AN EVALUATION OF THE INTERNATIONAL CLASSIFICATION OF HEALTH INTERVENTIONS TO ESTABLISH ITS SUITABILITY FOR GENERAL SURGERY CODING

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A Thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Doctor of Philosophy.

Johannesburg, 2021

DECLARATION

I, Sithara Satiyadev, declare that this Thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Sithara Satiyadev

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Signed at Johannesburg, on 19th day of November 2021

DEDICATION

To the many clinical coders who patiently toil daily and often do not see the light at the end of the tunnel…

PRESENTATIONS ARISING FROM THIS STUDY

1. The Private Healthcare Information Standards Clinical Coding Sub-committee Meeting
   Date: 25 February 2021
   Time: 10h50 to 11h30
   Virtual Presentation: *The Evaluation of the International Classification for Health Interventions to Establish its Suitability for General Surgery Coding*.

2. The Private Healthcare Information Standards Committee Meeting
   Date: 23 June 2021
   Time: 16h15 to 17h00
   Virtual Presentation: *My Experience of the ICHI as an Intervention Coding System.*

ABSTRACT

Health classification systems also known as clinical coding systems are widely utilised nationally and internationally to manage healthcare delivery systems by collecting quality health data that can be communicated in a consistent, predictable and reproducible manner. Health classification systems contribute to the improvement of efficacy of healthcare by standardised recording, and analysis of healthcare data for research, patient care, disease management planning, resource and budget allocation, performance and outcomes management and reimbursement. The World Health Organisation (WHO) International Classification of Health Interventions (ICHI) has been developed for countries that lack a national intervention system or those that would like to migrate to a WHO intervention system. In its Beta-3 version, the ICHI is open to comments from healthcare stakeholders.

The aim of the study was to evaluate the ICHI to establish its suitability for acute care general surgery coding from intervention data collected at three academic hospitals from the Gauteng province of South Africa. To achieve the aim, the following objectives were formulated:

- To evaluate the suitability of the ICHI for general surgery interventions by coding intervention descriptions extracted from a database to the ICHI codes.

- To identify gaps in the ICHI system and new stem codes to address South African requirements for general surgery coding.

- In relation to general surgery coding, to provide a rationale for the introduction, or rejection, of the ICHI as a nationally regulated intervention system for general surgery coding in South Africa.

In meeting the objectives, the relevant literature was reviewed, the strengths, challenges and gaps in national and international classification systems were presented. Intervention data collected in a retrospective database from three academic hospitals were utilised in the assignment of the ICHI codes to establish its suitability for acute care or in hospital general surgery coding. Three clinical coders

coded a sample of 3000 healthcare interventions into the ICHI codes by referencing the interventions descriptions documented by clinicians, ICD-10 codes or the radiology information. A positivist philosophy and a retrospective, descriptive study design was used to evaluate the data which allowed the research questions to be answered. Aligned to the positivistic paradigm, quantitative data analysis techniques were utilised to assess the degree of match between the intervention descriptions and the ICHI codes assigned, across the sample.

The results show that the ICHI has the ability to cater for the broad range of general surgery interventions deliberated in this study, thus indicating that the ICHI is suitable for general surgery coding and can replace the multiple data coding systems in South Africa for general surgery. To support the effective implementation of the ICHI, healthcare documentation needs to improve, coders need to be trained, and accredited and national ICHI standards and guidelines need to be developed. The detailed illustration of the various challenges and limitations in the assignment of the ICHI codes and the in-depth explanation of the recommendations, makes an invaluable contribution to the adoption and implementation of the ICHI as a national intervention coding system for general surgery.

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LIST OF ABBREVIATIONS

ACHI	-	Australian Classification of Health Interventions
AMA	-	American Medical Association
ATC	-	Anatomic Therapeutic Classification
BHF	-	Board of Healthcare Funders of Southern Africa
CCI	-	Canadian Classification of Health Interventions
CCM	-	Classification Commune des Actes Médicaux
CCSA	-	Complete Current Procedural Terminology for South Africa
CHBAH	-	Chris Hani Baragwanath Academic Hospital
CLaML	-	Classification Markup Language
CMJAH	-	Charlotte Maxeke Johannesburg Academic Hospital
CMS	-	Council for Medical Schemes
CPT	-	Current Procedural Terminology
CSV	-	Comma-separated Values
DIMDI	-	German Institute for Medical Documentation and Information
eCCR	-	Electronic Continuity of Care Record
EHR	-	Electronic Health Record
EPRs	-	Electronic Patient Records
ERCP	-	Endoscopic Retrograde Cholangiopancreatography
FM	-	Frequency Modulated
HCPC	-	Healthcare Common Procedure Coding System
HJAH	-	Helen Joseph Academic Hospital
HREC	-	Human Research Ethics Committee
ICD-6	-	International Statistical Classifications of Diseases and Related Health Problems, Sixth Revision
ICD-9-CM	-	International Statistical Classifications of Diseases and Related Health Problems, Ninth Revision, Clinical Modification
ICD-10	-	International Statistical Classifications of Diseases and Related Health Problems, Tenth Revision
ICD-10-AM	-	International Statistical Classifications of Diseases and Related Health Problems, Tenth Revision, Australian Modification
ICD-10-CM	-	International Statistical Classifications of Diseases and Related Health Problems, Tenth Revision, Clinical Modification
ICD-10-PCS	-	ICD-10 Procedure Coding System

ICD-11	-	International Statistical Classifications of Diseases and Related Health Problems, Eleventh Revision
ICD-O	-	International Classification of Diseases for Oncology
ICF	-	International Classification of Functioning, Disability and Health
ICHI	-	International Classification of Health Interventions
ICPM	-	International Classification of Procedures in Medicine
ILD	-	International List of Diseases
ISO	-	International Standards Organisation
HIS	-	Health Information System
HISs	-	Health Information Systems
MRC	-	Medical Research Council
NDoH	-	National Department of Health
NHI	-	National Health Insurance
NHRPL	-	National Health Reference Price List
PHCIS	-	Primary Healthcare Information System
PHISC	-	Private Healthcare Information Standards Committee
RVUs	-	Relative Value Units
SAMA	-	South African Medical Association
SACHI	-	South African Classification of Healthcare Interventions
SADC	-	Southern African Development Community
SAPPF	-	South African Private Practitioners Forum
SNOMED-CT-		Systematized Nomenclature of Medicine-Clinical Terms
SPSS		Statistical Package for the Social Sciences
UHC	-	Universal Health Coverage
UPFS	-	Unified Patient Schedule
US	-	United States
WHO	-	World Health Organisation
WHO-FIC	-	World Health Organisation-Family of International Classifications

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CHAPTER ONE

ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

1.1.1 Health Classification Systems

Health classification systems also known as clinical coding systems are widely utilised nationally and internationally to manage healthcare delivery systems by collecting quality health data and communicating the data in a common language globally. Health classification systems contribute to the improvement of efficacy of healthcare by standardised recording and analysis of healthcare data that is used for patient care, disease management planning, resource and budget allocation, performance and outcomes management and research. Furthermore, clinical coding enables health data to be communicated in a consistent, predictable and reproducible manner to address both safety and quality issues, as well as models for funding and healthcare planning and improvement of infrastructure (Shepheard, 2020).

The coding process entails the coding of medical terminology into codes that are classified in health classification systems. Different variants of health classification systems are utilised globally and these include diagnostic, procedural and pharmaceutical systems, amongst others. Some examples of classification or coding systems are: The International Classification Diseases and Related Health Problems, Tenth Revision, The Current Procedural Terminology, The Australian Classification of Health Interventions and The National Pharmaceutical Product Index.

The International Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) is an example of a diagnostic terminology coded into codes. The ICD-10 is an international classification system owned by the World Health Organisation (WHO), primarily utilised for collection and analysis of morbidity and mortality health data. The WHO supports a family of International Classifications (WHO-FIC) that consists of three reference classifications one of which is the ICD-10. The ICD-10 will be replaced by the International Classification of Diseases and Related Health problems, Eleventh Revision (ICD-11), The International Classification of Health Interventions (ICH) and the International Classification of Functioning, Disability and Health (ICF) (WHO, 2020). Together these three classifications enable healthcare workers to communicate in common, consistent language. Together with an intervention classification system, the scope of ICD-10 in many countries, including South Africa has been expanded to facilitate reimbursement between healthcare providers and funders. The ICF is in the process of being implemented in some countries in addition to ICD-10 and intervention coding systems to provide a full clinical picture of a patient's healthcare conditions and needs. Health classification or clinical coding systems are also utilised within groupers such as the Diagnosis Related Groups (DRG's) for reimbursement, and monitoring of efficiency within hospitals. Accuracy of clinically coded data is crucial for the correct assignment of DRGs and to prevent revenue losses for a hospital provider (Zafirah, Nur, Puteh and Aljunid, 2018).

1.1.2 The South African context

National implementation of the ICD-10 began in 2005 in South Africa under the auspices of a National ICD-10 Implementation Task Team that compiled an Implementation Review Document to track the phased implementation. The ICD-10 Implementation Review Document that describes the implementation from January 2004 to March 2010, refers to Health Classification systems being utilised to collect health data for several reasons. The United Kingdom's National Clinical Training Handbook (2017) notes that accurate and comprehensive clinically coded information is vital for reliable clinical and statistical analyses.

Despite the phased implementation of the ICD-10, it has become evident that the diagnostic coding system has not been fully implemented nationally (Matsoso, 2013). Furthermore, the absence of a national intervention coding system and resultant inadequate medical records, contribute to the challenges of effective healthcare delivery in South Africa. Matsoso (2013) further notes that the successful implementation of the National Health Insurance (NHI) is dependent on an appropriate information system and asserts that a National Health Data Dictionary including formally adopted coding systems are required.

Dyers, Evans, Ward, du Plooy et al., (2016) highlight the need for the ICD-10 coding training, coder accreditation, validation tools, clinician support and the management of competing practices to improve the quality of healthcare data. The lack of a national intervention coding system, however, results in a deficit in the understanding of the different interventions performed, associated risks and relevant resource utilisation for hospital patients. This has resulted in the use of multiple intervention and billing coding systems and schedules in South Africa, which are described below.

The public healthcare sector utilises a home-grown system known as the Unified Patient Fee Schedules (UPFS) Government Gazette (2015) to bill for services rendered in the public healthcare sector. Whilst the UPFS system allows some degree of data collection on interventions, it is unable to provide data for proper and appropriate research to be carried out on costs and quality of healthcare delivery in the public sector. Incorporated in the UPFS is a limited set of codes from the National Health Reference Price List (NHRPL), which enables the understanding of certain interventions performed. The UPFS system is updated annually by the National Department of Health (NDoH) and updates are communicated to the provinces for implementation on agreed dates. Some public sector hospitals utilise the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) Volume 3 or the ICD-9-CM procedure codes to collect intervention data. The ICD-9-CM Volume 3 was utilised by the United States (US) and other countries until the end of September 2015 for data collection and reimbursement. The system is no longer in use by the US and no further updates have taken place since 2015 thus, it is outdated.

The National Health Act number 61 of 2003 regulation 1 (v) makes provision for the use of the NHRPL billing systems in the private healthcare sector. This enables providers of healthcare to allocate NHRPL codes on medical claims submitted for reimbursement to healthcare funders. Different provider groups in South Africa use different versions of the NHRPL system, and intervention codes only appear in the medical practitioner NHRPL system. The NHRPL system has not been updated since 2006. This results in further limitations in the collection of intervention data.

Private hospitals, medical aid schemes, its administrators and managed care organisations have adopted and implemented a proprietary system for intervention coding, the Current Procedural Terminology (CPT). The CPT coding system was developed, and is maintained, by the American Medical Association (AMA). On license from the AMA, The South African Medical Association (SAMA) makes available the CPT system for use in South Africa. The South African version of CPT is referred to as “The Complete Current Procedural Terminology for South Africa” (CCSA) as the SAMA presentation of the CPT is different to that of the AMA. No changes are made by SAMA to the actual CPT codes or descriptions.

The original CPT system was developed by the AMA for Physician intervention coding and is governed by the United States Health Insurance and Portability Act of 1996.

In the absence of a national intervention coding system, the private healthcare sector utilises the CCSA for data collection and to a lesser extent for reimbursement within contractual agreements between hospitals and medical aid schemes. A new version of the CCSA is implemented every two years at the beginning of January through healthcare stakeholder participation via The Private Healthcare Information Standards Committee (PHISC). The PHISC is a member organisation that consists of various sub-committees and has broad representation from private healthcare stakeholders. The NDoH and some provinces attend some of the PHISC meetings. *"The principle objective of PHISC is to agree, communicate, provide implementation guidelines and monitor where possible, national health information standards in the private health industry and to do so with maximum co-operation with the State and all other interested parties"* (PHISC website, 2021). In the absence of a National Information Standards Body or Authority, the PHISC engages with healthcare stakeholders to develop and recommend healthcare standards where possible.

CCSA version control and coding standards/guidelines are discussed and adopted by the PHISC for implementation on agreed dates. The CPT system is updated annually by the AMA and the CCSA coding system is updated biennially by SAMA thus South Africa is usually one to two years behind with the AMA updates, which presents a challenge with coding of new technology and new interventions. The CPT or CCSA system is inappropriate for use as a hospital intervention coding system as its focus is on services provided by physicians and for reimbursement of these services (Kluyts, 2019). The appropriate measurement and management of costs and quality of care using CCSA, NHRPL or an outdated and minimally utilised ICD-9-CM data is not possible within the South African health care industry thus arises the need for a suitable intervention classification system such as the International Classification of Health Interventions (ICH).

1.1.3 The International Classification of Health Interventions

The WHO is in the process of developing an intervention classification system known as the ICHI The aim of the ICHI is to meet a number of use cases including international comparisons, a classification for countries that lack one, a base for future redevelopment of national classifications and expanded content for countries that have a national classification to include a range of functioning and public health content" (ICHI Beta-3 Reference Guide, 2020).for countries that lack a national intervention system or those that would like to migrate to a WHO intervention system. Internationally, most first world countries have developed intervention systems that have been in use for many decades and have proven to be effective for national intervention data collection but have been ineffective for international comparisons. The ICHI uses three axes to describe the intervention as explained by Fortune, Madden and Almborg (2018).These axes are:

Target: entity on which the Action is carried out.
Action: the deed done by an actor to a Target.
Means: process and methods by which the Action is carried out.

According to the ICHI ICH Beta-3 Reference Guide published by the World Health Organisation-Family of International Classification (2021), the ICHI aims to provide a tool for countries that lack an intervention system to report and analyse health interventions. The ICHI system caters for interventions carried out across the health system including primary care, acute care, rehabilitation, functioning assistance, prevention and public health. The system consists of stem codes and optional extension code than can add granularity to interventions.

Various iterations of beta versions of the ICHI were released by the WHO for testing by members states and interested healthcare stakeholders. The current beta-3 version has been tested by the World Health Organisation-Family of International Classification (WHO-FIC) Collaborating Centres in many member countries. The WHO-FIC Collaborating Centre in South Africa co-ordinated the beta testing of the ICHI in South Africa. The WHO plans to release the user version by 2022.

The South African Ministry of Health (MoH) has an interest in understanding the suitability of the ICHI for use in South Africa. (Minutes of the keynote address by the Minister of Health, WHO-FIC conference 2011) due to the lack of a national intervention coding system. The Presidential Health Summit Compact (2018) makes mention of the implementation of harmonised WHO classification systems for topographical, diagnostic, procedural, pharmaceutical and outcomes coding by 2024. Examples of coding systems noted in the Compact are the International Classification of Diseases, Eleventh Revision (ICD-11) and the ICHI. The ICHI is well positioned to meet the interventions needs in South Africa due to the broad range of interventions that it caters for and its ability for expansion by use of extension codes. The Beta-3 version of the ICHI was released in 2020 with the number of codes continuing to grow as the number of interventions and the granularity in the ICHI has been established with reference to the use cases of the ICHI and the need for a stable classification in future (Beta-3 Reference Guide, 2020).

Whilst, the ICHI caters for a broad range of services, this study focuses on the ICHI for coding of health interventions of in-patients or acute care coding. This entails the assignment of the ICHI codes to general surgery intervention data from three academic hospitals in Johannesburg. These hospitals were purposively selected as they had detailed, comparable records of surgical interventions that had been recorded by clinicians in their discharge summaries, and they were also conveniently accessible to the researcher. The surgical interventions had been recorded by the clinicians on patient healthcare records as a legislative requirement, as per the National Health Act (Republic of South Africa, 2003). In a joint project between the University of Witwatersrand (Wits) and the three hospitals, resources were provided by Wits to capture the surgical intervention data from the discharge summaries into an electronic database.

1.2 PROBLEM STATEMENT

A health sector that is resource constrained and overburdened with disease and poverty, requires a robust strategic plan to manage the limited resources and deliver quality healthcare. The healthcare provider's understanding of the diseases and intervention profiles coupled with appropriate human resources and information systems will contribute to the development and implementation of strategic plans to effectively deliver healthcare. Underpinning the success of such a plan is quality healthcare data that needs to be collected utilising diagnostic and intervention coding systems that are adopted and implemented nationally. To a certain extent, the implementation of the ICD-10 has addressed the healthcare sectors understanding of diseases prevalent in South Africa and the reasons for interventions.

However, the lack of a national intervention coding system and the current manner of intervention coding in South Africa by the use of multiple inappropriate intervention/billing systems for surgery does not support quality intervention data collection and patient outcomes reporting. This presents a challenge in the understanding of the different types of general surgery interventions performed in hospitals, the resources associated in the performance of the interventions and associated risks and complications. To address the national needs of intervention coding for general surgery, the following research questions are being examined:

- Is the ICHI suitable for general surgery coding?

- Does the ICHI have gaps within the South African surgical environment and can new codes be created to address these gaps?

- In relation to general surgery, can the ICHI be recommended for adoption in South Africa as a national intervention coding standard?

1.3 AIM OF THE RESEARCH

The aim of the study is to evaluate the ICHI to establish its suitability for acute care general surgery coding. This pertains to coding of intervention data for general surgery (the gastrointestinal, vascular and endocrine systems, breast surgery, trauma surgery, orthopaedic surgery, joint replacements and tumour surgery for adults and general paediatric interventions). The coding exercise will be used to identify potential gaps in the ICHI, develop new ICHI codes to address the gaps and provide a rationale for the national adoption of the ICHI. The accomplishment of this process will be dependent on coding the intervention descriptions to the ICHI codes. The expected outcome of the research is that the ICHI, when finalised, would be suitable for acute care general surgery coding in South Africa.

1.4 OBJECTIVES

- To evaluate the suitability of the ICHI for general surgery interventions by coding intervention descriptions extracted from a database to the ICHI codes.

- To identify gaps in the ICHI system and suggest new stem codes to address South African requirements for general surgery coding.

- In relation to general surgery coding, to provide a rationale for the introduction, or rejection, of the ICHI as a nationally regulated intervention system for general surgery coding in South Africa.

1.5 DEFINITION OF VARIABLES

Acute care surgery coding: is defined as coding of surgery performed in hospital facilities (Ball et al., 2010).

General surgery interventions: are defined as surgical interventions on the gastrointestinal, vascular and endocrine systems, breast surgery and trauma surgery (Hanford Healthcare, 2021). For this study orthopaedic surgery, joint replacements and tumour surgery for adults and general paediatric interventions were included in addition to general surgery.

Health Classification system: is defined as a system of categories to which morbid or intervention entities are assigned according to established criteria.

ICHI stem code: is represented by a title and a unique seven-character code denoting the axis categories for that intervention which are the Target, Action and Means components. (ICHI Beta-3 Reference Guide, 2020).

ICHI extension code: allows users to add additional information about and intervention and these codes are shared with ICD and ICF in the common foundation. (ICHI Beta-3 Reference Guide, 2020).

Intervention coding: is defined as the assignment of a code to a health intervention performed on a patient which could be a surgical or non-surgical intervention. (ICHI Beta-3 Reference Guide, 2020).

Health or surgical intervention: is defined as the act of operating on a patient to assess, maintain, promote, modify health functioning or health conditions (ICHI Beta-3 Reference Guide, 2020).

Suitability

Conceptual definition of suitability: associating an ICHI code to a surgical intervention.

Operational definition: will be ascertained by coding general surgery interventions to ICHI codes.

1.6 SIGNIFICANCE OF THE STUDY

The research seeks to evaluate the appropriateness of the ICHI for general surgery coding in South Africa as a means to strengthen clinical health information in order to support the introduction and development of the NHI system. Furthermore, it will provide data for research into case mix, costing, quality and access to clinical care in South Africa. The research will provide a proof of concept for the ICHI as a national intervention classification system for South Africa. Decision makers have sound reservations on adopting a new intervention classification system that has not been adequately tested. The issue of a national intervention classification system has been a challenge for the NDoH for over a decade. To this end, this research seeks to play an instrumental role in the formulation of a national policy for intervention coding with the ICHI as an obvious choice. This proof of concept will not only assist decision makers in South Africa but also further afield in so far as the adoption of the WHO ICHI classification system is concerned.

This research is extremely important for Africa especially the Southern African Development Community (SADC) as few countries in Africa have adopted and properly implemented a national intervention classification system. There is currently no information on the suitability of the ICHI. The research conducted will be the first evidence-based knowledge to be made available for Africa and globally. This research will, together with research conducted by Fortune et al., (2018) contribute to the development of the ICHI as an appropriate intervention classification system internationally. Furthermore, this research will contribute to developing a cross-disciplinary platform for African research and enhancement of the WHO-ICHI classification system.

1.7 FORMAT OF THE THESIS

Chapter 1: Introduction

The introduction provides an overview of health classification systems, background to the problem, the aim and objectives of the research, research questions to be answered, significance of the study and format of the study.

Chapter 2: Literature Review

In chapter two, a conceptual framework with dependent and independent variables is presented based on critical appraisal of literature. The strengths, challenges and gaps of international and national intervention and billing classification systems are presented in this chapter. As ICHI is a new classification system, the literature review will rely of articles published in journals and presentations.

Chapter 3: Research Methodology

Chapter three describes the positivist philosophy and the deductive methodology that the researcher adopted to evaluate the suitability of the ICHI for general surgery coding. In this chapter the researcher focused on a retrospective descriptive study design that enabled the sample selection and evaluation of a cross-sectional spectrum of data collected in a database from three academic hospitals in Gauteng. This chapter also addresses the quantitative data analysis technique that the researcher utilised to evaluate the overall degree of match between the intervention descriptions and the ICHI codes.

Chapter 4: Results

Chapter four presents the results of the statistical data analysis. This chapter presents an overview of the data, and the descriptive statistics, followed by a presentation of the central tendencies, mean, median, mode, standard deviation, skewness and kurtosis of the applicable results. Chapter four also presents the results of the inferential statistics calculations in this chapter to support whether the central tendency findings were statistically consistent. Graphs and tables were utilised to present the findings in relation to the research questions.

Chapter 5: Discussion of Results

In chapter five the results are discussed with critical evaluations in relation to the research questions posed.

Chapter 6: Overview, Conclusions, Limitations and Recommendations

Concluding the study, chapter six provides an overview of the main findings and conclusions drawn. An overview of the limitations and recommendations are also presented in this chapter.

1.8 CONCLUSION

The research aims and objectives can be achieved by retrieving data collected in a database, cleaning and coding the data to the ICHI codes, analysing the mapped data and presenting the findings. The research can result in providing a proof of concept for the national adoption of the ICHI and healthcare stakeholders addressing their current surgical intervention needs by migrating to the ICHI. Chapter one addressed the aim, objectives, the problem statement, significance and the format of the study. Next, chapter two is presented and contains details of the various literature sources that were consulted to establish a theoretical framework for the research.

CHAPTER TWO
LITERATURE REVIEW

2.1 INTRODUCTION

Literature review is defined as a comprehensive review of published and unpublished literature which informs the meaningful specification of the problem and research methods to solve the problem (Kumar and Singh, 2016). A critical assessment of the literature entails stating weaknesses and gaps, highlighting contrasting views of authors or raising questions. Trochim, Donnelly and Arora (2015) argue that the voluminous and technical nature of a literature review poses challenges to researchers in a quest for new discovery. Hence, the creation of a research synthesis which is a systematic study of previous research studies that have asked the same questions or have presented findings that can be utilised by other researchers. Pertinent literature relating to intervention classification in the delivery of healthcare was reviewed in this chapter. Literature review revealed that minimal research projects of this nature have been undertaken, hence the reliance on electronic journals, presentations and articles source from various databases such as Google Scholar, Pubmed, Springer, Research gate amongst others..

Although, there are many factors that impact the delivery of healthcare, a key requirement according to the National Health Act number 61 of 2003, is accurate health data collection, by trained personnel in information systems (Republic of South Africa, 2003). The affirmative relationship between service delivery and knowledge management is well documented by (Laudon and Laudon, 2015). However, in the current resource-constrained healthcare sector of South Africa, patients are demanding services and better outcomes as outlined in the Bill of Rights and the Constitution (Republic of South Africa, 1996). This compels the healthcare industry to collect better health-related data utilising international classification systems such as the ICD and the ICHI (Stojanovic et al., 2020).

The collection of quality health data is supported by Laudon and Laudon (2015), who assert that we live in information-economic times, and the creation and dissemination of information and knowledge are the greatest wealth and success that a business or nation can enjoy. Hejazi et al. (2015) exemplify the case with hospital-acquired pneumonia in Iran, which is a leading cause of death that attributes to 33% to 50% of hospital mortality. Similarly, the Centre for Disease Control and Prevention (2019) note that the leading cause of death in

South Africa is tuberculosis, which supports the views of Laudon and Laudon (2015) and Hejazi (2015).

Accurate health data collection, which entails the coding of medical terminology into codes, or other forms of knowledge management systems enables morbidity and mortality research (Hejazi et al., 2015). The WHO (2021) further illustrates this be stating that consistent and reliable data collected at healthcare facilities are vital for access to healthcare and the provision of quality healthcare services. According to the WHO, data collected at healthcare facilities play an integral role in clinical patient management, monitoring of services and performance and in wake of the corona virus disease (COVID-19) pandemic, the data will be crucial to evaluate the effect on health workforce and to collect statistics for future healthcare planning in addressing pandemics.

This study sought to evaluate the suitability of the ICHI for general surgery coding within a hospital setting, and this chapter presents a pertinent literature review that has already been performed on this topic. It begins with a conceptual framework and the definition of key terms, health classification systems, clinical coding, health interventions, and a clinical functioning classification. A conceptual framework illustrates the pathway of the research, which is firmly grounded in theoretical constructs whereby the researcher's understanding of how the different variables in the study link to one another (Adom et al., 2018). Next, a conceptual framework and a detailed overview of the WHO-FIC is presented, together with additional health coding systems that are in common use, globally. The conceptual framework in Figure 2.1 depicts the dependent and independent variables that link to one another. The dependent variable is the surgical intervention data captured into a database and the independent variables are the different health classification, coding and billing systems, coding tools, coder training and accreditation, healthcare documentation and the tow-tiered healthcare system in South Africa.

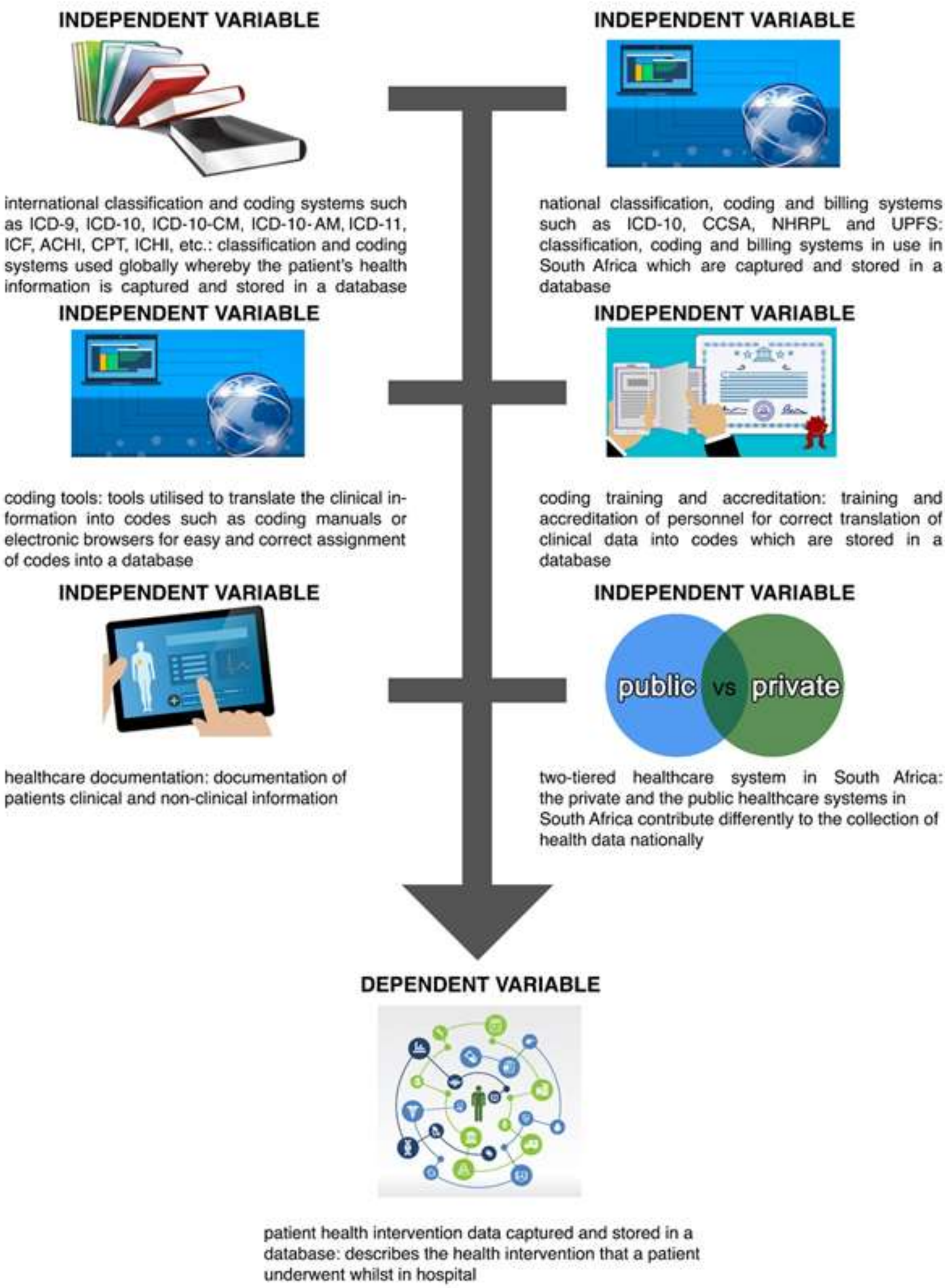

Figure 2.1 Conceptual framework with dependent and independent variables
Research Gate: Theoretical and Conceptual Framework: Mandatory Ingredients for a Quality Research

The independent variables consist of international and national classification and coding systems listed below:

- ACHI: National Australian coding system for interventions.
- CCSA: National SA coding system for interventions.
- CPT: National US coding and billing system for physicians.
- ICF: International WHO classification.
- ICHI: New International WHO classification.
- ICD-9: International WHO classification.
- ICD-10: International WHO classification.
- ICD-10-AM: National Australian classification system which is a clinically modified version of the WHO's ICD-10.
- ICD-10-CM: National US classification system which is a clinically modified version of the WHO's ICD-10.
- ICD-11: New International WHO classification.
- NHRPL: National SA billing system for medical practitioners.
- UPF: National SA fee schedule for billing.

The literature review critically appraises the current gaps and problems of the international clinical classification and coding systems, both globally, and in South Africa, by considering the clinical coding mechanisms that are currently in operation, their strengths, weaknesses, and challenges hampering their further implementation. This is all prepared in line with providing a solid literary basis for triangulating the findings of this study, and concluding the suitability of the ICHI for general surgery coding in South Africa.

2.2 DEFINITIONS OF KEY TERMS

2.2.1 Clinical coding

According to Ayegbayo (2017), clinical coding entails the assignment of numeric or alphanumeric depictions that are extracted from clinical documents, as a classification system for diseases or their interventions. Stated differently, a health classification is a mechanism for converting descriptions of health interventions or diagnoses into systematised statistical codes, through a process termed clinical coding (Abdulla et al., 2020). Jurek et al. (2018) claim that codes can state thousands of words, which play an integral role in healthcare provider reimbursement. The procedural and diagnostic codes are used by various healthcare stakeholders, such as private health insurance companies, government health programs, healthcare workers, software developers and workers' compensation funds for various needs (Rains et al., 2017). These include needs such as health informatics, public health improvement, direct surveillance of pandemic or epidemic outbreaks, knowledge creation, decision support systems, reimbursement purposes such as in finance and billing, and statistical analysis of therapies and disease treatments (Fung et al., 2019).

It is important to emphasise that there are various health classification systems, which differ based on their nomenclatures and/or statistical classification mechanisms (Roberts et al., 2018). The following main coding or classification systems exist for healthcare purposes:

- Procedural or intervention codes: These comprise of numeric or alphanumeric codes, to label particular health interventions executed by healthcare professionals. There are various international and national classification systems in operation as mechanisms of health interventions, such as the Canadian Classification of Health Interventions (CCI) and the Australian Classification of Health Interventions (ACHI), which are targeted primarily at surgical, medical and diagnostic interventions on patients in hospitals (Manchaiah et al., 2020). Many countries such as South Africa, however, do not have any national intervention classification systems; and those that do, lack intervention codes related to assistance with functioning, rehabilitation, allied health, public health, or prevention (Fortune et al., 2018). Other examples include the ICHI, the CPT; the International Classification of Procedures in Medicine (ICPM); and the Healthcare Common Procedure Coding System (HCPCS) (Paviot et al., 2011).
- Diagnostic codes: These comprise of numeric or alphanumeric codes, to reveal symptoms, disorders, and diseases, and can be applied to determine mortality, morbidity and facilitate reimbursement. Examples include the ICD-9-CM and the ICD-10 (Catling et al., 2018), ICD-11 and the International Classification for Oncology (ICD-O) which is a sub-set of the ICD (Nikiema et al., 2017) ;
- Topographical codes and Clinical Terminology: These indicate a particular location in the body, such as the Systematized Nomenclature of Medicine (SNOMED CT) (Fung et.al, 2019), and;
- Pharmaceutical codes: These are specifically utilised for the identification of medications, such as the Anatomical Therapeutic Chemical (ATC) Classification System (Tayebati et al., 2017).

2.2.2 The WHO Family of International Classifications (WHO-FIC)

The WHO supports a "family of international classifications (WHO-FIC)", or collection of classifications that are intended to assist with the internationally-consistent grouping and maintenance of information on various facets of healthcare systems and health (WHO, 2020). There are three reference classifications systems — two of which are the afore-mentioned ICD (Ohannessian et al., 2017), and the ICHI (Manchaiah et al., 2020). A third member of the WHO-FIC is the International Classification of Functioning, Disability and Health (ICF) (Fortune et al., 2018).

The three reference classification systems, together, are intended to offer a consistent and standardised basis for gathering and exchanging information, while systematising medical and health-related concepts such as health interventions, functioning, and diagnoses (Madden and Bundy, 2019; Zaiss and Dauben, 2018). A full review of each of the three members of the WHO-FIC, are presented later in the review.

2.2.3 Health intervention

Cambon et al. (2019, p.2) define an intervention as "A series of inter-related events occurring within a system where the change in outcome (attenuated or amplified) is not proportional to the change in input. Interventions are thus considered as ongoing social processes rather than fixed and bounded entities". The WHO (2019) illustrates this further, by defining a health intervention as an act that is conducted with, for, or in aid of a population or person whose purpose is to modify, promote, maintain, improve or assess health conditions or functioning.

2.2.4 Functioning

According to the WHO (2002), the term functioning, such as within the ICF, describes all forms of participation, activities, and bodily functions; while disability is a broad term explaining restrictions in participation, activity limitations, and impairments.

The literature review, now shifts to a review of the WHO-FIC classification systems.

2.3 OVERVIEW OF THE WHO-FIC REFERENCE CLASSIFICATIONS

The WHO-FIC has three reference classifications some of which are used for reporting globally. These classifications address diagnoses and related health problems, interventions and functioning, disability and health. This is discussed next.

2.3.1 The International Classification of Diseases (ICD)

The process of clinical coding commenced in the 17th century in England; whereby, certain disease information was collected and coded into numerical codes as an attempt to understand the common causes of death (Benson and Grieve, 2016). In the mid-1800s, William Farr, a medical statistician, began to classify diseases for the General Register Office of England and Wales, in an attempt to establish a suitable classification system of diseases (Heslop and Hoghton, 2019). In 1885, the Bertillon committee in Paris met to adopt a classification system including English, German, and Swiss classifications that were based on the principles proposed by Farr (BHF, 2007). This classification system was termed the Bertillon Classification of Causes of Death; and it was the first to receive approval and adoption by several countries, particularly those across North America (Canada, the US, and Mexico) (Conway, 2019).

The Bertillon effort evolved into the International List of Causes of Death by 1900, where the classification was revised at 10-year intervals, until 1920 (Franklin et al, 2017). These lists included updates of infectious and parasitic diseases, and reflected the progress made in medical science (Rains et al., 2017).During this period, the conference governing the revisions, the Health Organisation of the League of Nations, recognised the need for a list to be created to meet the need of a variety of healthcare interests, including insurers, health administrators, hospitals, and military medical providers. Consequently, the term International Lists of Diseases (ILD) was adopted (Hallett et al., 2016).

In 1946, had the International Commission of the WHO prepared the sixth revision of the International Lists of Diseases and Causes of Death, which became known as the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, later on to become the ICD (Hirsch et al., 2016). Consequently, the WHO was entrusted with the ICD at its creation in 1948 when publishing the ICD-6, which also began a new era of internationally-adopted lists overseen by the WHO (Hallett et al., 2016).

The ICD-6 consisted of two volumes, with Volume 2 being an alphabetical index for diagnostic terms; while it also incorporated morbidity for the first time and external causes of injury (BHF, 2007). Thereafter, the seventh revision was approved in 1955; and it incorporated essential changes, along with amendments of errors and inconsistencies (Hirsch et al., 2016). The eighth revision was approved 10 years later, in 1965, and was more substantial; however, it did not change the basic structure and philosophy of the manual (Stephens et al., 2016).

The ninth revision of the ICD was released in 1975, which added detail to the four-digit subcategories, with optional five-digit subdivisions; and it also included changes to increase the flexibility of the ICD for different situations (Monestime et al., 2019). In 1977, the worldwide medical community recognised the ICD system, which then prompted the National Centres for Health Statistics (NCHS) to expand the study to include clinical information (Hirsch et al., 2016). The ICD system was consequently expanded to include not only causes of death, but also clinical diagnoses, such as illnesses and injuries (Catling et al., 2018). Adding clinical diagnoses provided additional statistical information on basic healthcare, thereby providing a means to index medical records, make medical reviews easier to complete, and provide further opportunities for medical care (Barr et al., 2020).

The ICD-9 coding concepts developed at this time, are still in use, today (Hirsch et al., 2016). The United Stated (US) published the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), in 1979, for national use until 2015 (Jurek et al., 2018), whereby, the ICD-9-CM was a clinically modified version of the WHO ICD-9, and this modified version included intervention coding (Catling et al., 2018). Notably, the ICD-9-CM was the first classification that consisted of an intervention coding system. This edition was superseded by ICD-10, the tenth release by the WHO.

The ICD-10 includes codes for external causes of diseases or injuries, social circumstances, complaints, abnormal findings, signs and symptoms, and diseases (Alharbi et al., 2019). The 43rd World Health Assembly endorsed ICD-10 in May 1990; and it was initially implemented by member states from 1994 with ad hoc updates until 2018 — remaining current until January 2022, whereupon it is due to be superseded by the ICD-11 (Hackmann et al., 2019).

The ICD-10 introduced a change in the structure of the ICD-9 classification system; where alphanumeric three-to-five characters codes were introduced with a decimal point being placed after three characters (CMS, 2010). Consequently, it is impossible for ICD-9 data sets to be coded into the ICD-10 data sets, or vice versa (WHO, 2020a).

It is argued that the alphanumeric coding system employed in the ICD-10 is an improvement on the previous ICD-9 system, which had a restrictive format and limited codes (Monestime et al., 2019). Various countries around the globe adopted and implemented different revisions of the ICD-10, and modified versions of the ICD-10; thus, the ICD-10 has become the standard international diagnostic classification system for use, today (WHO, 2019). The US implemented a clinically modified version of the ICD-10 known as the ICD-10-CM in October, 2015 (Monestime et al., 2019). In parallel the US migrated to a newly developed intervention system referred to as the ICD-10 Procedure Coding System (ICD-10-PCS), which is the current intervention system in use in the US for hospital inpatient interventions only (Jurek et al., 2018). That is, the ICD-10-PCS was developed in the US to replace ICD-9-CM procedure codes (Volume 3).Consequently, the ICD-10-PCS is a completely separate health coding system to the ICD-10-CM system, comprising an added 87,000 codes for use exclusively in hospital inpatient settings in the US (DiSantostefano, 2010).

A considerable portion of the remainder of the international community has adopted the standard ICD-10 format (Manchikanti et al., 2015). In Australia, the International Classification of Diseases, Tenth Revision, Australian Modification (ICD-10-AM) was developed by the University of Sydney's National Centre for Classification in Health (Katzenellenbogen et al., 2019). The ICD-10-AM system has, since, been implemented by several countries including Saudi Arabia, the Republic of Ireland, and New Zealand (Alharbi et al., 2019).

Moving forward, developments have already begun on the ICD-11; where a version of the ICD-11 was released on 18 June 2018 to allow Member States to prepare for implementation, including coding the ICD into their national languages. After that, the interim ICD-11 was submitted to the 144th Executive Board Meeting in January 2019, and the Seventy-second World Health Assembly in May 2019 (Chen et al., 2019). Following endorsement, it is anticipated that some member states will begin reporting using the ICD-11, from 1 January 2022 (Hackmann et al., 2019).

Having presented a historical background to the ICD classification system, it is worth highlighting various criticisms that have been raised, in the literature. There were some early concerns following the implementation of the ICD-10, which centred on the lack of resources and costs associated with training professional coders and healthcare workers to use the ICD-10. In the US (ICD-10-CM), two common complaints also related to issues with the inclusion of infrequently encountered, or highly-specific circumstances, such as code: W55.22XA, which pertains to an initial encounter of being struck by a cow (Manchikanti et al., 2015). Manchikanti et al. (2015) argued that cluttering the coding system with superfluous codes that would almost never be used, was counter-productive. Other problems have also been noted with the ICD-10-CM, such as the extensive list of different potentially relevant codes provided for overlapping conditions like rheumatoid arthritis, which can lower efficiency and cause confusion among healthcare workers (Wu et al., 2019).

Authors such as Manchikanti et al. (2015) have also criticised the forced implementation of the ICD-10-CM and the ICD-10-PCS codes in the US, which the authors stated are specific to the US, and "vastly different" to the standard ICD-10 codes implemented in the rest of the globe. As an example, these authors emphasised that the ICD-10-CM is comprised of 144,000 codes, unlike the standard ICD-10, which has 14,400 codes (WHO, 2020a). Consequently, the authors argued that the ICD-10-CM is an elaborate and complex system that fails to correlate with the codes used in other countries. It can be concluded from the discussions by the various authors that a health classification system overseen by the WHO with a manageable numbers of codes is easier to implement and monitor nationally in comparison to classification systems that are clinically modified.

The literature broadens, now, to present a brief overview of another member of the WHO classification 'family', the ICF. This is discussed next.

2.3.2 The International Classification of Functioning, Disability and Health (ICF)

Due to the broad nature of health coding by the WHO, it is also worth discussing the ICF. The WHO defines the ICF as providing a standard framework and clinical language for describing health and the states related to health (WHO, 2002).

There is also a list of environmental factors within the ICF, which interact with each of these factors (Meshkov et al., 2020). In contrast, then, while the ICD-10 provides healthcare workers with an etiological framework for classifying diagnoses, disorders, diseases and other health-related conditions, the ICF is specifically designed as a classification system for the disability and functionality levels — and limitations — associated with health conditions (Blank et al., 2019). Since this study is specifically focused on the coding of interventions, and the ICHI in particular, a more detailed review of the ICF will not be presented, however the ICHI Beta-3 Reference Guide makes mention of the ICF and its relationship to the ICHI, after reviewing the background to the ICHI, which is presented next. The ICHI Beta-3 Reference Guide (2020), notes that the ICF categories for body functions, activities and participation and environmental factors are used as Target in ICHI It must be noted that the ICHI cannot be utilised on its own without other health classifications such as the ICD-10 or the ICD-11 and the ICF for meaningful health data collection.

2.3.3 The International Classification of Health Interventions

In parallel to the development of the ICD, the International Classification of Procedures in Medicine (ICPM) (II) was published by the WHO in 1978 for trial purposes, as a system of classifying procedures (Paviot et al., 2011). The ICPM was adopted by several countries for the classification of surgical procedures; however, it never received the same level of global acceptance as the ICD (Paviot et al., 2011). As a result of difficulties in the global discussion and a lack of interest in further development of the ICPM, international advancement of the classification was halted, in 1989 (Hongyong et al., 2018).

This meant that there was no standardised interventions classification system for global needs; thus several countries embarked on a journey to create intervention systems that met their own local needs, which was scarcely compatible with the approaches developed within the ICPM. In Germany, for instance, the Operationen- und Prozedurenschlüssel version 301 (OPS-301) classification system was developed in line with the extensions to the ICPM that had been developed in Holland, the ICPM-DE (Stausberg et al., 2001).

The evolution of technology presented an opportunity, and a need, for a more robust intervention classification system, and member countries of the WHO called for the development of a suitable intervention system (Fortune et al., 2018). Since 2007, then, the WHO initiated further development of a replacement for the ICPM, as outlined next, which it termed the ICHI (Fortune et al., 2017).

The newest classification mechanism in the WHO-FIC is the ICHI, which is still in the Beta-3 phase, and scheduled to be completed by the end of 2020 (Manchaiah et al., 2020). The ICHI alpha version was formulated with reference to from America's ICD-9-CM Volume 3, a classification for procedure for national coding (Cumerlato et al., 2013). In October 2017, the Beta version of ICHI was released with 7000 codes, after which the Beta-2 version was released in 2018, followed by Beta-3 version in 2020 with the number of codes continuing to grow (ICHI Beta-3 Reference Guide, 2020).

During the early stages of development, numerous iterations were performed by development teams, together with experts from collaborating centres in Germany, China, Australia and the Nordic countries, and the management of the ICHI, to make certain that the constraints were adhered to (Fortune et al., 2018). The key constraints that were used to develop the ICHI web-based system (Donada et al., 2018) were the following:

- Ensuring a strict editorial control across three different user profiles (editors, registered users, guests), each with varying degrees of editorial privilege on the system;
- Providing accessibility to reviewers to allow comments to be made throughout the review process;
- Ensuring functionality for exporting files including complete chapters or the entire ICHI, in ClaML, CSV, or Microsoft Excel formats;
- Allowing historical information and versioning for every entity;
- Incorporating a predisposition for Uniform Resource Identifiers (URI), which are strings of unambiguously identifiable characters for a specific resource, with a similar format to ICD-11;
- Allowing management for the interventions across the three axes, together with facility for extension codes that could be modified or evolved over time;
- Ensuring functionality within both the development phase of the classification system, and for maintenance in the future; and
- Providing storage facilities for the entire volume of necessary data to create the ICHI.

As explained by Fortune et al. (2018), then, the ICHI provides an all-inclusive system covering surgical, medical, mental health, primary care, allied health, assistance with functioning, rehabilitation and prevention health interventions, unlike various national intervention classification systems that cover largely surgical and medical interventions. The current Beta-3 2020 version of the ICHI is open-access and was freely available on the ICHI web platform hosted by the German Institute for Medical Documentation and Information (DIMDI) (ICHI, 2020; Stojanovic et al., 2020). The ICHI is now migrated the WHO-FIC Platform link https:/ /icd.who.int/dev11/f/en together with ICD-11 and ICF.

The ICHI classification is currently structured upon three axes, as follows (Donada et al., 2018):

- Axis 1: The target – the entity upon which an action is performed;
- Axis 2: The action — The act or deed performed by an actor, upon the target; and
- Axis 3: The Means — the methods and processes through which an action is performed.

A visual presentation of these three axes is shown in Figure 2.2. Each of the three axes are comprised of a coded list of expressive categories; while each intervention is comprised of a title, and a unique seven-digit stem code that represents the target, action, and means for that particular intervention (Manchaiah et al., 2020; Fortune et al., 2018). The first three digits of the stem code represent the Target, next two digits represent the Action and the last two digits represent the Means, example: Cholecystectomy KCF.JK.AA – the Target KCF is 'Gall bladder', Action JK is 'Excision, total', and Means AA is 'Open approach' (ICHI Beta-3 Reference Guide, 2020).Each health intervention also constitutes a distinctive arrangement of categories from the three axes (ICHI, 2020).

Figure 2.2 Three axes that define health interventions within the ICHI

Source: Fortune et al., 2018.

The ICHI classification is currently made up of 27 chapters of codes that are categorised into four sections, as follows (Fortune et al., 2018):

1. Chapters 1-12: Interventions relating to the functions and systems of the body;

2. Chapters 13-21: Interventions relating to participation domains and activities;
3. Chapters 22-26: Interventions relating to the environment; and
4. Chapter 27: Interventions relating to health-related behaviours.

It is also possible for extension codes to be added to the stem codes so that additional information about an intervention can be captured, such as medicaments, assistive products, and therapeutic products. Whilst the extension codes allow for additional information, it must be noted that in situations where the code title is a commonly utilised clinical term, the stem code comprises all mandatory features of an intervention, for example, a cholecystectomy includes a laparotomy and closure of the abdominal incision post removal of the gall bladder (ICHI Beta-3 Reference Guide, 2020). It must be noted that this is an important aspect of intervention coding whereby certain interventions that are performed during the main intervention are bundled into the main intervention code and are not separately reported. The ICHI extension codes and stem codes are also linked through a logical syntax system (Donada et al., 2018). Possibilities exist to utilise different syntax that can be used to describe interventions with stem codes only or with stem and extension codes (Donada et al., 2018). In light of these capabilities, then, it is valuable to consider the numerous strengths and benefits of the ICHI, next.

The ICHI is being formulated as a collective instrument for analysing, reporting and describing health interventions for reimbursement, quality, statistical and research purposes (Stojanovic et al., 2020). Its intention is to be all-encompassing, and to portray the complete spectrum of health interventions, in line with the biopsychosocial framework established within the ICF (Manchaiah et al., 2020). Concurrent with the paramount importance given to public health (PH) within all of the global health structures, public health forms an integral part of the ICHI (Stojanovic et al., 2020).The specific goal of the ICHI is to achieve a number of purposes, including providing a basis for redeveloping national classification instruments, and to expand content for countries where the national classification system is primarily only focused on surgical and medical intervention (Fortune et al, 2017). It will also provide a system for making health-related comparisons across borders; and offer a classification system in countries where one does not exist (Manchaiah et al., 2020).

Notably the ICHI can provide an information framework for improving patient safety and health system performance; while supporting global health initiatives, such as the Universal Health Coverage (UHC) initiative, and other sustainable development goals (ICHI Beta-3

Platform, 2020). Based on the discussions by various authors and the ICHI Beta-3 Reference Guide, it can be noted that the ICHI is well positioned as a comprehensive intervention classification system for national use. However, it must be noted that the use of the ICHI on data relating to public health is challenging thus training on the ICHI is crucial to fully understand the potential of the ICHI (Wübbeler, Geis, Stojanovic et al., 2021).

There are numerous strengths and benefits of the ICHI that have been described in the literature, despite the ICHI still being in its infancy. Fortune et al. (2018) argued that a key benefit of the ICHI is that the three core WHO 'Family' classifications – the ICHI, the ICF and the ICD, can be used collectively. The example shown in Figure 2.3 illustrates how the ICHI can be used to record diagnostic and investigative interventions that have been performed (in column 1), while supportive or therapeutic interventions are then conveyed (column 4). The ICF is also applied when defining the person's functional ability and necessity for environmental mediators (column 2); while the categorisation systems of the ICD are implemented (column 3) in order to record diagnoses (Manchaiah et al., 2020).

In a practical sense, therefore, the ICF and the ICHI can be used jointly to capture information on the process of setting goals, evaluating the outcomes of interventions, and reviewing goals; whereby, the tri-axial structure of the classification creates a standard model for describing and perusing all forms of health interventions (Fortune et al., 2018). Indeed, this inherent tri-axial format makes it contrastingly different in nature to the classifications contained in each aspect of the ICF, as well as the formats inherent within the ICD (Fortune et al., 2018).

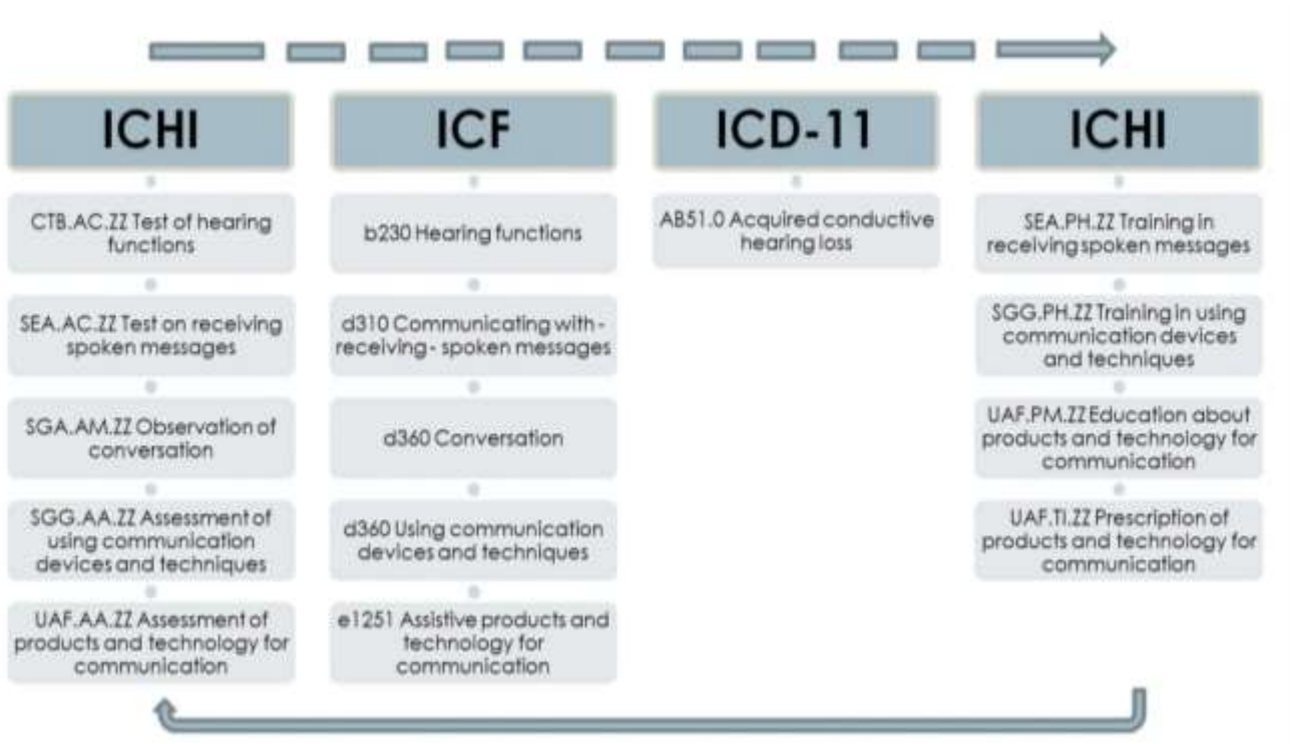

Figure 2.3. Collective use of the three WHO-FIC classifications

Source: Fortune et al., 2018

Manchaiah et al. (2020) note that in the case of audiology-related interventions, for instance, the ICHI supports codes for interventions that target body functions and systems, such as hearing functions and the tympanic membrane; activities and participation domains such as communication-receipt; environmental factors such as technologies and products for communication; and behaviours related to health, such as screening actions. Manchaiah et al. (2020) also assert that there are various relevant extension codes for depicting therapeutic products such as bone anchoring hearing systems; and assistive products such as Frequency Modulation (FM) systems or hearing loops (Manchaiah et al., 2020).

Ohannessian et al. (2017) and (2019) published papers on their experiences of the implementation of the ICHI extension codes, particularly to the classification of telestroke. Telestroke is defined as the technique of facilitating care for acute strokes, through telemedicine mechanisms such as remote health-care that uses telecommunications technologies and electronic information like the internet and other web-based approaches, to facilitate treatment without the provider and patient even though they are not physically together (Ohannessian et al., 2017).

After an assessment of the ICHI Alpha 2016 version for coding telestroke, Ohannessian et al. (2017) had determined that although it was possible to code acute stroke care process interventions with the ICHI, there were apparent shortcomings in the appropriateness of the telestroke coding system. Following discussions with the Family Development Committee that met in South Africa, in June 2017, two extension codes were incorporated into the ICHI, after which a third code was added to enumerate supplementary details about interventions within the ICHI. Consequently, Ohannessian et al. (2019) asserted that interventions for telestroke could be effectively coded with the Beta-2 version 2018 of ICHI telehealth extension codes.

In particular, the extension codes defined in the Beta-2 version, which include XH01, XH02, and XH03, are suitable for describing different distances between locations of provider-patient when interacting, and interventions supplied via technologies without human intervention (Ohannessian et al., 2019) This includes, for example, instances such as telehealth interventions involving artificial intelligence like automated screening for diabetic retinopathy (Ohannessian et al., 2019). These authors concluded that in the case of telestroke interventions, due to the addition of extension codes, the interventions could be effectively coded with the Beta-2 2018 version of the ICHI.

Perhaps not surprisingly, the majority of the strengths that have been noted in the literature, so far, have also highlighted the promises of the ICHI. Fortune et al. (2018), for instance, claimed that the ICHI promises to offer a flexible and broad-based classification for attaining information on the complete range of health interventions, such as for those with disabilities. Fortune et al. (2018), also state that it is expected to offer a platform for gathering information regarding the necessity for and equity of accessibility to interventions. Since it will function as a framework for data capturing and communication, as well as a common, international language standard, the ICHI will also play an integral role for use in practice, research, and policy development (Donada et al., 2018). In addition, because the ICHI is being formulated with an underpinning of the ICF’s biopsychosocial model, Manchaiah et al. (2020) propose that its mutual compatibility with the ICF will make it an important information framework for many years to come. Furthermore, Fortune et al. (2018) assert that utilising the ICHI, the ICF, and the ICD together will ensure that there is an effective foundation for improving health care quality, as well as monitoring the effectiveness of health systems. It can be concluded from the above discussions that the ICHI has the capacity to address different types of interventions performed in the healthcare environment and to be used concurrently with other health classifications systems. It is worth noting though that the implementation of a new classification such as the ICHI requires advocacy, dedicated resources and a cost benefit analysis of migrating existing systems to the ICHI (Fortune et al, 2018).

Conversely, the ICHI has some procedural weaknesses. Of note is a study performed by Stojanovic et al. (2020) to assess health technology assessment (HTA) systems, such as the ICHI, found that in many cases, a period of training was necessary due to the codes' structures; however, within a short time frame, "the technical handling of the platform was very workable". The authors noted, though, that the exact heading title of the interventions was not specified in the ICHI, requiring the researchers to describe the interventions with various appropriate keywords. Consequently, the Stojanovic team could often not assign a precise descriptive ICHI code to the intervention that was executed, and codes frequently needed to be used that would only approximate the interventions.

There were instances where interventions were associated with other "Action" and "Target" codes; while interventions relating to public health were sometimes imprecisely described, meaning that numerous different codes could be applied (Stojanovic et al., 2020). Stojanovic et al. (2020), consequently stated that a combination of the codes would have been more helpful. Nonetheless, the authors did assert that upon encoding each of the reported public health interventions in their study, it was apparent that numerous answers could be gathered within a reasonably small group of the ICHI categories (Stojanovic et al., 2020).

Chute (2013) argued that it is essential for modern classification systems to have an efficient web-based platform to facilitate effective and easy commenting and reviewing, more consistent maintenance, and collaborative development. Such platforms should also incorporate various inherent features, such as entity creation and adjustment features, user commenting functionality, search and navigation features, and various advanced features such as the capability to link to other classification systems and terminologies. Donada et al. (2018) also recommend that there should be an Application Programming Interface (API) functionality, for machine-to-machine communication. As noted by Tudorache et al. (2010), similar platforms were established, in simplistic forms, for the ICF and the ICD-10, with update platforms and browsers; and with more detailed capabilities for the ICD-11. Developments by the ICHI (2020) indicate that such factors are also, inherently, being introduced which suggests that the ICHI has the potential for integration into health information systems.

According to Donada et al. (2018), the ICHI Development Committee for the WHO drafted a list of constraints upon which to develop the ICHI platform, in line with previous knowledge and experience from the ICD-11's platform, while also incorporating particular attributes that were specific to the ICHI's needs. Fortune et al. (2018) maintain that the scope of the ICHI is ambitious, as it covers the full range of health interventions, and incorporates forms of interventions that have not, to date, been the focus of any overarching classification initiatives. This includes, for example, public health interventions. Due to the ambitious nature of the ICHI, therefore, it is important to discuss the relationship between the ICHI and other, non-WHO clinical classification systems. There are numerous links in the literature between the ICHI, and other international standards and clinical terminologies, such as the ISO 1828:2012 Categorical Structure (ISO 1828 CAST), and the SNOMED CT (Rodrigues et al., 2017b; Lee et al., 2019), which are described as follows:

- ISO 1828:2012 Categorical Structure (ISO 1828 CAST): This is a global nomenclature system that stipulates the minimal domain boundaries to facilitate the exchange of meaningful information, comparability and interoperability on surgical procedures, and the smallest characteristics of categorical terminological structures pertaining to surgical procedures, irrespective of language (Rodrigues et al., 2017b).
- SNOMED CT: This is a standardised database of clinical terminologies used by healthcare providers to exchange clinical health provisions comprising definitions, synonyms, terms, and codes (Lee et al., 2019).

While other clinical coding systems have many strengths, SNOMED CT is often highlighted, in the literature, for its role as "the most detailed clinical reference terminology for procedures used in the Electronic Health Record (EHR)", and cited as the most comprehensive, multilingual terminology system of clinical terms, in the world (Lawley et al, 2017). Due to its ubiquitous function in global healthcare, there has been considerable academic interest discussing the link between SNOMED CT and the ICHI (Monestime et al., 2019; Rodrigues et al., 2017a). While the ICHI may be suitable for statistical use, SNOMED CT may be considered as favourable in eHealth applications in terms of content expressivity and international usability (Thun and Dewenter, 2018). The ISO 1828: 2012 notes that the ICHI is based on a concept system that conforms to this standard similar to the French Classification Commune Des Actes Medicaux (CCM), the CCI and SNOMED CT. Thus it can be concluded that the ICHI is well positioned in terms of its alignment to international standards.

When considering the primary weaknesses of the ICHI, authors such as Rodrigues et al. (2017a) have criticised that there are numerous inconsistencies between SNOMED CT and the ICHI, which could cause discrepancies in the global health community. The authors noted examples such as for the "Insertion of temporary trans-venous pacemaker system", where the SNOMED CT concept model facilitates alignment with global standards such as ISO 1828, while in the ICHI, "there is no lexical map between ICD-9-CM '37.78' and ICHI 'HTB SN AH'", since no pacemaker device 'Target' code exists; and the "'HTB' code for cardiac function and 'DL' 'Action' code for 'insertion' cannot be applied". On a more universal level, the authors also complain that "only the ICHI 'Action' axis is aligned with ISO 1828 'Surgical deed' semantic category and the SNOMED CT 'Method' attribute." The authors therefore proposed various updates that should be made, to revise the coding structure of the ICHI to better align with global nomenclature systems such as SNOMED CT and ISO 1828 CAST (Rodrigues et al., 2017a).

It is also worth noting that after more-than ten years of development, where the beta version of the ICHI is currently in a final testing phase, it is inevitable that shortcomings and problems with the classification, as well as its strengths, will be apparent (Fortune et al., 2018). For instance, there are inevitable shortcomings within the ICHI, which are currently being explored, such as ambiguities in code definitions and titles, overlaps in categories, and gaps in content; however, authors such as Fortune et al. (2018) assert that the purpose of testing the beta-version of the ICHI is to identify these problems, and address them before it is finalised.

To facilitate this, the ICHI has been generated with an online, website-based platform to allow for updates and developments to be made to the classification systems; and upon the final approval, to support the continuous update and revision of the classification (Donada et al., 2018). The current testing of the beta version of the ICHI is argued to be providing a foundation for the development of training and educational resources (Fortune et al., 2018). It has also been asserted that incorporating a diverse range of potential users into the testing phase is essential for ensuring that the beta version can be evaluated for its capacity to meet the needs of different users throughout the different countries and applications, in which it will be applied. This covers, for instance, countries or regions characterised by low medical resources (Fortune et al., 2018). Based on the arguments presented by the various authors it is worth noting that the benefits of the ICHI outweigh any drawbacks that the ICHI may present.

It is also valuable to discuss the potential difficulties that are anticipated to arise with the implementation of the ICHI, following the completion of its beta testing phase. Of course, upon completion of the testing phase, implementation of the ICHI will form a core focus of efforts for individuals in centres working in collaboration with the WHO, who have assisted with the classification's development, and who will be committed to helping it realise its full potential (Fortune et al., 2018). Fortune et al. (2018) perhaps stated it best when they noted:

> *"In some respects, any international classification is always a work in progress: while it must provide a stable structure and basis for collecting data to support comparability over space and over time, there must also be scope for it to expand and evolve as required to serve the needs of its users."*

When considering the development of experience and practice pertaining to the ICF, for instance, across a broad array of applications, successive reviews of the literature illustrated the defining parameters surrounding its operationalisation, including the qualifiers and delimitations that could be used to depict its Activities and Participation (Jelsma et al., 2011). If the lessons learned from the implementation of the ICF, over the past two decades since its endorsement in 2001, by the World Health Assembly, can be applied to the ICHI, it suggests that the widespread uptake of a new classification such as the ICHI, will not happen automatically or spontaneously. Instead, Fortune et al. (2018) suggest that uptake will be characterised by a gradual and complex process that involves a detailed analysis of its limitations and strengths, together with an accurate clarification of its range of potential uses, and an accumulation of a body of knowledge pertaining to real-world experience and practice in its uses. The Fortune et al. (2018) study and the ICF implementation lessons learnt has implications for this research, as it has embarked on an evaluation of the suitability of the ICHI for general surgery interventions, by extracting intervention descriptions from a database in South Africa and coding these to ICHI codes.

Furthermore, it has been argued that it is inevitable that the ICHI will require progressive iterations of improvement; and that the classification should inherently be regarded only as a stable framework for gathering data, while there should be capacity for the framework to grow and develop, over time, as the need arises (Fortune et al., 2018).

Having presented a review of the literature on the WHO-FIC classifications and particularly the ICHI, it is worth noting that various other medical coding systems exist globally, and in

South Africa, which are worth deliberating for the purposes of this study. Furthermore, healthcare documentation and coder training require consideration in the adoption and implementation of healthcare classification systems, which is presented next.

2.4 ADDITIONAL MEDICAL CODING, HEALTHCARE DOCUMENTATION AND CODER TRAINING

The literature review turns, now, to a review of some other key medical intervention and billing coding systems that exist, globally, specifically the CPT and the HCPCS followed by healthcare documentation and coder training.

2.4.1 The Current Procedural Terminology (CPT) System

The CPT system of codes identifies the services performed on patients by doctors and other healthcare providers (Ward and Roth, 2017). CPT codes were developed by the American Medical Association (AMA) in the 1960's as a shorthand way to document medical treatment (Hirsch et al., 2016). These later evolved and matured to be endorsed by the US government, and universally used for the reimbursement of insurance claims (Kluyts, 2019). Thus, the original intent of the CPT codes was as a simplified means for doctors to document procedures performed on patients for the purposes of medical records, and not for payment of insurance claims (Hirsch et al., 2016). The first addition of CPT codes was numerical, with two-to-four digits. The second edition of the CPT codes occurred in 1970; where the coding system was developed into a five-digit format (BHF, 2007).

In 1983, the Centres for Medicare and Medicaid Services (formerly the Health Claim Financial Administration) combined the CPT coding system with the HCPCS coding system (Section 2.4.2), and the CPT coding system was to be maintained by the AMA, requiring its use for all Medicare billing (Deeken-Draisey et al., 2018). New editions of the updated CPT codes are released each year in October, and codes are added, removed, and revised with each revision (Chung et al., 2018). Changes to codes can be initiated by providers, medical societies, or responsible organisations, and changes are governed by the CPT editorial panel, which consists of 16 representatives (Deeken-Draisey et al., 2018). The next section presents a short summary of the differences between the CPT and the ICHI.

Quantifying the differences between the CPT and the ICHI, it is clear from the preceding sections of the review that the CPT is a medical code manual published by the AMA aimed at billing and reimbursement, while the ICHI is a WHO statistical classification. The CPT's codes describe the procedures performed during a patient's visit, including surgical, radiological, laboratory, diagnostic, and consultation procedures for use by Physicians, while the ICHI code describes interventions that cover all facets of a healthcare system and may be utilised by all healthcare practitioners and facilities (ICHI Beta-3 Reference Guide, 2020). The codes used in the CPT are more intricate and complex than those of the ICHI, because although there may only be a single ICHI code for describing an intervention such as a percutaneous transluminal angioplasty of artery of lower limb (ICHI Beta-3 Platform, 2020), there are numerous codes in CPT that name each artery in the lower limb where the angioplasty was performed (CPT 2020). In order to determine the CPT code it requires an understanding of various considerations of the visit. These include how many body systems the physician examined (Deeken-Draisey et al., 2018), how long the patient spent with the physician, and the circumstances of the patient's visit (Hirsch et al., 2016). Conversely, in order to determine an ICHI code it requires an understanding of the intervention performed, i.e. that Target, Action and Means components (ICHI Beta-3 Platform, 2020).

Grobler (2011) argued that CPT "makes ample provision for most scenarios", in South Africa, while "taking into consideration complexity and time" of a physician to examine, diagnose and treat a patient while the ICHI is not time based and is provider and setting neutral (ICHI Beta-3 Platform, 2020). However, it is important to emphasise that Grobler's paper was written nearly a decade ago, and fails to cater to the current medical environment in the country. More, on South Africa's medical coding, is presented in Section 2.5.

2.4.2 The Healthcare Common Procedure Coding System (HCPCS)

The second of the two key non-WHO coding systems noted here, the HCPCS coding system, was developed in 1983 by the Centres for Medicare and Medicaid (Rains et al., 2017). The intention of the HCPCS was to provide a standardised coding system for healthcare that covered both services and supplies (Hameed, 2017). Its intent was therefore to provide a uniform way to classify services, standardise coding, and meet the needs of Medicare and Medicaid (Hameed, 2017). The HCPCS system is based on the AMA's CPT codes, and the use of HCPCS became necessary for all government (Medicare and Medicaid), and private insurers to process claims consistently (Kanter and Molteni, 2019). HCPCS consists of three levels of codes (Rains et al., 2017) as follows:

- Level I: These are the AMA's CPT codes.
- Level II: These are codes for non-physician services not covered by CPT codes, such as ambulances, supplies, and medical devices. These codes begin with letters (A to V), followed by four numeric digits, and the codes are updated every year (Buck, 2017).
- Level III: These are local codes developed by Medicare contractors, state medical aid organisations, and private insurance companies. These codes are similar in structure to Level II codes, and begin with the letters W to Z, followed by four digits. The use of Level III codes was discontinued in 2003, in favour of coding that is consistent regardless of the agency or location.

It is worth noting that the ICHI caters for a range of interventions and services for data collection in a single classification system provider neutral (ICHI Beta-3 Platform, 2020). Conversely the CPT and HCPCS are both required to process claims and reimbursement is based on provider type (Kanter and Molteni, 2019). It can thus be concluded that the ICHI has the potential to replace multiple coding systems both for data collection and reimbursement with future national or WHO updates and revisions.

2.4.3 Healthcare documentation

The coding of health information into clinical codes is not only useful for patient treatment but also for storing data into a database and used for many purposes (Shepheard, 2020). Shepheard further highlights that the integrity of coded data is dependent on the quality of healthcare documentation**.** Of note is that the quality of healthcare documentation is negatively impacted by incomplete and disorganised documentation in healthcare records on the one hand and an increasing expectation of quality healthcare documentation by health information and clinical managers on the other hand (Doktorchik et al. 2019). Healthcare documentation and coding accuracy are interlinked thus it is incumbent on clinicians to document complete and concise information in discharge summaries that coders utilise for clinical coding (Mahbubani et al., 2018). Accordingly Roberts et al., (2018) share a similar view whereby mention is made that junior doctors are tasked with the completion of discharge summaries, which are the primary source for clinical coding. Furthermore complete and clear healthcare documentation is a legal requirement of clinical personnel which not only supports accurate reimbursement but also optimises patient management and outcomes (Roberts et al., 2018). Coding departments within hospitals have a responsibility to train junior doctors on quality healthcare documentation to support clinical coding and clinical coding can be optimised by the use of new technology such as programmes that are able to extract clinical information from discharge summaries (Mahbubani et al., 2018). The authors concur that complete and accurate healthcare documentation is critical for correct assignment of clinical codes for quality health data collection. It can thus be concluded that a key factor in the successful implementation of a classification system such as the ICHI for quality healthcare data collection is dependent on accurate, complete and clear healthcare documentation.

2. 4. 4 Coder training and coding tools

Training of coders in Canada is regulated at regional and provincials levels and coders are required to participate in medical education to maintain their certification. Training programmes are offered at universities and colleges nationally and all coding programmes are accredited by the Canadian College Health Information Management. In a study on clinical data quality by Lucyk et. al., (2017), it was noted that training is not a barrier to data quality due to adequate regulation that governs coder training and accreditation of coding programmes. Similarly, clinical coders are trained in Australian tertiary institutions to code clinical terms into codes and clinical coding is recognised as a highly specialised skill that entails an understanding of health classification systems, healthcare documentation and the treatment process and procedures of patients (Shepheard, 2020).

In countries like England, where coding is undertaken by non-clinical personnel and coder training is not as rigidly regulated or Thailand where professionally trained coders are not available at all sites, coded data quality is compromised (Lucyk et.al. 2017). Dyers et al. (2016) highlight the need for ICD-10 coding training, coder accreditation, validation tools, clinician support and the management of competing practices to improve the quality of healthcare data. Frequent training on national coding standards and refresher coding training and workshops are solutions to decreasing coding errors (Robert et al., 2018). Coder training and the availability of appropriate coding tools in developed countries contribute to quality coding whilst the shortage of coding tools such as coding manuals and the adoption of train-the-trainer coding programmes to minimise costs or employing poorly trained coders results in poor data quality (Alharbi et al., 2020). It can thus be concluded that coder training and appropriate coding tools play an instrumental role in the implementation of health classification system such as the ICHI.

2.5 CLINICAL CODING IN SOUTH AFRICA

South Africa is one of more than 100 countries using the ICD-10 system of classifications to facilitate international comparability in the presentation, processing, cataloguing and collection of mortality and morbidity statistics (Dyers et al., 2016). An overview of the implementation of the ICD-10 in South Africa, is presented next.

2.5.1 ICD in South Africa

According to the Republic of South Africa (2014), the ICD-10 was implemented in South Africa in July, 2005, under the directive of the National ICD-10 Task Team — a joint task team between the Council for Medical Schemes (CMS) and the NDoH. The Director General of Health formalised the Task Team in 2012, appointing it as a ministerial task team which functioned under the NDoH; while the ICD-10 continues to remain under the responsibility of the NDoH (Republic of South Africa, 2018). The principles of the ICD-10 in South Africa are that the coding standards should be used in conjunction with the ICD-10's standard training material and manuals, as a system to assist clinical coders; it has been developed to track changes and keep records of healthcare implementation (Republic of South Africa, 2014).

While, global public healthcare facilities primarily use the ICD-10 codes for assessing the quality of care, as well as for ascertaining the severity and acuity of cases, the codes are primarily used, in South Africa, by public healthcare facilities for scrutinising mortality and morbidity, and for patient billing (Dyers et al., 2016). Furthermore, despite government policies impelling public sector clinicians to use the ICD-10 codes for every patient in South Africa, coding has not been systematically implemented or monitored for quality and coverage (Dyers et al., 2016).

The lack of systematic implementation has been supported by Matsoso and Fryatt (2013), who stated that despite the implementation of the ICD-10 being numerous years ago, in 2005, it is evident that the diagnostic coding system is still not fully implemented, nationally. It has also been argued that the absence of a national intervention coding system and resultant inadequate medical records, have contributed to the challenges of achieving effective healthcare delivery in South Africa (Hall, 2019). Matsoso and Fryatt (2013) asserted that the successful implementation of the NHI is dependent on an appropriate information system, arguing that a National Health Data Dictionary comprising of formally adopted coding systems, is required.

There have been numerous reasons proposed, in the literature, for the failures in the ICD-10 implementation across South Africa. Contrary to clinicians and hospitals in the private sector, who often have dedicated coders to assist with this process, the clinicians in the public sector themselves, are said to be responsible for coding the diagnoses of all inpatients (Tomita and Moodley, 2016). Tomita and Moodley (2016) propose that with already-heavy workloads, this means that strict compliance with the ICD-10 coding in public healthcare facilities, has been neglected. There is also other academic testimony that the ICD-10 coding quality in South Africa needs to be improved, particularly for the surveillance of mortality; where authors such as Nojilana et al. (2009) argued that there has, historically, been a need to improve the ICD-10 coding quality. Furthermore, a review of the site performance of the NHI pilot, 18 months after the pilot began, argued that the ICD system was not yet functioning acceptably, and that it would need to be improved (Matsoso and Fryatt, 2013).

Authors such as Groom (2000), in a landmark congress paper, proposed that in order to improve the quality of the ICD coding, various support processes were essential, such as supervisory review and a peer review of coding practices, communication between healthcare practitioners, accreditation of coders, continual programmes for training coders, and initial training and orientation for new ICD users and interns. It appears that these issues are therefore not recent; and after decades of persistent challenges, they have failed to be resolved. Authors such as Hohnloser et al. (1995), too, not long after South Africa's entry to democracy, proposed that various suitable assistive instruments, such as coding guidelines and software should be made more readily available to coders.

While training programmes have been demonstrated to generate positive effects on the coding quality of professional coders, Dyers et al. (2016) argued that clinicians find issue with attending accredited ICD-10 coding courses as they are often time-consuming and costly. In the case of the Department of Health of the Western Cape Government, for instance, Dyers et al. (2016) asserted that implementing such recommendations for broad-based training and assistive tools, would be challenging, due to limitations in the current capacity of the department.

In the Western Cape, an electronic application called the Continuity of Care Record (eCCR) was introduced, in 2015, in an attempt to increase the ICD-10 coding quality. It did so by integrating functionality for the ICD-10 code searches to assist the clinicians with the preparation of discharge summaries (Dyers et al., 2016). Dyers et al., 2016 performed a study to assess the precision and completeness of the ICD-10 codes gathered at hospitals in the Western Cape, with the use of the eCCR tool; and the authors found 74.0% primary ICD-10 code accuracy, with 45.3% of the sample of patient records having complete ICD-10 codes. The researchers also found that there was a statistically significant association between the seniority or rank of the clinicians, as well as the age, comorbidity rates and female gender of the patients and the completeness of the ICD coding, leading the researchers to conclude that their evidence supported the use of a computer application to assist with the ICD coding. Dyers et al. (2016) did, however, contend that more interventions, such as oversight and training of junior clinicians, and additional validation tools for the ICD codes, were required.

It is worth noting, however, that the Dyers et al. (2016) study was a cross-sectional study; and consequently, it did not compare the ICD-10 codes before versus after the implementation of the eCCR tool. It was therefore only conjecture that the efficacy of the ICD coding among the sample clinicians, was actually due to the eCCR tool, and not some other confounding factor. The researchers also did not perform any longitudinal analysis to determine whether the accuracy of the ICD-10 codes was better, or in fact worse, than before the eCCR was introduced at the test hospital.

Dyers et al. (2017) did, nonetheless, performed a retrospective, follow-up study in 2017, to evaluate the impact of the eCCR at the test hospital, relative to a control site; as well as the quality of the ICD-10 coding at the test site, before versus after implementing a support and training system on the eCCR. The researchers found that the eCCR had a 38.0% increase on the completeness of the ICD coding, relative to the control hospital; while a multiple regression analysis also determined a 6.6 adjusted odds ratio (OR) improvement of the completeness of the ICD-10 codes after, versus before the introduction of the support and training package. This led the researchers to claim that there was, indeed, “pragmatic evidence” to verify the use of support and training packages for generating significant positive effects on the completeness of the ICD coding in hospitals in South Africa (Dryers et al., 2017).

Next, the other primary clinical coding systems in South Africa for medical procedures, such as the Complete Current Procedural Terminology for South Africa (CCSA), and the South African Classification of Healthcare Interventions (SACHI), are reviewed.

2.5.2 Clinical coding in South Africa for medical procedures

The lack of a national intervention coding system has resulted in the use of multiple inappropriate intervention/billing systems for surgery which does not support quality intervention data collection and patient outcomes reporting. This presents a challenge in understanding interventions performed at various healthcare facilities. The different intervention/billings systems in use in South Africa are described below.

Private hospitals, medical aids, administrators and managed care organisations have adopted and implemented the CCSA which is published by the SAMA on license from the AMA. The CCSA is an adapted version of the proprietary CPT system for intervention coding developed and maintained by the AMA, as explained in Section 2.4.1. (Kluyts, 2019). The CPT was not designed as a hospital intervention coding system, as it is currently being used in South Africa, and the system is inappropriate for use as a hospital procedure coding system since it does not provide appropriate procedural data (Matshidze and Hanmer, 2007).

The South African Private Practitioners Forum (SAPPF) is a body whose mission has been stated as supporting the private healthcare sector by expanding, promoting, preserving and protecting private medical practice (SAPPF, 2020). The SAPPF established the SACHI as a multiparty coding body for reviewing new coding and tariffs structures in the country (Grobler, 2011). According to (HealthMan, 2017) the objectives of SACHI were:

- To be an independent, non-profit organisation with multiple stakeholders, free of any social or political pressures;
- To promote public benefit campaigns in line with the Income Tax Act (Republic of South Africa, 1962);
- To establish and regulate fees for SACHI members;
- To gather and evaluate coding data;
- To assign relative value units (RVUs) to existing or new codes;

- To recommend updates or revisions to various health professional societies, including SAPPF, the South African Medical Association (SAMA), and other interested parties;
- To manage and assist coding procedures by South African healthcare providers.

Since its initial conception, though, it has been a decade with virtually no developments; and authors such Selesho (2019) have argued that "It remains to be seen how SACHI is going to be constituted", and indeed, whether the Competition Commission (CC) could view the body as inherently unlawfully competitive. This has argued to be particularly the case if SACHI is formed by organisations or individuals directly involved in healthcare practise (Selesho, 2019). Two important coding systems are, however, in use in South Africa for reimbursement purposes —UPFS and the NHRPL — as outlined, next.

2.5.3 Clinical coding in South Africa for reimbursement purposes

The public healthcare sector utilises an internally-developed system known as the UPFS, which was implemented in November, 2000, to bill for services rendered in the public sector where relevant (BHF, 2007). The UPFS has been developed to function as a consistent schedule of patient fees for use primarily in public hospitals; although it is also applicable to externally-funded patients through the South African Police and Correctional Services, patients funded with inter-departmental charges, Workmen's Compensation and Road Accident Fund beneficiaries; and medical aid scheme members (Selesho, 2019). Its objectives are to take different levels of the delivery of health services into consideration, to ease adjustments to cost structure changes, to be founded upon the activities of health services, and to be easily implemented in both computerised and manual systems (Matshidze and Hanmer, 2007).

While the UPFS system allows some degree of procedural data collection, it is not able to provide data for proper and appropriate research to be carried out on the costs or quality of healthcare delivered in the public sector (Matshidze and Hanmer, 2007). The UPFS is being broadly utilised in every province; although it is being implemented in phases in the Eastern Cape, KwaZulu Natal, and the Western Cape (Selesho, 2019). The UPFS categorises the different charges according to the specific situation, for each patient; whereby, the patients are categorised into one of three groups, as follows (Republic of South Africa, 2009):

- Full paying patients such as patients who are externally funded, treated by a private practitioner, and certain categories of non-South African citizens;
- Fully subsidised patients such as those that have been referred to a hospital via the Primary Healthcare Services; and
- Partially subsidised patients such as those where service costs are either free based on particular circumstances — or where costs are partly covered based on individual incomes.

The NHRPL was developed on behalf of the South African NDoH by the CMS, and initially published in 2004 (Ramjee, 2010). Created by assembling submissions from each of the parts of the health services sectors, the list does not contain an inventory of negotiated prices, but suggestions on the actual costs of running practices (Grobler, 2011). Since hospitals do not participate in the classification process, the NHRPL-calculated rates do not pertain to such larger health centres (Ramjee, 2010). Consequently, the NHRPL is applied more as a guideline for medical aid schemes and practitioners for calculating their tariff structures, rather than as a reflection of the true fees of medical practices (Selesho, 2019). It is noted, for instance, that medical practitioners can charge as much as 500% of the listed prices on the NHRPL, though medical aid schemes will typically only cover up to the medical aid rate, leaving patients to cover the deficit (Ramjee, 2010).

The NHRPL system has not been updated since 2006, which Selesho (2019) argues, has resulted in limitations in the collection of significant procedural medical data. Ramjee et al. (2010) has also argued that the appropriate measurement and management of costs and quality of care are not possible when using CCSA and NHRPL data within the South African health care industry (Ramjee, 2010). This has implications for this research, since a new coding system, such as the ICHI, would need to be able to map NHRPL codes or intervention descriptions extracted from a database to ICHI codes, to function in South Africa's healthcare environment. This study has therefore evaluated the suitability of the ICHI for general surgery interventions by extracting intervention descriptions from a database to ICHI codes. The next section, presents literature that has discussed the use of the ICHI in South Africa.

The two-tiered healthcare system in South Africa: private and public healthcare systems contribute differently to the collection of health data. Notably, from discussions by various authors the ICD-10 is not fully implemented in the public healthcare sector, and more effort is required to improve the quality of coding. Conversely, in the private healthcare sector, the ICD-10 and intervention/billing coding systems are well implemented as regulation 5(f) of the Medical Schemes Act 131, of 1998 requires providers of healthcare to submit diagnostic and other codes on claims to healthcare funders for the purpose of reimbursement. This regulation compels the private healthcare stakeholders to utilise clinical coding for reimbursement and the Medical Schemes Act also requires the funders of healthcare to submit clinical codes for reporting purposes. Furthermore, the Prescribed Minimum Benefits (PMBs) a feature of the Medical Schemes Act requires funders of healthcare to reimburse 270 healthcare conditions from the insured portion of medical aid benefits. To this end, the CMS developed Annexure A which contains a list of conditions that are coded in ICD-10 which is used to identify and manage the PMBs.

2.5.4 Use of the ICHI in South Africa

Currently, with the ICHI being such a new classification system, still in its beta stage of development (Section 2.3.3), there is sparse peer-reviewed literature on the use of the ICHI as a coding system in South Africa. To date, there has been some governmental interest shown towards introducing the ICHI, together with better transitional implementation of other WHO classifications such as the ICD-10 and ICD-11; however, in the Presidential Health Summit 2018 Compact, there was a stated intention to introduce ICHI and ICD-11- (Republic of South Africa, 2018). According to the WHO-FIC Africa (n.d.), the South African Medical Research Council's (MRC) Burden of Disease Research Unit is responsible for coordinating the testing of the ICHI in South Africa with any interested parties, and that interested parties had up until 30th September, 2019, to perform any such ICHI testing. However, at the date of writing this literature review, no apparent publications were evident from that testing phase; and it is also anticipated that the SARS-COV-2 global crisis of 2019-2020 (De Oliveira Araújo et al., 2020), may have hampered or delayed the publication of testing efforts, in this regard. South Africa participated in the ICHI beta-2 field testing under the auspices of the SA WHO-FIC Collaborating Centre together with thirteen other countries and it was noted that there was good coding performance overall despite the limitations in the ICHI index terms and the ICHI browser hosted by DIMDI (WHO, 2020). Before ending the literature review, some other challenges facing intervention coding in South Africa, namely the two-tiered healthcare system and failures in the electronic records systems, are outlined, next.

2.5.5 Additional challenges facing intervention coding in South Africa

South Africa's previous Health Minister, Zweli Mkhize has highlighted that there are various issues facing the country's healthcare system, such as the two-tiered nature of healthcare, which is hampering intervention coding in the country (Phakathi, 2019). According to Mkhize, despite the Government's efforts and developments since 1994, the healthcare system has "stubbornly remained two-tiered, fragmented and inequitable, consisting of the public and private health sectors" (Phakathi, 2019). The Minister noted that there is still extreme inequality in the Government's subsidisation for the large majority of the population in public healthcare centres, while only 16% of the population are covered by private medical aid schemes, which is creating a considerable burden in providing facilities to those from poorer households. A mechanism that is currently being prepared to address this, is the NHI (Phakathi, 2019); and this is also likely to have effects on the implementation of intervention coding, such as the ICHI, across the country, as well.

In 2012, South Africa published its eHealth Strategy, acknowledging that health information systems (HISs) should be employed to boost the strength of the country's public healthcare system (Republic of South Africa, 2012). HISs are argued to enhance healthcare quality by decreasing medication errors, increasing disease surveillance, and improving the observance of guidelines (Khalifa, 2017). It has also been proposed that electronic systems for recording patient records (EPRs) can lower the amount of time required for nurses to process documentation in healthcare facilities (Samadbeik et al., 2017).

Authors such as Wright et al. (2017) contended, though, that although the benefits of electronic HIS are well documented, their implementation in South Africa's public healthcare system remains low; with patient data still being recorded manually in patient files, and data for the purposes of evaluation and monitoring being written into registers by hand, by the nurses. In spite of this, Wright et al. (2017), in fact, proposed that the benefits of HISs and EPRs are more theoretical, and often not realised in practice, even when HISs and EPRs are installed. The author supported this with claims that successful cases of improved patient safety and quality of care are limited to "only a few locations", globally; while there is also insufficient evidence for their cost effectiveness.

Consequently, it has been suggested that HISs and EPRs may indeed lower the efficiency of primary clinical work, particularly in cases where the HIS is not developed to fit the task flow, or if the healthcare worker is not technologically-inclined, or computer literate (Wright et al., 2017). In the case of secondary healthcare work, though, such as for billing, research and audits, it has been noted that HIS have been proposed to make work more efficient, due to the increased access to all data in a single repository (Johnson et al., 2018).

Wright et al. (2017) performed a review of the existing electronic HISs in South Africa's public healthcare system, and found that there is a broad array of HIS instruments that are currently being used in the country. However, only one system — the Primary Health Care Information System (PHCIS) — was categorically noted to provide ICD-10 coding functionality to the healthcare providers, as shown in Table 2.1.

Table 2.1 Primary HISs implemented in South Africa

HIS focus	Description
Operational and strategic-level systems for evaluation and monitoring purposes	
National Health Patient Registration System:	Installed in 650 public health facilities in SA, it records reasons for visit, and supports identity verification.
District Health Information System (DHIS):	An open-source software responsible for gathering and analysis functionality of fundamental healthcare data in district hospitals and primary healthcare centres in the public sector; covering 200 indicators.
Patient and operational-level systems for administration purposes	
CLINICOM Hospital Information System:	Used by nearly every hospital in the Western Cape to provide hospital administration and patient demographic data. A distinctive patient identity value is shared between other public-sector HISs.
Delta 9™ Hospital Information System:	Used in more than 108 clinics and hospitals in both private and public sectors, it supports a master patient index with administrative and demographic data about patients.
Patient Administration and Billing System (PAAB):	Operated by a private company owned by the Department of Health, with administration and clinical data recording functionality.
RxSolution:	Funded by the US Centres for Disease Control and Prevention (CDC), and rolled out in hospitals and clinics in at least five provinces, it provides stock control functionality.
Primary Health Care Information System (PHCIS)	Produced for clinics and public sector heath centres in the Western Cape, it supplies ICD-10 codes, and patient demographic data together with distinctive patient identity numbers from CLINICOM.
Patient Record and Health Management Information System (PREHMIS):	Operated by the City of Cape Town for primary care clinics, the system captures patient records on a Linux-based system.
Patient Level systems for Supporting services and clinical care	
Electronic health records (EHR) and Electronic Patient Records (EPR) Systems	In line with South Africa's National Health Insurance strategy, EHRs are being implemented across the country. By 2017, five out of the nine provinces had some type of EPR system in the public hospitals.
Picture archiving and communication systems (PACS):	Implemented in many South African public sector hospitals, the systems are intended for radiology imaging facilities to communicate information; however, very few are said to be operating normally.
JAC Pharmacy System:	Launched in 1999 as a proprietary system for pharmacy stock control and dispensing, which, as of 2017, was installed in most Western Cape hospitals.

Developed for clinics and health centres in the Western Cape public sector, PHCIS captures the ICD-10 codes together with demographic data for patient visits, while using distinctive identifications for patients as bar codes administered by CLINICOM — another wide-spread HIS. Wright et al. (2017) summarised the main HISs in South Africa as belonging to either operational and strategic-level systems, such as those for evaluation and monitoring; patient and operational-level systems, such as those used by administration departments; and patient-level HIS, such as those used for supporting services and clinical care.

2.6 CONCLUSION

There are many factors that impact on the delivery of healthcare and the creation and dissemination of information and knowledge through efficient medical coding systems, which is a vital step in delivering such healthcare services. The ICD-10 is the tenth release of the ICD by the WHO, which includes codes for diseases, external causes of diseases or injuries, social circumstances, complaints, and abnormal findings, signs and symptoms. Various countries around the globe have adopted and implemented standard and modified revisions of the ICD-10, which include various approaches to intervention coding; however, the newest classification system in the WHO-FIC classifications is the ICHI, which is scheduled to be completed by the end of 2020. There are numerous strengths and benefits of the ICHI, while its primary disadvantage is that it a new classification system which is in its beta version.

South Africa is one of more than 100 countries using the ICD-10 system of classifications to facilitate international comparability in the presentation, processing, cataloguing and collection of mortality and morbidity statistics. However, challenges have been observed with the implementation of the ICD-10 and other clinical coding systems in South Africa, such as the CCSA, SACHI, UPFS, and the NHRPL. These have been caused by, among other things, the two-tiered healthcare system, inadequate coding training, shortage of coding tools and inefficient healthcare records in South Africa. While the new ICHI is intended to be introduced in South Africa, there are numerous challenges also anticipated with its implementation, such as the ability of the ICHI to map to South Africa’s NHRPL codes, or the assignment of the ICHI codes to intervention descriptions extracted from a database in South Africa’s healthcare environment. This study has therefore evaluated the suitability of ICHI for general surgery procedures. The methods used to target this research aim, and answer the research questions of the study is outlined next.

CHAPTER THREE
RESEARCH METHODS

3.1 INTRODUCTION

This chapter addresses the key aspects pertaining to the methods employed in this research project. A summary of the methodology, the rationale for the research methods, and the research philosophy, research design and research strategy, are provided. In so doing, the target population, sampling, research instrument, and the methods of data collection and analysis are described. To answer the research questions, two phases were used for the assignment of the ICHI codes, which comprised coding the intervention descriptions that appear in Table 3.2 into the ICHI codes, and establishing the corresponding match between the data. Validity, reliability and bias are also addressed in this chapter followed by an explanation of ethical considerations in the use of patient health information.

3.2 RESEARCH PHILOSOPHY

Before considering the methodology that was undertaken, it is important to consider the research philosophy, as it underpins the entire epistemological focus of a study (Saunders et al., 2019). This study adopted a positivist philosophy as in-patient intervention data were logically and rationally studied and coded into the ICHI codes (Babbie, 2015). Babbie (2015) reflects on how Auguste Comte's third stage of positivism philosophy, replaced religion and metaphysics that was based purely upon beliefs, with knowledge by observation through the five senses. This enabled the logical and rational study of entities and societies. A quantitative or deductive paradigm was utilised to evaluate the suitability of the ICHI for general surgery coding, by coding intervention data to the ICHI codes. In-patient intervention explicit data were utilised to create a general explanation or a theory to explain the data (Schutt, 2019).

The theory in quantitative research allowed the researcher to justify the relationship between the variables such as the intervention performed, age and gender of the patient that are being tested to predict phenomena as discussions, figures and rationales (Creswell and Creswell, 2017). This epistemological paradigm was chosen as it provides the researcher with the framework to deductively answer the research questions.

Based on the epistemological paradigm, the study was able to answer the research questions, and specifically, to deduce whether the ICHI can be recommended for adoption in South Africa as a national intervention coding standard. The research design is outlined next.

3.3 RESEARCH DESIGN

A retrospective, descriptive study design was used to evaluate a cross-section of data, which had been pre-collected into a database at three South African academic hospitals. This design was chosen, as it was deemed that retrospective data could be suitably incorporated into the study design, while obviating the need for prospective data to be gathered. A single cross-sectional spectrum of data allowed the research questions to be answered. To adhere to the scope of the research design, and work within pre-determined timelines, the researcher developed a detailed research plan and research proposal, prior to commencing the study. The ICHI code assignment and the data analysis assisted researcher in answering the research questions. The plan, as depicted in Figure 3.1, outlined the research processes followed.

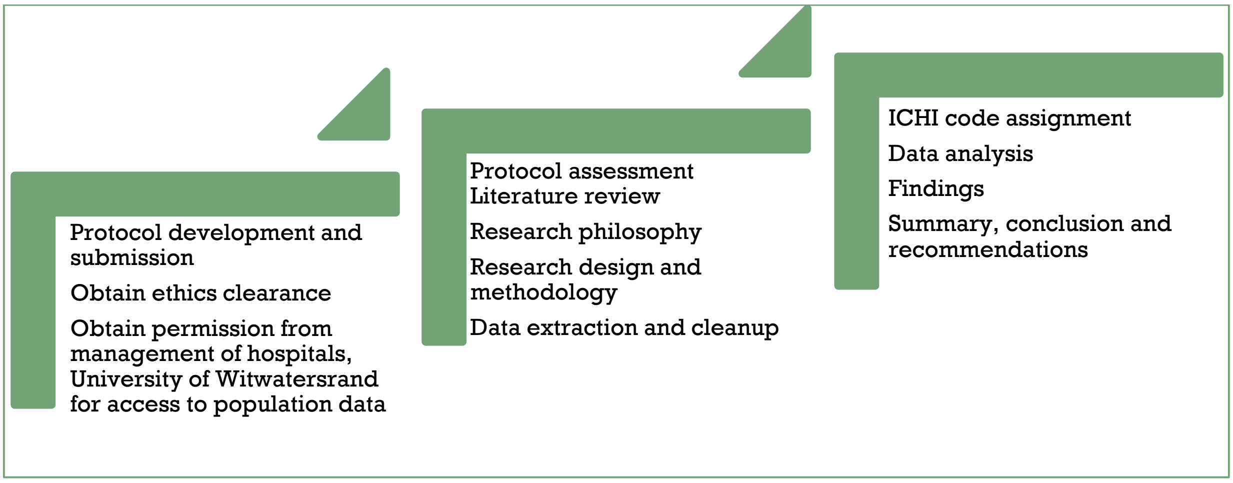

Figure 3.1. Research plan and processes followed

The individual aspects of the research design that were planned and implemented, namely the study or target population, sampling, data collection, and data analysis techniques that were followed, are outlined below.

3.3.1 Target population

The target population included data sets from surgical patient interventions at three academic hospitals in Johannesburg: the Chris Hani Baragwanath Academic Hospital (CHBAH), the Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), and the Helen Joseph Academic Hospital (HJAH). The CHBAH is the largest of the three hospitals with 3 400 beds and is located in Soweto. It provides tertiary and specialised health services to the south western regions of Johannesburg and serves as a referral hospital to a large part of South Africa and neigbouring African countries. The CMJAH is located in Parktown with 1088 beds and offers tertiary and highly specialised health services to the greater Johannesburg region and neighbouring provinces. The HJAH is located in Auckland Park with 485 beds and provides tertiary health services to the northern and southern regions of Johannesburg. The three hospitals provide services to both the urban and rural areas of the Gauteng province and surrounding provinces as they function as referral hospitals for regional and district hospitals in rural areas.

The target population consisted of surgical interventions that had been performed on patients' at all three hospitals, as well as paediatric patients from the CMJAH. The total population comprised 30,000 discharge summaries from patient records that had been captured electronically into a database as shown in Table 3.1.

Table 3.1. Population data from three academic hospitals

Academic Hospital	**Total in numbers**	**Total in percentage**
Charlotte Maxeke	15 000	50%
Chris Hani Baragwanath	10 000	33%
Helen Joseph	5 000	17%

3.3.2 Sampling strategy

The sample was purposefully selected from three academic hospitals and extracted from a retrospective database containing 30 000 in-patient healthcare records. The sample extracted from the population enabled the researcher to establish if the ICHI is suitable for in-patient general surgery coding (Thompson, 2012). A probability sampling approach was adopted for this research due to its ability to be generalised to the target population at large, and its statistical reliability. This sampling method afforded every unit of the population an equal opportunity for inclusion in the final sample set (Etikan and Bala, 2017). Stratified random sampling was utilised to select the study samples. Data were categorised into strata according to inherent collectively exhaustive and mutually exclusive characteristics of having complete age, gender, diagnosis and intervention descriptions, and ICD-10 and NHRPL codes and their descriptions. This is because the hospital database consisted of numerous different fields, which were divided into structured and free-text fields, as outlined in Table 3.2.

Table 3.2. Structured and free-text fields in the hospital database

Structured fields:	**Free text fields:**
Date of admission and discharge NHRPL codes and descriptions ICD-10 codes and descriptions	Admission examination findings Procedure/intervention description ICD-10 narrative, pathology and radiology investigations and results Discharge summary Demographic details of the patient Referral centre/referral clinician Follow up visits: date, time and place Discharge medication Clinician name and practice number Hospital details

The inclusion criteria for this study were general surgery procedures performed in two academic hospitals on adults only, and general surgery procedures performed on adults and children in one academic hospital of Johannesburg. The sample set was limited to 10% of the population, and exclusively to the intervention data. The study was confined to surgical data from the three academic hospitals, which had been collected from April 2013 to August 2019; and also only considered the intervention descriptions to the ICHI codes. This was to the exclusion of other coding systems utilised in South Africa; while other exclusion criteria included other surgical procedures performed at the three academic hospitals that did not fall under general surgery, as well as interventions performed at other healthcare facilities in South Africa or internationally. Although additional information was present in the sample, such as the NHRPL codes, this was excluded in the coding.

Consequently, for the purpose of this research, only the following variable fields were included in the sample: age, gender, diagnosis, radiology findings/comments and intervention descriptions, ICD-10 and NHRPL codes and descriptions. This was to ensure the confidentiality and privacy of the subjects. The population was evaluated for invalid, incomplete or duplicate NHRPL codes and intervention descriptions, per patient, and all duplicate NHRPL codes and intervention descriptions were excluded from the target population. Members of the population that satisfied the above criteria were selected at random. The subjects were identified independently by the Wits database administrator; the sample was selected with the aid of a computer that randomly generated numbers from 30 000 healthcare records.

3.3.3 Sample and sample size

Ten percent, (10%) of 30,000 healthcare records was selected, for inclusion in the study sample by the database administrator. This sample size was selected as it was assumed that this number of units would provide sufficient numbers of data points to establish if the ICHI is suitable for general surgery coding at the selected academic hospitals in South Africa, and to identify potential gaps and new codes. This sample may not be representative of general surgery interventions performed at regional and district hospitals as well as private hospitals in South Africa. This is largely due to regional and provincial variations in services offered at private hospitals and different levels of public sector hospitals i.e. tertiary, regional and district. Variations may also be due to the quality and manner of healthcare documentation and process of healthcare documentation between the public and private hospitals. Private hospitals have less healthcare documentation per patient than public hospitals. A repeat admission in the private hospital is considered as a new patient and a new set of healthcare records are compiled whilst the same healthcare record is utilised in public hospitals for repeat admissions. New clinical information is added to the existing public sector healthcare records thus providing a more comprehensive set of healthcare records. It is important to emphasise that no power analysis was performed to determine the required sample size needed because no previous studies of this nature existed to establish a suitable benchmark effect size (and therefore sample size). Upon gathering the sample of data, the following procedures were performed to collect usable data for the purposes of the study.

3.3.4 Data collection

Having assembled the study sample, the next phase of the research design required the collection of usable data for the purposes of coding the intervention descriptions into the

ICHI codes. To code the intervention descriptions into the ICHI codes, the data set was initially exported to Microsoft Excel. Each intervention description was coded into corresponding ICHI code(s) by use of an online ICHI browser. Where the intervention description was incomplete, omitted or vague, the radiology findings and the ICD-10 code and description or the diagnostic information was referenced to assign the most appropriate ICHI code(s). Once the ICHI code(s) were assigned, a relationship key that describes the manner in which the intervention description was coded into the ICHI code was assigned per ICHI code. The keys illustrated in Table 3.3 were used to represent the relationships between the intervention descriptions and their ICHI code(s).

Table 3.3 Relationship keys for coding of intervention description to the ICHI codes

Key	Meaning	Explanation
E	Equivalent coding	Direct coding of intervention descriptor to one ICHI stem code. This means that the description was coded directly into an ICHI stem coder that had the same or similar description to that of the surgical intervention.
B	Broader concept	The intervention concept or description is broader than the ICHI stem code. This results in more than one intervention descriptor being translated coded to one ICHI code. This means two or more intervention descriptions are coded into one ICHI stem code.
N	Narrower concept	The intervention concept or description is narrower than the ICHI stem code This results in one intervention descriptor being coded to many ICHI codes. This means that one intervention description is coded to two or more ICHI stem codes.
TM	Target component coding	Intervention descriptor translates to the ICHI Target component
AA	Action component coding	Intervention descriptor codes to the ICHI Action component
AM	Means component coding	Intervention descriptor codes to the ICHI Means component
NC	No corresponding code	No corresponding ICHI code for intervention descriptor
NI	No intervention information	Procedure and radiology fields in database were blank or intervention information was not documented, only findings were documented.
RI	Radiology information	ICHI code was assigned on clinical radiology report as the intervention field in the database was blank
II	ICD-10 information/diagnostic information	ICHI code assignment was verified with ICD-10 code/diagnosis description to establish if intervention was appropriate for the diagnosis as the intervention information was either incomplete or vague

When capturing the coding of the intervention descriptions in their respective ICHI codes, the data elements were represented in 11 different columns, as depicted in Table 3.4. Two columns represented relationships keys, i.e relationship key 1 that illustrates the ICHI code selected based on the intervention data and relationship key 2 that illustrates the ICHI code selected based on the ICD-10 code/diagnostic information or radiology findings as the intervention data was missing or incomplete. While additional information was present in the sample, such as the NHRPL codes, these were excluded in the coding, because the NHRPL codes included high volumes of incorrect translations of intervention descriptors to NHRPL codes. The coding was also limited to the ICHI stem codes: The ICHI extension codes were excluded as they are optional components of the ICHI classification system (Donada et al., 2018). Some intervention descriptions and the ICHI codes were age- and gender-specific; thus, the age and gender edits were taken into consideration in the assignment, when appropriate.

Table 3.4. Data representation for coding the intervention terminologies

Column	Description
Column A	Diagnostic description
Column B	ICD-10 code
Column C	Gender of the patient
Column D	Age of patient
Column E	Intervention description
Column F	Radiology findings
Column G	ICHI code
Column H	ICHI description
Column I	Relationship key 1
Column J	Relationship key 2
Column K	Comments

The coding process was performed by the researcher and two other clinical coders independently. The process entailed coding the sample data into the ICHI codes utilising the same data set, by all three coders. The ICHI code that best described the intervention description was assigned and the ICHI coding rules and conventions were adhered to in the assignment of the codes. As per the ICHI Beta-3 Reference Guide (2020) these included the following:

- Assignment of the most appropriate ICHI code by searching for the code using the intervention description,
- Choosing the domain Interventions on Body Systems and Functions to access the ICHI code that most appropriately described the intervention when the code was not derived by searching on the intervention description,
- Choosing the Target, Action or Means axes when the code was not derived by using the domain or by the direct search of the intervention description,
- Before the selection of the stem code, it was ensured that the ‘Target’, ‘Action’ and ‘Means’ categories corresponded to the intervention description in the health record (ICHI Beta-3 Reference Guide, 2020).

The full descriptions and instructions were then appraised prior to the selection of the appropriate stem code an example of which is reflected in Appendix A. These included the following:

- Definition appraisal: this described the intervention and defined the axis category from which the code was created.
- Index terms appraisal: this provided guidance regarding the content of the stem code, while providing examples of terms that ought to be classified in the stem code (non-exhaustively), such as synonyms.
- The “Includes notes”: this further defined or explained the scope of the stem code, where these notes stated intervention elements that were inherent in the intervention; or otherwise, inclusions for the axis categories in the stem codes.
- Appraisal of ‘code also’ or ‘code when’: this provided guidance to the user to assign an additional code when related interventions were performed.
- Appraisal of excludes notes: this provided a list of the ICHI interventions that were classified elsewhere in the classification; as well as a general guidance regarding intervention types for which the code was not appropriate, and delimitations on the use of the codes.
- The comments column (see column K in Table 3.4) was utilised by the researcher and the clinical coders to document additional comments that they felt required further clarification, or later re-evaluation.

Once the initial phase of coding the intervention descriptions into the ICHI codes was concluded, the second phase involved establishing the corresponding match between the ICHI codes and the intervention descriptions. To do so, the data were firstly checked for accuracy, by randomly spot-checking the intervention descriptors and codes to identify invalid and incomplete codes. In the process, when reviewing the extracted intervention descriptions against the assigned ICHI codes, all incorrect and invalid ICHI codes were corrected.

Upon establishing the accuracy of the data, the data were then assessed to ascertain the match between the ICHI code and the intervention description, by assigning a numeric value from 1 to 7 to the key in Table 3.2, excluding RI and II, which were utilised to verify the most suitable ICHI code for assignment when the intervention data was vague, incomplete or missing. A value of 1 indicated that there was an exact match between the ICHI code and the intervention description, while a value of 7 indicated that there was no match; and incremental integer values of 2-to-6 represented an ordinal scale of varying degrees of match. Criteria for listing which ranked numeric values, from 1-to-7 were used, was left up to the subjectivity of the researcher and the two clinical coders.

3.3.5 Data analysis

In line with the positivistic paradigm, quantitative data analysis techniques were utilised to assess the overall degree of match between the ICHI codes and the intervention descriptions, across the sample.

IBM Statistical Package for the Social Sciences (SPSS) version 24 was used for the analysis of the data, according to the guidance of Field (2013); a suitably qualified statistician was secured to assist with programming the data into the SPSS, and running the inferential statistics portions of the data analysis. The results illustrated what percentages of the data had direct matches with the ICHI codes, and which specific columns of data were more- or less-directly associated with the ICHI codes. It also highlighted which data columns more closely matched their ICHI codes thereby requiring limited expansion to be able to generate suitable codes, and which data columns required the broad creation of new codes. The quality of the healthcare documentation had a direct impact on the data columns, where the intervention description was correctly documented the data columns closely matched the ICHI codes. Where the healthcare documentation was incomplete or unclear, data columns required broader creation of new codes and this was seen across the dataset. The complete data set comprised of 21 variable types, which were either qualitative (text strings), nominal, ordinal, or interval data variables. Each variable comprised 3000 associated data point entries, which were either single observations or blank (missing) cells relating to the clinical data of 3000 patient cases.

The findings after the data analysis were depicted in appropriate graphical illustrations, and are presented in Chapter four; while discussion of these results is presented in Chapter five.

3.4 VALIDITY, RELIABILITY, AND THE ELIMINATION OF BIAS

Content, construct and criterion validity were addressed to ensure that intervention data in a retrospective database were correctly coded into the ICHI codes. Various forms of reliability applicable to the research was addressed and is described under 3.4.2. The elimination of bias was addressed through the design, data collection, sample selection, data analysis and publication.

3.4.1 Validity

There are typically three main forms of validity that are considered to be important in research, as follows:

- Content validity: a form of internal validity, this depicts how completely the constructs being measured are able to provide a full reflection of all the aspects of the phenomenon being studied (Almanasreh et al., 2019). To maximise this study's content validity, the researcher approached data from three healthcare facilities, and provided measures of 10 different aspects of the intervention codes (Table 3.4). The NHRPL codes from the wide spectrum of surgical interventions at the three academic hospitals, were also assessed and excluded due to the high volume of errors in the coding.
- Construct validity: another form of internal validity, which depicts how closely the constructs being measured provide data to answer the actual research questions that were asked (Mohamad et al., 2015). Two techniques that are used to depict construct validity are convergent and divergent validity, where overlapping or opposing variables should provide complementary or conflicting (or inversely proportional) values, respectively (Wang et al., 2018). To maximise construct validity and precisely measure the notion of whether the ICHI can be recommended for adoption in South Africa as a general surgery intervention coding standard, this study generated a variable (on an ordinal scale from 1-to-7) measuring the degree of match between the ICHI codes and the intervention descriptions. A correlation analysis was performed to demonstrate the convergent and divergent validity of the data.
- Criterion validity: a form of external validity, this depicts how closely the findings that are generated relate to the true overall state of the phenomenon, such as by measuring the findings relative to industry benchmarks or gold-standards (Cooper et al., 2019). Two forms of criterion validity — concurrent and predictive validity — illustrate whether the findings reflect the state of the phenomenon at the same time as the study, or relative to later standards, respectively (Evans et al., 2019). Criterion validity was maintained through the use of secondary data at three large academic hospitals in Johannesburg, which had been produced by the healthcare professionals

themselves. Thus, the data was deemed to be an accurate and a true reflection of the current state of general surgical intervention coding in three academic hospitals in South Africa, and requiring no further industry comparisons; while also being large enough to generalise to the target population as a whole.

3.4.2 Reliability

There are typically four main forms of reliability that are considered to be important in research, as follows:

- Internal consistency: a form of internal reliability, this provides an indication of how closely the individual research instruments used in a study reflect consistent results when performing repeated measurements of the same or different constructs in the study (Tavakol and Dennick, 2011). Internal consistency was maintained by ensuring that only one key was assigned per intervention description in the coding of the intervention descriptors into the ICHI codes. Additionally, to measure the internal consistency of the data, Cronbach's alpha was also calculated, during the data analysis portion of the study, as per the guidance of Tavakol and Dennick (2011). A statistically-defined alpha value of 0.7 or above was deemed to indicate data with a suitable degree of internal consistency (Heale and Twycross, 2015).
- Parallel forms reliability: another form of internal reliability, this provides an indication of how consistently repeated measurements of the same constructs are produced by the different research instruments in the study (Hilger and Beauducel, 2017). To ensure parallel forms reliability, numerous different components of the interventions were studied, when coding the intervention descriptions to the ICHI codes; namely: the equivalent coding, broader concept, narrower concept, target component coding, action component coding, and means component coding.
- Interrater reliability: a form of either internal or external reliability, this indicates how closely other researchers or independent parties form the same conclusions, when assessing the findings and conclusions of the study (Marques and McCall, 2005). To ensure interrater reliability, the researcher and two assistant coders performed an initial trial-run of the ICHI codes, and were in continuous communication, thereafter, to ensure that the generation of the ICHI codes and

the ordinal scale representing its match, were created consistently. The researcher is a professional coder with twenty three years of coding experience, coder two is a formally trained coder up to an advanced level with five years of coding experience and coder 3 is a junior formally trained coder up to an intermediate level with two years of coding experience. The researcher provided the assistant coders with an overview of the ICHI and coders were orientated on the use of the ICHI platform. Instructions were also provided to the coders regarding the process to access the ICHI platform and download the ICHI Beta-3 Reference Guide and ICHI Platform User Guide.

In addition, the ICHI code that best described the intervention, which included the correct Target, Action and Means was always assigned, first, for consistency, and the ICHI coding rules and conventions, were adhered to in the assignment of the codes. This entailed reading the ICHI code, the ICHI description, the Target Action and Means components, the inclusion and exclusion notes, the index terms and code also. Where it was relevant, additional ICHI stem codes were assigned to fully describe the intervention performed.

3.4.3 Elimination of bias

Kumar (2019) states that bias can be viewed as purposefully concealing information, or highlighting aspects due to vested interests which, can include the following:

- Design bias: where flaws may have been integrated during the design of the study's aim and methods (Macleod et al., 2004);
- Selection bias: where units of the sample have been preferentially included (Curtis et al., 2020);
- Data collection bias: where procedures are inherently flawed that can skew the results in a specific way (Althubaiti, 2016);
- Analysis bias: where the researcher intentionally or unintentionally pursues preconceived or anticipated findings (Curtis et al., 2020); and
- Publication bias: where specific studies, topics, and/or findings are preferentially selected for publication and dissemination (Macleod et al., 2004).

Design bias was minimal since the ICHI is a classification system in its beta phase, the researcher could not be biased to a classification system that had not been tried and tested, as strengths and weaknesses of the system still need to be established. Some bias can be anticipated by limiting the data collection to three academic hospitals in Johannesburg as the findings from these three hospitals may not be reflective of interventions performed in all hospitals within South Africa. A further bias could be researcher bias as the researcher was one of the coders and this could have potential impact on the choice of literature for review and discussions.

To minimise selection bias, the sample was randomly selected from the population, and the intervention data were collected by healthcare personnel that had no interaction with the researcher, or any knowledge of its intended use in this study. There was no contact with the patients or the clinicians involved in the recording of the intervention data. Bias was also eliminated by utilising anonymised data, which prohibited the researcher from accessing social, financial or economical information on subjects that may have prejudiced the final sample.

Data collection bias was eliminated since the subjects were identified independently by the respective hospital's database administrator, and participants of the sample were selected with the aid of randomly generated numbers. There was the possibility for bias to enter during the data preparation phase of the study, as changes and corrections to the information could have altered the findings of the research; however, the code sets and clinical information in the database were utilised without changes or corrections, to avoid such biases from being introduced. Both complete and incomplete healthcare records were included in the sample thereby eliminating data collection bias.

Analysis bias was minimised through the use of a suitably qualified statistician, who assisted with programming the data into SPSS, and running the inferential statistics portions of the data analysis. The statistician also had no vested interest in whether the ICHI had gaps within the South African surgical environment, or to pursue any preconceived answers for whether the ICHI was suitable for general surgery coding.

Finally, publication bias was minimised by selecting various national and international publication journals that focus on a wide range of healthcare issues and are not limited to publication of health classification research.

3.5 ETHICAL CONSIDERATIONS

Permission was obtained from the Faculty of Health Sciences at Wits (Appendix B) and Human Research Ethics Committee (Appendix C) to undertake this study. According to Bell and Waters (2014), it is a researcher's responsibility to ensure that no ethical or legal boundaries are breeched when undertaking a research project. The core areas of ethics in research that need to be adhered to, include (Artal and Benfieldld, 2017):

- Truthfulness: informing the participants and stakeholders of the truthful nature of the study, and any risks involved for participating;
- Informed consent: ensuring that the participants consent to the use of the information they provide;
- Confidentiality: ensuring that the names of individuals and stakeholders are kept confidential, unless otherwise agreed;
- Autonomy: ensuring that the participants have the ability to refrain from participating, or withdraw from the study at any time they choose;
- Beneficence: ensuring that the welfare of the participants is at the heart of the study;
- Nonmaleficence: ensuring that no harm befalls the participants.

As this was a retrospective study, patients' informed consent was not required, however consent and approval to utilise the data was obtained from the Chief Executive Officers, Clinical Director, Chairman and The Heads of Departments of Surgery (Appendixes D, E, F and G) from the three participating hospitals. Consent was also obtained from the database administrators (Appendix H).

Limited personal details of subjects were extracted, such as age, gender and other relevant diagnostic and intervention information; and privacy and confidentiality were maintained by the researcher not disclosing the raw data to any party except the supervisors. Thereafter, only de-identified data was utilised for the sake of data analysis by the statistician(s) to ensure that the welfare of the participants is at the heart of the study and that no harm befalls the patients. The researcher also abided by the Code of Ethics for Professional Coders (SA ICD-10 Morbidity Coding Standards Document and Guidelines), and the Nursing Professional Code of Conduct, as the researcher is both a professional coder and a registered nurse.

3.6 CONCLUSION

This study adopted a positivist philosophy and a quantitative or deductive methodology or paradigm for evaluating the suitability of the ICHI for general surgery coding, by coding intervention data to ICHI codes, as it provided the researcher with the framework to be able to deductively answer the research questions. To address the research questions outlined below the researcher focused on a retrospective descriptive study design that evaluated a cross-sectional spectrum of data, which had been pre-collected into databases at three selected academic hospitals:

- Is the ICHI suitable for general surgery coding?
- Does the ICHI have gaps within the South African surgical environment and can new codes be created to address these gaps?
- In relation to general surgery, can the ICHI be recommended for adoption in South Africa as a national intervention coding standard?

The target population included 30,000 surgical patient intervention records from the three purposely selected academic hospitals in Johannesburg, which had been retrospectively gathered into a database. These were used as they had complete, comparable details of surgical interventions recorded by clinicians in their discharge summaries, and they were conveniently accessible to the researcher. Stratified random sampling was utilised to generate a sample of 10% of the complete patient intervention records; whereby, the data were first categorised into strata according to inherent collectively exhaustive and mutually exclusive characteristics of having complete age, gender, diagnosis and intervention descriptions and the ICD-10 and NHRPL codes and descriptions.

Data were collected in two phases which comprised of coding the intervention terminologies into the ICHI codes, and establishing the corresponding matches between the data. Quantitative data analysis techniques were utilised to assess the overall degree of match between the ICHI codes and the intervention descriptions, across the sample of data. Various efforts were also made to maximise the validity and reliability of the study, to eliminate bias, and to conduct the study with moral and ethical considerations. The findings that were generated from this methodology, are outlined in Chapter four.

CHAPTER FOUR
RESULTS

4.1 INTRODUCTION

This chapter presents the results of the statistical data analysis. It begins with an overview of the data, and the descriptive statistics, together with a presentation of the central tendencies, mean, median, mode, standard deviation, skewness and kurtosis of the applicable results. Then, the results of the inferential statistics calculations are presented, to support whether the central tendency findings were statistically consistent, or likely to have simply occurred due to chance.

4.2 OVERVIEW OF THE DATA

The complete data set comprised of 21 variable types, which were either qualitative (text strings), nominal, ordinal, or interval data variables. Each variable was comprised of 3000 associated data point entries, which were either single observations or blank (missing) cells relating to the clinical data of 3000 patient cases. The 10 nominal categorical variables included the:

- patients' gender;
- ICD-10 code for each patient's case information;
- NHRPL intervention code for each patients' case information;
- ICHI code(s) generated by each clinical coder;
- two sets of relationship keys RK1 denoted by E,B,N,TM,AA and AM and RK2 denoted by RI and II, stating how the clinical coder produced the associated ICHI code/s;
- four sets of match variables indicating whether there was consensus between the ICHI codes generated by the three coders (SS vs AS vs MR; SS vs AS; SS vs MR; and AS vs MR).

To generate the ICHI code, column D in Table 3.4 was referenced; while if the information was incomplete, unclear or missing in column D, then column E ('radiology findings/comments') was referenced instead. The relationship key reflected in Table 3.3 (RK) was listed as 'E' if the data in either of the columns directly coded to the correct ICHI code; while, key ‘RI’ (RK2) was used to indicate that the radiology data (column E) had been referenced. The same applied when the ICD-10 code (column B) was referenced, where RK ‘II’ (RK2) was added to clarify that the ICD-10 code or diagnostic information had been referenced; however, the ICHI code that was assigned could have been labelled with an RK of either ‘E’ (EQUIVALENT), ‘B’ (BROADER), or ‘N’ (NARROWER).

The diagnostic information by means of ICD-10 codes/diagnostic information and radiology findings/comments (RK2) were included since the coders needed to reference the ICD-10 codes/diagnostic information or the radiology findings/comments, in some situations, due to the lack of suitable healthcare documentation to derive the ICHI codes. If the ICD-10 codes/diagnostic information and radiology findings/comments had been excluded, there would have been a greater number of healthcare records without the ICHI codes.

The following five qualitative variables were composed of strings of text, which pertained to each patient’s case information:

- The ‘diagnosis description’;
- The ‘intervention description’;
- The ‘findings’;
- The ‘radiology findings’; and
- The ICHI descriptions created by each clinical coder.

Two interval-data variables also existed, which were:

- The age of each of the 3000 patients (in years); and
- The total coding experience of the clinical coders (in years).

In order to perform the data analysis and generate more quantifiable variables for the purposes of answering the study’s research questions, four new variables also were created, as follows:

- A new categorical variable was created, based on the first letter of the ICD-10 codes, to provide more concise information pertaining to the ICD-10 chapter groupings for each of the 3000 patients;

- The categorical variable of the ICHI codes of the three coders, which at times consisted of one or more codes, was separated into individual variables to indicate the coders' initial (primary) code choice, secondary code choice, and so forth (as individual categorical variables);
- A new interval-data variable was created to indicate how many different ICHI codes the three coders listed for each patient case entry; and
- A new dichotomous variable was created to represent whether the ICHI codes of the three coders were completely mismatched (no consensus), or whether there was some degree of consensus (match) between two or more of the coders.

The descriptive statistics pertaining to the data follow next.

4.3 DESCRIPTIVE STATISTICS

The descriptive statistics section presents the results of the central tendency analysis on the patient data, the clinical coders' data, and the ICHI coding data. The inferential statistics revealed the match between the coders' ICHI codes by use of relationship keys. Various tests were performed to present the different results. These include for example, the Shapiro-Wiks test, and the McNemar chi-squared test amongst others.

4.3.1 Patient results

4.3.1.1 Demographic data

As shown in Figure 4.1 there were 3000 patient case entries, where the age of the patients ranged from 0 years (n = 7, 0.2%) to 100 years (n = 1, 0.03%, SD = 19.2 years, mean = 45.5 years, median = 46.0 years, mode = 58 years). Despite the general observation that the patient age distribution was approximately normally distributed, both a Shapiro-Wilk's (S-W) and a Kolmogorov-Smirnoff (K-S) test confirmed that the data was non-parametric (S-W (3000) = 0.99, p = 0.0). This was likely due to the twin-peaks on the frequency distribution histogram; and the skewness (-0.05) and kurtosis (-0.6) confirmed the central tendencies of the patients' age data. There were also considerably fewer females (n = 1331, 44.4%) in the patients' data than males (n = 1669, 55.6, skewness = -0.2); as shown in Figure 4.1.

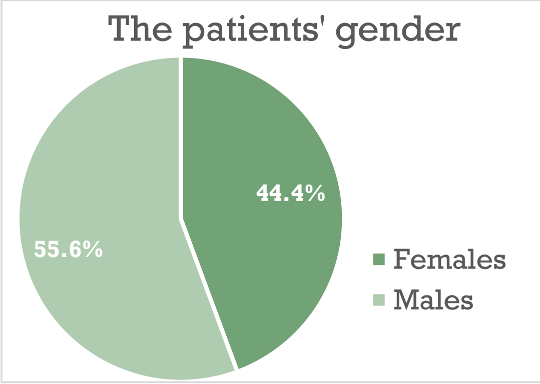

Figure 4.1 Frequency distribution of patients' gender

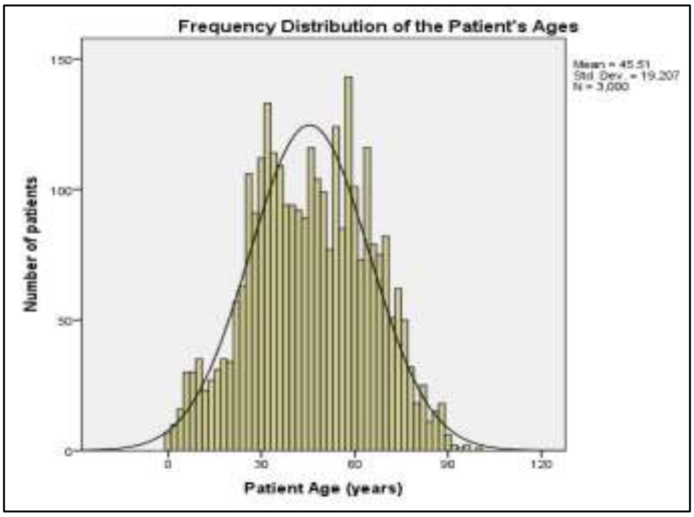

Figure 4.2 Frequency distribution of patients' age in years

4.3.1.2 CD-10 codes and chapter distributions

Categorical data pertaining to the ICD-10 codes showed that a range of 888 different variants of ICD-10 codes existed across the 3000 patient case entries, where the most frequently-listed ICD-10 codes were ‘K35’ (n = 108, 0.3%), ‘C25.0’ (n = 54, 0.2%), ‘K80’ (n = 54, 0.2%), ‘I10’ (n = 44, 0.1%), and ‘I70.21’ (n = 40, 0.1%). When considering the chapters to which the patients’ ICD-10 codes belonged, the results confirmed that the most frequently-coded chapter was Chapter XI: Diseases of the digestive system (code range K00-K93, n = 1003, 33.4%), as shown in Appendix I, which presents a full listing of the code ranges and names of the different ICD-10 chapters.

The second most frequently-cited chapter was Chapter XIX: Injury, poisoning and certain other consequences of external causes (code range S00-T98, n = 557, 18.6%), where the most frequent ICD-10 codes from that chapter were ‘S42.40’ (n = 31, 0.1%) ‘S52.50’ (n = 21, 0.1%), and ‘S82.30’ (n = 20, 0.1%). Other ICD-10 chapters that were observed frequently were Chapter II: Neoplasms (code rage C00-D48, n = 426, 14.2%), Chapter XIII: Diseases of the musculoskeletal system (code range M00-M99, n = 250, 8.3%), and Chapter IX: Diseases of the circulatory system (code range I00-I99, n = 235, 7.8%) as illustrated in Figure 4.3.

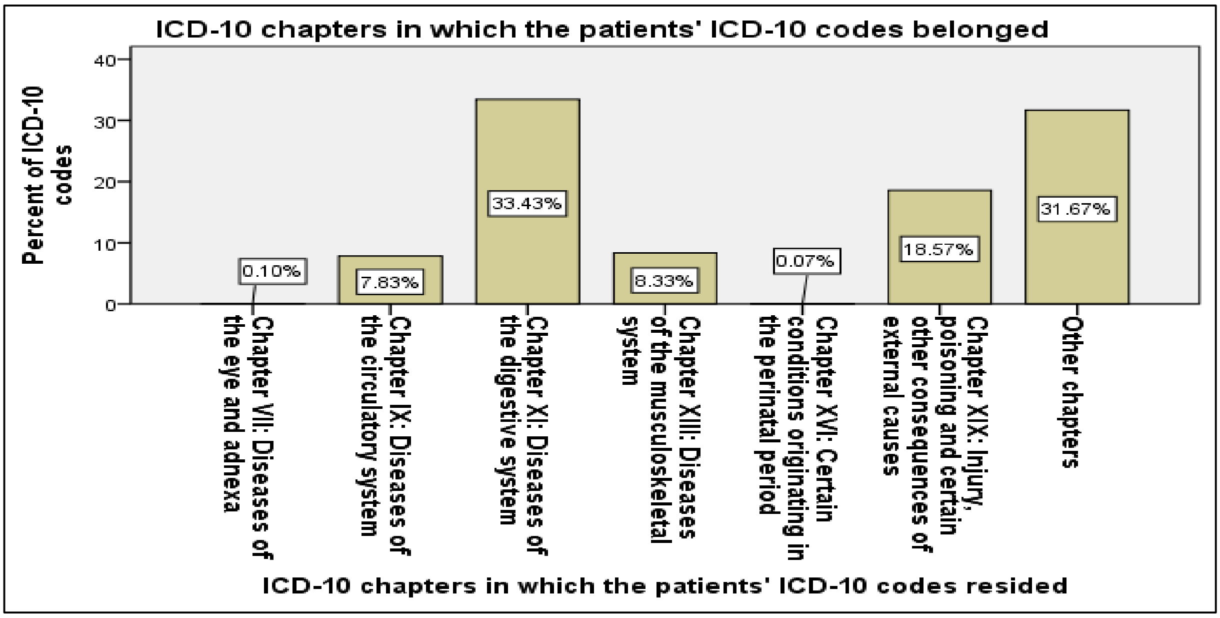

Figure 4.3 Most and least frequently observed ICD-10 chapters

Some ICD-10 chapters were also notable for their infrequency of observation in the data, where there were no instances of Chapter VIII: Diseases of the ear and mastoid process codes (code range H60-H95); nor were there any Chapter XXII codes: Codes for special purposes (code range U00-U99). Codes for Chapter XVI diseases: Certain conditions originating in the perinatal period (P00-P96) and Chapter VII: Diseases of the eye and adnexa (code range H00-H59), were also very infrequently observed (n = 2, 0.07%; and n = 3, 0.1%, respectively). A figure with the full frequency distribution of observed ICD-10 chapters is provided in Appendix J which presents a figure with the full frequency distribution of observed ICD-10 chapters).

A total of 443 different NHRPL intervention codes existed across the 3000 patient case entries; while of the 3000 patient inputs, n = 126 inputs (4.2%) were either missing a valid intervention code, or otherwise consisted of information that was not in an appropriate coded format — meaning that a value was listed that was not a standard intervention code. The single-most frequent intervention code observed was the NHRPL intervention code: '1809', with an associated intervention description of 'Laparotomy', which was observed in n = 309 (10.3%) instances across the data (see Figure 4.4). Even though the NHRPL codes were excluded in coding of the ICHI codes, they were included in the analysis where a high recurrence of repeated interventions were noted in the data. A chi-squared test confirmed, with a high statistical significance, that there was a greater-than-expected number of observations of these NHRPL codes among the patient case entries with unmatched codes or a difference in the assignment of the ICHI codes amongst the three coders, than among the rest of the (matched) patient case data. It was noted that the most experienced coder coded the intervention description 'laparotomy' to a large extent to ICHI codes that described interventions such as appendicectomy or abdominal drainage, whereas the less experienced coders coded the intervention to an equivalent ICHI laparotomy code.

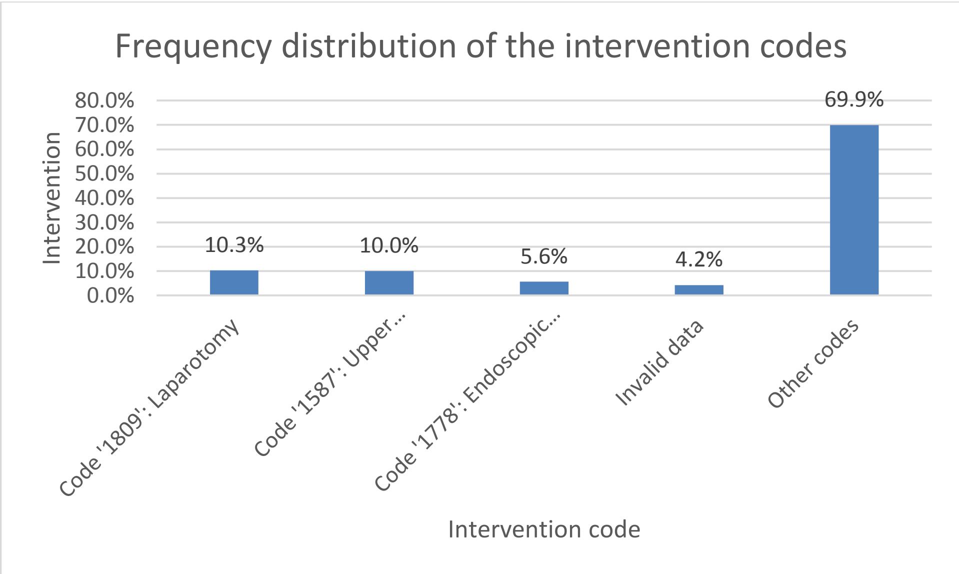

Figure 4.4 Frequency distribution of the intervention codes and invalid data

This was followed by intervention code: '1587', with an associated intervention description of 'Upper gastro-intestinal endoscopy: Hospital equipment'; and intervention code: '1778', with an associated intervention description of 'Endoscopic Retrograde Cholangiopancreatography (ERCP): Endoscopy + catheterisation of pancreas duct or choledochus'). These two intervention codes ('1587' and '1778') were observed in the patient data n = 299 (10.0%) and n = 168 (5.6%) instances each, respectively; while the other intervention codes, with a cumulative total of n = 2097 (69.9%) of the cases, were observed in lesser individual quantities than the above three codes.

It is important to emphasise that the actual data that the clinical coders used to create the ICHI codes did not include the patient's NHRPL codes, but only the findings (Dataset Column D Table 3.4), the radiology findings (Column E Table 3.4), and the ICD-10 codes, as explained previously. Thus, the NHRPL codes were only incorporated as supporting data during the data analysis works, since the dataset columns 'D' and 'E' comprised qualitative data that were unsuitable for the quantitative analysis of 3000 patient records. There were also some interesting findings that pertained to the intervention codes themselves (Section 4.4.2), making it valuable to provide an overview of them, here.

4.3.1.3 Qualitative data

The other data variables relating to the patients' clinical findings, namely their intervention descriptions, findings, and radiology findings, each existed as qualitative data that could not be accurately or reliably quantified in numerical formats to observe any central tendencies in the data. Grouping these variables according to alphabetic recurrences, for instance, did not present an accurate means of quantifying the entries, since it was often the case that spelling mistakes or inconsistent terminologies had been captured in the respective data cells. Performing a thorough qualitative content or thematic analysis to decipher the patterns of themes and codes across the scripts of qualitative data, was outside of the scope of this study.

4.3.2 The clinical coders' results

A team of three clinical coders were involved in this study, where Coder 1, with initials SS Coder 2, with initials AS,; while Coder 3, with initials MR, The coders' years of clinical coding experience can be seen in Figure 4.5. The coders' initials are referred to, hereafter.

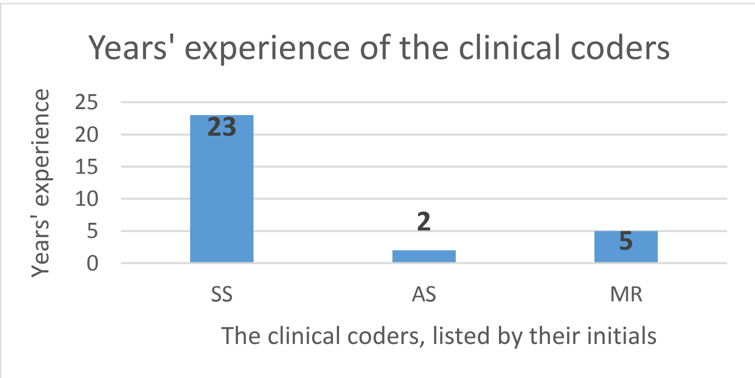

Figure 4.5 Experience of clinical coders in years (n=3)

4.3.3 The ICHI coding results

4.3.3.1 Initial ICHI codes

The ICHI codes were assigned based on the ICD-10 codes, comments, and radiology findings columns of data, for each respective patient (Section 4.2). Coder SS provided the ICHI codes for the largest proportion of the 3000 patient cases (n = 2857, 95.2%), while Coder AS provided the ICHI codes the least (n = 2457, 81.9%) among the 3000 patient cases. Coder MR, provided the ICHI codes in slightly fewer instances than Coder SS, but more than Coder AS, in n = 2844 (94.8%) of the 3000 patient cases.

One aspect that was tested in this study was whether the ICHI codes were a ‘narrower concept’ than the intervention description, resulting in one intervention descriptor being coded to many ICHI codes. There were numerous instances where Coder SS provided more than one single ICHI code for a particular patient case entry, presenting a second, third, and fourth ICHI code in n = 405 (13.5%), n = 19 (0.6%), and n = 8 (0.3%) of the 3000 patients’ cases, respectively. Coder AS provided a second, third, fourth and also a fifth ICHI code option in n = 393 (13.1%), n = 25 (0.8%), n = 9 (0.3%), and n = 1 (0.03%) of the 3000 patients’ cases, respectively (see Figure 4.6). Coder MR provided a second, third, fourth, fifth, and also a sixth ICHI code option in n = 455 (15.2%), n = 27 (0.9%), n = 13 (0.4%), n = 3 (0.1%), and n = 1 (0.03%) of the 3000 patients’ cases, respectively.

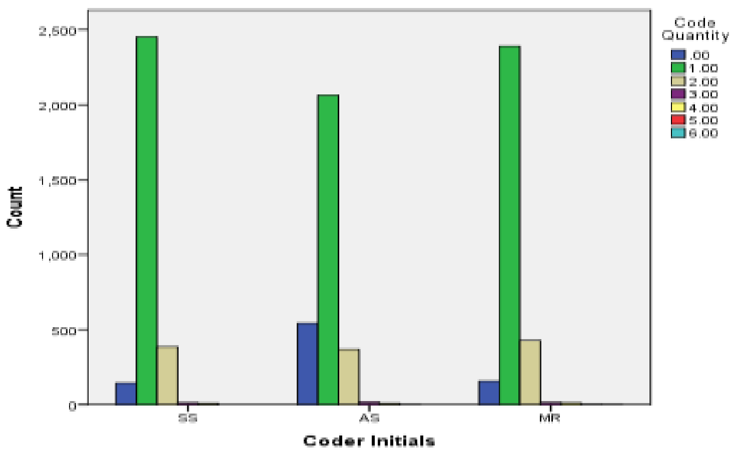

Figure 4.6 Frequency distribution of different ICHI codes by coders

Coder SS presented 467 different ICHI codes, with the ICHI code ‘KBF.AE.AD’ and an associated ICHI description of ‘Gastroscopy’, being the single-most frequent ICHI code observed, as observed in n = 307 (10.2%) of the patient case entries. The second- and third-most frequent ICHI codes that were observed, respectively, were the ICHI code 'KBO.JK.AA', with an associated ICHI description of 'appendicectomy' (n = 131, 4.4%); and the ICHI code 'KCO.BA.BB', with an associated ICHI description of 'endoscopic retrograde cholangiopancreatography' (n = 112, 3.7%), as shown in Figure 4.7.

Coder AS presented 416 different ICHI codes, with the ICHI code 'KBF.AE.AD' (Gastroscopy), similarly to Coder SS, being the single-most frequent ICHI code observed (n = 282, 9.4%). The second- and third-most frequent ICHI codes observed were also the ICHI codes 'KBO.JK.AA' (appendicectomy, n = 125, 4.2%), and 'KCO.BA.BB' (endoscopic retrograde cholangiopancreatography, n = 102, 3.4%), respectively. Coder MR presented 445 different ICHI codes, with the same three ICHI codes of 'KBF.AE.AD' (Gastroscopy), 'KBO.JK.AA' (appendicectomy), and 'KCO.BA.BB' (endoscopic retrograde cholangiopancreatography) being observed in n = 287 (9.6%), n = 127 (4.2%), and n = 100 (3.3%) of the patient case entries, respectively.

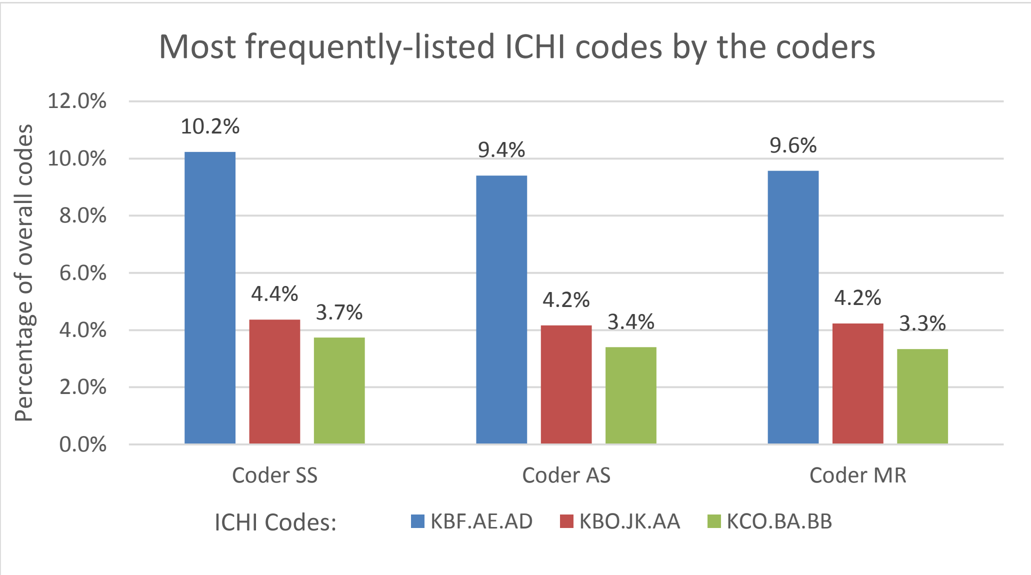

Figure 4.7 Most frequently-listed ICHI codes by coders

Inferential statistics tests, including chi-square, likelihood ratio, and Cramer's V, were performed to determine whether there were any statistically significant differences or associations between the ICHI code listings, as shown in Section 4.4.1.

4.3.3.2 Relationship keys

As explained previously, clinical coders were requested to indicate a relationship key (RK) for each coding of an intervention description to an ICHI code. As explained in Section 4.2, the RKs could either have been ‘E’, ‘B’, ‘N’, ‘TM’, ‘AA’, ‘AM’, ‘NC’, ‘RI’, or ‘II’; although, as shown in Table 4.2, the coders did also list some un-defined RK options of ‘NI’, ‘RM’, and ‘AD’ (no intervention information). The most common RK among all three coders was relationship key ‘E’, which indicated that the ICHI code could be generated through an equivalent coding, since it was found (during the coding process) that there was a direct coding of the intervention descriptor to a single ICHI code.

Table 4.1 Proportional distributions of relationship keys per case by coders

SS Relationship Key 1			AS Relationship Key 1			MS Relationship Key 1		
RK	Frequency	Percent	RK	Frequency	Percent	RK	Frequency	Percent
E	2282	76.1%	E	2111	70.4%	E	2439	81.4%
N	301	10.0%	NI	545	18.2%	RI	228	7.6%
RI	165	5.5%	RI	110	3.7%	NI	148	4.9%
NI	141	4.7%	AA	107	3.6%	N	88	2.9%
II	44	1.5%	B	55	1.8%	II	39	1.3%
TM	26	0.9%	N	55	1.8%	AA	19	0.6%
B	14	0.5%	AM	11	0.4%	B	17	0.6%
AA	13	0.4%	TM	4	0.1%	TM	15	0.5%
AM	8	0.3%	II	1	0.0%	AD	2	0.1%
NC	5	0.2%	NC	1	0.0%			
RM	1	0.0%						

The perceptions of the three coders varied quite considerably, with Coder SS stating that n = 2282 (76.1%) of the ICHI codes had been generated through a direct coding of the intervention descriptors to an ICHI code (RK-‘E’), while Coders AS and MR noted that n = 2111 (70.4%) and n = 2439 (81.4%) of the patient cases, had been generated through RK-‘E’ (see Figure 4.8).

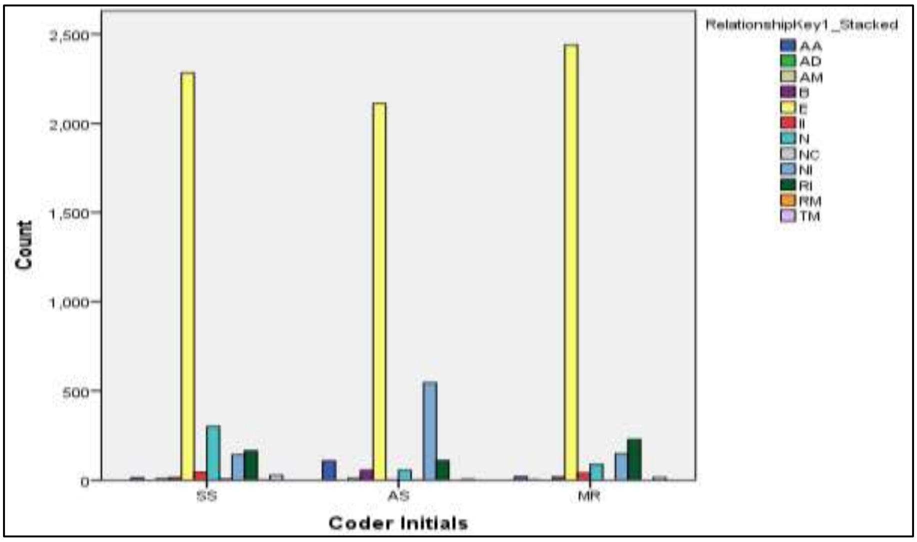

Figure 4.8 Frequency distribution of the relationship keys by coders

Other variability between the coders also appeared to exist, where Coder SS stated that n = 301 (10.0%) of the ICHI codes were a narrower concept (RK-'N'), resulting in one intervention descriptor being coded to many ICHI codes, while Coders AS and MR instead argued that only n = 55 (1.8%) and n = 88 (2.9%) were generated through RK-'N', respectively. Coder SS also noted that n = 165 (5.5%) and n = 44 (1.5%) of the ICHI codes, respectively, were generated via RK-'RI' and RK-'II', respectively (meaning that the ICHI code was assigned based on radiology information or ICD-10/diagnostic information, respectively). However, these relationship keys, in the case of AS and MR, were n = 110 (3.7%) and n = 1 (0.03%); and n = 228 (7.6%) and n = 39 (1.3%), respectively.

In the case where the relationship key noted was either RI or II, a second relationship key label was noted to explain how, relative to the 'RI' or 'II' supplementary information, the ICHI code had been selected. Here, again, there was some variability between the coders, since Coder SS, who had noted n = 165 (5.5%) RK-'RI' and n = 44 (1.5%) RK-'II' during the initial round of relationship key allocation (total n = 209), respectively, indicated a total of 208 relationship keys on the second round of RK allocations. These were n = 180 (86.5%) RK-'E', and n = 28 (13.5%) keys 'AA', 'AM', 'N', or 'TM (see Figure 4.9).

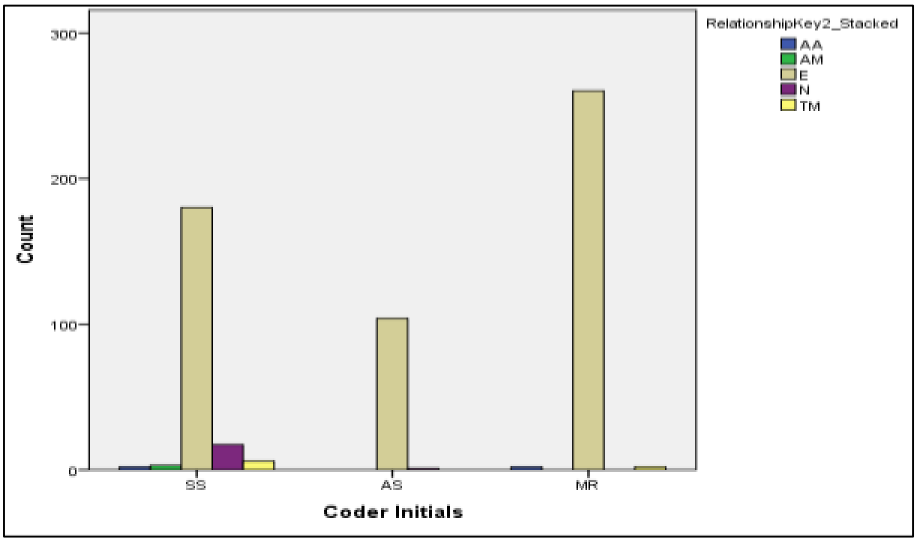

Figure 4.9 Frequency distribution of relationship keys RI or II in the listing of the ICHI codes

Coder AS, who had noted n = 111 (3.7%) 'RI' or 'II' keys, initially, only indicated a total of n = 105 relationship keys on the second round, being n = 104 (99.0%) RK-'E', and n = 1 (1.0%) RK-'N'. Conversely, Coder MR, who had noted n = 267 (8.9%) 'RI' or 'II' keys, initially, only indicated a total of n = 264 relationship keys on the second round, being n = 260

(98.5%) RK-'E', and n = 4 (1.6%) RK-'AA" or RK-'TM'. Inferential statistics tests (such as chi-squared tests) were also performed (Section 4.4.2), later in the results), to confirm whether the variation in the relationship key allocations between the three coders, was statistically significant.

4.3.3.3 Matches between the coders' ICHI listings

In the final set of data considerations, observations were made on the matches between the data to determine whether there was a match:

- Whether the initial (primary) ICHI code for any single patient case entry matched; and,
- Whether all the different variants of the ICHI codes for any single patient case entry (all the ICHI codes within the entry) matched.

Four dichotomous variables were formulated (true versus false) to indicate whether there was a match between the initial ICHI code listed by Coders SS and AS, SS and MR, AS and MR, and SS, AS and MR (all three coders together). As shown in Figure 4.10, there was an exact 'true' match of only 67.6% of the initial ICHI codes between Coders SS, AS, and MR, while 32.4% were not an exact match, indicating that there was 32.4% variability between the codes generated by all three coders (skewness = -0.8).

The two coders with the initial ICHI codes that most-closely matched were Coders SS and MR, who displayed an 85.9% match (skewness = -2.1) between their initial ICHI code listings. Coder AS showed lower proportional matches compared to the other two coders, having only a 76.6% match with the initial ICHI listings of Coder SS (skewness = -1.3); and a 69.4% match with the initial ICHI listing of Coder MR (skewness = -0.8). As shown in these results, a larger (more negative) skewness confirmed that there was more consensus between the coders, since a smaller skew (less negative) suggested a more symmetrical probability distribution between the true and false values; and therefore, less consensus between the coders' listings.

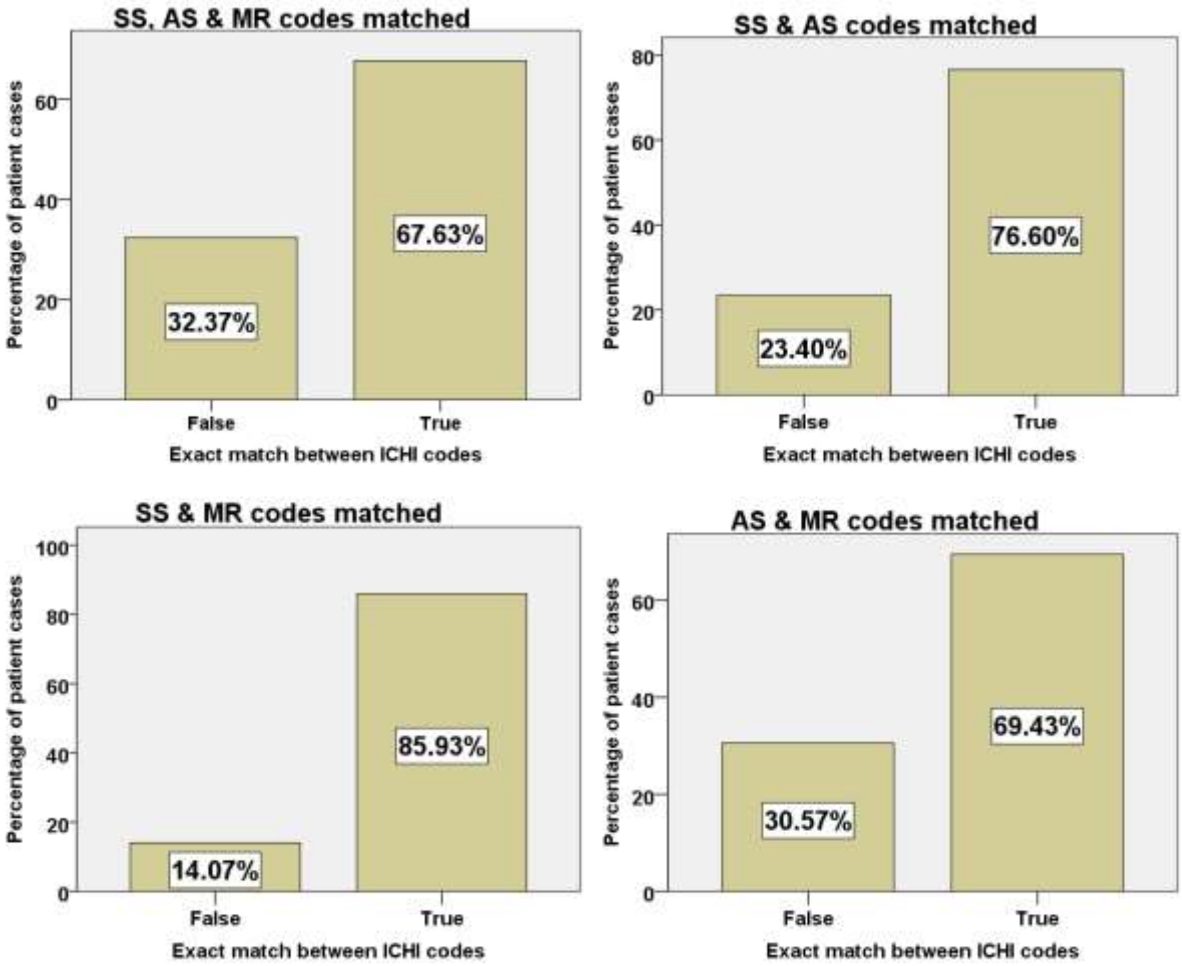

Figure 4.10 Proportions of the ICHI code matches between the coders

It is also important to note that an exact match, above, was confirmed by a match between the coders' initial (primary) ICHI code listing. However, as was to be expected when considering matches between all the different variants of the CHI codes for any single patient case entry (all the ICHI codes within the entry), the proportion of exact matches between the coders dropped somewhat. That is, when considering the entire ICHI code listing of all the different codes listed, and not only the initial ICHI code listing, the matches between Coders SS, AS and MR dropped to 63.4%; while between Coders SS and MR, the matches dropped to 81.1%; between Coders SS and AS, the matches dropped to 76.3%; and between AS and MR, the matches dropped to 65.2%.

Although there appeared to be some discrepancies between the ICHI codes listed by the three coders, as shown in Figure 4.11, there was only a small proportional number of patient entries (n = 99, 3.3%) where there was no consensus between any of the three coders. For instance, while 67.6% of the patient case entries had agreement between all three coders, and 29.1% of entries had some degree of consensus between two of the three coders, in only 3.3% of the patient cases it was observed that the coders failed to list an ICHI code that was in agreement with either of the other coders. A McNemar chi-squared statistic was calculated, as shown in Section 4.4.2, to determine whether the variation between the coders' matches, was statistically significant, or likely to have occurred due to chance (a random outcome).

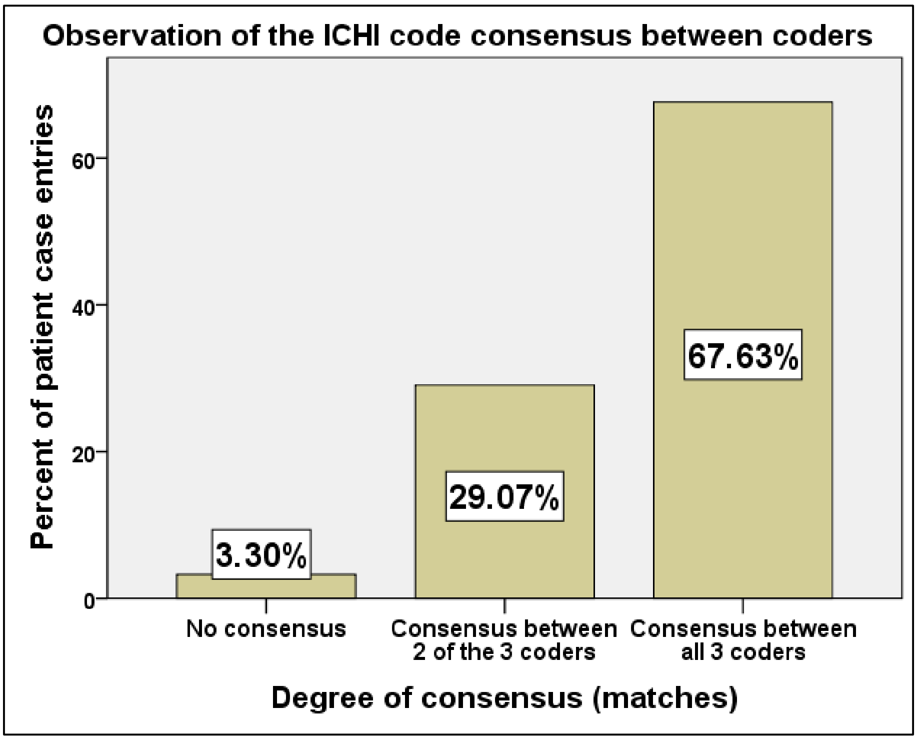

Figure 4.11 Observation of the ICHI code consensus between the coders

It was valuable to observe what the frequency distributions of the ICD-10 and intervention codes were within the 3.3% of mismatched patient case entries, to provide a preliminary observation of possible 'problem areas' that may have existed in the generation of the ICHI codes by the three coders. There were 83 variants of the ICD-10 codes observed for the patient case entries where the coders consistently failed to generate any ICHI code consensus (matches). As shown in Figure 4.12, there also appeared to be some repetition among some of these 83 ICD-10 codes, which appeared to recur more frequently than the other ICD-10 codes among the non-matching data.

The two ICD-10 codes: 'C20' (Chapter II: Neoplasms), and 'I70.21' (Chapter IX: Diseases of the circulatory system), for instance, were observed in recurrence in n = 4 (4.0%) instances each, respectively. Similarly, the ICD-10 codes 'A18.3' (Tuberculosis of intestines, peritoneum and mesenteric glands), 'B23' Human immunodeficiency virus[HIV] disease resulting in other conditions) , ‘C15’ (Malignant neoplasm of oesophagus), ‘K35.0’ (Acute appendicitis with generalized peritonitis), ‘K40’ (Inguinal hernia), ‘K42’ (Umbilical hernia), ‘K56.2’ (Volvulus) , ‘K56.5’ (Intestinal adhesions [bands] with obstruction), ‘K65’ (Peritonitis), and ‘K80’ (cholelithiasis) were observed in n = 2 (2.0%) instances each, respectively; while the n = 71 other ICD-10 code variants occurred in isolation, and are therefore not shown. Chi-squared tests were performed to confirm whether there was any statistically significant association between these ICD-10 codes and the ICHI code mismatches, in an attempt to provide preliminary statistical evidence for whether the ICD-10 code categories, themselves, may have affected the ICHI coding discrepancies.

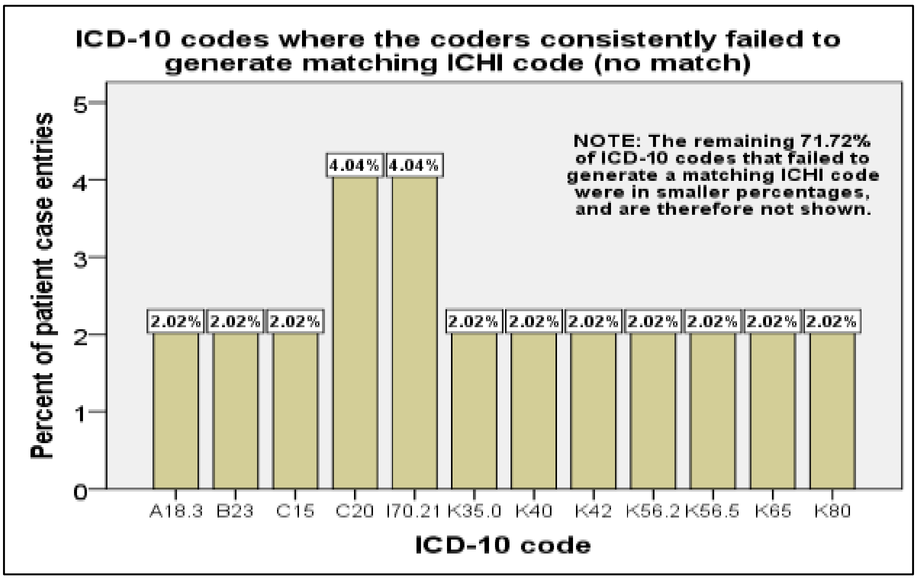

Figure 4.12 ICD-10 codes where coders failed to generate matching ICD-10 codes

Next, it was also observed that among the patient case entries where the coders consistently failed to generate any ICHI code consensus (matches); n = 52 variations of intervention codes were also observed to recur. As shown in Figure 4.13, the intervention code ‘1809’ (Laparotomy) surprisingly recurred in n = 21 (24.1%) of the mismatched cases; while intervention codes ‘1778’ (Endoscopic Retrograde Cholangiopancreatography (ERCP): Endoscopy + catheterisation of pancreas duct or choledochus) (n = 5, 5.8%); ‘0304’ (Major debridement of wound, sloughectomy or secondary suture) and ‘1587’ (Upper gastro-intestinal endoscopy: Hospital equipment). (n = 3, 3.5% each, respectively); and ‘1549’ (Oesophagoscopy with dilatation of stricture) and ‘1819’ (Inguinal or femoral hernia: Adult) (n = 2, 2.3% each, respectively) were also observed in recurrence. The remaining n = 45 (51.7%) of the intervention code variants occurred in smaller percentages (n = 1, 1.2% each, respectively), and are not shown.

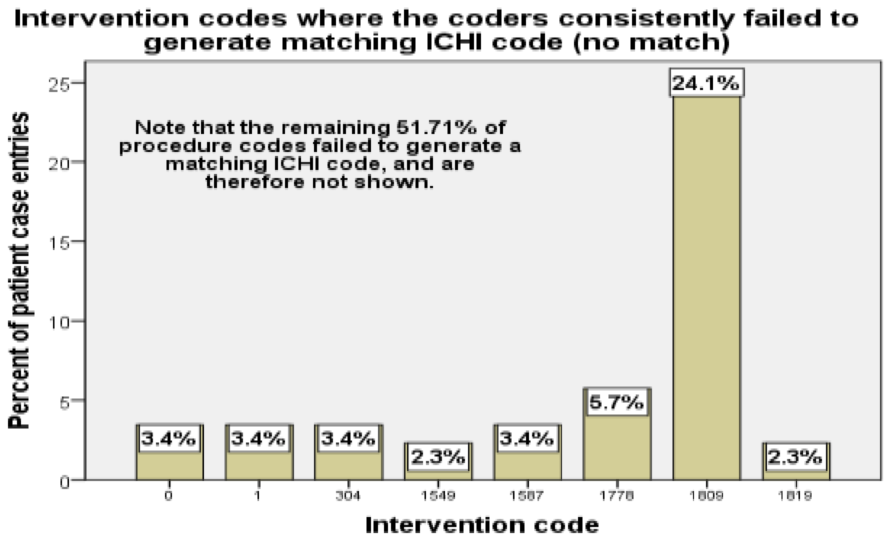

Figure 4.13 NHRPL intervention codes where coders failed to generate ICHI code consensus

A chi-squared test was performed to determine whether the variations between the different intervention codes were statistically significant, or likely to have occurred due to chance (a random outcome).

Next, the inferential statistics results of the data analysis are presented.

4.4 INFERENTIAL STATISTICS

The inferential statistics section presents the results of the statistical analyses that were performed on the clinical coders' data, the generation of relationship keys, and important associations between the matching ICHI code data.

4.4.1 Initial coding

As noted in Section 4.3.3.1, there was a considerable degree of variation in the number of the ICHI codes provided by each of the three coders for any one patient case entry. Coder SS, for instance, at times gave up to four different ICHI codes for a single patient entry; while Coders AS and MR, at times, gave up to five, or six different ICHI codes per case, respectively. To confirm whether the variation in the number of the ICHI code allocations between the three coders was statistically significant, a chi-squared test was performed.

The chi-squared test confirmed, with a p-value below the alpha of 5%, that there was a statistically consistent tendency for Coder AS to list more than expected codes, and for Coder SS to list fewer than expected codes, which was unlikely to have occurred due to chance, alone ($\chi^2 = 415.8$; $p = 0.0$). Note that an assumption of the chi-squared test is that the sample sizes should be large enough for individual categorical levels to have more than five repeating observations. However, during the chi-squared test, n = 6 of the cells (28.6%) had fewer than five observations — particularly in the case where larger numbers of ICHI codes (four, five or six codes) were listed within the patient case entries.

In the case where more than 20% of the cells have fewer than five observations, the p-value of the likelihood ratio (LR) should also be considered to confirm whether the result is indeed statistically significant, since it is less sensitive to small sample size violations. The post-hoc LR result also confirmed that the chi-squared statistic was statistically significant ($\chi^2 = 389.9$; $p = 0.0$), verifying that the original chi-squared result was robust. Additionally, a post-hoc Cramer's V test provided an indication of effect size, where the results ($V = 0.152$, $p = 0.0$) showed that there was a low, but statistically significant variability in the number of ICHI codes given. Stated differently, 15.2% of the outcome regarding the number of different ICHI code variations listed per case, was determined by the coder who was generating the ICHI codes.

This was evident, for instance, where Coder AS left more patient entries than expected empty (n = 543 cells were left with zero ICHI codes), when they would have been expected to leave a total of 280.7 cells empty, if this had been a chance occurrence. Conversely, Coders SS and MR left fewer-than-expected ICHI code entries empty, with only n = 143 and n = 156 entries left empty (lower than the expected n = 280.7 entries), respectively. Similarly, in instances with two, three, four, five, or six different ICHI code listings, the chi-squared test confirmed that the coders consistently listed more- (or less-) than the expected number of ICHI codes, with enough consistency to verify that it was unlikely to have occurred by chance, alone.

A correlation analysis was also valuable for ascertaining whether the number of the ICHI codes listed by the different coders was in any way correlated. To determine whether a parametric or non-parametric correlation needed to be performed, the data were tested with a Shapiro-Wilks test. The S-W test determined that the number of ICHI codes listed per case did not follow a normal distribution for either Coders SS ($W(3000) = 0.6$, $p = 0.0$), AS

(W(3000) = 0.7, p = 0.0), or MR (W(3000) = 0.6, p = 0.0); so the non-parametric correlation statistic, Kendall's tau (τ), was calculated. As shown in Table 4.3, there was a strong statistically significant correlation between the number of the ICHI codes listed by Coders SS and MR (τ = 0.9, p = 0.0). As shown in Figure 4.14, this meant that in patient cases where Coder SS gave no ICHI entry, Coder MR also very often gave no ICHI entry; and in instances where Coder SS gave higher numbers of the ICHI entries, Coder MR also very often gave higher numbers of the ICHI entries.

Table 4.2 Correlation coefficients for quantities of the ICHI codes listed by the coders

	Analysis Detail	AS Code Qty	MR Code Qty
SS Code Qty	Correlation coefficient (τ)	0.6	0.9
	Sig. (2-tailed)	0.0	0.0
	N	3000	3000
AS Code Qty	Correlation coefficient (τ)	1.0	0.6
	Sig. (2-tailed)	N/A	0.0
	N	3000	3000

The correlation between Coder AS's answers were also statistically significantly associated with those of Coders SS and MR; although, as was to be expected based on the lower percentage of code matches, the correlations were not as strong (Figure 4.14; Coder SS τ = 0.6, p = 0.0; Coder MR τ = 0.6, p = 0.0).

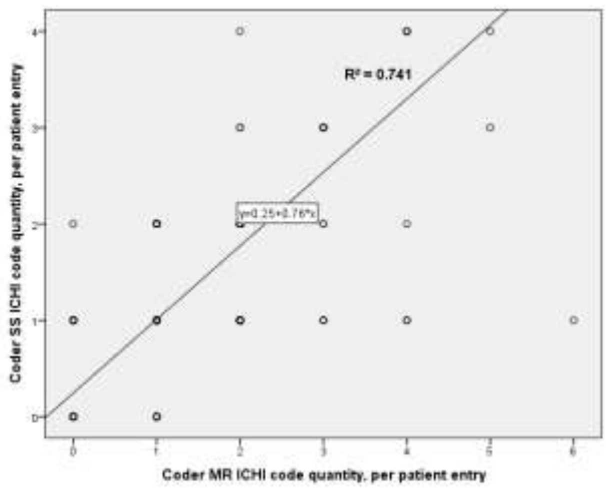

Figure 4.14 Correlation between the quantity of the ICHI codes listed per case entry by Coders SS and MR

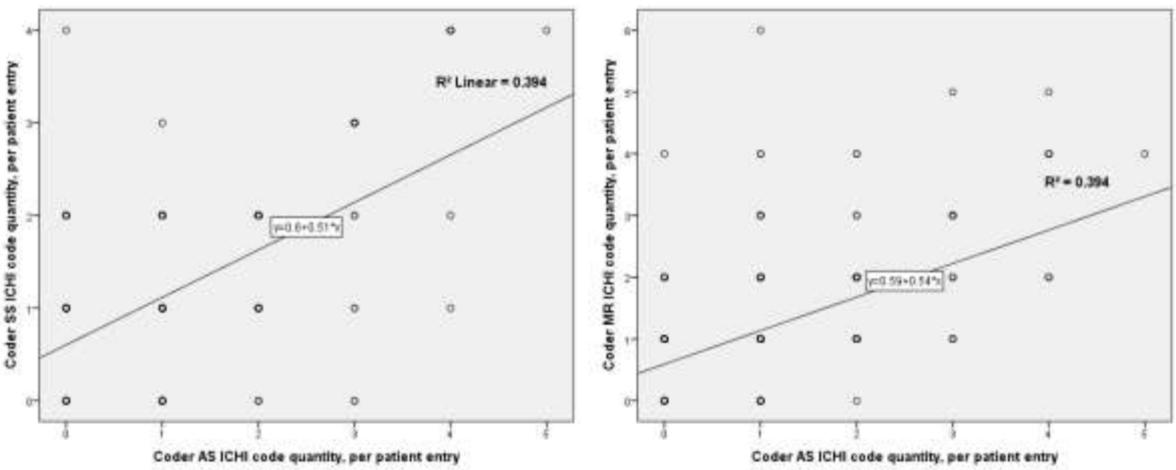

Figure 4.15 Correlation between the ICHI codes listed per case entry by Coders SS and AS (left) and MR and AS (right)

Next, a correlation analysis was performed to provide additional information on whether the amount of experience the coders had (in years), may have affected the overall number of the ICHI codes listed. The correlation analysis confirmed that there was a statistically-significant correlation between the coders' experience (in years), and the overall number of the ICHI codes they listed — including whether they left the case entry blank ($\tau = 0.1$, $p = 0.0$), on a scale between -1 (a perfect negative correlation) and +1 (a perfect positive correlation). This meant that the coders with fewer years' experience consistently listed fewer case entries (with zero ICHI codes denoting blank entries); while an increase in the number of years' experience reduced the likelihood that the coders would leave the case entries blank. The result was statistically significant below the alpha of 5%.

The effect size of this correlation was weak, indicating that only 10.3% of the outcome of the overall number of the ICHI codes listed per entry (including zero entries), was determined by the coders' experience (Figure 4.16). This low effect size was likely due to the fact that, in terms of the higher rates of the ICHI codes listed, the correlation did not appear to be very linear. That is, as the number of years' experience increased, so the overall number of the ICHI codes listed per entry did not also increase.

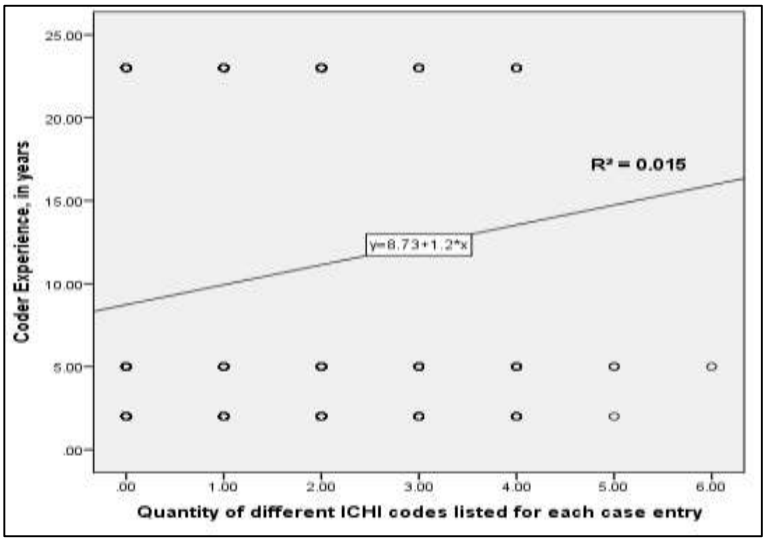

Figure 4.16 Correlation between the quantity of the ICHI codes per case entry by coders and their experience (in years)

Stated differently, the result of the correlation analysis suggested that the maximum number of the ICHI codes to be provided was likely not a linear correlation — but rather, a non-linear association that was subject to other confounding factors not present in the coders' experience or the ICHI code quantity variables. For instance, Coder AS, provided up to a maximum of five ICHI codes; while Coder MR, provided up to six ICHI codes. However, Coder SS, only listed up-to four codes (as opposed to seven or more, as would have been the case in a linear correlation). This thereby weakened the correlation statistic, when considered in relation to higher numbers of the ICHI code listings per case.

4.4.2 Relationship keys

As noted in Section 4.3.3.2, the perceptions of the three coders appeared to vary quite considerably, with Coder SS stating that 71.4% of the ICHI codes had had a direct intervention descriptor coding to a single ICHI code (RK-'E'); while Coders AS and MR stated that 70.4% and 81.4% of the patient cases, respectively, had had an equivalent coding. To confirm whether the variation in the RK allocations between the three coders was statistically significant, another chi-squared test was performed.

The chi-squared test confirmed, with high statistical significance, that there was a consistent variability between the RK allocations of the coders, which was unlikely to have occurred by chance ($\chi^2 = 925.5$; $p = 0.0$). During the chi-squared test, 25% of the cells had fewer than five observations — particularly in the case of the uncommon relationship keys, such as

'AD', 'NC', 'RM' and 'TM'. However, the post-hoc LR also confirmed that the chi-squared statistic was statistically significant ($\chi2 = 901.8$; $p = 0.0$); and a post-hoc Cramer's V showed that 22.7% of the outcomes of which RK was chosen, was determined by who was coding the relationship keys ($V = 0.2$, $p = 0.0$).

This was evident, for instance, where Coder SS labelled more patient entries than expected with RK-'N' (observed RK-'N' entries = 301, expected RK-'N' entries = 148.1). Similarly, Coders AS (observed RK-'N' = 55) and MR (observed RK-'N' = 88) labelled consistently fewer entries as RK-'N' than expected. Furthermore, in the case of the other RK labels, the chi-squared statistic confirmed that there were consistently more- (or less-) than the expected RK listings, to verify that it was highly unlikely to have occurred by chance.

Next, in the case where the RK noted was either 'RI' or 'II', a second RK label was recorded to explain how, relative to the 'supplementary' information, the ICHI code had been selected. As noted previously, in Section 4.3.3.2, there was also some variability between whether the coders recorded keys 'AA', 'AM', 'N', or 'TM. This was confirmed with a chi-squared test ($\chi^2 = 40.8$; $p = 0.0$) and LR ($\chi^2 = 46.6$; $p = 0.0$) to be statistically significant, at below the alpha of 5%; where Cramer's V determined that 18.8% of the outcome of which RK2 was chosen, was determined by who was coding the RK ($V = 0.2$, $p = 0.0$).

4.4.3 Matches between the coders' ICHI listings

McNemar's test of symmetry was performed to observe whether the variation in the matches (consensus) between the coders' ICHI listings was statistically significant, or likely to have occurred due to chance (a random outcome). The McNemar test statistic was statistically significant, at an alpha below 5% ($p = 0.0$), which confirmed that the variation in the differences between SS and AS, compared to SS and MR, was not likely to have occurred simply by chance. Stated differently, the amount of mismatch between SS and AS and between AS and MR, was statistically significantly higher than the amount of mismatch between SS and MR. Discussions on the reason this may have been the case, are presented in Chapter five.

Next, as explained in Section 4.3.3.3, it was observed that there were notable frequency distributions of the ICD-10 and intervention codes within the 3.3% of mismatched patient case entries; where of the 83 variants of the ICD-10 codes observed, some ICD-10 codes (such as ‘C20’ and ‘I70.21’) appeared to occur frequently. Similarly, of the 54 variants of intervention codes observed within the 3.3% of mismatched patient case entries, some (such as intervention code ‘1809’ (Laparotomy)) appeared to also occurred frequently.

A chi-squared test with p=0.346 could not confirm, below the alpha of 5%, that there was any statistically consistent variability between the ICD-10 codes (such as ‘C20’, ‘I70.21’ and so forth) occurring consistently more- or less-frequently in the non-matched ICHI entries than they were throughout the rest of the (matching) patient case entries. Stated differently, there was insufficient consistency among the ICD-10 codes to occur within the non-matching entries, to confirm that their recurrences there were not simply due to random coincidence; as opposed to the result of an inherent aspect of the specific ICD-10 codes being associated with the ICHI code mismatches.

The same, however, was not the case when calculating the chi-squared statistic for the NHRPL codes, since the chi-squared test confirmed, with a high statistical significance, that there was a consistent variability between the NHRPL codes (such as ‘1809’, ‘1778’, ‘1587’, and so forth) to occur consistently more- or less-frequently in the non-matched ICHI entries than throughout the rest of the (matching) patient case entries ($\chi^2 = 29.1$; $p = 0.0$). The post-hoc LR result also verified that the chi-squared statistic was robust ($\chi^2 = 25.7$; $p = 0.0$); while a post-hoc Cramer’s V showed that 12.2% of the outcomes regarding which intervention code was observed, was associated with whether the coders ICHI codes were mismatched ($V = 0.2$, $p = 0.0$).

As shown in the full table in Appendix K which presents the results of the chi-squared test of procedure codes listed in the unmatched patient case entries), in terms of the observed count (OC) and expected counts (EC) of the intervention codes, there was greater-than-expected number of observations of the codes ‘0’ (OC = 3, EC = 1.7), ‘1’ (OC = 3, EC = 0.7), ‘1549’ (OC = 2, EC = 0.4), ‘1809’ (OC = 21, EC = 13.7), and ‘1819’ (OC = 2, EC = 1.2) among the patient case entries with unmatched ICHI codes, than among the rest of the (matched) patient case data. However, while these intervention codes were consistently in higher proportions among patient case entries with unmatching ICHI codes, it is worth noting that the NHRPL codes ‘1587’ (OC = 3, EC = 13.3), and ‘1778’ (OC = 5, EC = 7.5) were, in fact, in lower proportions among patient case entries with unmatching ICHI codes, than in the remainder of the data set.

It should be emphasised that the results of the chi-squared test could not specifically indicate causality, or confirm whether the NHRPL codes themselves were to ‘blame’ for the ICHI code mismatches. However, the test results did confirm that there was a statistically significant association between these specific NHRPL codes and whether the ICHI codes were mismatched. Importantly, the clinical coders did not have access to the NHRPL codes during the ICHI coding process, and they were only provided with the ‘findings’ (dataset column ‘D’), ‘radiology findings’ (dataset column ‘E’) and ICD-10 codes, in order to generate the ICHI codes — the NHRPL codes were only incorporated as supporting data, during the data analysis works.

This suggests that it is possible that other confounding variables, such as the intervention descriptions, or other co-correlated factors that were not immediately observable (due to their qualitative nature), might have been to blame for the intervention code observation anomalies. It is also possible that the statistically significant intervention code outcome was a latent variable observation of the qualitative variables, which could not be directly measured. Discussions on these considerations, as well as further research that would be necessary to answer the research questions, are made in Chapter Five. Some statistical reliability considerations are outlined next.

4.5 RELIABILITY OBSERVATIONS

Cronbach’s alpha was used to determine whether there was internal consistency among the interval and dichotomous variables. Cronbach’s alpha statistic provides a measure of the internal consistency of some data, by considering how much internally consistent variance exists within the dataset. As shown in Table 4.4, the Cronbach’s alpha, when comparing the ICHI code quantities of the three clinical coders, was 0.9. This was above the recommended minimum of 0.7 — where an alpha of 0.7 is considered to be suitable in most research applications. This also indicated that the internal consistency of these three variables, when compared together, was suitably high; or that 87.3% of the variability of these three variables, in a composite score, could be classified as reliable, internally consistent variance.

Similarly, when comparing the four matching (consensus) variables between the clinical coders’ ICHI codes, the Cronbach’s alpha statistic was 0.9. This indicated that the internal consistency of these four variables, when compared together, was sufficiently above 0.7;

and that 87.7% of the variability of these four variables, when calculated within a single composite score, could be regarded as reliable, internally consistent variance.

Table 4.3 Cronbach's alpha to observe internal consistency among the important interval and dichotomous variables

Variables compared	N of items	Cronbach's alpha
Coder SS ICHI code quantity, per case entry Coder AS ICHI code quantity, per case entry Coder MR ICHI code quantity, per case entry	3	0.9
SS, AS and MR codes match SS and AS codes match SS and MR codes match AS and MR codes match	4	0.9

4.6 CONCLUSION

The descriptive analysis has revealed that there was an even distribution of the ICD-10 chapters in relation to the intervention data. Furthermore, the analysis revealed that the coders were able to code most of the intervention descriptions into the ICH codes despite some variability between the coders. The variability was largely as a result of incomplete, vague or missing healthcare records. Inferential statistics determined the match between the coders' listing of the ICHI codes by use of relationship keys. The data analysis identified gaps in the ability of the ICHI system for generating unambiguous codes, and presented areas for attention to address South Africa's general surgery requirements. The results have provided a basis to argue for the introduction, or rejection, of the ICHI as a nationally-regulated intervention system for South African general surgery coding; the discussion and arguments for this rationale are presented in Chapter five.

CHAPTER FIVE
DISCUSSION

5.1 INTRODUCTION

Descriptive and inferential analysis of data coded in the ICHI enabled the researcher to answer the research questions that were asked in chapter one. The analysis enables discussions regarding the correlation and matching of the ICHI coding amongst the three clinical coders, the consistency in the assignment of the relationship keys and role of inferals and quality of healthcare documentation in the assignment of the ICHI codes.

There has been some interest towards introducing the ICHI in South Africa, together with the ICD-10 or ICD-11; however, the Government's intention to do so has not been heavily emphasised (Republic of South Africa, 2018). This study evaluated the suitability of the ICHI for general surgery interventions by statistically analysing the ICHI codes from three clinical coders, which had been coded from intervention descriptions extracted from a patient database. In this chapter the results are discussed and they systematically address the research objectives as follows: to evaluate the suitability of the ICHI for general surgery interventions by coding intervention descriptions extracted from a database to the ICHI codes, to identify gaps in the ICHI system and suggest new stem codes, in relation to general surgery coding, to provide a rationale for the introduction, or rejection, of the ICHI as a nationally regulated intervention system for South Africa.

5.2 SUITABILITY OF THE ICHI FOR GENERAL SURGERY CODING IN SOUTH AFRICA

The first objective of the study was to evaluate the suitability of the ICHI for general surgery interventions by coding the intervention descriptions extracted from a database, to the ICHI codes. In the public healthcare sector of South Africa, the UPFS system is utilised as a fee schedule for public hospitals and external funders such as the Road Accident and the Compensation Fund (Selesho, 2019). Applied since 2004 as a guideline for medical aid schemes and practitioners for calculating tariff structures (CMS, 2010; Ramjee, 2010; Grobler, 2011), the NHRPL system has not been updated since 2006, prompting considerations of other classification systems (Selesho, 2019; Matshidze and Hanmer, 2007). Implemented in the private healthcare sector is the CCSA coding system for intervention data collection which is a customised version of CPT that is utilised in the United

States for reimbursement of medical physician insurance claims (Kluyts, 2019). A new coding system such as the ICHI, though, would need to be able to map the UPFS, CCSA and NHRPL codes or intervention descriptions extracted from a database to the ICHI codes to function in South Africa's healthcare environment.

When considering the suitability of the ICHI for general surgery coding in South Africa, this research has considered the ICHI from three aspects: Firstly, the comparison of the ICHI to other health intervention or coding systems; secondly, how fully the ICHI has catered for the needs of the patient cases in this study; and thirdly, how additional information such as the ICD-10/diagnostic information and radiology findings/comments were utilised for the inferral of the ICHI codes.

5.2.1 Comparison of the ICHI to other health intervention coding systems

When comparing the ICHI to other health intervention systems, it must be noted that the ICHI classification is currently made up of 27 chapters of codes that are categorised into four sections. The chapters respectively consider interventions relating to the functions and systems of the body, activities and participation domains, environment and health-related behaviours (Fortune et al., 2018). In contrast, the ICD-10-PCS intervention system consists of 17 sections for coding of hospital in-patient procedures (Jurek et al., 2018). On the other hand, the CPT coding system consists of six sections that is utilised for Physician billing in the United States (Kluyts, 2019), whereas the same CPT system known as CCSA is utilised in South Africa largely for data collection in the private healthcare sector. The 27 chapters of the ICHI cater for an all-inclusive system covering surgical, medical, mental health, primary care, allied health, assistance with functioning, rehabilitation and prevention health interventions (Fortune et al., 2018). This is unlike the CPT/CCSA coding system with six sections that cater largely for intervention coding designed for physician billing. The CPT coding system contains evaluation and management codes, codes for anaesthesia, pathology and radiology billing and codes for surgical interventions. The ICD-10-PCS coding system is a detailed system that contains codes for medical and surgical interventions, obstetrics, placement, administration, measurement and monitoring, imagining, nuclear medicine, and radiation oncology. The ICHI on the other hand contains codes for interventions on all body systems and functions, interventions on activities and participation domains, interventions on the environment, and interventions on health-related behaviours thus making it all-inclusive system to support to support comprehensive coding for all disciplines and healthcare facilities (Fortune et al., 2018).

5.2.2 How fully the ICHI catered to the needs of the patient cases

When considering how fully the ICHI catered for the needs of the patient cases in this study, it is important to acknowledge that the three coders managed to code intervention terminology into the ICHI codes in 67.63% the patient cases. Comparatively, very few of the patient cases were left empty. This indicates that the coding of the intervention data into the ICHI codes was possible when the intervention data was correctly documented. For instance, it was apparent that the coders left case entries blank in only 4.8%, 18.1%, and 5.2% of the patient case entries, respectively. This suggests that the ICHI was, despite the range of variability on code options listed by the coders, able to cater to the broad range of general surgery procedures considered, in this study. Furthermore, this suggests that coders with more experience are able to assign the ICHI codes to more case entries than the less experienced coder. The experienced coders were able to extract clinical information from other sources such as the diagnostic information or the ICD-10 code and the radiology information to complete the ICHI code assignment. Shepheard (2020) emphasises that the integrity of coded data is dependent on the quality of healthcare documentation.

Notably, coders with more experience and training were not only able to assign the ICHI codes to more patient case entries but they also provided more than one ICHI code per case entry than the coder with less experience and training in clinical coding (refer to Figure 4.14). This illustrates that experienced coders are able to apply the multiple coding rule whereby more than one code is required to fully describe an intervention or when multiple codes are assigned for multiple interventions. Furthermore, coder training contributes to quality coding whilst employing poorly trained coders result in poor data collection (Alharbi et al., 2020). Conversely, it must be noted that there was a weak correlation between the quantity of the ICHI codes listed and the number of years of experience of the coders.

The coder with two years' experience, provided up to a maximum of five ICHI codes; while the coder with five years' experience, provided up to six ICHI codes. However, the coder with 23 years' experience listed up-to four codes only (as opposed to seven or more, as would have been the case in a linear correlation). Coder SS abided by the bundling rule whereby minor interventions performed during a main procedure are not separately reported. The less experienced coders unbundled and reported the minor interventions separately, which is a violation of the intervention coding rules. Thus it is worth noting that coder experience and training plays an integral role in the correct assignment of the ICHI codes, which is consistent with the findings in literature review that are presented in chapter two. It is significant to highlight that despite the variability in experience of coders, all three coders consistently assigned the same three ICHI codes for the top three intervention descriptions in the database namely, ‘KBF.AE.AD’ (Gastroscopy), ‘KBO.JK.AA’ (appendicectomy), and ‘KCO.BA.BB’ (endoscopic retrograde cholangiopancreatography) (Refer to Figure 4.7).

It is noteworthy that only 3.7% of the patient case entries in the database depicted in Table 3.3 in chapter four were left blank by the coders as the intervention descriptions were missing and the diagnostic and radiology information failed to provide sufficient clinical information for the inference of an ICHI code. Healthcare documentation and coding accuracy are interlinked thus it is incumbent on clinicians to document complete and concise information in discharge summaries that coders utilise for clinical coding (Mahbubani et al., 2018).

The most common relationship key (RK) listed by the three coders was ‘E’ (equivalent), which indicated that the ICHI code could be generated through an equivalent coding of the intervention description for 76% of the intervention descriptions in the database (Refer to Figure 4.8). As 3.7% of the patient case entries had no intervention information, the remaining 20.3% of the intervention descriptions were coded by the three coders through the ‘Target’, ‘Action’ or “Means’ components which illustrates that not all the interventions extracted from the database could be assigned via direct coding into an ICHI code or at least not initially.

The following example illustrates the challenges in coding of intervention data into an ICHI code for some interventions: Proctoscopy with biopsy-on searching “protoscopy biopsy”, no ICHI code was found. The coder had to access the Target component, rectum to arrive at the correct ICHI code: KBW.AD.AD: Endoscopic biopsy of rectum. Following the search via the “Target” component, the coder searched for biopsy of rectum and arrived at the same code, in this instance via a direct coding or an equivalent relationship key. This has implications for the search functionality of the ICHI Tool which may require expansion over time as not all intervention terms are included. Proctosigmoidoscopy appears in the

"Includes Notes" of the ICHI Tool; however, proctoscopy is excluded. It has been argued by Fortune et.al. (2018) that the ICHI will require progressive iterations of improvement; and that the classification should inherently be regarded only as a stable framework for gathering data, while there should be capacity for the framework to grow and develop over time, as the need arises (ICHI Beta-3 Reference Guide, 2020). It is also worth pointing out that coders with more experience are able to find the ICHI codes more frequently via a direct coding than coders with less experience as illustrated in Table 4.3 in Chapter four.

A significant amount of unclear interventions that were found in the database required the three coders to reference either the ICD-10 codes or the radiology findings/comments. This was valuable as it provided a means of illustrating what initial patient case information was required to be able to generate an ICHI code. This, in turn, showed how laborious the process was for the coders to be able to generate the ICHI codes for some healthcare records, and how extensively they needed to search, to be able to determine an appropriate ICHI code. This is because, while the initial aim of the study was to determine the ability to code intervention descriptions extracted from a database to the ICHI codes, ICD-10 codes/diagnostic information and radiology findings/comments were also included due to poor healthcare documentation. It should be emphasised that this is not, in many countries, considered acceptable practice, and coders are typically only required to code what is documented (Miranda-Escalada et al., 2020; Horsky et al., 2017).

It is worth pointing out that 14.7% of the codes assigned by the three coders had a RK of 'N' which represented that the intervention descriptors had a narrower concept than the ICHI code (refer to Table 4.1). This means that several ICHI codes were assigned to the intervention descriptions listed in the database to completely describe the interventions performed on the patient. The following example illustrates the narrower concept: open reduction of the knee joint with internal fixation is described by the assignment of two ICHI codes, i.e. MMJ.LD.AA: Open reduction of knee joint and MMJ.DN.AA: Implantation of device into knee joint. This will present a challenge for users that are familiar with coding one code to report both interventions and over time the ICHI may need to evolve to cater for this. The ICHI is a work in progress as it must provide a stable structure and basis for collecting data to support comparability as well as it must have the scope to expand and evolve as required to serve the needs of its users (ICHI Beta-3 Reference Guide, 2020).

Variabilities in the assignment of the ICHI codes and relationship keys were present amongst the three coders. This is because the ICHI code-generating process may currently be at risk of subjectivity, variability, and consequent reductions in reliability. Subjectivity and variability are disadvantageous properties, when considered in relation to clinical coding (Yang et al., 2020), as they result in significant complications, discrepancies, disagreements and difficulties in the delivery of optimum healthcare services (Souza et al., 2018). Furthermore the variabilities could be attributed coders sequencing of multiple codes.

An important paper by Cheng et al. (2009), for instance, concluded that coding inaccuracy or miscoding, was a significant cause for the inappropriate funding of health services — equating to a revenue discrepancy of nearly AU$575,300 across 752 cases audited; unreliable hospital performance tables being produced; and errors for disease surveillance and epidemiology programs. Studies on the rates of miscoding and errors found that, even in the 1980s and 1990s, error rates ranged from 0-to-70% (O'Malley et al., 2005). In many instances, this rate of clinical miscoding is still unacceptably high (Sarabi et al., 2020). With a core purpose of the ICHI being its intention to reduce miscoding and its associated errors, this is therefore an important issue that cannot be overlooked.

Considering this issue in more detail, with some of the coders listing 80% and others listing only around 70% of the patient records with a single code, it was possible that prior coding training or experience may have been a significant driver of their coding tendencies. To provide more understanding on this notion, the relative experience of the three coders in this study, was considered (refer to Figure 4.14 and Figure 4.15). A correlation analysis confirmed that coders with fewer years' experience consistently left more entries blank while coders with more years' experience left both fewer patient case entries blank, and fewer ICHI code options (greater ICHI code precision).

This suggests that a prior amount of experience or training might be needed for the ICHI to be accurately implemented, when measured relative to the overall number of 'blank' listings, and single ICHI codes listed. However, when multiple ICHI codes are listed, there appears to be considerable differences among coders to list numerous varieties of the ICHI codes, regardless of their prior coding experience. This is because a correlation analysis confirmed that in patient cases where Coder SS provided multiple ICHI codes per intervention record, Coder MR also provided multiple ICHI codes per intervention record in some instances, however, Coder AS only provided single ICHI codes per intervention record. In instances where Coder SS left entries blank, Coder MR also very often left entries blank and Coder AS left more entries blank that were coded by Coders SS and MR.

Since ICD-10 codes and diagnostic information was referenced in the assignment of the ICHI codes where the intervention data was missing, unclear or vague, a brief analysis was conducted on the ICD-10 codes. It was interesting to consider, therefore, the distribution of ICD-10 chapters that were covered in the patient data of this study. As described in the results of Chapter four, a range of 888 different variants of ICD-10 codes existed across the 3000 patient case entries, where the most frequently listed ICD-10 codes were from Chapter XI: Diseases of the digestive system. The second most frequently cited chapter was Chapter XIX: Injury, poisoning and certain other consequences of external causes; while other ICD-10 chapters that were observed frequently were Chapter II: Neoplasms, Chapter XIII: Diseases of the musculoskeletal system, and Chapter IX: Diseases of the circulatory system. Notably, these chapters are consistent with the intervention descriptions in the database since the database consisted of interventions performed on general surgery patients.

In this study, some ICD-10 chapters were noteworthy for their infrequency of observation in the data where there were no instances of Chapter VIII: Diseases of the ear and mastoid process, or Chapter XXII: Codes for special purposes. Codes for Chapter XVI: Certain conditions originating in the perinatal period and Chapter VII: Diseases of the eye and adnexa, were also very infrequently observed. This was noteworthy because diagnoses from these chapters are generally not appropriate for interventions that are classified under general surgery. As noted in the results chapter the most frequently listed ICHI stem codes are for gastroscopy, appendicectomy and cholangiopancreatography which is consistent with the ICD-10 findings. This finding suggests that the ICD-10 and ICHI stem codes are limited to the general surgery discipline. It is important to note that there is strong link between diagnostic and relevant procedure codes (Tam et.al. 2020) as illustrated by the distribution of the ICD-10 chapters in the analysis.

In addition, to the diagnostic information by means of the ICD-10 code, radiology findings/comments were included since the coders needed to reference the radiology findings/comments, in some situations, due to the lack of suitable healthcare documentation to derive the ICHI codes. In some cases, this allowed an ICHI code to be inferred where it was omitted. This was the case, for instance, where many instances of ‘pigtail’ were documented in the healthcare record as interventions, with no mention of the associated site. The radiology finding/comments were referenced, in such instances. An example that illustrates this is the documentation of ‘pigtail’ in many instances with no mention of the associated site. The ICD-10 code/diagnostic information and radiology finding/comments were referenced, in such instances, and if the ICD-10 code stated for example ‘abscess of the peritoneal cavity’ and the radiology comment indicated ‘percutaneous insertion of pigtail’, the ICHI code for percutaneous drainage of the peritoneal cavity was listed. Pigtails are sterile catheters or drains that are utilised to drain excessive fluid or abscesses from body organs or body cavities.

The final rationale for the introduction or the rejection of ICHI as a nationally regulated intervention system for general surgery coding in South Africa, is presented in Section 5.3. Having evaluated the suitability of the ICHI for general surgery interventions, by coding intervention descriptions extracted from a database to the ICHI codes, the next objective — to identify gaps in the ICHI system, is discussed next.

5.3. GAPS IN THE ICHI SYSTEM

The second objective of this study was to identify gaps in the ICHI system and suggest new stem codes, if necessary, to address South African requirements for general surgery coding. In this study, a core means of determining gaps in the ICHI system was achieved through observations on the matches between the coders’ ICHI codes. To achieve this, observations were made to determine whether the initial (primary) ICHI code for each single patient case entry matched; and whether all the different variants of the ICHI codes for each single patient case entry (all the ICHI codes within the entry) also matched.

There was an exact ‘true’ match of only 67.6% of the initial ICHI codes between coders SS, AS, and MR, indicating that there was 32.4% variability between the codes generated by all three coders. This means that, among the three coders, they managed to provide robust coding, without error or discrepancy, among two-thirds of the patient cases based on the data extracted from the database.

It is also important to note that an exact match was confirmed by a match between the coders’ initial (primary) ICHI code listing. However, as was to be expected when considering matches between all the different variants of the ICHI codes for any single patient case entry (all the ICHI codes within the entry), the proportion of exact matches between the coders dropped somewhat. That is, when considering the entire ICHI code listing of all the different codes listed — with all of the different ICHI code options presented by the coders — the overall matches between the coders dropped from 67.6% to 63.37% (refer to Figure 4.11). McNemar tests conducted on paired nominal data confirmed that there was a statistically significant amount of variation in the mismatches between SS and AS and between AS and MR, which was unlikely to have occurred by chance alone.

While it may initially have appeared that the variability in the ICHI codes applied could have been down to cognitive, experiential, or human errors on the part of the coders, it was observed that there was only a small, 3.3% of patient case entries, where there was no consensus between any of the three coders (see the results, of Chapter four). As discussed in the previous section, a potential reason that this may have been the case was because of the degree of experience of the coders, which confirmed that unless the coders generating the ICHI codes were equipped with a considerable amount of time in coding — five years' worth of experience in coding, or more — they were likely to provide a considerable amount of variability and inconsistency in their ICHI codes. The variability can be attributed largely to the sequencing of the ICHI codes, whereby coders selected different primary ICHI codes for the same case entry which highlights the need for coder training and ICHI coding standards.

This also appeared to align with findings in the literature that weaknesses with the ICHI are often procedural. A study performed by Stojanovic et al. (2020) to assess the ICHI, for instance, found that in many cases, a period of training was necessary due to the codes' structures. However, Stojanovic et al. (2020:4) do propose that after a short orientation period, "the technical handling of the platform was very workable". The authors noted, too, that the exact heading titles of the interventions in their study were not specified in the ICHI, requiring the researchers to describe the interventions with various appropriate keywords. Consequently, the Stojanovic (2020) team could often not assign a precise descriptive ICHI code to the intervention that was executed, and codes frequently needed to be used that would only approximate the interventions.

It is worth noting that the variations in assignment of the ICHI codes and relationship keys between the coders are procedural rather than an imminent gap in the ICHI system itself. Procedural matters such as training need to be addressed to avoid a greater degree of variability among a wider range of professional coders. This also did not provide a large supporting basis for the robustness of the ICHI as a coding system, to be relied upon among healthcare professionals from many different areas of medicine, and across different geographical locations, as called for in the literature (Wojcik et al., 2006).

5.3.1 Potential new codes for general surgery interventions

One of the proposed benefits of the new ICHI system is that it is possible for extension codes to be incorporated into the ICHI, so that additional information about an intervention can be captured (Donada et al., 2018). The ICHI extension codes and stem codes, for instance, are also linked through a logical syntax system (Donada et al., 2018). Ohannessian et al. (2017) and (2019) published papers on their experiences of the implementation of the ICHI extension codes, particularly to the classification of telestroke. After assessing the ICHI Alpha 2016 version, Ohannessian et al. (2017) determined that while it was possible to code acute stroke care process interventions with the ICHI, there were apparent shortcomings in the appropriateness of the telestroke coding system. Currently, the ICHI contains one stem code for telestroke AAA.AI.BL: Video or radio-telemetered electroencephalography monitoring (ICHI Platform, V1.16.0, 2021). Thus this is an area that potentially requires expansion either by creating additional stem codes or by use of extension codes. It is worth noting that ICHI does not include diagnostic information as this is included in the ICD (ICHI beta-3 Reference Guide, 2020).

As extension codes were excluded in this study, in order to determine potential new codes in the ICHI to address South African requirements for general surgery procedures, it was valuable to observe what the frequency distributions of the NHRPL codes were within the 3.3% of totally mismatched patient case entries in this study. This provided a means of observing possible 'problem areas' that may have existed and potential new codes to address South African requirements for general surgery procedures. There were 83 variants of the ICD-10 codes observed for the patient case entries, where the coders consistently failed to generate any ICHI code consensus (refer to Figure 4.12).

The two ICD-10 codes: 'C20' (Chapter II: Neoplasms), and 'I70.21' (Chapter IX: Diseases of the circulatory system) were observed in recurrence, together with the ICD-10 codes 'A18.3', 'B23', 'C15', 'K35.0', 'K40', 'K42', 'K56.2', 'K56.5', 'K65', 'K80', and other ICD-10 code variants in isolation. Importantly, a chi-squared test found insufficient consistency among the ICD-10 codes to confirm that these recurrences were not simply due to random coincidence. This meant that these ICD-10 codes could not be highlighted as potential targets for new codes to be generated to improve the ICHI's coding efficacy.

While the ICD-10 code associations failed to provide any statistically consistent problem areas, it was observed that variations in the NHRPL codes did, in fact, occur. For instance, of the 443 different NHRPL codes that existed across the 3000 patient case entries, the intervention description 'laparotomy' depicted by the NHRPL code '1809' surprisingly recurred in one quarter of the mismatched cases; while intervention description 'upper gastrointestinal endoscopy' denoted by NHRPL code '1587', 'endoscopic retrograde cholangiopancreatography' denoted by NHRPL code '1778', 'oesophagoscopy with stricture' denoted by NHRPL code '1549' and 'inguinal or femoral hernia: adult denoted by NHRPL code'1819' were also observed in recurrence. Even though the NHRPL codes were excluded from this study, they were included in the analysis were a high recurrence of repeated interventions were noted in the data. It was confirmed statistically that these NHRPL codes recurred frequently in the patient case entries and in the unmatched codes or a difference in the assignment of the ICHI codes amongst the three coders, than among the rest of the (matched) patient case data.

It was noted that Coder SS coded the intervention description 'laparotomy' to a large extent to the ICHI codes that described interventions such as appendicectomy or abdominal drainage, whereas Coder MR and Coder AS coded the intervention to an equivalent ICHI laparotomy code. Similarly, for the endoscopic interventions depicted by NHRPL codes "1587", "1778" and "1549", coder SS assigned the ICHI codes that described the therapeutic interventions whilst coders MR and AS often assigned the ICHI code that described the diagnostic ICHI intervention. The following example illustrates the variation in codes assigned by the coders, coder SS coded "'Duodenal stent placed under flouroscopy using ERCP scope" into the ICHI code KBI.LH.AD: Endoscopic dilation with insertion of device into duodenum while coders MR and AS assigned the ICHI code KCO.BA.BB: Endoscopic retrograde cholangiopancreatography.

This means that no new ICHI codes are required to address the general surgery coding needs in South Africa. Instead, the quality of healthcare documentation requires attention and coders need to be trained in coding and anatomy, physiology and interventions performed in hospitals. Indubitably, as noted in the literature, despite more-than ten years of development, it is inevitable that shortcomings and problems with the ICHI's classification, as well as its strengths, will be apparent (Fortune et al., 2018). Fortune et al. (2018) asserted that the purpose of testing the beta version of the ICHI is to determine these problems, and to improve them before it is finalised; and studies such as this one have helped to do so. Furthermore, it has been argued that it is inevitable that the ICHI will require progressive iterations of improvement (Fortune et al., 2018). This also has implications for this research, and the rationale for the introduction, or rejection, of the ICHI as a nationally regulated intervention system for general surgery in South Africa.

In order to discuss this finding further, it is worth noting that the intervention descriptions laparotomy, and insertion pigtail which were observed so frequently across all of the patient data in this study, may have been inclined to appear among the list of mismatched patient cases purely due to its high rate of observation in the data. However, due to the high rate of error (mismatching) in the ICHI codes between the three coders, it indicates, firstly, that coder training, coding experience and quality healthcare documentation are critical in the assignment of correct ICHI codes and that the ICHI classification system itself may not have significant gaps in coding of general surgery interventions. It also indicates that, where such procedure codes recur so often, it may be beneficial for national ICHI coding standards to be provided to ensure that these common procedure codes can be consistently converted to the ICHI format, with precision and without ambiguity.

It should be emphasised that these results could not specifically indicate causality or confirm whether the intervention descriptions themselves were to 'blame' for the ICHI coding mismatches. However, the test results did confirm that there was a statistically significant association between these specific intervention descriptions and whether the ICHI codes were mismatched (refer to Figures 4.14 and 4.15). It is also important to emphasise that the NHRPL codes were only incorporated as supporting data, during the data analysis works.

This indicates that it is possible that variables, such as the intervention descriptions, or other factors that were not observable (due to their qualitative nature), might have contributed to observation anomalies. It is also possible that the statistically significant NHRPL code outcome was a latent variable observation of the qualitative variables, which could not be directly measured (Kotov et al., 2015).

Having observed potential ICHI codes to address South African requirements for general surgery procedures, the final objective of this study, is discussed next.

5.4 RATIONALE FOR THE INTRODUCTION, OR REJECTION, OF THE ICHI

The final objective of this study was to provide a rationale for the introduction, or rejection, of the ICHI as a nationally regulated intervention system for South Africa. There are numerous strengths and benefits of the ICHI that have been described in the literature, despite the ICHI still being in its infancy. A key benefit is that the ICHI, the ICF and the ICD — the three core WHO-FIC classifications – can be used collectively (Manchaiah et al., 2020; Fortune et al., 2018), where the terminology and ontological structure of the ICHI is consistent with the ICF and the ICD-11 systems (Zeng et al., 2020). These have been important considerations when developing the rationale for introducing or rejecting the ICHI for general surgery coding in South Africa.

When considering the potential for the ICHI to perform as a nationally regulated intervention system for general surgery coding in South Africa, then, this research has had to rely upon three core lines of argument. That is, the argument of this final objective has been fundamentally based on the degrees of variability or error (mismatches) that were observed between the three coders' ICHI codes; the potential for overcoming these variabilities or errors; and the potential suggested in the literature for overcoming shortfalls in coding using classification systems. These are discussed, next.

5.4.1 Degree of variability between the ICHI codes

This study has followed a relatively new approach of using ICD-10, diagnosis information and radiology findings/interventions to infer an intervention, and its associated ICHI code(s). Consequently, it cannot be ignored that factors that may have caused some variation in the coders' ICHI code listings would have been the incompleteness of the original 3000 patients' case records.

As stated by Hall (2019) the absence of a national intervention coding system and inadequate medical records contribute to the challenges of achieving effective healthcare delivery in South Africa. Such characteristics within the sample data of this study, therefore, did not provide an ideal mechanism of the ICHI code creation. Yet, it must be acknowledged that such a coding environment is typical of general surgery in South Africa (Marutha and

Ngoepe, 2017). Thus, any future ICHI coding efforts would need to navigate a similar spectrum of challenges and gaps in patient records; a similar potential for mismatches would likely need to be accepted (Mthethwa and Matjila, 2019).

In terms of general error rates, miscoding is an important eventuality that occurs with any coding system. Studies on the rates of miscoding and errors in the 1980s and 1990s, for instance, found that error rates ranged from 0% to 70% (O'Malley et al., 2005). In many instances, this rate of clinical miscoding is still, decades later, unacceptably high in many parts of the world (Sarabi et al., 2020). As alluded to previously, coding inaccuracy is a significant cause for revenue discrepancies, unreliable hospital performance tables, and errors for disease surveillance and epidemiology programs (Cheng et al., 2009). With a core purpose of the ICHI being its intention to reduce miscoding and its associated errors, then, the overall match rates of the three Coders SS, AS and MR (63.4%) is an important issue that cannot be overlooked.

Cronbach's alpha was calculated to observe the internal consistency among the interval and dichotomous variables. Cronbach's alpha statistic provides a measure of the internal consistency of some data, by considering how much internally consistent variance exists within the dataset. As shown in Table 4.4 the Cronbach's alpha, when comparing the ICHI code quantities of the three clinical coders, was 0.873. This was above the recommended minimum of 0.7 — where an alpha of 0.7 is considered to be suitable in most research applications. This indicated that in a composite score, the variability of the coders could be classified as reliable, and an internally consistent variance.

5.4.2 Potential for overcoming variability when generating the ICHI codes

Similarly, when comparing the four matching (consensus) variables between the clinical coders' ICHI codes, the Cronbach's alpha statistic was 0.877 which is discussed under 5.4.1.

When considering the potential for the ICHI to be introduced to South African for general surgery coding, then, it must be considered whether strategies that could be implemented to reduce this rate of mismatching, would be successful. Three potential areas for improvement, in the literature, have considered the potential for computerisation of coding records, training, and adjustments to the ICHI codes. Consequently, it is worth considering whether it would be advisable for the ICHI to be implemented, in South Africa, in combination with some form of coding improvement mechanism and efforts to improve documentation quality by clinicians.

There has been some argument for the implementation of computerisation systems to improve clinical coding in South Africa. In the Western Cape, for instance, the eCCR was introduced, in 2015, in an attempt to increase the ICD-10 coding quality, by integrating functionality for ICD-10 code searches to assist clinicians (Dyers et al., 2016). As noted in chapter two, Dyers et al. (2016) assessed the precision and completeness of the ICD-10 codes gathered; and in 2017, the authors found that the eCCR had a 38.0% increase on the completeness of the ICD coding, relative to a control hospital (Dyers et al., 2017). Campbell and Giadresco (2020) proposed that suitable assistive instruments, such as computer-assisted coding can improve the quality of clinically coded data and coders should view computer-assisted coding as an opportunity to acquire new skills. This provides considerable weight to the argument that such mechanisms may assist with improving the completeness and consistency of the ICHI coding, following this current study, as well.

Extending on from this, the correlation analysis in this study confirmed, with statistical significance, that coders with fewer years' experience consistently left more entries blank, and more ICHI code variability than coders with more coding experience. This suggests that there was considerable supporting evidence in this study that additional skills or training would likely improve the efficacy of the ICHI coding, if implemented on a broader scale for general surgery in South Africa. This finding was also supported in the study by Dyers et al. (2017), which found evidence that training enhancement, such as through training packages, produced significant positive effects on the completeness of coding in South African hospitals.

While training programmes have been demonstrated to generate positive effects on the coding quality of professional coders in South Africa (see chapter two), Dyers et al. (2016) argued that clinicians find issue with attending the ICD-10 coding training due to time constraints and cost implications. In the case of the Department of Health of the Western Cape Government, for instance, Dyers et al. (2017) asserted that implementing broad-based training and assistive tools would be challenging, due to capacity limitations. To this end doctor training programmes need to highlight the importance of quality healthcare documentation by clinicians to support the correct assignment of the ICHI codes by coders rather than expecting the doctors to attend training and perform the coding function. An example of note is the documentation of laparotomy for abdominal or pelvic surgery rather than the actual intervention performed such as an appendicectomy.

5.4.3 Potential for adjustments to the ICHI extension codes

Next, it must be considered whether the ICHI itself is capable of accommodating the coding requirements of general surgery in South Africa, and that its current capabilities for coding would be sufficient to support the country's general surgery needs. When considering the primary weaknesses of the ICHI, for instance, Thun and Dewenter (2018) highlighted the inconsistencies between SNOMED CT and ICHI whereby it was stated that the ICHI does not cover a whole range of medical terminologies which are catered for in SNOMED CT. It must be noted that the aim of ICHI as a health classification covers an all-inclusive range of health interventions and not terminologies, which are included in SNOMED CT. Hence the inconsistencies noted by Thun and Dewenter (2018). Manchaiah et al. (2020) also concurred that in the case of audiology-related interventions, the ICHI supports codes for interventions that target body functions and systems; and also highlighted the benefits of implementing the various relevant extension codes. Thus, while numerous potential extension codes have been discussed, in the previous section of this discussion, it remains to be seen whether these modifications would help to improve the efficacy rates of the ICHI coding as these were excluded from the study.

5.4.4 Potential suggested in the literature for the ICHI to overcome shortfalls

Before making a final conclusion on the rationale for the introduction, or rejection, of the ICHI as a nationally regulated intervention system for general surgery coding in South Africa, it is worth reflecting on more of the arguments in the literature. When considering the suitability of the ICHI content, Stojanovic et al. (2020) argued that the ICHI classification shows a strong clinical focus, due to its representation of the historically larger numbers of health professionals undertaking clinically focused disease managements.

Whilst not all types of interventions are included in this study, of pertinence in the current age of clinical coding is the ICHI's application to the COVID-19 pandemic. Zeng et al. (2020) recently used the WHO-FIC frameworks to generate a coding structure for a programme of COVID-19 rehabilitation, by establishing intervention and evaluation, terminology, and rehabilitation systems that focused on the service delivery, intervention, and evaluation of disease functioning related to COVID-19 rehabilitation. Although their study was not exclusively related to surgical interventions, they did provide supporting arguments that the ICHI is flexible in its ability to describe interventions for different conditions, such as COVID-19, which were not initially devised during the development of the ICHI system (Zeng et al., 2020).

New and similar work by Sharma et al. (2020) applied coding from the ICHI to create a model for enumerating the priority list of medical devices that are required in India. Importantly, the authors did not specifically critique the ICHI for its ability or otherwise, to generate their model; however, the fact that they were able to generate their model with critical application suggests that the ICHI does, indeed, hold merit for academic relevance in diverse applications. A recent study by Fortune et al. (2021) highlighted the classification challenges in multi-component public health interventions for example the assignment an ICHI code for an intervention that involves more than one ICHI target or the ICHI action. This study which concluded that the ICHI can be appreciated as an 'epistemic hub' that can enable flexibility to meet different information needs of public health stakeholders.

In spite of these recent arguments for the strengths of the ICHI, there remains a considerable amount of debate regarding its flaws and shortcomings. Recent work by Malmgren Fänge et al. (2020), used the ICHI to classify interventions related to satisfaction of caregivers providing healthcare services for patients living at home with cognitive disorders, based on an international selection of 35 mixed methods and quantitative research papers. Malmgren Fänge et al. (2020) incorporated a far smaller number of cases compared to this study, and as with such a small number of case code conversions, it was not surprising that the authors failed to highlight any issues with the use of the ICHI for classifying the interventions. However, authors suggested that almost 50% of the interventions were classified by the ICHI as participation-related activities; they proposed that additional research was needed to provide a clearer definition of the use of the ICHI guidelines. The authors also noted that a distinction needs to be made between the satisfaction of the caregiver and the recipient and address this simultaneously. In this respect the ICHI can harmonise intervention coding, globally.

Other recent work by Tu et al. (2020) has also attempted to develop a generalised content model that is based on WHO-FIC and which defines the information structure and semantic roles of the ICHI, the ICF and the ICD-11 entities. However, it has failed to provide conclusive evidence to support any rationales for the introduction, or rejection, of the ICHI (Tu et al., 2020). Charif et al. (2020) also classified innovation types in Quebec, Canada, using the ICHI; and although their study was not intrinsically researching the ICHI classification, it incorporated the ICHI to determine the preparedness of the primary care innovators in scaling up for evidence-based primary care innovations. Consequently, it was unable to offer much useful material to assist with answering questions in this study.

Alluded to above, there is a considerable amount of inconclusive research in the international literature, regarding the ICHI, which has further elevated the importance of the results of this study. Consequently, in terms of the final research objective, it can be concluded that there is sufficient rationale for the introduction of the ICHI as a nationally regulated intervention system for South Africa for general surgery coding despite the ICHI system having potential deficits in other domains such as coding of interventions related to telestroke. There could be merit to consider the further use of the ICHI system for general surgery coding, provided certain baseline criteria are considered. This includes the consideration of computerised systems; the training of coders; and the incorporation of certain high-error extensions, as outlined in this study. The adoption of the ICHI as a national intervention classification system can replace the multiple intervention data coding systems in use in South Africa and enable international intervention data comparisons. Added benefits to South Africa will be the update process of the ICHI as the ICHI will be updated by the WHO and South African can adopt the updates with no or negligible changes. Furthermore, South Africa will have access to the WHO ICHI training materials.

5.5 CONCLUSION

Considering that at least one ICHI stem code could be generated in the vast majority of the patient cases, suggests that the scope of the ICHI is likely to be sufficient for general surgery coding. The variability of the ICHI code and relationship key assignments between the three coders suggests that ICHI coding standards will be required in South Africa in parallel to quality healthcare documentation and coder training to avoid the risk of variability, subjectively and, consequent reductions in reliability.

Although the ICD-10 coding system and radiology information was utilised in some instances to facilitate the assignment of the ICHI code, there were no areas in the ICHI stem codes that could be significantly highlighted as potential targets for new ICHI stem codes to address South African general surgery requirements. It can be determined, from this study, that there is sufficient rationale for the introduction of the ICHI as a nationally regulated intervention system for South Africa for general surgery coding. Evidence provided in this study and in the literature indicates that there could be merit in adopting the ICHI for general surgery coding in South Africa, provided certain baseline criteria are addressed. In chapter six, an overview of the study, conclusions, limitations and recommendations are presented next.

CHAPTER SIX

OVERVIEW, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1 OVERVIEW

This research was aimed at evaluating the ICHI to establish its suitability for general surgery coding and to make recommendations for the adoption and implementation of the ICHI as a national intervention classification system for use in South Africa. Since this is pioneering research, the results of the study will have implications for South Africa as well as the global coding community. The evaluation of the ICHI focused on the acquisition of knowledge on the strengths and limitations of ICHI and areas that may require expansion and improvement not limited to the classification system. In the evaluation of the ICHI to establish its suitability for general surgery coding, an additional aim was to investigate other factors that impact the assignment of the ICHI codes such as the quality of healthcare documentation, coder training and accreditation, and coding tools to support the coding process.

Intervention classification systems in use internationally, focus largely on medical, diagnostic and surgical interventions for inpatients and lack the ability to describe interventions related to preventative and public health, allied health, rehabilitation and assistance with functioning (Manchaiah et al., 2020). Chapter one of the thesis provided a background to international health classification systems and a context to the multiple health classification and billing systems that are in use in South Africa. Included in the background is an introduction to the ICHI as a comprehensive intervention classification system. Chapter one also presented the problem statement, which lead to the following research questions:

- Is the ICHI suitable for general surgery coding?
- Does the ICHI have gaps within the South African surgical environment and can new codes be created to address these gaps?, and
- In relation to general surgery, can the ICHI be recommended for adoption in South Africa as a national intervention coding standard?

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In chapter two, a conceptual framework with dependent and independent variables was presented and explored. The literature was appraised in relation to the dependent and independent variables and the strengths, challenges and gaps of international and national intervention and billing classification systems. Chapter three described the positivist philosophy that informed the deductive approach that the researcher adopted to evaluate the suitability of the ICHI for general surgery coding. The chapter detailed the study design and methods that enabled the evaluation of a cross-section of healthcare data collected in a database from three academic hospitals in Gauteng.

Chapter four presented the results of the study in relation to the objectives formulated, followed by an integrated discussion, in chapter five of the results in relation to the research questions posed at the outset of the study.

6.2 CONCLUSIONS

Although there are not many studies available on the ICHI and the ICHI is still in the development stage (Manchaiah et al., 2020), the researcher was able to review adequate up-to-date literature pertaining to health classification systems and conduct analysis of intervention descriptions collected in a database to arrive at a conclusion, answer the research questions and establish if the ICHI is suitable for general surgery coding in acute hospitals. This section presents the major findings in relation to the research questions of the study.

- Is the ICHI suitable for general surgery coding?

In answering this question the researcher considered the ICHI from three aspects:
1) The utilisation of radiology findings/comments and ICD-10/diagnostic information by means of the ICD-10 codes when healthcare documentation was vague, incomplete or the intervention information was missing. Though not ideal or common practice in many countries, this assisted the three coders in assigning the ICHI codes by inference to more healthcare records as opposed to leaving the records blank. As stated by Tam et.al (2020) there is a strong link between diagnostic and procedure codes, which was illustrated by the distribution of the ICD-10 chapters.

2) The comparison of the ICHI to other health intervention classifications or coding systems addressed the second aspect. The 27 chapters of the ICHI cover interventions comprehensively by the inclusion of interventions associated with the functions and systems of the body, participation domains and activities, and health-related behaviours (Fortune et al., 2018). In comparison, other coding or intervention classification systems such as the ICD-10-PCS consist of 17 sections and are limited to hospital inpatient coding of medical and surgical procedures (Jurek et al., 2018). The CPT coding system with its six sections is utilised in the US for Physician billing (Kluyts, 2019), and is limited to medical and surgical interventions performed on in-patients and the physicians consulting rooms. The same CPT system known as CCSA in South Africa is utilised largely for in-patient surgical data collection in the healthcare sector. Thus is can be concluded that the ICHI is a more comprehensive intervention classification system and the implication is that the ICHI can replace existing coding systems in use for data in South Africa. Furthermore the ICHI can cater for interventions in other healthcare domains such as participation domains and activities which are currently not coded with any intervention or coding system.

3) The third aspect addressed how fully the ICHI catered for the different general surgery interventions performed at three academic hospitals in Gauteng. It is important to note that the three coders were able to assign at least one ICHI code to majority of the interventions, leaving minimal case entries blank. Coders with more training and experience were able to assign more ICHI codes per case entries where multiple interventions were performed in comparison to coders with less experience and training. Similarly coders with more experience and training were able to assign more specific ICHI codes to intervention descriptions where descriptions were incomplete or poorly documented, such as the documentation of laparotomy for appendicitis by the clinician. In this instance experienced and trained coders assigned the ICHI code for appendectomy whilst the less experienced coder assigned the ICHI code for the laparotomy. Though there was variability in coding amongst the three coders, it is worthy to note that the ICHI is able to cater for the broad range of general surgery interventions deliberated in this study thus indicating that the ICHI is suitable for general surgery coding.

- Does the ICHI have gaps within the South African surgical environment and can new codes be created to address these gaps?

This study has identified variability in coding between the coders which was determined by observations on the matches between the coders' ICHI codes. It is worth noting that there was only a 3.3% of patient case entries, where there was no consensus between the three coders. The variability and mismatch between the three coders is attributable to incomplete, vague and missing intervention data, and the experience and training of coders. High volumes of mismatches between the three coders were noted in the documentation of diagnostic descriptions of endoscopic interventions. Whilst the less experienced coders coded the endoscopic diagnostic intervention descriptions into endoscopic diagnostic ICH codes such as gastroscopy and colonoscopy, the experienced coder through the reference of radiology comments and ICD-10 codes assigned the ICHI codes for therapeutic interventions that were performed such a repair of intestine and pyloroplasty.

Whilst the variations in coding between the coders is evident, it is worth noting that the variability in assignment of the ICHI codes and relationship keys are largely procedural rather than an imminent gap in the ICHI classification itself. As stated by Resslar et al (2019) procedural matters need to be addressed to avoid subjectivity and an increased degree of variability amongst a wider range coders assigning ICHI codes to a larger data set. Whilst the study highlighted mismatches and variability in the ICHI coding between the three coders, there was no evidence to indicate that new ICHI stem codes need to be created.

- In relation to general surgery, can the ICHI be recommended for adoption in South Africa as a national intervention coding standard?

When considering the potential for the ICHI to perform as a nationally regulated intervention system for general surgery coding in South Africa, the research had to rely upon three core lines of argument, which describe the degrees of variability or error (mismatches) that were observed between the three coders' ICHI codes; the potential for overcoming these variabilities or errors; and the potential suggested in the literature for overcoming shortfalls in coding using classification systems.

This study followed a relatively new approach of using diagnosis and radiology findings/interventions to infer an intervention, and its associated ICHI code(s), which contributed to some of the variability as a result of incomplete healthcare records. It has been noted in the literature review that inadequate medical records and the absence of a national intervention coding system impact negatively on effective healthcare delivery in

South Africa. Furthermore mention is made in literature that significant coding errors exist decades after health classification systems are implemented globally which impact negatively on revenue discrepancies, unpredictable performance indicators and questionable disease surveillance and epidemiology programmes. Of note in literature is that a common barrier to quality clinically coded data is incomplete and disorganised healthcare records with a failure to communicate with physicians for clarification. All of the discussions raised by the different authors in the literature suggest that the quality of healthcare documentation undoubtedly requires attention and improvement to support the ICHI as a national intervention coding system.

Additional areas in literature that need be considered to support the ICHI as a national intervention coding system are computerisation of coding records, coder training and development of coding standards and guidelines. The introduction of the eCCR in 2015 by the Western Cape Department of Health (WCDoH) revealed a 38% improvement in the quality of ICD-10 coding over a two year period (Dyers et al., 2017). Though the eCCR project implemented by the WCDoH is yielding positive results, it must be noted that the use of HIS remain low in South Africa’s public sector as patient data is largely recorded manually. Furthermore, the literature mentions that the computerising of healthcare records can decrease efficiency if workers are not computer literate or technologically-inclined. Conversely, the use of HIS produces efficiency due to the increased access to data in a single repository (Johnson et al., 2018). To this end, the adoption and implementation of the ICHI as a national intervention coding system requires consideration of computerising coding records and ensuring that healthcare workers are computer literate.

The correlation analysis in this study confirmed with high statistical significance that coders with fewer years’ experience consistently left more entries blank, and more ICHI code variability for patient case entries than coders with more coding experience. This suggests that training and accreditation of coders will improve the efficacy of the ICHI coding, if implemented on a broader scale for general surgery in South Africa. This finding is supported in the Dryers et al. (2017) study, which found evidence that training contributed to an improvement in the quality of ICD-10 coding. The study also notes that it will be a challenge for clinicians to attend ICD-10 accredited training due to time constraints and cost implications. Doktorchik et.al (2019) note that interactive coding programmes for clinical coders and the streamlining of source documents for coding will contribute to an improvement of clinically coded data. To alleviate pressure on clinicians from performing a coding function, training of coders and the compilation of clinical information by trained compilers from healthcare records requires deliberation in the ICHI becoming a national intervention coding system.

Numerous benefits of the ICHI have been highlighted, of note is a recent study by Zeng et al., (2020) which illustrates that the ICHI is flexible in its ability to adapt and accommodate new disease interventions, such as COVID-19, which was initially not addressed during the ICHI development phase. Similarly, work produced by Sharma et al. (2020) whereby the ICHI was utilised to create a model for enumerating the priority list of medical devices that are required in India does promise that the ICHI holds merit for academic significance in diverse applications. The discussions by these authors highlight the ability of the ICHI to accommodate the diverse intervention needs of a healthcare industry which favourably positions it to become a national standard in South Africa.

There are diverse opinions in the international literature, regarding the ICHI, which has further elevated the importance of the findings of this study. Consequently, in terms of the answering the final research question of this study, it can be concluded that there is sufficient rationale for the introduction of the ICHI as a nationally regulated intervention system for South Africa for general surgery coding despite the ICHI system being in a beta version.

6.3 LIMITATIONS AND DELIMITATIONS

The limitations of a study consider factors that may have hampered its smooth completion, while the delimitations consider the inclusion and exclusion criteria of the study.

A limitation in the writing of the thesis was the absence of other similar studies in South Africa and limited international studies, thus literature pertaining to diagnostic and other intervention classification systems in use internationally were reviewed to draw conclusions. Although data quality was acceptable, there were several records that resulted in the three coders referencing the ICD-10 codes or radiology information to make inferences in the assignment of the ICHI codes when the intervention description was incomplete or vague. Though this may have an impact on data quality, it must be noted that 4.7% of the healthcare records had incomplete, vague or missing information. A further limitation was the failure to assign the ICHI codes to some healthcare records as the intervention description was missing and the ICD-10 code and radiology information documented was unable to assist the three coders in making an inference. Another limitation of the study was the exclusion of the ICHI extension codes which may have provided different results.

The experience and training of the coders was also a limitation as the analysis revealed that unless a coder is adequately trained and has more than five years of coding experience, variability in coding is likely to occur. Another limitation was the assignment of the relationship keys by the coders which indicates that procedural matters require attention to avoid a greater degree of variability amongst a wider range of coders. The study was delimited to surgical data from three academic hospitals that were collected from April 2013 to August 2019, focusing on coding intervention descriptions to the ICHI codes to the exclusion of other surgical disciplines and coding systems utilised in South Africa. The study was delimited to this data as the data was conveniently available to the researcher through a joint project between Wits and the three academic hospitals.

6.4 RECOMMENDATIONS

On completion of the study and in view of the limitations, the researcher presents the following recommendations:

6.4.1 Opportunities for future research

A similar research to be undertaken with a larger sample size that is inclusive of all disciplines across more public healthcare facilities as well as private hospitals to (1) establish the suitability of the ICHI for all interventions performed at healthcare facilities in South Africa; and (2) to establish if the quality of healthcare documentation in the different healthcare facilities supports clinical coding. Inclusion of intervention data from all surgical disciplines at the three selected academic hospitals and all healthcare facilities in South Africa may provide a more comprehensive view of the ICHI that could present a more palatable appeal to interested healthcare stakeholders (Olufowote, 201).

It is worth noting that there were some areas in the study, that the statistical analysis was unable to generate conclusive answers. There were data variables relating to the patients' clinical findings, for instance, namely their intervention descriptions, diagnostic comments, and radiology findings/comments, which each existed as qualitative data that could not be accurately or reliably quantified in numerical formats, to observe any central tendencies in the data. Further research can include these data variables to establish coding patterns or themes.

It was also not possible to accurately determine whether there were many instances where the three coders sometimes labelled one ICHI code (relative to an ICD-10 code or NHRPL code), but at other times labelled a different ICHI code. This was because of the variability in the number of different ICHI codes listed, which made it impractical to consider, on a broad scale across the 3000 patient cases, whether there were consistent variations between the different ICHI codes listed by the coders. Furthermore, since only 3.3% of the patient entries failed to generate any form of consensus between at least one of the other coders, it was considered that such variability would have been minor, and difficult to observe, or test statistically reliably.

There are, however, some additional avenues of analysis that could be addressed in future research. For instance, new research can consider how often the coders gave more than one ICHI code, when relationship key RK-‘E’ was listed, which may reveal some degree of inconsistency among the coders, in the form of human error. Another means of establishing human error could be addressed by determining if there were instances of RK1 (as II or RI) not being labelled with an RK2; and it could also be assessed whether the coders sometimes, on an ICHI code, listed one RK; but at other times listed a different RK.

6.4.2 Healthcare documentation and computer literacy

It is recommended that healthcare documentation with complete intervention descriptions be included in the sample to avoid inference from diagnostic and radiological information in the ICHI code assignment. To this end healthcare practitioners need to be educated on the importance of quality healthcare documentation to support accurate clinical coding and it is essential for authorities such as the Health Professions Council of South Africa to be engaged in this process.

Training on computer literacy and the electronic documentation of healthcare records can contribute to quality data collection as demonstrated by the WCDoH eCCR project. Projects of this nature need to be implemented in other provinces in South Africa in a phased manner. In healthcare facilities where manual healthcare records exist, compilers need to be employed to review the healthcare record and compile all the clinical information for ease of coding by coders. Where information is missing, vague or incomplete, compilers can communicate with clinicians to obtain the required information. Administration clerks can perform the function of compilers and coders can concentrate on the coding function which is a specialised function.

6.4.3 An implementation strategy for the ICH

It is recommended that the ICHI to be adopted as a national intervention coding system by the NDoH and a national implementation strategy is required to address the implementation of the ICHI in South Africa. To this end a National Coding Authority (NCA) needs to be established for oversight of clinical coding as standardised coding systems enable the sharing of meaningful data, monitoring of quality of care and are integral of functioning healthcare systems (Health Market Inquiry Report, 2019). It is suggested that the NCA establish an ICHI Implementation Task Team with representation from all healthcare stakeholders, similar to the ICD-10 Task Team to support the implementation of the ICHI at all healthcare facilities. Such a task team may consist of sub-committees that can address the various aspects pertaining to the ICHI, which include but are not limited to: privacy, security and confidentiality, technical (rules and conventions), systems, messaging and training. It is essential that such a NCA engage with the WHO on the progress of the ICHI development to ascertain the release date for the ICHI user version as the current Beta version cannot be utilised for implementation.

6.4.4 Coder training, accreditation and experience

It is recommended that clinical coders undergo formal training and accreditation in the ICHI and other coding systems in use in South Africa to avoid coding errors and variability in the ICHI code selection. This requires reflexive and collaborative engagement with intellectual capital, relevant healthcare stakeholders, the NDoH, tertiary and training institutions, the South African Qualifications Authority and The Sector Education and Training Authority to develop multi-disciplinary, inter-disciplinary and job-specific training programmes and qualifications. Blended learning programmes need to be developed to address different target audiences and to cater for unforeseen circumstances such as the current COVID 19 pandemic that disallows face-to-face training. This type of training will also assist coders that are deployed in rural settings and are unable to travel long distances to attend training. The current qualification ID, 66389 Higher Certificate: Diagnostic and Procedural Coding needs to be revised to accommodate the ICHI. The literature that was reviewed reveals that a coder's knowledge plays an integral role in quality coding and a lack of clinical or coding knowledge contributes to mediocre health data collection, which in turn has a negative impact on healthcare delivery and patient outcomes.

6.4.5 National ICHI coding standards and guidelines

National ICHI coding standards and guidelines need to be developed to assist coders in the interpretation of the ICHI coding rules and guidelines to maintain accuracy, consistency, uniformity and specificity in coding. A national ICHI implementation Task Team with relevant healthcare stakeholders can participate in the development of these standards and guidelines, which ought to be aligned to international ICHI standards and guidelines where possible.

6.4.6 The expansion of the ICHI to support reimbursement

The ICHI was developed as an intervention classification for data collection and can replace the current intervention data collection systems in use in South Africa. However, the ICHI cannot replace the multiple billing systems in use in South Africa in its current form. For hospital billing and in support of the NHI implementation an ICD-10/ICD-11 and ICHI Diagnosis Related Grouper (DRG) can be developed. In addition to the DRG being a reimbursement tool, it can play an integral role in budget and resource allocation, quality management, peer review, healthcare planning amongst others. One can also suggest the creation of relative value units (RVUs) by the relevant healthcare stakeholders to evolve the ICHI into a billing system for medical, allied and support health professionals. To this end, the ICHI does have the potential to replace all the multiple coding and billing systems in use in South Africa with appropriate national policies and regulations.

6.5 CONCLUSION

The ICHI is a ground breaking all-inclusive health classification system as it contains surgical and medical interventions, interventions for participation domains and activities, and interventions relating to the environment and health-related behaviours unlike any other intervention system in use globally. This research has highlighted the strengths and challenges of the ICHI through a review of the literature and an analysis of retrospective general surgery intervention data.

The detailed illustration of the various challenges and limitations in the assignment of the ICHI codes and the in-depth explanation of the recommendations, makes an invaluable contribution to the adoption and implementation of the ICHI as a national intervention coding system for general surgery. This study also makes a significant contribution to evidence-based knowledge as no ICHI research of this magnitude currently exists for general surgery acute care coding. In conclusion, this study has significant implications for the general adoption and implementation of the ICHI in countries that either lack a national intervention coding system or wish to migrate to the ICHI from a current intervention system that is in use nationally.

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APPENDIX A

EXAMPLE OF AN ICHI CODE AND DESCRIPTION WITH CODING RULES AND CONVENTIONS:

Example: Intervention description: Arthroscopic repair of cartilage of the knee with chondroplasty and multiple drillings

- ICHI code: MMC.MK.AB

Which represents:

- Stem code: MMC.MK.AB arthroscopic repair of cartilage of the knee

Inclusion terms:

- Arthroscopic:

5. Chondroplasty of the knee
6. Mosaicplasty of the knee

The “inclusion term” indicates that chondroplasty and mosaicplasty are included in the code MM.MK.AB, and cannot be reported separately.

- *Includes notes:* multiple drilling

The “includes notes” indicate that multiple drillings are inherent to code MM.MK.AB, and cannot be reported separately.

APPENDIX B

PERMISSION LETTER FROM THE HEAD OF SCHOOL AT THE FACULTY OF HEALTH SCIENCE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Faculty of Science

Division of Postgraduate Academic Management

SUBMISSION OF THE RESEARCH PROPOSAL

Name of Candidate:	Sithara Satiyadev		
Person Number:	1325365		
Programme:	Doctor of Philosophy		
School:	School of Clinical medicine		
Name of Supervisor/ Co-Supervisor	**Supervisor/ Co-Supervisor**	**School**	**% of Supervision**
Professor Judith Bruce	Supervisor	School of Therapeutic Sciences	50%
Professor Richard Madden	Co-supervisor	National Centre for Classification of Health, University of Sydney	50%

Title of Research Proposal: The evaluation of the International Classification of Health Interventions to establish its suitability for general surgery coding

		Yes	No
1	Will the research involve animal experimentation? If YES, please certify that clearance was obtained from the Animal Ethics Committee. **Clearance Number:**		x
2	Will the research involve the use of human subjects? If YES, please certify that clearance was obtained from the relevant Ethics Committee. **Clearance Number:**		x
3	Will the research involve using genetically modified organisms or substances? If YES, please certify that clearance was obtained from the relevant Biosafety Review Board. **Clearance Number:**		x
4	**ORCID number:**		

Candidate's Signature: [signature]

Supervisor's Name: Professor Judith Bruce **Supervisor's Signature:** JBruce

Co-supervisor's Name: Professor Richard Madden **Co-supervisor's Signature:** [signature]

Head of School/ Designate Name: [signature] **Head of School/ Designate Signature:** [signature]

Date: 2018/08/17

A Research Proposal should include the following components:
- Introduction
- Aim
- Hypotheses and Questions
- Methodology
- Work plan

Guidelines on the length of a Research Proposal:
- PhD [± 3000 words]
- MSc (dissertation) [± 3000 words]
- MSc (coursework and research report) [1500 to 1800 words]

APPENDIX C

HUMAN RESOURCE ETHICS CLERANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Ms S Satiyadev
School of Clinical Medicine
Department of Surgery
Medical School
University

E-mail: Sithara.Satiyadev@wits.ac.za

CC: Supervisor: Professors J Bruce & R Madden & Dr W Sive
<Judith.Bruce@wits.ac.za>
and <HREC-Medical.ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 15/08/2018

REF: *R14/49*

PROTOCOL NO: M180553 *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

PROJECT TITLE: *The evaluation of the International Classification of Health Interventions to establish its suitability for general surgery coding*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

APPENDIX D

PERMISSION LETTER FROM THE HEAD OF DEPARTMENT OF SURGERY AT THE CHBAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

Directorate: Department of Surgery

☎011 933 8804 / 9267 / 8386

011 938 2002
11 June 2018

Dr
Chief Executive Officer
Chris Hani Baragwanath Hospital

11 June 2018

Dr GG Maseko
Acting Chief Executive Officer
Chris Hani Baragwanath Hospital

Dear Dr Maseko ,

Re: PhD Study: Ms Sithara Satiyadev: The Evaluation of the International Classification of Health Interventions (ICHI) to establish its suitability for general surgery coding. Ethics Number: M180553.

The above student requires the permission of Chris Hani Baragwanath CEO to conduct the above PhD study. As HOD of the Department of Surgery at Chris Hani Baragwanath, I give permission for the study to be conducted.

On completion of the study, a copy thereof should be submitted to the Chris Hani Baragwanath Hospital.

Thank you

Prof MD Smith
Head of the Department of Surgery
CHBAH

APPENDIX E

PERMISSION LETTER FROM THE HEAD OF DEPARTMENT OF SURGERY AT THE CMJAH

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Department of Surgery

9th Floor Medical School, 7 York Road, Parktown 2193 South Africa
Tel: +27 (0) 11 717-2080 Fax: +27 (0)11-484-2717

29 March 2018

To: Faculty of Health Sciences Human Research Ethics Committee

Re: Sithara Satiyadev, PhD
Tel: 082 461 7690
Email: sithara.satiyadev@wits.ac.za

Title: The Evaluation of the International Classification of Health Interventions (ICHI) to establish its suitability for general surgery coding

Dear Colleagues,

This research aims to examine present clinician coding practice and determine if the WHO International Classification for Health Interventions (ICHI) could be applied in the South African Healthcare environment.

The project aims to use the Faculty of Health Sciences patient discharge summary. The database was created as a retrospective record of discharges to enable point of care information retrieval and analysis of aggregated data. This is an existing clinical registry of patients discharged from the Department of Surgery at CMJAH since April 2015.

The data will be de-identified and be used to compare how closely the previously so-called NHRL codes correlate with the associated ICHI codes.

As the HOD of the Department of Surgery at CMJAH, I give permission for the appropriate de-identified data set to be made available to the student for analysis, with the following conditions:

1. The source of the data must be cited/acknowledged in the research report and any publications based on this data
2. When the research concludes, the senior departmental members must be given an opportunity to collaborate on a research paper, if they are interested. If none express interest in doing so, then there is no obligation on the side of the student to include a co-author from the Department of Surgery.

Signature: Date: 2018/04/04

Thifhelimbilu Luvhengo
Thifhelimbilu.Luvhengo@wits.ac.za
Charlotte Maxeke JHB Academic Hospital
Tel +27 11 488 3397
Fax+27 11 488 4322

APPENDIX F

PERMISSION LETTER FROM THE CLINICAL DIRECTOR AND THE CHIEF EXECUTIVE OFFICER AT THE CMJAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:
Ms. N. Mzila
Office of the Clinical Director
Email:Nolwazi.Mzila@gauteng.gov.za
Tell: (011): 488-4812
25 April 2018

Dear Ms. S. Satiyadev

STUDY TITTLE: The Evaluation of the International Classification of Health Interventions (ICHI) to Establish Its Suitability for General Surgery Coding

Permission to conduct the above mentioned study is provisional approved. Your study can only commence once Ethics approval is obtained. Please forward a copy of your Ethics Clearance Certificate as soon as the study is approved by the Ethics Committee for the CEO's office to give you the final approval to conduct the study.

Supported / ~~not supported~~

Dr. M.I. Mofokeng
Clinical Director
DATE: 25/04/2018

Approved / not approved

Bogoshi

Ms. G. Bogoshi
Chief Executive Officer
DATE: 26.04.2018

APPENDIX G

PERMISSION LETTER FROM THE CHAIRPERSON AND THE CHIEF EXECUTIVE OFFICER AT THE HJAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Gauteng Department of Health
Helen Joseph Hospital
Enquiries: Dr. M.R. Billa
Chief Executive Officer
Tel :(011) 489-0306/1087
Fax :(011) 726-5425
E mail: Raymond.Billa@gauteng.gov.za
Date: 30 May 2018

Dr.M.R.Billa
Chief Executive Officer
Helen Joseph Hospital

Dear Dr. M.R Billa

STUDY: The Evaluation of the International Classification of Health interventions to establish its suitability for general surgery coding

RESEARCHERS: Ms Sithara Satiyadev

Ethic No: M180553

Above the study was discussed at the Research Committee Meeting. We recommend that permission be granted for Helene Joseph Hospital to be used as a site for the above research, However, since this is individual /patients.

Upon completion of the study, a copy thereof should be submitted to Helen Joseph Hospital.

It is the duty of the researcher to collect the data to the relevant department after the Research Committee approved the study.

Thank you

Dr. Murimisi Mukansi
CHAIRPERSON
DATE:

Approved

Dr. M.R. BILLA
CHIEF EXECUTIVE OFFICER
DATE: 31.05.2018

APPENDIX H

PERMISSION LETTER FROM THE DATABASE ADMINISTRATOR

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Department of Surgery

9th Floor Medical School, 7 York Road, Parktown 2193 South Africa
Tel: +27 (0) 11 717-2080 Fax: +27 (0)11-484-2717

11 March 2018

To: Faculty of Health Sciences Human Research Ethics Committee

Re: Sithara Satiyadev, PhD
Tel: 082 461 7690
Email: sithara.satiyadev@wits.ac.za

Title: The Evaluation of the International Classification of Health Interventions (ICHI) to establish its suitability for general surgery coding

University of Witwatersrand
Faculty of Health Sciences
School of Clinical Medicine
Department of Surgery

Dear Colleagues,

This research aims to examine present clinician coding practice and determine if the WHO International Classification for Health Interventions (ICHI) could be applied in the South African Healthcare environment.

The project aims to use the Faculty of Health Sciences patient discharge summary. The database was created as a retrospective record of discharges to enable point of care information retrieval and analysis of aggregated data. This is an existing clinical registry of patients discharged from the Department of Surgery at CMJAH since April 2015.

The data will be de-identified and be used to compare how closely the previously so-called NHRL codes correlate with the associated ICHI codes.

As the database custodians we give permission for the appropriate de-identified data set to be made available to the student for analysis.

Mike Klipin
michael.klipin@wits.ac.za
083-482-7005

11 March 2018

Irma Mare
Irma.mare@wits.ac.za
082-577-3495

29 Mar 2018

APPENDIX I

ICD-10 CHAPTERS AND CODE RANGES

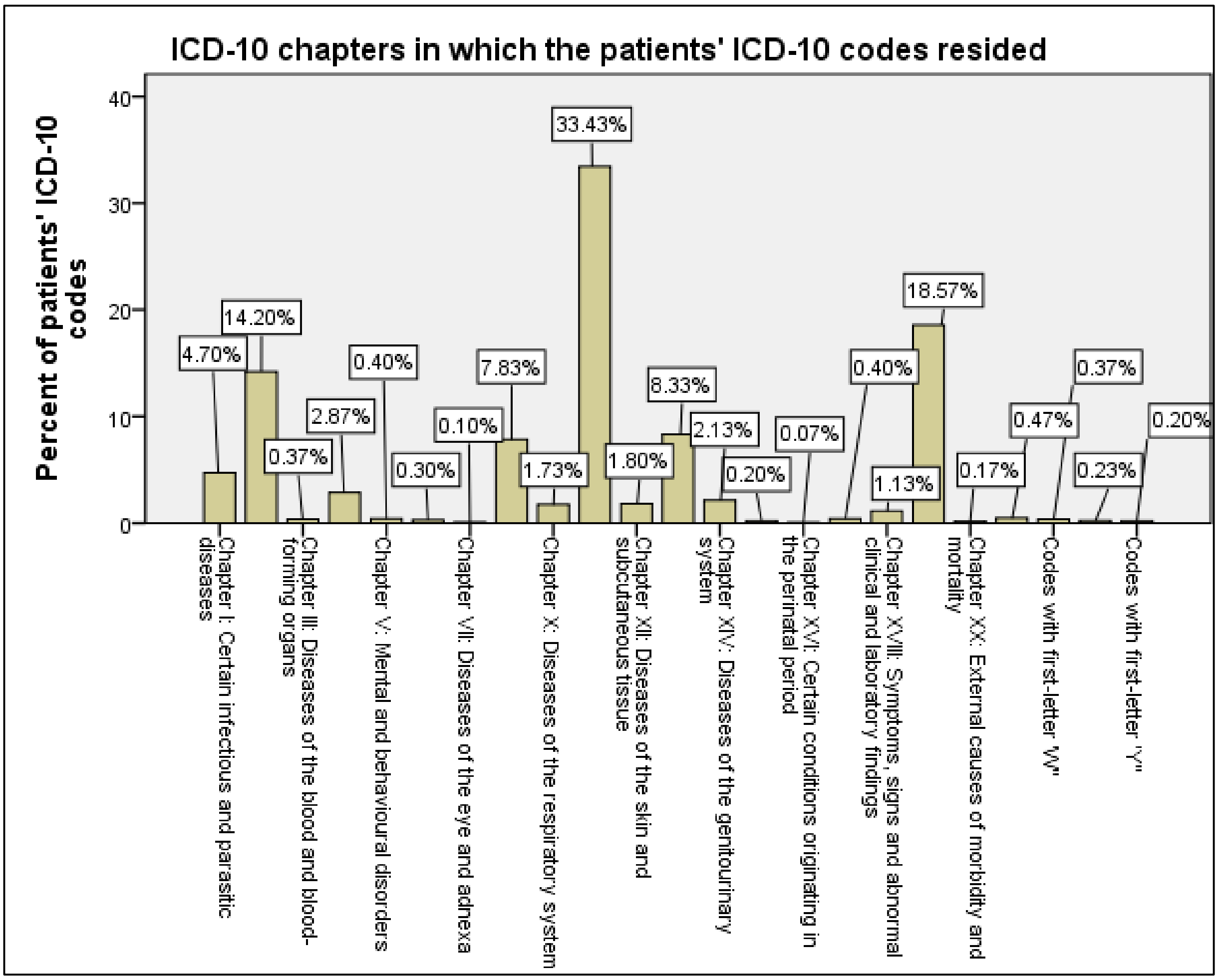
Special Group Chapters	**Body System Chapters**
Chapter I: Certain infectious and parasitic diseases (code range A00-B99)	Chapter VI: Diseases of the nervous system (code range G00-G99)
Chapter II: Neoplasms (code rage C00-D48)	Chapter VII: Diseases of the eye and adnexa (code range H00-H59)
Chapter III: Diseases of the blood and blood-forming organs (code range D50-D89)	Chapter VIII: Diseases of the ear and mastoid process (code range H60-H95)
Chapter IV: Endocrine, nutritional and metabolic disorders (E00-E90)	Chapter IX: Diseases of the circulatory system (code range I00-I99)
Chapter V: Mental and behavioural disorders (code range (F00-F99)	Chapter X: Diseases of the respiratory system (code range J00-J99)
Chapter XV: Pregnancy, childbirth and puerperium (code range O00-O99)	Chapter XI: Diseases of the digestive system (code range K00-K93)
Chapter XVI: Certain conditions originating in the perinatal period (P00-P96)	Chapter XII: Diseases of the skin and subcutaneous tissue (code range L00-L99)
Chapter XVII: Congenital malformations, deformations and chromosomal abnormalities (code range Q00-Q99)	Chapter XIII: Diseases of the musculoskeletal system (code range M00-M99)
Chapter XIX: Injury, poisoning and certain other consequences of external causes (code range (S00-T98)	Chapter XIV: Diseases of the genitourinary system (code range N00-N99)

Supplementary chapters:

- Chapter XVIII: Symptoms, signs and abnormal clinical and laboratory findings (code range R00-R99)
- Chapter XX: External causes of morbidity and mortality (code range V01-V98)
- Chapter XXI: Factors influencing health status and contact with health services (code range Z00-Z99)
- Chapter XXII: Codes for special purposes (code range U00-U99)

APPENDIX J

FREQUENCY DISTRIBUTION OF OBSERVED ICD-10 CHAPTERS



APPENDIX K

CHI-SQUARED TEST RESULTS OF PROCEDURE CODES LISTED IN THE UNMATCHED PATIENT CASE ENTRIES

Crosstab

Chi-Square Tests

	Value	df	Asymptotic Sig. (2-sided)
Pearson Chi-Square	29.085[a]	7	.000
Likelihood Ratio	25.691	7	.001
N of Valid Cases	944		

a. 5 cells (31.3%) have expected count less than 5. The mir

			Ordinal observation of the amount of matches between coders: No matches observed	Ordinal observation of the amount of matches between coders: All 3 coders matched	Total
Procedure Codes (Unmatched)	0	Count	3	36	39
		Expected Count	1.7	37.3	39.0
	1	Count	3	13	16
		Expected Count	.7	15.3	16.0
	304	Count	3	73	76
		Expected Count	3.4	72.6	76.0
	1549	Count	2	7	9
		Expected Count	.4	8.6	9.0
	1587	Count	3	296	299
		Expected Count	13.3	285.7	299.0
	1778	Count	5	163	168
		Expected Count	7.5	160.5	168.0
	1809	Count	21	288	309
		Expected Count	13.7	295.3	309.0
	1819	Count	2	26	28
		Expected Count	1.2	26.8	28.0
Total		Count	42	902	944
		Expected Count	42.0	902.0	944.0

APPENDIX L

TURNITIN REPORT

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APPENDIX M

PLAGIARISM DECLARATION

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

FACULTY OF HEALTH SCIENCES

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Sithara Satiyadev (Student number: 1325365) am a student registered for the degree of Doctor of Philosophy in the academic year 2021

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: ____________ Date: 13/08/2021

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