xx	xx	xx	-
Minute	6	56	xx	56	xx	xx	xx	-	xx	xx	xx	xx	xx	xx	-
Leather Empty	7	56	56	xx	xx	xx	xx	-	xx	56	56	xx	56	56	-
		0 Qi Wild qual's w/ <70% agreement							2 Qi Wild qual's w/ <70% agreement						
Robust Volume															
HFO	10	xx	xx	xx	xx	xx	xx	-	56	55	56	56	56	56	-
Robust Pounding	11	45	53	56	48	48	47	-	48	47	45	52	45	42	-
Flooding Excess	12	xx	xx	xx	xx	xx	xx	-	54	49	56	56	55	56	-
Inflated	13	xx	xx	xx	xx	xx	xx	-	56	56	56	56	54	56	-
		0 Robust Vol qual's w/ <70% agreement							0 Robust Vol qual's w/ <70% agreement						
Reduced Volume															
(QD) Yielding	14	56	55	56	56	56	56	-	56	56	56	56	54	56	-
(QD) Diminished	15	56	43	56	56	56	56	-	56	56	47	56	53	45	-
(QD) Feeble	16	56	54	56	56	56	56	-	xx	56	56	xx	56	56	-
Reduced Substance	18	43	56	53	39	35	35	2	51	41	44	56	31	42	1
Reduced Pounding	19	56	56	56	56	56	56	-	53	52	56	56	49	54	-
Diffuse	20	48	56	56	52	53	53	-	56	50	56	56	55	56	-
Deep	21	56	xx	xx	56	56	56	-	56	56	39	56	49	51	-
(Feeble) Absent	22	56	54	56	56	56	56	-	53	52	48	49	56	47	-
Flat	23	xx	xx	xx	xx	xx	xx	-	56	56	56	56	56	56	-
Suppressed Pounding	24	xx	xx	xx	56	50	51	-	xx	xx	xx	xx	xx	xx	-
Muffled	25	30	56	56	56	56	56	1	35	47	44	40	38	39	2
Dead	26	xx	xx	xx	xx	xx	xx	-	56	56	56	56	56	56	-
		2 Reduced Vol qual's w/ <70% agreement							2 Reduced Vol qual's w/ <70% agreement						
Depth															
Hollow	33	56	xx	56	xx	xx	xx	-	56	56	56	56	56	56	-
		0 Depth qual's w/ <70% agreement							0 Depth qual's w/ <70% agreement						
Width															
Thin	34	47	44	53	56	56	56	-	47	41	40	42	49	37	1
		0 Width qual's w/ <70% agreement							1 Width qual w/ <70% agreement						
Shape															
Slippery	38	56	54	49	51	39	39	-	41	49	54	40	56	54	-
Taut	39	56	56	56	56	56	56	-	56	56	56	56	56	56	-
Tense	40	51	52	56	44	44	44	-	51	51	46	51	51	44	-
Tight	41	50	47	56	49	52	52	-	40	51	51	45	49	44	-
Wiry	42	55	56	56	56	56	56	-	56	56	56	56	56	52	-
Choppy	44	37	56	55	42	31	30	3	49	37	41	56	44	38	2
Smooth Vibration	45	47	39	56	56	56	56	-	47	52	56	49	52	56	-
Rough Vibration	46	43	56	56	56	56	56	-	41	52	56	44	46	55	-
Amorphous	49	53	56	56	56	56	56	-	xx	xx	xx	xx	xx	xx	-
Hard Leather	50	56	56	56	56	56	56	-	56	56	56	56	56	56	-
		1 Shape qual's w/ <70% agreement							1 Shape quality w/ <70% agreement						
Modifier															
Transient	54	44	54	56	44	43	45	-	50	49	37	41	38	43	2
		0 Modifier qual's w/ <70% agreement							1 Modifier quality w/ <70% agreement						

FI	First Impressions	QD	Qi Depth	AQD	Above Qi Depth	BD	Blood Depth
OD	Organ Depth	O-B	Organ-Blood Depth	O-O	Organ-Organ Depth	xx	Quality not found in that position/category
LDP	Left Distal Posn.	LPP	Left Proximal Posn.	RMP	Right Middle Posn.		Test-retest agreements <70% (39)
LMP	Left Middle Posn.	RDP	Right Distal Posn.	RPP	Right Proximal Posn.		Less reliable qualities common to both

5.3.1.2 INTER RATER RELIABILITY

Large Segment

The inter rater reliability results for qualities according to large segment pulse categories are presented in Table 5-8. The greatest reliability was found in the Qi Wild, Robust Volume, Width and Depth groups where all constituent pulse qualities demonstrated agreement of at least three of the four testers in more than half the subjects ($\geq 75\%$ agreement between testers in \geq seven subjects).

The Shape group exhibited the least reliability with four pulse qualities gaining $\geq 75\%$ agreement between testers in only six subjects or less. These were Choppy (2) subjects, Tense (3) and Slippery (3) all found at the *Organ-Blood* and *Organ-Organ Depths*, as well as Smooth Vibration (5) at the *Qi Depth*. Reduced Volume displayed three qualities; Muffled (2) subjects in *First Impressions*, Reduced Substance (3) at the *Organ*, *Organ-Blood* and *Organ-Organ Depths*, and Diminished (6) at the *Qi Depth*. Within the Modifier class Transient showed (5 subjects) at the *Organ Depth* and (6) at the *Organ-Blood Depth*.

Inter rater reliability of pulse qualities with respect to large segment pulse category (columns of Table 5-8) repeated the trend found with intra rater reliability. Again the Organ-Blood and Organ-Organ Depths demonstrated the most pulses qualities with $\geq 75\%$ tester agreement in the least number of subjects. The least reliability was found with Choppy (2) subjects followed by Reduced Substance, Tense and Slippery (3) all at the Organ-Blood and Organ-Organ Depths. Review of the kappa analysis (Table 5-5)

showed these categories to have the lowest average inter rater kappa values (0.52 and 0.53 respectively) of those included in Table 5-8.

Small Segment

Inter rater reliability of qualities according to small segment principal positions (Table 5-8) were generally less than that of the large segment. The Depth, Robust Volume, Width and Modifier classifications showed the greatest reliability. While Depth was the only class that demonstrated all component qualities to have $\geq 75\%$ agreement between testers in more than half the subjects, the remaining three groups each demonstrated only one pulse quality just outside these parameters.

The Shape group displayed the least inter rater reliability with four pulse qualities gaining $\geq 75\%$ tester agreement in only six subjects or less. These were Tight (4) subjects *Right Distal*, (6) *Left Distal*, (6) *Right Proximal Positions*; Slippery (5) subjects *Right Distal Position*; Choppy (1) subject *Left Middle*, (4) *Right Proximal Positions*; and Rough Vibration (5) subjects *Right Distal*, (6) *Left Distal Positions*. Reduced Volume also displayed lower reliability that was considered equivalent to the Shape group due to the comparably low number of subjects with $\geq 75\%$ agreement exhibited by three qualities; Reduced Substance (2) subjects *Right Middle*, (3) *Left Middle*, (4) *Left Proximal Positions*; Muffled (3) subjects *Right Middle*, (4) *Left Distal*, (5) *Right Proximal Positions*; and Deep (5) subjects *Left Proximal Position*.

Qi Wild exhibited two pulse qualities with $\geq 75\%$ agreement in only six or less subjects, Change of Amplitude (2) subjects *Left Distal*, (3) *Left Proximal*, (3) *Right Distal*, (3) *Right Middle*, (5) *Right Proximal Positions*; and Change of Quality (5) subjects *Right*

Proximal, (6) Left Proximal Positions. Change of Amplitude proved to be the least reliable quality for the pulse small segment as it demonstrated inter rater agreement outside the defined parameters in five of six principal positions.

Reliability of pulse qualities considered in terms of small segment positions (columns of Table 5-8), indicated the *Right Proximal Position* as having eight pulse qualities with $\geq 75\%$ agreement in six or less subjects, followed by the *Left Proximal Position* with five. The pulse quality with the least number of subjects showing $\geq 75\%$ agreement was Choppy (1) subject in the *Left Middle Position*. The kappa analysis (Table 5-6) corroborated these findings with the lowest inter rater reliability found in the *Left Middle Position* followed by the *Right Proximal Position* with average inter rater kappas of 0.49 and 0.52 respectively.

Large and Small Segments

When the inter rater data was considered via the rows of Table 5-8 five qualities showed lower comparable inter rater reliability across both the large and small segments of the pulse. Two qualities (Reduced Substance and Muffled) were constituents of the Reduced Volume classification; two (Slippery and Choppy) belonged to Shape; and one (Transient) to the Modifier group. Of these Reduced Substance demonstrated the least reliability with three categories and positions in both segments gaining only two to four subjects with $\geq 75\%$ inter rater agreement. It was also noted that Change of Amplitude met the analysis criteria within the pulse large segment.

Table 5-8 Inter rater reliability – number of subjects where at least 3 of 4 testers agreed

PULSE QUALITY/VARIABLE		LARGE SEGMENT PULSE CATEGORIES							SMALL SEGMENT PRINCIPAL POSITIONS						
Pulse Quality	Variable	FI	QD	BD	OD	OB	OO	No. Cat's <7 sub's ≥3 test's agree	LDP	LMP	LPP	RDP	RMP	RPP	No. Posn's <7 sub's ≥3 test's agree
Qi Wild															
Empty	1	14	xx	14	14	14	14	-	14	9	13	14	11	14	-
Change Quality	2	14	14	14	14	14	14	-	8	10	6	10	8	5	2
Change of Amp	3	8	xx	xx	xx	xx	xx	-	2	8	3	3	3	5	5
Unstable	4	xx	xx	xx	xx	xx	xx	-	14	14	14	14	14	14	-
Scattered	5	14	14	xx	xx	xx	xx	-	xx	xx	xx	xx	xx	xx	-
Minute	6	14	xx	14	xx	xx	xx	-	xx	xx	xx	xx	xx	xx	-
Leather Empty	7	14	14	xx	xx	xx	xx	-	xx	14	14	xx	14	14	-
		0 Qi Wild qual's ≥75% agree in <7 sub's							2 Qi Wild qual's ≥75% agree in <7 sub's						
Robust Volume															
HFO	10	xx	xx	xx	xx	xx	xx	-	14	13	14	14	14	14	-
Robust Pounding	11	12	13	14	12	11	11	-	10	8	9	12	7	5	1
Flooding Excess	12	xx	xx	xx	xx	xx	xx	-	13	9	14	14	13	14	-
Inflated	13	xx	xx	xx	xx	xx	xx	-	14	14	14	14	13	14	-
		0 Rob Vol qual's ≥75% agree in <7 sub's							1 Rob Vol quality ≥75% agree in <7 sub's						
Reduced Volume															
(QD) Yielding	14	14	14	14	14	14	14	-	14	14	14	14	13	14	-
(QD) Diminished	15	14	6	14	14	14	14	1	14	14	8	14	13	9	-
(QD) Feeble	16	14	13	14	14	14	14	-	xx	14	14	xx	14	14	-
Reduced Substance	18	8	14	13	3	3	3	3	13	3	4	14	2	7	3
Reduced Pounding	19	14	14	14	14	14	14	-	13	12	14	14	11	13	-
Diffuse	20	10	14	14	12	13	13	-	14	11	14	14	14	14	-
Deep	21	14	xx	xx	14	14	14	-	14	14	5	14	11	10	1
(Feeble) Absent	22	14	13	14	14	14	14	-	13	12	9	12	14	11	-
Flat	23	xx	xx	xx	xx	xx	xx	-	14	14	14	14	14	14	-
Suppressed Pounding	24	xx	xx	xx	14	11	11	-	xx	xx	xx	xx	xx	xx	-
Muffled	25	2	14	14	14	14	14	1	4	8	8	8	3	5	3
Dead	26	xx	xx	xx	xx	xx	xx	-	14	14	14	14	14	14	-
		3 Red Vol qual's ≥75% agree in <7 sub's							3 Red Vol qual's ≥75% agree in <7 sub's						
Depth															
Hollow	33	14	14	14	14	14	14	-	14	14	14	14	14	14	-
		0 Depth qual's ≥75% agree in <7 sub's							0 Depth qual's ≥75% agree in <7 sub's						
Width															
Thin	34	11	10	13	14	14	14	-	11	4	7	5	8	4	3
		0 Width qual's ≥75% agree in <7 sub's							1 Width qual's ≥75% agree in <7 sub's						
Shape															
Slippery	38	14	12	7	10	3	3	2	8	10	13	5	12	13	1
Taut	39	14	14	14	14	14	14	-	14	14	14	14	14	14	-
Tense	40	11	12	14	8	3	3	2	12	11	9	10	12	7	-
Tight	41	11	8	14	10	12	12	-	6	11	12	4	11	6	3
Wiry	42	13	14	14	14	14	14	-	14	14	14	14	14	12	-
Choppy	44	8	14	14	7	2	2	2	11	1	8	13	11	4	2
Smooth Vibration	45	8	5	14	14	14	14	1	10	14	14	11	11	14	-
Rough Vibration	46	8	14	14	14	14	14	-	6	12	14	5	8	14	2
Amorphous	49	13	14	14	14	14	14	-	xx	xx	xx	xx	xx	xx	-
Hard Leather	50	14	14	14	14	14	14	-	14	14	14	14	14	14	-
		4 Shape qual's ≥75% agree in <7 sub's							4 Shape quality ≥75% agree in <7 sub's						
Modifier															
Transient	54	9	13	14	5	6	7	-	12	10	6	7	6	6	3
		1 Modifier quality ≥75% agree in <7							1 Modifier quality ≥75% agree in <7 sub's						

FI	First Impressions	QD	Qi Depth	AQD	Above Qi Depth	BD	Blood Depth
OD	Organ Depth	O-B	Organ-Blood Depth	O-O	Organ-Organ Depth	xx	Quality not found in that position/category
LDP	Left Distal Posn.	LPP	Left Proximal Posn.	RMP	Right Middle Posn.		≥75% tester agreement in ≤ 6 subjects
LMP	Left Middle Posn.	RDP	Right Distal Posn.	RPP	Right Proximal Posn.		Less reliable qualities common to both

5.3.2 PULSE QUALITIES SPECIFIC TO PULSE CATEGORIES OR POSITIONS

5.3.2.1 LARGE SEGMENT




Intra and inter rater reliability of pulse qualities specific to the large segment are shown in Table 5-9. Of these the Flooding deficient waveform demonstrated the least reliability with 36 (<70%) intra rater test-retest agreements and only five subjects with $\geq 75\%$ inter rater agreement.

Although the pulse qualities that represented width at the blood depth all displayed $\geq 70\%$ intra rater agreement, inter rater agreement where three or more of the four testers agreed ($\geq 75\%$) was found in only five subjects in both the *Blood Heat* and *Blood Thick* categories.

When cross-referenced with the large segment kappa analysis Table 5-5 it was found that the Waveform and Blood Depth categories both shared the lowest inter rater reliability with average kappas of 0.49. It was further noted that these categories showed considerable disparity between intra and inter rater reliability by concurrently exhibiting average intra rater kappas of 0.78 (excellent agreement) and 0.73 (good to moderate agreement) respectively.

Table 5-9 Intra and inter rater reliability for large segment pulse qualities

		INTRA RATER		INTER RATER	
Pulse Category/Quality	Variable	No. Test-retest agreements	No. Qual's with <70% agreement	No. Subjects where ≥3 testers agreed	No. Qual's <7 sub's with ≥3 testers agreed
Anomalies					
Fan Quan/San Yin	57	47	-	9	-
Ganglion	58	56	-	14	-
Local Trauma	59	56	-	14	-
		0 Anomalous qualities <70% agreement		0 Anomalous qualities ≥75% agree in <7 sub's	
Waveform					
Hollow Full Overflowing	10	55	-	12	-
Flooding Excess	12	53	-	11	-
Normal	60	56	-	14	-
Flooding Deficient	61	36	1	6	1
Hesitant	62	41	-	8	-
Suppressed	63	54	-	12	-
		1 Waveform <70% agreement		1 Waveform ≥75% agree in <7 sub's	
Rhythm					
Rate Change at Rest	64	44	-	10	-
Intermittent	65	56	-	14	-
Interrupted	66	56	-	14	-
Normal	67	46	-	10	-
		0 Rhythm qualities <70% agreement		0 Rhythm qualities ≥75% agree in <7 sub's	
Blood Depth Width					
Blood Unclear	68	56	-	14	-
Blood Heat	69	44	-	5	1
Blood thick	70	47	-	5	1
		0 Blood Width qualities <70% agreement		2 Blood Width qualities ≥75% agree in <7 sub's	
Above Qi Depth					
Floating Tight	27	55	-	13	-
Floating Tense	28	56	-	14	-
Floating Yielding	29	56	-	14	-
Floating Smooth Vibration	30	47	-	9	-
Floating Slippery	31	56	-	14	-
Cotton	32	53	-	14	-
		0 Above Qi qualities <70% agreement		1 Above Qi quality ≥75% agree in <7 sub's	

 Intra rater test-retest agreements <70% (40)
 ≥75% inter rater agreement in ≤ 6 subjects
 Lesser intra and inter rater reliability

5.3.2.2 SMALL SEGMENT

Intra and inter rater reliability of pulse qualities specific to the small segment are shown in Table 5-10. It was found that intra rater agreement was ≥70% (≥39 test-retest matches) for all qualities in all the relevant positions. Similarly, inter rater

reliability demonstrated $\geq 75\%$ (agreement of at least three of the four testers) in \geq seven subjects for all qualities in the appropriate positions.

Table 5-10 Intra and inter rater reliability for small segment pulse qualities

		INTRA RATER		INTER RATER	
Pulse Position and Quality	Variable	No. Test-retest agreements	No. Qual's with <70% agreement	No. Subjects where ≥ 3 testers agreed	No. Qual's <7 sub's with ≥ 3 testers agreed
Large Intestine					
Biting	47	54	-	12	-
Small Intestine					
Biting	47	54	-	13	-
Left Neuropsychological					
Doughy	48	41	-	8	-
Right Neuropsychological					
Doughy	48	40	-	7	-
Diaphragm					
Inflation Equal	74	50	-	9	-
Inflation Left>Right	75	50	-	9	-
Inflation Right>Left	76	50	-	14	-
		0 Pulse qualities <70 % agreement		0 Pulse qualities $\geq 75\%$ agreement in <7 sub's	

Combined Complementary Positions

The Combined Complementary Positions was identified by the kappa analysis as having significantly lesser intra rater reliability than the other small segment pulse positions and poor (Jelles F, Van Bennekom CAM et al. 1995) or unacceptable inter rater reliability with an average inter rater kappa = 0.34 (Table 5-6, Figure 5-1).

On closer examination of the components of the *Combined Complementary Positions* (Table 5-11) it was found that intra rater reliability of the *Pleura* demonstrated the least reliability with 38 test-retest matches, falling just short of 70% agreement. In addition, inter rater disagreement was skewed to two component positions. Again the *Pleura*, and also the *Esophagus Position* displayed $\geq 75\%$ (agreement of three or more testers) in only four and three subjects respectively, indicating these positions were to

a certain extent responsible for the poor reliability of the *Combined Complementary Positions* category.

It was further noted that these positions are both included as part of the assessment of the right diaphragm and therefore determined rating of the *Diaphragm Position*. When these results were cross-referenced with the small segment kappa analysis (Table 5-6) it was found that the *Diaphragm Position* showed an average intra rater kappa of 0.70, however, it concurrently demonstrated the next lowest inter rater reliability behind the *Combined Complementary Positions* with an average inter rater kappa = 0.46. This suggested the *Pleura* and *Esophagus Position* might have been implicated in the lower inter rater agreement of the *Diaphragm Position*.

Table 5-11 Intra and inter rater reliability for the *Combined Complementary Positions*

		INTRA RATER		INTER RATER	
Associated Principal Position Component Complementary Posn.	Variable	No. Test-retest agreements	No. Posn's with <70% agreement	No. Subjects where ≥3 testers agreed	No. Posn's <7 sub's with ≥3 testers agreed
Heart (Left Distal Posn.)					
	Pericardium	77	54	-	14
	Large Vessel	78	56	-	14
	Heart Enlarged	79	41	-	9
		0 Heart Comp. Posn's <70% agreement		0 Heart Comp. Posn's ≥75% agreement in <7 sub's	
Lung (Right Distal Posn.)					
	Pleura	80	38	1	4
		1 Lung Comp. Posn. <70% agreement		1 Lung Comp. Posn. ≥75% agree in <7 sub's	
Liver (Left Middle Posn.)					
	Distal Liver Engorged	81	47	-	7
	Radial Liver Engorged	82	46	-	7
	Ulnar Liver Engorged	83	40	-	8
		0 Liver Comp. Posn's <70% agreement		0 Liver Comp. Posn's ≥75% agree in <7 sub's	
Stomach/Spleen (Right Middle Posn.)					
	Esophagus	84	42	-	3
	Special Spleen	85	44	-	9
	Pancreas/Peritoneal Cavity	86	54	-	13
	Duodenum	87	55	-	14
		0 Stomach/Spleen Comp. Posn's <70% agreement		1 Stomach/Spleen Comp. Posn. ≥75% agree in <7 sub's	

 Intra rater test-retest agreements <70% (39)
 ≥75% inter rater agreement in ≤ 6 subjects

5.3.3 SUMMARY OF FINDINGS FOR RELIABILITY OF PULSE QUALITIES

Analysis of the case summaries showed less reliable pulse qualities occurred most frequently in the *Organ-Blood* and *Organ-Organ Depths* of the pulse large segment. Muffled, Choppy and Reduced Substance showed less comparable intra and/or inter reliability across both segments, while Change of Amplitude displayed the most occurrences of problematic reliability for the small segment. In terms of pulse quality classification, Reduced Volume consistently exhibited the greatest number of qualities with intra and inter rater reliability less than the defined agreement parameters.

With respect to pulse qualities specific to certain pulse categories/positions reduced inter rater agreement was exhibited by the Flooding deficient, Blood Heat and Blood Thick qualities. These findings suggested a possible correlation to the comparable disparity of average intra and inter rater kappas demonstrated by the categories *Waveform* and *Blood Depth*. Similarly the low reliability exhibited by the *Pleura* and *Esophagus Positions* may have significantly contributed to the unacceptable or poor inter rater agreement found in the *Combined Complementary Positions*.

Chapter 6

6 DISCUSSION

This is the first time a major study has been undertaken to rigorously test the reliability of an established, operationally defined system of pulse diagnosis such as CCPD to assess the radial artery of subjects. The design defined by the findings of earlier studies, included 14 subjects who had 34 different pulse attributes assessed and re-assessed by four consistent testers. The tester responses generated a vast amount of statistical data that was analysed, and further cross-referenced for thorough evaluation. The moderate to excellent levels of agreement demonstrated within and between testers for 33 of 34 pulse attributes appraised, substantiated that with stringent procedural conditions and comparable tester skill, the results of pulse diagnosis as implemented in a clinical situation can be reliable.

6.1 RELIABILITY OF PULSE RATES

The results for the rate variables demonstrated that differences existed between the subjects' *Beginning Rate*, *End Rate*, *Exertion Rate* and *Rate Change with Exertion*. Of course variance of these rates would be expected within a sample population, however of more importance is that each of the testers were able to detect these rate differences within acceptable margins. The fact that no significant difference was found between testers for any of the rate variables confirmed that testers counting pulse rates timed by a clock was indeed reliable.

6.2 THE KAPPA COEFFICIENT

6.2.1 USE OF KAPPA

The kappa coefficient usually compares the opinions of two raters regarding the incidence of a characteristic within a sample population. Each must nominate a dichotomous response about that characteristic, where one response discounts the other. In this study however, the pulse qualities were not mutually exclusive and selection of multiple qualities was possible for each category/position. Typical analysis of the data would have involved calculating kappa values for each pulse quality at every category/position, resulting in innumerable calculations. As a result the qualities were construed as 'the population' and the testers rating of the pulse qualities as 'present' or 'absent', for the mutually exclusive alternatives.

Thus the study employed the kappa coefficient in a way that the calculations determined the level of agreement in terms of pulse quality matches for one pulse position in one subject. They were used as a descriptive measure, akin but superior to reporting percentage agreement, to identify pulse positions that seem to have reliable assessments, and those that appear to exhibit lower levels of reliability. The study did not use kappa as an inferential measure, generalize values to other pulse positions or subjects, test a hypothesis or explore sampling variation. Accordingly standard errors were not reported with the results.

6.2.2 REPORTING THE KAPPA VALUES

The statistical literature (Tooth LR and Ottenbacher KJ 2004) discusses concerns regarding the misinterpretation of kappa in studies reporting rater reliability. (Berk

RA 1979; Maclure M and Willett WC 1987; Suen HK 1988; Guggenmoos-Holzmam I 1996; Rigby A 2000) Intra rater reliability addresses the extent to which raters produce essentially the same score (Berk RA 1979; Ottenbacher K and Tomchek SD 1993; Portney LG and Watkins MP 2000) and represents an index of proportional consistency across raters or over time. (Suen HK 1988) Here lays the first caveat encountered with the application of kappa to the data. With test-retest measuring of intra rater reliability there will always be some degree of correlation or dependence between the responses from testers over time. (Thompson WD and Walter SD 1988; Sim J and Wright CC 2006) An attempt to validate the study design was made by reducing dependence (Sim J and Wright CC 2006) or allowing 28 days between ratings to reduce rater memory of the previous test (Sim J and Wright CC 2006) and optimise the parameters of stability (Altman DG 1991) defined by the female subjects' pulses.

Another caution that proved relevant to the study related was the reporting of mean or average kappa values and kappa ranges. (Tooth LR and Ottenbacher KJ 2004) The literature expresses some concern that these may disguise variability that might be important to the research. (Tooth LR and Ottenbacher KJ 2004) However in addition to these, the results also presented raw or individual kappa totals. The twofold descriptive application of kappa justified the method of reporting the results. Kappa averages and ranges were used as strategic markers to direct the discussion, and raw values established levels of agreement or reliability.

6.2.3 THE PARADOX OF PREVALENCE WITH THE KAPPA COEFFICIENT

Negative kappa values were intermittently observed in the individual kappa values and often appeared with a higher incidence in some of the subjects. Investigation of the statistical literature indicated that kappa scores <0.00 can reflect disagreement, but also paradoxes termed prevalence and bias. (Feinstein AR and Cicchetti DV 1990; Sim J and Wright CC 2006) Prevalence relates to the occurrence of a low kappa value appearing with a high percentage of agreement. (Tooth LR and Ottenbacher KJ 2004) It occurs when the incidence of a variable is very high or low, thus increasing the agreement expected by chance and decreasing the magnitude of kappa. (Dormer A and Klar N 1996) Prevalence proved to be a significant factor and influenced the data in many of the pulse categories/positions.

To help understand this paradox and decipher pure disagreement from the effect of prevalence, emphasis can be placed on the raw data by presenting the associated contingency tables (Brenan P and Silman A 1992) and the observed percentage agreement alongside the kappa value. (Hoehler FK 2000; Portney LG and Watkins MP 2000) For agreement to be acceptable, percentages should be $\geq 70\%$ when associated with a low kappa score (Stremmler SE 2004) or there be a minimum of 10 cases per cell to ensure that the kappa result is valid (Nelson LD and Cicchetti DV 1995).

The intra rater results for subject 13, reported as having the lowest intra rater reliability (page 85), illustrates the paradox of prevalence. *Waveform* and *Qi Depth* demonstrated the lowest reliability for that subject, thus the contingency tables for

tester 1 in these categories are presented in Figure 6-1 and Figure 6-2. Considering the cross tabulations and observed percentage agreement in conjunction with the kappa values provided more information to interpret the data.

Waveform (Figure 6-1) has a total of six possible variables. Kappa was calculated to negative 0.200, however, from the cross table we can see there was concurrence between d1 and d2 on the absence of four of the six pulse qualities giving 66.7% agreement. However, as agreement is <70% this case is considered unacceptable by the criteria outlined in the literature (Stremmler SE 2004) so reliability for *Waveform* t1d1*t1d2 must be considered poor or unacceptable.

Figure 6-1 Subject 13, *Waveform*, t1d1*t1d2: K = - 0.200 with 66.7 % agreement

Count				
		t1d2		Total
		1	2	
t1d1	1	4	1	5
	2	1	0	1
Total		5	1	6

		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Measure of Agreement	Kappa	-.200	.139	-.490	.624
N of Valid Cases		6			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Qi Depth (Figure 6-2) has 29 possible qualities or variables. Kappa computed to negative 0.074, but the cross table showed agreement on the absence of 25 of the 29 qualities giving 86.2% agreement. As agreement was ≥70% we can attribute the negative kappa to the effect of prevalence (Stremmler SE 2004) and establish *Qi Depth* t1d1*t1d2 reliability as acceptable.

Figure 6-2 Subject 13, *Qi Depth*, t1d1*t1d2: K = - 0.074 with 86.2% agreement

t1d1 * t1d2 Crosstabulation					
Count		t1d2			
		1	2	Total	
t1d1	1	25	2	27	
	2	2	0	2	
Total		27	2	29	

Symmetric Measures					
		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Measure of Agreement	Kappa	-.074	.037	-.399	.690
N of Valid Cases		29			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

As prevalence was a significant factor for the study, its effect on the calculations could not be ignored. The reason being a high percentage agreement together with a low kappa value implies the interpretation of kappa is actually more ambiguous than the guidelines originally put forward by Landis and Koch (1977) might suggest. (Morris R, MacNeela P et al. 2008) As a result simply accepting the kappa scores stated in this study at face value means accepting intra and/or inter rater reliability may have been lower than was actually the case.

6.2.4 INTERPRETATION OF KAPPA VALUES

In determining the strength of kappa there are no fixed rules or absolutes (Devane D 2005) and the kappa values used to interpret the data in the study (Jelles F, Van Bennekom CAM et al. 1995) were simply a guide. Statistics cannot replace clinical judgements (Thompson WD and Walter SD 1988) so interpretation depends on the circumstances and variables being tested. (Devane D 2005) The current pulse diagnosis literature has no recommendations regarding kappa, however several

authors suggest values ≤ 0.40 may be unacceptable in clinical situations. (Devane D 2005; Sim J and Wright CC 2006)

As the results of pulse assessments are an integral part of formulating diagnoses and plans of treatment, the kappa values that judge the reliability of the tool should be accordingly stringent. The rating of moderate to good agreement (kappa 0.41–0.74) recommended by (Jelles F, Van Bennekom CAM et al. 1995) is too large for the purposes of patient management and further differentiation is warranted. Therefore the findings of this study suggest that kappa values ≤ 0.40 poor or unacceptable agreement, 0.41 to 0.59 moderate agreement, 0.60 to 0.74 good agreement and kappa ≥ 0.75 excellent agreement, are more appropriate indicators with respect to pulse diagnosis.

6.3 RELIABILITY ACCORDING TO THE KAPPA ANALYSIS

Prior to discussing rater reliability, the ambiguity of kappa values due prevalence must be re-emphasised. Low kappa scores not only represent pure disagreement but may also correspond to a situation where there is increased agreement expected by chance, thus decreasing the value of kappa. It was beyond the scope of the research to determine how many of approximately 3000 raw kappas ≤ 0.40 actually showed acceptable agreement by also reporting their percentage agreement. Therefore it must be kept in mind that the stated kappa values may indicate a situation of lesser agreement than reality, as they do not include corrections for prevalence.

Based on the values proposed by the study and not allowing for prevalence, intra rater reliability proved to be excellent (kappa ≥ 0.75) in 43.2%, good (kappa 0.60–0.74) in 23.8%, moderate in (kappa 0.41–0.59) in 18.7% and poor or unacceptable (kappa ≤ 0.40) in 14.3% of the raw kappa scores. Inter rater agreement was excellent (kappa ≥ 0.75) in 23.5%, good (kappa 0.60–0.74) in 20.6%, moderate (0.41–0.59) in 25.4% and poor or unacceptable (≤ 0.40) in 30.5% of the individual calculations. (See Table 6-1)

Table 6-1 Agreement due to proposed kappa ranges for pulse diagnosis

	Agreement			
Entire Pulse	Excellent Kappa ≥ 0.75	Good Kappa 0.60 – 0.74	Moderate Kappa 0.41 – 0.59	Poor Kappa ≤ 0.40
Intra rater (1680 kappas)	43.2% (726)	23.8% (399)	18.7% (314)	14.3% (241)
Inter rater (10 080 kappas)	23.5% (2366)	20.6% (2076)	25.4% (2566)	30.5% (3072)
Large Segment				
Intra rater (616 of 1680)	56.5% (348)	15.6% (96)	14.8% (91)	13.1 % (81)
Inter rater (3696 of 10 080)	36.6% (1351)	16.2% (599)	20.2% (746)	27% (1000)
Small Segment				
Intra rater (1064 of 1680)	35.5% (378)	28.6% (304)	20.9% (222)	15% (160)
Inter rater (6384 of 10 080)	15.9% (1015)	23.1% (1477)	28.5% (1820)	32.5% (2072)

When these results were amalgamated they demonstrated good to excellent agreement for a large proportion of the raw kappa calculations (67% of intra rater and 44.1 % of inter rater). This established that using CCPD the testers were able to reliably detect similar pulse patterns on the same subject on different occasions, substantiating the findings of Cole (1977) and Craddock (1997). Further, such large proportions of good to excellent kappas indicated CCPD overall to be dependable, and confirmed the previous finding that good reliability is possible when the system of pulse diagnosis is operationally defined. (King E, Cobbin D et al. 2002; King E, Walsh S et al. 2006)

The fact that inter rater reliability was generally lower than that of intra rater reliability indicated the testers tended to agree with themselves more often than they did with others. This suggested an inherently subjective aspect existed within CCPD where testers agreed with their own judgements when rating pulses in the same subjects, but disagreed with the assessment of others. This further validated the suggestion of Cole that each tester perceived their own gestalt in the pulses of subjects that influenced their decisions and what they recorded. (Cole P 1977)

6.3.1 VARIANCE OF INTRA AND INTER RATER RELIABILITY

Where intra rater kappa values were <0.60 (moderate to poor), tester and subject were both implicated. Lower levels of reliability demonstrated in one tester (average intra rater kappa 0.52 remaining testers all ≥ 0.62) may have resulted from varied experience (Gorelick MH and Yen K 2006) affecting how decisions are made in the face of uncertainty. Another consideration however, was that two of the four subjects assessed by that tester showed the lowest averaged intra rater kappas of all subjects and may have influenced the results.

Variability of the 30.5% (3072) poor or unacceptable inter rater calculations (kappa ≤ 0.40) was found to be negligible according to the combination of testers and/or days. The distribution of inter rater disagreement however, was yet again skewed in terms of subject as well as pulse category or position. These findings suggested variability was intrinsic to the pulses of some subjects, but also existed in several of the pulse categories or positions. This warranted further discussion.

6.3.1.1 VARIANCE IN RELIABILITY DUE TO SUBJECT

Variability in both intra rater and inter rater reliability was found to be concentrated in three subjects, all exhibiting uncommon negative (Rae G 1988; Portney LG and Watkins MP 2000) individual kappa values. Despite no correction of the kappa values for prevalence, disagreement was clearly skewed to three subjects. Further examination of the raw data revealed all testers recorded a *Fan Quan* or *San Yin* pulse quality for each of these subjects.

Pulses that are in a constant state of flux may represent either the *Fan Quan* or *San Yin* pulse quality, or the *Qi Wild* condition. (Hammer L 2005¹) In the first instance blood shunted between an anomalous divergent vessel and the true radial artery results in varying sensations where the pulse is palpated. It affects all pulse positions, and depending on the degree of irregularity, may render the pulse exam invalid. (Hammer L 2005¹) In the absence of anomaly, pulses with no fixed characteristic other than the change itself are thought to represent a situation of extreme deficiency and vulnerability to disease (the *Qi Wild* condition). (Hammer L 2005¹) In both situations lower levels of intra rater and inter rater agreement could be expected due to the constant fluctuation in pulse qualities.

6.3.1.2 VARIANCE DUE TO PULSE CATEGORY OR POSITION

In comparison to other pulse categories/positions the results for the *Combined Complementary Positions* indisputably exhibited lower levels of intra, and unacceptable inter rater reliability despite no allowance for prevalence. (Figure 5-1) This category incorporated eleven complementary positions that are indicated on the CCPD pulse form as being present or absent and rarely have specific pulse

qualities recorded for them. These complementary positions are found in relation to a principal (main) pulse position and represent yang organs or areas of the body. The sensations felt at these positions are often transient and difficult to access (Hammer L 2005¹) which may have influenced agreement, however repeated kappas ≤ 0.40 (poor agreement) indicate other factors were most probably implicated.

The results for the constituents of the *Combined Complementary Positions* (Table 5-11) reported the *Pleura* as the only component position to have <70% intra rater agreement, and the *Esophagus* and *Pleura Positions* as demonstrating only three and four subjects where inter rater agreement achieved $\geq 75\%$. Both these positions were assessed to judge the *Diaphragm Position*, which was also established by the kappa analysis (Table 5-6) to have the next least inter rater reliability behind the *Combined Complementary Positions*. These results supported the findings of previous studies, (Cole P 1977; Kass R 1990; Craddock D 1997; Walsh S, Cobbin D et al. 2001; King E, Cobbin D et al. 2002) and suggested variance existed within the technique of the testers. This was possibly a result of continued ambiguity existing within the CCPD terminology or unclear instructions for accessing these positions.

Of the 13 complementary positions, kappa analysis (Table 5-6) showed the *Diaphragm* to have the second highest intra rater reliability (average intra rater kappa 0.70) but the second lowest average inter rater agreement (average inter rater kappa 0.46). Similarly the *Combined Complementary Positions* demonstrated moderate intra rater but unacceptable inter rater reliability (average inter rater kappa 0.34). The trends within these positions (inter rater significantly less than

intra rater reliability) suggest the phenomenon of the testers agreeing with their own assessments but disagreeing with those of others (Cole P 1977) may actually be accentuated in the face of imprecise operational definitions.

This finding suggested rather than testers recording “what they expected to feel in subjects’ pulses,” (Cole P 1977) when the terminology or descriptions are less meticulous, increased variance due to tester gestalt results from each tester interpreting descriptions differently. Each individual thus develops their own technique resulting from poor or vague instructions, increasing the margin for error due to rater subjectivity. Even though the same tester may be able to reproduce the same responses reliably, by comparison, agreement between testers is reduced as each interprets the information differently. Therefore accurate and precise CCPD terminologies are crucial to regulate tester comprehension to counter this effect and control for subjective variance in implementing the technique.

6.4 RELIABILITY ACCORDING TO ANALYSIS OF PULSE QUALITIES

Investigation of the case summaries for pulse qualities common to both segments (Table 5-7 and Table 5-8) identified several points worthy of discussion. Prior to discussing these it must be emphasised that this portion of the analysis was strictly comparative. Pulse qualities were compared to each other by percentage agreement and not judged to possess either acceptable or unacceptable reliability via a numeric scale. Although some visible trends emerged, the interaction of several factors made it difficult to rate reliability, so that even those qualities that appeared to be less dependable than others could not be definitively classified as unreliable.

In comparison to other qualities Reduced Substance, Muffled (both constituents of the Reduced Volume group) and Choppy (classified with Shape) demonstrated reduced intra and inter rater reliability. Each of these qualities concurrently displayed both large and small segment pulse categories/positions with <39 (<70%) intra rater test-retest matches, and six or less subjects with $\geq 75\%$ inter rater agreement. Of these Choppy demonstrated the least intra rater reliability (<70% in three large and two small segment categories/positions) while Reduced Substance was the least reliable for inter rater (three categories/positions in both segments gaining only two to four subjects with $\geq 75\%$ rater agreement). These findings indicated these pulse qualities were less reliable than others, but did other factors also influence the results?

Large segment intra and inter rater reliability showed consistent findings with the least reliable qualities being Muffled in the *First Impressions*, and Choppy and Reduced substance in the *Organ-Blood* and in the *Organ-Organ Depths*. Although correlation was not quite as defined for the small segment, Reduced Substance displayed problematic intra and inter rater reliability in the *Right Middle Position*. The fact reduced intra and inter rater reliability for these qualities was repeated in the same categories/positions indicated the reliability of the categories/positions themselves may have influenced the results for these pulse qualities.

Combined these findings suggested the reliability of individual qualities was not clearly defined and was in fact dependent on several complicated factors. Agreement within and between testers identifying the presence or absence of individual pulse qualities was in part decided by the quality itself, but was also a

function of which category/position it was found in, and what classification or grouping the quality belonged to. The complexity of these issues will be elaborated.

6.4.1 RELIABILITY OF PULSE QUALITY AND LOCATION

The tendency for some qualities to be less reliable in the *First Impressions*, *Organ-Blood*, *Organ-Organ Depths* and to a lesser extent the *Right Middle Position* was further explored by review of the kappa analysis. *First Impressions* exhibited excellent intra (average kappa 0.75) and good inter rater reliability (average kappa 0.65) so the fact Muffled showed the least intra and inter rater reliability within this category indicated that without doubt the quality itself was problematic. This finding was corroborated by the most reliable small segment position, *Left Distal Position* (average intra rater kappa 0.74, inter rater 0.64), where Muffled gained only 35 intra rater test-retest agreements and four subjects with $\geq 75\%$ inter rater reliability, indicating the issue was perhaps with the quality itself.

On the other hand low reliability for Choppy and Reduced Substance in the *Organ-Blood* and *Organ-Organ depths* was tempered by the fact these were also the least reliable of the large segment categories. Despite this they still exhibited good intra rater (average kappas 0.63) and moderate inter rater reliability (average kappas 0.53 and 0.52) further obfuscating the interpretation of reliability for these qualities.

For additional clarification, the results for the pulse category with the highest reliability were thus considered. *First Impressions* showed Reduced Substance met all criteria of analysis and Choppy fulfilled inter rater reliability, however intra rater

narrowly missed the selection criteria with 37 test-retest agreements (or just <70%). As kappa analysis revealed excellent intra rater reliability for *First Impressions* (average kappa 0.75) the Choppy quality proved slightly less reliable than Reduced Substance, however both were clearly more reliable than Muffled.

Similarly Reduced Substance in the *Right Middle Position* demonstrated the least intra and second least inter rater reliability for the small segment, however the average kappas for this position showed good intra (0.65) and moderate inter rater reliability (0.54). Further the *Right Middle Position* showed three other pulse qualities with intra and inter rater reliability less than the parameters of analysis, as was also the case for other small segment positions. Therefore the lower reliability of Reduced Substance could not be attributed to the quality alone and was interpreted as less significant.

Further validation of this finding was established by cross-referencing the reliability of Reduced Substance in the principal position that achieved the highest average kappas. The *Left Distal Position* confirmed Reduced Substance as reliable with 51 intra rater test-retest agreements and 13 subjects where inter rater agreement was $\geq 75\%$. This suggested the finding of lower comparable reliability for Reduced Substance was less significant than that for the Choppy quality.

6.4.2 RELIABILITY OF PULSE QUALITY DUE TO COMPLEXITY

Of qualities common to both large and small segments Muffled, Choppy and Reduced Substance exhibited the least comparative intra and inter rater reliability

across the most categories/positions. Additional qualities also proved to be less reliable than others but were confined to specific portions of the pulse examination.

In the small segment (Table 5-7 and Table 5-8) Change of Amplitude showed less reliability than the parameters of analysis for intra rater in two, and inter rater reliability in five of six positions; the *Waveform* Flooding Deficient (Table 5-9) exhibited both reduced intra and inter rater reliability; and qualities relating to the *Blood Depth*, Blood Heat and Blood Thick (Table 5-9) while showing good intra rater reliability showed only five subjects each where inter rater agreement was $\geq 75\%$.

In the case of Blood Heat and Blood Thick the phenomenon of testers agreeing with their own decisions but disagreeing with those of others, (Cole P 1977) or high intra with disproportionately low inter rater reliability, was again seen. This supports the previously discussed suggestion that in the face of uncertainty, resulting from vague or imprecise descriptions for discerning the pulse quality, the testers developed varying techniques and comprehensions for these qualities that while consistent individually differed from that of other testers.

The pulse qualities demonstrated by the results to have less comparable reliability were Muffled, Choppy, Reduced Substance, Change of Amplitude, Flooding Deficient, Blood Heat and Blood Thick. The CCPD definitions for each of these pulse qualities are quite complex and have a number of significant descriptive aspects that were relevant for their sensory differentiation. In making their decision regarding the presence or absence of these qualities in the appropriate pulse categories and

positions, the testers would have considered each of these characteristics prior to making their final judgement. Therefore the contemplation of multiple defining traits might have increased the difficulty of the decisions made and influenced the reliability of these pulse qualities accordingly.

For example Reduced Substance is described as feeling less 'buoyant, elastic and resilient' than the normal pulse and is 'likened to a sweater whose cloth is becoming threadbare'. (Hammer L 2005¹) Similarly the sensations of Change of Amplitude, Blood Heat, Blood Thick, Flooding Deficient, Muffled and Choppy all require the consideration of several or more descriptive attributes. In contrast to this, other pulse qualities are more simplistic containing only one or two determining traits in their sensory description and thus presentation to the fingertips.

Take for example Robust Pounding and Reduced Pounding, two qualities that showed greater comparable reliability than those listed above. By comparison these qualities presented the testers with a seemingly easy decision, either the impulse struck their fingers with force/vigour (Robust pounding) or without force/vigour (Reduced Pounding).

These findings support the suggestions of earlier authors that intra and inter rater agreement is related to the complexity of a pulse quality. (Kass R 1990; Craddock D 1997; King E, Cobbin D et al. 2002) However the results also established that other qualities (such as Hollow Full-Overflowing, Flooding Excess and Inflated – see Appendix 6) despite possessing equally complex descriptions, demonstrated better reliability than those discussed above. This suggested the complexity of definitions

of pulse quality sensation, although important, was not the only factor responsible for determining their reliability.

6.4.3 RELIABILITY OF PULSE QUALITY DUE TO CLASSIFICATION

The Shape grouping showed one pulse quality in the large and small segment to have less intra rater (Table 5-7), and four qualities in both large and small segment to have less inter rater reliability (Table 5-8) than the parameters for analysis. The individual qualities however, were either not consistent or lay just outside the limit of 70% intra rater, and six or less subjects with $\geq 75\%$ inter rater agreement. On the other hand Reduced Volume demonstrated two qualities in the large and small segments to have less than specified intra rater and three qualities in both segments to have less inter rater reliability. Two of those, Muffled and Reduced Substance were repeated in all instances.

Further to this, Flooding Deficient was also identified by the case summary analysis to have lesser comparable reliability. Therefore nearly half of those indicated as exhibiting less comparable reliable were constituents of the Reduced Volume category. This classification represents qi and yang deficiency and includes the pulse qualities 'whose impulse and wave lack intensity and force' (Hammer L 2005¹), that is, they are weaker than the Robust Volume qualities that strike the finger with more force, strength and vigour. In cases of extreme yang deficiency the impulse at the radial artery can be very weak and difficult to detect, or even completely absent.

In subjects or pulse categories/positions where the impulse possessed more power and strength, the testers perhaps had more sensory information on which to base their decisions regarding the presence or absence of individual qualities. On the other hand, when a sensation was barely perceptible, it stands to reason reduced or lack of afferent tactile information confronted the testers with more uncertainty, resulting in less reliability for this group of pulse qualities.

6.5 RELIABILITY OF THE LARGE AND SMALL PULSE SEGMENTS

There was a tendency for greater reliability in the large versus small segment of the pulse that was consistent across all methods of analysing the data. Average kappas for the large and small segments showed good intra rater agreement (0.74 and 0.65 respectively), and moderate inter rater reliability (0.59 and 0.51). Interpretation of these values indicated acceptable agreement, however it was evident large segment values were approximately 0.10 units higher. Review of the individual kappas confirmed this finding where good to excellent agreement ($\kappa \geq 0.60$) for the large segment was obtained in 72.1% of intra and 52.8% of inter rater; and for the small segment in 64.1% of intra and 39% of inter rater calculations. (Table 6-1)

Similarly, the results for the analysis of pulse qualities replicated this pattern. The large segment exhibited three qualities with reduced intra and eight with reduced inter rater reliability (Table 5-7), compared with the small segment that showed seven and twelve respectively (Table 5-8). Additionally Change of Amplitude, the quality that exhibited the least inter rater reliability within the small segment, proved to be considerably more reliable in large segment. Together these data

demonstrated the large segment of the pulse as being more dependable, and displaying less problematic qualities, compared with that of the small segment.

Testers assessed large segment categories using their index, middle and ring fingers of both hands at the same time (Figure 4-2) while small segment positions were assessed using only one finger (Figure 4-3). The trend of greater reliability found within the large segment of the pulse suggested bilateral palpation of the subjects' wrists improved the reliability of testers' ratings. This was most likely a result of the increased surface area provided by three fingers contacting the arterial pulsations and additionally, the palpation of both wrists simultaneously. Combined these factors might have made more sensory information available to the cognitive processes on which the testers based their judgements.

Within CCPD the large segment or broad focus of the pulse, includes the rate categories, rhythm, first impressions, uniform qualities on the sides, also the Qi, Blood, and Organ depths. It is thought to provide important insight into cardiovascular function and as well as an overall indication of the body's substances and the presence/absence of pathogens. For these reasons information obtained from this segment takes precedence when interpreting the pulse evaluation. The results demonstrating bilateral palpation methods as more dependable further support the validity of this preferential organisation within the CCPD framework.

6.5.1 RELIABILITY OF THE INDIVIDUAL POSITIONS

The principal and complementary positions (with exception of those discussed as components of the *Combined Complementary Positions*) demonstrated similar levels of reliability. Both showed good intra rater reliability (principal position average kappa 0.71, complementary position average kappa 0.63) and moderate inter rater agreement (principal position average kappa 0.56, complementary position average kappa 0.49).

Within the principal positions consistent good intra rater reliability (average kappas between 0.60 and 0.74) was established for the distal, middle and proximal positions. Inter rater agreement was good for the distal (average kappa 0.61) and moderate for both the middle (average kappa 0.52) and proximal (average kappa 0.55) positions. This indicated the distal positions were ever so slightly more reliable than the proximal and middle positions. These differences however were minor and more significantly, the values of the kappa scores confirmed that single finger palpation techniques consistently showed less reliability (or lower average kappa scores) than those that engaged the use of both hands.

Chapter 7

7 IMPLICATIONS OF THE STUDY

This study has shown without doubt that under controlled circumstances pulse diagnosis can provide reliable diagnostic information. When pulse systems are operationally defined (as with CCPD) and those who implement the tool interpret all definitions in the same way, and exactly replicate the procedural methods with every clinical application, acceptable levels of intra and inter rater agreement can be demonstrated. Further the results of this study were even more significant as the effect of prevalence and the ambiguous nature of the kappa coefficient were not taken into account, thus the outcomes may have been in reality more favourable than reported in Chapter 5.

The trend of greater intra rater versus inter rater reliability (intra rater kappas generally higher than inter rater kappas) established consistently across different methods of analysis, support the suggestion of earlier authors that testers can agree with their own decision but not necessarily with those of others. This implies when practitioners assess patient pulses a portion of the procedure remains subjective, or what some within the field describe as 'intuitive'.

Some pulse positions, the *Diaphragm* for example, demonstrated very high intra rater reliability and disproportionally low inter rater agreement. This suggested the proportion of subjectivity involved in testers judgements was amplified when the

terminology used was less conclusive. This factor appears to be countered however by the operational definitions of the system. Precise language and decisive descriptions for both pulse positions and pulse qualities reduce the influence of subjectivity on raters' decisions, and therefore control for variance of this nature.

Across the methods of analysis, for rates, pulse categories, positions and qualities, the large segment of the pulse consistently proved to be more reliable than the small segment. Although the majority of unilateral palpation methods (small segment) still exhibited acceptable levels of agreement, these results clearly demonstrated bilateral palpation techniques (large segment) as more dependable. From a clinical stand point this suggests pulse systems that incorporate the use of both hands, or all six fingers, at the same time could provide the practitioner with more reliable information than those that only use one finger methods.

The study established the reliability of individual pulse qualities as a rather complicated issue that depended on several factors. Although previous authors discussed the complexity of the quality description as the primary determinant of reliability, the results revealed other considerations were equally relevant. The location of the quality significantly influenced tester agreement, demonstrated by the different reliability of Reduced Substance and Choppy found in *First Impressions* compared to *Organ-Blood* and *Organ-Organ Depths*, further three qualities that demonstrated lesser comparable reliability were classified as Reduced Volume, or those that strike the finger with less force and strength. This suggests offsetting the deficit in tactile information with even more explicit descriptions may ensure the clinical dependability of these types of pulse qualities.

Poor or unacceptable inter rater reliability exhibited by the *Combined Complementary Positions* largely related to the *Pleura* and *Esophagus Positions* and accounted for the comparably low inter rater reliability for the *Diaphragm Position*. This indicated variance did exist within the techniques of the testers and suggested the terminology or language used within the CCPD descriptions for these positions might need revision. If variance continues, then the reliability of these positions within a clinical context needs to be re-evaluated entirely. Additionally the pulse qualities Muffled, Change of Amplitude, Blood Heat, Blood Thick and perhaps Flooding Deficient, although not shown to be unreliable, had markedly lower inter rater reliability suggesting the definitions for these qualities may also need some modification.

It is essential to continue investigation of the subjective diagnostic techniques used in Oriental medicine such as pulse diagnosis with accepted scientific methods of analysis. Although the results of this study have answered many of the questions regarding the reliability of CCPD, there are many other pulse systems used today that provide the practitioner with diagnostic information relevant to the theories of their specific traditions. Whether for example, it is the Kampo or Toyohari traditions of Japan or those that belong to the medical practices of Korea, if currently used to help diagnose patients, future research should probe the integrity of such procedures.

Although favourable reliability for CCPD was established, the validity of using information obtained from the pulse to assist in formulating diagnoses within the

CCPD and larger theoretical framework of Chinese medicine remains questionable. Particularly the claim common to all traditions that specific predictable changes occur in pulse qualities and positions in the presence of dysfunction or disease, and that these are detectable via manual palpation remains unsubstantiated. Future studies should therefore investigate the capacity of the radial pulse to accurately indicate the physiological state of the individual within the relevant theoretical paradigms. This would address the issue of validity, or whether or not Oriental medicine practitioners should use pulse diagnosis as a tool to collect diagnostic information from their patients.

Further to this, many more questions remain unanswered regarding the way in which pulse data is actually integrated with other diagnostic information, or, the methods of clinical reasoning used by practitioners to identify diagnoses. These strategies that vary amongst traditions, are critical to the decision-making process and directly determine treatment plans and therefore patient management. Despite this, to date no study has attempted to investigate any methods of clinical reasoning existing within the practice of Oriental medicine. Future studies should therefore assess the reliability and validity of those that are currently used by practitioners to establish patient diagnoses.

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Appendices

1 APPENDIX: PULSE DIAGNOSIS THROUGH HISTORY

1.1 ANCIENT EGYPTIANS

Many concepts surviving in modern cardiovascular medicine may be traced to the practices of ancient Egypt.¹ The enduring influence of this civilization has resulted largely from their expertise of preserving or the art of embalming the human body in order to preserve it for eternity encased inside the mummy. Similarly preservation of contemporary theories was made possible by their discovery of papyrus.² The innovation of the written word initiated the prolific historical writings that followed across many cultures.

Within their anatomical model the Egyptians perceived the heart as the biological engine of the body, the seat of intelligence and also responsible for human emotions and desire.¹ As it was believed to be the body's most essential organ, it was held as equally important to both the living and the dead.² Consequently the heart was the only internal organ that was embalmed with the body and entombed with the mummy.²

Due to the crucial importance of the heart, diagnosis by way of pulse became prominent to the medicine of this civilization. The ancient Egyptians established that peripheral pulses reflected beating of the heart.³ They believed the vessels [metu] were filled with air [vitality], mixed with blood and water, and that the pulse of the vessels reflected the beating of the heart.⁴ Palpation of the pulse was therefore viewed as the sole "window" into the heart³ and referred to as "the messenger that never fails."⁵

Several significant papyri named for their discoverers describe the importance of the heart and cardiovascular system to the ancient Egyptians. The Edwin Smith

Papyrus (c. 1600 BC although the contents can be traced as far back as 3000 BC)^{1,6} and the Ebers Papyrus (c. 1555 BC)¹ form the oldest archive of medical knowledge existing today¹ and in parts describe palpating the pulse relevant to the methods of diagnosis and treatment used within the medical model of ancient Egypt.

The information contained in these early papyri suggests the principals of ancient Egyptian medicine were entwined with mythology and mysticism. Despite this these physicians were very skilled in observation, history taking, physical examination, and clinical diagnosis.⁶ The importance of the cardiovascular system is evident. As the heart was thought to record a lifetime of good and evil acts, it was believed its weight at the time of judgement determined the eternal course for the owner – that of salvation or damnation.¹ The concept that the pulse was the method by which one could examine the heart preceded by many years the use of this clinical skill by Greek physicians of the third century in Alexandria.⁶

1.2 ANCIENT GREECE

The role of Egyptian medicine in the development of the scientific foundations of Greek medicine is significant.⁶ After defeating Persia in the third century BC, Alexander the Great, founded the city of Alexandria, which was to become the medical and intellectual capital of the ancient Mediterranean world.^{1,7}

4TH CENTURY BCE WRITERS: PLATO, ARISTOTLE AND HIPPOCRATES

The natural Greek philosophers such as Plato and Aristotle had a keen sense of empiricism. They contemplated physical phenomena and utilised explanatory principals to detail their observations. They believed everything on earth had a purpose and was derived from intermixtures of four elements – water, fire, air and earth.⁸

This principal of efficiency and simplicity guided biological science and their notion that Nature would never allow a body part to exist that had no function. Plato stated that there was three parts to the soul (spiritedness, desire and wisdom) and like wise three principal organs in the body (the brain, the heart, and the liver). Aristotle

was the first to describe the pulsation of blood vessels and suggested a connection with the heart even though the venous and arterial systems were not differentiated until the next generation.⁹

Hippocrates and the Hippocratic writers sought to create general biomedical 'laws' that could explain why someone was sick. They devised the doctrine of the four humours by corresponding elemental theory to the human body. Accordingly blood was perceived as hot and moist (air), phlegm as cold and moist (water), yellow bile as hot and dry (fire), and black bile as cold and dry (earth). Health resulted from a balance of these humours, while disease was a manifestation of imbalance. They also suggested a preponderance in individuals towards one humour (sanguine, phlegmatic, choleric, or melancholy).⁴

While the Hippocratic writers had an appreciation of the empirical circumstances surrounding illness and formulated a way to approach diagnosis and prognosis in order to prescribe treatment,⁸ none actually practiced the art of pulse diagnosis. The first Greek thought to adopt the skill is Praxagoras, a disciple of Hippocrates, from the Island of Kos.¹⁰

LATER WRITERS: PRAXAGORAS, HEROPHILUS, AND ERASISTRATUS

It is believed Praxagoras was born around 330 BC and is recognised as the first to distinguish arteries from veins.¹¹ He observed that the arteries were multi layered and due to this he deduced an arterial specialization of carrying pneuma [breath] while the simpler veins carried blood [nourishment].⁸ He also insisted that although the heart dilates and contracts, the arteries ability to pulsate was completely autonomous or independent of the heart.⁹

Erasistratus (304 BC – 250 BC) shared many tenets with Praxagoras; two separate vascular systems (arteries carried pneuma, veins blood or nourishment),¹² and that the construction of the heart reflected this.¹² He described the left side as a pneuma

pump sending the vital substance into the arteries and believed that this was the cause of the pulse.⁸

Erasistratus established a link between arrhythmias and mental health issues and thus became one of the first to use pulse examination in clinical diagnosis.¹³ History records that the King Seleucus I, one of Alexander's commanders, married a young and beautiful princess. Soon after the marriage the king's son was taken ill. The king's physician Erasistratus was called, and after discovering that the young prince's pulse quickened when Staromice entered the room, he diagnosed love-sickness. The physician persuaded the king to divorce his wife so that his son could marry the object of his love thereby curing his illness.⁴

Herophilus (335 – 280 BC) was a pupil of Praxagoras. He repeats the assertion of his teacher by declaring the layers of the arteries to be six times as thick as the veins therefore recognising a complicated physical construction of the artery.⁸ Herophilus describes the pulse of the arteries as consisting of systole and diastole and reasserts the relationship of the heart and arteries. He believed the power allowing them to dilate and contract flowed from the heart through the arterial layers or coats.⁹

Herophilus developed an elaborate classification of different pulse types based on age and particular pulse characteristics. Based on rhythms he described a theory of four stages in the development of human pulse (infancy, adolescence, adulthood, old age).⁹ He also acknowledged that pulses differed in volume, size, speed, strength, and rhythm and categorised them according to these parameters.⁹ Herophilus described abnormal pulses such as the 'gazelle-like' pulse, the 'ant-like' pulse and the 'quivering pulse' that he associated with pathophysiological conditions.⁹

GALEN

Claudius Galenus, commonly known as Galen, was born in 130 AD.¹² After receiving medical training in Smyrna and Alexandria, he gained fame as a surgeon to the

gladiators of Pergamos.¹³ In treating their injuries Galen was able to investigate internal anatomical structure thus furthering anatomical knowledge of the day.¹³

After his fame was established Galen became the physician to Emperor Marcus Aurelius in Rome.¹³ During this time he authored more than 500 treatises¹² several of which he devoted to the development of his theory on pulse-lore.¹⁰ Galen's prolific writings on his medical thinking went on to influence the accepted knowledge of the time and the practice of medicine for the next fifteen centuries.¹³

Probably Galen's most important contribution to medical science is proof (via his experiments on cannulation) that the arteries contain blood. Galen gave the arteries the role of carrying blood, carrying pneuma, and engaging in the pulse.⁸ He believed the heart endowed blood with pneuma and this 'vital blood' flowed through the arteries to carry the 'vital spirits'. 'Nutritive blood' on the other hand was made by the liver and carried through the veins providing nutrition or energy to all the organs of body. Galen also described interventricular 'pits' or 'pores' that allowed blood to travel through the dividing septum of the heart and thus pneuma (spiritual essence) to pass into that part of the bloodstream.¹²

In keeping with the Hippocratic writers Galen held that an imbalance in the four humours (blood, yellow bile, black bile and phlegm) was the cause of pathology and eventual morbidity.⁸ His meticulously study of pulse responses to a variety of different stimuli such as sleep, exercise, exposure to heat or cold and taking different nutrients¹³ gave a collection of diagnostic and prognostic indications for the ancient physician. He also distinguished pulse types that he correlated with emotional states. In anger he noted the pulse to be deep, large, vigorous, quick, and frequent. Accompanying grief was a pulse small, slow, faint, and sparse. In sudden violent cases of fear, it is quick, tremulous, irregular, and uneven. When fear has been present for a long time he described the pulse to be similar to that of someone with grief.¹⁴

Based on these observations he analysed different pulse types according to four variables: (i) magnitude as measured along the length, breadth, and depth of the

artery; (ii) speed of alternating diastole and systole; (iii) frequency, or ratio of pulses to intervals; and (iv) regularity versus irregularity.¹⁵ He also differentiated the coating of the arteries which made the pulse either hard or soft.¹³ Galen believed each of these variables conveyed specific information about the state of the vital spirit's functioning and the body's struggle with disease¹⁵ and that it was possible for the physician to detect different pulse combinations by touch.¹³ Obviously Galen assumed a long and painstaking process was necessary to acquire the skill of accuracy or sensitivity of touch to diagnose from the pulse.¹³

As Galen's anatomical studies and theories were the most advanced for many generations, his model came to be held as sacrosanct and ultimately became an obstacle to progress. For 1500 years, no one challenged the medical doctrine of Galen's concepts. Although Ibn-an-Nafis, a 13th century Arab physician, seems to have been the first to question Galen's contention that the interventricular septum contained pores^{12,16} it was not until 1628 that William Harvey definitively proved they did not exist finally.

1.3 GRECO – PERSIAN (UNANI)

There is little information available on when the art of pulse diagnosis reached the physicians of Persia. They were most probably incorporating pulse reading into their clinical technique during the seventh century when much of Galen's work was translated into Arabic at Jundi-Shapur.¹⁷ However, as the Arab tradition borrows from many medical systems particularly the Greek, Chinese and Ayurvedic, it is thought that they may have been practicing the skill even earlier due to their exposure to these cultures through their prolific trade on the Silk Route.¹⁰

The most famous of the Greco-Persian physicians was Ibn Sina known as Avicenna to the West. He was born in Asia Minor in 980 AD and is recognised for his contributions to medicine through his life-work, *Al-Qanun f'it Tibb* (the Canon of Medicine) completed in 1025.¹⁸ The Canon is divided into five volumes or books and is viewed as linking ancient Greek, Chinese and modern medicine. Many consider Ibn Sina to be Galen's successor and until the seventeenth century his five

volume Canon was adopted as the standard medical text in both the Arab world and Europe.⁴

The first volume of Ibn Sina's Canon contains generalities concerning the human body, sickness, health and general treatment and therapeutics. He considered the pulse to be a major part of the clinical exam and often led the way to diagnosis. Accordingly a large chapter in the first volume is dedicated to the teaching of the pulse.¹⁰

The theories of Ibn Sina's medicine were based on the medical principals of ancient Greek . In particular he cites, criticises and compares his teachings with that of the Greek physician Galen.¹⁰ Like the Greek physicians Ibn Sina builds his medicine on the doctrine of elements and humours. His view of blood and circulation also followed that of the Greeks. Blood was produced in the liver and transported through the inferior vena cava to the right side of the heart where it was circulated to provide the organs and tissues with nutrients. The veins were believed to carry the nutrients because of the darker blood that they carried. Arterial blood was lighter and warmer than the venous blood as it was endowed with 'celestial and luminous breath.'¹⁰ This breath was stored in the left side of the heart and circulated via the arteries. The veins and the right side of the heart and the arteries and the left side of the heart were thought of as separate systems with no connections in-between.¹⁰

Ibn Sina based clinical examination upon investigation of the pulse, urine and stools and sometimes palpation of the abdomen. He comprehensively describes the pulse, and records the effects of a variety of conditions on the pulse such as the environment, food, drink, age, exercise, pregnancy, sleep and waking, pain, temperament, and various emotional states such as anger, pleasure, joy, grief and fear.⁴

Often the diagnosis and treatment would depend on the pulse of the patient. Accordingly a complete pulse examination could take as long as three hours to perform.¹⁹ He emphasised the wrist as the ideal location for taking the pulse and

advocated the importance of the concentration, calm demeanour and tranquil posture of the physician. This suggests Ibn Sina was aware of Chinese concepts on the pulse incorporating traditional Chinese and ancient classic medical views.¹³

Ibn Sina detailed a special technique for feeling the pulse and identified ten features to be assessed.^{1**} He distinguished more than fifty pulse types and described two kinds of irregular pulses, regularly irregular or irregularly irregular, and that the differences between these might be difficult to appreciate.¹⁰

By the time Arab civilization began its decline during the thirteenth century, the teachings of Ibn Sina had already reached Europe through eleventh century Latin translations of his medical Canon.⁴ There they were studied for 600 years or more²⁰ laying the foundations for the eventual discovery of circulation and the invention of the sphygmograph, a mechanical device for the study of the pulse.⁴ The extent of the influence of Ibn Sina's pulse theory is also evidenced by its role in shaping Ayurvedic medicine which to this day practices thorough palpation of the pulse.²¹

1.4 INDIAN (AYURVEDA)

The chronology of Ayurvedic texts is not easy to trace and difficult to date exactly. The earliest were written sometime during the first millennium BC, however it is believed that the knowledge of Ayurveda may date as early as 2300 BC.²² In the early classics Sushruta (c. 1000 - 100 BC), Vagbhata (c. 100 BC) and the other treatises such as the Bhel Samhita (c. 1000 - 100 BC) and Hareet Samhita (c. 1000 - 100 BC) there was little mention of the topic of pulse diagnosis.²² The exception to this can be found in Charaka (c. 1000 - 100 BC), in the Indriyasthan, where it is stated that cessation of pulsation of ever pulsating Manya, or the carotid artery, is indicative of death.²³ It was not until the fourteenth century AD, an important time in the development of Ayurveda, that Sharnagadhara introduced pulse

^{1**} [1] Amount of diastole estimated in length, breadth and thickness, if all were decreased, the pulse was defined as small; if all were increased, the pulse was known as large. [2] Quality of impact imparted to the finger of the observer at each beat. [3] Duration of cycle or of time occupied in each movement. [4] Consistence of the artery. [5] Emptiness or fullness of the vessel between the beats. [6] The feel - whether hot or cold. [7] Duration of time occupied by pauses between two successive beats. [8] Equality or inequality of force of successive beats. [9] Regularity or irregularity; orderliness or disorderliness. [10] Metre, Rhythm, Harmony.

assessment into the medical paradigm. From this time the knowledge has evolved and flourished.²²

Since the fourteenth century the skill of pulse diagnosis has been practiced and preserved by the generations of Brahmin physicians who were by birthright the only caste allowed the privilege of medical education in ancient India.¹¹ Although modern Ayurvedic practitioners extend beyond India's caste system, the tradition that was handed down remains an important part of Ayurvedic assessment today. Even in this era of advanced science and technology people seeking Ayurveda expect diagnosis to include palpation of the pulse.²³

The model of Ayurveda perceives all things in the universe as being composed of five elements space, air, fire, water and earth. Within the body these five elements coalesce to form three fundamental biological energies or doshas. Space and air become the dosha vata, fire and water become pitta and water and earth form kapha. Vata is the lightest and most mobile of the doshas and is responsible for all kinds of biological movement. Pitta being the only dosha that contains fire is primarily concerned with digestion and the transformation of substances within the body. Kapha is the heaviest of the bioenergies and brings solidity and stability to the body and mind.²⁴ These three energies are seen as controlling all physiological functions within the human body.²⁴

As the doshas influence the cycle of life and direct the interactions of all bodily functions they are seen as responsible for the regulation of health. Balance of the three doshas is required for optimum health while disease is viewed as a result of an imbalance of the activities of these doshas.²⁵ This imbalance results from unhealthy lifestyles, exposure to physical, biological and chemical agents, extreme weather conditions, over exertion from mental or physical activities or a combination of these factors.

The manifestations of the three doshas are perceived to move in the blood. The general constitution of a person and the balance of the doshas can be felt at the radial artery under the combined index, middle and ring fingers. To assess the

details of the doshas, however each is palpated with an individual finger. The qualities of vata are felt with the index fingers, pitta with the middle fingers and kapha with the ring fingers.²⁶

Although not well explained by the texts, there are seven levels to the pulse in Ayurvedic medicine. Depending on the technique studied and practiced by the physician the seven levels give information about the state of each subtype of the doshas, the status of prana (the life giving force) and the body tissues.²⁶ For the most accurate pulse reading some advocate palpating the right hand in men and the left hand in women. Others maintain that both sides must be felt to obtain all the necessary information to diagnose balance of the doshas.²⁶ Some Ayurvedic physicians may also take pulse readings from other arteries. These include the brachial artery on the inside of the arm above the elbow, the carotid artery at the base of the neck, the femoral artery that travels down the inside of the leg, and pulse points at the temples, at the ankles, and on the top of the feet.²⁷

Although the pulse is viewed as providing important information, Ayurvedic physicians use other diagnostic tools in conjunction with pulse analysis to diagnose their patients. These include interviewing the patient and closely observing the physical characteristics of the tongue, voice, skin, eyes, appearance, urine, and stool, in addition to utilizing conventional diagnostic methods.²⁷

1.5 MAYAN

The traditional medical system of the Maya people relies on the human senses as the primary resource for diagnostics. Surviving for generations, pulse diagnosis is still practiced today among some of Belize's diminishing population of traditional healers. The skill does however appear to be disappearing as the methods of current Maya healers appear to be less developed than that of the previous generation who used it extensively as a diagnostic tool, therapeutic tool, and as a means for tracking patients' progress.²⁸

The difficulty of thoroughly investigating the use of pulse within Maya medicine is that very little information has been recorded on the topic. Despite this, one significant difference that comes to light specific to this medicine is the use of the pulse therapeutically.²⁸ As part of treatment, the physician would recite prayers 'into' the pulse as it was believed to be a direct path to the persons' blood or 'essence of their being.'²⁹ Nine prayers, a sacred number to the Mayans,⁴³ were said for each ailment, three starting at the right wrist, then the left wrist followed by three with the physician's hand held above the forehead of the patient.²⁸

Diagnosis in the traditional Mayan medical model as practiced in Belize is based on several factors. The healers determine if the patient's affliction is due to physical or spiritual causes,³⁰ a loss of the body's thermal equilibrium resulting from a rapid change in external or internal body temperature, or the influence of winds which merge both the physical and spiritual worlds.²⁸ The pulse is palpated to identify the source of the illness so the physician can employ either spiritual or physical intervention or a combination of both.

Within the traditional Maya medical system, twenty eight pulse types have been identified some of which appear to be similar in description and interpretation to those found in Chinese medicine.²⁸ Others that are indicative of 'mal vientos' or bad winds have no Chinese medical equivalent. Throughout the course of treatment the Maya physician continues to closely track the pulse of the patient and on later subsequent visits to identify if the malady has been cured or returned.

1.6 CHINA

Indisputable and voluminous textual evidence from China proves that the circulation of blood was an established medical theory by the second century BC. For this hypothesis to have been fully elaborated and developed by this time it stands to reason that information gained from the pulse was used diagnostically in China about two thousand years before it was in the West.¹³ In actuality it could be claimed that the art of sphygmology probably originated in China, where palpation of the pulse was known as early as the 6th century BC.³¹

Several monumental classic texts (Nei Jing, Nan Jing, Mai Jing and Bin Hue Mai Xue) contain vast amounts of information regarding the use of pulse diagnosis to diagnose illness. The first and probably most influential was *The Yellow Emperor's Classic of Internal Medicine* or the *Neijing*, one of Chinese medicine's foremost classical texts. It is generally attributed to a period 300-100 BC, but is thought to represent medical knowledge from several sources and lineages that existed prior the Han dynasty (206 BC – 220 AD); the 'Naturalists' and the 'Gentlemen with Recipes' developed through the Spring and Autumn (770 – 476 BC) and Warring States (475 – 221 BC) periods,³² the Han dynasty *Mawangdui Manuscripts* that included a scroll titled the 'vessels texts',³³ and the Han writings of Sima Qian (145-86 BC) who chronicled the life of the Warring States physician, Chun Yu-Yi.³² The *Neijing* incorporates two distinct books the *Suwen* and the *Lingshu*. Book five of the *Suwen* or 'Simple Questions' deals entirely with the importance of the pulse, how and when to perform an assessment, and the meaning of some basic qualities in terms of health and disease. Chapter 10 of the *Lingshu* contains parts of the 'vessels texts' from the *Mawangdui Manuscripts*.³³

Chinese medical theory perceived each of the major organ systems to be represented at the radial artery, therefore the ancient Chinese physician could diagnose relevant pathological factors within the organs by integrating information from the pulse with those of other diagnostic investigations such as observation, auscultation and history of the patient's illness. Treatment was applied according to the diagnosis.

As the practice of Chinese medicine proliferated and reached neighbouring civilizations these cultures adopted and evolved the medicine according to their specific ethnic models. As such we see different methods of pulse diagnosis developing in Korea, Japan and Vietnam. Some of these systems of pulse diagnosis survive in the medicine as it is practiced today. In fact it is believed that a pulse tradition surviving in Vietnam may be a major influence on Contemporary Chinese Pulse Diagnosis™ (CCPD), the topic of this research.

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2 APPENDIX: RECRUITING SUBJECTS

Investigating the reliability of Contemporary Chinese Pulse Diagnosis™ as a diagnostic tool in Oriental medicine

Initial testing for research investigating the reliability of Contemporary Chinese Pulse Diagnosis™ will be conducted at Dragon Rises College of Oriental Medicine.

As indicated through out the Oriental medicine program at DRCOM, people who are experienced with Contemporary Chinese Pulse Diagnosis™ assume the information gathered through palpating the pulse at the radial artery is a dependable clinical indicator of the patient's condition. To date this has not been proved or disproved by any type of evidence-based research. Recent studies have shown that when the system used to evaluate the pulse is consistent, statistically significant levels of agreement within testers (intra - rater) and between testers (inter - rater) can be obtained. This indicates the information gained during the pulse evaluation can be a reliable indicator of the patient's condition and a useful tool in the diagnostic process.

Specifically, the study aims to assess the reliability of the Shen-Hammer system of pulse diagnosis. 15 volunteers are required to conduct this research. 4 pulse testers will evaluate the radial pulse of 15 subjects on two separate occasions. Volunteers will be required to commit approximately 3 1/2 hours of their time on 2 days, 28 days apart, in early 2007.

The pulse testers testing Contemporary Chinese Pulse Diagnosis™ in this research study are: Dr. Leon Hammer, Brandt Stickley, Laisha Canner, Hamilton Rott, Jamin Nichols, Karen Bilton.

Volunteers are needed so this study can be organized and conducted in the indicted time frame. As students and supporters of DRCOM it is hoped that you will see the benefit of this research to investigate the primary diagnostic method of the school.

If you are interested in being a subject in this research please contact Laisha Canner at DRCOM (352) 371 2833 and register your name as soon as possible.

3 APPENDIX: HEALTH QUESTIONNAIRE

Investigating the reliability of Contemporary Chinese Pulse Diagnosis™ as a diagnostic tool in Oriental medicine

Project Directors: Karen Bilton, L.Ac., P.T., Leon Hammer, M.D., Sean Walsh Ph.D.

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Pulse Testers: Karen Bilton, L.Ac., P.T., Laisha Canner, A.P., Leon Hammer, M.D., Jamin Nichols, A.P., Brandt Stickley, A.P., Hamilton Rott A.P.

Please answer the following questions:

Do you have any illnesses that are currently being treated by allopathic or Oriental medicine?
If yes please list.

Are you currently taking any medications?
If yes please list.

Has the dose of any of these changed since the first round of data collection?
If yes please list.

Are you currently taking any Chinese herbal medicines?
If yes please list.

Have these remained consistent since the first round of data collection?
If no please list changes.

Do you currently have any acute illnesses such as a respiratory cold or influenza or intestinal flu?
If yes please describe.

Have you received acupuncture in the last 3 days?

**You will be contacted by Laisha Canner regarding the results of your pulse evaluation.
Thank you for your participation in this study.**

4 APPENDIX: INFORMATION AND CONSENT FORM

Investigating the reliability and validity of Contemporary Chinese Pulse Diagnosis™ as a diagnostic tool in Oriental medicine

Project Directors: Karen Bilton, L.Ac., P.T., Leon Hammer, M.D., Sean Walsh Ph.D.

Project Coordinator: Karen Bilton (917) 202 2751

Pulse Testers: Karen Bilton, L.Ac., P.T., Laisha Canner, A.P., Leon Hammer, M.D., Jamin Nichols, A.P., Brandt Stickley, A.P., Hamilton Rott A.P.

Please read the following information:

- 1. The purpose of the project is to test the validity of using Contemporary Chinese Pulse Diagnosis™ as a diagnostic tool in Oriental medicine. The first step in reaching this goal is to measure the reliability of testers using this method of pulse diagnosis. This will be achieved by testers measuring the radial arterial pulse on the same volunteer subjects on two separate occasions.**
- 2. If you consent to participate, you will be involved in two phases of data collection. Both phases are identical and will involve having your radial artery measured by four pulse testers. Each phase should take about three and a half hours of your time.**
 - Upon signing an informed consent, you will select a day and time for both phases of data collection.
 - The phases of data collection will occur at exactly the same time of day, 28 days apart. This will reduce diurnal variance in the pulse, and replicate the menstrual cycles of female subjects.
 - All pulse assessments will be taken in the sitting position.
 - You may participate if you are routinely receiving Oriental medical treatment (acupuncture and herbal preparations), however, the herbal medicine must remain constant through both phases of data collection and acupuncture cannot be received for 3 days prior to each phase of testing.
 - You may participate if you are taking routine medication for a medical condition, however, the medication must remain constant for both phases of data collection.
 - You will be asked to refrain from stimulants of any nature – coffee, tea etc, and excessive exercise, excessive work, excessive food and sex for 12 hours prior to the exam.
 - You will be asked to report any acute illnesses prior to both phases of data collection.

- You will be asked to report any changes made by your doctor to the dose or type of any routine medications that you are taking. If any of these have changed between phases of data collection your results cannot be used in all intended parts of the study.
3. **There are no risks associated with participation in the phases of data collection.**
 4. **There are no direct benefits from participating in the study. If desired feedback will be provided to the study subjects regarding the pulse measurements that may contribute to a greater knowledge of their health.**
 5. **The results of both phases of data collection are strictly confidential. When the data are presented in the written report, you will not be linked to the data by your name, title, or any other identifying item. A subject number will be assigned to you and only that number will be used on pulse forms. All pulse forms will be filed in a locked cabinet in the investigator's office.**
 6. **Participation in this project is voluntary. You have the right to withdraw at any time. If you have any questions about your rights, or feel uncomfortable in any way, you may contact Karen Bilton at the number listed above.**
 7. **There is no compensation for participation in this study. Subjects can receive an evaluation of their health based on their individual pulse forms after the completion of both phases of data collection. At this time appropriate medical referrals will be offered if indicated.**

I am fully aware of the nature and extent of my participation in this project as stated above and the outcome arising from it. I hereby agree to participate in both phases of data collection for this project. I acknowledge that I have received a copy of this consent statement.

(Signature of subject or responsible agent)

(Date)

(Printed name of subject)

Karen Bilton(Project Coordinator)

5 APPENDIX: PULSE OR DATA COLLECTION FORM

Investigating the reliability of Contemporary Chinese Pulse Diagnosis													
Contemporary Chinese Pulse Record			Refer by:			Date:							
Name:		Gender:		Age:		Hgt:		Wgt:					
Rhythm:			Rate/Min:			B	End	W/Exert	Chng				
First Impressions of Uniform Qualities			Other Rates During Exam:										
Left Side:			Right Side:			<u>Depths</u> Above Qi: <input type="text"/> Qi: <input type="text"/> Blood: <input type="text"/> Organ: <input type="text"/> O-B: <input type="text"/> O-O: <input type="text"/> <u>Waveform</u> <input type="text"/>							
PRINCIPAL POSITIONS					COMPLEMENTARY POSITIONS								
L:		Distal Position		R:		L:		Neuro-psychological					
								R:					
								L:		Special Lung		R:	
										Pleura			
										<u>Heart</u>			
Pericardium						Mitral Valve:							
L:		Middle Position		R:		Enlarged		Large Vessel					
								L:		Diaphragm			
								R:					
								<u>Liver</u>					
								Liver Engorged:					
Distal		Radial		Ulnar		Gall Bladder:							
Spleen-Stomach		Esophagus		Spleen		Stomach-Pylorus Extension:							
L:		Proximal Position		R:		Peritoneal Cavity/Pancreas							
								Duodenum					
								Large		<u>Intestines</u>		Small	
								L:		<u>Pelvis/Lower Body</u>		R:	
								R:					
<u>Three Burners</u>					<u>Comments:</u>								
Upper:					- = Change (1 - 5) = low - high degree								
Middle:													
Lower:													

6 APPENDIX: VARIABLES INCLUDED IN THE STUDY

QI WILD

Empty – Variable 1

Sensation

The Empty quality is palpable on the pulse only at the qi depth. The pulse Separates or is Absent at the blood and organ depths.

Interpretation

This quality occurs in the yin stages of the six stages of disease, especially the lesser yin and terminal yin. Empty is usually a sign of advanced deficiency where operative contact between yin and yang has been lost, indicating potentially serious illness is imminent.

Change in quality – Variable 2

Sensation

Change of Quality occurs in two situations. Firstly, if there is a constant variation in the pulse qualities being felt under the fingers and it is difficult to nominate the enduring quality. Secondly, a sudden or abrupt change from very robust qualities to the Feeble or Absent quality.

Interpretation

Represents severe qi, blood, yin and yang deficiency, extreme imbalance and serious 'qi wild' where operative contact between yin and yang has been lost, indicating potentially serious illness is imminent.

Change in Amplitude – Variable 3

Sensation

With Change in Amplitude there is a change in the strength and amplitude of the each impulse.

Interpretation

Entire Pulse

On the whole pulse a Change in Amplitude signifies Heart qi or yang deficiency depending upon the accompanying qualities.

Principal Position

In a principal position it reflects moderate deficiency of qi, blood, and yang with a minor separation of yin and yang in the associated organ.

Complementary position

In a complementary position Change in Amplitude indicates impaired function in the associated organ or area.

Unstable – Variable 4

Sensation

The Unstable pulse rebounds off the finger tremulously and erratically, like a pulsating point that moves from one part of the finger to another with a quick, jerky, and constantly changing movement.

Interpretation

Unstable represents injury to qi, blood, yang and especially the parenchymal material of a yin organ.

Scattered – Variable 5

Sensation

Scattered is similar to the Empty quality in that it is found only at the qi depth. However, instead of feeling a continuous impulse when rolling the fingers distal to proximal position, it disperses into separate pieces, as if divided or broken into fragments.

Interpretation

The Scattered quality is one of the most serious Empty qualities, and indicates severe qi, blood, yin and yang deficiency. It is an extreme form of 'qi wild' and one of the traditional 'eight pulses of death.'

Minute – Variable 6

Sensation

The Minute quality is found at the blood depth, is extremely Thin and Feeble, shows little resistance to pressure and resembles the Scattered pulse in its lack of longitudinal continuity.

Interpretation

It signifies severe and extensive qi and yang deficiency in a seriously ill person and a more advanced 'Qi wild' than the Scattered quality in which there is not enough yang left to rise to the surface. It indicates impending death.

Leather – Variable 7

Sensation

Leather is similar to Empty in that it is palpable only at the qi depth except it feels much harder at the surface.

Interpretation

Leather represents a very serious or extreme deficiency of essence, yin, or blood with the separation of yin and yang and implications of serious illness.

Amplitude change side to side – Variable 8

Sensation

There is a Change of Amplitude palpated on one side while simultaneously, the Amplitude of the other side remains constant. Suddenly this situation reverses where the Change of Amplitude swaps sides with side of constant Amplitude. The Change of Amplitude side to side continues throughout the pulse examination.

Interpretation

Commonly indicates a current and ongoing severe inter-individual conflict. Less commonly it represents the recent and sudden onset of overwork or overexercise far beyond one's energy.

Qualities shifting side to side – Variable 9

Sensation

The overall qualities that appear with differentiation side to side suddenly or abruptly change sides e.g. diminished qualities left side with robust right side abruptly reverse to become robust qualities left side with diminished right side. The change continues throughout the pulse examination.

Interpretation

Depending on accompanying pulses qualities this situation either represents marked physiological or cardiovascular instability.

ROBUST VOLUME

Hollow Full-Overflowing – Variable 10

Sensation

The Hollow Full-Overflowing Wave has the formation of a normal sine wave beginning between the organ and blood depths and rising above the qi depth. It can

be distinguished from the Normal Wave in that it clearly rises above the qi depth with an expansive feeling under the fingers. The Hollow Full-Overflowing separates under pressure somewhere above the blood depth, and then regains its substance as one moves toward the organ depth. It can be found on the entire pulse or in an individual position.

Interpretation

The interpretation of the Hollow Full-Overflowing can be found on the entire pulse or in an individual position and depends on what other qualities are present. When found with the Tense quality it is a sign of excess heat in the blood, and when found with Tight a sign of chronic heat from deficiency in the blood.

Robust Pounding – Variable 11

Sensation

The impulse strikes the finger with force, is hard hitting and throbbing.

Interpretation

Robust Pounding is a sign of excess heat.

Flooding Excess – Variable 12

Sensation

The Flooding Excess Wave is felt as a strong sine wave originating at the organ depth, surging over the qi depth, then drops off precipitously as its apex hits the fingers. It can be found on the entire pulse or in an individual position.

Interpretation

The Flooding Excess waveform primarily indicates heat from excess usually associated with a significant infection when found on the entire pulse. When it is found in one position it indicates intense heat or fire or infection in that organ.

Inflated – Variable 13

Sensation

The Inflated quality feels like an inflated balloon, the sensation follows the finger as it is lifted, with a constant level of tension within the three depths and equal at all of them.

Interpretation

The Inflated quality reflects qi trapped in an organ or area.

REDUCED VOLUME

Yielding Qi Depth – Variable 14

Sensation

The qi depth is more pliable, or yielding than a Normal pulse on gentle pressure.

Interpretation

This is the earliest sign of qi deficiency.

Diminished Qi Depth – Variable 15

Sensation

The sensation at the qi depth is diminished or becoming weaker.

Interpretation

Represents mild qi deficiency.

Feeble Absent Qi Depth – Variable 16

Sensation

The qi depth is either Feeble or not present.

Interpretation

The qi depth Feeble Absent represents progressing qi deficiency from mild to moderate.

Spreading – Variable 17

Sensation

The qi depth is absent and the blood depth separates on pressure.

Interpretation

The process of losing qi has progressed to include qi and blood deficiency, indicating a condition of longer duration or some other reason for depletion of both vital substances.

Reduced Substance – Variable 18

Sensation

The Reduced Substance quality lacks substance, strength, elasticity, buoyancy and resilience when compared to the Normal pulse. The sensation is likened to a sweater whose cloth is becoming threadbare or akin to that of a cigarette from which some of the tobacco has been removed.

Interpretation

Moderate qi deficiency, the body is depleted of qi and blood.

Reduced Pounding – Variable 19

Sensation

The impulse beats against the finger without force, energy or vigour. It may at first give the impression of force commonly associated with more robust pounding, but it does not retain this strength.

Interpretation

It indicates advancing qi deficiency.

Diffuse – Variable 20

Sensation

The substance of the Diffuse quality has become so reduced that it lacks clearly defined borders and boundaries with the surrounding tissue.

Interpretation

Advancing qi deficiency and blood deficiency.

Deep – Variable 21

Sensation

In the Deep quality both the qi and blood depths Separate or are Absent.

Interpretation

The Deep quality represents advanced qi or yang deficiency.

Feeble Absent – Variable 22

Sensation

All depths are Separating or Absent.

Interpretation

Feeble Absent is indicative of severe qi deficiency with the blood and yin and yang all compromised.

Flat – Variable 23

Sensation

The Flat quality is found at the Organ depth; it is stifled and compressed, with a very small or even no wave.

Interpretation

The Flat quality reflects an energetic situation in which qi cannot penetrate into the organ.

Suppressed Pounding – Variable 24

Sensation

The Suppressed quality feels like the sine wave of the Normal pulse however the apex is cut off or flattened.

Interpretation

The Suppressed quality is more often a sign of anti-hypertensive medications or less commonly it can represent suppression of feelings.

Muffled – Variable 25

Sensation

The Muffled quality feels obscured as if the pulse is being felt through layers of cloth. The sensation is muted and unclear.

Interpretation

The Muffled quality indicates stagnation of all substances, neo-plastic activity, breakdown of cellular function.

Dead – Variable 26

Sensation

There is a sensation of presence and substance lacking in movement. It can be likened to touching a dead animal.

Interpretation

Though infrequently identified, it has always been associated with advanced, neoplastic malignancy.

DEPTH

Floating Qualities – Variables 27-31

The Floating quality is accessed in a very narrow range just below the skin, does not have a waveform and is not connected to other qualities deeper in the pulse, even if the other qualities come above the qi depth. The Floating pulse is found to be Tense, Tight, Slippery, Yielding or Smooth Vibration.

Floating Tight – Variable 27

Sensation

Floating and Tight.

Interpretation

Flaring of internal Liver wind.

Floating Tense – Variable 28

Sensation

Floating and Tense.

Interpretation

External stagnation of wei qi caused by wind-cold.

Floating Yielding – Variable 29

Sensation

Floating and Yielding.

Interpretation

External agitation of wei qi caused by wind-heat.

Floating Smooth Vibration – Variable 30

Sensation

Floating Smooth Vibration.

Interpretation

External deficiency and agitation of wei qi.

Floating Slippery – Variable 31

Sensation

Floating and Slippery.

Interpretation

This quality, also known as wind-water, is a sign of stagnation of qi (wind-cold) or agitation of qi (wind-heat), which interferes with the movement of fluids at the surface of the body, often presenting as hives.

Cotton – Variable 32

Sensation

The Cotton quality is spongy, amorphous structureless and increasingly resistant as gentle pressure is exerted from the surface to the depth other qualities on the pulse are first accessed.

Interpretation

The Cotton quality is a sign of superficial or wei qi stagnation and is associated with sadness and Lung qi deficiency and stagnation.

Hollow – Variable 33

Sensation

The Hollow pulse is felt clearly at the Qi depth. As pressure is increased to the blood depth, the pulse Separates or disappears completely until the organ depth is reached, where the pulse returns.

Interpretation

The Hollow quality is a sign of blood deficiency and is an indication that the blood vessel wall and the blood itself are not sufficiently in contact.

WIDTH (NARROW)

Thin – Variable 34

Sensation

The Thin quality is thinner than the Normal pulse but the resilience and flexibility remain unaltered. On palpation the Thin pulse does not feel harder or softer than the Normal pulse.

Interpretation

Alone the Thin pulse is a sign of blood deficiency. The Thin and Tight quality together suggest blood and yin deficiency, while the Thin and Yielding pulse suggests blood and qi deficiency.

LENGTH

Short – Variable 35

Sensation

The Short quality is only palpable at the Middle position, the Distal and Proximal positions are absent.

Interpretation

Short indicates Deficiency in the Upper and Lower Burners, and or stagnation in the Middle Burner.

Restricted – Variable 36

Sensation

The Restricted pulse, found in the Special Lung Position, is very short and feels constricted in length as well as width. It occupies a very small area.

Interpretation

Restricted is associated with severe qi stagnation and deficiency of the Lungs and indicates a fibrotic process occurring in the Lungs.

Long – Variable 37

Sensation

The Long quality feels elongated through and beyond the three principal positions.

Interpretation

It is a sign of robust body condition unless it is very Tense or has substantial Robust Pounding in which case it implies excess heat.

SHAPE (FLUID)

Slippery – Variable 38

Sensation

With the Slippery quality the pulse slides under the fingers, its movement flows in one direction only and is felt clearly under the centre of the finger. The sensation does not alter with a change in finger pressure.

Interpretation

Except in pregnancy, Dr. Shen regarded the Slippery quality as indicating a pattern of disharmony with impaired function. While it is often associated with excessive fluid, the physiological situation that it represents is complex and dependant on where the Slippery quality is found.

Entire pulse at all Depths

Depending on what accompanying pulse qualities the Slippery is appears with, if found at all depths it can indicate pregnancy, elevated blood lipids or glucose, blood

infection, Heart qi deficiency and shock to the circulation, hypertension, iatrogenic causes or blood dyscrasias or autoimmune diseases.

Qi Depth

Slipperiness alone at the qi depth indicates that the qi is deficient and less able to move fluids in the connective tissue; if the qi depth is Tense and Slippery it is often a sign of elevated blood glucose; while a transiently Slippery pulse at the qi depth is thought to be a sign of dampness in the protective level due to an external attack of wind.

Blood Depth

When found at the Blood depth Slippery is a sign of turbulence in the Blood and an indication that the conditions for the accumulation of arterial plaque (arterio-atherosclerosis) already exist. Slippery at the blood depth often accompanies pulse qualities described by Dr. Shen as 'blood unclear' (impure blood), 'blood heat,' or 'blood thick.' In Western terms, this would be perceived as various stages of toxicity or increasing blood viscosity.

Organ Depth

Slipperiness at the organ depth alone over the entire pulse is rare and is associated with severe systemic infection.

Individual Positions

When the Slippery quality is found at an individual position the general meaning is a damp condition in the organ represented by that location.

SHAPE (NON-FLUID - HARD EVEN)

Taut – Variable 39

Sensation

Taut has the resilience and flexibility of a very wide rubber band that has been moderately stretched, but has considerable give on pressure. Palpation demonstrates only slightly more tension than that of a normal pulse.

Interpretation

This quality represents the earliest sign and first stage of qi stagnation from causes other than shock. It is the mildest form of qi stagnation perceptible by pulse diagnosis in a person with a relatively good level of energy and of average constitution.

Tense [Tense-Tight] – Variable 40

Sensation

The rubber band described in connection with Taut is somewhat narrower with the Tense quality. It has less flexibility and resilience, and feels harder against one's fingers, though still more elastic than the Tight or Wiry qualities. Palpation demonstrates a perceptible increase in tension and hardness, and a discernable decrease in diameter in comparison to a normal pulse.

Interpretation

The Tense quality signifies increasing qi stagnation with the development of excess heat. The slight narrowing and hardening of the pulse (relative to the Taut quality) are signs of heat.

Tight [Tight-Tense] – Variable 41

Sensation

The Tight quality is harder, less resilient and flexible, and usually narrower than the Tense quality. Palpation demonstrates increasing tension and hardness, and decreasing diameter that is much differentiated from the normal pulse.

Interpretation

Entire Pulse and Principal Positions

In affluent modern societies the Tight quality is most commonly associated with heat from yin deficiency, however depending accompanying pulse qualities it can also be a sign of pain, trauma, infection, hyperactivity, and Cold.

Complementary Positions

In the complementary positions Tight suggests inflammation and irritation.

Wiry – Variable 42

Sensation

The Wiry quality literally feels like a metal wire. With the slightest pressure it feels thin, hard, and cutting to the touch. It is long and continuous, and does not move away with an increase in finger pressure. Palpation demonstrates extreme tension and hardness, and a tremendous decrease in diameter bearing no resemblance to the normal pulse.

Interpretation

The Wiry quality represents the final, extreme stage in the depletion of yin. It is a sign of extreme yin and essence deficiency.

Ropy – Variable 43

Sensation

When a pulse is Ropy it feels like a cord with the edges clearly delineated and as if one could lift the pulse away from the surrounding tissues. It is usually found on the whole pulse, and rarely only in the left middle position.

Interpretation

Hardening of the vessel walls due to heat vulcanising fluids or lack of fluid (Yin deficiency) nourishing the intima. It is associated with developing arteriosclerosis, sometimes preceded or accompanied by hypertension.

SHAPE (NON-FLUID - HARD UNEVEN)

Choppy – Variable 44

Sensation

The Choppy quality is rough to the touch and if one rolls the finger distal to proximal across the position, the sensation is uneven and grating, like rubbing it across a washboard. The degree of roughness varies with the position and the degree of associated stagnation.

Interpretation

The Choppy quality is a sign of serious pathology and depending on the accompanying qualities may represent blood stagnation in the tissues, toxicity, or inflammation.

Smooth Vibration – Variable 45

Sensation

Smooth Vibration is a very fine buzzing sensation under the finger. The terms trembling, tingling, reverberating, palpitating, shivering, wavering, quivering, vacillating, and oscillating are all useful synonyms.

Interpretation

Entire Pulse

Smooth Vibration on the entire pulse is usually a sign of worry or a tendency to worry, and less commonly a lack of sleep. The deeper, more consistent, and ubiquitous its appearance, the longer it has persisted and the more profound the worry.

Individual Position

Smooth Vibration is most commonly found by itself at the left distal position, the mitral valve and neuro-psychological positions where it is a sign of Heart qi agitation.

Rough Vibration – Variable 46

Sensation

With Rough Vibration the sensation under the fingers is that of a very coarse buzzing.

Interpretation

Entire Pulse

Rough Vibration over the entire pulse is a sign of severe emotional shock, or a physical shock with a strong emotional component. The deeper, more consistent, and rougher the Vibration, the more dangerous the condition it represents.

Individual Position

Rough Vibration at any individual position is a sign of parenchymal damage and serious physiological dysfunction.

SHAPE (MISCELLANEOUS)

Biting – Variable 47

Sensation

The Biting quality feels like a sharp nipping sensation at the finger pad.

Interpretation

Biting found exclusively at the Intestine positions is an extreme form of the Tight or Wiry qualities. It is a sign of abdominal discomfort, intestinal inflammation and pain.

Doughy – Variable 48

Sensation

Doughy is an ill-defined, undifferentiated impulse that is perhaps best described as an amorphous glob of clay, whose shape is never the same and whose volume varies from very faint to moderately robust.

Interpretation

It is the most common quality found in the Neuro-psychological positions. Dr. Shen identified the Doughy quality as a sign of Kidney yang essence (marrow) deficiency in association with chronic neurological disease such as multiple sclerosis.

Amorphous – Variable 49

Sensation

There is a total lack of definition to the pulse, and no distinct qualities from the first moment of access throughout the examination. The sensation is one of palpating very loose cotton throughout the radial pulse, and occurs only over the entire pulse.

Interpretation

The Amorphous quality is associated with the San Yin Mai and Fan Quan Mai. The amorphous quality can alternate with a full set of qualities, at which time it is thought the blood is shunted through the anomalous artery.

Hard-Leather – Variable 50

Sensation

The qi depth is very hard, like leather, to the touch. The other depths are intact, neither Hollow nor Empty, and there is no Floating above the qi depth.

Interpretation

The Hard-Leather quality is aligned with those indicating severe depletion of yin, blood, and essence and is thought to be associated with exposure to radiation.

Electrical – Variable 51

Sensation

The Electrical quality is akin to that of holding a live wire, and though not as powerful or continuous, it is very distinct.

Interpretation

The Electrical quality occurs at the Neuro-psychological position and represents some problem of neuro-propagation, indicating epilepsy in all of its forms, including grand mal, petit mal, or psychomotor.

Bean 'spinning' – Variable 52

Sensation

This quality is rare. It feels Tight, hard, short, and often like a hard object (such as a tiny bean) sticks out from and counter to the longitudinal flow of the rest of the pulse.

Interpretation

Clinically this quality is associated with profound emergent and traumatic events (pain, severe fright or terror, and physical trauma) always involving a profound disturbance to the physiology.

Split Vessel – Variable 53

Sensation

In the Split Vessel quality there is a medial component to the position and an addition lateral sensation that is not continuous with the medial or main portion of the position.

Interpretation

Split vessels are rare and mostly found at the middle or proximal positions. Clinically they are associated with any experience that arouses profound fear of the unknown. These include prospective death as with malignancy, many or significant losses among friends and family, and most importantly, contemplation of suicide.

MODIFIERS

Transient – Variable 54

Sensation

Transient refers to a quality that is fleeting, appearing and disappearing at a particular position throughout the examination.

Interpretation

The Transient quality modifies the meaning of the principal quality in the direction of a less disharmonious condition than when the same quality is more enduring at that position.

Separating – Variable 55

Sensation

On pressure, the pulse moves in two directions, both distally and proximally at the same time. Simultaneously there is no sensation felt directly under the pad of the finger.

Interpretation

This modifier helps define the sensation of the Empty, Hollow, and Spreading qualities. It is always associated with the early stages in the development of these qualities, and is independent of location.

Rough – Variable 56

Sensation

Rough is partially defined by its opposite, Smooth. It feels grating and uneven.

Interpretation

Rough indicates stagnation and agitation of qi.

ANOMALOUS

Fan Quan Mai/ San Yin Mai – Variable 57

Sensation

These qualities refer to the presence of a congenitally anomalous branch of the brachial artery that can often be palpated on the dorsal side of the forearm. It can occur on the left side (San Yin Mai) or both sides (Fan Quan Mai). The impulse that is felt at the site of the radial artery may be Amorphous or pulse qualities may vary as blood is shunted between the different branches of the artery.

Interpretation

There are degrees of clinical significance of San Yin Mai and Fan Quan Mai, the level of which depends on the strength ratio between the sensation palpated at the ventral or radial artery site compared with that at the dorsal or anomalous site. The greater the strength of the impulse or presence of blood in the anomalous artery,

the less reliable the information gained from the radial artery. In the presence of an anomalous artery, the predominance of the Absent or Amorphous quality at the radial site renders the pulse diagnostically invalid.

Ganglion – Variable 58

Sensation

A ganglion is a small synovial cyst that forms in association with a tendon at any time for no clear reason. In some instances ganglions fill the area on the wrist usually occupied by the radial artery.

Interpretation

The presence of a ganglion that obliterates or interferes with the palpation of the impulse renders the pulse useless as a diagnostic tool.

Local Trauma – Variable 59

Sensation

Intra-arterial tubes inserted for the emergency delivery of blood can traumatize the radial artery.

Interpretation

This damage can interfere with the transmission of the impulse and renders the information taken from the pulse as useless.

WAVEFORM

Normal Wave – Variable 60

Sensation

The Normal Wave is a sine curve that begins at the Organ depth and gradually rises to the Qi depth, then subsides again to the Organ depth. On palpation the wave approaches and leaves the finger in the exactly the same way.

Interpretation

The Normal Wave is a sign that qi or Yang activity is within normal limits.

Flooding Deficient – Variable 61

Sensation

The front part of the Flooding Deficient Wave rises normally as a sine curve, reaches or almost reaches the Qi depth but then falls or precipitously drops out from beneath fingers.

Interpretation

It is a sign of moderate qi deficiency of the Yin organs or what Dr. Shen described as a physical “Push Pulse.” It denotes physical overwork or over exercise beyond one’s available energy.

Hesitant – Variable 62

Sensation

The Hesitant Wave has lost its normal sine wave form, where the approach to and from the wave peak becomes sharp and abrupt, instead of being a gradual rise and fall. On palpation it feels faltering or balking to the fingers, yet not missing a beat.

Interpretation

It is a sign of moderate Heart Yin deficiency or what Dr. Shen described as a mental “push pulse.” It indicates obsessive-compulsive behaviour and the tendency to ruminate or think on a single subject incessantly.

Suppressed – Variable 63

Sensation

In the Suppressed Wave the sine wave of the Normal pulse is cut off or flattened at the apex. There may also be a Robust Pounding quality at the organ depth that is markedly diminished at the blood and qi depths.

Interpretation

It is a sign that synthetic materials foreign and toxic to human ecology impede the circulation of qi and blood and an indication of medications. Less commonly is a sign of suppressed feelings.

[Hollow Full-Overflowing] – See Variable 10

[Flooding Excess] – See Variable 12

RHYTHM

Change in rate at rest – Variable 64

Sensation

The rate of the pulse continuously speeds up and slows down, independent of respiration.

Interpretation

Heart qi agitation, if found occasionally. Heart qi deficiency if found consistently.

Intermittent – Variable 65

Sensation

This pulse stops or misses beats on a regular basis or cycle (frequently or infrequently) either consistently or occasionally. The Intermittent pulse can also be described as delayed or syncopated.

Interpretation

Heart qi, blood and Yang deficiency, the more frequent and consistent the missed beats the more severe the depletion.

Interrupted – Variable 66

Sensation

This pulse stops or misses beats irregularly that cannot be predicted by a cycle. The beats are skipped either frequently or infrequently and are present either consistently or occasionally.

Interpretation

Moderate Heart qi agitation and Heart qi deficiency that increases in severity with increased frequency and consistency of the missed beats.

Normal Rhythm – Variable 67

Sensation

The rhythm remains constantly the same, there are no missed beats and the pulse does not speed up and slow down.

Interpretation

Normal rhythm indicates a normal amount of Heart substances. There is neither deficiency nor excess of any Heart yin, qi, blood and yang.

WIDTH (WIDE)

Blood Unclear – Variable 68

Sensation

The pulse exhibits a barely perceptible increase in size, rather than a decrease, at the Blood depth as the fingers are raised from the Organ depth. As pressure is released from the Blood to the Qi depth, the size diminishes.

Interpretation

The Blood Unclear quality indicates mild stagnation of blood in the vessels and due to environmental toxins [especially solvents], inadequate metabolism of toxins in the Liver, or inadequate digestion, particularly of proteins.

Blood Heat – Variable 69

Sensation

As one raises one's fingers from the Organ depth the pulse expands in the Blood depth even more than in Blood Unclear. The pulse diminishes as one continues to release pressure to the Qi depth.

Interpretation

The Blood Heat quality indicates moderate stagnation of blood in the vessels and heat in the blood usually associated with Liver qi stagnation.

Blood Thick – Variable 70

Sensation

As one raises one's fingers from the Organ depth the pulse expands in the Blood depth and continues to expand as one releases pressure from the Blood depth all the way to the Qi depth.

Interpretation

The Blood Thick quality indicates advanced stagnation of blood in the vessels due to profound heat in the blood with particles in suspension such as lipids.

SIDES (AMPLITUDE – INTENSITY)

Sides Equal – Variable 71

Sensation

The strength and amplitude on the left side of the pulse equals that on the right side.

Interpretation

The relative strength or energy of 'Digestive System' and 'Organ System' as described by Dr. Shen are equal.

Left Side > Right Side – Variable 72

Sensation

The strength and amplitude on the left side of the pulse is greater than that on the right side.

Interpretation

The strength of qi within the 'Organ System' is stronger than that of the 'Digestive System' as described by Dr. Shen. This indicates that the ability of postnatal qi derived from the 'Digestive System' to support prenatal qi or the 'Organ System' is compromised and signifies a prognosis that is less than optimal.

Right Side > Left Side – Variable 73

Sensation

The strength and amplitude on the right side of the pulse is greater than that on the left side.

Interpretation

The strength of qi within the 'Digestive System' is stronger than that of the 'Organ System' as described by Dr. Shen. This indicates that the postnatal qi derived from the 'Digestive System' is ample to support the prenatal qi or 'Organ System' and denotes a favourable situation for recovery.

DIAPHRAGM

Inflation Equal Bilateral – Variable 74

Sensation

Rolling the index finger down or proximal from the distal position, and rolling the middle finger up or distal from the middle position one feels as though they are rolling up a small hill. The fingers do not remain level while rolling rather they encounter an elevation that is equal on both the left and right wrists.

Interpretation

Indicates qi stagnation in the chest and diaphragm area usually associated with an acrimonious separation where tender feelings formerly felt for the lost person are repressed by the Heart, and the angry feelings accentuated in order to make the break are driven by the Liver. Can also represent great unexpressed rage when the Heart and Liver qi is strong.

Inflation Left > Right – Variable 75

Sensation

Rolling the index finger down or proximal from the distal position, and rolling the middle finger up or distal from the middle position one feels as though they are rolling up a small hill. The fingers do not remain level while rolling rather they encounter an elevation that is greater or more perceptible on the left compared with the right wrist.

Interpretation

Indicates qi stagnation in the chest and diaphragm area usually associated with an acrimonious separation where tender feelings formerly felt for the lost person are repressed by the Heart, and the angry feelings accentuated in order to make the break are driven by the Liver.

Inflation Right > Left – Variable 76

Sensation

Rolling the index finger down or proximal from the distal position, and rolling the middle finger up or distal from the middle position one feels as though they are rolling up a small hill. The fingers do not remain level while rolling rather they encounter an elevation that is greater or more perceptible on the right compared with the left wrist.

Interpretation

Indicates qi stagnation in the chest and diaphragm area that is the result of repeated heavy lifting beyond one's energy.

7 APPENDIX: EXAMPLE TESTER RESPONSE (SUBJECT 1)

Contemporary Chinese Pulse Record		Refer by:		Date:	
Name: H 1	Gender: g	Age: 44	Hgt: 5'3"	Wgt: 127	Occup: Student
Rhythm: N	Rate/Min: Begin: 60 End: 50 W/Excursion: 72 Chng: 22				
First Impressions of Uniform Qualities			Other Rates During Exam:		
A int 3, thin 2, light 3 Muffled 2, choppy 2, red substrate 2			Depths Above Qi Depth: Cotten 2 Qi: diminished; thinner 2, tighter Blood: Thin 3; suff 2; Bl 11.2 Organ: tense - tight, red prot 2, red prot 2, red prot 2 O-B: tight, red prot 2 O-Q: tight, red prot 2 Wave: Horizontal		
Left Side:		Right Side:			
		Panner & tighter			
PRINCIPAL POSITIONS					
L: Distal Position		R: Distal Position			
Suff 3, thin 2 Red light 2 Suff 1; int A 3 FA		Tight 4, red FA			
Pericardium					
L: Middle Position		R: Middle Position			
Tight 2; Muffled 2 Choppy 2 red prot red substrate		Tense - tight robust prot 2 organ separates			
L: Proximal Position		R: Proximal Position			
Tight 3 Muffled 2 A int 3 Red substrate		Muffled 2 Tight - tense Red prot 2 A int 3 choppy			
Upper:		Three Burners			
Middle:					
Lower:					
COMPLEMENTARY POSITIONS					
L: Neuro-psychological		R: Neuro-psychological			
Muffled 2, choppy 3 A int 3		choppy 2, red prot 2 choppy 2			
L: Special Lung Position		R: Special Lung Position			
Muffled 3, thin 3 A int 3		Tight 2, red 3 suff 2 FA			
Heart		Pleura: Tight 3, suff 2			
Mitral Valve: Suff 2; 3 int					
Enlarged:		Large Vessel:			
L: Diaphragm		R: Diaphragm			
Inflated 1		Inflated 1/2-1			
Enlarged:		Liver			
Distal: -		Radial: ~ 1 int -			
Gall Bladder: tense 2, Muffled 2		Ulnar: 1			
Spleen-Stomach		Spleen: 2			
Esophagus: 2		Stomach: 2			
Stomach: 2		Spleen: 2			
Peritoneal Cavity: Pnervous		Duodenum:			
Large:		Intestines: Small:			
Tight 2, suff 2		Muffled 2, tight			
Red prot 2		choppy 2, FA			
L: Pelvis/Lower Body		R: Pelvis/Lower Body			
Tense - tight 2, red prot 2, suff 2		Red 2, red prot 2			
A int 2, choppy 2		suff 3, muffled 2			
		A int 3, choppy 2			
Comments:					
Fin Area 2					
▲ - Change (1 → 5) - low → high degree					