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The Development of a Novel Positive Health Framework to Improve the Understanding of Recovery after Chronic Subdural Haematoma

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BPsych(Hons)

A thesis submitted in the fulfilment of the requirements for the degree of

Doctor of Philosophy

Department of Psychology

College of Healthcare Sciences

James Cook University

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Statement of Contribution by Others

I declare that the work presented in this thesis is, to the best of my knowledge and belief, original and my own work, except as acknowledged in the text.

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Moffatt, **C. E.**, Hennessy, M. & Marshman, L. A. G. (2019). Long-term Health Outcomes in Survivors after Chronic Subdural Haematoma (submitted), *Journal of Clinical Neuroscience.*

Piers, T., **Moffatt**, **C. E.,** Rudd, D. & Marshman, L. A. G. (2019). S-100B in Chronic Subdural Haematoma: Prospective Cohort study (in press), *Journal of Clinical Neuroscience.*

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Thesis Submission

The material has not been submitted, either in whole or in part, for a degree at this or any other university.

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Abstract

The definition of health continues to be a topic of significant contention and interest. Human health was once considered the basic level of functional and metabolic efficiency required for a living organism. However, as our understanding of the human body has evolved, so has the conceptualisation of health and health research. Advancements in medicine have allowed empirical investigation into disease, illness, and ailments that affect human functioning. As such, the once neutral concept of health is now largely governed by a focus on disease and illness, and theoretical models of health have been established to inform these investigations.

The most widely accepted models of health are termed as the biomedical model of health, and the biopsychosocial model of health. Both models aim to understand the determinants of disease, illness or pathology. Whilst the biomedical model is inherently focused on only biological determinants of disease, the biopsychosocial model also considers the contribution of psychological and social factors that give rise to symptoms, illness, and pathology. In keeping with the disease-focus of each model, current health research and practice tends to focus on the negative determinants of disease and illness, such as mortality rates, morbidity rates, recurrence rates, and factors that hinder patient adherence to treatment protocols. There is a consistent focus on patients experiencing poorer outcomes, whilst those patients whom recover well, are seldom investigated.

Whilst the contribution of each of these models to epidemiological research has been insurmountable, the ability to conceptualise these models as cohesive health models is significantly limited. Both the biomedical model and the biopsychosocial model fail to

acknowledge the importance of positive human experience and the factors that contribute to it. The inherent focus on the negative determinants of health, negates the importance of well-being as a contributing factor to positive a recovery. Evidence suggests that there are positive health assets that significantly contribute to positive outcomes after disease and illness, beyond disease-factors identified in conventional medical models. Therefore, a focus on the positive side of health may result in a far more cohesive understanding of disease and factors that contribute to a positive recovery.

The conceptualisation of health beyond the absence of disease is a guiding principle of Positive Health. Positive Health suggests that there are factors relevant to positive human experience that subsequently contribute to reduced disease risk, improved recovery after illness, and long-term well-being. If determined to be successful, a Positive Health approach may be able to identify positive health assets that contribute to a positive recovery after disease and subsequently identify targets for future treatment and intervention. Therefore, this thesis aimed to explore and determine the usefulness of a Positive Health approach to the understanding of a condition that has only been investigated from a biomedical perspective, with limited information regarding long-term outcome and well-being.

Chronic Subdural Haematoma (CSDH) is the most common neurosurgical condition in individuals with incidence rates estimated at 56 in 100,000. It involves the development of a substantial blood clot (>50mls) between the layers of skin surrounding the brain. Presenting symptoms include headaches, confusion, speech abnormalities and coma. CSDH has been considered a benign event rectified by neurosurgical intervention. The medical literature following CSDH has focused substantially on acute neurosurgical outcomes in the first few months post-injury. However, recent research suggests that patients may experience higher

mortality and morbidity rates following a CSDH, with poorer outcomes related to age>65years, male gender, minor brain trauma, alcohol abuse, and anticoagulant and antithrombotic medication use. Limited research suggests a reduction in independence, overall health and life expectancy. Given the current aging population, incidence rates for CSDH are expected to increase significantly, placing a significant burden on healthcare services. Therefore, research is required to understand and inform long-term treatment and management of this health condition.

To determine the usefulness of a Positive Health approach to understanding outcome after CSDH, an existing Positive Health framework was used to explore health assets that contribute to a positive outcome among patients. Seligman's Positive Health was initially applied to CSDH literature to determine the viability of a Positive Health approach to understanding outcome and recovery (see Chapter 3). Seligman defines Positive Health as a state beyond the mere absence of disease which is definable and measurable. According to Seligman, Positive Health can be operationalised by a combination of excellent status on subjective, biological and functional measures and it is possible to use these measures to test whether positive health predicts increased longevity, decreased health costs, improves mental health, and reduced risk of disease. The conclusions from Chapter 3 suggest the potential of a Positive Health approach to understanding the biological, functional and subjective assets relevant to a positive recovery after CSDH.

For subjective health assets, limited evidence suggests that an absence of depressive symptoms significantly contributes to a positive recovery after CSDH. However, for biological health assets, existing evidence suggests that biological health assets including female gender, protein kinase p38y, non-smoking behaviour, healthy alcohol-use, nutritional diet, absence of

anticoagulation/antithrombotic therapy. Finally, for functional positive health, existing literature suggests the contribution of health assets including optimal concentration and word recognition, prospective memory, adaptation to one's environment, and positive social relationships.

The conclusions from Chapter 3 demonstrate the potential of a Positive Health approach to understanding what constitutes a positive recovery after CSDH but further highlight the limited information describing outcome after this condition. In response to these limitations, this thesis used both a retrospective and prospective approach to explore Positive Health in the understanding of outcome after CSDH. outcomes of this research informed the development of a novel Positive Health framework presented in this thesis.

The first study (Chapter 4) consisted of an extensive retrospective study applying an existing Seligman's Positive Health framework to better understand health assets relevant to a good recovery after CSDH. The sample consisted of CSDH patients (n=51) previously admitted to the Townsville Hospital for neurosurgical intervention during the period of January 2003 to 2011. Comparisons were also made to a clinical control group (n=31) consisting of patients who had sustained other forms of intracranial haemorrhage, and a healthy age and gender matched control group (n=52). As per Seligman's Positive Health framework, a series of measures were included to assess subjective, biological, and functional health assets that combine to form a positive recovery after CSDH.

According to the findings, CSDH patients demonstrated significantly reduced health and well-being after injury compared to healthy, age and gender matched controls, as well as clinical controls. For subjective outcomes, CSDH patients demonstrated increased depressive symptomology compared to healthy controls ($F_{(2,126)}$=9.05, p<.001, *f*'=.394). For biological

outcome, CSDH patients demonstrated significantly more comorbidities compared to healthy controls (χ^2 2, N=86 = 35.47, p<.001). Finally, for functional outcomes, CSDH patients demonstrate impaired performance on daily functioning and independence compared to ICH patients and healthy-controls ($F_{(2,126)}$=8.46, p=.001, f'=.29, 1−β=.995), and reduced social well-being compared to healthy-controls ($F_{(2,127)}$=14.32, p=.001, f'=.444, 1−β=.91).

Additionally, a combination of positive health assets was shown to contribute to a positive recovery after CSDH. Biological health assets included age at the time of injury, not female but male gender, bilateral or right-sided CSDH, non-smoking behaviour, and low-risk alcohol use (Chapter 4, pp.77-80). Functional assets included optimal global cognitive functioning, high social functioning and greater independence in daily activities (Chapter 4, pp.80-84). Subjective health assets included high psychological well-being (Chapter 4, pp.84-86). These positive health assets combined to form a profile of what constitutes a successful recovery after CSDH.

The findings of Chapter 4 supported the hypotheses and specific biological, functional, and subjective positive health assets were found to significantly contribute to the positive recovery of CSDH patients. Interestingly, health assets specific to Biological Positive Health and Functional Positive Health domains were found to be more relevant to a positive outcome after injury, whilst Subjective Positive Health was not considered to significantly contribute to a positive recovery. The contributions of this research were two-fold. First, the findings identified positive health assets that significantly contribute to a positive outcome after CSDH. Second, the conclusions from this research provide the first potential targets for the development of patient-centred treatment and rehabilitation programs for managing outcome

after injury. Importantly, whilst efforts were made to adequately identify positive health assets in a retrospective sample, the application of a positive framework to a largely disease-focused breadth of data proved challenging resulting in limitations associated with this research. The limitations highlighted the need for a more inclusive and structure positive health framework for standardised use in empirical research.

The limitations of the first study prompted the development of a novel Positive Health theoretical framework for the understanding of health and disease (Chapter 5). The novel Positive Health framework was developed to address the limitations of existing ideas, including a lack of clearly defined terms, a lack of theoretical structure, and the absence of empirically measurable variables. Two objectives directed the development of the proposed novel framework of Positive Health; it is vital that the subdomains are organised into an evidence-based theoretical structure, and the ability to translate the framework into empirical research and practice should remain at the forefront of its development.

Experimental, observational, and clinical health research was extensively examined and deconstructed to inform the development of the framework. The findings from this extensive review informed the development of a novel Positive Health framework that was based on a human-systems approach to health. A clear theoretical structure was outlined with significant support from the literature, organising Positive Health into biological, functional and subjective domains. Additionally, the novel Positive Health framework provides a theoretical structure for each Positive Health domain, to adequately inform empirical research and ensure standardised methodological design.

The Biological domain of the novel Positive Health framework is underpinned by the theoretical debate of nature vs. nurture. Quite simply, is human functioning and behaviour

determined by genetic inheritance and biological factors, or by an individuals environment. This thesis argues for the importance of both. Inherent genetic factors, and the influence of the environment and lifestyle factors are equally contributing factors to health and therefore represent the two equivalent subdomains under biological positive health. Static biological assets refer to the influence of nature and are largely predetermined. These may include gender, age, genetic factors. Dynamic biological assets refer to those variables that are influenced by the environment and are likely to alter, including exercise, body mass index, lifestyle factors. The biological domain is the building block from which function and subjective health may prosper.

The domain of functional health is organised into a hierarchy of human functioning. In line with literature describing the characteristics of a system, Functional Positive Health begins with the foundation required for human functioning described as cognitive assets and represents the basis for cerebral functioning. This domain may include cognitive assets relevant to attention, memory, executive functioning and global cognition. Cognitive Assets are the building blocks for an individual's social environment; optimal cognitive functioning if required for optimal human interaction. Therefore, Cognitive assets provide the basis for Prosocial Assets; the possession of skills and tendencies that support positive and rich relationships. Cognitive and prosocial assets then combine to allow our functioning in the wider environment. This is represented by person-environment-fit, or the ability for an individual to positive engage with their environment and adapt to any challenges. There is evidence that strongly supports the influence of each of these three subdomains in recovery after illness and have therefore been included in this domain.

Finally, with support from existing evidence, the novel Positive Health framework defines Subjective Positive Health as the optimal integration of one's own psychological functioning, emotional functioning, and perceived physical well-being. Subjective positive health represents a state of positive mental well-being where an individual realises their own potential, can cope with normal stresses of life, can work productively and fruitfully, and is able to contribute to their community.

The second study (Chapter 6) examined the utility of the novel Positive Health theoretical framework in a prospective investigation. The objective of this research was to further explore the positive health assets that combine to support a positive recovery after CSDH and determine their relationship with health-related outcomes. A sample of CSDH patients admitted to the Townsville Hospital for neurosurgical intervention were recruited to the study (n=114). The differential relationship between biological, functional, or subjective positive health assets and health-related outcomes were hypothesised. It was expected that biological health assets and functional health assets would significantly contribute to improved survival, reduced morbidity, improved global functioning, and reduced healthcare utilisation after CSDH. Subjective health assets were expected to contribute to reduced morbidity, improved global functioning, and reduced healthcare utilisation.

To determine the relationship between Positive Health assets and health-related outcome, the novel theoretical framework was used to measure variables relevant to short- and long-term mortality, morbidity after CSDH, global functioning, and independence after injury. The hypotheses were partially supported.

Biological health assets shown to contribute to the long-term survival of CSDH patients included: lower age ATOI ($F_{(1,111)}$=5.317, p<.05, d'=.704), mild atrophy (χ^2=3.814, p=.00), and lower scores on the Markwalder Neurological Grading system at discharge (χ^2=15.266, p=.01). For Functional health assets, greater independence in activities of daily living measured on discharge was the only known functional asset to contribute to increased survival at either discharge or six months post-surgery. No significant differences or relationships were observed for Subjective health assets.

For Biological health assets and recurrence, patients of male gender were less likely to experience a recurrence (χ^2=3.964, p=.046). Whilst no significant differences or trends were noted for Functional health assets and recurrence, a trend was identified for a subjective health asset with patients with greater emotional well-being and optimism were also at reduced risk of morbidity and recurrence after injury ($F_{(2,13)}$=3.31, p=.60),

For global functioning, Biological assets including lower age ATOI ($F_{(5,107)}$=4.87, p=.01, f'=.305, 1−β=.975), no history of trauma (χ^2=3.534, p=.056), absence of dementia (χ^2=18.130, p=.001), dense haematoma appearance (χ^2=7.655, p=.006), mild atrophy (χ^2=16.969, p=.001), and low scores on the Markwalder Neurological Grading System contributed to improved functioning at six months post-surgery (χ^2=28.262, p=.01). No significant differences were observed for Functional assets or Subjective assets.

For healthcare utilisation, Biological assets included lower age ATOI ($F_{(5,108)}$=3.146, p=.011, d'=.611, 1−β=.865), absence of dementia (χ^2=7.676, p=.01), haematoma density (χ^2=5.145, p=.023), reduced atrophy (χ^2=7.676, p<.006), and low scores on the Markwalder Neurological Grading System (χ^2=19.95, p=.001). For Functional assets, greater preoperative independence was associated with reduced healthcare utilisation in the period following injury

(χ^2=5.60, p<.05), as well as lower scores on independence in daily activities ($F_{(2,14)}$=3.438, p=.60). No significant differences were observed for Subjective health assets.

Functional assets including higher verbal fluency, greater preoperative independence and greater independence in activities of daily living, with patients being more likely to be discharged home as opposed to another hospital, rehabilitative centre, or nursing home. No significant differences were found for Subjective health assets.

Findings from this study (Chapter 6) indicate that Biological health assets were found to be most impactful, particularly in regards to survival after CSDH, whilst Functional assets were found to significantly contribute to morbidity, global functioning, and healthcare utilisation after CSDH. Evidence did suggest a relationship between specific Subjective health assets and morbidity after CSDH, however the relationship between these assets and health-related outcomes was weaker than expected. According to the findings from this study, specific positive health assets were found to significantly predict health-related outcomes among CSDH patients and further contribute to directions for future treatment.

Theoretically driven and empirically validated research is required for determining the use of a Positive Health approach to understanding health and disease. The implication of biological and functional health assets to recovery after CSDH was well-supported in this thesis and warrants further investigation. Despite the findings for Subjective Positive Health, further research into the relationship between psychological well-being, emotional well-being, and physical well-being should be conducted.

The accurate application and measurement of Positive Health assets in CSDH populations is vital. This clinical group consist of patients at risk of increased mortality rates and significant health decline, yet no current rehabilitation or treatment programs exist to

manage their outcome or recovery. If successful, a Positive Health approach to understanding outcome after CSDH could greatly expand breadth of knowledge pertaining to this patient group and may inform the basis for the first successful patient-centred rehabilitation programs.

Table of Contents

Publications

Publications Arising from the Research in this Thesis

Moffatt, **C. E.**, Hennessy, M. & Marshman, L. A. G. (2019). Long-term Health Outcomes in Survivors after Chronic Subdural Haematoma (submitted), *Journal of Clinical Neuroscience.*

Piers, T., **Moffatt**, **C. E.,** Rudd, D. & Marshman, L. A. G. (2019). S-100B in Chronic Subdural Haematoma: Prospective Cohort study (in press), *Journal of Clinical Neuroscience.*

McMillan, C. **E.**, Hennessy, M., Marshman, L. A. G. & Blackwood, L. (2016). Positive Health and Chronic Subdural Haematoma: Is it survival of the socially connected? Poster presented at the 8th European Conference on Positive Psychology, Angers, France.

Hennessy, M., Marshman, L.A.G., **McMillan, C**. & Costa, M. (2015). Do Positive Emotions Influence Recovery After Chronic Subdural Haematoma? Poster presented at the 5th INS/ASSBI Pacific Rim Conference, Sydney, NSW, Australia.

List of Tables

List of Figures

Glossary of Abbreviations

ABI	Acquired brain injury
ADLs	Activities of Daily Living
AEDH	Acute extradural haematoma
ANOVA	Analysis of Variance
ASDH	Acute subdural haematoma
ATOI	At the time of injury
AUDIT	The Alcohol Use Disorder Identification Test
BMI	Body Mass Index
CD	Crohn's disease
CES-D	Centre for Epidemiological Studies Depression Scale
CHD	Coronary heart disease
CIT	Comprehensive Inventory of Thriving
COGTEL	The Cognitive Telephone Screening Instrument
CRP	C-reactive protein
CSDH	Chronic subdural haematoma
CT	Computer tomography
CVD	Cardiovascular disease
F	Female
FAQ	Functional Activities Questionnaire
GCS	Glasgow Coma Scale
GDS	Geriatric Depression Scale

GOS	Glasgow Outcome Scale
IBM SPSS	International Business Systems Statistical Package for the Social Sciences
ICD-10	International Classification of Diseases-Version 10
ICH	Intracranial haemorrhage
ieMR	integrated electronic Medical Record
IHD	Ischemic Heart Disease
LASA	Longitudinal Aging Study Amsterdam
M	Male
M	Mean
mDES	modified Differential Emotions Scale
MG	Markwalder's Neurological Grading System
MHC-SF	Mental Health Continuum-Short Form
MMPI	Multiphasic Personality Inventory
MMSE	Mini-Mental State Examination
MRI	Magnetic resonance imaging
mRS	modified Rankin Scale
MS	Multiple sclerosis
NAS	Normative Aging Study
PAIS	Psychological Adjustment to Illness Scale
PBM	Peak Bone Mass
PEI	Perceived Emotional Intelligence
PWB	Perceived Well-being scale

QoL	Quality of Life scale
REM	Rapid eye movement
RFA	Rankin Focused Assessment
S100B	S100 calcium-binding protein B
SD	Standard deviation
SIP	Sickness Impact Profile
SWB MHC-SF	Social Well-being Subscale of the Mental Health Continuum
TBI	Traumatic brain injury
TOA	Time of Assessment
TTBK-1	Tau Tubulin Kinase-1
VP Shunt	Ventriculoperitoneal shunt
WHO	World Health Organisation

Chapter 1: Synopsis

The aim of this thesis was to develop a novel theoretical framework of Positive Health to better understand recovery after chronic subdural haematoma (CSDH). This research has made several significant and novel contributions to the literature. First, an existing Positive Health framework was used to better understand biological, functional, and subjective outcomes in a retrospective sample of CSDH patients. The findings from this study identified health assets that contribute to a positive outcome after CSDH and illustrated the potential benefits of a Positive Health framework in the understanding of disease. Second, an inclusive and empirically driven novel framework of Positive Health was developed to better explain outcome after disease. This novel Positive Health framework informed a prospective study conducted to determine the relationship between health assets and long-term outcome after CSDH. The findings from this research suggest potential biological, functional, and subjective health assets that significantly contribute to a reduction in morbidity and mortality after injury, whilst simultaneously improving functioning in the post-operative period. These findings have not been documented in the literature and currently, no treatment intervention exists for the long-term management of CSDH patients. This thesis significantly extends the breadth of knowledge pertaining to outcome after CSDH and provides the first potential targets for treatment development. This synopsis will present a brief overview of the selected literature that was included in this thesis and the findings that have emerged from each of the experimental chapters.

In 2003, approximately 2.3% of Australians were affected by an acquired brain injury (ABI) and approximately 95% of the total population experienced limitations or disability that

required treatment and management (*Disability in Australia: acquired brain injury*, 2007). Chronic subdural haematoma (CSDH) represents one of the most common ABIs with incidence rates occurring in approximately one in 100,000. The injury involves a substantial collection of old blood situated between the protective layers of skin, or *meninges,* surrounding the brain. The haemorrhage acts as a slow bleed and can lead to symptoms of confusion, loss of power to the limbs, speech problems, memory loss, instability, dizziness, seizures or coma. Evidence also suggests a reduction in functional and psychological health after injury, with a significant proportion of patients experiencing states of depression, anxiety, cognitive decline and reduced life satisfaction both at the time of injury, and post-surgery (Adhiyaman, Chattopadhyay, Irshad, Curran, & Abraham, 2017; Berghauser Pont, Dammers, Schouten, Lingsma, & Dirven, 2012; Honda et al., 2015; Ishikawa, Yanaka, Sugimoto, Ayuzawa, & Nose, 2002; Yang et al., 2012).

CSDH has long been regarded as a non-threatening condition, with favourable outcomes after surgical intervention (Miranda, Braxton, Hobbs, & Quigley, 2011; Pahatouridis et al., 2013). However, evidence is accumulating against this view (Dumont, Rughani, Goeckes, & Tranmer, 2013; Manickam, Marshman, & Johnston, 2016; Shapey, Glancz, & Brennan, 2016). According to Manickam et al. (2016), CSDH patients experience a dramatic decline in health after injury and life expectancy is dramatically reduced with mortality rates reaching 60% at five years post-CSDH.

Despite the high prevalence rates, symptom severity, and dramatically reduced life expectancy, limited information exists regarding the biological, functional, or subjective outcome of CSDH patients. Additionally, limited information exists regarding the characteristics of a successful outcome after CSDH and variables that may contribute to a

positive recovery. Moreover, no long-term intervention or treatment programs exist to manage the recovery of CSDH patients resulting in a lack of adequate care and health service delivery.

This lack of information can be explained by the use of the biomedical model for the clinical management and treatment of CSDH patients. Currently, the management of CSDH patients has been largely governed by the biomedical model of health resulting in limited information relevant to functional or subjective outcome. The biomedical model of health is primarily concerned with the diagnosis and treatment of disease, illness and pathology (Zigmond, 1976). According to the model, disease and illness can be completely explained by deviations from normal biological states, whilst functional or psychological factors are rarely considered. As such, the management of CSDH is primarily concerned with physiological symptoms and biological determinants of disease, such as risk factors, morbidity rates, recurrence rates, and mortality (Baechli, Nordmann, Bucher, & Gratzl, 2004; Berghauser Pont et al., 2012; Borger et al., 2012; Jack, O'Kelly, McDougall, & Findlay, 2015). A review of this literature is presented in Chapter 2. The review focused on the current use of the biomedical model to investigate outcome after CSDH and the consequence of this approach.

Based on this research, there are four major limitations that limit the breadth of knowledge regarding outcome after injury: (a) the application of the biomedical model to CSDH research has resulted in a preoccupation with short-term measures of biological outcome, including neurosurgical procedure, recurrence rates, and mortality rates, with assessment periods rarely exceeding six to twelve months; (b) limited information exists regarding functional or mental health outcome after CSDH; (c) no research exists investigating those patients who have had a successful recovery as the primary focus; and (d) no known

intervention exists to adequately manage the biological, functional, or psychological recovery of CSDH patients.

To address these limitations, a more cohesive health framework was sought to better explain outcome after CSDH and variables relevant to a successful recovery (see Chapter 6). A statement provided by the World Health Organisation considers health to be a positive combination of physical, mental, and social well-being and is not simply the absence of disease or infirmity (*Constitution of the World Health Organization*, 1948; Misselbrook, 2014). As such, a health model should be inclusive of all areas of functioning and acknowledge the importance of well-being in recovery after disease. According to Seligman (2008; 2013) a framework of Positive Health resembles such an approach.

Positive Health is the scientific investigation of positive health assets that determine recovery after disease and illness, beyond the conventional approach of the biomedical model. As such, a Positive Health theoretical framework aims to determine biological, functional, and subjective health assets that positively contribute to recovery after illness, disease prevention, and well-being. To better understand the applicability of Positive Health to understanding outcome after CSDH, an existing Positive Health framework was used to inform a review of existing CSDH literature (see Chapter 2).

A selected review of experimental, quasi-experimental, and clinical CSDH research supported the use of a Positive Health framework to understand recovery and evidence was provided for potential health assets shown to contribute to a positive outcome (see Chapter 3). The conclusions from Chapter 3 demonstrated the potential efficacy of a Positive Health framework in CSDH research but further highlighted the lack of existing information regarding long-term outcome and the need for further research.

Chapter 4 presents an empirical application of an existing Positive Health framework to a retrospective sample of CSDH patients. The objective of the research was to use Seligman's (2008; 2013) Positive Health framework to explore the recovery of CSDH patients after injury and identify variables relevant to a successful outcome. The findings indicated that a successful recovery is comprised of specific biological, functional, and subjective health, and there was a significant relationship between these assets and long-term health outcome. Specifically, biological assets including male gender, unilateral CSDH, and decreased age at the time of injury were found to significantly contribute to a positive outcome. For functional assets, functional independence in daily activities and higher levels of social well-being were predictive of a successful recovery after CSDH. Finally, higher psychological well-being had a considerable impact on the health and well-being of patients after injury.

Support was found for the use of a Positive Health framework in CSDH research, however the findings from this study highlighted the challenges associated with the retrospective application of a Positive Health framework to a largely biomedical wealth of data. Further, this research emphasised the need for a more inclusive and empirically measurable Positive Health framework.

A novel theoretical framework of Positive Health was developed to address the limitations of existing ideas (see Chapter 5). Upon assessment, the power of existing theoretical frameworks to adequately identify health assets relevant to outcome after illness were affected by the following: a lack of theoretical structure in the subdomains, leading to ambiguity and a lack of direction in selecting variables; ill-defined variables and terms, and; a lack of consideration for the empirical application of a theoretical framework to empirical research. The proposed novel Positive Health framework addressed these limitations and

significantly extended and refined existing Positive Health theory. Evidence-based research and established theoretical concepts were used to provide a clearly defined theoretical structure to the subdomains of the Positive Health framework. Clear consideration was given to the empirical potential empirical application of this framework, and evidence was provided for its use in health research.

The novel Positive Health framework was used to determine factors that predict a positive outcome after CSDH (see Chapter 6). The prospective investigation applied the Positive Health framework to a sample of CSDH patients admitted for neurosurgical intervention. To determine the relationship between Positive Health assets and health-related outcome, the novel theoretical framework was used to measure variables relevant to short- and long-term mortality, morbidity after CSDH, global functioning, and independence after injury.

Biological health assets shown to contribute to the long-term survival of CSDH patients included: male gender, lower age ATOI, bilateral or left sided haematoma, mild atrophy, and lower scores on the Markwalder Neurological Grading system at discharge. For functional health assets, greater independence in activities of daily living measured on discharge was the only known functional asset to contribute to increased survival at either discharge or six months post-surgery. No significant differences or relationships were observed for subjective health assets. Similar to findings from Study One (see Chapter 4), patients of male gender were less likely to experience a recurrence. Similarly, patients with greater emotional well-being and optimism were also at reduced risk of morbidity and recurrence after injury.

For global functioning, biological assets including lower age ATOI, no history of trauma, absence of dementia, dense haematoma appearance, mild atrophy, and low scores on the Markwalder Neurological Grading System contributed to improved functioning at six

months post-surgery. Functional assets including higher verbal fluency, greater preoperative independence and greater independence in activities of daily living, with patients being more likely to be discharged home as opposed to another hospital, rehabilitative centre, or nursing home. No significant differences were found for subjective health assets. The findings from this research significantly extend knowledge pertaining to outcome after CSDH. This study is the first to document and identify clinically measurable health assets shown to reduce long-term morbidity, recurrence, and mortality. The conclusions from this research have the potential to inform preclinical screening measures and effective, evidence-based interventions.

Chapter 7 concludes with an integration of the empirical results with the novel Positive Health theoretical framework developed in this thesis and existing Positive Health theory. The contribution of this research to the understanding of outcome after CSDH is evidenced by the presentation of clearly distinguishable characteristics of a positive recovery, and quantifiable variables shown to predict outcome following injury. The contribution of this research is further exemplified by providing the first empirically supported targets for the future development of intervention strategies to manage outcome after CSDH.

The limitations of this research are acknowledged, including the limitations of applying novel theory to existing health data and methodological concerns, such as sample composition, test selection, and method of data analysis. A number of future directions are discussed to specifically address the limitations identified in this research. An evidence-based approach to test selection that accounts for the capacity of CSDH patients to complete self-report assessments is recommended. Further, this thesis suggests refinements to the novel Positive Health framework to further support usefulness in health research. Most importantly, the

conclusions highlight the need to continue with theoretically driven research to advance the adequate management and rehabilitation of CSDH patients.

Chapter 2: Toward a New Positive Health Model

2.1. Introduction

The definition of health continues to be a topic of significant contention and interest. Human health was once considered the basic level of functional and metabolic efficiency required for a living organism (Sigerist, 1941). However, as our understanding of the human body has evolved, so has the conceptualisation of health and health research. Advancements in medicine have allowed empirical investigation into disease, illness, and ailments that affect human functioning. As such, the once neutral concept of health is now largely governed by a focus on disease and illness and theoretical models of health have been established to inform these investigations.

The most widely accepted theory of health provides a biomedical perspective, describing health as freedom from disease, pain, or defect (Zigmond, 1976). The biomedical model exists to understand physiological determinants of illness and biological factors relevant to the reduction of symptomology. The biomedical model is the guiding framework for current medical intervention, however the purely biological focus has resulted in the emergence of more inclusive models.

More recent conceptualisations propose a more integrative approach, wherein disease can be explained from a biopsychosocial perspective, which considers biological, psychological or social factors relevant to an individual (Engel, 1977, 1979). The biomedical and biopsychosocial models of health have governed a large proportion of existing epidemiological research, yielding important findings related to disease pathogenesis. The preferential use of these models has been largely contingent on their practical and empirically

measurable qualities in biomedical research and patient management. More simply, these models provide a quantifiable method of measuring symptoms and outcome that can be readily used in clinical practice.

Despite the contribution to epidemiological research, there are significant constraints and limitations associated with the use of these models in health research. First, purely biological focus observed in the biomedical model results in a significant gap in knowledge pertaining to functional and subjective health after disease. Further, the preoccupation with the negative determinants of health observed in both models, results in an absence of knowledge regarding the mitigating effect of well-being in disease recovery and disease prevention. This chapter will critically evaluate existing health models, providing evidence for their use and applicability in current health research. The constraints of these existing models will be discussed before evaluating a new approach of Positive Health to better understand recovery after disease. An existing theoretical framework of Positive Health will be applied to literature relevant to a specific clinical group, to establish potential efficacy and applicability to future health research.

2.2. The Biomedical Model of Health

Currently, the biomedical model of health is the most widely accepted theoretical framework in clinical practice and intervention (Larson, 1999). The biomedical model of health is primarily concerned with the diagnosis and treatment of disease, illness and pathology. From a fundamental perspective, the human body is viewed as a machine comprised of individual parts. Once the specific physical symptoms of an individual have been rectified, it

is assumed a person will return to optimal functioning (Wade & Halligan, 2004). The biomedical model holds four fundamental principles, these will now be outlined.

2.2.1. Principles of the Biomedical Model of Health

Firstly, the model argues that illness can be completely accounted for by measurable deviations from normal biological states, referred to as a disease (Engel, 1977; Wade & Halligan, 2004). As such, treatment of disease and illness may be resolved by sole consideration for abnormal biophysical parameters. The result of this approach is that treatment is symptom-focused.

Secondly, the model contends that all diseases give rise to symptoms, experienced as illness, and although other factors may influence the experience of illness, they are not related to its development or manifestation. More simply, the model argues that disease and illness arise from a purely physiological background, negating the potential effect of psychosocial factors.

Finally, this model views the patient as a passive entity, with little responsibility for the presence or cause of the disease or illness. It is assumed that if a patient is treatment-compliant, then there is a strong likelihood that the symptoms will reduce in severity or diminish completely. This principle proposes a cause-and-effect relationship between symptomology and treatment, in which social or environmental obstacles are rarely considered during the initial treatment plan.

In its inception, the biomedical model also maintained that the experience of mental illness is inherently unrelated to disturbances of bodily function. It was stated that mental phenomena, such as emotional disturbance or delusions, are separate and uninfluenced by the

functions of the body, and vice versa. Whilst this may not be the current manner in which mental illness is viewed, this foundational principle highlights the preconception with biological functioning and to date, much of health practice and research does not fully consider the importance of mental functioning in physical health (Álvarez, Pagani, & Meucci, 2012).

As discussed by Zigmond (1976) the biomedical model assumes an elementary mechanical view of disease and illness, and consequently the body that it occurs in. Therefore, disease and illness are simply a fault in the system and once rectified, the individual may be deemed as healthy. Interestingly, the principles of the commonly named 'disease' model of health are in fact, the foundations for the most significant limitations of a paradigm that dictates so many interventions in health practice. The limitations of the biomedical model of health will now be discussed.

2.2.2. Limitations of the Biomedical Model of Health

Firstly, the model contends that illness and disease are completely determined by deviations from normal bodily functions, whilst psychosocial elements of human functioning have little effect. In direct contrast, there is an abundance of research that demonstrates the effect that psychosocial factors, such as emotions, can have on physical health.

Todaro, Shen, Niaura, Spiro, and Ward (2003) aimed to determine whether the negative emotions significantly contributed to the development of coronary heart disease. This study was conducted as part of a wider program of research termed the Normative Aging Study (NAS). The NAS program of research aimed to determine biological and psychological variables implicated in the natural process of aging among men in the United States. The

longitudinal study collected data from 2,280 men between the ages of 21 and 80, over a nine-year period.

The study prospectively examined the relationship between negative emotions in predicting future incidences of coronary heart disease (CHD). Negative emotions as measured using the Minnesota Multiphasic Personality Inventory (MMPI), along with sociodemographic characteristics, health behaviours, components of metabolic syndrome, and stress hormones in the form of epinephrine and norepinephrine, were used to predict incident CHD over a three-year follow-up period. Using both unadjusted and adjusted logistic regression analyses, findings indicated that negative emotions significantly predicted CHD among patients. In fact, an increase of one standard deviation of negative emotions such as depression and anxiety, corresponded to a 51% increase in future risk for the development of coronary heart disease (Todaro et al., 2003).

Conclusions from this research strongly support the relationship between psychological factors and future disease-risk and can be further demonstrated in research investigating the relationship between psychosocial factors and cardiovascular disease, cancer, rheumatoid arthritis, chronic disease, and aging studies (Antoni & Lutgendorf, 2007; Cacioppo & Cacioppo, 2014; Kojima, 2012; Kubzansky & Kawachi, 2000; Mulroney & Taché, 2010; Umberson, Crosnoe, & Reczek, 2010). Hence, the biomedical approach to health largely negates potentially causal psychosocial factors that may predict disease-risk, recovery and prevention.

Perhaps the most notable limitation of this model is the assumption that the absence of illness results in the wellness of an individual. According to Seligman (2008), a perfect correlation does not exist between illness and good health. The absence of one does not result

in the presence of the other. Keyes (2002) further supports this argument, particularly in relation to a clinical setting. It is suggested that mental health does not reliably ensue once mental illness has been treated, and as such, health and illness do not exist as a uni-modal, causal relationship. Westerhof and Keyes (2010) further argue that mental illness and mental health exist on a *two continua* model: one continuum indicates the presence or absence of mental health, the other indicating the presence or absence of mental illness. Although discussed in terms of mental health, this idea could provide a potential opportunity for adaptation in a wider health context.

The limitations of the biomedical model of health prompted the development of a more integrative approach to understanding disease, illness and recovery. The biopsychosocial approach was developed to consider all potential mitigating factors that could affect the disease progression and recovery of an individual. The mechanisms, advantages and limitations of the biopsychosocial model of health will now be discussed.

2.3. A Biopsychosocial Approach to Disease

2.3.1. Introduction

The biopsychosocial model argues that the understanding of disease must emerge from a clear appreciation of the biological, psychological and social factors that will affect the health and treatment of an individual. Developed by Engel (1977, 1979), the biopsychosocial model is a re-statement of General System Theory and suggests that disease and disability should be conceptualised in terms of the successful relative functioning of different natural systems

within and around the individual (See *Figure 1*). The intended use of this model is to treat and manage a person by encompassing all information relevant to the individual.

2.3.2. Advantages of the Biopsychosocial Model of Health

The advantages of a systems-oriented approach to health is most noticeable in the clinical treatment of illness and disease. The biopsychosocial approach to investigating the presenting illness, also incorporates those factors individual to the patient. Rather than prescribing a 'one size fits all' treatment, this model allows for a more patient-centred approach in which the individual's psychological state, cognitive functioning, social support and socio-economic status are also considered mitigating factors in the course of treatment. In doing so, issues that may affect treatment adherence and compliance can be addressed in the prognostic phase of treatment and incorporated into the management of the patient (Álvarez et al., 2012; Smith, Fortin, Dwamena, & Frankel, 2013).

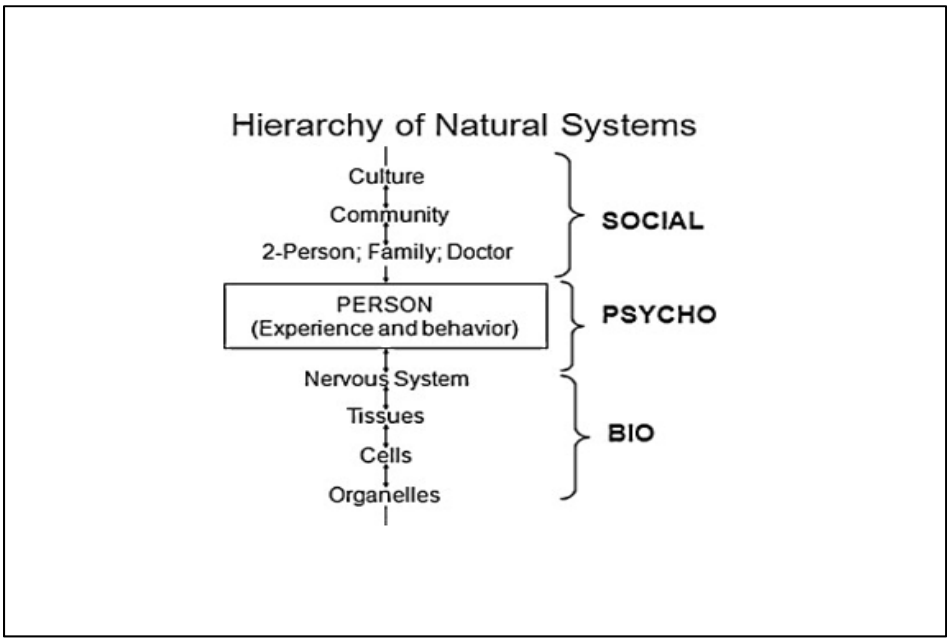

Figure 1 *The Biopsychosocial Approach to Health within the Systems Hierarchy*.

Reprinted from "An evidence-based patient-centered method makes the biopsychosocial model scientific", by Smith, R. Fortin, A., Dwamena, F. and Frankel, R., 2013, Journal of Patient Educating and Counseling, *91*(3), 266. Copyright 2013 by Elsevier Ireland Ltd.

The biopsychosocial model of health has theoretically guided a wealth of health research resulting in novel and potentially significant findings. Investigations into chronic illness, diabetes, psychopathology, treatment adherence, multiple sclerosis, and Crohn's disease, have demonstrated the utility of a biopsychosocial approach to patient management (Álvarez et al., 2012; Bitton et al., 2008; Havelka, Lučanin, & Lučanin, 2009; Michalski, Liebig, Thomae, Hinz, & Bergh, 2011; Möller-Leimkühler, 2010; Olson & Sameroff, 2009; Peyrot, McMurry, & Kruger, 1999; Suls & Martin, 2011).

For example, Bitton et al. (2008) aimed to predict relapse in Crohn's disease using a biopsychosocial approach. Crohn's disease (CD) is a chronic inflammatory disorder of the bowel of uncertain aetiology. The progression of CD is marked by relapsing and remitting

chronic intestinal inflammation with significantly debilitating symptoms affecting the quality of life of the patient. Previous treatment of Crohn's disease operated under the biomedical model of health, hence treatment was largely centred on pharmacological intervention. However, the biomedical approach was not able to account for the entirety of relapses in the patient population and evidence suggested the presence of other confounding factors. Bitton et al. (2008) aimed to discern other factors predictive of relapse in CD patients. The investigation was expanded to include psychosocial predictors of relapse among a sample of patients with inactive CD (N=101, 41 males, 60 females). Several variables were shown to predict relapse. For biological variables, serum C-reactive protein (CRP), fistulising disease behaviour and colitis were shown to predict relapse among patients. However, a multivariate Cox regression model also indicated a significant interaction between psychosocial stress and relapse. Those exhibiting higher levels of perceived stress and avoidance coping tendencies were at a higher risk of relapse during inactive CD. This study supports a biopsychosocial approach to the exacerbation and relapse of Crohn's disease.

The use of a biopsychosocial approach provides a means of understanding the aetiology of disease and illness when ill-health cannot be fully accounted for by purely biological deviations. Research is now able to identify psychosocial variables relevant to recovery after disease and preoperative psychosocial variables that significantly predict outcome and the success of medical intervention. Although the biopsychosocial model provides a more cohesive framework in the understanding of health, this model is hindered by two significant limitations, as the following will demonstrate.

2.3.2. Disadvantages of the Biopsychosocial Model of Health

The first major limitation of the biopsychosocial model is the generalised approach to understanding the biological, psychological or social determinants of disease. Currently, the biopsychosocial approach provides only general suggestions of what may constitute psychosocial variables relevant to a person, their disease and their recovery. This limitation violates the primary assumption of a theoretical model.

A theory is a set of statements that are arrived at through a process of continuing abstractions. Theories are formulated to explain, predict and understand phenomena, and at times, challenge and extend existing knowledge using generalised statements and conceptual discussion (Abend, 2008; Mooney & Swift, 1999). Hence, a theoretical framework supports the theory by introducing and organising the concepts relevant to the topic and illuminating why the problem under study exists.

Comparative to the general approach of theoretical development, a theoretical *model* is a purposeful representation of reality (Mooney & Swift, 1999). The origin of the term *model,* can be traced to literature describing mathematical modelling, and it describes the process of approximating specific phenomena, using quantifiable and measurable means. In its simplest terms, a model is the empirical and practical application of the theory. Based on this knowledge, the biopsychosocial model can only be considered a theoretical framework at best, as it lacks the necessary structure and purposeful, empirical characteristics required for a theoretical model. By Engel's (1977) own admissions, the biopsychosocial model provides only general "guidelines for a more inclusive model" (Engel, 1979, p. 160).

The consequence of providing gross theoretical guidelines is the resulting subjective interpretations of what variables should be included in the model. The general suggestions put

forth by Engel (1977, 1979) have resulted in marked differences in the application of the biopsychosocial model and a lack of consensus when considering variables relevant to illness or disease. A study conducted by Machalski, Liebig, Thomae, Hinz and Bergh (2011) provides an example. The study aimed to investigate pain in multiple sclerosis (MS) patients. Using the biopsychosocial approach, the study aimed to identify potential biological, psychological and social factors affecting the development and course of pain in MS patients (N=38, 7 men, 31 women, *Mage*=42±11.5years). Whilst a significant relationship was found between the measured variables and the pathogenesis of pain, the measurement of psychosocial factors was limited, potential confounding factors such as, mood, anxiety, cognitive processes and thought patterns, perceived social support, perceived solitude, and self-efficacy were not considered (Harrison, Silber, McCracken, & Moss□Morris, 2015; Young, Edwards, & Grp, 2014). Without a clear framework from which to guide research, variations in interpretation may lead to significant gaps in research and concerns regarding the reliability of a self-declared cohesive model of health.

The second significant limitation of the biopsychosocial model is the focus on purely negative determinants of health. Like the biomedical model of health, the biopsychosocial model assumes that treatment focused on relieving the pathological symptoms of the patient will result in a patient being 'cured'.

As instructed by Engel (1979) in his original work, the treatment of the patient should involve the systematic identification of biological, psychological and social symptoms and malfunctions that have led to illness or disease. However, this thesis maintains that treating negative symptoms does not immediately propel the patient into having a life marked by good physical health, mental health, social connectedness, prosperity or optimism (Keyes, Emory, &

Haidt, 2003; Seligman, 2008; Seligman & Csikszentmihalyi, 2000; Seligman et al., 2013; Westerhof & Keyes, 2010). For example, a long-term follow-up study investigating patients in remission after Cushing's disease demonstrated that the absence of illness, does not equate to the presence of wellness. Despite the long-term (2-25years) cure of the disease, patients experienced a considerable decrease in quality of life, and a reduction in physical and psychosocial health with no clear indication of predictive factors (van Aken et al., 2005). Hence, the biopsychosocial model of health remains largely a model of disease, not health, and the importance of well-being after disease remains precluded.

Interestingly and suggestive of a third limitation, the biopsychosocial model also fails to provide a clear basis to inform treatment. The model focuses heavily on the understanding of the origin of disease, however the model does not give equal attention to outlining an appropriate approach to treatment. Therefore, the use of the biopsychosocial model may only prove useful in the understanding of the origin of disease or illness yet prove less efficacious in patient-management.

More recent work has suggested that the limitations of the biopsychosocial model could be addressed by considering the impact of *contextual dynamics* on the biopsychosocial health of an individual (Lehman, David, & Gruber, 2017). Central dynamics include broad patterns of shared culture, norms, policies and values. These factors are suggested to shape interpersonal, psychological and biological factors and are in turn, shaped by them. According to Lehman et al. (2017), the existing biopsychosocial model fails in that it does not consider the impact of contextual dynamics, their importance to the individual and how these factors may shape the health of a person over time. However, the inclusion of such a method into the application of a generic framework or model, may limit the capacity of applying that model to a wider

population. Should the individual circumstances of each person be considered both in the present and over time, this may limit any conclusions to be made due to limits to generalisability. Notwithstanding, the impact of individual differences, context, social identity and culture remain to be important, influential factors in an individuals' health and future and should be recognised in future models.

The evidence discussed in this section identifies the individual limitations of currently accepted health models and highlights the potential need for a more inclusive model of health. The overarching limitations of current health models will now be discussed. The consequence of these limitations will be demonstrated with reference to existing health literature and a direction will be provided for the future development of a more inclusive model of health.

2.4. Limitations of Current Health Models

In 1948, The World Health Organisation (WHO) defined human health as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity, and currently remains the most widely accepted conceptualisation of health. This definition acknowledges a complete state of health in which persons' biological, psychological and environmental functioning are all considered contributing factors to their state of well-being. Although widely accepted, this definition of health has been minimally translated into practice.

Currently, the biomedical and biopsychosocial models of health guide the objectives and methodological approach of health research. The biomedical model of health argues that illness can be completely accounted for by measurable deviations from normal biological states, referred to as a disease (Engel, 1977; Wade & Halligan, 2004). Correspondingly, the

biopsychosocial model incorporates a more integrative approach to understanding disease, whereby the biological, psychological and environmental factors of an individual are considered.

What is most interesting when discussing each of these theoretical models is the use of language when describing health. Each of these models is deemed a model of health, and yet there is an obvious negative connotation in their focus and an inherent preoccupation with disease and adverse symptomology. A health model that describes only management of disease illustrates only half of the health picture. The assumption that the absence of illness inherently results in the presence of wellness, is the most significant limitation of current health models.

Health research negates the importance of positivity in health, such as the presence of protective health assets, protective psychological traits and the importance of positive human experience. A complete understanding of health can only be achieved with an appreciation of those elements of life that protect against the development of disease and promote recovery after illness. This ideal is the foundation for the novel theoretical framework, which will now be discussed.

2.5. The Conceptualisation of Positive Health

2.5.1. Introduction

A causal relationship does not exist between illness and good health; the absence of one does not result in the presence of the other (Seligman & Csikszentmihalyi, 2000). Despite both illness and good health being related constructs, they remain independent (Seligman, 2008). This statement represents the fundamental principle of Positive Health theory. Fundamentally, Positive health theory posits that good health lies beyond the absence of illness, and variables

important to good health and well-being can be equally defining factors in patient outcome and quality of life.

2.5.2. A History of Positive Health

The development of Positive Health theory is a relatively new undertaking, however the link between mind, body and well-being is well-recognised. The relationship between health and well-being is underpinned by two traditions; the hedonistic tradition, and the eudaimonic tradition (Deci & Ryan, 2008). These ancient schools of thought describe the fundamentally independent relationship between well-being and physical health, beyond the influence of disease and illness, and provide the guiding principle of modern Positive Health theory.

The origin of hedonic beliefs can be traced to the earliest works of Epicurus, an Ancient Greek philosopher (Deci & Ryan, 2008). Hedonism, derived from the Ancient Greek word for pleasure, describes the pursuit of happiness and self-gratification. Hedonistic tradition holds that physical health and well-being can be supported by the experience of positive emotions, or *happiness,* and even the fleeting experience of these emotions can significantly contribute to perceived life satisfaction. Interestingly, this relationship has been demonstrated in modern research. Recent evidence suggests that the ability to savour positive emotions dramatically reduces the risk of depression, whilst off-setting the physical effects associated with loneliness (Smith & Hollinger-Smith, 2015). Further, the experience of positive emotions may further contribute to the emotional resilience of an individual, whilst further protecting against future disease and illness (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Fredrickson, 2004; Fredrickson, Tugade, Waugh, & Larkin, 2003; Kok et al., 2013). This evidence suggests that a relationship may exist between the short-term experience of positive emotions and positive

health, however the origin of Positive Health theory also recognises the importance of long-term and sustained factors of well-being, such as those observed in eudaimonic well-being.

Eudaimonic tradition posits that well-being and good physical health can be achieved through a life of meaning (Deci & Ryan, 2008). Compared to the concepts held by hedonic tradition, eudaimonia refers to sense of accomplishment and self-actualisation that has been cultivated over a longer period of time. In its earliest form, the concept of eudaimonia was first distinguished in the works of Aristotle describing the Supreme Good (Aristotle, Ross, & Brown, 2009). In *the Nicomachean Ethics*, Aristotle chronicles The Supreme Good, or *eudaimonia,* as a state whereby an individual has reached a state of flourishing marked by the possession of virtues such as temperance, contemplation or friendship. According to Aristotle, eudaimonia is fundamental to the physical health and mental well-being of an individual and is vital to our essential nature as humans.

To summarise, the fundamental principles of Positive Health theory are based on the essential relationship between hedonic and eudaimonic traditions. Positive Health theory recognises that the experience of positive emotions and the search for meaning significantly contribute to positive human experience and health. The following section will now discuss the modern conceptualisation of Positive Health theory and its application to understanding health.

2.5.3. Current Positive Health Theory

Positive Health is the contemporary label assigned to an Ancient idea. As previously discussed, positive human health is a combination of hedonic and eudaimonic human experience and in its modern form, Positive Health may represent a clear shift in health discourse. The current theory of Positive Health is most easily understood when discussed in

terms of the health definition provided by the World Health Organisation (*Constitution of the World Health Organization*, 1948). The definition states that "health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (*Constitution of the World Health Organization*, 1948, p. 1).

Interestingly, the previously discussed biomedical and biopsychosocial models of health have largely focused on the concluding premise of this definition; the absence of disease of infirmity. However, it is the initial clause that represents the foundation for Positive Health and the importance of human functioning as a state of complete physical, mental, and social well-being.

The first conceptualisation of Positive Health was explored by Seeman (1989). Seeman used the WHO definition of health to define Positive Health using a human systems-based approach. According to Seeman (1989), the WHO definition encompasses the interactions between the major systems of the human body; *physical, mental,* and *social.* Therefore, Positive Health is the optimal interaction between the major dimensions of human existence. This definition was later refined, stating that Positive Health is the result of optimally functioning biological systems that contribute to disease prevention, recovery after illness, and reductions in economic burden associated with disease (Ryff & Singer, 1998; Ryff, Singer, & Dienberg Love, 2004; Seligman, 2008; Seligman et al., 2013). Based on this definition, Positive Health theory aims to understand biological, functional, and subjective factors that positively contribute to health and well-being. Currently, there are three existing theoretical frameworks based on Positive Health theory; Seeman's Positive (1989), Ryff and Singer's Positive Health (2004), and Seligman's Positive Health framework (2008; 2013). The origins, development, and related concepts of these existing frameworks will now be discussed.

2.5.3.1. Seeman's Theoretical Framework of Positive Health

According to Seeman (1989), the initial clause of the WHO definition of health provides the foundation for a human-systems approach to health, in which the physical, mental and social all combine to encompass the major dimensions of the human organism. In Seeman's (1989) theoretical framework, Positive Health is organised into subsystems that share a hierarchical structure. A reciprocal relationship exists between these subsystems suggesting that optimal functioning in one subsystem can result in a flow-on effect in others. In addition, a horizontal relationship is also delineated, indicating the influence of developmental processes over time (1989). The theoretical framework is organised into five subsystems, which will now be outlined.

2.5.3.1.i. The Subsystems of Seeman's Positive Health Framework

Seeman's (1989) Positive Health framework provides a systematic organisation of health consisting of five subsystems; the biochemical, physiological, perceptual, cognitive, and interpersonal/ecological (see *Figure* 2). The biochemical subsystem represents the foundation for optimal human functioning, from which the remaining subsystems flourish. The positive integration of biochemical systems, such as the glucose or metabolic system, contribute to the positive health of a person by reducing inflammatory responses and future disease-risk (Messier, 2004; Nieoullon, 2002). The physiological system extends the biochemical subsystem further, and includes organismic behaviour directly related to physical health, such as lifestyle, level of physical fitness and functional health of the individual.

The perceptual subsystem represents the point of convection between the body and brain and is the process of consolidating sensory information into visual, auditory or semantic stimuli that a person can readily understand. According to Seeman (1989), higher levels of

perceptual functioning result in higher speeds of cognitive processing of complex figures, more efficient visual processing, cognitive organisation and problem-solving (Foxman, 1976; Grant & Spivey, 2003; Newman, Carpenter, Varma, & Just, 2003; Seeman, 1989). The relevance of the perceptual subsystem to Positive Health is a matter of availability. The more efficient an information-processing system is, the more information is available to the individual which inherently informs rational decision-making and problem solving in higher levels of cognitive functioning. This higher level of functioning is indicative of the cognitive subsystem.

The cognitive subsystem is the mind-brain relationship that consolidates the information provided by the perceptual subsystem. This information combines with the psychological and emotional tendencies of a person, to form an individual's self-concept. This definition of self largely influences the way in which individuals interact with others and their environment. These contexts are combined in the final subsystem, Interpersonal/Ecological.

Seeman (1989) takes a developmental approach to this subsystem, indicating that optimal interpersonal relationships and harmony with one's environment fosters Positive Health. However, this is largely contingent on the different developmental stages of the person, and the associated social and environmental obstacles and opportunities that are predicted at each life-stage.

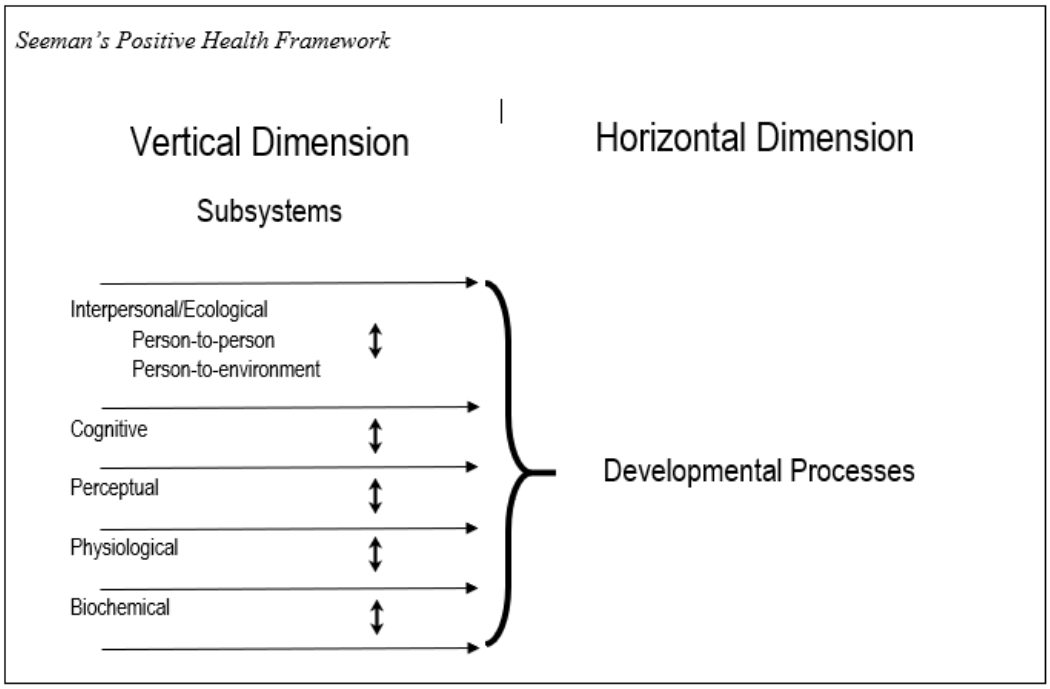

Figure 2 *The Human Systems Health Structure.*

Adapted from "Toward a Model of Positive Health" by Seeman, J. American Psychologist, 44(8), 1102. Copywright 1989 by the American Psychological Association.

To conclude the discussion of this theoretical framework, this section will outline the proposed functions suggested for Seeman's Positive Health framework. According to Seeman;

> "One function of a model is to provide structure and guidance for our thinking about a domain. There are some ways in which the foregoing model of positive health serves that function. In particular, the model has the possibility of contributing to our thinking in three areas: the basic conception of health, health research, and health enhancement." (Seeman, 1989, p. 1107).

In regards to the basic conception of health, this model argues for a systems-approach to health whereby all levels of human functioning are considered comprehensive and transactional in nature. Further, this model argues that the understanding of disease is not the only way to understand health, and consequently health management. For health research, the main function of this framework is heuristic in nature, leading towards identifying gaps in research and focal points for future investigation. Finally, it is argued that this;

> "…model offers guidance along several dimensions with respect to programs of health enhancement. The model's human-system framework expands program possibilities in the sense that we can envision and promote more effective functioning for persons who are already functioning moderately well." (Seeman, 1989, p. 1108).

This theoretical framework offers the first attempt to logically organise the theory of Positive Health. By using a systems approach to Positive Health, Seeman provides a well-considered and methodical approach to understanding optimal functioning in humans. Evidence for each subsystem is well-documented in past literature and can also be identified in current health research. The consideration for all elements of human functioning indicates that this theoretical framework is the first to conceptualise the true definition of health.

Notwithstanding the potential of this framework, further assessment does in fact, yield several key limitations that hinder the growth of this framework into an empirically measurable model of health. The limitations will now be discussed.

2.5.3.1.ii. Limitations and Constraints of Seeman's Positive Health Theoretical Framework

The first limitation observed in this theoretical framework, lies at its inception. As can be inferred from direct quotations and arguments derived from Seeman's (1989) work, the terms *theoretical framework* and *model* appear to be used interchangeably. However, as reiterated by this thesis, there is a clear and practical separation between each of these terms. A theoretical framework provides an organised structure of concepts relevant to a theory, whereas a model is the practical and empirically measurable application of those concepts. The structure provided by Seeman is fundamentally, a theoretical framework. Important concepts related to Positive Health are outlined and supported by previous health research, however empirically measurable variables relevant to the subsystems are only vaguely discussed, or completely absent. Therefore, confusion surrounds the appropriate uses of this framework and its applicability to current health research. Unfortunately, the ambiguity of terms is a consistent limitation of this theoretical framework.

Seeman's (1989) distinction of Perceptual versus Cognitive subsystems is hindered by ambiguity and ill-defined terms. Seeman (1989) discusses the optimal functioning in the Perceptual subsystem as high levels of perceptual organisation, visual organisation, verbal comprehension and personality integration. However, optimal functioning in the Cognitive subsystem describes healthy perceptions of stressful situations, self-concept, and effective personal functioning.

Firstly, the variables described in the Perceptual subsystem are in fact the basic cognitive processes of the human brain (Gazzaniga & Davies, 2008). For example, visual organisation represents a set of clear, cognitive processes, such as Gestalt theory, or

consolidating stimuli to form a large image ("Gestalt theory," 2010). Verbal comprehension refers to the cognitive process of language and further requires the appropriate function of attention and memory (Boyle, Lindell, & Kidd, 2013).

Therefore, the Perceptual subsystem of Seeman's (1989) Positive Health framework appears to confuse and combine variables that should align with the Cognitive subsystem of Positive Health. Instead, the Cognitive subsystem of Seeman's framework provides only general and at times, vague definitions, such as *effective personal functioning*. The Cognitive subsystems appear to include elements more relevant to psychological well-being, such as self-efficacy and self-concept, however psychological or emotional health is not defined here. Therefore, it is difficult to discern exactly what is included in Seeman's (1989) Cognitive subsystem.

The final constraint of this theoretical framework is the lack of information regarding how each of these subsystems transpire across the developmental stages of an individual. At the outset, Seeman (1989) states that it is important to conceptualise health as it relates to the lifespan, and yet there is a lack of information describing developmental changes to each subsystem across the life course. The only subsystem that is discussed in terms of developmental stages is the Interpersonal/Ecological subsystem. However, no clear guidelines or estimates of appropriate developmental milestones are provided, therefore it is difficult to predict where in fact changes in this subsystem should be expected.

Whilst the uses of this theoretical framework do outweigh the limitations, future Positive Health frameworks should pursue a more definitive approach to the theoretical development. Such an approach was later attempted by Ryff and Singer (1998) .

2.5.3.2. Ryff and Singer's Positive Health Theoretical Framework

In 1998, Ryff and Singer (1998) aimed to develop a theoretical framework of Positive Health grounded in ancient philosophy. Interestingly, Ryff and Singer argue that the contemporary framework of Positive Health should be based on the ancient philosophy of eudaimonism and the concept of the good life. Three principles underlie the formulation of their Positive Health framework.

First, Positive Health is not a medical question in its final analysis, but a philosophical question that requires articulation of what is considered a good life. Positive Health may be supported by optimal functioning in several life domains, but Positive Health fundamentally, is a philosophical issue. Therefore, it is philosophy that should determine those life domains that are considered relevant.

The second principle is that human wellness is largely contingent on the interconnections between the mind and the body. Thus, a comprehensive assessment of Positive Health must include both mental and physical components, and the subsequent interactions of these domains.

Third, Positive Human health is best defined as a multidimensional and dynamic process, rather than a discrete end state. Positive Health is supported by engagement in living as it transpires across the lifespan and involves the expression of a broad range of human qualities, including intellectual functioning, social functioning, emotional, and physical functioning. These principles represent the foundation for Ryff and Singer's Positive Health framework and provide a largely eudaimonic approach to the organisation and conceptualisation of Positive Health theory. The core features of this theoretical framework will now be outlined.

2.5.3.2.i. The Core Features of Ryff and Singer's Positive Health Theoretical Framework

The core features of this theoretical framework are largely based on the specific underlying principles of eudaimonic and hedonic well-being. As discussed in this thesis, eudaimonia represents a state of human flourishing whereby an individual is not only free from pain or infirmity, but also benefitting from a life of meaning, social interaction and healthy mindedness. Comparatively, hedonia represents a more short-lived and transient state of well-being, whereby an individual actively seeks short-term pleasure, whilst aiming to avoid experienced states of pain. Hence, hedonia is reflection of fleeting states that are measured on a short-term basis (Deci & Ryan, 2008; Ryff & Singer, 1998; Ryff, 1989b).

The core features of Ryff and Singer's (1998) Positive Health framework are based on adaptations of eudaimonic and hedonic well-being, and include; purpose in life, quality connections with others, self-esteem, and mastery. The theoretical argument provided for each core feature of this framework is brief and lacks a clear definition. Therefore, this thesis will now outline each core feature based on the information provided.

(a) Purpose in Life

Leading a life of purpose appears to describe opportunities to actively pursue projects that give meaning and value to one's life. Ryff and Singer (1998) provide evidence from existing eudaimonic theory, stating that leading a life of purpose and meaning, with self-realisation and enactment of one's unique abilities, thereby enhances one's physical health.

(b) Quality Connections with Others

Quality connections with others incorporates the universality of needs for deep, meaningful human connections. Significant theoretical support for the inclusion of this core

feature is provided, however a discussion of the relevant variables that constitute quality connections with others is largely absent.

(c) Positive Self-regards and Mastery

Positive self-regard and mastery are suggested as core features of Positive Health; however, no clear definition is provided. As can be inferred from this information, the theoretical framework suggested by Ryff and Singer (1998) requires a more definitive and cohesive approach to conceptualising Positive Health, and the limitations largely hinder its use in either theoretical or empirical practice. The limitations of Ryff and Singer's (1998) Positive Health framework will now be discussed.

2.5.3.2.ii. The Limitations of Ryff and Singer's Positive Health Theoretical Framework

The theoretical framework provided by Ryff and Singer (1998) does not satisfy the requirements of a theoretical framework. Firstly, there is a significant lack of theoretical structure and definitive terms. Specifically, there is an absence of clear definitions to describe the domains or *features* included in the theoretical framework. According to Ryff and Singer (1998);

"…our primary intent is not to establish a final, definitive set of criterial goods, but rather to connect philosophical accounts of quality living to biology" (Ryff & Singer, 1998, p. 9).

Whilst this approach is philosophical in nature, it does not satisfy the requirements set about by the definition of a theoretical framework discussed in this thesis. As such, the exact mechanisms of the core features included in this framework are not clearly understood. For example, the definition of *quality connections with others* only vaguely describes the need to obtain 'deep connections' with others and little information is provided describing the specific

dimensions of this domain. Further, the potential domains of *positive self-regard* and *mastery* are not clearly discussed or defined, further adding to the limitations of this theoretical framework. Whilst an abundance of literary support is provided to include these domains the conceptualisation of Positive Health as put forth by Ryff and Singer (1998) cannot be considered a theoretical framework due to the fundamental violations of what constitutes a theoretical framework and requirement for clearly definable terms.

Whilst this conceptualisation of Positive Health cannot be considered a theoretical framework by definition, the contributions of it to the field of Positive Health should not be undervalued.

2.5.3.2.iii. The Contributions of Ryff and Singer to the Field of Positive Health

Despite the limitations of the proposed theoretical framework, the contributions of Ryff and Singer (1998) to the theory of Positive Health are invaluable. Firstly, the philosophical approach to the understanding of Positive Health establishes Ryff and Singer's (1998) conceptualisation as being grounded in theory. The use of Ancient Greek philosophy to provide a theoretical basis for Positive Health enables an investigation into the wealth of literature describing the benefits of eudaimonic and hedonic well-being. As such, Ryff and Singer's (1998) contribution provides a theoretical background for the future development of a well-structured and cohesive theoretical framework.

The second notable contribution is the provision of preliminary evidence to support Positive Health theory as it relates to eudaimonic and hedonic well-being. Following their initial attempt to conceptualise Positive Health, Ryff et al. (2004) empirically investigated the relationship between the proposed core features and health.

Ryff et al. (2004) measured the relationship between the core features identified in their framework, and biological variables among a sample of ageing women (n=135, *age range* 61-91 years). Findings indicated that those with higher levels of eudaimonic well-being, exhibited lower levels of daily salivary cortisol, pro-inflammatory cytokines, cardiovascular risk and longer duration of rapid eye movement (REM) sleep. There was limited evidence to suggest a link between hedonia and biological correlates. To summarise the findings from this research, eudaimonic well-being was demonstrated to reduce perceived stress and inflammatory responses, whilst promoting cardiac health and efficient sleep behaviour. Hedonic well-being was shown to actively contribute to the health of an individual.

The conclusions from this research are significant. This research provided the first indication of Positive Health variables relevant to health and illustrates a clear direction for the development of a more inclusive, definitive Positive Health framework. Therefore, whilst the original organisation of Positive Health provided by Ryff and Singer (1998) does not suffice the requirements of a theoretical framework, the contributions of their empirical investigations greatly extended the breadth of knowledge relevant to Positive Health.

To address the limitations of existing ideas, Seligman provided a theoretical framework for understanding health beyond the mere absence of disease. This thesis will now discuss and critique Seligman's Positive Health framework.

2.5.3.3. Seligman's Positive Health Theoretical Framework

Seligman first discussed the need for a new medical model in an early commentary based on observations in his own personal life and the need for positive psychology in health research (Seligman & Csikszentmihalyi, 2000). The preliminary work yielded several

important conclusions that would later inform Seligman's (2008) Positive Health framework. First, psychological treatment, much like medical treatment, has a distinct focus for the negative determinants of health and patient suffering. Second, the same methodical strategies that were once devoted to understanding risk factors, disease progression and treatment, should also be used to understand the concept of human flourishing. Similar to the previous Aristotelian arguments discussed in this thesis, Seligman suggests that health research and practice should focus on measuring, understanding and building those elements of human functioning that make life most worth living. As a result, clinicians and practitioners will not only be able to help individuals and communities to endure and survive, but to flourish (Seligman & Csikszentmihalyi, 2000).

Seligman (2008; 2000; 2013) later refined these ideas and defined Positive Health well-being beyond the mere absence of disease. Seligman argued that like illness, Positive Health is a definable and empirically measurable construct with the potential to increase longevity, reduce health costs, and improve mental health and prognosis. This definition provides the basis for Seligman's theoretical framework of Positive Health, which this thesis will now outline and critique.

2.5.3.3.i. The Domains of Seligman's Positive Health Theoretical Framework

In 2008, Seligman (2008; 2013) established a conceptual framework of Positive Health from which future health research could be operationalised. Support for this framework is provided from evidence documenting successful links between psychological assets and cardiovascular health. According to Seligman (2008), the possession of psychological assets such as optimism, positive affect, and positive explanatory style not only aid in recovery of patients after a major cardiac event, but also act as protective factors against future ailment and

early-onset mortality. Based on this evidence, Seligman further delineated the theory of Positive Health, and provided three conceptually structured subsystems, or domains; Subjective Positive Health, Biological Positive Health, and Functional Positive Health.

Subjective Positive Health is defined by optimal standards of several psychological states. These states are: (a) a sense of positive physical well-being; (b) the absence of *bothersome* symptoms; (c) a sense of durability, hardiness, and confidence about one's body; (d) an internal health-related locus of control; (e) optimism; (f) high life satisfaction; (g) positive emotion; and (h) meaning and purpose (Seligman, 2008; Seligman et al., 2013). It is stated that this domain is the quantifiable link between good physical health and positive mental health, however no further explanation is provided.

The second domain to be discussed is Biological Positive Health, which is designed as "the positive ends of physiological function and anatomical structure distributions". This domain is further divided into two dimensions; those biological variables relevant to health generally, such as body mass index, blood pressure or temperature; and those biological variables that are specific to particular disorders, such as the importance of exercise tolerance performance in relation to coronary heart disease or congestive heart failure (Seligman, 2008; Seligman et al., 2013).

The third domain outlined in this theoretical framework, is Functional Positive Health. Seligman divides this domain into two classes of data; Optimal performance on laboratory test data, such as speed of gait and choice reaction time, and high levels of person-environment fit measured by an optimal state of adaptation between bodily functions and the physical requirements and demands of that individual's chosen lifestyle. Scales including the Psychological Adjustment to Illness Scale (PAIS), Sickness Impact Profile (SIP) or the Global

Assessment of Functioning, were suggested to quantify this domain. However, little information is provided for specific variables or concepts that would be relevant to Functional Positive Health (Bergner, Bobbitt, Pollard, Martin, & Gilson, 1976; Derogatis, 1986; Startup, Jackson, & Bendix, 2002).

In 2013, Seligman refined and extended the variables included under each Positive Health domain (see Table 1).

According to Seligman (2008; 2013), the use of a Positive Health theoretical framework to better understand disease and health alike is a two-stage process. First, research must identify health assets relevant to a particular disease or condition. These assets represent factors that combine to form a successful recovery after disease with the potential to predict health and well-being beyond conventional risk factors. Second, research should be conducted to determine whether these health assets significantly contribute to health-related outcomes, including longevity, morbidity, quality of life, and healthcare utilisation.

To date, Positive Health research has focused on the first stage of integrating Positive Health into health research. The completion of Seligman's Positive Health framework initiated several programs of research to re-examine longitudinal datasets in health research. Seligman applied his theoretical framework to existing literature involving patients with cardiovascular disease (CVD) and cardiac ill-health (Seligman et al., 2013). In doing so, Seligman (2013) was able to identify potential positive health assets that were shown to predict health and recovery beyond existing biomedical and biopsychosocial models. For instance, a variable of Positive Health, optimism, was positively associated with reduced recurrences of coronary heart disease (CHD), Satisfaction with life domains (Functional Positive Health) was shown to potentially

promote heart health, and Purpose in life was positively associated with reduced risk of myocardial infarction.

Table 1

Seligman's Theoretical Framework of Positive Health

Positive Health Domain	Variables
Biological Positive Health	A. Biological Markers 1. Rapid wound healing 2. Exceptionally low blood pressure 3. High heart-rate variability 4. High HDL/LDL Ratio 5. Greater telomere lengths for one's age 6. Low body mass index (BMI) 7. Vitamin D level 8. Neuropeptide Y 9. Oxytocin 10. Maximal Oxygen Uptake 11. Low fibrinogen B. Physiological Reserves 1. Cardiovascular reserves 2. Pulmonary reserves 3. Renal reserves 4. Hepatic reserves 5. Central Nervous System reserves C. Recuperative Ability 1. Less frequent and briefer self-limited ailments and infections (cold) 2. Rapid recovery from injury 3. No recurrence following successful treatment of a primary cancer

Positive Health Domain	Variables
	4. Chronic diseases with exceptionally benign courses, complete recoveries, and/or long lives.
Subjective Positive Health	1. Zest 2. Absence of bothersome symptoms 3. Optimism/hope 4. Hardiness 5. Internal health locus of control 6. Life satisfaction 7. Positive emotion/positive affect/hedonic capacity 8. Low negative emotion 9. Subjective well-being 10. Engagement 11. Meaning 12. Vitality 13. Curiosity 14. Mastery/sense of control 15. Sense of coherence 16. Subjective sense of overall physical well-being
Functional Positive Health	A. Positive Physical Functioning 1. Exceptional sensory acuity 2. Exceptional motor performance and musculoskeletal function 3. Exceptional central nervous system function B. Positive Role Function C. Positive Social Integration and Support

From "Positive Health and Health Assets: Re-analysis of Longitudinal Datasets," (Seligman et al., 2013)

This overly generalised approach is a consistent limitation of Seligman's Positive Health framework, and indicative of the limitations present. Despite work being conducted to

retrospectively test the presence and impact of health assets in longitudinal datasets, Seligman's (2008; 2013) Positive Health framework lacks a theory-driven approach to better inform the identification of health assets relevant to the three Positive Health domains. Similar to limitations of Engel's (1977, 1979) biopsychosocial model, Seligman fails to adequately draw on existing theoretical evidence to provide the basis for each health asset and its' relevance to Positive Health. This has led to an overly generic framework that limits application to empirical research.

Seligman (2013) also acknowledges that research imploring the second wave of Positive Health has not yet been undertaken. Still to be determined is whether and how health assets contribute to health-related outcomes, including longevity, morbidity, quality of life, and health care utilisation. The lack of support for the use of a Positive Health framework to determine health-related outcomes further limits the preference for Positive Health theory over and above existing medical models. The following section will now discuss the limitations and boundaries of Seligman's Positive Health framework. This thesis will then provide a series of recommendations for the future development and course of Positive Health, followed by the development of a novel Positive Health framework to address the limitations and constraints existent in current theoretical frameworks.

2.5.3.3.ii. Limitations of Seligman's Theoretical Framework of Positive Health

Seligman's Positive Health framework is the most recent attempt of organising a theory that has the potential to challenge and change current health discourse. However, potential limitations exist that question the efficacy of this framework in health research.

Firstly, the framework may be hindered by a lack of organising and overarching structure. Unlike the interconnected hierarchical structure put forth by Seeman (1989),

Seligman's (2008) Positive Health domains appear to lack a consideration for the interdependent relationships between levels of human functioning. To quote the order in which these domains are discussed, Subjective Positive Health is provided first, followed by Biological Positive Health and concluded with Functional Positive Health; indicating that there is little acknowledgement of the hierarchical structure that largely dictates human functioning. Furthermore, Seligman fails to adequately discuss the interrelations between these domains. Each domain is presented clearly and with supporting evidence, however Seligman fails to establish that functioning in one domain can foster flourishing in another. This lack of overarching structure gives little importance to reciprocal relationships between the functioning systems of the human body. Therefore, the application of this framework in health research may in fact result in a negligence of important interactions and correlational relationships whereby results in one domain may affect performance in others.

Secondly, the discussion of each individual domain of Positive Health demonstrates a potential lack of theoretical guidance and organisation. The concepts, ideas and potential variables put forth for each domain provide incongruent and inconsistent information. The Subjective Domain is the most obvious example of this limitation. Firstly, a definition for Subjective Positive Health is provided, followed by a long series of potential variables, see Table 1. The difficulty in applying this domain to health research is the lack of theoretical guidance and structure that should in fact, dictate the variables suggested. With only a definition and many suggested variables, it is difficult to understand exactly which variables, if not all, should be used in health research. The lack of theoretical guidance in this domain has resulted in an almost random selection of subjective variables, whilst others are absent. Several important variables relevant to disease recovery and prevention were not included in this

domain, including, engagement in one's community and flourishing (Keyes, 2002, 2005, 2013; Keyes et al., 2003; Ryff & Keyes, 1995; Westerhof & Keyes, 2010).

Finally, it is unclear whether the application of Seligman's framework to positive health research would be hindered by overly generalised concepts and incongruences within domains. In the Biological domain, Seligman suggests that whilst there are variables relevant to general health, Biological Positive Health should also be considered disease-specific. Interestingly, this assumption is not argued in other domains, in spite of evidence suggesting that variables relevant to Functional or Subjective Positive Health are largely altered depending on the patient sample (Albinet, Boucard, Bouquet, & Audiffren, 2010; Antoni & Lutgendorf, 2007; Caprara, Caprara, Kanacri, Gerbino, & Zuffianò, 2014; Cattell, 2001; Charlson et al., 2014; Pérez et al., 2015; Verkuil, Brosschot, de Beurs, & Thayer, 2009; Weeks, Weeks, Wild, Ploubidis, & Naicker, 2014).

To summarise, Seligman's theoretical framework represents the most recent and extensive attempt to organise the theory of Positive Health, however the efficacy of the framework for use in health research warrants further investigation. This thesis will now review existing health literature through the lens of Seligman's Positive Health framework to determine its use in understanding health and recovery after disease. To facilitate this review of existing literature, a specific clinical sample was selected for investigation. This clinical sample consists of those patients with a chronic subdural haematoma where evidence suggests a significant lack of information regarding patient outcome after injury. This thesis will now apply Seligman's Positive Health framework to better understand outcome after chronic subdural haematoma, and the efficacy of Positive Health in understanding outcome after disease.

Chapter 3: The Application of Seligman's Positive Health Framework to Chronic Subdural Haematoma

3.1. Introduction

Seligman's Positive Health framework represents the most recent contribution to Positive Health theory and is currently the only Positive Health framework to be empirically applied to health research. In 2013, Seligman et al. (2013) authored a White Paper outlining the initial stages of a Positive Health oriented program of research. The program of research involved the application of the theoretical framework to the re-analysis of existing longitudinal datasets to determine potential health assets relevant to outcome after disease, specifically cardiac disease. The research involved the re-analysis of four longitudinal datasets including the Whitehall II Cohort, the Normative Aging Study, and the Health and Retirement Study and identified several important and influential health assets relevant to cardiac health. A synthesis of the findings indicates that subjective health assets including optimism, emotional vitality, and life satisfaction all contribute to recovery after cardiac illness, and future disease prevention (Boehm, Peterson, Kivimaki, & Kubzansky, 2011a; Boehm, Peterson, Kivimaki, & Kubzansky, 2011b; Ikeda et al., 2011; Kim, Park, & Peterson, 2011; Kim, Sun, Park, Kubzansky, & Peterson, 2013). Based on this evidence, Seligman's (2008; 2013) Positive Health framework may represent the first Positive Health framework found to be effective in health research.

Despite its potential use, this framework warrants further investigation in existing health literature and future empirical research. As discussed by this thesis, there are potential limitations identified in Seligman's theoretical framework that may hinder its efficacy in

understanding health, patient outcome, and recovery after disease (see Chapter 2). Therefore, it is imperative that the utility of this framework be assessed in existing health literature pertinent to vulnerable clinical populations.

The following section applies Seligman's Positive Health framework to existing literature to describing a specific and vulnerable clinical sample. The framework will be used to investigate outcome after chronic subdural haematoma, a severe form of acquired brain injury that results in a significant reduction in health and well-being after injury.

3.2. Chronic Subdural Haematoma; Disease Aetiology and Outcome

Chronic subdural haematoma (CSDH) is the most common neurosurgical presentation affecting individuals. Currently, incidence rates are estimated at 58 in 100,000 and the condition is most commonly observed among young infants and the male elderly population (Kudo, Kuwamura, Izawa, Sawa, & Tamaki, 1992).

The injury involves a substantial collection of old blood situated between the protective layers of skin, or *meninges,* surrounding the brain (See Figure 3). The haemorrhage slowly forms between the arachnoid and dura mater layers and commonly occurs after a minor head trauma. The haemorrhage subsequently acts as a slow leak, bleeding for several days, weeks or perhaps months before symptoms present. At this time, symptoms may include confusion, loss of power to the limbs, speech problems, memory loss, instability, dizziness, seizures or coma. There is also evidence suggesting patients experience states of depression, anxiety, cognitive decline and reduced life satisfaction both at the time of injury, and post-surgery (Adhiyaman et al., 2017; Berghauser Pont et al., 2012; Honda et al., 2015; Ishikawa et al., 2002; Yang et al., 2012).

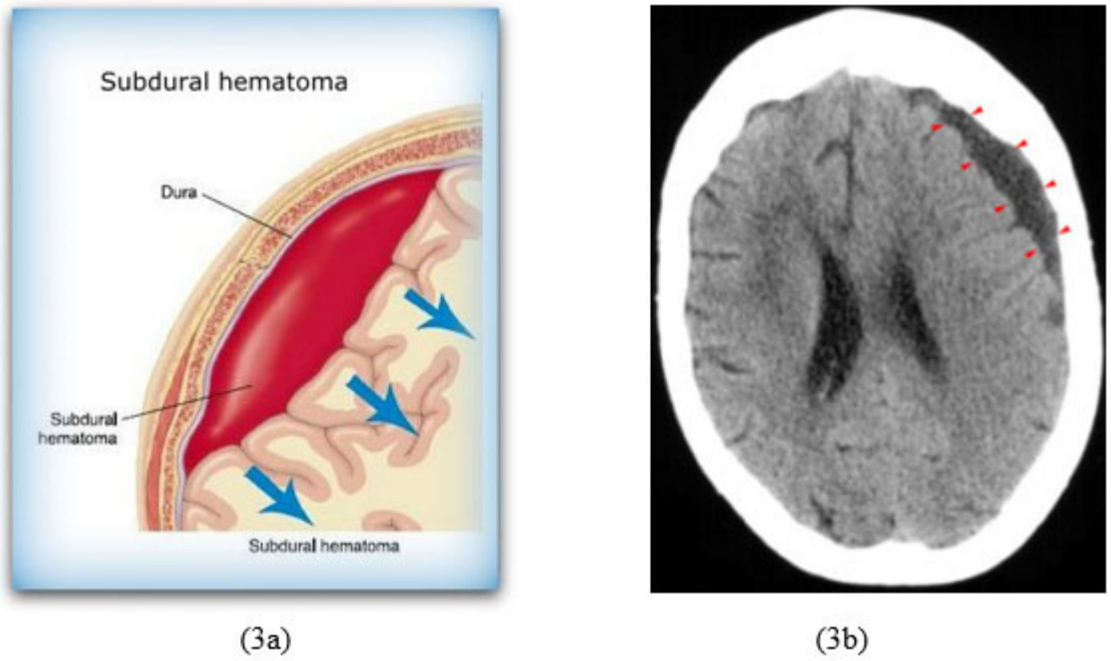

Figure 3 *Chronic Subdural Haematoma on imaging.*
Figure 3a *Diagram of Chronic Subdural Haematoma.* Retrieved from http://www.pacificneuroscienceinstitute.org/blog/patient-story/patient-story-subdural-hematoma/.

Figure 3b *Chronic Subdural Haematoma on Computed Tomography.*
Retrieved from http://scarysymptoms.com/2012/03/stroke-symptoms-compared-to-chronic/

While minor head trauma appears to be the most common risk factor to CSDH development, research also highlights male gender, increased age, alcohol-abuse, anticoagulant or antithrombotic medications as potentially predisposing factors (Asghar, Adhiyaman, Greenway, Bhowmick, & Bates, 2002; Baechli et al., 2004; Borger et al., 2012; Forster et al., 2010; Marshman, Manickam, & Carter, 2015; Okano et al., 2014). Whilst general risk factors have been identified, research has not yet uncovered the exact mechanisms behind CSDH development, and a justification for the male bias remains inconclusive (Marshman et al., 2015).

Despite the excessive cerebral haemorrhaging and adverse symptoms, this disorder is considered a relatively benign event that can be easily managed with a neurosurgical procedure. The literature provides slight variations regarding the efficacy of differing surgical procedures, but it is usually advised to either pursue a conservative route where the patient is monitored, and the clot is expected to resolve. If the patient does require neurosurgical management, burr hole surgery (BHS) with drainage is the most common surgical procedure (Ahmed, Agrwal, Kale, & Mahapatra, 2011; Asaduzzaman et al., 2014; Gelabert-González, Iglesias-Pais, García-Allut, & Martínez-Rumbo, 2005; Peng & Zhu, 2016; Santarius et al., 2009; Shah, Rehman, Ahmed, Chaudhry, & Shabir, 2014). During the immediate post-operative period, imaging scans are conducted to assess for residual bleeding, and if no further complications are observed, the patient is discharged.

Outcome after CSDH was once considered relatively positive, with a high proportion of patients experiencing a reduction in symptoms during the acute period post-surgery (Adeolu, Rabiu, & Adeleye, 2012). However, recent estimations of incidence rates indicate a significant increase in the prevalence of CSDH in the population. A study conducted in 1975 estimated incidence rates to be approximately 1.7 in 100,000 individuals (Fogelholm & Waltimo, 1975). However, the most recent estimations place the incidence rates of CSDH at approximately 58 in 100,000 individuals (Kudo et al., 1992). The increase in incidence rates has been linked to the steady increase observed in the ageing population and has initiated a surge in research to better understand the development, outcome and appropriate treatment of this condition (Adhiyaman et al., 2017).

The conclusions from this research are concerning. Contrary to previous beliefs, recent research has uncovered that CSDH is not a benign event, but rather a disease characterised by a

significant increase in morbidity, mortality, and health decline after injury (Manickam et al., 2016). These findings regarding outcome and recovery after CSDH will now be discussed.

3.2.1. Outcome after Chronic Subdural Haematoma

Existing research investigating outcome after CSDH is indicative of the biomedical approach to understanding disease. Research focuses on measures of morbidity, recurrence, and mortality post-injury, and rarely exceeds the period beyond short-term recovery (Baechli et al., 2004; Borger et al., 2012; Christopher et al., 2018; Okano et al., 2014; Peng & Zhu, 2016).

Firstly, findings from existing research indicate a potentially significant relationship between CSDH and disease in the acute period of recovery. Adhiyaman, Asghar, Ganeshram, and Bhowmick (2002) investigated incidence rates and short-term outcome of CSDH patients (n=66). Specifically, the study sought to measure mortality rates among a sample of CSDH patients in North Wales. The results indicated that approximately 25% of patients died within 30-days after surgery. Further, approximately 25% of these deaths were directly attributed to the CSDH, whilst the rest were attributed to other co-morbidities. Whilst the specific comorbidities were not identified in this study, the evidence does suggest a potential relationship between CSDH and future disease, and this conclusion is consistent with other evidence. According to existing literature, CSDH may lead to a marked decrease in physical health after injury and a subsequent increase in comorbid disorders such as sepsis, pneumonia, heart failure, renal failure, dementia and Alzheimer's disease, and ischemic heart disease (Amirjamshidi et al., 2007; Borger et al., 2012; Dakurah, Iddrissu, Wepeba, & Nuamah, 2005; Dumont et al., 2013; Manickam et al., 2016). A common objective of CSDH research is to also investigate recurrence rates and the re-accumulation of CSDH in patients after surgery.

A CSDH recurrence describes a complication of CSDH treatment whereby the patients experience a re-bleed, usually at the site of the original haematoma (Amirjamshidi et al., 2007; Jack et al., 2015). According to the literature, a recurrence is significantly associated with higher morbidity and mortality rates post-injury and a large section of CSDH literature aims to determine factors relevant to the re-accumulation of the haemorrhage. For instance, a study conducted by Amirjamshidi et al. (2007) observed recurrence in 12% (n=10) of CSDH patients (n=82) at 3-months post-operatively. Correspondingly, Lin et al. (2014) observed recurrence at six months in 14% of CSDH patients (n=44) treated with burr hole surgery. The disparity in assessment periods is a common trend in the literature, ranging from two days post-operatively, up to one year (Adeolu et al., 2012; Borger et al., 2012; Jack et al., 2015; Santarius et al., 2009; Shah et al., 2014; Tahsim-Oglou, Beseoglu, Hänggi, Stummer, & Steiger, 2012). Despite the variation in assessment periods, CSDH recurrence appears to be a significant predictor of outcome after CSDH and remains a clear focus of CSDH research.

Finally, CSDH research maintains a significant focus on mortality rates among patients after surgery. In fact, research investigating mortality after CSDH is the most commonly investigated post-operative indicator of outcome. Findings from this research provide significant support for the severity of this condition. For example, Asghar et al. (2002) demonstrated mortality in 13 (33%) of CSDH patients at six-months post-surgery. Bapat, Shapey, Toma, Platt, and Luoma (2017) demonstrated in-hospital mortality in 3 (0.06%) CSDH patients during the immediate post-operative period. However, a retrospective chart audit conducted by Dumont et al. (2013) indicated a linear relationship between age and mortality post-CSDH in patients (n=287). Findings indicate that mortality significantly increased with age, with deaths recorded in 55% of patients within a 14-year period.

These findings are further supported by a longitudinal retrospective study conducted by Manickam et al. (2016). The study aimed to investigate the long-term mortality rates of CSDH patients (n=155), and factors relevant to the cause of death. The results from this study provide further support for additional conclusions. Firstly, a steady increase in mortality was observed between six months - 5 years post-surgery, with deaths occurring in approximately 45% of CSDH patients. Secondly, elderly age was not considered a confounder in the long-term survival of CSDH patients. Findings indicated that the life expectancy of CSDH after injury was approximately 5.3 years, as opposed to 17.7 years for age-matched, healthy controls. Thirdly, the causes of death provide support for the argument that CSDH is a sentinel health event, leading to an overall reduction in physical health. According to the findings, the causes of death after CSDH treatment included sepsis or pneumonia (25.8%), ischemic heart disease (22.5%), heart failure (0.08%), renal failure (0.06%) and dementia or Alzheimer's disease (0.06%).

Existing evidence describing outcome after CSDH has yielded several important conclusions regarding health decline, recurrence, and mortality among patients. However, the use of the biomedical model to guide CSDH research has resulted in a significant lack of information describing the patient outcome. Existing research predominantly focuses on gross measures of outcome, such as morbidity, recurrence and mortality. Although significant to understanding disease, this approach fails to investigate the specific mechanisms that contribute to recovery and outcome after CSDH beyond disease or death. In fact, further examination of the literature indicates that during the past decade of research, approximately 89% of studies are preoccupied with only basic measures of outcome, whilst information

regarding long-term functional outcome, psychological or emotional outcome, or well-being post-injury is scarce.

3.3. Application of Seligman's Positive Health Framework to Outcome after Chronic Subdural Haematoma

As discussed in Chapter 2, Seligman's Positive Health framework consists of three health domains: biological, functional, and subjective positive health. The following section aims to align Seligman's Positive Health framework with existing CSDH literature to distinguish variables relevant to positive outcome post-injury. Less than twenty studies have empirically measured recovery after CSDH beyond a purely biomedical approach and currently, there are no existing studies that have investigated Positive Health among patients. Therefore, this chapter aims to identify potential Positive Health asset from the re-analysis of existing CSDH literature. A summary of Positive Health assets can be seen in Table 2.

3.3.1. Biological Positive Health and Chronic Subdural Haematoma

According to Seligman (2008; 2013), Biological Positive Health consists of those specifiable anatomical or physiological variables that foster adaptation to environmental changes, responses to illness, and recovery after disease, as discussed in Chapter 2 (Seligman, 2008; Seligman, et al. 2013). Although existing CSDH literature focuses on illness-oriented variables of recovery, existing research provides a potentially rich source of information relevant to positive biological variables post-CSDH.

A study conducted by Manickam et al. (2016) retrospectively investigated predictors of long-term survival among CSDH patients (n=155, 97 male, 58 female). The sample included a cohort of patients who underwent surgical intervention between 2006 and 2011, and the

follow-up maximum was 14.19 years. According to the findings, several risk factors of CSDH were identified including increased age, a history of falls, coagulation disorders, epilepsy, Ventriculoperitoneal (VP) shunt or lumbar drain, documented alcoholism or poor diet, seizures and most importantly, cerebral atrophy. Potential biological health assets can therefore be identified from existing literature discussing positive behaviours or characteristics that in turn, protect against the development of these conditions that are implicated in CSDH development.

For instance, literature describing the impact of increasing age on recovery after disease may yield important conclusions regarding the health of CSDH patients after injury. Existing evidence suggests that positive recovery among younger clinical patients may be due to an increase in a concept defined as, physiologic reserve. Mosqueda (2004) defines physiologic reserve as the buffer that allows individuals to cope with and recovery from stressors, including disease and illness. According to Mosqueda's model (2004), people reach their peak physiological reserve at approximately twenty-five years of age. Then, a reasonably predictable and consistent decline occurs over time. The steepness of this slope can be further impacted by injury, such as CSDH development.

The presence of such an injury hastens the progressive reduction of physiologic reserve. Therefore, those patients who are younger at the time of injury may possess a larger store of physiologic reserve in comparison to their older counterparts, resulting in a less steep and rapid decline in health after disease. As this effect has not yet been measured among CSDH patients, research is required to determine factors relevant to recovery after injury. In keeping with this method, several other potential variables have been identified in existing literature.

For instance, research indicates that a large proportion of CSDH may result from minor head trauma due to falls, with common causal factors being hypotension, or low blood

pressure, dementia or heart disease (Asghar et al., 2002; Borger et al., 2012; Szczygielski, Gund, Schwerdtfeger, Steudel, & Oertel, 2016; Yang et al., 2012). Hence, positive biological health assets relevant to prevention include ideal blood pressure targets to reduce risk of hypotension, protective proteins including kinase p38y protein that may protect against the development of dementia, and healthy lifestyle choices to reduce risk of heart disease, including non-smoking behaviour (Collins et al., 2010; De Strooper et al., 1995; Ittner et al., 2016; Jackson, Lynch, & Harper, 2006; Langlois, Rutland-Brown, & Wald, 2006).For instance, a study conducted by Berghauser Pont, Madders, Shouten, Lingsma and Dirven (2012) used a retrospective design to determine possible predictors of outcome of CSDH patients (N=496) treated with burr-hole craniotomy. Measures included patient demographics, previous medication, haematoma location, treatment characteristics in terms of surgical procedure, and laboratory values. According to the findings, CSDH development is far more common in males compared to females, indicating a ratio of 3:1. Although this study applies the disease-oriented biomedical model of health, a significant conclusion can be drawn. Findings suggest that males are at an increased risk of CSDH, however these findings also suggest that the female gender may represent a biological asset that protects against the development of this intracranial bleed. In keeping with this method, this chapter identifies several potential biological health assets relevant to outcome after CSDH.

Further to this evidence, literature also supports potentially protective health assets relevant to diet and pharmaceutical therapy (Baechli et al., 2004). An individual who has engaged in the healthy use of alcohol and an efficient, nutritional diet may be less likely to develop CSDH (Baechli et al., 2004; Manickam et al., 2016; Marshman et al., 2015). Further, individuals who not require the use of anticoagulant or antithrombotic therapy in the form of

medications such as Warfarin or Aspirin, are also less likely to experience a CSDH (Berghauser Pont et al., 2012; Borger et al., 2012; Marshman et al., 2015).

To summarise, biological health assets relevant to the prevention and successful recovery after CSDH may include; lower age, female gender, an ideal blood pressure ratio, efficient inflammatory system, and kinase p38y protein, a nutritional diet, low-risk alcohol behaviour, and reduced use of anticoagulant or antithrombotic medication. The inclusion of such factors in CSDH provides a potential opportunity to target these variables in at-risk patients to reduce the likelihood of future intracranial haemorrhage of this form. The following section aims to determine functional positive health assets that may be further implicated in a successful recovery after this sentinel health event.

3.3.2. Functional Positive Health and Chronic Subdural Haematoma

Functional indicators of positive health, as described by Seligman (2008; 2013) include factors relevant to optimal physical functioning and optimal role functioning of an individual. Optimal physical functioning includes exceptional sensory acuity such as vision, taste or hearing, exceptional motor performance and musculoskeletal function, and optimal functioning of central nervous system in the form of cognitive functioning. Likewise, positive role functioning describes the concept of *person-environment-fit* described in Chapter 2. This domain describes harmony between an individual's physical capabilities and the demands of their circumstances and lifestyle. Seligman (2013) also briefly indicates that optimal social integration may also be a predictor of positive health and physical well-being.

Literature discussing the functional health of CSDH patients is limited. There is currently only one known study that aims to measure positive functional recovery post-CSDH. Brand, Alber, Fladung, and Knauer (2014) aimed to investigate cognitive performance among

patients with varying forms of intracranial haemorrhage (CSDH patients, n=14, subarachnoid patients, n=60, intracranial haemorrhage patients, n=25). Measures of cognitive processing included the following: attention, concentration, processing speed, logical thinking, spatial construction, verbal learning and memory, and short-term visual memory. According to the analyses, those patients who demonstrated higher levels of concentration and word recognition post-injury, were also deemed to have a more successful recovery post-CSDH. Further to these conclusions, the evidence from this research also provides a comparison to other forms of acquired brain injury and a point of reference to better understand the functional capacity of CSDH patients. The performance of CSDH patients was compared to clinical groups consisting of patients who had sustained a trauma-related brain haemorrhage and the evidence suggests that CSDH patients may reflect similar deficits to patients with trauma, despite a history of trauma documented in only 40% of CSDH patients (Adhiyaman et al., 2002). This further demonstrates the need to better understand the differential recovery of cognitive functioning post-CSDH.

The relationship between cognitive functioning and recovery post-CSDH is further supported in the literature. Kawasaki et al. (2012) demonstrated a significant relationship between prospective memory and recovery after CSDH. The findings indicated that those patients that exhibited restored prospective memory during the early post-operative period (two-days post-surgery), also demonstrated features of a good recovery after injury as measured by reduced risk of morbidity and mortality. In agreement, Ishikawa et al. (2002) reported a potential association between general cognitive functioning and recovery after CSDH. Those with improved general cognitive functioning as measured by the Mini-Mental State Examination at two-weeks post-surgery, also demonstrated a more successful recovery as

measured by Activities of Daily Living (ADLs). Evidence for potential cognitive assets in promoting recovery among CSDH patients highlights the importance of cognitive processes including attention, memory and verbal reasoning (Brand, Alber, Fladung, & Knauer, 2014; Forster et al., 2010; Inagaki et al., 2003; Kawasaki et al., 2012; Maeshima et al., 2001; Maeshima, Okumura, Nakai, Itakura, & Komai, 1998; Tanaka et al., 1992; Ye, Kim, Kim, Cho, & Kim, 2008).

For *person-environment-fit*, there are currently no studies that directly assess or report this Positive Health domain among CSDH patients. To reiterate, *person-environment-fit* incorporate skills and tendencies that promote an optimal state of coping and adaptation to the stressors of one's environment (2008; 2013). This includes any assessment or inclusion of variables such as resilience, coping, problem solving, stress regulation, or behaviours directed towards an active return to a workplace or community. Whilst conclusions cannot be drawn from existing CSDH literature, evidence does suggest that the possession of such assets may buffer against disease development and, support recovery post-injury.

According to Thomése and Broese van Groenou (2006), *person-environment-fit* is particularly influential when considering adjustment to health decline among older adults. The argument provided by the research suggests that health decline and functional loss can strongly impact the well-being of individuals later in life, and may lead to depressive symptoms and a further decline in health. The study was conducted using data from the Longitudinal Aging Study Amsterdam (LASA) and included a nationally representative cohort of Netherlands residents (n=3,805, age range 55-85years). A series of self-report measures were provided to participants, including the Centre for Epidemiological Studies Depression Scale (CES-D), a self-report functional disabilities scale, a scale investigating *person-environment-fit* and

adaptations to their environment and health status. According to the findings, a relationship exists between *person-environment-fit* in the form of adaptations to health decline, and the presence of depressive symptoms. Those individuals who were able to positively adapt to their changing environment, also exhibited lower levels of depressive symptoms.

Based on this information, *person-environment-fit* may buffer against the negative effects of health decline among the elderly population and may therefore be implicated in the recovery of patients post-CSDH. However, due to the secondary nature of this evidence, it is suggested that future research directly investigate this relationship among the target sample in order to establish relevance among CSDH patients.

In keeping with Seligman's (2008; 2013) Positive Health framework, positive social integration represents the final domain of Functional Positive Health, which will now be discussed. Positive social integration is defined as the quantity and quality of one's interpersonal relationships and social relationships, perceived levels of social support from other, and membership in a diverse social network. According to Seligman (2013), greater social integration leads to greater longevity, less cognitive decline with aging, greater resistance to infectious disease, and improved outcomes with serious disease. Seligman (2013) briefly introduces the potential relationship between positive social integration and health.

Evidence indicates that the measurement of social variables occurs in one single study. Forster et al. (2010) assessed differences in traumatic versus atraumatic CSDH and included a psychosocial measure in the form of the Quality of Life (QoL) scale. According to the study findings, patients with the presence of more positive social relationships also exhibited higher levels of global functioning post-CSDH, subsequently supporting recovery post-injury.

To summarise, functional assets that combine to form a successful recovery post-CSDH may include, higher performance in concentration, word recognition, or prospective memory, in conjunction with more efficient adaptation to one's changing environment and the presence of positive social relationships. These variables represent the way in which an individual may function with and in their environment. During a period of ill-health as is experienced by CSDH patients, emotional reactions and perceptions of their changing environment may also play a causal role in determining their recovery. Therefore, variables relevant to Subjective Positive Health will now be discussed to further illustrate the many factors relevant to a positive recovery and potential targets for future research.

3.3.3. Subjective Positive Health and Chronic Subdural Haematoma

There is a significant lack of research investigating Subjective Positive Health among CSDH patients. Currently, only three known studies are shown to report measures of mental health among CSDH patients. A case study conducted by Inagaki et al. (Inagaki et al., 2003) reported significantly depressive symptomatology in a 55-year-old, CSDH patient post-injury. According to the information provided, the patient demonstrated depressive symptoms consistent with mental illness whilst also demonstrating other symptoms indicative of a poor outcome, including hallucinations and memory-loss. Interestingly, a second case-study reported the presence of depressive symptoms in a patient deemed to be exhibiting a poorer functional recovery after CSDH (Nagatomo, Ueyama, Fukuzako, & Matsumoto, 1990). These findings are further supported in information provided by a case-report depicting an elderly 82-year-old CSDH patient displaying clinical depression associated with cerebral haemorrhage (Elie, Primeau, & Cole, 1996).

Unsurprisingly, it is difficult to draw conclusions from this evidence due to the methodological approach. Single-case studies are limited in their capacity and provide information on usually abnormal or uncommon cases. Despite this, an underlying trend does exist. Based on evidence from these case-studies, it can be inferred that those patients who display a poorer recovery and experience adverse complications, also exhibit symptoms of depression. As depression does include variables related to psychological or emotional health, a potential association remains. Those who exhibit higher levels of psychological or emotional well-being, and lower levels of depressive symptoms may experience a reduction in adverse complications or morbidity post-CSDH. In agreement with previous recommendations, future research should incorporate variables relevant to Subjective Positive Health to distinguish the potential relevance in recovery post-CSDH.

Table 2

Summary of Positive Health Assets Identified in Existing CSDH Research

Summary of Biological Positive Health Assets

Author	Sample	Outcome Measures	Findings	Positive Health Asset
Berghauser, Pont, Madders, Shouten, Lingsma & Dirven, 2012	n=496 374 Male 122 Female	GCS	CSDH development significantly more common among males	Female Gender
Manickam, Marshman, & Johnston, 2016.	N=155 97 Male 58 Female	GCS	Risk factors of CSDH include history of falls, coagulation disorders, epilepsy,	Protein protein kinase p38y, non-smoking behavior, healthy alcohol-

			VP shunt or Lumbar drain, documented alcoholism, poor diet, seizure activity, and atrophy.	use, nutritional diet, absence of anticoagulation/ Antithrombotic therapy.

Summary of Functional Positive Health Assets

Author	Sample	Outcome Measures	Findings	Positive Health Asset
Brand, Alber, Fladung, & Knauer, 2014.	n=14 CSDH patients. 9 Males 5 Females	Test d2 PTS IST H-W IT VLRT Benton Test Trail-making test Revision test	Higher performance on concentration and word recognition tasks associated with improved outcome.	Concentration and word recognition cognitive processes.
Kawasaki et al. 2012	n=16 CSDH patients. 14 Males 2 Females	Rivermead Behavioural Memory Test	Higher performance on prospective memory tasks associated with improved acute recovery (2 days post-op).	Prospective memory
Ishikawa et al. 2002	n=26 21 Male 5 Female	MMSE	Higher general cognitive functioning at two-week post-surgery associated with higher performance on ADL measures.	General cognitive functioning, efficient attention, memory and verbal reasoning processes,
Thomese and Broese van Groenou, 2006	n=2,059 959 Male 1,098 Female	CES-D	Higher person-environment-fit associated with lower levels of depression and adjustment to health	Person-environment-fit and adaptation.

			decline among elderly.	
Forster et al. 2010	n=144	QoL Scale Barthel Index	Presence of positive social relationships associated with higher levels of global functioning post-CSDH.	Positive social relationships

Summary of Subjective Positive Health Assets

Author	Sample	Outcome Measures	Findings	Positive Health Asset
Inagaki et al. 2003	n=1 Male, 55years	Case study	Presence of depressive symptoms associated with poor outcome post-CSDH	Absence of depressive symptoms.
Nagamoto, Ueyama, Fukuzako, & Matsumoto, 1990	n=1 Male 82years	Case study	Presence of depressive symptoms associated with poor outcome post-CSDH	Absence of depressive symptoms.

Abbreviations: CSDH=chronic subdural haematoma, GCS=Glasgow Coma Scale, VP=ventriculoperitoneal shunt, MMSE=Mini Mental State Examination, PTS=Performance testing system, IST=Intelligence Structure Test, H-W IT=Hamburg-Wechsler Intelligence Test, VLRT=Verbal learning and retention test, ADL=Activities of Daily Living, CES-D= Epidemiologic Studies Depression Scale, QoL=Quality of Life Scale.

3.4. Conclusions and Future Direction

In summary, an analysis of the literature indicates several important and potentially causal variables relevant to a successful recovery post-CSDH. Findings indicate that those variables relevant to biological, functional, or subjective positive health may in fact, combine to illustrate a profile of a successful recovery after injury (see Table 2). If supported, these variables may represent empirical targets for future research aimed at determining the long-term recovery of CSDH patients. Furthermore, these variables may then serve as potential

targets for future intervention strategies to improve outcome after this cerebral crisis. Therefore, it is the intention of the first study to establish the first application of a Positive Health framework to the understanding of recovery after CSDH. The identified positive health assets will be assessed to distinguish their relevance to a successful recovery post-injury and establish whether they may be of use in empirical research focusing on outcome among CSDH patients.

Chapter 4: The Application of an Existing Positive Health Framework to Chronic Subdural Haematoma; a Retrospective Study

4.1. Introduction

There has been one main approach to the investigation of recovery after chronic subdural haematoma (CSDH): the biomedical approach considered in Chapter 2. Over 80% of studies published in the last decade have used a disease-oriented approach, resulting in a paucity of research investigating cognitive, functional or psychological recovery post-CSDH. Additionally, questions remain regarding the pathogenesis of the condition including the biological, functional or subjective factors that contribute to a successful recovery after injury (Santarius & Hutchinson, 2009). As a result, CSDH patients suffer from limited service delivery, a lack of long-term treatment options, and potentially negligent patient-care post-injury. This thesis argues that a theoretical framework of Positive Health provides a more efficient approach to the understanding of disease, as the positive assets identified by this research can directly inform future treatment strategies. Currently, no existing studies have considered an approach to CSDH from the perspective of Positive Health, despite the potential utility demonstrated in Chapter 2. This approach is critical for the development of future treatment strategies to improve outcome after CSDH.

The objective of this chapter is to determine the empirical utility of Seligman's Positive Health framework for use in CSDH research. Seligman's Positive Health framework was used to distinguish variables relevant to a successful outcome post-injury from existing literature. This information was used to inform a retrospective study to determine whether these variables combine to form a profile of positive recovery after CSDH.

4.2.1. Aims and Hypotheses

The overall objective of the first study was to use an existing Positive Health framework to distinguish health assets relevant to a successful outcome after CSDH. Specifically, the aim of this study was to understand the relationship between biological, functional or subjective positive health among patients and whether health assets identified in existing literature represent a successful recovery after CSDH.

This study used a retrospective between-groups factorial design. In conjunction with data from CSDH patients, a clinical-control group, and healthy age and gender matched control group was recruited. The clinical-control group consisted of patients with other forms of intracranial haemorrhage (see Table 2). Potential patients were identified by screening hospital medical records during the same period, using the same ICD-10 codes corresponding to traumatic subdural haemorrhage and subdural haemorrhage. Comparisons were also made to a healthy age- and gender-matched control group.

For within group differences, hypotheses are stated for biological, functional, and subjective variables relevant to a positive recovery after CSDH. For biological positive health, it was hypothesised that:

H1: It was predicted that those patients of female gender would demonstrate improved functional and subjective positive health.

H2: It was predicted that those with reduced aged at the time of injury would demonstrate improved functional and subjective positive health post-injury.

H3: It was predicted that those patients with a unilateral CSDH would demonstrate greater functional and subjective positive health post-intervention.

H4: It was hypothesised that patients who did not have anticoagulation disorders or who were not required to take prescribed anticoagulant or antithrombotic medications would also demonstrate optimal functional and subjective positive health.

For functional positive health, it was predicted that:

H5: patients who demonstrated higher cognitive performance on the Cognitive Telephone Screening Instrument (COGTEL) would demonstrate better outcomes post-injury.

H6: patients demonstrating higher levels of social well-being as measured on the Mental Health Continuum-Short Form (MHC-SF), would experience better outcome post-injury.

H7: those patients who demonstrated higher performance on daily activities as measured by the Functional Activities Questionnaire (FAQ), would also demonstrate better outcome post-CSDH.

For Subjective Positive Health, this study provides three hypotheses relevant to outcome post-CSDH.

H8: It was hypothesised that participants who exhibited higher levels of psychological well-being as measured by the MHC-SF would contribute to reduced risk of recurrence, morbidity, or mortality post-CSDH.

H9: It was hypothesised that participants who exhibited higher levels of emotional well-being as measured by the MHC-SF would contribute to reduced risk of recurrence, morbidity, or mortality post-CSDH.

H10: It was also predicted that reduced mental illness symptoms as measured by the Geriatric Depression Scale (GDS), would also contribute to a better outcome after injury.

For between-group comparisons, hypotheses are provided to predict the performance of CSDH patients when compared to clinical controls, and healthy age and gender matched control participants on measures of functional, and subjective health.

H11: Based on previous literature comparing CSDH patients to patients with other forms of ICH (Brand et al., 2014), CSDH patients were expected to exhibit similar performance to that observed among ICH clinical controls.

H12: For scores on the FAQ, COGTEL, and measures of social well-being, CSDH patients are expected to demonstrate similar performance as indicated by clinical control patients, however reduced performance when compared to healthy, age and gender matched controls.

H13: CSDH patients were expected to exhibit comparable subjective well-being to clinical controls, as measured by scores on the MHC-SF psychological well-being and emotional well-being. However, CSDH patients are expected to exhibit lower subjective well-being compared to healthy controls.

H14: CSDH patients and ICH are expected to exhibit comparable depressive symptomatology as measured by scores on the GDS, however CSDH patients are expected to report a higher frequency of depressive symptoms compared to healthy controls.

4.2. Method

4.2.1. Participants

A longitudinal retrospective study was conducted at The Townsville Hospital, North Queensland, Australia. Potential participants were identified by screening hospital medical records between the years of 2003 and 2011, using the ICD-10 codes S06.5 (traumatic subdural haemorrhage) and I62.0 (subdural haemorrhage). Potential participants were considered against the following inclusion criteria: confirmed diagnosis of a CSDH, aged 18 or over at the time of injury, English as a primary language, capacity to consent, and adequate hearing to participate in a telephone interview. A total of n=184 eligible participants were invited to participate, n=133 were excluded due to an inability to contact, or declined (n=55). Fifty-one CSDH patients were retained for the current analyses. Mean age at the time of assessment was 67.7±11.6 years (Range = 28-85). Thirty-seven males (67.3%) and fifteen females (27.7%). All patients underwent the same operative procedure and were treated with two burr holes with saline irrigation, combined with a subdural drain *in situ* for 24 - 48 hours.

A clinical-control group consisting of patients with other forms of intracranial haemorrhage were recruited for comparison. Patients with other forms of intracranial haemorrhage have been reported to exhibit poor health outcomes on the measures included in this research and have been included for the purposes of comparison to a brain injury sample (Brand et al., 2014). Potential patients were identified by screening hospital medical records during the same period, using the same ICD-10 codes corresponding to traumatic subdural haemorrhage and subdural haemorrhage, the distribution of diagnosis can be viewed in Table 3.

Table 3

ICH Clinical Control Group Distribution of Diagnosis

Diagnosis	Frequency	Sample (%)
ASDH	17	51.5
AEDH	2	6.1
TBI	12	36.4
Hydrocephalus	1	3.0
Stroke	1	3.0

N=33; Abbreviations; ASDH=acute subdural haematoma, AEDH=acute extradural haematoma, TBI=traumatic brain injury

A control group of aged-matched, healthy community dwelling adults was recruited via appropriate organisations and retirement villages, using snow-balling techniques and advertisement. Data corresponding to previous demographic information medical conditions, comorbidities at the time of injury, occupational and educational history, and social history were collected.

4.2.2. Measures

The allocation of measures within a particular Positive Health domain were based on a consideration of potential variables demonstrating successful recovery post-CSDH, as previously discussed in this chapter.

4.2.2.1. Assessment of Biological Positive Health

Biological Positive Health was assessed using a self-report demographic and medical history screen, in conjunction with previous medical history and clinical presentation information extracted from medical records using the integrated electronic Medical Record (ieMR) system under Queensland Health.

4.2.2.2. Assessment of Functional Positive Health

Three measures were selected to assess Functional Positive Health. Cognitive function was assessed using the Cognitive Telephone Screening Instrument (COGTEL) (Ihle, Gouveia, Gouveia, & Kliegel, 2017). Social functioning was measured using the Social Well-being subscale from the Mental Health Continuum-Short Form (Keyes, 2002), and functioning in activities of daily living was measured using the Functional Activities Questionnaire (FAQ) (Pfeffer, Kurosaki, Harrah Jr, Chance, & Filos, 1982).

The COGTEL is a telephone-adapted test battery that allows the detailed assessment of performance in six cognitive domains: prospective memory, short-term memory, long-term memory, working memory, verbal fluency, and inductive reasoning. The COGTEL is a brief screening tool for use in epidemiological and aging studies, and demonstrates high test re-test reliability for the six domains, as well as for the total score (Ihle et al., 2017). Previous research also indicates strong convergent validity between the COGTEL and Mini-Mental State Examination (Breitling et al., 2010; Kliegel, Martin, & Jäger, 2007).

Positive social functioning was assessed using the Social Well-being subscale from the Mental Health Continuum-Short Form (MHC-SF) (Keyes, 2002). The Mental Health Continuum-Short form is derived from the Mental Health Continuum-Long Form and aims to measure well-being using a 14-item self-report assessment (Keyes, 2007). The MHC-SF consists of three subscales measuring psychological well-being, emotional well-being, and social well-being. The MHC-SF uses a Likert-type rating scale with higher scores indicating higher levels of psychological, emotional, or social well-being. Overall, the MHC-SF demonstrates excellent psychometric properties, and the use of the individual subscales has been shown to be valid and reliable in cross-cultural studies and clinical populations (Lamers, Westerhof, Bohlmeijer, ten Klooster, & Keyes, 2011).

The Functional Activities Questionnaire (FAQ) (Pfeffer et al., 1982) is a social functioning scale for use with the elderly population. The FAQ is a self-report measure assessing four levels of functioning on ten activities. The four levels of functioning are arbitrarily weighted and resemble the following: dependent=3, requires assistance=2, has difficulty but does by self=1, never did=0, never did but could do now=0, and never did but would have difficulty doing now=1. Performance on the FAQ is calculated using the summed total score, with higher scores indicating poorer social functioning. The FAQ demonstrates excellent inter-rater reliability, high convergent validity with other relevant measures, and strong criterion-related evidence for its use as a measure of social functioning (Kojima et al., 2009; Pfeffer et al., 1982).

4.2.2.3. Assessment of Subjective Positive Health

Two measures were selected to measure subjective positive health among CSDH patients. Subjective well-being was measured using the Psychological well-being and Emotional Well-being subscales from the previously discussed Mental Health Continuum-Short Form (Keyes, 2002).

The absence of mental illness was measured using the 15-item Geriatric Depression Scale (GDS) (Brink, Yesavage, & Lum, 2013; Ishihara & Terada, 2011; Sheikh & Yesavage, 1986; Yesavage et al., 1982). The GDS is not a diagnostic tool, but rather a brief, clinical screening tool for depressive symptoms for use with the elderly population. The scale uses a 15-item dichotomous rating scale, 10-items indicate the presence of depressive symptoms when positively endorsed, 5-items are reversed indicating the presence of depressive symptoms when answered negatively (items 1,5,7,11,13), and an endorsed item indicates a weighting of 1. Performance is calculated by providing a summed total score. The GDS provides a

diagnostic summary, with total scores of 0-4 indicating normal functioning, scores of 5-8 indicate mild depression, scores of 9-11 are indicative of moderate depression, and scores of 12-15 indicate severe depression. The psychometric properties of the 15-item GDS is considered high, with construct validity and internal consistency demonstrated in cross-cultural samples, as well as among elderly community-dwelling populations (Friedman, Heisel, & Delavan, 2005; Sheikh & Yesavage, 1986; Yesavage et al., 1982).

4.2.3. Procedure

Ethical approval for the inception of the retrospective study was acquired in 2011 via a National Ethics Application Form (NEAF) process, see Appendix A. Following the completion of screening procedures, potential participants were sent a letter of invitation, study information sheet and participant consent form, see Appendix B. Patients received a follow-up phone call approximately seven days after the initial letter of invitation was sent. During the initial phone call, the nature of the study was explained and if permitting, informed consent was obtained. Upon consent, a phone interview was scheduled whereby participants completed a telephone-based assessment. For healthy controls, participants were recruited via engagement with community-based social groups and snowballing techniques. Control participants were provided with an information sheet and consent form and were contacted within three days of the initial contact. A phone-based interview was scheduled, and healthy controls completed the telephone-based assessment, excepting items relevant to a head injury, see Appendix C.

4.2.4. Statistical Analyses

Where missing data exceeded 5%, mean substitution was used. In mean substitution, the mean value of a variable is used in place of the missing data value for the same variable. This allows for the utilisation of data in an incomplete data set (Kang, 2013). The theoretical

background of the mean substitution is that the mean is a reasonable estimate for a randomly selected observation from a normal distribution. Mean substitution occurred for the COGTEL variables only. One-Way Analyses of Variance (ANOVA) were used to examine between-group differences for continuous variables. Post-hoc analyses were conducted for variables with more than two levels. Associations between nominal variables was measured using the Chi-square ($\chi 2$) test for indendence. In cases where associations between ordinal variables were assessed, the Chi-square ($\chi 2$) test for independence was applied and interpreted using a linear transformation. Assumption testing included the Shapiro-Wilk statistic, Levene's test for equality of variance, and Mauchly's test of sphericity. Where assumptions were violated, equal variances were not assumed for independent samples testing. For categorical variables, $\chi 2$ was not calculated when $n>5$. A significance level of $\alpha<.01$ was used for all statistical tests and the Bonferroni adjustment was applied for correction of multiple comparisons when equal variances were assumed, whilst the Games-Howell correction was used for unequal variances. Trends were identified by statistical significance at $1.0>\alpha<.05$. For calculations of effect size, Cohen's *d* was used for analyses containing an independent group with two levels or less, with small effect sizes ranging from .2 - .4, medium ranging from .5 - .7, and large effect sizes equal to .8 or above. For independent variables with more than two levels, effect size was calculated using Cohen's *f,* with small effect sizes ranging from .1 - .2, moderate ranging from .25 - .3, and large effect sizes equal to .4 or above. Observed power was also included to determine the likelihood of Type II error associated with the analyses. All statistical analyses were made using IBM SPSS software package V.25.0.

4.3. Results

4.3.1. Patient Sample Information

Demographics and medical characteristics are summarised in Table 4. CSDH participants were assessed at an average of 5.5±2.1 years post-injury. The average length of admission was 14.2±14.7 days. Bilateral CSDH occurred in 21.6% of patients.

Table 4

Retrospective Cohort Patient Characteristics and Clinical Information

Patient Information	CSDH	ICH	Controls
Demographic			
N	51	31	52
Gender (M/F)	34/17	23/10	36/16
Age (*M*±SD, Range)	67.7±14.78, 25-88	45.2±16.7, 24-79	71.0±9.12, 50-88
Clinical Information			
Admission days	14.23±14.77, 1-76	25.9±24.3, 1-97	
Time since injury	5.5±2.1, 2-10	5.8±2.04, 3-10	
Midline shift (mm)	5.4±4.01, 0-16		
CSDH width (mm)	14.2± 7.9, 5-28		
Discharge mRS			
No symptoms at all	7 (13.7%)	0 (0.00%)	
No significant disability	25 (49.0%)	4 (19.0%)	
Slight disability	12 (23.5%)	7 (33.3%)	
Moderate disability	4 (7.8%)	10 (47.6%)	
Moderate/Severe	0 (0.00%)	0 (0.00%)	
Severe disability	0 (0.00%)	0 (0.00%)	
Dead	0 (0.00%)	0 (0.00%)	
CSDH Position (n, %)			
Bilateral	11 (21.6%)		

Patient Information	CSDH	ICH	Controls
Unilateral (Left)	19 (37.3%)		
Unilateral (Right)	12 (23.5%)		

Abbreviations: M=male, F=female, *M*=mean, SD=standard deviation, CSDH=chronic subdural haematoma, ICH=intracranial haemorrhage, TOA=time of assessment, mRS=modified Rankin Scale; *Sig. level determined at p<.05*

For between-groups analysis, relevant descriptive information including patient group means, standard deviations, significance values, and measures of effect size are provided in Appendix D.

4.3.2. Biological Positive Health

4.3.2.1. Between-groups Comparisons

A chi-square test for goodness of fit indicated that CSDH patients have a significantly higher frequency of comorbid conditions compared to healthy controls (χ^2 2, N=86 = 35.47, p<.001) (see Table 5).

Table 5

Comorbidity Information of Participant Samples

Comorbidity	CSDH	Controls
Hypertension	13(26%)*	14 (33%)
Diabetes Mellitus II	8 (16%)*	3 (7%)
Atrial Fibrillation	6 (12%)*	1 (2%)
Ischemic Heart Disease	9 (18%)*	4 (9%)
Stroke	1(2%)*	0 (0%)
Dementia	1(2%)*	0 (0%)
Coagulation Disorders	2(4%)*	1 (2%)
Cancer	5(10%)*	2 (5%)

Clinical Depression	5 (10%)*	1 (2%)

N=51; * *indicates significance level p<.01*

A chi-square test for independence indicated that ICH patients exhibited a higher frequency of smoking behaviour compared to CSDH patients and healthy controls (χ^2 2, *N*=137 = 14.12, *p*=.001).

4.3.2.2. Within-Group Comparisons

The following section provides result relevant to within-group differences and a profile of recovery for CSDH participants. For correlational analyses included for within-groups comparisons, see Appendix E. For the effect of age, correlational analyses indicated a potential trend between those lower in age at the time of injury, exhibiting lower scores on the FAQ at the initial assessment *(r*=.296, *p*=.037) and lower total comorbidities (*r*=.369, *p*=.008). Further, a trend was observed for CSDH patients lower in age at the time of injury and performance on the psychological well-being subscale of the MHC-SF (*r*=-.305, *p*=.039). A significant negative correlation was observed for age and scores on the GDS (*r*=.377, *p*=.01), with younger patients exhibited reduced depressive symptomology.

For gender, significant differences were observed between male and female CSDH patients on scores for the mRS at discharge (χ^2 3, *N*=51 = 14.12, = 35.47, *p*=.003) with males demonstrating improved functioning compared to females. Results also indicated that males achieved higher performance on the FAQ ($F_{(1,50)}$=18.08, *p*=.001, *d'*=1.12, 1−β=.113). Further, analyses also indicate a significant difference for gender on the prospective memory ($F_{(1,1,37)}$=7.4, *p*=.01, *d'*=-.94, 1−β=.10), verbal long-term memory ($F_{(1,37)}$=.696, *p*=.01, *d'*=-1.45, 1−β=.10), and the COGTEL total score ($F_{(1,50)}$=14.52, *p<.001, d'*=-1.173, 1−β=.20). In all cases, male CSDH patients demonstrated improved performance compared to females.

A trend was observed for age on the verbal fluency ($F_{(1,37)}$=5.69, p=.022) and inductive reasoning ($F_{(1,37)}$=5.86, p=.02) subscales of the COGTEL, with a potential difference in performance associated with male gender, however these values did not reach statistical significance. No further gender differences were observed for Biological Positive Health.

Active smoking behavior at the time of injury was not found to contribute to the frequency of comorbid conditions at the time of assessment (*all p>.05).* However, smoking behaviour was observed to contribute to performance on the mRS, with non-smokers at the time of injury experiencing greater levels of functioning and reduced symptomatology (χ^2 3, N=47, =16.296, p=.001). Further, those who were considered non-smokers also demonstrated better performance on the working memory subscale of the COGTEL ($F_{(1,37)}$=8.618, p=.006, d'=-1.773, 1−β=.415), and scores on the social well-being subscale of the MHC-SF ($F_{(1,44)}$=10.05, p=.003, d'=-.638, 1−β=.742).

For alcohol-use, those individuals deemed to engage in high-risk alcohol behaviour also exhibited a significantly higher number of comorbidities at discharge ($F_{(1,48)}$=10.39, p=.001, d'=-.943, 1−β=.842). Alcohol-use was not found to contribute to performance on the mRS at discharge ($p>.05$) or at six months ($p>.05$). Several trends towards significance were identified for comparisons relevant to alcohol-use. A trend was observed for those individuals who engaged in low-risk alcohol-use and higher performance on the verbal long-term memory ($F_{(1,37)}$=4.32, p=.045, d'=-.732, 1−β=.10) and verbal fluency ($F_{(1,37)}$=4.12, p=.05, d'=-.27) subscales of the COGTEL, compared to those with high-risk alcohol behaviour. Further, a trend towards significance was also identified for measures of emotional well-being and depressive symptomology. Those patients with low-risk alcohol-use may also potentially demonstrate higher emotional well-being ($F_{(1,48)}$=6.45, p=.014, d'=-.784) and lower indicators of geriatric depression ($F_{(1,43)}$=5.23, $p<.05$), p=.027, d'=.65) at the time of assessment.

For descriptive information relevant to CSDH position, see Table 4. A significant main effect was observed for CSDH position and total number of comorbidities ($F_{(2,45)}$=5.53, p=.007, f'=2.76), with those patients with right CSDH experiencing significantly more comorbid conditions compared to patients with left and bilateral CSDH ($p<.01$). Further, a main effect was observed for CSDH position and scores on inductive reasoning ($F_{(2,35)}$=5.68, p=.007, f'=.477, 1−β=.10) subscales of the COGTEL, with individuals with a left hemispheric CSDH demonstrating significantly higher performance on the inductive reasoning subscale of the COGTEL compared to those patients with right-sided or bilateral CSDH ($p<.01$). A trend was observed for CSDH position and performance on the verbal long-term memory subscale of the COGTEL ($F_{(2,35)}$=3.45, p=.043, f'=.41, 1−β=1.0), indicating a potential association between left-sided CDSH and higher performance on verbal long-term memory.

Table 6

Mean Differences between CSDH Site and Functional Performance

Measure	Left-sided CSDH	Right-sided CSDH	Bilateral CSDH
n	n=14,	n=23	n=10
Total comorbidities	2.0±.96	2.82±1.07**	1.72±..90
mRS at Discharge	1.30±.83	1.26±.75	1.0±.47
FAQ Total Score	1.94±1.94	4.90±5.9	3.05±3.89
COGTEL			
Prospective Memory	3.20±3.79	2.19±3.80	4.80±3.7
VSTM	2.89±1.45	2.09±1.08	2.83±1.60
VLTM	3.6±1.35*	2.35±1.04	2.35±1.61
WM	5.24±2.56	5.57±1.70	4.67±1.55
VF	5.24±2.49	4.70±1.45	4.03±1.64
IR	7.37±2.40*	4.14±2.39	5.38±2.74
COGTEL Total Score	26.7±5.01	21.03±8.26	24.77±5.61

N=51, **indicates sig. at the level $p<.001$, *indicates sig. at the level $p<.01$.
Abbreviations: mRS=modified Rankin Score, FAQ=Functional Activities Questionnaire, COGTEL=Cognitive Telephone Screening Tool, VSTM=Verbal short-term memory, VLTM=Verbal long-term memory, WM=Working memory, VF=Verbal fluency, IR=Inductive reasoning.

A diagrammatic representation of biological health assets that were found to contribute to a successful recovery after CSDH is provided below (see Figure 4)

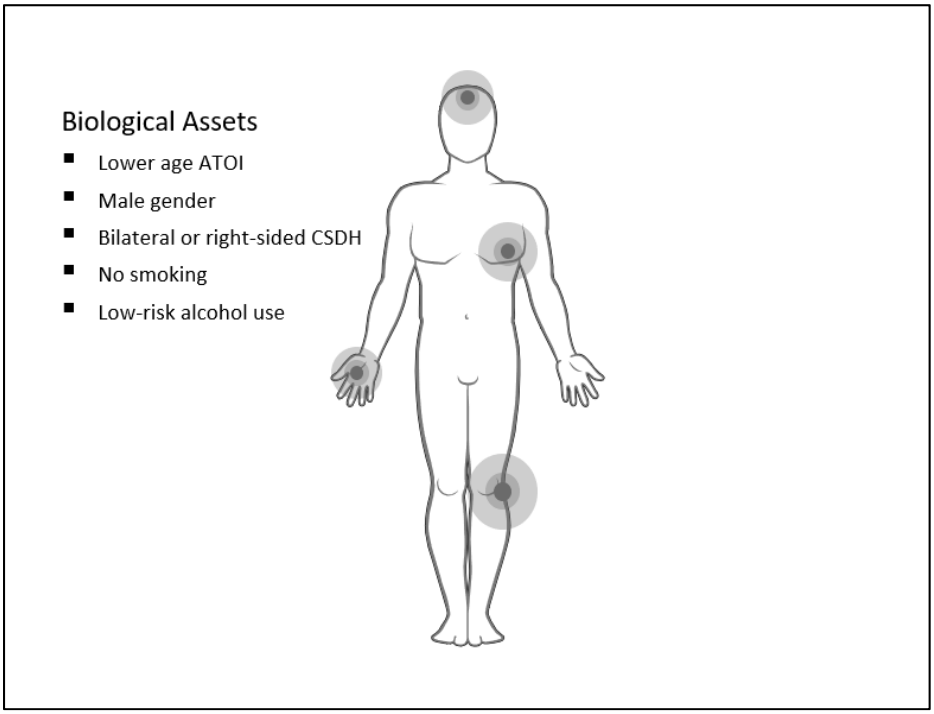

Figure 4 Biological Assets that Contribute to a Positive Recovery after CSDH

4.3.3. Functional Positive Health

4.3.3.1. Between-Group Comparisons

No significant differences were observed between patient and control groups on COGTEL performance (*all* $p>.05$). Significant differences were observed for performance on

the FAQ, with CSDH patients performing significantly worse compared to ICH patients and controls ($F_{(2,126)}$=8.46, p=.001, f'=.29, 1−β=.995). Group differences were also observed for scores on the social well-being subscale of the MHC-SF ($F_{(2,127)}$=14.32, p=.001, f'=.444, 1−β=.91),, whereby CSDH patients demonstrated the significantly reduced levels of social well-being, compared to controls (p=.002) (see Figure 5).

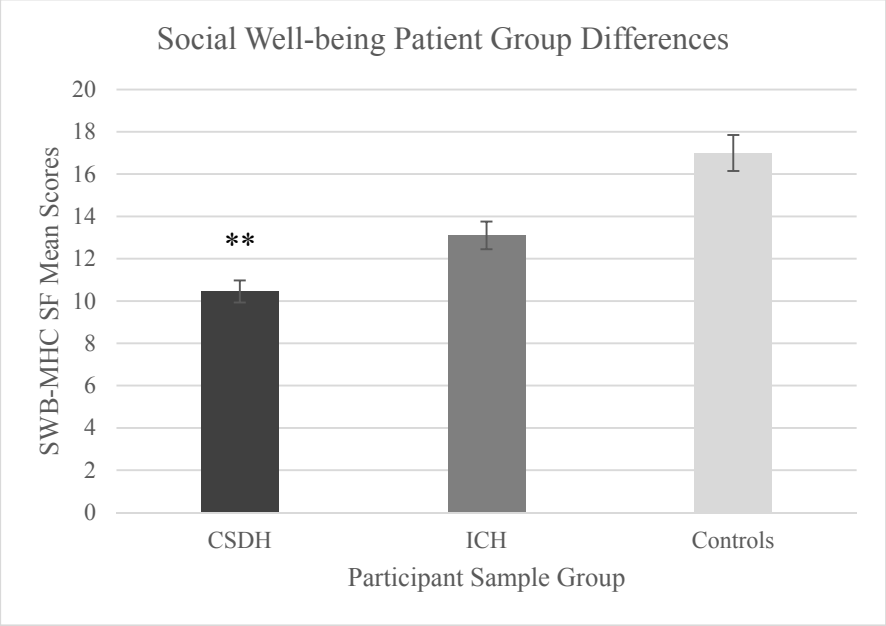

Figure 5 *Mean Scores for Social Well-being Subscale of the MHC-SF*
**Indicates sig. at the level p<.01. CSDH=chronic subdural haematoma, ICH=intracranial haemorrhage, SWB-MHC SF=Social Well-being subscale of the Mental Health Continuum Short Form

4.3.3.2. Within-Group Comparisons

For functional outcome at Time 1, main effects were identified for scores on the mRS and subscales scores on the COGTEL. A main effect was identified between scores on the mRS and performance on working memory ($F_{(3,32)}$=4.089, p=.01, f'=.56, 1−β=.80). Likewise, a main effect was observed between mRS scores and verbal fluency ($F_{(3,32)}$=5.563, p=.003, f'=.669, 1−β=.91) Further, a main effect was also observed between mRS at discharge and COGTEL

total scores ($F_{(3,32)}$=6.838, p=.001, f'=.716, 1−β=.96). In all instances, CSDH patients with lower scores on the mRS demonstrated higher performance on the working memory, verbal fluency, and inductive reasoning subscale scores of the COGTEL (*all* p<.01). A trend was observed for scores on the mRS and the inductive reasoning subscale of the COGTEL ($F_{(3,32)}$=3.503, p=.026, f'=.586), indicating a potential relationship between lower scores on the mRS and higher performance on inductive reasoning.

For performance on the COGTEL, a trend was observed between performance on prospective memory and the FAQ total score (r=-.366, p=.022), indicating a potential relationship between higher performance on the prospective memory subscale of the COGTEL and lower scores on the FAQ. Concurrently, a trend towards significance was also observed for verbal short-term memory, whereby higher scores may be associated with higher levels of emotional well-being as measured by the MHC-SF (r=-.331, p=.04). Additionally, a trend was also observed for higher performance on verbal short-term memory and reduced total comorbidities (r=-.330, p=.04). No significant relationships were observed for verbal long-term memory or working memory.

A significant negative correlation was observed between the COGTEL inductive reasoning subscale and total scores on the GDS (r=-.407, p=.01). Those patients with reduced performance on inductive reasoning also demonstrated higher depressive symptomology. A trend was observed between performance on the inductive reasoning subscale of the COGTEL and total scores on the FAQ, indicating a potential relationship between inductive reasoning and improved daily functioning (r=-.355, p=.027). Finally, total scores on the COGTEL were significantly associated with performance on the FAQ (r=-.431, p=.001), those patients with improved overall cognitive functioning also demonstrated improved functioning in daily activities. Likewise, a negative relationship was also observed between total scores on the

COGTEL and performance on the GDS with those patients with higher cognitive performance also less likely to exhibit depressive symptomology (r=-.420, p=.004).

For indicators of social integration, those patients with higher social well-being subscale scores also exhibited higher levels of emotional well-being (r=.534, p=.001) and psychological well-being (r=.369, p=.010) as measured by the MHC-SF. However, those with higher social well-being subscale scores also indicated a higher number of total comorbidities (r=.389, p=.006).

For *person-environment-fit*, higher performance on the FAQ was also associated with improved functioning on the verbal fluency subscale of the COGTEL (r=-.418, p=.008) and the COGTEL total score (r=-.431, p=.001). Trends towards significance were identified for prospective memory (r=-.366, p=.022) and inductive reasoning (r=-.355, p=.027). Further, a trend was also observed for scores on the FAQ indicating a potential relationship between better performance on the FAQ and higher levels of psychological well-being on the MHC-SF subscale (r=-.297, p=.040). For correlational analyses included for within-groups comparisons, see Appendix E.

A diagrammatic representation of cumulative health assets that were found to contribute to a successful recovery after CSDH is provided below (see Figure 6).

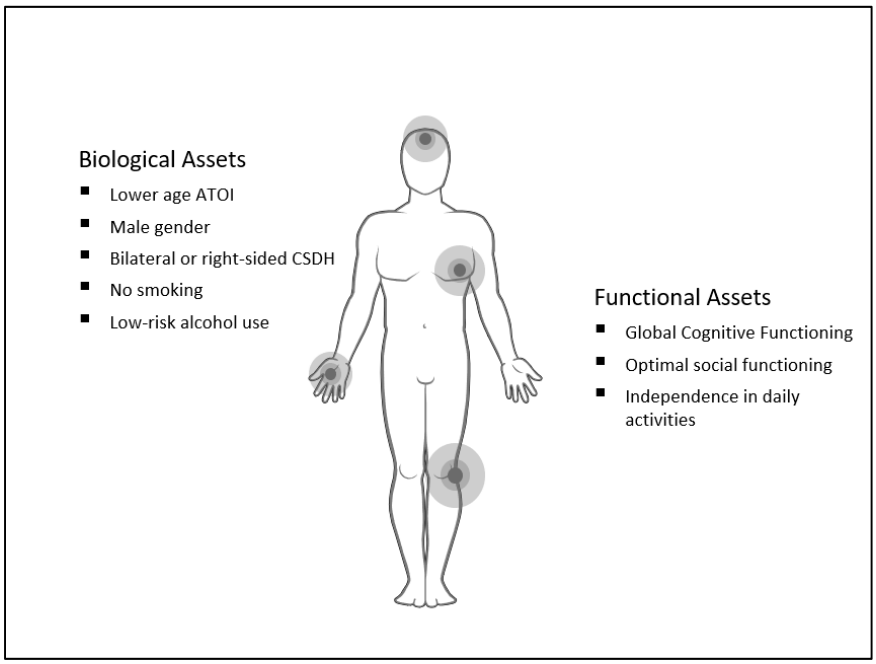

Figure 6 Biological and Functional Assets that Contribute to a Positive Recovery after CSDH

4.3.4. Subjective Positive Health

4.3.4.1. Between-Group Comparisons

Significant group differences were observed for all measures of Subjective Positive Health. First, a significant main effect was observed for emotional well-being ($F_{(2,129)}$=5.24, p=.006, f'=.289, 1−β=.633) and psychological well-being ($F_{(2,128)}$=4.84, p=.009, f'=.282, 1−β=.403) subscales of the MHC-SF, respectively. In both cases, ICH patients demonstrated reduced emotional well-being compared to controls (p<.001) and no significant differences were observed for CSDH patients. A significant main effect was also observed for total scores on the MHC-SF ($F_{(2,126)}$=10.51, p<.001, f'=.395, 1−β=.799), ICH patients (p<.001) and CSDH patients (p=.008) demonstrated significantly reduced total scores on the MHC-SF when compared to controls, respectively.

A significant main effect was observed for total scores on the GDS ($F_{(2,126)}$=9.05, p<.001, *f'=.394*), with higher levels of depressive symptomatology recorded among ICH (p<.001*)* and CSDH (p<.025*)* patients, respectively, (see Figure 7).

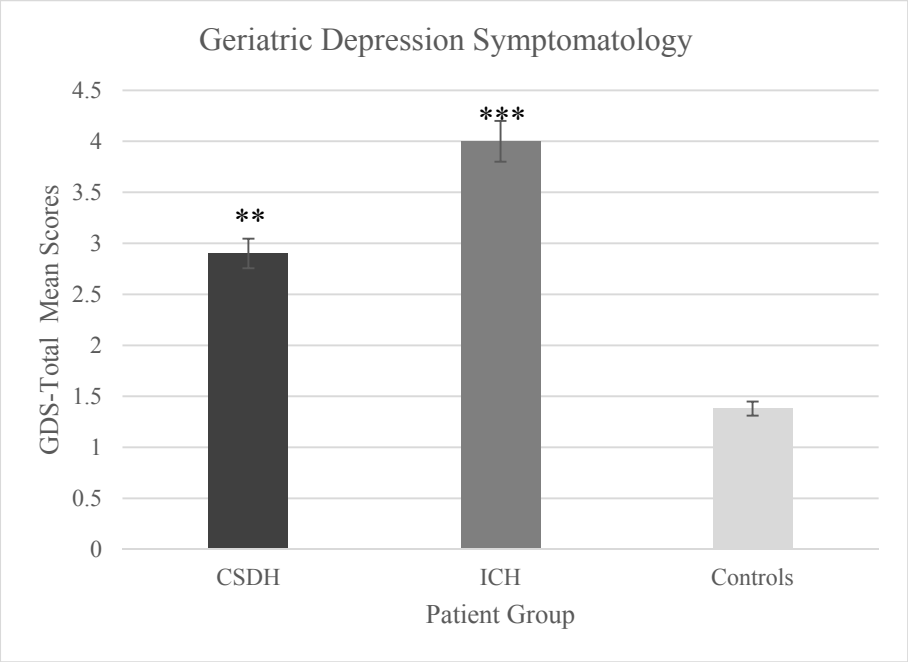

Figure 7 *Mean Scores for Geriatric Depression Scale*
**Indicates sig. at the level p<.01. ***Indicates sig. at the level p<.001.CSDH=chronic subdural haematoma, ICH=intracranial haemorrhage, GDS-Total=Geriatric Depression Scale Total Score

4.3.4.2. Within-Group Comparisons

For variables relevant to Subjective Positive Health, a trend towards significance was observed for higher scores on the Psychological Well-being subscale of the MHC-SF and lower scores on the FAQ for CSDH patients (r=-.297, p=.040). Whilst a significant positive correlation was observed between psychological well-being and emotional well-being. CSDH patients who demonstrated higher scores on Psychological Well-being also demonstrated higher performance on Social Well-being (r=.369, p=.010), Emotional Well-being (r=.38, p=.008), and the MHC total score (r=.829, p<.001). No other significant correlation or trends

towards significance were identified. For emotional well-being, those higher on Emotional Well-being also exhibited lower scores on the GDS (r=-.452, p=*.002*), demonstrating that those CSDH patients who exhibited higher levels of Emotional Well-being also demonstrated lower symptoms of depression. No other significant associations were observed for emotional well-being.

Finally, for depressive symptomology, those with lower total scores on the GDS, also exhibited higher total scores on the COGTEL (r=-.420, p=.004). No other significant associations were observed for scores on the GDS. For correlational analyses included for within-groups comparisons, see Appendix E. A diagrammatic representation of the health assets that were found to contribute to a successful recovery after CSDH is provided below (see Figure 8).

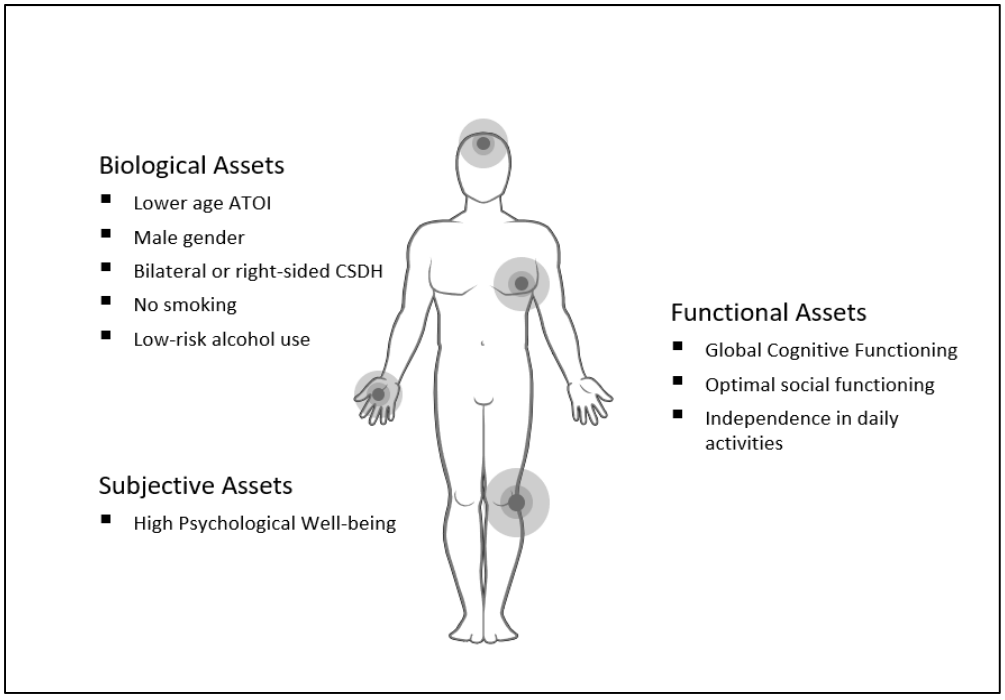

Figure 8 Positive Health Assets that Contribute to a Positive Recovery after CSDH

4.4. Discussion

This study used a Positive Health framework to better understand recovery after CSDH. The objective of this study was to understand the relationship between biological, functional or subjective positive health among patients and whether the potential health assets identified in existing literature represented a successful recovery after CSDH. Seligman's Positive Health framework provided the structure in which long-term recovery of CSDH patients was analysed, with comparisons made to healthy, age-matched controls. The following section provides a summary of the relevant variables extracted from the analyses, followed by a discussion of the implications of this research and future directions.

4.4.1. Outcome after CSDH

As the chapter has discussed, outcome after CSDH has long been considered favourable. The consequence of this assumption has resulted in a lack of cohesive long-term treatment options that aim to manage recovery post-injury. To better understand the progression of this disease and the health of patients post-intervention, this study measured the biological, functional, and subjective outcome of patients as they compared to a clinical-control, and healthy control group. The findings from this study demonstrate the disparity between current medical management of CSDH patients and the reality of recovery after this condition. As indicated by the results, CSDH patients demonstrate poorer outcome on measures of biological, functional and subjective health when compared to controls.

In conjunction with this evidence, the findings indicate that the functional recovery and subjective outcome of CSDH was significantly worse compared to ICH patients. This conclusion is noteworthy. The ICH patient group was a sample comprised of patients who

sustained a traumatic, acute injury caused by an external force such as blunt-force trauma, or contrecoup injury. Comparatively, CSDH patients rarely experience an injury of this severity and a significant proportion do not report a trauma that precipitated the haemorrhage. Therefore, CSDH patients not only demonstrate significantly impaired functioning up to seven years post-injury, but also experience symptoms that are comparable to patients who have sustained a significant and traumatic brain injury. Thus, contrary to current thought surrounding this condition, outcome after CSDH is not favourable and these patients represent a particularly vulnerable group that require management and long-term patient-centred care post-injury.

To adequately develop an efficacious intervention to address the needs of CSDH patients, it is first vital to understand the profile of a successful recovery to inform intervention targets. The following section discusses the positive health assets relevant to a positive recovery as they relate to biological, functional, and subjective positive health.

4.4.1.1. Biological Positive Health Assets in CSDH

For the relationship between age and outcome, lower age was expected to contribute to recovery and well-being (Adhiyaman et al., 2002; Adhiyaman et al., 2017; Asghar et al., 2002). Whilst existing evidence demonstrates a dramatic decline in health among older patients post-CSDH, the positive relationship between lower age and well-being has not been reported in this clinical sample. Findings from the current study support the influential relationship of age on outcome, with patients lower in age at the time of injury experiencing improved psychological well-being, lower levels of depression and comorbidities, and greater adaptation to their environment over time.

This evidence does suggest the potential impact of physiologic reserve, as previously discussed in this chapter (Mosqueda, 2004). The presence of lower age at the time of injury appears to protect against the overall reduction of health observed among older patients. The clinical relevance of this protective biological asset is most relevant to preclinical screening methods. Whilst there is no capacity for altering the age of an individual to improve outcome, this information enables the identification of at-risk patients and warrants the involvement of gerontology services to support patient recovery and improve outcome.

For gender, female gender was expected to contribute to a more successful recovery post-CSDH. The significant incidence of male bias has been consistently reported in the literature, however evidence for gender difference in patient outcome post-CSDH is limited. The current result was consistent with existing evidence, demonstrating that females were less likely to develop a CSDH (Marshman et al., 2015). However, females appeared to experience a poorer outcome post-CSDH. According to the findings, females experienced poorer functional and cognitive outcome after injury, indicating that whilst males are more likely to develop this condition, there may be protective factors in place that support recovery in comparison to females.

This gender difference is supported by existing recent evidence. A study conducted by Hotta, Sorimachi, Honda, and Matsumae (2017) investigated gender differences to determine more efficient preventative and therapeutic medical interventions for CSDH patients. Clinical factors and computer tomography (CT) findings were retrospectively analysed in a sample of consecutive patients diagnosed with CSDH (n=490). Although CSDH development was more common in men, impaired activities of daily living, consciousness disturbance, and mortality rates were more frequent among female patients. Women also demonstrated a lower alcohol

intake compared to men, but also demonstrated less frequent instances of good recovery. Multivariate analyses demonstrated that female gender was an independent predictor of consciousness disturbance at admission, as well as death at discharge (Hotta et al., 2017).

These results may be indicative of the overriding effect of age in recovery after CSDH. For the current study, the mean age of women with CSDH was 2.06years older than the male participants in this study. This seniority in female patients may be related to reduced recovery post-CSDH and further support the inclusion of reduced age as a health asset post-CSDH. As previously discussed, those younger in age are more likely to exhibit a more successful outcome, irrespective of other biological factors including gender.

For CSDH laterality, improved outcome was expected for those patients with unilateral haemorrhages. Significant deficits in functioning have been reported among patients with bilateral CSDHs (Mori & Maeda, 2001). However, the current result is consistent with findings reported by Gelabert-Gonzalez, Igelesias-Pais, Garcia-Allut, and Martinez-Rumbo (2005).

Additionally, there appears to be a relationship between the site of the CSDH and outcome after injury. Those patients with a right-sided CSDH were more likely to experience a higher frequency of comorbid conditions when compared to those with a left-sided or bilateral CSDH. Additionally, those patients with bilateral CSDH also demonstrated reduced morbidity post-injury, and patients with left hemispheric CSDH demonstrating improved verbal long-term memory after injury and reduced comorbid conditions post-CSDH. MacFarlane, Weerakkody, and Kathiravel (2009) report CSDH development to be more common in the left hemispheric and suggest misdiagnosis as a potential cause. However, limited information exists to document the site-specific outcome among CSDH patients and no information exists reporting the functional recovery of patients due to CSDH position. Moreover, the current

results describing improved verbal long-term memory and inductive reasoning in patients with left-sided CSDH are perplexing and inconsistent with existing evidence describing language function. The lateralisation of language function is well-documented in existing literature. There is significant evidence suggesting the dominant auditory-language pathways to be located in left temporal lobe of the brain (Parker et al., 2005). As such, patients with a left-sided CSDH would be expected to exhibit deficits in cognitive function particularly related to language. The current findings are inconsistent with this evidence and warrant further investigation including a more inclusive measure to adequately assess the relationship between CSDH laterality and language function. Hence, the findings from the current study greatly extend present knowledge regarding biological health assets and outcome specific to CSDH position.

These results have not been reported in existing literature. In fact, significant deficiencies in performance on verbal tasks have been reported in patients with left CSDHs (Tsai, Lieu, Hwang, Huang & Hwang, 2010).

Hypotheses corresponding to smoking and alcohol-misuse were supported. Those who abstained from smoking and engaged in healthy alcohol-use exhibited improved cognitive functioning, improved mental well-being, and reduced risk of morbidity post-injury. These findings are consistently reported in existing literature, indicating the protective qualities of healthy lifestyle behaviours in preventing CSDH, among other diseases (Okano, et al. 2014).

To summarise, health assets relevant to Biological Positive Health among CSDH patients include; reduced age at the time of injury, left hemispheric CSDHs, absence of smoking behavior, and healthy alcohol-use. Considering these health assets in outcome after injury, future management of CSDH should incorporate screening measures to identify at-risk

patients and develop interventions targeted at smoking cessation and healthy lifestyle behaviours.

4.4.1.2. Functional Positive Health Assets in CSDH

For functional performance post-CSDH, those patients with improved global functioning at discharge as measured by the modified Rankin Scale, also demonstrated improved cognitive performance on assessment and follow-up. This finding is consistent with existing literature reporting a relationship between baseline cognitive and neurological functioning, and outcome after injury (reference – baseline neurological condition).

Interestingly, the influence of positive social integration was less impactful than expected. The contribution of positive social relationships to recovery post-CSDH was limited, with relationships only observed between the remaining well-being measures. It could be argued that social well-being contributes to the recovery of CSDH patients via a residual contribution to overall well-being post-injury, however it appears that social well-being is less important in comparison to other functional assets.

A positive relationship was expected between higher performance on *person-environment-fit* and outcome after injury. The current findings supported this hypothesis, indicating that those patients who reported higher adaptation to their environment and improved daily functioning, also exhibited improved cognitive performance and higher levels of psychological well-being. These findings have not been reported in literature describing outcome after CSDH, however these observations are consistent with literature describing the potential benefits of *person-environment-fit* among the elderly population. According to Iwarsson (2005), higher *person-environment-fit* may protect against the frailty and loss of independence associated with aging. Those individuals who demonstrate an ability to adapt to

their environment and remain independent in their daily activities, also exhibit improved physical health and mental well-being.

Notwithstanding the potential benefits of these health assets to recovery after CSDH, patients demonstrated reduced performance compared to controls. To reiterate, CSDH patients were expected to exhibit similar cognitive performance compared to patients with other forms of ICH. This prediction was supported in the current findings, with CSDH patients displaying similar performance to ICH patients and despite improvements post-injury, the residual and ongoing effects of CSDH may be more severe than initially documented. This is particularly concerning as the performance of CSDH is comparable to patients who had previously sustained a trauma-related injury. This suggests that the atraumatic nature of CSDH is severely underestimated and should be considered alongside traumatic forms of brain injury. To summarise, baseline cognitive and neurological functioning, in conjunction with higher *person-environment-fit* may contribute to a successful recovery after CSDH. Social integration may be less vital to a successful recovery after injury.

4.4.1.3. Subjective Positive Health Assets in CSDH

For Subjective Positive Health assets, improved psychological well-being was expected to contribute to a successful recovery after CSDH. A significant relationship was observed, indicating that those patients higher in psychological well-being also demonstrated higher performance on *person-environment-fit*. This finding has not been reported among CSDH patients, however Iwarsson (2005) demonstrated the psychological benefits associated with higher *person-environment-fit* among the elderly. Therefore, psychological well-being may be the outcome of improved independence and functioning, rather than a predictive health asset among CSDH patients.

Finally, emotional well-being was expected to support recovery after CSDH, however a relationship was only observed between higher emotional well-being and lower indicators of depressive symptoms.

4.4.2. Implications for a Positive Recovery after Chronic Subdural Haematoma

The findings from this study are noteworthy. Previous research investigating recovery after CSDH is minimal and inconsistent. To date, limited information exists describing the cognitive, functional, or subjective outcome of patients post-CSDH and currently, there are no studies that investigate factors that may precipitate a successful outcome post-injury. The novel conclusions from the current study significantly increase the breadth of information describing outcome after this sentinel health event.

First, a successful recovery after CSDH may be highly contingent on the combination of biological or functional health assets, whilst subjective health assets may be less fundamental. According to the findings, lower age, absence of smoking behavior, presence of healthy alcohol-use, and optimal cardiac health may reduce the likelihood of developing CSDH. Whilst female gender was initially considered a protective health asset, findings indicate that female patients with increased age at the time of CSDH development may in fact, be at risk of poorer outcome.

Interestingly, the importance of subjective health assets appears to be less fundamental to recovery after CSDH than initially expected. Whilst mental well-being may residually support and cultivate recovery after injury, it appears that a restoration to functional or biological health may be more impactful to the overall outcome of patients. Specifically, *person-environment-fit* appears to be a highly impactful health asset that supports the physical

and mental resilience of patients after injury, whilst social integration is less paramount to a successful recovery.

4.4.3. Methodological Concerns

There are a number of methodological concerns that are pertinent to the results of this study. These include the boundaries of the methodological design, the limitations of cognitive screening tools, and sample composition. First, the use of Seligman's (2008; 2013) Positive Health framework to structurally organise health assets relevant to outcome after CSDH highlights the constraints and limitations of this approach in retrospective research. The application of this framework to a retrospective cohort resulted in a general, non-specific approach to identifying health assets relevant to CSDH. The variables available for inclusion into this framework included general health behaviours, such as non-smoking behaviour, nutritional diets, and functional independence, all of which are vital to recovery after many diseases. Therefore, these health assets are self-evident and do not completely encapsulate disease-specific variables that contribute to a successful recovery. The use of a prospective design to clearly identify disease-specific health assets relevant to outcome after CSDH should be an area of future research in order to clarify CSDH-specific variables for empirical research.

Second, the ability to detect cognitive dysfunction is dependent on the tests employed. This study used a theoretically derived cognitive screen to measure functioning post-injury, however the use of multiple measures for quantitative processes is recommended for the adequate assessment of cognitive functioning (Cohen, Swerdlik & Phillips, 1996). The use of telephone-based assessments in this study largely precluded the use of other cognitive assessments in this study and their use was further hindered by the cognitive capacity of patients for sustained attention. The utility of brief, telephone-based cognitive measures in

clinical groups needs to be addressed in future research with consideration for length and method of delivery.

Finally, there are a number of issues regarding sample sizes and composition. The sample used in the current study was small, and low power may have precluded the achievement of statistical significance on a number of tasks. Whilst efforts were made to recruit a homogenous sample of CSDH patients, the difficulties of a retrospective design in a clinical cohort have been previously noted. The sample used in this study may also have contributed to a potential increase in Type I error. The average assessment of patients in the current study occurred up to 5.5 years post-injury, indicating that these patients not only survived the condition but were also operating at a capacity to consent and be involved in the course of research.

According to a recent study investigating long-term survival post-CSDH, a linear increase in mortality rates is observed for CSDH patients up to 14.19 years, with deaths recorded in approximately 60% of patients (Manickam, Marshman & Johnston, 2016). Therefore, the sample recruited for this study not only represent the upper limit of patients deemed to have survived this condition, but also include those patients with the restored cognitive functioning and independence. Hence, the sample investigated in this study may represent a group differentiated by their successful recovery post-CSDH, with elevated performance compared to the wider population of CSDH patients. Given that existing evidence indicates a decline in overall health and independence after injury, future research should aim to prospectively assess a representative patient group from the period of discharge.

4.4.4. Conclusions

This study is unique in its use of a positive, theoretically driven approach to the understanding of recovery after CSDH. Seligman's Positive Health framework was used to identify health assets relevant to a successful recovery after CSDH. Conclusions from this study significantly extend what is known about recovery after CSDH and the vulnerability of this patient group. To accomplish this, this research identified health assets relevant to a successful recovery to better inform patient-centred interventions. Health assets relevant to biological and functional Positive Health were shown to be the most reliable indicators of a successful recovery after injury. The baseline neurological functioning of patients and restored independence in daily living promoted long-term outcome and further supported the mental well-being of patients. While the results should be cautiously interpreted due to the small and potentially optimal sample, the findings do indicate the benefits of a Positive Health approach to understanding recovery post-CSDH. By reliably identifying positive health assets relevant to a successful recovery, future research can focus on the development of preclinical screening tools and health interventions to better manage and support the long-term recovery of CSDH patients

Chapter 5: Toward a Novel Theoretical Framework of Positive Health

5.1. Introduction

A well-structured theoretical framework is critical for empirical research, the importance of which was demonstrated in Chapter 3. To evaluate a new theory of health, Seligman's Positive Health framework was applied to a retrospective sample of CSDH patients. The findings highlighted the consequences of a gross theoretical framework and further demonstrated the need for a well-structured theory and empirically-based framework. Based on the limitations discussed in Chapter 3, this chapter provides three recommendations for the structural development of a Positive Health framework, before proposing a novel theoretical framework of Positive Health. The recommendations will now be summarised.

First, to address the lack of theoretical structure in existing Positive Health frameworks, a systematic approach to the organisation of concepts and variables relevant to Positive Health is recommended. Similar to ideas discussed in Seeman's (1989) framework, human functioning is largely a product of systematic integration. Therefore, the conceptual organisation of a Positive Health theoretical framework should systematically organise and define human systems that contribute to effective disease recovery and prevention. Additionally, the approach to defining variables within these domains should be equally measured, with consideration for the practical application to research and clinical settings.

Second, to reduce the presence of ambiguity, lack of clear definitions, and lack of consensus in existing frameworks, it is recommended that consideration be given to the relationship between the theoretical structure of the framework, and its translation to empirical research and clinical application underpin framework development. Future Positive Health

frameworks should endeavour to provide standardised and concrete theoretical definitions that have the ability to translate into empirical research. Each Positive Health domain should be comprised of clearly defined and operationalised variables for use in empirical research thus reducing the ambiguity observed in existing Positive Health literature. This thesis will now outline the structure of the novel Positive Health framework, with supporting evidence provided. The framework will then be used to re-examine existing CSDH literature to determine the level of efficacy in health research.

5.1.1. A New Definition of Positive Health

Seeman (1989) defines Positive Health as a state of optimal functioning that arises from the positive integration of all human behavioural, physiological and functional subsystems. Similarly, Ryff, Singer and Dienberg Love (2004) state that Positive Health results from the effective functioning of multiple human systems, resulting in a state of flourishing and well-being (Ryff et al., 2004). In contrast, Seligman (2008; 2013) suggests a more real-world approach whereby Positive Health is defined as well-being beyond the mere absence of disease with the potential to increase longevity, reduce health costs, and improve mental health and prognosis. The existing definitions of Positive Health are indicative of the limitations and lack of consensus surrounding existing theoretical frameworks.

For instance, the theoretical frameworks developed by Seeman and Ryff, Singer and Dienberg Love explain Positive Health from a systematic and science-based perspective. Each human system and subsystem is methodically organised and concrete. The advantage of this methodical approach is that variables for empirical research are more easily identifiable and standardised. The obligation of this research-focused approach is that strong links need to be drawn between the empirical and practical applications to demonstrate the real-world efficacy

of the theoretical framework. However, Seeman and Ryff, Singer and Dienberg alike, fail to link their theoretical frameworks to practical outcomes within the health sector, including the real-world application to patient management, health costs, and health promotion.

In contrast, Seligman intrinsically links his Positive Health framework with practical health outcomes, including a reduction in health costs, clinical patient management and prognosis, and health promotion. Further, Seligman's Positive Health structure remains the only theoretical framework to be empirically tested in data relevant to clinical samples, as discussed in Chapter 3. The retrospective study conducted in Chapter 3 of this thesis highlighted the limitations of Seligman's Positive Health framework and further demonstrates the consequences that result from the use of a framework that lacks clarity, clear and methodical definitions, and limited specificity.

This thesis refines and extends existing ideas to define Positive Health as the successful functioning of human systems, resulting in a state of well-being beyond the absence of illness. Positive Health results from possession of biological, functional or subjective assets that promote successful recovery after disease, whilst reducing risk of future illness. The following section provides the structure of a novel Positive Health framework to better understand disease recovery and prevention. The following represents a structural organisation of the framework domains and supporting evidence is provided from existing health literature.

5.2. A Novel Theoretical Framework of Positive Health

This thesis proposes a framework of Positive Health that is constituted by the successful integration of three internal subsystems; a Biological subsystem, a Functional subsystem, and a Subjective subsystem (see Figure 9).

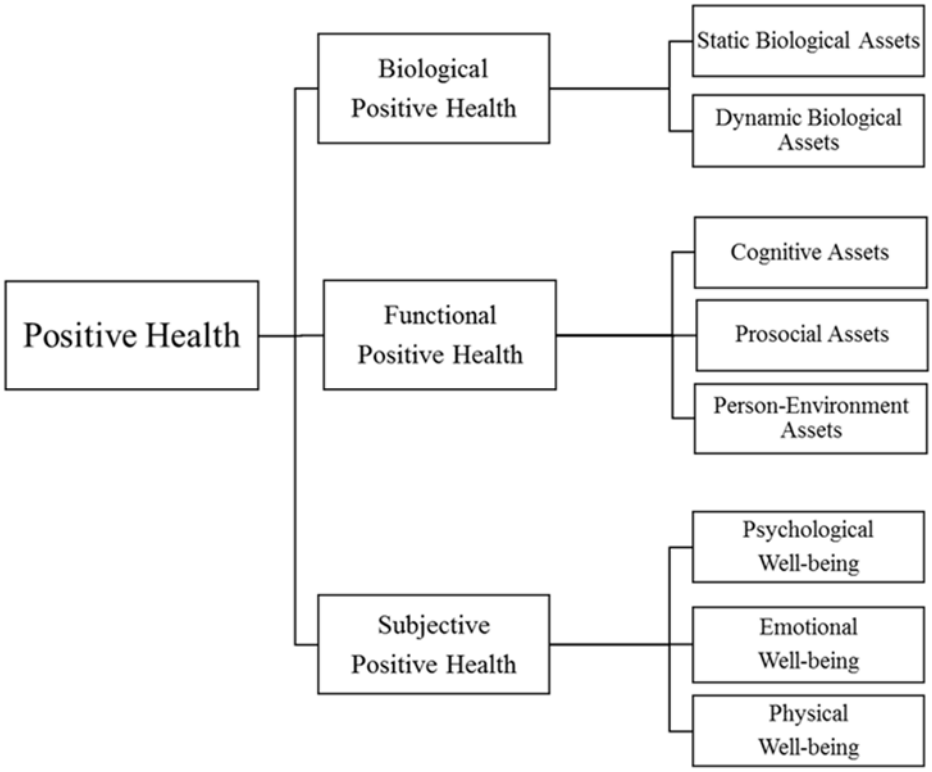

Figure 9 *Structure of the Proposed Theoretical Framework of Positive Health*

5.2.1. Biological Positive Health

Earlier Positive Health frameworks attempted to define Biological Positive Health. In Seeman's (1989) framework Biological Positive Health assets are divided into two subsystems: a Biochemical subsystem and Physiological subsystem. The positive integration of biochemical subsystems, such as the glucose or metabolic system, aid in inflammatory responses of the human body. The physiological subsystem is an extension of the biochemical system, and functions to support behaviour related to the physical health of the individual, including physical fitness and functional health. Contrary to this distinction, Seligman (2008) proposes a single Biological subsystem which is grossly organised into those positive biological parameters that are relevant to general health, and those that are disease-specific. This chapter

proposes a variation of these concepts, dividing Biological Positive Health into those variables that are static versus dynamic.

The support for this distinction between *static* and *dynamic* biological assets is underpinned by the theoretical debate of nature versus nurture (Plomin, 1994). The nature versus nurture argument debates whether human behaviour or functioning is determined by either genetic inheritance and biological factors (nature), or whether by an individual's environment (nurture). The novel positive health framework argues for the importance of both concepts in the understanding of health, whereby nature and nurture are not considered opposing concepts, but are equally important determinants of human functioning. Inherent biological characteristics and the influence of experience both combine to determine human functioning. Hence, these concepts both represent the two equivalent subsystems of Biological Positive Health.

The static variables of health represent the influence of nature, or biology. They are largely predetermined, biological factors that impact one's health. These static assets are factors relevant to genetics, heritability, or natural developmental progression, or are disease specific. *Static* refers to those protective biological parameters that are unlikely to change, such as sex, or genetic heritability (Breton, Breton, Labelle, Berthiaume, & Royer, 2012; Gao, Tao, He, & Song, 2015). In a disease-specific context, *static* health assets would be those physiological variables that protect against the development of disease and contribute to recovery after illness, for example, male or female sex (Seligman, 2008; Seligman et al., 2013).

Comparatively, *Dynamic* health assets represent the influence of nurture. The lifestyle, diet and level of physical fitness of an individual are a result of one's environment and are largely acquired behaviours or tendencies that are subject to change. Variables relevant to

dynamic assets may include lifestyle variables that are transient and subject to change, such as body mass index, nutritional health, heart rate variability, or pharmacological therapy (Cheung, Chan, Chan, Chau, & Li, 2010; Koethe, Jenkins, Shepherd, Stinnette, & Sterling, 2011; Malishkevich, Amram, Hacohen-Kleiman, Giladi, & Gozes, 2015; Silvia, Silvia, Jackson, & Sopko, 2014). This thesis will now provide evidence for each of the subsystems proposed to comprise Biological Positive Health.

5.2.1.1. Static Biological Assets

Evidence for the protective qualities of Static Biological Assets in health and recovery after disease is well supported in the literature. For example, research investigating outcome after malaria suggests that specific genes protect against mortality associated with the disease. Aidoo et al. (2002) found that the protective effects of sickle cell trait (HbAS) significantly contributed to a reduced risk of mortality associated with severe malarial anaemia and high-density parasitaemia.

Other examples of static biological assets may include gender, age and genetic structure at the molecular level (Breton et al., 2012; Christopher et al., 2017; Fuller-Iglesias, Sellars, & Antonucci, 2008; Ittner et al., 2016). Importantly, these variables do not solely predict human health or disease. Factors relevant to an individual's environment can largely impact the development of illness and disease, and the predicted success of recovery (Cassel, 1974). The following section aims to demonstrate the impact of such variables, labelled as dynamic biological assets.

5.2.1.2. Dynamic Biological Assets

Evidence for Dynamic Biological Assets is also well-supported in the health research. To reiterate, Dynamic Biological Assets are representative of the individual's environment and may include variables related to lifestyle, such as physical fitness or diet. These variables are heavily reliant on environmental factors of functioning and are considered highly mitigating factors during the course of disease and recovery.

For instance, a retrospective study conducted by Cheung and colleagues (2010) investigated the relationship between Body Mass Index (BMI) values and long-term outcome in patients after renal transplant surgery (N=131). The mean BMI of the sample at time of transplantation was 21.8 ± 4.0 kg/m2. One hundred and thirteen (86.3%) patients were classified as non-obese, and eighteen patients as obese (13.7%). Surprisingly and despite successful transplant procedures in all patients, the pre-surgery BMI of patients was shown to be a highly influential factor that determined graft loss and mortality in patients after transplantation. The evidence suggests that irrespective of the successful transplantation, those with higher BMIs were at a greater risk of transplant rejection or mortality. Comparatively, those who engaged in a healthy lifestyle and exhibited lower BMIs at the time of operation, experienced significantly increased rates of transplant success and good health post-surgery.

Evidence for the buffering effects of dynamic biological assets is consistently supported in the literature. Dynamic health assets such as good heart-rate variability, healthy diet, healthy weight, increased physical activity, and positive lifestyle behaviours such as abstaining from smoke or high-risk drinking behaviour, have been shown to reduce the risk of rheumatoid arthritis, cognitive decline, and prostate cancer (Aho & Heliövaara, 2004; Albinet et al., 2010; Cuzick et al., 2014).

Together, static and dynamic health assets combine to support the health of an individual across the lifespan. Static biological health assets provide the protective scaffold from which an individual may flourish in their environment, utilising their dynamic biological health assets to further protect against disease and aid in recovery after illness.

this thesis will now define the subsystem of Functional Positive Health. This domain of Positive Health represents the product of optimally functioning biological assets, and represents the perceptual, social and environmental functioning of the human being.

5.2.2. Functional Positive Health

As discussed in the previous section, evidence for the distinction of Biological Positive Health is well-supported in the literature, however the concept of Functional Positive Health remains particularly ambiguous and ill-defined.

Seeman (1989) does not include Functional Positive Health in his initial model of Positive Health, but rather divides the concept of function among three subsystems; Interpersonal-Ecological, Cognitive, and Perceptual. In contrast, Seligman (2008) provides a single Functional domain of Positive Health but the support for this domain is limited due to a lack of structure or clearly definable variables (Seligman, 2008; Seligman & Csikszentmihalyi, 2000).

To address these limitations, this thesis defines Functional Health as the successful integration of subdomains relevant for the effective functioning of an individual on a cognitive, social and environmental level. Functional Positive Health is supported by the possession of assets relevant to optimal cognitive functioning, successful social engagement and interaction, and person-environment fit. As such, this thesis proposes the organisation of Functional

Positive Health into three subdomains; Cognitive Assets, Prosocial Assets, and Person-Environment Assets.

5.2.2.1. Cognitive Assets

Cognitive assets are measured as mechanisms that support optimal cognitive functioning in attention, executive functioning, and memory. Optimal cognitive performance is reliant on optimal short and long-term memory functioning, optimal attentional shifting, and successful executive functioning. These variables combine to support the processing, capacity and problem solving of an individual. The benefits of high functioning cognitive processes include: greater abilities to problem-solve, more successful decision-making, greater social interaction, greater understanding of health and risk during times of illness, and more supported mental health due to emotional regulation (Boyle et al., 2013; Fredrickson, 2001; LePine, Colquitt, & Erez, 2000; Uchino et al., 2012; Weeks et al., 2014)

Evidence suggests that the possession of these functional assets not only protects against the development of disease, but aids in recovery after illness. Two studies conducted by Salovey, Stroud, Woolery and Epel (2002), examined the relationship between Perceived Emotional Intelligence (PEI) and psychophysiological measures of adaptive coping. The Trait Meta-Mood Scale was used to measure emotional intelligence in terms of the individuals' beliefs about attending to moods (attention), the clarity of their own experiences of mood (clarity), and their efforts to repair mood states (repair). Findings from the first study indicate a significant positive relationship between PEI and psychological and interpersonal functioning. Findings from the second study reinforced these results, indicating a significant positive relationship between PEI and adaptive psychological coping, attenuated cortisol release following repeated stress, and greater habituation to repeated stressors (Salovey et al., 2002).

The findings from each study support the role of optimal cognitive functioning in human adaptation and experience. Optimal perceived emotional intelligence was shown to significantly support positive psychological and interpersonal functioning. Moreover, individuals with higher perceived emotional intelligence were also deemed to be able to cope more successfully in response to stress with greater habituation to repeated stress. The findings not only suggest that aspects of optimal functioning significantly contribute to the mental health and social functioning of an individual, but also act as a buffer during periods of acute or chronic stress.

These findings are not limited to those processes which we are consciously aware of, such as perceived emotional intelligence. A more recent study identified a significant positive relationship between processing speed and functioning in everyday activities (Ball, Edwards, & Ross, 2007). Similarly, Lepine, Colquitt and Erez (2000) observed a significant association between information processing and successful decision-making.

Additionally, Weeks et al. (2014) investigated the relationship between childhood cognitive ability and future mental illness during adolescence, identifying those with greater cognitive ability during childhood exhibited lower levels of depression and anxiety during adolescence (Weeks et al., 2014). The optimal functioning of cognitive processes is the foundation for functioning in a wider context.

Cognitive assets are shown to protect against the development of long-term illness or psychopathology, and further support an individual's functioning in a social or environmental context, which will now be discussed. Similar to the findings observed by Salovey et al. (2002), optimal cognitive functioning and ability is shown to significantly contribute to the health of an individual. Greater cognitive ability during childhood appears to protect against

the development of mental illness in adolescence. Therefore, the impact of optimal cognitive functioning not only appears to buffer against the negative effects of stress and mental illness in acute periods, but also acts as a buffer against long-term mental illness and ill-health.

5.2.2.2. Prosocial Assets

Prosocial Assets are supported by cognitive functioning, leading to the hierarchical structure of Functional Positive Health. Prosocial Assets include socially directed skills and tendencies that promote mutually beneficial and prosperous interpersonal relationships. The foundation of Prosocial Assets as defined in this thesis, is supported by earlier conceptualisations of prosocial behaviour.

Prosocial behaviour as it was originally termed, describes the intent to benefit others and includes behaviours such as helping, cooperation, or volunteering (Dunn & Munn, 1986). Historically, prosocial behaviour was outwardly focused and was measured based on the behaviour of an individual in helping others. However more recently, prosocial behaviour has also been described using a more inward focus, suggesting that individuals possess prosocial tendencies that contribute to their behaviour. According to Penner, Dovidio, Piliavin, and Schroeder (2005), there are multiple levels to prosocial behaviour: the *meso* level which describes helper-recipient dyads in the context of a specific situation, the micro level which describes prosocial tendencies and the sources of variation in these tendencies, and the macro level with involves prosocial actions that occur within the context of groups and large organisations. The micro-level is the focus of the proposed novel Positive Health framework and describes the innate tendencies of an individual to seek and foster positive interpersonal relationships and social engagement. These tendencies, or assets, may include trait altruism,

social intelligence, or communication skills (Cunningham, 2011; Leaf et al., 2015; Stürmer & Snyder, 2010).

Research in the field of positive psychology provides evidence for the preventative, and rehabilitative nature of these Prosocial Assets. A study conducted by Das and Sharma (2015) investigated the relationship between altruism and stress during times of illness among rheumatoid arthritis patients. The study observed altruistic behaviour among these patients, despite suffering from the adverse symptoms. Those patients whom engaged in higher levels of altruism despite their illness, inherently experienced lower levels of personal stress and were in fact, less likely to be affected by the symptoms of their illness.

Caprara et al. (2014) observed similar findings in an intervention study aimed at promoting prosocial behaviour among middle-school students (n=324, 151 prosocial intervention, 173 controls). The intervention involved sensitisation to prosocial values, emotion regulation skills, perspective-taking skills, interpersonal-communication skills and civic engagement. Unsurprisingly, individuals who exhibited prosocial behaviour experienced lower levels of aggression during their adolescence. However, this intensity of this relationship across the lifespan was not expected. Not only did these individuals experience lower levels of aggression at the time of testing, but enhanced academic performance was documented throughout their schooling years, demonstrating a resounding and long-term benefit (Caprara et al., 2014).

The long-term benefits of Prosocial assets are a consistent theme in the literature. Prosocial assets are shown to support positive interpersonal relationships, positive emotions and future well-being (Stavrova, Stavrova, & Ehlebracht, 2015). For example, Stavrova et al. (2015) demonstrated that individuals who engage in more prosocial behaviour, such as altruism

or social engagement and involvement in social activities, were more likely to possess stable and fulfilling romantic relationships. Interestingly, this effect persisted even after accounting for individual differences in personality traits.

The robustness of Prosocial assets is further observed on a cellular level. A recent study investigated the effect of prosocial relationships on telomeres, an essential part of human cells (Uchino et al., 2012). Telomeres form the structures at the end of chromosomes that aid in promoting the stability of that chromosome, subsequently guarding against cell death (Cawthon, Smith, O'Brien, Sivatchenko, & Kerber, 2003; Uchino et al., 2012). Findings from this study indicate a significant relationship between social relationships and telomere length. Those individuals with ambivalent or negative social relationships were found to have significantly shortened telomeres, whereas, the existence of more positive social relationships did not significantly predict longer telomere length but rather protected against the shortening of these cells and subsequent cell death. These findings only further demonstrated the underestimated, yet significant impact of Prosocial assets in supporting longevity and good health.

The hierarchical nature of Functional Positive Health argues that these Prosocial assets result in a cascading effect, whereby these characteristics allow an individual to engage, interact and flourish in their environment. Therefore, Person-Environment assets will now be discussed.

5.2.2.3. Person-Environment-Fit

Finally, Person-Environment-Fit represents adaptation and resilience in one's own environment. This incorporates a balance between the capabilities of an individual, with the demands and requirements of their environment. For example, an individual would be

considered to have high person-environment-fit in their organisation, if their skills and competencies aligned appropriately with the requirements of their role and responsibilities.

Similar to the ideas put forth by Seeman (1989) and Seligman (2008), this thesis defines Person-Environment-Fit as the possession of skills and tendencies that promote an optimal state of coping and adaptation to the demands and requirements of their environment. Optimal functioning in this domain is the extent to which an individual may exhibit high levels of problem solving, stress regulation, and coping, as well as congruent ideologies with a prospective workplace or environment.

A recent study conducted by Chu (2014) provides an example of this domain and its benefits among female hospital workers. The study investigated the relationship between work stress and work-family balance, and the potentially mitigative effect of person-environment-fit. For the purposes of this study, person-environment-fit was operationalised as the congruence of needs, values and objectives between the individual and the organisation. Two significant findings emerged from this research. First, a significant relationship was demonstrated between levels of perceived stress and work-family conflict. Unsurprisingly, higher levels of perceived stress were significantly associated with more severe work-family conflict. The second finding provides a more interesting conclusion. Person-Environment functioning was shown to mediate the effect of perceived stress on work-family conflict, demonstrating that the more harmonious the relationship between an individual and their work environment, the more likely they were to experience reduced levels of stress, more positive personal relationships and higher levels of well-being in a wider context.

5.2.3. A Commentary on the Proposed Human Systems Approach

The functional domain of the proposed Positive Health model is representative of a 'systems' approach to health. Functioning in everyday life requires optimal interactions between cognitive processes, social functioning and person-environment adaptation. The functional domain of the proposed framework describes the way in which an individual may utilise inherent biological and personal assets to interact with the world around them. Each system is reliant on the other, and in turn, must all function to promote positive health. This further demonstrates the utility of a Positive Health framework over and above currently accepted 'disease' models of health.

In keeping with the systems approach to health, the next section outlines the final component of the novel theoretical framework. Our biology and functional capacity largely translate to our subjective experience of the world around us, and in turn, our subjective characteristics, traits and tendencies have the capacity to alter our behaviour, functional capacity and biological health. Therefore, the domain of Subjective Positive Health will now be outlined.

5.2.4. Subjective Positive Health

Existing definitions conceptualise Subjective Positive Health incorporating empirically measurable variables of subjective human experience. Currently, reference to Subjective Positive Health exists only in Seligman's (2008; Seligman et al., 2013) Positive Health framework, and is defined as high levels on sixteen variables related to psychological or emotional health. To reiterate, the limitations of Seligman's Subjective domain include a significant lack of theoretical structure and a lack of clearly definable and operationalised

terms, such as *a lack of bothersome symptoms*. The excessive number of variables included in this domain is also difficult to translate to health research and use with clinical patients. Furthermore, it is not clear whether the total amount of variables should be included under general Positive Health, or are they in fact, disease-specific. This thesis aims to address these limitations by providing theoretical structure and clearly operationalised terms to the domain of Subjective Positive Health.

This thesis defines Subjective Positive Health as the optimal integration of one's own psychological functioning, emotional functioning, and perceived physical well-being. Subjective Positive Health represents the positive mental functioning of an individual and includes an individual's perceptions and evaluations of their own lives and quality of their functioning within that life. Whilst the term Subjective Positive Health, is less documented in the literature, similar ideas are expressed in an existing concept, defined as *subjective* well-being. Subjective well-being describes people's cognitive and affective evaluations of their lives and this concept is well-documented in the literature. In general terms, subjective well-being largely encompasses the concept of happiness and living a good life (Diener, 2000). Similar to the traditional ideas of hedonia, subjective well-being argues for the importance of happiness, pleasure, and positive moods in leading a fulfilled life. Diener's (200) subjective well-being provides a hedonic aspect to the domain of Subject Positive Health included in the proposed Positive Health framework, however as previously mentioned, the importance of eudaimonic principles in well-being are of equal importance, and most recently referred to as psychological well-being.

As previously discussed in this thesis (Chapter 2), eudaimonia distinctly describes the concept of the 'good life', however the ideals are less concerned with the fleeting nature of

emotions and more concerned with the resonating sense of gratitude that comes with a sense of life purpose, personal growth, autonomy and environmental mastery (Deci & Ryan, 2008; Ryff, 1989a; Ryff & Keyes, 1995). Therefore, the conceptualisation of Subjective Positive Health is underpinned by both hedonic and eudaimonic principles.

To provide theoretical structure to the domain of Subjective Positive Health, this thesis adapts existing ideas from Ryff and Keyes (1995) and Seligman et al. (2013). The proposed subdomains of the Subjective Positive Health include, Psychological Well-being, Emotional Well-being, and Physical Well-being. The theoretical basis for these subdomains will now be deconstructed and evidence for their use in health research provided.

5.2.4.1. Psychological Well-being

The importance of eudaimonia principles in the development of a Positive Health model have been argued in this thesis. To reiterate, eudaimonia refers to the concept of the 'good life' which represents a sense of purpose, accomplishment and mastery. In it's current form, the good life is conceptualised as psychological well-being, consisting of positive relationships with others, personal mastery, autonomy, a feeling of purpose and meaning in life, and personal growth and development (Lindfors, Berntsson, & Lundberg, 2006; Reker & Wong, 1984; Ryff & Keyes, 1995).

According to Huppert (2009), the concept of functioning effectively involves the development of one's potential, a sense of mastery over one's life, having a sense of purpose and experiencing positive relationships. Interestingly, relationships have been drawn between these concepts and inherent personality traits, including extroversion and openness (Ryan & Deci, 2001), whereas Urry et al. (2004) suggest that psychological well-being may be linked to

activations in areas of the brain responsible for positive emotional styles, such as the prefrontal cortex.

To better understand the dynamics of Psychological well-being, Ryff and Keyes (1995; 1989b) developed a theoretical framework of Psychological Well-being that could facilitate the study of psychological wellness in health research. Using a factorial approach, Ryff and Keyes (1995) demonstrated several factors that combine to support Psychological Well-being in a large adult sample (n=1,108). According to the findings from this study, Psychological Well-being includes self-acceptance, environmental mastery, positive relations, purpose in life, personal growth and autonomy. Existing evidence suggests that these dimensions of psychological well-being are vital to one's own mental health and functioning within their environments, including those relevant to an individuals' work life, education, and social environment (Abbott et al.; Gasper & Clore, 2000; Marmot, Ryff, Bumpass, Shipley, & Marks, 1997).

Based on this evidence, this thesis proposes the subdomain of Psychological Well-being to be inclusive of the following variables: self-acceptance, environmental mastery, positive relations, purpose in life, personal growth, and autonomy. To better understand the relationship between Psychological Well-being factors and health, existing evidence and literature was assessed and critiqued.

The re-examination of health research yielded several interesting conclusions for the rehabilitative and protective nature of Psychological Well-being.

A hallmark study conducted by Danner, Snowdon, and Friesen (2001) demonstrate the relationship between psychological well-being and longevity among a sample of nuns belonging to the School Sisters of Notre Dame. The 'Nun Study' as it is titled, was a

longitudinal study of aging and Azheimer's disease among previous sisters of the American School Sisters of Notre Dame (n=678). The study was a retrospective qualitative study, analysing the handwritten autobiographies completed by each nun during their time in the convent from the period between 1930 and 2000. After the process of coding, relationships were analysed between factors of psychological well-being expressed in autobiographies and measures of longevity including life expectancy and mortality. Significant findings indicated that those nuns who expressed content relevant to life satisfaction, positive mood, and psychological well-being, had increased rates of survival compared to those nuns who did not report experiencing factors relevant to psychological well-being. The findings from this study are significant and further demonstrate the impact of psychological well-being on survival and health.

The relationship between psychological well-being and health is consistent throughout the literature. Brown (2010) demonstrated the protective quality of self-esteem in buffering the negative emotions associated with rejection and negative feedback. Whilst, Charlson et al. (2014) demonstrated the importance of self-affirmation in improving behavioural compliance in patients with chronic cardiopulmonary disease. There is also evidence to suggest a significant positive relationship between autonomy, confidence. The inclusion of Psychological Well-being under the domain of Subjective Positive Health is vital. As can be inferred from the literary evidence, Psychological Well-being demonstrates mediating, moderating and preventative qualities that promote recovery after illness whilst protecting against the development of future disease.

In keeping with the human systems approach to Positive Health, there is a notable relationship between psychological well-being and emotional well-being. The residual effects

of psychological well-being incur the experience of emotional well-being, and vice versa. Therefore, the subdomain of Emotional Well-being will be discussed with supporting evidence from current health research.

5.2.4.2. Emotional Well-being

Emotional Well-being represents the hedonistic approach to Positive Health. This traditionalist view of well-being is included in contemporary thought surrounding Positive Health and is termed, Emotional Well-being. Emotional Well-being refers to the experience of positive emotions, or *positive affect,* to support the well-being of an individual (Kahneman & Deaton, 2010). The experience of these emotions can either be relatively dispositional in the form of positive emotional style, or transient and fleeting.

Firstly, positive emotional styles refer to the tendency to consistently experience positive emotions across the lifespan, such as vigour, happiness, calmness, life satisfaction or optimism (Cohen, Doyle, Turner, Alper, & Skoner, 2003; Cohen & Pressman, 2006; Keyes, 2002; Keyes et al., 2003). The positive relationship between positive emotional styles, and well-being and physical health is consistently demonstrated in the literature. For example, a study conducted by Scheier et al. (1989) investigated the relationship between dispositional optimism and recovery after cardiovascular disease. Dispositional optimism as assessed prior to surgery, proved to be a powerful predictor in recovery after a major cardiac event. Higher levels of dispositional optimism was not only associated with adaptive coping and problem-solving post-surgery but was also predictive of a faster rate of physical recovery in the post-operative period. Additionally, higher dispositional optimism also predicted a faster return to functional capacity and everyday activities, whilst also resulting in improved long-term quality of life at six months post-surgery.

Correspondingly, Łopuszańska, Szklarska, Lipowicz, Jankowska, and Kozieł (2013) demonstrate the buffering effect of life satisfaction on future cardiac health. A retrospective study was conducted with a sample of Polish adults from the general population (n=1080, M 489, F 591) to determine the relationship between life satisfaction scores, as measured by the Self-Anchoring Self-Esteem Scale, and risk factors indicative of future cardiac illness. Participants were assessed for a period of five years and risk factors for future cardiac risk included total cholesterol (TCH), low-density-lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C) and triglycerides (TG). Those participants with low life satisfaction on the initial assessment, experienced increased risk of cardiac disease, regardless of sex. Whilst those patients with higher life satisfaction demonstrated reduced risk of future cardiac illness and cardiovascular disease. The importance of factors relevant to emotional well-being is clearly demonstrated in the literature. Those who experience greater life satisfaction and demonstrate consistent positive emotional styles are more likely to recover successfully after stroke, are less likely to develop clinically diagnosed mental illness, and are at reduced risk of developing cardiovascular disease (Charlson et al., 2014; Fredrickson & Levenson, 1998; Ostir, Berges, Ottenbacher, Graham, & Ottenbacher, 2008; Thompson et al., 2013).

Fredrickson (2004) argues for the potential benefits of more fleeting positive emotions, stating that the experience of short, momentary positive emotions can equally contribute to an individual's well-being. According to Fredrickson (2004) there are ten core positive emotions that occur on a temporary basis. These include love, joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, and awe. The frequency of these positive emotions, however

brief, significantly contributes to the overall well-being and emotional resilience of an individual (Cohn et al., 2009; Fredrickson et al., 2003; Fredrickson & Joiner, 2002).

This benefit refers to the reciprocal relationship, termed the *broaden-and-build theory of positive emotions.* According to Fredrickson (2004), the brief experience of positive emotions momentarily broadens a person's thought-action processes. During states of joy, interest or love, an individual is more likely to engage in successful decision-making processes and rational action, as opposed to the restricted and anxiety-driven thought processes that may incur from the experience of negative emotions, such as despair. In turn, this broadening mindset functions to build the personal resources of an individual, such as physical or intellectual resources, or emotional resources such as resilience (Fredrickson, 2004; Fredrickson & Levenson, 1998; Fredrickson et al., 2003; Fredrickson, 2001; Fredrickson & Joiner, 2002).

This relationship has been demonstrated in research investigating determinants of life satisfaction (Cohn et al., 2009), physical health (Kok et al., 2013), and during periods of crisis or illness (Fredrickson & Levenson, 1998; Fredrickson et al., 2003). To demonstrate the concept of fleeting positive emotions, Cohn et al. (2009) explored the potential relationship between daily positive emotions and life satisfaction in a sample of University of California students (n=86, 35 male, 51 female). The study examined the frequency of positive emotions using a daily emotions diary. Interestingly, those individuals who experienced a higher frequency of fleeting positive emotions throughout their day, were more satisfied with life. Conclusions drawn from this research indicated that the high frequency of positive emotions supports the internal resources such as resilience, significantly contributing to one's life satisfaction.

To summarise, two important components combine to support Emotional Well-being among individuals. First, the consistent tendency to experience and engage in positive emotional styles significantly supports intrinsic emotional well-being. Second, a higher frequency of brief positive emotions further supports an individual in building personal resources, such as resilience, physical and intellectual resources. In addition, this evidence only further reiterates the inherent relationship between mental well-being and physical health.

Based on this evidence, this thesis proposes the subdomain of Emotional Well-being as it contributes to Subjective Positive Health. Emotional well-being includes the predisposition to positive emotional styles, such as happiness, vigour, calmness, and life satisfaction. Emotional Well-being is further supported by a high frequency of brief positive emotions, including; love, joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, and awe.

Until this point, the discussion of Subjective Well-being has largely related to the possession of psychological or emotional styles. Subjective Well-being has been discussed in terms of an individual's thoughts, feelings and emotions. However, mental health and physical functioning should not be considered independently (Damasio, 2006). The following section describes the subdomain of Physical Well-being. A term used to describe an individual's subjective understanding of their own physical capabilities and physical functioning.

5.2.4.3. Physical Well-being

Throughout the literature, there appears to be a clear divide between the experience of biological functioning, and the conscious experience of thoughts, feelings and emotions. Although we now understand the relationship between our mental and physical health, there remains a gap in knowledge. What is less explored, is the relationship that we consciously share with our physical selves. The concept of Physical Well-being was first developed by

Reker and Wong (1984), suggesting that overall well-being is strengthened by the positive relationship that one shares with one's own body. In the many variables put forth by Seligman (2008) in his Subjective domain of Positive Health, particular reference is made to what can now be defined as, Physical Well-being. According to Seligman, the subjective experience of Positive Health and Physical Well-being encompasses several interdependent, yet unique, dimensions: (a) an overall sense of physical and global satisfaction with one's health and physical capacities; (b) a positive appreciation and sense of satisfaction and pleasure in one's physical capabilities; and (c) a sense of physical security.

Research in this domain of Positive Health is particularly limited, however there is evidence to suggest a positive relationship between perceived physical well-being and overall health. An early study conducted by Dickie, Ludwig and Blauw (1979), explored the relationship between perceived physical health, activity levels and future orientation with life satisfaction among a sample of clinically-diagnosed psychiatric patients (n=30, Controls=32). According to the findings, there was a significant relationship between perceived health status and life satisfaction. Those participants who demonstrated higher levels of perceived physical health, also conveyed higher levels of life satisfaction, irrespective of participant group.

Based on conclusions from existing literature and potential evidentiary support from health literature, this thesis defined Physical Well-being as the perceived confidence in one's own body. The variables include: (a) satisfaction with physical health; (b) pleasure regarding one's physical capabilities; and (c) perceived physical security in response to illness, disease or impairment. Similar to other domains, this thesis proposes a hierarchical approach to these variables.

This thesis argues that a baseline perception of satisfaction with one's physical health is the foundation from which Physical Well-being may flourish. This level of satisfaction represents contentment with one's own body and presumes an absence of worrisome symptoms or physical ailments. It is only with a level of perceived satisfaction, can one experience pleasure. The pleasure in one's physical capabilities describes this state beyond neutrality, in which a person experiences pleasure and pride in their own abilities. The experience of both satisfaction and pleasure, combine to support a level of perceived physical security, or the confidence that in periods of illness, one's own physical resilience will prevail.

5.3. A Novel Theoretical Framework of Positive Health: A Summary

To summarise, this thesis proposes a novel framework of Positive Health to better understand disease recovery, and future wellness. This thesis proposes a hierarchical systems approach to Positive Health, whereby Positive Health is organised into Biological, Functional and Subjective domains (see Figure 9). Each domain is organised into subdomains indicative of a hierarchical structure.

Biological Positive Health is defined as the optimal integration between static and dynamic physiological variables. Biological Positive Health results from possession of static biological assets that protect against the development of disease or ailment, such as protective genes; and the optimal functioning of dynamic biological assets considered relevant to the overall health and well-being of the individual, such as diet or body mass index.

Functional Positive Health is the successful integration of subdomains relevant for the cognitive, social, and environmental functioning of an individual. Functional Positive Health is supported by the possession of assets relevant to optimal cognitive functioning, such as high

processing speed; prosocial assets, such as social engagement; and assets relevant to person-environment fit.

Subjective Positive Health is defined as the optimal integration of one's own psychological well-being, emotional well-being, and perceived physical well-being. Assets relevant to Psychological Well-being may include, optimism or self-efficacy. Emotional Well-being includes a high frequency of briefly experienced positive emotions, or positive emotional styles, and Physical Well-being describes perceived satisfaction, pleasure and security with one's own physical capabilities.

The purpose of this thesis is to develop a novel theoretical framework of Positive Health to better understand recovery and outcome after disease. Therefore, it is imperative that the novel theoretical framework be applied to existing literature in clinical populations to determine efficacy and usefulness. Therefore, this thesis will now apply the proposed novel framework of Positive Health to a vulnerable clinical population of chronic subdural haematoma patients. Currently, chronic subdural haematoma patients represent a clinical population marked by limited research or information regarding recovery, outcome or health post-injury. Therefore, these patients represent a potentially rich data source to test the efficacy of this framework, with the intention of improving future patient care and management.

This thesis will now define, describe and discuss the pathogenesis of chronic subdural haematoma; the patient population characteristics, risk factors and assumed patient outcomes. Existing research and limitations will be critiqued, and the novel Positive Health framework will be applied to understand potential assets relevant to patient recovery and well-being.

5.4. Application of the Proposed Positive Health Framework to Recovery after Chronic Subdural Haematoma

Chronic subdural haematoma was once considered a non-threatening event with favourable outcomes after surgical intervention, a concept discussed in Chapter 2. However, as literary evidence and the findings from Chapter 3 suggest, CSDH leads to a marked reduction in overall health and well-being after injury. As such, CSDH patients represent a vulnerable patient-group that require therapeutic intervention guided by factors known to support a successful outcome. Despite this inherent need for patient-centred care, there is a paucity of treatment options for CSDH patients and there is limited knowledge surrounding what constitutes a successful outcome.

The conclusions from Chapter 3 suggest the potential benefits of applying a Positive Health framework to better understand recovery after CSDH. However, the limitations of applying Seligman's Positive Health framework to a retrospective sample hindered the identification of disease-specific positive health assets relevant to a successful recovery after CSDH (see Chapter 3). In order to address these limitations and determine the efficacy of the newly proposed framework, it is paramount that the novel theoretical structure be applied to existing CSDH literature, prior to application to prospective research.

The following section represents findings and conclusions from the application of the proposed Positive Health framework to literature describing outcome after CSDH. The validity and potential use of the novel theoretical framework will be assessed for application to future research.

5.4.1. Chronic Subdural Haematoma and Biological Positive Health

The proposed model of Positive Health aims to distinguish Static and Dynamic health assets as they relate to outcome after CSDH. As previously mentioned, Static Biological Assets refer to components of biophysical structure that remain unchanged, such as gender and genetic structure, whereas Dynamic Biological Assets, refer to those variables of bio-physiology that are transient. This area of research is well documented in CSDH research and can be observed in literature specifically discussing potential risk factors of CSDH.

For instance, a study conducted by Berghauser Pont, Madders, Shouten, Lingsma and Dirven (2012) used a retrospective design to determine possible predictors of outcome of CSDH patients (n=496) treated with burr-hole craniotomy. Measures included patient demographics, previous medication, haematoma location, treatment characteristics in terms of surgical procedure, and laboratory values. According to the findings, CSDH development is far more common in males compared to females, indicating a ratio of 3:1. Although this study applies the disease-oriented biomedical model of health, a significant conclusion can be drawn. This finding suggests that being male may increase risk of developing a CSDH, however these findings also suggest that the female gender may represent a static biological asset aiding in the protection against the development of this intracranial bleed. This method of mining the literature for potential positive health assets yields several other significant conclusions, as the following will demonstrate.

According to the literature, risk factors for the development of CSDH include increasing age, vulnerabilities leading to myocardial infarction, the presence of diabetes, and cerebral atrophy (Baechli et al., 2004; Okano et al., 2014). In terms of potential Static Biological Health Assets, an inherent and healthy physiological subsystem that promotes

cardiac health, such as inflammatory response systems, may in fact protect against CSDH development. Furthermore, genes or proteins that protect against atrophy may also be considered Static Biological Health Assets.

For example, research suggests that a specific protein, kinase p38y may protect against forms of dementia, particularly Alzheimer's disease (Ittner et al., 2016). Therefore, the possession of this protein would be considered a positive health asset in reducing the likelihood of atrophy and subsequent CSDH development. A continuation of this argument yields several protective proteins that reduce the risk of atrophy and potential intracranial haemorrhage (Christopher et al., 2017; Jonsson et al., 2012; Liu et al., 2014; van Blitterswijk et al., 2014).

In conjunction with this evidence, literature also supports the identification of potential Dynamic Biological Health Assets in understanding the pathogenesis of CSDH. Baechlie, et al. (2004) identified several transient risk factors in the development of CSDH. Risk factors include previous alcohol misuse, the use of anticoagulant or antithrombotic drug therapy, the use of Warfarin or Aspirin, and poor diet. Based on this evidence, an individual who has engaged in the healthy use of alcohol, exhibits efficient levels of blood pressure, a reduced risk of blood clots and a good diet may be less likely to develop CSDH and may experience a more successful recovery if this cerebral event is to occur.

Manickam et al. (2016) support this conclusion in a recent study investigating long-term survival (LTS) in CSDH patients. According to the findings, a relationship exists between LTS and anticoagulant therapy use, indicating that the use of anticoagulant therapy results in a marked reduction in life expectancy post-injury. Likewise, it can be concluded that those who do not require anticoagulant therapy have a higher likelihood of a successful recovery after CSDH.

To summarise, static biological assets relevant to the prevention and successful recovery after CSDH include; female gender, efficient inflammatory system, and kinase p38y protein. Alternatively, dynamic biological assets include healthy lifestyle factors including non-smoking behaviour, low-risk alcohol behaviour, and reduced use of anticoagulant or antithrombotic medication.

5.4.2. Chronic Subdural Haematoma and Functional Positive Health

Functional Positive Health includes the subdomains of Cognitive Assets, Prosocial Assets and Person-Environment Assets. The following section will demonstrate evidence for Functional Positive Health in literature investigating patient outcome after CSDH.

5.4.2.1. Cognitive Assets Among Chronic Subdural Haematoma Patients

Literature discussing the functional health of CSDH patients is limited. There is currently only one known study that aims to measure cognitive function as its primary objective. Brand et al. (2014) aimed to investigate cognitive performance among patients with varying forms of intracranial haemorrhage (CSDH patients, n=14, subarachnoid patients, n=60, intracranial haemorrhage patients, n=25). Measures of cognitive processing included the d2 Test for Attention , the Performance test system (PTS), the Intelligence Structure Test (IST), the Hamburg-Wechsler Intelligence Test, the verbal learning and retention test, the Benton test, and the Trail-making test. Cognitive domains assessed included the following: attention, concentration, processing speed, logical thinking, spatial construction, verbal learning and memory, and short-term visual memory. The findings indicated that CSDH patients performed consistently worse on most measures, when compared to the remaining patient groups, and these patients were subsequently deemed to experience a poorer recovery.

From a perspective of Positive Health, the findings of this study demonstrate the potential implication of cognitive functioning in outcome after CSDH. Higher levels of concentration and word recognition were associated with a more successful recovery post-intervention, suggesting potential targets for the development of future intervention strategy and patient management. Unfortunately, these findings although promising, should be interpreted with caution due to clear methodological limitations.

Firstly, a healthy-control group was not included in this study, therefore it is difficult to discern cognitive assets intrinsic to CSDH patients as they compare to a healthy population. Therefore, comparisons can only be made between CSDH patients and patients with other forms of intracranial haemorrhage. Secondly, there is a notable disparity between the sample size of each clinical group, with CSDH representing the smallest of all tested (n=14). Therefore, it is also difficult to generalise these findings to the wider clinical population, and results may be more indicative of individual differences, comorbidities, or post-operative factors known to contribute to recovery. Based on this evidence, it is difficult to reliably deduce the relationship between cognitive functional assets and recovery after CSDH.

Notwithstanding these limitations, further assessment of the literature yielded three more studies that provided potential evidence of cognitive assets among CSDH patients, consistent with the previous study. According to Kawasaki et al. (2012) a significant relationship exists between prospective memory and recovery after CSDH. The findings indicated that those patients that exhibited restored prospective memory during the early post-operative period (two-days post-surgery), also demonstrated features of a good recovery after injury.

Correspondingly, Ishikawa et al. (2002) reported a potential association between general cognitive functioning as measured by the Mini-Mental Statement Examination, and recovery after CSDH. Those with improved general cognitive functioning at two-weeks post-surgery, also demonstrated a more successful recovery as measured by Activities of Daily Living (ADLs). Evidence for potential cognitive assets in promoting recovery among CSDH patients highlights the importance of cognitive processes including attention, memory and verbal reasoning (Brand et al., 2014; Forster et al., 2010; Inagaki et al., 2003; Kawasaki et al., 2012; Maeshima et al., 2001; Maeshima et al., 1998; Tanaka et al., 1992; Ye et al., 2008). .

Despite the potentially promising relationships demonstrated in this literature, the limitations hinder any reliable deduction or argument. Therefore, it is imperative that future research implore a methodologically sound design to address the paucity of information describing the cognitive outcome of CSDH patients.

5.4.2.2. Pro-Social Assets Among Chronic Subdural Haematoma Patients

Evidence indicates the measurement of Prosocial Assets in one study. Forster et al. (2010) assessed differences in traumatic versus atraumatic CSDH and included a psychosocial measure in the form of the Quality of Life scale (QoL). Initially adapted from the Sickness Impact Profile (SIP), the QoL is a self-report measure assessing psychosocial and physical consequences of illness (Burckhardt & Anderson, 2003; Flanagan, 1978). Importantly, the QoL includes a subscale directed at understanding the quality of an individual's interpersonal relationships. According to the study findings, patients whose CSDH resulted from a trauma also experienced a poorer outcome, as measured by global functioning. Interestingly, these patients were also identified as having more negative interpersonal relationships. The evidence suggests that the nature of the injury, despite usually being minor, is still considered an

important factor in the quality of life of patients. The mechanisms behind this relationship are not yet known, but the evidence does suggest that those patients who present with a CSDH due to trauma are at increased risk of poorer recovery after injury. The evidence further suggests the importance of social relationships during the immediate period following recovery and therefore, warrants further investigation.

Therefore, the presence of Prosocial assets may in fact, buffer the negative effects of a trauma-associated CSDH. However, these conclusions are only based on the findings of an individual study, and therefore research investigating the effect of Prosocial Assets in promoting recovery after CSDH is vital.

5.4.2.3. Person-Environment Assets among Chronic Subdural Haematoma Patients

Person-Environment assets incorporate skills and tendencies that promote an optimal state of coping and adaptation to the demands and requirements of one's environment. There are currently no studies that directly assess or report person-environment-fit among CSDH patients. This includes any assessment or inclusion of variables such as resilience, coping, problem solving, stress regulation, or behaviours directed towards an active return to a workplace or community.

Thus, there is limited research assessing the reintegration of CSDH patients into their environment. Future research should aim to assess the current state of person-environment fit among CSDH patients, and subsequently identify potential assets relevant to person-environment-fit that predict and promote adaptation of CSDH patients to their environment after injury.

5.4.3. Chronic Subdural Haematoma and Subjective Positive Health

There is a significant lack of research investigating Psychological Well-being, Emotional Well-being, or Physical Well-being among CSDH patients. Currently, only three known studies are shown to report measures of psychological well-being or emotional well-being among CSDH patients in the form of case-studies. Hence, the domain of Subjective Positive Health in relation to CSDH is presented concurrently.

A case study conducted by Inagaki et al. (2003) reported significantly lower psychological well-being in a 55-year-old, CSDH patient post-injury. According to the information provided, the patient demonstrated depressive symptoms consistent with mental illness whilst also demonstrating other symptoms indicative of a poor outcome, including hallucinations and memory-loss. Interestingly, a second case-study reported the presence of depressive symptoms in a patient deemed to be exhibiting a poorer functional recovery after CSDH (Nagatomo et al., 1990). These findings are further supported in information provided by a case-report depicting an elderly 82 year old CSDH patient displaying clinical depression associated with cerebral haemorrhage (Elie et al., 1996).

Unsurprisingly, it is difficult to draw conclusions from this evidence due to the methodological approach. Single-case studies are limited in their capacity and provide information on usually abnormal or uncommon cases. Despite this, an underlying trend does exist. Based on evidence from these case-studies, it can be inferred that those patients who display a poorer recovery and experience adverse complications, also exhibit symptoms of depression. As depression does include variables related to psychological or emotional health, a potential association remains. Those who exhibit a more successful recovery after CSDH may also exhibit higher levels of psychological or emotional well-being.

Therefore, future research should include a structured, theoretically driven approach to further elucidate the potential relationship that may exist between Subjective Positive Health and recovery after CSDH.

5.5. Conclusions and Future Recommendations

In support of a significant shift in health discourse, this chapter aimed to develop and apply a novel theoretical framework of Positive Health. Firstly, the conceptual organisation of the novel framework was outlined, with supported evidence from existing health literature provided. Evidence for the structure and utility of this novel framework was well-supported in the literature and the mining of existing research provided significant support for the distinction of each individual domain and subdomain in the framework.

The application of this framework to CSDH patients was inconclusive and limited. The use of this novel framework to better understand recovery after CSDH only further solidifies the constraints, boundaries and gaps in knowledge that result from a purely biomedical approach to disease. Information regarding long-term outcome is plagued by methodological flaws, whereas any understanding of cognitive or psychological outcome is especially limited. Furthermore, the application of this novel Positive Health framework only further elucidates the complete absence of measures pertaining to the well-being of CSDH patients, or what constitutes a successful recovery.

Therefore, this thesis proposes the use of this novel Positive Health framework to the understanding of recovery after CSDH. The benefits of such research would be invaluable. Firstly, the theoretical structure and clear organisation of this framework will ensure a standardised approach to the assessment of outcome. Second, this proposed research would be the first to cohesively document all domains relevant to human functioning among CSDH

patients. Thirdly, if successful, this research would also be the first study to measure global Positive Health as a primary objective. The findings from such research would not only address the significant gaps in knowledge pertaining to this condition but would be the basis for future intervention and treatment strategies that extend far beyond the focus of symptomatology and disease. The advantages and potential of this novel Positive Health framework also extends beyond the CSDH, as will now be demonstrated.

5.5.1. Advantages of the Positive Side of Health

The suggested course of this theoretical framework is to transcend into an empirically measurable novel model of health. The advantages of a novel Positive Health model, over the more traditional biomedical and biopsychosocial models of health, are threefold. Firstly, a model of Positive Health provides the first truly cohesive model of health. As previously argued, the biomedical model and biopsychosocial models of health focus on purely negative parameters that determine disease, illness and psychopathology. Therefore these more traditional models, whilst efficient in understanding the development and progression of disease, fail to acknowledge the importance of good health in predicting recovery, resilience and reduced morbidity across the lifespan (Charlson et al., 2014; Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Crescioni et al., 2011; Das & Sharma, 2015; Fredrickson & Levenson, 1998; Kok et al., 2013; Ostir, Berges, Ottenbacher, Graham, & Ottenbacher, 2008; Scheier et al., 1989; Thompson et al., 2013).

Secondly, a Positive Health model is not only useful in addressing the current state of the individual but is also useful for promoting good health and wellness across the lifespan. The biomedical and biopsychosocial models tend to focus on the momentary specific ailment affecting the patient. The origin of the illness is dissected, and treatment is developed to

address the identified causes, therefore the effects are relatively disease-specific and short-term. Comparatively, a model of Positive Health may reduce the symptoms of specific illness whilst promoting a more inclusive state of good health of a patient beyond a purely symptom-free state.

A study conducted by Das and Sharma (2015) investigated stress experienced by rheumatoid arthritis patients. If this research were to follow the biomedical or biopsychosocial models of health, the potential causes of stress would be identified and addressed, returning the patient to a stress-free state. Interestingly, researchers took an approach more indicative of the proposed Positive Health model. Stress was not the focus of this research but rather a positive behaviour known as altruism. As stated by the authors, altruism or the process of helping others without recognition or reward, not only reduces stress but at the same time improves mood, self-esteem, and happiness whilst protecting against disease, specifically rheumatoid arthritis (Das & Sharma, 2015). Findings from this study support the use of a Positive Health model in rheumatoid arthritis patients with altruistic behaviour not only reducing stress levels of patients, but also promoting health beyond a symptom-free state. Patients not only experienced reduced symptoms associated with illness, but also expressed elevated moods, reduced stress over a longer period and had a more positive perspective towards life.

The third advantage for the use of a Positive Health model is the reduced burden on the economy and public health sector. According to recent reports, the cost of disease and illness has reached extreme values. For example, a recent report estimated that avoidable health-related costs of alcohol abuse in Australia between 2004 and 2005 were over $10.8 billion (Collins & Lapsley, 2008). Similarly, reports calculate the economic costs of disease comorbidities with mental illness to be estimated at $45.4 billion in 2004 (RANZCP, 2005).

The use of a Positive Health model in treating disease may not only reduce the effects associated with specific illnesses but may also reduce future morbidity and the frequency of that patient re-engaging with the health services (Crescioni et al., 2011; Fields, Hoyt, Linnville, & Moore, 2016; Kok et al., 2013).

5.5.2. Final Recommendations

The recommendation of this chapter is to finally establish this change in health discourse. The benefits, usefulness and applicability of a novel Positive Health framework to health research has been established in health literature. Therefore, it is advised that this novel Positive Health framework be applied in health research, particularly among those vulnerable patient groups, such as those observed in the CSDH population.

Chapter 6: The Application of a Novel Positive Health Framework to Outcome after CSDH: A Prospective Study

6.1. Introduction

The delineation of a successful recovery after CSDH is a challenge for current research. CSDH patients represent a vulnerable population in need of improved patient-centred care, however a lack of information exists to inform effective health interventions. To address this lack of knowledge, this thesis undertook a novel approach to better understand recovery after CSDH and factors that promote well-being after injury. As previously stated, most approaches to health research have focused on the absence of illness and equate good health to a reduction in symptoms. This thesis has demonstrated that this approach incurs significant limitations to understanding the dimensions of health and illness, beyond the absence of disease. Therefore, in contrast to existing biomedical and biopsychosocial models, this thesis suggests a Positive Health framework for understanding those positive factors relevant to a good recovery after disease and their relationship to well-being after illness.

6.2.Positive Health and Health-Related Outcomes after Chronic Subdural Haematoma

According to Seligman (2008; 2013), a Positive Health approach to understanding disease and health alike, is a two-stage process. Research must first begin to identify health assets relevant to a particular disease or condition. Positive Health empirically identifies health assets by determining factors that predict health and illness beyond conventional risk factors or biomedical models. This approach allows the understanding of what constitutes a good

recovery after illness and provides potential targets for the future development of treatment interventions.

Second, to adequately determine the efficacy of a Positive Health framework for use in health research, research must be conducted to assess whether Positive Health assets significantly predict health outcomes after disease or illness. According to Seligman (2013) this second wave of Positive Health research has not yet been undertaken. Still to be determined is whether and how health assets contribute to health-related outcomes, including longevity or survival, morbidity, global functioning, and healthcare utilisation. The following section will discuss the approach of this thesis thus far and the outcomes that have arisen.

As stated, the first stage of introducing Positive Health theory to health research is to first identify potential positive health assets relevant to a particular disease, using a Positive Health theoretical framework. As such, Seligman's Positive Health framework was used to conduct an extensive review of the literature to better understand variables relevant to a successful recovery post-CSDH (see Chapter 3). Evidence from the literature provided the first indication of variables relevant to a successful recovery post-CSDH, subsequently informing a retrospective study conducted to determine the validity of these variables in a clinical population (see Chapter 4). Preliminary findings supported the use of a Positive Health theoretical framework in CSDH research, identifying potential biological, functional, and subjective variables that contribute to a successful outcome post-injury. However, the conclusions from this research also highlight the limitations and challenges associated with the application of an existing Positive Health theoretical framework in research using a retrospective design (see Chapter 4).

To summarise, the application of Seligman's Positive Health (Seligman, 2008) framework to existing CSDH literature (see Chapter 3) resulted in the identification of general, non-specific variables for use in retrospective research (see Chapter 4). It was apparent that Seligman's (2008; 2013) Positive Health framework lacked the theoretical structure required for a framework and resulted in the identification of generalised positive health assets that lack the specificity to support the use of a Positive Health framework beyond existing medical-models (Seligman, 2008; Seligman et al., 2013).

In addition, the limitations of the research conducted in Chapter 4 are further exemplified by the challenge of applying a structured theoretical framework to a retrospective sample. Specifically, the difficulty associated with adapting a positive framework to a largely negative breadth of knowledge. As argued in Chapter 3, the main approach to recovery after CSDH has focused on negative, biological determinants of illness, whilst a Positive Health framework values those variables shown to support well-being. This incompatibility resulted in a failure to draw well-supported correlations between Positive Health theory and a disease-focused body of evidence. Therefore, it is paramount that an investigation of recovery post-CSDH be guided by prospective research, using an empirically measurable and theoretically structured Positive Health framework (see Chapter 5).

The research presented in the previous chapters of this thesis represent the first stage of determining the efficacy of a Positive Health framework in CSDH research. As previously stated, it is first pertinent to identify relevant health assets that combine to form a successful recovery after illness (see Chapters 3 and 4). The conclusions from this research demonstrated the relevance of biological, functional, and subjective health assets to outcome after CSDH and later informed a novel Positive Health framework to better understand outcome after disease

(see Chapter 5). However, what remains is whether the health assets identified in the novel Positive Health framework contribute to health-related outcomes among CSDH patients, such as longevity, morbidity, quality of life after injury, and health-care utilisation. The following section presents a review of literature demonstrating the relationship between the identified health assets and health-related outcomes among CSDH patients, followed by an empirical investigation demonstrating this relationship in a prospective sample of CSDH patients.

6.2.1. Biological Health Assets and Health-outcome after Chronic Subdural Haematoma

For CSDH patients, understanding factors that contribute towards survival, morbidity, global functioning and healthcare utilisation are of significant importance particularly in light of recent evidence suggesting a significant decline in health after injury (Manickam et al., 2016). The conclusions from the retrospective study conducted in Chapter 4 and the novel Positive Health framework provided in Chapter 5 indicate potential biological health assets that combine to form a positive recovery after CSDH. However, the relationship between these potential health assets and health-related outcomes after CSDH have not yet been investigated. This section will now outline potential relationships between identified biological health assets and health-related outcomes. This information will be used to inform directional hypotheses included in a prospective investigation presented in this Chapter.

6.2.1.1. Biological Positive Health Assets and Survival after Chronic Subdural Haematoma

Evidence provided in Chapter 3 suggests a marked decrease in survival after CSDH. According to existing literature, mortality rates reach approximately 60% after five years post-CSDH. In keeping with the biomedical model, CSDH literature identifies factors relevant to

mortality among CSDH patients, however factors that contribute to the longevity of CSDH patients are not well-documented. Therefore, a similar approach as demonstrated in Chapter 3 of this thesis, is required to understand the relationship between biological health assets and longevity after CSDH. Existing literature was mined for potential relationships between the biological health assets identified in the novel theoretical framework and survival after CSDH. For a summary of relevant biological health assets see Table 7.

The novel Positive Health framework provided in this thesis differentiates between *Static* and *Dynamic* biological health assets. Static biological assets include those biological assets that are largely influenced by genetic, hereditary, or disease-specific factors, see Chapter 5. Health assets may include age, gender, or disease-specific variables such as CSDH position, volume, or laterality. See Table 7 for a summary of relevant *Static* health assets. Literature outlining the relationship between *Static* health assets and longevity after CSDH is scarce, however important conclusions can be reasoned.

For instance, a significant relationship has been identified between age at the time of injury at the time of injury and survival rates among CSDH patients. According to Ramachandran and Hegde (2007) increased age at the time of injury, significantly predicted increased mortality rates in a retrospective sample of 647 CSDH patients. Similarly, Asghar et al.'s (2002) research supports this relationship suggesting that increased mortality is associated with the increased age of CSDH patients. This may be due to the frailty associated with older age and the inability to recover from the extensive decline in health caused by the CSDH itself.

For gender, inferences describing the association of gender with survival rates after CSDH are limited. In agreement with findings observed in this thesis (see Chapter 4), female CSDH patients are suggested to experience poorer outcome after CSDH in the form of

increased risk of recurrence and a reduction in functional health (Hotta et al., 2017). However, limited information exists regarding gender-based longevity, long-term survival, or mortality. To date, only one study has documented the differences in clinical outcome between male and female CSDH patients (Hotta et al., 2017). A retrospective sample of 490 patients previously presenting for neurosurgical management of CSDH between January 2006 – December 2015 was analysed for gender differences in clinical outcome. According to the findings, death as a result of CSDH at discharge occurred more frequently in women, compared to men. In congruence with the findings discussed Chapter 4, whilst CSDH may be more prevalent among men, women are expected to experience poorer outcome and this relationship may in fact, extend to longevity and survival after CSDH.

For characteristics specific to CSDH, limited information exists regarding the relationship between haematoma volume, laterality, or appearance and increased survival rates. Evidence suggests that reduced haematoma volume may reduce the risk of mortality in the acute period following intervention (Patel et al., 2009), whilst evidence also suggests potential implications for CSDH position, or laterality.

Evidence suggests a causal link between bilateral CSDH and outcome (Lee & Park, 2014). According to Agawa et al. (2016) poor clinical outcome may be associated with bilateral CSDH. A total sample of 368 cases was retrospectively analysed and according to the findings, bilateral CSDH was associated with rapid health decline and mortality at seven days post-operation. As such, the development of a unilateral CSDH may be implicated in improved survival rates among CSDH patients, compared to those with a bilateral haematoma. This evidence suggests that whilst bilateral CSDH may result in a reduction in survival, unliteral CSDH may support longevity among CSDH patients. This warrants further investigation.

Information relevant to previous medical history is less clear. Existing literature identified several pre-existing conditions relevant to the development of a CSDH (Asghar et al., 2002; Berghauser Pont et al., 2012; Marshman et al., 2015). Conditions such as ischemic heart disease, hypertension, diabetes and dementia have all been implicated in the development of CSDH, however less information exists regarding the relationship between these conditions and survival after CSDH. Therefore, it is vital that these conditions are considered in research investigating survival after CSDH.

Despite this lack of information, an assessment of existing research investigating the progression of these conditions as primary factors albeit in other clinical samples, provides potential answers. The Global Burden of Disease Study conducted in 2010 estimated the global and regional mortality rates associated with IHD (Moran et al., 2014). Despite increased benefits of medical care and intervention, the conclusions from this longitudinal research identified IHD as the leading cause of mortality, globally. Similarly, a history of diabetes, hypertension, or dementia has been demonstrated to significantly contribute to increased mortality rates across varied clinical samples and general populations (Agüero-Torres, Fratiglioni, Guo, Viitanen, & Winblad, 1999; Garland, Barrett-Connor, Suarez, & Criqui, 1983; Morgan, Currie, & Peters, 2000) . Therefore, it would be expected that the same relationship would exist among CSDH patients, and absence of these conditions would significantly contribute to the survival of CSDH patients.

It is also important to consider factors specific to CSDH patients as a collective group. As outlined in Chapter 3, CSDH development commonly occurs in the elderly population and as such, factors relevant to the health of the elderly population should not be overlooked. Enzinger et al. (2005) argue that appropriate investigations involving members of the aging

population must consider health factors commonly implicated in old age. Therefore, in conjunction with the consideration for previous medical history, it is also important to assess other variables implicated in the elderly population. For instance, cerebral atrophy associated with an aging brain is of considerable importance when conducting research with the elderly population. Cerebral atrophy refers to a loss of brain cells, or *neurons* in the brain and a degradation of the connections between them. Commonly associated with aging, atrophy of the brain is associated with a loss of functioning and has been implicated in dementia-related disorders. Evidence suggests a significant relationship between atrophy severity and health decline amongst the general population and clinical samples (Rusinek et al., 2003). More recently, cerebral atrophy has also been implicated as a potential risk factor to CSDH development (Yang et al., 2012). As such, the adequate assessment of CSDH patients should recognise the potential influence of cerebral atrophy in this aging population, particularly regarding recovery after brain haemorrhage. *Dynamic Biological Assets,* much like *Static Biological Assets*, have been shown to significantly influence recovery and health-related outcomes after disease.

As outlined by the novel Positive Health framework presented in Chapter 5, *Dynamic* biological assets refer to those positive health assets that are transient and largely affected by lifestyle factors and may include factors such as medication-use, smoking behaviour, alcohol consumption, and variables relevant to acute physiological functioning. Evidence for the influence of *Dynamic* biological assets on health-related outcomes after CSDH is scarce. As argued in Chapter 5, there is strong evidence for the relationship between lifestyle factors and CSDH development. Specific medications, smoking behaviour, high-risk alcohol consumption, and gross measures of functioning as identified by the modified Rankin Scale, have all been

implicated in CSDH development (Asghar et al., 2002; Baechli et al., 2004; Berghauser Pont et al., 2012; Borger et al., 2012; Jack et al., 2015; Marshman et al., 2015). Despite the strong evidence suggesting the influence of lifestyle factors on CSDH development, the focus remains largely negative and there is little evidence suggesting a relationship between these variables and health-related outcomes after the disease. It would be expected that an absence of prejudicial lifestyle factors implicated in CSDH development would increase the likelihood of positive health-related outcomes in the postoperative period, however further research is required.

6.2.1.2. Functional Positive Health Assets and Health-related Outcome after Chronic Subdural Haematoma

Functional Positive Health, as defined by the novel Positive Health framework provided in this thesis, represents a combination of Cognitive Assets, Prosocial Assets, and optimal functioning on Person-Environment-Fit (see Chapter 5). Despite strong support for the causal relationship between these health assets and health-related outcomes after disease, information on functional health assets and outcome after CSDH is scarce (see Chapter 5).

For the relationship between cognitive functioning and outcome after CSDH, the findings outlined in Chapter 3 represent the first successful identification of cognitive assets relevant to a positive recovery after CSDH. As discussed, cognitive assets including optimal functioning in working memory and verbal fluency may support the positive recovery of patients following CSDH.

These findings are consistent with existing evidence describing the importance of optimal working memory and verbal fluency in predicting functional capacity amongst the

elderly population (Hasher & Zacks, 1988). Further, working memory and verbal fluency have also been implicated in the functional outcome of patients after single-episode psychosis, suggesting a significant relationship between cognitive function and recovery after disease (Konig, Buhner, & Murling, 2005). Whilst no current evidence exists regarding cognitive assets and health-related outcome after CSDH, evidence suggests a significant relationship between specific cognitive functions and functional recovery after disease. In keeping with the suggested novel Positive Health framework, optimal social integration is also expected to contribute to the recovery and outcome of patients after CSDH.

Positive social integration, or *Prosocial Assets*, describe the presence of positive and supportive social relationships (see Chapter 5). Evidence for the positive relationship between *Prosocial Assets* and health-related outcomes is consistently supported throughout the literature. According to Cohen (1988), there is substantial evidence to suggest a causal link between social support and health-related outcomes including relationships, mortality, morbidity, and subsequently, disease prevention. It is suggested that after controlling for common risk factors of total mortality, such as smoking, cardiac abnormalities, or prejudicial medical history, individuals who possess greater social support or positive social relationships are at lower risk than their respective counterparts. This relationship has also been demonstrated with regard to the development of disease, including coronary artery disease, coronary heart disease, stroke, and cancer (Antoni & Lutgendorf, 2007; Cohen, 1988; Cunningham, 2011; Engberg & Teasdale, 2004; Engel, 1979; Hawe & Shiell, 2000).

In conjunction with this evidence, there is also suggestion of a significant relationship between Prosocial Assets and recovery after disease. According to Berkman et al. (2003), the presence of perceived social support and positive relationships is a significant determinant in

the recovery of patients after myocardial infarction. These findings are also consistent with evidence describing Prosocial Assets in recovery after stroke (Glass & Maddox, 1992). A retrospective study investigated factors relevant to the recovery of a sample of patients after stroke (n=44). The participants were assessed for a total of six months after injury and the findings indicated that strong emotional support from social relationships significantly contribute to the functional and long-term recovery of stroke patients. Therefore, it is expected that the presence of Prosocial Assets may significantly contribute to health-related outcome after CSDH.

The final subdomain relevant to Functional Positive health, is the concept of *Person-Environment-Fit* which describes an ability to adapt to one's environment and remain independent in daily functioning, particularly in response to disease. *Person-environment-fit* is of considerable importance to outcome after CSDH. As per the findings discussed in Chapter 4, the ability of an individual to adapt to their environment after CSDH is of vital importance to a successful recovery after CSDH. However, the relationship between *Person-Environment-Fit* and specific health-related outcomes after CSDH is less understood. According to existing evidence, there is a strong suggestion that higher adaptability to the environment, particularly after disease, strongly predicts health-related outcomes including morbidity, global functioning, and healthcare utilisation. For example, higher levels of *Person-Environment-Fit* have been implicated in positive health-related outcomes amongst Alzheimer patients (Dooley & Hinojosa, 2004). Similarly, evidence also suggests that higher *Person-Environment-Fit* appears to mitigate the potential for future disease, acting to reduce stress and cardiac ill-health in the general population (Chu, 2014; Edwards, 1996; Schnall, Landsbergis, & Baker, 1994).

Therefore, it is strongly suggested that this relationship will be supported in relation to health-related outcome after CSDH.

6.2.1.3. Subjective Positive Health Assets and Health-related Outcome after Chronic Subdural Haematoma

The relationship between Subjective Positive Health and outcome after CSDH remains unclear. As discussed in Chapter 4, psychological well-being, emotional well-being, and physical well-being appear to be less implicated in outcome after CSDH than initially expected. Despite these findings, evidence does suggest a relationship between Subjective Positive Health and health-related outcome after disease. For instance, Boehm et al. (2011a) demonstrated the significant relationship between psychological well-being and coronary heart disease (CHD). A prospective sample of 7,942 participants without a previous history of CHD were assessed over a five-year period. Interestingly, when controlling for other known risk factors, individuals with greater psychological well-being were significantly less likely to develop CHD or cardiac ill-health, indicating the potential of psychological well-being in the prevention of disease. This relationship has been consistently demonstrated in the literature, suggesting a significant relationship between psychological well-being and disease prevention amongst varied clinical samples including elderly populations and patients diagnosed with Cushing's disease. (Das & Sharma, 2015; Haywood, Garratt, & Fitzpatrick, 2005; Reker & Wong, 1984; Ryff, 1989a; Ryff & Keyes, 1995; Smith & Hollinger-Smith, 2015; van Aken et al., 2005). These findings are also consistent with evidence describing the relationship between emotional well-being and disease prevention.

A population-based study conducted by Doll, Petersen, and Stewart□Brown (2000) suggested a potential relationship between emotional well-being and chronic illness. Fredrickson and Levenson (1998) suggest that the experience of positive emotions accelerate recovery after cardiac illness.

Finally, existing evidence also suggests a significant relationship between physical well-being and disease prevention. In fact, existing evidence suggests physical well-being and perceived physical health may be a predictive and contributing factor to survival in the general population (Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997).

Therefore, despite the non-significant findings observed in Chapter 4 of this thesis, the relationship between Subjective Positive Health and health-related outcome warrants further investigation.

6.2.2. Aims and Hypotheses

The objective of the current study was to further explore health assets relevant to a good recovery after CSDH and determine whether these biological, functional, or subjective health assets contribute to short-term and moderate-term health-related outcome after CSDH, including survival, morbidity, global functioning, and healthcare utilisation. The specific hypotheses are as follows:

For biological Positive Health, it was predicted that:

H1: *Static* biological assets including reduced age, male gender, unilateral CSDH, an absence of a history of trauma, reduced time since injury, protective previous medical history and variables specific to the CSDH would

differentially alter health-related outcomes in CSDH patients, including survival, morbidity, global functioning, and healthcare utilisation.

H2: It was expected that the presence of *Dynamic* health assets including an absence of high-risk pharmacotherapy, an absence of smoking behaviour, reduced alcohol-use, and improved physiological functioning would significantly contribute to health-related outcome after CSDH.

For Functional Positive Health, it was predicted that:

H3: The presence of *Cognitive Assets* including improved short-term memory, long-term memory, and executive functioning would significantly contribute to specific health-outcomes after CSDH. Based on previous research, it was expected that *Cognitive Assets* would significantly contribute to a reduction in morbidity after CSDH, improved global functioning, and reduced utilisation of healthcare.

H4: For *Prosocial Assets,* it was expected that the presence of positive social relationships would significantly contribute to a reduction in morbidity, improvement in global functioning, and reduced healthcare utilisation after CSDH.

H5: For *Person-Environment-Fit,* it was expected that those patients with greater adaptation and independence in their environment would experience improved survival rates, reduced morbidity after CSDH, improved quality of life and independence, and reduced healthcare utilisation.

For hypotheses relevant to Subjective Positive Health, it was expected that:

H6: Those patients with higher *Psychological Well-being* would be more likely to experience reduced morbidity after CSDH, improved global functioning, and reduced healthcare utilisation after CSDH.

H7: It was predicted that higher *Emotional Well-being* would significantly contribute to reduced morbidity after CSDH, improved global functioning, and reduced healthcare utilisation after CSDH.

H8: The presence of greater *Physical Well-being* was expected to predict health-related outcomes after CSDH, including reduced morbidity and reduced healthcare utilisation.

For a comprehensive summary of the novel Positive Health domains included in this research and relevant variables, see Table 7.

6.3. Method

6.3.1. Participants

Participants included consecutive cohort of patients previously admitted to the Neurosurgical Department of the Townsville Hospital for surgical intervention. Potential participants were considered against the following inclusion criteria: confirmed diagnosis of a CSDH, aged 18 or over at the time of injury, English as a primary language, capacity to consent, and adequate hearing to participate in a telephone interview. A total of n=114 eligible participants were invited to partake in the study. A total of n=86 (*Mean age*= 73±1.3 years, Male=65) were retained for the current analyses, see Figure 10. A total of n=28 eligible participants were removed from analysis due to attrition. Reasons for attrition included mortality in hospital, a worsening in physical condition as an inpatient, or participant decline.

6.3.2. Measures

Data was collected via medical records, clinical presentation notes, clinical operation records, physiological samples, and self-report assessments. For a complete summary of relevant domains, measures and variables included in this study, see Table 7.

6.3.2.1. Biological Positive Health

Data relevant to Biological Positive health was collected from medical records, clinical presentation information, intra- and interoperative records, and subjective self-report assessments.

6.3.2.1.i. Static Biological Assets

Static biological variables included biological demographic variables and disease-specific variables. Demographic variables included gender and age at the time of injury. Disease-specific variables included information relevant to previous medical history, presentation symptoms, intraoperative variables, biochemical analyses at the time of injury, and mortality. Variables relevant to previous medical history included a history of CSDH, a history of trauma precipitating the injury, time since injury recorded at discharge, and existing history of ischemic heart disease, a history of diabetes, a history of hypertension or stroke, and whether a pre-existing diagnosis of dementia was present. Variables recorded on presentation included the site of the CSDH, midline shift, total haematoma volume, and presence of atrophy as diagnosed by the Oishi index (Oishi, Mochizuki, & Shikata, 1999). Intraoperative variables included measurements of intracranial pressure and haematoma appearance as measured by Nakaguchi class (Nakaguchi, Tanishima, & Yoshimasu, 2001). Samples of the haematoma site

and biochemical targets included tau-tubulin kinase-1, total tau, albumin, amyloid beta, and S100B.

6.3.2.1.ii. Dynamic Biological Assets

Dynamic biological variables included factors relevant to pharmacological therapy, smoking behaviour, alcohol-use, and general physiological and motor functioning after CSDH. Information relevant to anticoagulant and antithrombotic medication use was obtained from medical records. Smoking behaviour was recorded from medical records and subjective records from CSDH patients. The presence of an existing diagnosis of alcoholism was obtained from existing medical records. Current alcohol-use and behaviour was recorded from scores provided on the Alcohol Use Disorders Identification Test (Saunders, Aasland, Babor, De La Fuente, & Grant, 1993). The Alcohol Use Disorders Identification Test (AUDIT) is a 10-item self-report screening tool for identifying hazardous and harmful alcohol consumption (Saunders et al., 1993). The AUDIT was developed from a six-country collaborative project involving the World Health Organisation for the purposes of early intervention and management of alcohol-related problems. Responses range from 0 - 4 for each item, with a maximum possible score of 40. Additionally, the AUDIT offers three subscales measuring alcohol consumption, dependence, and alcohol-related problems. Two supplementary questions are included to provide clinical information associated with the participants' perception of their alcohol-use and severity, however these are not included as part of the published AUDIT assessment. The AUDIT is found to be a valid and reliable assessment tool for use among demographically and culturally diverse samples and was deemed appropriate for use in this clinical sample (Gache et al., 2005; Moehring et al., 2018). The AUDIT was scored as per the recommended guidelines and the subscale scores were used for data analysis.

Information relevant to general physiological and motor functioning included scores on the Markwalder's Neurological Grading System (Markwalder, Steinsiepe, Rohner, Reichenbach, & Markwalder, 1981) and scores on the Glasgow Coma Scale (Teasdale & Jennett, 1974). Markwalder's Neurological Grading System (MG) is a prognostic tool used specifically for categorising the functional capacity of CSDH patients on presentation (Markwalder et al., 1981). The grading system used a tiered approach ranging from Grade 0 (neurologically normal) to Grade 4 (comatose with absent motor responses to painful stimuli, decerebrate or decorticate posturing). The Glasgow Coma Scale is the most common scoring system used to describe the level of consciousness in an individual following a traumatic brain injury (Teasdale & Jennett, 1974)

6.3.2.2. Functional Positive Health

Functional variables included those relevant to cognitive function, social interaction, and person-environment-fit (see Chapter 5).

6.3.2.2.i. Cognitive Assets

Data relevant to Cognitive Assets was recorded using information obtained from presenting information, medical records at the time of discharge, and subjective self-reports.

The Glasgow Coma Scale (GCS) is a neurological scale developed to measure the conscious state of a person (Teasdale & Jennett, 1974). The GCS measures three functions; eye opening, verbal response, and motor response. Scores range from a possible 3 - 15, with lower scores indicating greater severity of injury.

Indicators of specific cognitive functions were recorded using the Cognitive Telephone Screening Tool (Kliegel et al., 2007). The Cognitive Telephone Screening Tool (COGTEL) is a

telephone-adapted test battery that allows the detailed assessment of performance in six cognitive domains: prospective memory, short-term memory, long-term memory, working memory, verbal fluency, and inductive reasoning. The COGTEL is a brief screening tool for use in epidemiological and aging studies and demonstrates high test re-test reliability for the six domains, as well as for the total score (Ihle et al., 2017). Previous research also indicates strong convergent validity between the COGTEL and Mini-Mental State Examination (Breitling et al., 2010; Kliegel et al., 2007). The subscale and total COGTEL score were calculated as per the recommended formulas, and scaled subscales and formula total score were used for the purposes of data analysis.

6.3.2.2.ii. Prosocial Assets

Positive social functioning was assessed using the Social Well-being subscale from the Mental Health Continuum-Short Form (MHC-SF) (Keyes, 2002). The Mental Health Continuum-Short form is derived from the Mental Health Continuum-Long Form and aims to measure well-being using a 14-item self-report assessment (Keyes, 2007). The MHC-SF consists of three subscales measuring psychological well-being, emotional well-being, and social well-being. The MHC-SF uses a Likert-type rating scale with higher scores indicating higher levels of psychological, emotional, or social well-being. Overall, the MHC-SF demonstrates excellent psychometric properties, and the use of the individual subscales has been shown to be valid and reliable in cross-cultural studies and clinical populations (Lamers et al., 2011). The MHC-SF Social Well-being subscale score was calculated as per the recommended guidelines and syntax, and the final subscale score was included for data analysis.

6.3.2.2.iii. Person-Environment-Fit

Person-environment-fit describes functional independence after disease or injury, and was measured using clinician-rated assessments, presenting information, medical records, and self-report assessments. The degree of independence was recorded in the form of the living situation during the time prior to injury. Additionally, specific functioning and independence in basic and instrumental activities of daily living (ADLs) were recorded from scores on the Functional Activities Questionnaire (Pfeffer et al., 1982).

The Functional Activities Questionnaire (FAQ) (Pfeffer et al., 1982) is a self-report social functioning scale measuring activities of daily living (ADLs) among the elderly population. The FAQ uses an ordinal scale to measure four levels of functioning on ten activities. The four levels of functioning are arbitrarily weighted and resemble the following: dependent=3, requires assistance=2, has difficulty but does by self=1, never did=0, never did but could do now=0, and never did but would have difficulty doing now=1. The FAQ demonstrates excellent inter-rater reliability, high convergent validity with other relevant measures, and strong criterion-related evidence for its use as a measure of social functioning (Kojima et al., 2009; Pfeffer et al., 1982). Performance on the FAQ is calculated using the summed total score, with higher scores indicating poorer social functioning.

6.3.2.3. Subjective Positive Health

6.3.2.3.i. Psychological Well-being

Psychological well-being was measured using the Psychological Well-being subscale from the Mental Health Continuum Short Form (MHC-SF). The MHC-SF is a 14-item self-

report scale developed to measure three dimensions of well-being; psychological, emotional, and social (Keyes, 2007). The Psychological Well-being subscale of the MHC-SF consists of 6-items rated on a 6-point Likert-type rating scale, with higher scores indicating greater psychological well-being (Lamers et al., 2011). Existing evidence supports the three-factor structure of the MHC-SF and provides psychometric support for the use of the individual subscale in both clinical practice and research (Keyes et al., 2008; Lamers, Glas, Westerhof, & Bohlmeijer, 2012).

Additionally, psychological well-being was also recorded using the Geriatric Depression Scale (GDS) to measure the presence or absence of depressive symptoms (Ishihara & Terada, 2011). The MHC-SF Psychological Well-being subscale was calculated as per recommended guidelines and the subscale total was used for data analysis. The GDS is a 15-item self-report scale developed to measure the presence of depressive symptomology among the elderly population (Brink et al., 2013; Ishihara & Terada, 2011; Sheikh & Yesavage, 1986; Yesavage et al., 1982). The scale uses a 15-item dichotomous rating scale, 10-items indicate the presence of depressive symptoms when positively endorsed, 5-items are reversed indicating the presence of depressive symptoms when answered negatively (items 1,5,7,11,13), and an endorsed item indicating a weighting of 1. Performance is calculated by providing a summed total score. The GDS provides a diagnostic summary, with total scores of 0 - 4 indicating normal functioning, scores of 5 - 8 indicating mild depression, scores of 9 - 11 being indicative of moderate depression, and scores of 12 - 15 indicating severe depression (Sheikh & Yesavage, 1986). The GDS it is not a diagnostic tool, but rather a brief, clinical screening tool for use with the elderly population. The psychometric properties of the 15-item GDS are considered high, with construct validity and internal consistency demonstrated in cross-cultural

samples, as well as among elderly community-dwelling populations (Friedman et al., 2005; Sheikh & Yesavage, 1986; Yesavage et al., 1982). The total GDS score is calculated by summing the total number of endorsed items indicating depressive symptoms and this value was included for data analysis.

6.3.2.3.ii. Emotional Well-being

Emotional well-being was determined from scores on the emotional well-being subscale of the MHC-SF, scores on the modified Differential Emotions Scale, and optimism subscale of the Comprehensive Inventory of Thriving (CIT).

The Emotional Well-being subscale is a three-item subscale included in the MHC-SF. The Emotional Well-being subscale measures the dimensions of happiness, interest in life, and life satisfaction on a six-point Likert-type rating scale, with higher scores indicating greater levels of emotional well-being. Existing evidence supports the factor structure, inter-rater reliability, test-retest reliability of the subscale and provides support for the individual use of the subscale in research and clinical settings (Lamers et al., 2012; Lamers et al., 2011). As per relevant guidelines, the MHC-SF Emotional Well-being subscale score was calculated by summing the values for the relevant items to form a subscale score and included for data analysis.

The modified Differential Emotions Scale (mDES) is a modified and more inclusive form of the original Differential Emotions Scale developed by Izard (1977). The scale in its current form asked to rate the experience of 20-emotions over the previous two weeks using a 5-point Likert-type rating scale (1=not at all, 5=extremely) (Fredrickson, 2001). Higher scores indicate a higher frequency of experienced emotions. Separate aggregate subscales can be

calculated in the form of a positive emotions subscale and negative emotions subscale (Fredrickson, 2001). Existing evidence indicates moderate-high Cronbach's alpha (α=.76), supporting the use of the mDES in a research setting (Galanakis, Stalikas, Pezirkianidis, & Karakasidou, 2016). As per recommendations, the mDES total score was calculated by summing the values for each item and was included for data analysis.

The presence of optimism was measured using the Optimism subscale from the Comprehensive Inventory of Thriving (CIT) (Su, Tay, & Diener, 2014). The CIT is a 54-item self-report measure that was developed to measure a broad range of constructs relevant to well-being and positive functioning. The CIT is comprised of 18-subscales and has been found useful in predicting health outcomes in both clinical and research settings. The Optimism subscale includes three items rated on a 5-point Likert-type rating scale, with higher scores indicating a greater presence of optimism. Existing evidence supports the individual use of CIT-subscales for both clinical and research purposes (Duan, Guan, & Gan, 2016). The CIT-Optimism subscale score represents the mean score of the subscale items this value was included for data analysis purposes.

6.3.2.3.iii.Physical Well-being

Physical well-being was measured using the Physical well-being from the Perceived well-being subscale (Reker & Wong, 1984). The Perceived well-being (PWB) subscale is a 14-item self-report measure developed to assess perceived psychological and physical well-being. The PWB scale includes two 7-item subscales; psychological well-being and physical well-being. Scores are rated on a 7-point Likert-type rating scale, and higher scores indicate higher levels of perceived well-being. The Physical well-being subscale was developed to measure

perceived physical health and vitality, coupled with a perceived absence of physical illness and symptomology. Existing research assessing the physical well-being subscale provides for evidence for convergent validity with other measures of physical symptomology and acceptable measures of internal consistency, supporting the use in clinical and research settings (Adams, Bezner, & Steinhardt, 1997). The Physical well-being subscale score was calculated as per the recommended guidelines, and the Physical well-being subscale score of the PWB was included for data analysis.

Table 7

Summary of Novel Positive Health Domains and Study Variables

Positive Health Domain	Variables
Biological Positive Health	
Static Biological Assets	1. Age 2. Gender 3. History of trauma 4. Time since injury 5. Ischemic Heart Disease 6. Diabetes 7. Hypertension 8. Stroke 9. Dementia 10. CSDH Laterality 11. Midline shift 12. Intracranial pressure 13. Haematoma appearance • Nakaguchi Class 14. Total haematoma volume 15. Atrophy • Oishi index 16. Biochemical targets: tau-tubulin kinase-1, total tau, albumin, amyloid beta, S100B.
Dynamic Biological Assets	17. Anticoagulant medication • Warfarin

Positive Health Domain	Variables
	• Heparin 18. Antithrombotic medication • Aspirin • Clopidogrel 19. Statins 20. Smoking behaviour 21. Pre-existing diagnosis of alcoholism 22. Alcohol-use • AUDIT 23. General Physiological and Motor Functioning • Markwalder's Neurological Grading System • Glasgow Coma Scale
Functional Positive Health	
Cognitive Assets	24. Cognitive Functioning • COGTEL
Prosocial Assets	25. Social Well-being • MHC-SF Social Well-being Subscale
Person-Environment Fit	26. Independence in Daily Activities • Pre-operative Independence or disability • Functional Activities Questionnaire (FAQ)
Subjective Positive Health	
Psychological Well-being	27. Psychological Well-being • MHC-SF Psychological Well-being Subscale 28. Absence of Depressive Symptoms • Geriatric Depression Scale (GDS-SF)
Emotional Well-being	29. Emotional Well-being • MHC-SF Emotional Well-being Subscale 30. Positive Emotions • modified Differential Emotions Scale 31. Optimism • CIT Optimism Subscale
Physical Well-being	32. Perceived Physical Well-being

Positive Health Domain	Variables
	• PWB Physical Well-being Subscale

• *Denotes measure used to assess variable.*
Abbreviations: CSDH=Chronic subdural haematoma, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

6.3.3. Health-related Outcome Variables

Health-related outcome after CSDH was measured at discharge and at 6-months post-injury. Variables included: (a) mortality at less than two weeks post-intervention and at six months; (b) morbidity was measured by recurrence at discharge <2weeks and at 6-months; (c) Global Functioning as measured by modified Ranking Scale (mRS) at discharge and at 6-months; and (d) Healthcare utilisation as measured by discharge destination (see Table 8).

Table 8

Health-Related Outcome after CSDH

Health-related Outcome	Variables
Survival after CSDH	*Mortality at discharge*
	Mortality 6mths post-CSDH
Morbidity	*Recurrence*
Global Functioning	*modified Rankin Scale*
	0 = No symptoms 1 = No significant disability, despite symptoms; able to perform all usual duties and activities 2 = Slight disability; unable to perform all previous activities but able to look after own affairs without assistance 3 = Moderate disability; requires some help, but able to walk without assistance

Health-related Outcome	Variables
	4 = Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance 5 = Severe disability; bedridden, incontinent, and requires constant nursing care and attention 6 = Death
Healthcare Utilisation	*Discharge Destination* Home Family Rehabilitation Other Hospital Nursing Home Death in Hospital

Abbreviations: CSDH=Chronic subdural haematoma.

6.3.4. Procedure

Ethics approval was obtained from the Townsville Hospital and Health Service Human Research Ethics Committee, see Appendix F. Potential participants were approached prior to surgical intervention and provided with two separate information sheets and consent forms, see Appendix G. The first informed consent involved the methods necessary for collecting pathophysiological samples from the dura mater, subdural haematoma cavity, and fluid for the purposes of biochemical analysis. The collection of this material was to occur intra-operatively and would be collected by the operating neurosurgical registrar. The second informed consent outlined the process for collecting data via access to medical records, clinical notes, and a self-report questionnaire, see Appendix G.

The pathophysiological data was collected during routine surgical intervention. Patients underwent burr-hole surgery with a drain inserted *in situ* for 2 - 3days post-surgery to release CSDH fluid accumulation during the acute period of recovery. During the process of clot removal, the dura mater is cut to allow access to the blood clot. This material, although usually discarded and diathermied, was collected during the operative procedure and analysed by a research team member responsible for pathology analyses under the field of medical laboratory science. The colour of the subdural fluid was also monitored for up to 3days post-operatively. Other biological data corresponding to age, gender, CSDH location, drug and alcohol history, smoking behavior, medication history, previous medical history and information related to the mechanism of injury was collected after patient consent was obtained. This information was collected using the electronic inventory of medical records (ieMR) and previous medical records.

Functional imaging data was collected by neurosurgery registrar staff using computer tomography (CT) and magnetic resonance imagery (MRI). Data obtained from self-report assessments was collected during neuropsychological assessment within two weeks post-surgery and at 3 – 6 months follow-up, see Appendix H.

6.3.5. Statistical Analyses

Where missing data exceeded 5%, mean substitution was used. In mean substitution, the mean value of a variable is used in place of the missing data value for the same variable. This allows for the utilisation of data in an incomplete data set (Kang, 2013). The theoretical background of the mean substitution is that the mean is a reasonable estimate for a randomly selected observation from a normal distribution. Mean substitution occurred for the COGTEL

variables only. One-Way Analyses of Variance (ANOVA) were used to examine between-group differences for continuous variables. Paired-samples t-tests were conducted to assess changes over time, the chi-square ($\chi 2$) test for independence for categorical variables, and for differences among categorical and ordinal variables, the ordinal-by-ordinal chi-square value was substituted. Post-hoc analyses were conducted for chi-square tests using adjusted residual values (*adjusted-*R^2), with values above 1.96 indicating significant associations between groups. Assumption testing included the Shapiro-Wilk statistic, Levene's test for equality of variance, and Mauchly's test of sphericity. Where assumptions were violated, equal variances were not assumed for independent samples testing. In cases of unequal variances, non-parametric testing was applied. For categorical variables, $\chi 2$ was not calculated when $n>5$. A significance level of $\alpha<.01$ was used for all statistical tests, with $.02>\alpha<.6$ used to indicate trends towards significance. Bonferroni correction was applied to account for multiple comparisons when equal variances were assumed. Where independent variables contained groups of less than two cases or contained unequal variances, post-hoc analyses were performed using the Games-Howell test for unequal variances or groups. For calculations of effect size, Cohen's *d* was used for analyses containing an independent group with two levels or less, with small effect sizes ranging from .2 - .4, medium ranging from .5 - .7, and large effect sizes equal to .8 or above. For independent variables with more than two levels, effect size was calculated using Cohen's *f,* with small effect sizes ranging from .1 - .2, moderate ranging from .25 - .3, and large effect sizes equal to .4 or above. Observed power was also included to determine the likelihood of Type II error associated with the analyses. All statistical analyses were made using IBM SPSS software package V.25.0.

6.4. Results

6.4.1. Patient Sample Information

Demographics and medical characteristics are summarised in Table 9.

Table 9

Prospective Cohort Patient Characteristics and Previous Medical History

Variable	**Frequency (%)**
Demographic	
n	114
Gender (M/F)	86/28
Age (*M*±SD, Range)	72.99 ±13.6, 23-93 years
Previous Medical History	
Dementia	17 (14.2%)
Ischaemic Heart Disease	36 (30%)
Hypertension	76 (63.3%)
Stroke	15 (12.5%)
Dialysis	1 (0.8%)
Cholesterol	28 (31.7%)
DVT/PE	4 (3.3%)
Diabetes	19 (15.8%)
Atrial Fibrillation	21 (17.5%)
Current Smoker	19 (15.8%)
Alcoholism	8 (6.7%%)
Drug History	
ACEi	25 (20.8%)
A2RB	22 (18.3%)
Statin	40 (33.3%)
Antiplatelet	48 (40%)
Anticoagulant	15 (12.5%)

N=114

The total sample of recruited participants consisted of n=114 (86 Male, 28 Female, *MeanAge*=72.99±13.6, range 23-93 years) CSDH patients previously admitted to the Townsville Hospital for neurosurgical management of CSDH (see Figure 10).

Presenting clinical information is found in Table 10. The average length of admission was 14.45±15.9 days. The average time since injury and presentation was 31.85±23.76 days and CSDH patients most commonly presented as alert and with mild symptoms as measured by the Markwalder's Grade.

Table 10

CSDH Patient Information on Presentation

Variable	**Frequency (%)**
Presenting Information	
Admission days	14.45±15.9 days
Time since injury	31.85±23.76 days
Preoperative Markwalder Grade	
Normal	1 (0.8%)
Alert, headache, mild symptoms	69 (57.5%)
Confused, drowsy, focal deficit	39 (32.5%)
Stuporous, severe deficit	3 (2.5%
Comatose	2 (1.7%)

N=114

A flow-diagram depicting the study participants and available data collection methods can be seen in Figure 10. As indicated, a significant proportion of patients were considered unable to complete self-report assessment measures due to incapacity or mortality.

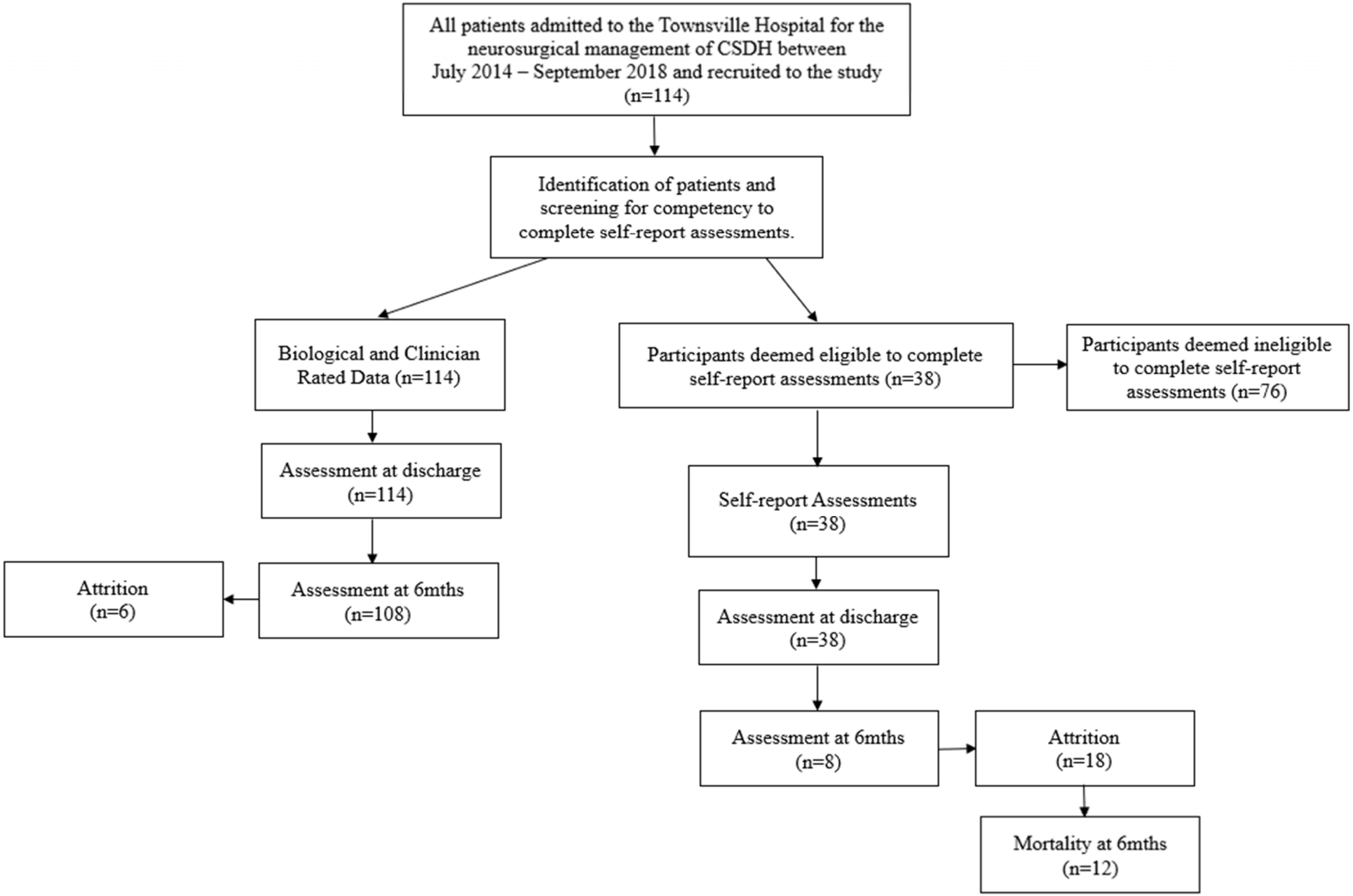

Figure 10 Flow-diagram of Study Participants and Available Data Collection Methods

Intention-to-treat analyses indicated that no significant differences existed between those patients recruited to the study and those patients who declined or were considered unable to complete the self-report protocol on the following variables: gender, age, time since trauma, history of trauma, or CSDH laterality (all $p>.05$). Information was also obtained regarding the characteristics and position of the CSDH. Left-hemispheric CSDH development was most common, with approximately 40% of patients presenting with left-sided CSDH. For further information regarding CSDH characteristics on imaging see Table 11.

Table 11

CSDH Characteristics on Imaging

Variable	**Frequency (%)**
CSDH Characteristics on Imaging	
Midline Shift (mm)	
Unilateral CSDH	8.28 ± 4.59
Bilateral CSDH	7.23 ± 4.6
Total Haematoma Volume (ml)	
Unilateral CSDH	102.6 ± 47.3
Bilateral CSDH	325.32.17 ± 62.07
CSDH laterality	
Left CSDH	49 (40.8%)
Right CSDH	38 (31.7%)
Bilateral	26 (21.7%%)
CSDH Morphology	
Homogenous	24 (20.0%)
Laminar	25 (20.8%)
Separated	19 (15.8%)
Trabeculated	17 (14.2%)

N=114

Information relevant to operation notes and clinical outcomes are included in Table 12. The majority of CSDH patients presented with severe atrophy (56.7%). Burrhole surgery was most commonly performed for the removal of CSDH with a large proportion of patients exhibiting a significant reduction in symptoms post-surgery as measured by mRS scores on discharge, see Table 12. Recurrences occurred in approximately 11% of patients 19.5 days after surgery.

Table 12

CSDH Operation Information and Clinical Outcomes

Variable	**Frequency (%)**
Oishi Index for Cerebral Atrophy	
Normal-Mild	6 (5.0%)
Moderate	39 (32.5%)
Severe	68 (56.7%)
Operation Clinical Information	
Time to Operation	3.18 ± 5.60 days
Operation Type	
Burrholes	89 (78.1%)
Craniotomy	25 (21.9%)
Intraoperative Intracranial Pressure	
Low	8 (6.7%)
Moderate	54 (45.0%)
High	11 (9.2%)
Post-operative Clinical Outcome	
mRS at Discharge	
No symptoms	2 (1.7%)
No significant disability	48 (40.0%)
Slight disability	10 (8.3%)
Moderate disability	29 (24.2%)
Moderate/Severe disability	22 (18.3%)
Severe disability	1 (0.8%)
Dead	2 (1.7%)

Variable	Frequency (%)
Recurrences	12 (10.5%)
Average time to recurrence	19.5 ± 14.88 days

N=114

Abbreviations: CSDH=Chronic subdural haematoma, DVT/PE=deep vein thrombosis/pulmonary embolism, AF=atrial fibrillation, ACEi=Angiotensin-converting-enzyme inhibitor, A2RB=Angiotensin II receptor blockers, mm=millimeters, ml=milliliters, mRS=modified Rankin Scale.

The following section provides the analyses conducted in this research. Findings have been organised in the relevant domains proposed by the novel Positive Heath framework provided in this thesis.

6.4.2. Survival after Chronic Subdural Haematoma

The following analyses address hypotheses predicting the relationship between positive health assets and survival after CSDH. The novel Positive Health framework has been used to organise the findings relevant to each domain and a summary of the relevant hypotheses is provided.

6.4.2.1.Biological Positive Health

The following analyses report findings relevant to Biological Positive Health and survival after CSDH.

6.4.2.1.i. Static Biological Assets

The hypothesis relevant to *Static Health Assets* and health-related outcomes after CSDH: *Static* biological assets including reduced age, male gender, unilateral CSDH, an absence of a history of trauma, reduced time since injury, protective previous medical history and variables specific to the CSDH would differentially alter health-related outcomes in CSDH patients, including survival, morbidity, global functioning, and healthcare utilisation.

(a) Static Biological Assets and Survival after CSDH

For descriptive information regarding Static Biological Assets and survival after CSDH see Appendix I. For information relevant to statistical significance, see Appendix J.

A one-way ANOVA was conducted to determine significant differences in age ATOI and survival after CSDH. No significant main effects were identified for mortality at discharge and age ATOI. However, a trend towards significance was observed for age ATOI and mortality at six months ($F_{(1,111)}$=5.317, $p<.05$, d'=.704), with older age ATOI potentially implicated in increased mortality rates after CSDH. No significant associations between gender and mortality after CSDH at discharge or six months were observed ($p>.05$).

A chi-square test for independence was conducted to determine whether a history of trauma preceding CSDH development was significantly associated with mortality at discharge or six months, indicating no significant associations (all $p>.05$). For the relationship between time since injury and mortality at discharge or six months after CSDH, no significant main effects were observed ($p>.05$).

For variables relevant to previous medical history, chi-square tests of independence indicated no significant association between a history of IHD, diabetes, hypertension, stroke or dementia and survival at discharge (all $p>.05$). Similarly, no significant associations were observed for a history of IHD, diabetes, stroke, or dementia and mortality at six months post-CSDH ($p>.05$). However, a trend towards significance was identified for a history of hypertension and mortality at six months post-CSDH, indicating that those patients with a history of hypertension may experience reduced survival rates after CSDH (χ^2=3.849, p=.05).

For CSDH laterality, no significant associations were observed for survival at discharge. However, a trend towards significance was identified using a chi-square test for independence indicating a potential association between unilateral CSDH and mortality at six

months (χ^2=3.862, p=.49). One-way ANOVAs indicated no significant main effects for mortality at discharge or at six months post-CSDH on midline shift or intracranial pressure at the time of surgery. For haematoma appearance using the Nakaguchi class, a chi-square test for independence specific to linear-by-linear associations indicated a significant association (χ^2=6.662, p=.01), with those patients with homogenous or laminar haematomas experiencing reduced survival rates at six months post-CSDH. For haematoma volume, no significant main effects were observed for mortality at discharge or six months post-CSDH (all p>.05).

For atrophy using the Oishi Index, no significant associations were observed for mortality at discharge. However, a chi-square test for independence indicated a significant association between scores on the Oishi index and mortality at six months, with patients with severe atrophy were more likely to experience reduced survival at six months post-CSDH (χ^2=3.814, p=.00). Finally, for biochemical targets a significant main effect was observed for albumin and mortality at discharge, indicating that higher concentrations of albumin were presented in patients that did not survive CSDH at discharge ($F_{(5,107)}$=5.443, p<.05, d'=1.667, $1-\beta$=.67). One-way ANOVAs indicated no other significant main effects for the biochemical targets and mortality at discharge or at six months post-CSDH were observed (all p>.05).

(b) Static Biological Assets and Morbidity after CSDH

As stated, morbidity has been operationalised as CSDH recurrence (see Table 8). For descriptive information for Static Biological Assets and recurrence after CSDH see Appendix I. For a summary of analyses and statistical significance, see Appendix K.

For age, a one-way ANOVA indicated no main effect for recurrences and age ATOI (p>.05). For gender, a trend towards significance was observed indicating a potential association between female gender and recurrence (χ^2=3.964, p=.046).

For a history of trauma preceding CSDH development, a chi-square test for independence indicated no association relevant to CSDH recurrence ($p>.05$). A one-way ANOVA also indicated no significant main effects for recurrence rates and time since injury ($p>.05$). No significant associations were identified for CSDH laterality and recurrence rates ($p>.05$). Further analyses indicated no significant main effects for recurrence rates and midline shift or intracranial pressure ($p>.05$).

Chi-square tests for independence indicated no significant associations between recurrence rates and scores on the Nakaguchi class of CSDH appearance or the Oishi Index measuring atrophy (all $p>.05$). For biochemical targets, one-way ANOVAs indicated no significant main effects for recurrence rates and concentrations of tau-tubulin kinase-1, total tau, albumin, amyloid beta, or S100B.

(c) Static Biological Assets and Global Functioning after CSDH

For descriptive information regarding *Static Biological Assets* and global functioning see Appendix L. For a summary of analyses and statistical significance, see Appendix N. As stated, global functioning was operationalised as mRS scores at six months post-CSDH (see Table 8). For age, a one-way ANOVA indicated a significant main effect was observed for age ATOI and mRS at six months and ($F_{(5,107)}=4.87, p=.01, f'=.305,$ $1-\beta=.975$). Post-hoc analyses revealed those patients older in age ATOI were more likely to be diagnosed with moderate disability at six months post-injury ($p<.01$). For gender, a chi-square indicated no significant associations with mRS scores at six months after CSDH ($p>.05$).

For a history of trauma preceding CSDH development, a chi-square test of independence indicated a trend towards significance for a history of trauma and performance on the mRS at six months post-CSDH ($\chi^2=3.534, p=.059$). This indicates that a history of

trauma may negatively impact global functioning after CSDH. A one-way ANOVA showed no significant main effects for scores on the mRS and time since trauma (p>.05).

For variables relevant to previous medication history, a history of IHD, diabetes, hypertension or stroke were not significantly associated with performance on the mRS at six months post-CSDH (all p>.05). However, a previous diagnosis of dementia was significantly associated with poorer functioning at six months, as measured by the mRS (χ^2=18.130, p=.001).

One-way ANOVAs indicated no significant main effects for performance on the mRS at six months post-CSDH and midline shift or intracranial pressure at the time of surgery (all p>.05). For CSDH appearance on Nakaguchi class, a chi-square test for independence specific for linear-by-linear associations demonstrated a significant association between Nakaguchi class and mRS at six months (χ^2=7.655, p=.006) with patients with homogenous haematomas more likely to demonstrate impaired functioning at six months (*adjusted-R^2*=2.8). For performance on the mRS at six months post-CSDH and atrophy, a chi-square for ordinal transformations indicated a significant association between Oishi index scores and scores on the mRS at six months post-injury (χ^2=16.969, p=.001). Patients with greater atrophy were more likely to demonstrate higher scores on the mRS at six months post-injury indicating poorer functioning at post-CSDH. For biochemical targets, one-way ANOVAs indicated no significant main effects for concentrations of tau-tubulin kinase-1, total tau, albumin, amyloid beta, or S100B and performance on the mRS at six months post-CSDH.

(d) Static Biological Assets and Healthcare Utilisation after CSDH

As stated, healthcare utilisation was operationalised as discharge destination (see Table 8). For descriptive information regarding *Static Biological Assets* and discharge destination, see Appendix M. For a summary of analyses and statistical significance, see Appendix N.

For age, a one-way ANOVA indicated a significant main effect for age ATOI and discharge destination ($F_{(5,108)}$=3.146, p=.011, d'=.611, 1−β=.865). Patients older in age at the time of injury were more likely to be discharged to a rehabilitation facility, as opposed to their home ($p<.05$). For gender, a chi-square test for independence indicated no significant relationship for discharge destination ($p>.05$).

Similarly, no significant differences were observed for a history of trauma preceding the CSDH, CSDH laterality, midline shift, intracranial pressure, or haematoma volume and the discharge destination after CSDH (all $p>05$). Chi-square tests for independence also indicated no significant associations between discharge destination and a history of IHD, hypertension, diabetes, or stroke. However, a significant association was identified between a preexisting diagnosis of dementia and the discharge destination (χ^2=7.676, p=.01). This indicates that those with a history of dementia were less likely to be discharged home post-surgery (*adjusted-R^2=±2.5*) and more likely to be discharged to another hospital for continued care (*adjusted-R^2=±2.8*).

For CSDH appearance, a chi-square test with linear transformation revealed a trend towards significance for Nakaguchi class and discharge destination (χ^2=5.145, p=.023). Those patients with a trabeculated haematoma may be more likely to be discharged home (*adjusted-R^2*=2.7), whereas those patients with a laminar haematoma may be more likely to be discharged to a nursing home (*adjusted-R^2*=2.2). For atrophy, a chi-square test for independence with linear transformation indicated Oishi index scores were significantly associated with discharge destination, thus indicating that those patients with greater atrophy ATOI were less likely to be discharged home post-surgery (χ^2=7.676, $p<.006$). No significant differences were observed for discharge destinations and concentrations of biochemical targets including tau-tubulin kinase-1, total tau, albumin, amyloid beta, or S100B.

6.4.2.1.ii. Dynamic Biological Assets

The hypothesis relevant to *Dynamic* health assets and health-related outcomes after CSDH the presence of *Dynamic* health assets including an absence of high-risk pharmacotherapy, an absence of smoking behaviour, reduced alcohol-use, and improved physiological functioning would significantly contribute to health-related outcome after CSDH.

(a) Dynamic Biological Assets and Survival after CSDH

For descriptive information for *Dynamic Biological Assets* and survival after CSDH, see Appendix I. For information relevant to statistical significance, see Appendix J.

Chi-square tests for independence were conducted to determine the relationship between pharmacotherapy medications including Warfarin, Heparin, Aspirin, Clopidogrel and Statins, and mortality at discharge and six months after CSDH, with no significant associations observed (all $p>.05$). Further, chi-square tests for independence indicated no significant associations between smoking behaviour and mortality at discharge or six months post-CSDH (all $p>.05$). Further, one-way ANOVAs indicated no significant main effects for CSDH recurrence and alcohol-consumption as measured by scores on the AUDIT (all $p>.05$).

For scores on Markwalder's Neurological Grading System (MG), no significant associations were identified between MG grades at discharge and mortality at discharge. However, a chi-square test for independence indicated higher scores on the MG grade were associated with increased mortality rates at six months ($\chi^2=15.266, p=.01$), with reduced survival at six months associated with a MG grade of 1 at discharge (*adjusted-*$R^2=2.2$).

For scores on the Glasgow Coma Scale (GCS), one-way ANOVAs indicated no significant main effects for mortality at discharge or at six months, and scores on the GCS (all $p>.05$).

(b) Dynamic Biological Assets and Morbidity after CSDH

For descriptive information for *Dynamic Biological Assets* and recurrence after CSDH, see Appendix I. For a summary of analyses and statistical significance, see Appendix K. Chi-square tests for independence indicated no significant associations between pharmacotherapy medications including Warfarin, Heparin, Aspirin, Clopidogrel and Statins, and CSDH recurrence (all $p>.05$). Further, chi-square tests for independence indicated no significant associations between smoking behaviour and CSDH recurrence ($p>.05$). Further, one-way ANOVAs indicated no significant main effects for CSDH recurrence and alcohol-consumption as measured by scores on the AUDIT (all $p>.05$).

A chi-square test for independence with linear transformation indicated no significant associations between CSDH recurrence and MG grade ($p>.05$). Further, a one-way ANOVA indicated no significant main effects for CSDH recurrence and GCS scores ($p>.05$).

(c) Dynamic Biological Assets and Global Functioning after CSDH

For descriptive information regarding *Dynamic Biological Assets* and global functioning, see Appendix L. For a summary of analyses and statistical significance, see Appendix N. No significant associations were identified for pharmacotherapy medications, smoking behaviour, or alcohol consumption and scores on the mRS at six months post-CSDH (all $p>.05$).

For MG grading, a chi-square with linear transformation indicated a significant association with scores on the mRS at six months ($\chi^2=28.262, p=.01$). Those patients who received a MG grade of 0 (0=*alert, headache, mild signs*) were more likely to exhibit no

significant disabilities at six months (*adjusted-R^2*=3.4). Correspondingly, those patients who received a MG grade of 1 (1=*confused, drowsy, focal deficit*) exhibited greater symptoms of severe disability at six months, than expected (*adjusted-R^2*=2.2). No other significant associations or differences were observed.

(d) Dynamic Biological Assets and Healthcare Utilisation

For descriptive information regarding *Dynamic Biological Assets* and discharge destination, see Appendix M. For a summary of analyses and statistical significance, see Appendix N. No significant associations were identified for pharmacotherapy medications, smoking behaviour, or alcohol consumption and discharge destination (all $p>.05$).

A chi-square test for independence with linear transformation indicated a significant association between MG grade at discharge and discharge destination after CSDH ($\chi^2=19.95$, $p=.001$), see Figure 11. Patients with an MG grade of 0 (0=*alert, headache, mild signs*) at discharge, were more likely to be discharged to their home residence (*adjusted-R^2*=3.7). Those patients with a MG grade of 1 (1=*confused, drowsy, focal deficit*) at discharge, were more likely to be discharged to another hospital (*adjusted-R^2*=2.2). Whilst those patients with a MG grade of 3 (3=*Stupurous, severe deficit*) were more likely to be discharged to another hospital (*adjusted-R^2*=2.4). Whereas, those patients with a MG grade of 4 (4=*comatose*) were more likely to succumb to death before discharge (*adjusted-R^2*=5.2).

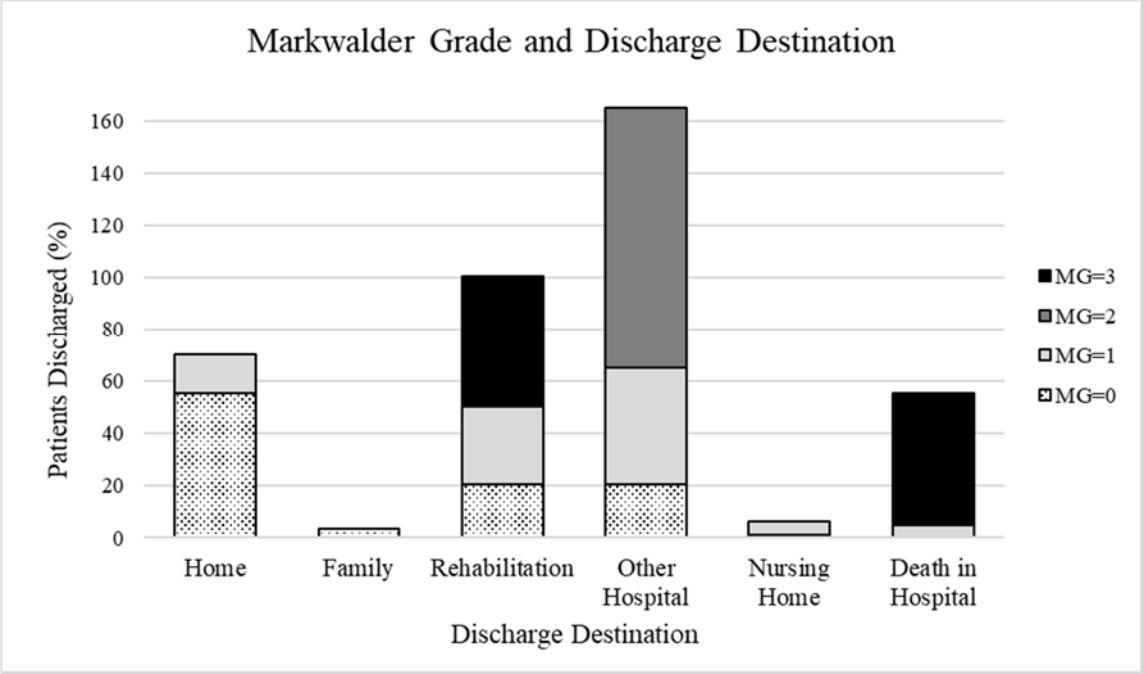

Figure 11 Relationship between Markwalder Neurological Grade and Discharge Destination

A one-way ANOVA indicated a significant main effect for discharge destination and GCS scores ($F_{(5,108)}$ = 3.198, p=.01, f'=*.364,* 1−β=.87*).* Those patients with lower GCS scores on presentation were more likely to be discharged to another hospital, as opposed to discharge home (p=.001) or into the care of family members (p=.016).

6.4.3. Functional Positive Health

6.4.3.1. Cognitive Assets

The hypothesis relevant to *Cognitive Assets* and health-outcomes after CSDH was that improved short-term memory, long-term memory, and executive functioning would significantly contribute to specific health-outcomes after CSDH. Based on previous research, it was expected that *Cognitive Assets* would significantly contribute to a reduction in morbidity after CSDH, improved global functioning, and reduced utilisation of healthcare.

(a) Cognitive Assets and Morbidity after CSDH

For descriptive information for *Cognitive Assets* and recurrence after CSDH, see Appendix I. One-way ANOVAs indicated no significant main effects for COGTEL subscale or total scores and recurrence after CSDH (all $p>.05$).

(b) Cognitive Assets and Global Functioning after CSDH

For descriptive information regarding *Cognitive Assets* and global functioning, see Appendix L. For a summary of analyses and statistical significance, see Appendix N. A trend was observed for scores on the Verbal Fluency subscale of the COGTEL on mRS at discharge ($F_{(3,12)}=3.770, p=.053$), indicating those patients who exhibited a greater presence of disability may perform more poorly on verbal fluency tasks after CSDH.

(c) Cognitive Assets and Discharge Destination after CSDH

For descriptive information regarding *Cognitive Assets* and discharge destination, see Appendix M. For a summary of analyses and statistical significance, see Appendix N. A one-way ANOVA with Games-Howell correction indicated no significant main effect for discharge destination and performance on the COGTEL subscale scores or total score (all $p>.05$).

6.4.3.2. Prosocial Assets

The hypothesis relevant to the relationship between *Prosocial Assets* and health-related outcomes after CSDH was that the presence of positive social relationships would significantly contribute to a reduction in morbidity, improvement in global functioning, and reduced healthcare utilisation after CSDH.

(a) Prosocial Assets and Morbidity after CSDH

For descriptive information for *Prosocial Assets* and recurrence after CSDH, see Appendix I. One-way ANOVAs indicated no significant main effects or trends for recurrence after CSDH and performance on the MHC-SF Social Well-being subscale (all $p>.05$).

(b) Prosocial Assets and Global Functioning after CSDH

For descriptive information regarding *Prosocial Assets* and global functioning, see Appendix L. For a summary of analyses and statistical significance, see Appendix N. A one-way ANOVA with Games-Howell correction indicated no significant main effects or trends for scores on the MHC-SF Social Well-being subscale and mRS at six months (all $p>.05$).

(c) Prosocial Assets and Discharge Destination after CSDH

For descriptive information regarding *Prosocial Assets* and discharge destination, see Appendix M. For a summary of analyses and statistical significance, see Appendix N. A one-way ANOVA with Games-Howell correction indicated no significant main effect or trends for performance on the MHC-SF Social Well-being subscale and discharge destination (all $p>.05$).

6.4.3.3. Person-Environment-Fit

The hypothesis relevant to *Person-Environment-Fit* and health-related outcomes after CSDH was that those patients with greater adaptation and independence in their environment would experience improved survival rates, reduced morbidity after CSDH, improved quality of life and independence, and reduced healthcare utilisation.

(a) Person-Environment-Fit and Survival after CSDH

For descriptive information for *Person-Environment-Fit* and survival after CSDH, see Appendix I. For information relevant to statistical significance, see Appendix J.

A one-way ANOVA with Bonferroni correction demonstrated no significant main effects for preoperative independence and mortality at either discharge or six months post-CSDH (all $p>.05$).

For performance on the Functional Activities Questionnaire (FAQ), no significant main effects were identified for mortality at discharge ($p>.05$). However, a one-way ANOVA with Bonferroni correction indicated a significant main effect for and scores on the FAQ and mortality at six months post-CSDH ($F_{(1,15)}=12.870$, $p=.01$, $f'=5.26$, $1-\beta=.918$), those patients with higher scores on the FAQ at discharge were less likely to survive as measured by mortality at six months ($p<.01$), (see Figure 12).

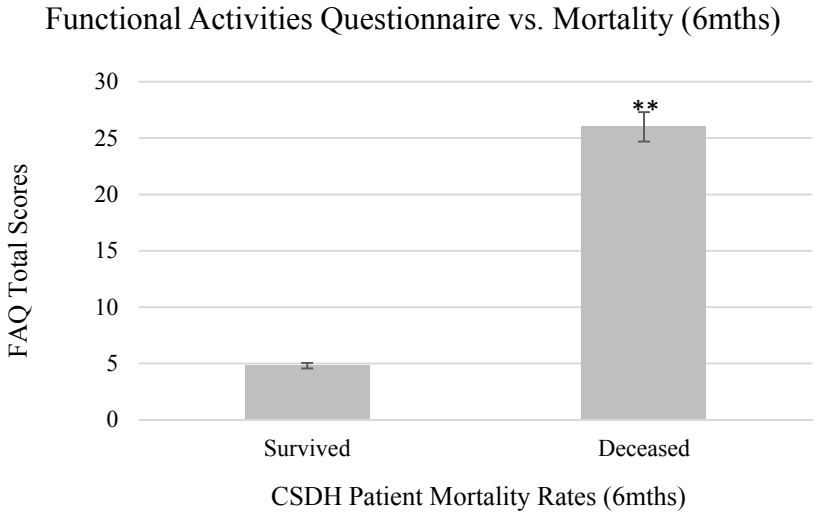

Figure 12 *Mean Performance on Person-Environment-Fit and Mortality Rates at Six Months.*
***Indicates sig. at the level p<.01.*
CSDH=chronic subdural haematoma, FAQ=Functional Activities Questionnaire

(b) Person-Environment-Fit and Morbidity after CSDH

For descriptive information for *Person-Environment Fit* and recurrence after CSDH, see Appendix I. For a summary of analyses and statistical significance, see Appendix K. A

series of one-ANOVAs indicated no significant main effects for recurrence after CSDH and preoperative independence or performance on the FAQ (all $p>.05$).

(c) Person-Environment-Fit and Global Functioning after CSDH

For descriptive information regarding *Person-Environment-Fit* and global functioning, see Appendix L. For a summary of analyses and statistical significance, see Appendix N. A chi-square test for independence with linear transformation indicated that preoperative independence was significantly associated with scores on the mRS at six months ($\chi^2=12.271$, $p<.01$). Those patients who were independent at the time of presentation were more likely to exhibit no symptoms at six months as measured by the mRS (*mRS Score = 0, adjusted-*$R^2=2.5$). Further, those patients who were being cared for by a family member or carer at the time of injury, were more likely to exhibit moderate disability at six months (*mRS Score = 3, adjusted-*$R^2=4.2$). Finally, those patients who resided in a nursing home prior to injury were more likely to exhibit severe disability at six months (*mRS Score = 5, adjusted-*$R^2=10.6$) indicating that those patients who were cared for by either a family member or carer preoperatively, were more likely to demonstrate symptoms of moderate disability at six months post-injury (*adjusted-*$R^2=4.2$).

For performance on the FAQ, a one-way ANOVA showed a significant main effect performance on the FAQ and mRS at six months ($F_{(3,13)}=6.076$, $p<.01$, $f'= 1.72$, $1-\beta=.956$). Post-hoc analyses with Games-Howell correction indicated that those patients with higher scores on the FAQ at discharge were more likely to demonstrate moderate disability at six months as measured by the mRS ($p<.05$), (see Figure 13).

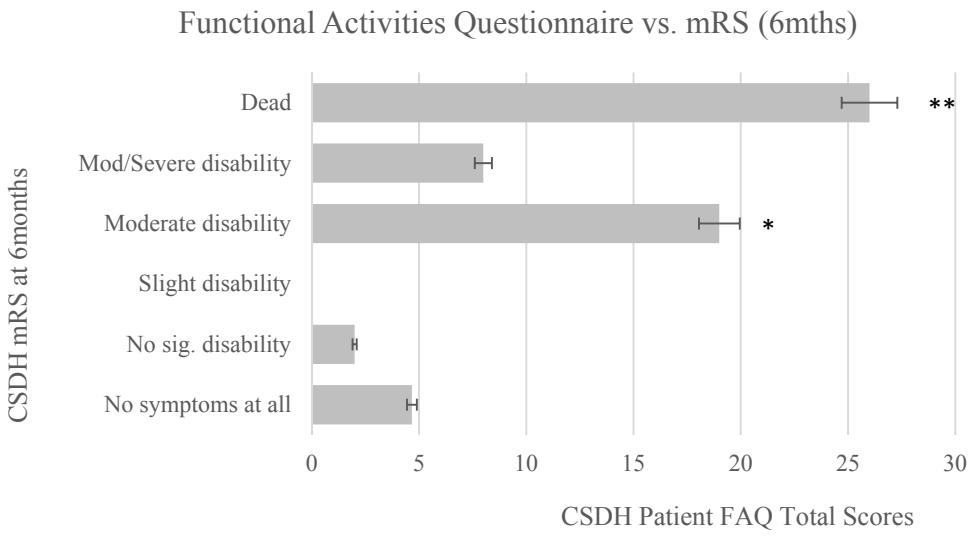

Figure 13 *Performance on the FAQ at Discharge and mRS at Six Months.*
***Indicates sig. at the level p<.01. *Indicates sig. at the level p<.05*
CSDH=chronic subdural haematoma, FAQ=Functional Activities Questionnaire, mRS=modified Ranking Scale

(d) Person-Environment-Fit and Discharge Destination after CSDH

For descriptive information regarding *Person-Environment-Fit* and discharge destination, see Appendix M. For a summary of analyses and statistical significance, see Appendix N. For a summary of analyses and statistical significance, see Appendix N. For information relevant to statistical significance, see Appendix J. A chi-square test for independence with linear transformation indicated a significant association for preoperative independence and discharge destination (χ^2=5.60, p<.05). Those patients who were cared for by either a family member or carer prior to injury, were more likely to be returned to their family member or carer as opposed to discharged to their home residence (*adjusted-*R^2=2.1).

For performance on the FAQ, a one-way ANOVA with Bonferroni correction demonstrated a trend towards significance for performance on the FAQ and discharge destination ($F_{(2,14)}$=3.438, p=.60). This indicates that those patients with higher scores on the FAQ may have been more likely to be discharged to a rehabilitation facility post-surgery.

6.4.4. Subjective Positive Health

6.4.4.1. Psychological Well-being

The hypothesis relevant to Psychological Well-being and health-related outcomes after CSDH is as follows:

> H6: Those patients with higher *Psychological Well-being* would be more likely to experience reduced morbidity after CSDH, improved global functioning, and reduced healthcare utilisation after CSDH.

(a) Psychological Well-being and Health-related Outcomes after CSDH

For descriptive information and information relevant to statistical significance for *Psychological Well-being* and health-related outcome after CSDH, see Appendix I-J. No significant main effects or trends were observed for scores on the Psychological Well-being subscale of the MHC-SF for recurrence after CSDH, for mRS at six months, or for discharge destination (all $p>.05$). Furthermore, no significant findings or trends were observed for scores on the GDS and performance on morbidity, global functioning, and healthcare utilisation (all $p>.05$)

6.4.4.2. Emotional Well-being

The hypothesis relevant to Emotional Well-being and health-related outcomes after CSDH was that higher *Emotional Well-being* would significantly contribute to reduced morbidity after CSDH, improved global functioning, and reduced healthcare utilisation after CSDH.

(a) Emotional Well-being and Health-related Outcome after CSDH

For descriptive information for *Emotional Well-being* and health-related outcomes after CSDH, see Appendix I-J. For performance on the MHC-SF Emotional Well-being subscale, a

one-way ANOVA indicated a trend towards significance for scores on the Emotional Well-being (EWB) subscale of the MHC-SF and recurrence rates ($F_{(2,13)}$=3.31, p=.60), indicating that those patients with higher scores on the EWB subscale may have been less likely to experience a recurrence after the initial injury. A series of one-way ANOVAs indicated that there were no significant main effects or trends observed for scores on the Emotional Well-being subscale of the MHC-SF mRS at six months or discharge destination (*all* p>.05.).

For optimism, a one-way ANOVA indicated a significant main effect for recurrence after CSDH and scores on the CIT-Optimism subscale ($F_{(1,10)}$=8.986, p<.05, f'= 2.1). Those patients with higher optimism scores were less likely to develop a recurrence post-injury (p<.05), (see Figure 14).

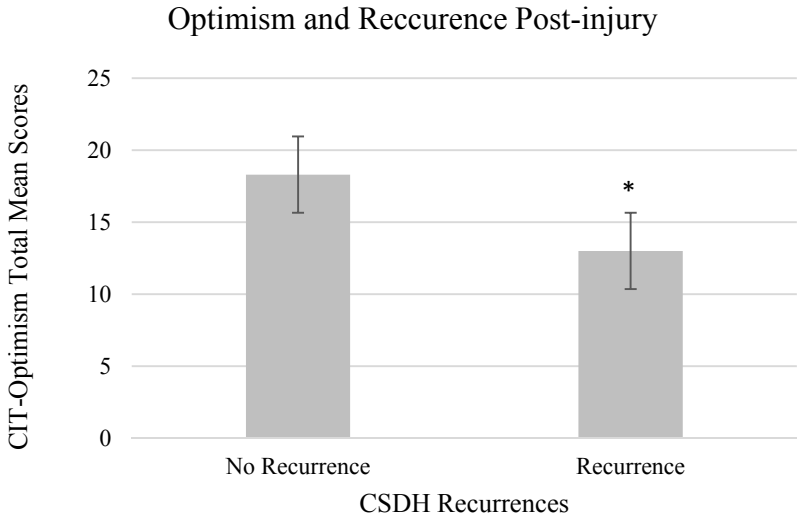

Figure 14 *Mean Performance on Optimism and Recurrence Rates at Six Months*
*Indicates sig. at the level p<.05.
CSDH=chronic subdural haematoma, CIT-Optimism=Comprehensive Inventory of Thriving-Optimism subscale

No significant main effects or trends were observed for performance on the CIT-Optimism subscale and mRS at six months or discharge destination (all p>.05).

6.4.4.3. Physical Well-being

The hypothesis relevant to Physical Well-being and health-related outcomes after CSDH was that greater *Physical Well-being* was expected to predict health-related outcomes after CSDH, including reduced morbidity and reduced healthcare utilisation.

For descriptive information for *Psychological Well-being* and health-related outcome after CSDH, see Appendix I-J. For performance on the Physical well-being subscale, a one-way ANOVA indicated a trend for scores on the Physical Well-being subscale and recurrence rates ($F_{(1,10)}$=3.588, p=.08). This indicates that those patients with higher scores on the PWB Physical Well-being subscale may have been less likely to develop a recurrence post-injury. No further main effects or trends towards significance were observed for physical well-being and global functioning as measured by the mRS, or discharge destination (p>.05).

6.5. Discussion

In this study, a novel theoretical framework of Positive Health was applied to the investigation of recovery after CSDH. The objective of this study was to further explore health assets relevant to a positive recovery after CSDH and the relationship of these assets to long-term health-related outcomes. It was hypothesised that the biological, functional, and subjective health assets proposed by the novel framework would positively contribute to a successful outcome as measured by survival, morbidity, global functioning, and health utilisation.

An unexpected outcome arose from this research. As per the information provided in Figure 10, attrition rates and mortality greatly exceeded initial expectations, and a large proportion of patients were found to be incapable of completing self-report assessments. As such, this study was terminated at six months and findings are discussed in terms of short-term and moderate-term health outcomes. Albeit this limitation does hinder the ability to draw causal links between positive health assets and long-term outcome after CSDH, the findings of this research represent novel discoveries pertinent to recovery after CSDH.

For the relationship between positive health assets and health-related outcome after CSDH, the hypotheses were partially supported. Variables relevant to static biological assets significantly contributed to outcome post-CSDH, whilst dynamic biological assets were shown to be less impactful. For functional positive health, cognitive assets nor prosocial assets were not significantly implicated in health outcomes, whilst person-environment-fit consistently impacted health-related outcomes among CSDH patients. Similar to findings discussed in Chapter 4, Subjective Positive Health was found to be less important to health-related

outcomes. However there is evidence that suggests a potential relationship between optimism and recovery after CSDH, which should be explored further.

These results will now be reviewed according to each domain proposed by the novel Positive Health framework and integrated with previous research and evidence.

6.5.1. Biological Health Assets and Outcome Following CSDH

This thesis integrated disease-relevant variables and variables relevant to lifestyle to develop the domain of Biological Positive Health. Disease-relevant variables were included in the domain of *Static Biological Health,* whilst variables relevant to lifestyle and environmental impact were included in the domain of *Dynamic Biological Health.*

Static biological health assets were expected to predict improved outcome after CSDH as measured by mortality, morbidity, global functioning, and healthcare utilisation. For age, sexagenarians demonstrated improved functioning, greater rates of survival and reduced risk of decline up to six months post-injury. The significant results are consistent with findings reported by Pilitsis et al. (2013) demonstrating that improved outcome was associated with patients under the age of eighty at the time of injury. A progressive decline in health in the general elderly population is expected, however this information adds to the knowledge of risk factors associated with this condition, and further enables the identification of patients at-risk of poorer outcomes.

Although there is a lack of information describing the profile of a successful outcome after CSDH, evidence suggests that male individuals are more likely to be affected by the injury (Marshman et al., 2015), and poorer outcomes are observed in octogenarians (Pilitsis et al., 2013). The current findings support the male bias associated with this condition but provide differential information regarding outcome. Similar to those findings observed in Chapter 3 of

this thesis, CSDH is considered more prevalent among males however women are observed to experience poorer outcomes post-injury. According to Marshman et al. (2015), the known risk factors do not account for the male bias observed among CSDH patients. However, further investigation into the gender differences associated with this disease may yield information to better explain the potential protective factors of male gender during the period following injury. In doing so, research may yield potential targets for the development of gender-specific rehabilitation programs to improve outcome among female patients.

The remaining *Static Biological Health* variables included a history of CSDH, a history of trauma precipitating the injury, time since injury recorded at discharge, and existing history of ischemic heart disease, a history of diabetes, a history of hypertension or stroke, and whether a pre-existing diagnosis of dementia was present. For a history of trauma and time since trauma, the current findings were not conclusive and did not support a relationship between these variables and health-related outcome post-injury. Existing evidence appears to implicate a history of trauma in the development of CSDH, whilst connections have not been demonstrated between this history of trauma and outcome after injury (Adhiyaman et al., 2002; Ahmed et al., 2011; Deci, 2004). Similarly, existing evidence appears to implicate the time since the trauma in the development and size of the CSDH, yet no connections have been established between this characteristic and outcome. Similar to conclusions from the current findings, a history of trauma and the time since that trauma may be more pertinent to the development of CSDH but less relevant to post-operative outcome.

Similarly, known risk factors such as IHD or hypertension could be considered primarily relevant to the development of CSDH. However, the current findings suggest that cardiac ill-health is not implicated in the development of the CSDH, but rather outcome after

the condition. The findings suggest that those patients with a history of cardiac ill-health are more likely to experience a decline in health post-injury. Correspondingly, those patients deemed to have good cardiac health ATOI are more likely to experience more successful health-related outcomes post-CSDH. Existing research does not provide evidence of a predictive nature, however Manickam et al. (2016) provide vital information regarding the relationship between these pre-existing cardiac diagnoses and long-term survival after CSDH. According to the findings, approximately 34% of CSDH were deceased at approximately five years post-injury, and a significant association was observed between IHD and long-term functioning. In fact, IHD was identified as the cause of death among approximately 22% of CSDH patients. This evidence is consistent with the findings from the current study and subsequently demonstrates the prejudicial effect of cardiac ill-health on outcome after CSDH, and the potential protective qualities of positive cardiac health after injury.

In addition to cardiac health, a pre-existing diagnosis of dementia or atrophy on imaging was also implicated in health-related outcome after CSDH. Similar to other known risk factors, atrophy is considered a prevalent contributing factor to the development of CSDH. Baechli et al. (2004) suggest that the loss of tissue associated with cerebral atrophy, allows more movement in the brain which may contribute to haemorrhaging beneath the dura mater, particularly following a minor trauma. The current findings suggest that a predictive, negative relationship also exists between atrophy severity and outcome after CSDH. Those patients with more severe atrophy at discharge, were also expected to have a poorer long-term outcome post-injury. The progressive decline associated with dementia is well-documented in the literature, therefore a decline would be expected in patients with pre-existing diagnosis irrespective of a CSDH diagnosis. Nevertheless, this information further contributes to what constitutes a poor

or successful outcome after CSDH, further strengthening the preclinical factors available for screening purposes.

For biochemical analyses, a significant and detrimental relationship was observed between albumin levels at the time of injury, and long-term mortality rates among patients. Produced in the liver, albumin protein is responsible for ensuring fluid does not leak out of blood vessels and the transportation of specific hormones and enzymes (Peters Jr, 1995). There is a lack of information implicating albumin protein in CSDH fluid. However existing evidence suggests that abnormal albumin protein levels in the blood area are associated with liver damage, malnourishment, and inflammation (Peters Jr, 1995). Further, recent evidence suggests abnormal albumin protein levels may be implicated in the development of multiple sclerosis and may further determine the course of many diseases (LeVine, 2016). For the current study, a significant relationship was observed between albumin protein extracted from the subdural fluid, and mortality rates at six months post-injury. Those patients with higher albumin protein levels at the time of injury, were less likely to survive. This finding is significant and has not been documented in CSDH literature.

In summary, the hypothesis that the *Static* health assets identified by the novel Positive Health framework would contribute to a positive outcome after CSDH was only partially supported. Findings suggests that male patients, younger in age at the time of injury, with good cardiac health, reduced risk of atrophy, and lower albumin levels upon injury are more likely to experience a successful outcome after CSDH. History of trauma and time since trauma appear to be risk factors for the development of CSDH, and less relevant to outcome post-injury. The hypothesis predicting the effect of biological health assets was also inclusive of *Dynamic*

biological health assets as stipulated by the proposed Positive Health framework. The findings relevant to *Dynamic* health assets will now be discussed.

Dynamic health assets relevant to lifestyle factors were expected to significantly contribute to a positive health-related outcome post-CSDH. Whilst known risk factors of CSDH include alcohol misuse, smoking behaviour and anticoagulant medications, the presence of health alcohol-use, non-smoking behaviour, and absence of anticoagulant medications did not predict a successful outcome after CSDH. Similar to previous conclusions provided in this Chapter, alcohol-use, smoking behaviour, and anticoagulant pharmacotherapy appear to be strong predictors of CSDH development but do not appear to contribute to outcome after injury. Despite the non-significant findings, this information provides vital information regarding disease prevention.

As discussed throughout this thesis, a CSDH is a sentinel health event leading to a marked decline in health. Therefore, the prevention of this disease is equally important as is the treatment. Whilst healthy alcohol-use, non-smoking behaviour, and an absence of anticoagulant medications were not deemed to effect recovery post-injury, these *Dynamic* health assets may prevent the development of a disease known to dramatically reduce the life expectancy of a person. As discussed in Chapter 2, the purpose of Positive Health research is to identify health assets relevant to recovery after illness and disease prevention. Hence, *Dynamic Biological Health Assets* may prevent the development of disease and consequently, warrant further investigation.

6.5.2. Functional Health Assets and Outcome Following CSDH

For *Functional Positive Health,* the *Cognitive Assets, Prosocial Assets,* and assets relevant to *Person-Environment-Fit* were expected to contribute to a positive outcome post-

CSDH. For *Cognitive Assets*, only measures of general cognitive functioning were shown to predict a successful outcome post-CSDH, whilst no significant associations were observed for specific cognitive functions, including prospective memory, verbal short-term memory, verbal long-term memory, or inductive reasoning. A potential trend was observed for mRS at discharge and verbal fluency on assessment, however this did not reach statistical significance. Brand et al. (2014) reported a reduction in short-term memory, judgement, spatial sense, and verbal fluency in CSDH patients after injury which may indicate a potential decline in cognition post-injury. However, these findings are significantly compromised due to a small, heterogenous sample size and the reliability of the results are not entirely supported. This limitation also applies to the findings of the current study. The final sample size included for analysis of specific cognitive domains was small, potentially resulting in a significant increase in Type I error. For further details regarding the limitations of the current study, see 5.4.4. *Methodological Concerns* provided in this Chapter.

For *Prosocial Assets,* an overall positive relationship between social well-being and outcome after CSDH was expected. Non-significant differences were found for the measures of social well-being used to measure this domain. The presence of social well-being among CSDH patients has not been documented in the literature, and the findings from the current study are not conclusive. Therefore, it is pertinent that the non-significant findings are investigated in future research, and the measurement of *Prosocial Assets* is refined.

The significant results for *Person-Environment-Fit* are noteworthy. The findings indicate that those patients with greater independence and adaptation to their environment at the time of injury, were more likely to experience a successful outcome post-CSDH. Dooley and Hinojosa (2004) report the importance of *person-environment-fit* after disease and

demonstrate the beneficial outcome of including *person-environment-fit* oriented interventions in the treatments of conditions such as Alzheimer's disease. The results from this study are consistent with their conclusions. Increased *Person-environment-fit* at the time of injury was shown to predict acute measures of recovery including discharge destination and general cognitive functioning, whilst also predicting a successful long-term outcome. Hence, functional independence at the time of injury greatly increases the likelihood of a successful outcome. In addition, Dooley and Hinojosa (2004) demonstrate the efficacy of *person-environment-fit* focused interventions in diseases, particularly among dementia-related populations.

6.5.3. Subjective Health Assets and Outcome Following CSDH

For *Subjective Positive Health,* assets relevant to psychological well-being, emotional well-being, and physical well-being were expected to contribute to a positive outcome post-CSDH. This hypothesis was only partially supported. Psychological well-being and physical well-being were not shown to significantly contribute to outcome post-CSDH. Psychological well-being and physical well-being among CSDH patients during the post-operative period has not been documented in the literature. Therefore, it is unclear whether the current findings are representative of the wider CSDH population. Important to note, the limitations of the current study and reduced sample size may have significantly increased the likelihood of Type I error in the current analyses and future research should aim to test these domains among a larger sample. Despite these non-significant findings, the effect of *Subjective Positive Health* on recovery after CSDH was still supported.

According to the results, assets relevant to emotional well-being were significantly associated with recurrence post-injury. The current result indicated that those patients who demonstrated higher levels of optimism, were less likely to experience a CSDH recurrence.

The positive effect of optimism in predicting a successful recovery after disease is well-documented in the literature (Boehm et al., 2011a; Boehm et al., 2011b; Ikeda et al., 2011; Kubzansky, Park, Peterson, Vokonas, & Sparrow, 2011; Scheier et al., 1989). However, the current study provides the first documented relationship between optimism and recovery after CSDH. The current findings suggest that optimism may significantly contribute to recovery after CSDH and further prevent the accumulation of a sequential CSDH.

6.5.4. Methodological Concerns

There are a number of methodological concerns that are pertinent to the results of this study. These include the sample composition, test selection, and selection of outcome variables. First, there are several issues regarding the sample composition and the ability to conduct self-report assessments among this group of patients. Prior to this study, the psychological or cognitive assessment of CSDH patients was limited and the capabilities of these patients to complete self-report assessments was not documented. During the initial and follow-up stages of data collection, the presence of confusion and dementia-related symptoms significantly affected the ability of patients to complete self-report assessments. Whilst efforts were made to assess all domains stipulated by the Positive Health framework, the incapacity of patients to complete the self-report assessments resulted in a lack of data relevant to Subjective Positive Health. Furthermore, the data that was collected was provided by patients deemed to be fit to complete the assessments, which in turn, may skew the data and represent highly functioning subset of patients, rather than a general patient sample. Moreover, the final sample used for the analysis of subjective health assets was small, and low power may have precluded the achievement of statistical significance on a number of scales. Additionally, the small sample

size may have also contributed to Type II error, and significant results should be interpreted with caution.

Second, the ability to detect positive health assets relevant to all domains is dependent on the scales and tests employed. This study used a theoretically derived framework to inform empirical research (see Chapter 4). Whilst all relevant positive health domains were included in the methodological design, the tests used were not evenly distributed among those domains. This resulted in greater content-validity for the assessment of static biological assets, cognitive assets, and person-environment-fit. Comparatively, dynamic health assets, prosocial assets, psychological well-being, and emotional well-being lacked content-validity and were underrepresented in this study. With regard to the specific selection of tests for Positive Health research, the use of biological data, clinician-rated assessment, and self-report assessments is recommended for the assessment of positive health assets in a clinical population (Seligman et al., 2013). This study aimed to assess patient recovery using a multidimensional approach however, there are undoubtedly challenges that need to be considered when conducting self-report assessments with CSDH patients, and this warrants future research attention.

Finally, the selection of outcome variables requires refinement and further consideration. The outcome variables included in this research provide an indication of the relationship between positive health assets and general functioning, morbidity, recurrence and mortality. However, these outcome variables are biological in nature and do not completely incapsulate the entirety of health and recovery after disease. Wilson et al. (2002) proposed a theoretical model to inform the adequate selection of patient outcomes in health research. According to the model, an assessment of health outcomes in a clinical population should consider biological and physiological variables, symptom status, functional status, general

health perceptions, and psychosocial variables relevant to quality of life (Wilson et al., 2002). Therefore, a focus of future research should be the appropriate identification of outcome variables that encapsulate the health and recovery of patients after CSDH.

6.5.5. Conclusions

This study is unique in its use of a novel, theoretically driven approach to the assessment of recovery after CSDH. Based on the proposed novel framework of Positive Health, methods were selected for assessing the biological, functional, and subjective health assets shown to predict a health-related outcome of CSDH. Biological and functional health assets were the most effective in predicting improved functioning and health after injury. The predictive ability of *Static Biological Health Assets* was well-supported in the current findings and the positive effect of *Person-Environment-Fit* was noteworthy. In addition, *Emotional Well-being* further demonstrated the importance of *Subjective Positive Health* in recovery after disease. These domains were not only associated with a reduced risk of morbidity and mortality after injury but were also implicated in improved functioning after CSDH.

Whilst the results should be cautiously interpreted due to the reduced sample size and potential lack of content validity in specific domains, the findings indicate potential variables vital to a successful recovery after CSDH. These findings are novel and significantly extend what is known about recovery after CSDH

Chapter 7: Conclusion

7.1. Review of the Aims

The purpose of this program of research was to better understand recovery after chronic subdural haematoma (CSDH) from a perspective of Positive Health. The introduction of this thesis (see Chapter 2) highlighted the need for a new health model that better explained recovery after disease. In keeping with this approach, the utility of an existing Positive Health framework was explored with specific consideration given to recovery after CSDH, (see Chapter 3). Based on the theoretical findings identified in Chapter 3, an empirical investigation was conducted to understand the effectiveness of an existing Positive Health framework in determining variables relevant to a successful recovery after CSDH (see Chapter 4). The findings from this empirical investigation highlighted the vulnerability of CSDH patients and further demonstrated the need for a more inclusive and empirically measurable theoretical framework of Positive Health. These limitations informed the development of a novel theoretical framework of Positive Health for use in CSDH research (see Chapter 5). The utility of the novel Positive Health framework was investigated in a clinical sample of CSDH patients (see Chapter 6). The following discussion will examine evidence for the novel Positive Health framework in determining outcome after CSDH. Evidence from existing theories will be examined in conjunction with the empirical findings presented in previous chapters. Directions are provided for future research and treatment, and the limitations of this program of research are recognised.

7.2. Contribution of Knowledge to Understanding Outcome after Chronic Subdural Haematoma

This thesis used an integration of biomedical, biopsychosocial, functional and neuropsychological and positive health research to determine the effectiveness of Positive Health theory in understanding outcome after CSDH. The findings from Study 1 (see Chapter 4) offer modest support for the use of an existing Positive Health framework to determine variables relevant to a successful outcome post-CSDH. Findings from this research demonstrate the importance of restoring the functional capacity of CSDH patients during the early postoperative period, suggesting a direct correlation between independence in activities of daily living (ADLs) and an improvement in long-term outcome. These results are consistent with existing neuropsychological research illustrating the importance of independence in ADLs after brain injury. A pivotal study conducted by Wade and Hewer (1987) denoted the significant relationship between functional capacity and outcome after brain injury. The findings suggested that greater functional independence during the acute period following stroke was significantly associated with reduced mortality rates at six months. Similarly, Carod-Artal and Egido (2009) further demonstrate the significance of functional capacity after stroke and the relationship this has with Health-Related Quality of Life (HRQoL). There is evidence suggesting that those patients with improved functional ability in the acute period following injury experience improved psychological and subjective well-being after brain injury.

Interestingly, the findings from Study 1 (see Chapter 4) demonstrated a differential outcome associated with important variables relevant to Biological Positive Health. The presence of a male bias in development of CSDH is well-documented in the literature, hence

female patients were expected to experience improved outcome post-CSDH (Marshman et al., 2015; Oh, Shim, Yoon, & Lee, 2014). However, whilst the development of CSDH was more common amongst males, the findings from Study 1 (see Chapter 4) suggest males experience a more favourable outcome, whilst female patients are more likely to experience a reduction in cognitive functioning and an increased risk of recurrence. Research investigating the differential outcome of female CSDH patients is limited, however evidence does suggest that female CSDH patients are more likely to experience poorer outcome post-CSDH (Hotta et al., 2017). Findings from Study 1 (see Chapter 4) contribute to the growing breadth of knowledge regarding gender differences and recovery after CSDH, and warrant further investigation and replication.

Perhaps the most notable contribution of the findings from Study 1 (Chapter 4) is the identification of health assets that combine to form a positive recovery after CSDH. This research identified biological health assets, including male gender, bilateral or right-sided CSDH, non-smoking behaviour, and low-risk alcohol use (Chapter 4, pp.77-80). Functional assets included optimal global cognitive functioning, high social functioning and greater independence in daily activities (Chapter 4, pp.80-84). In contradiction, only weak support was found for Subjective health assets in improving outcome after CSDH, specifically high psychological well-being (Chapter 4, pp.84-86). The findings for Subjective Positive Health are not consistent with existing evidence.

Alternate conclusions are well-documented in the literature, documenting the significant relationship between emotional well-being and outcome after mild traumatic brain injury (Rimel, Giordani, Barth, Boll, & Jane, 1981). Rabinowitz et al. (2015) suggest the importance of social well-being in predicting cognitive outcome after brain injury. These

findings are further supported, with psychological well-being shown to significantly contribute to outcome following acquired brain injury (Boosman et al., 2017). The findings from Study 1 (see Chapter 4) do not reflect those conclusions identified in existing literature and suggest that variables relevant to Seligman's (2013) domain of Subjective Positive Health do not contribute to outcome after CSDH. The results found here are the first to be documented in a CSDH sample and warranted replication along with an examination of the structural quality of Seligman's (2001) Positive Health framework (see Chapter 4).

The limitations of Seligman's (2008; 2013) Positive Health framework were discussed in Chapter 3 of this thesis. As discussed, the lack of theoretical structure and standardisation in existing Positive Health frameworks result in varied interpretations of factors relevant to Positive Health and a lack of empirically measurable variables. Hence, an alternative organisation of Positive Health was proposed (see Chapter 5).

The novel framework was based on a human systems approach and focused on the conceptual organisation of Positive Health domains and the relationship between the theoretical structure and the translation to empirical research. The general organisation of the framework was derived from the existing structure provided in Seligman's (2008; 2013) Positive Health framework which contends that Positive Health is comprised of a combination of biological, functional, and subjective health assets. However, the subdomains were significantly refined and organised using a theoretically driven approach.

As discussed in Chapter 5, the organisation of the biological, functional, and subjective domains of the novel framework used a human systems approach (Seeman, 1989). This thesis proposed a framework of Positive Health that is constituted by the successful integration of three internal subsystems; a Biological subsystem, a Functional subsystem, and a Subjective

subsystem. The organisation of these subsystems was theoretically driven, and existing health literature was used to identify potential health assets relevant to each domain. The utility of this novel Positive Health framework in the understanding of outcome after CSDH was examined in Study 2 (see Chapter 6).

The findings from Study 2 (see Chapter 6) further supported findings observed in Study 1, with additional results provided. First, the findings from Study 2 indicated a significant relationship between functional capacity and person-environment-fit¸ and outcome after CSDH. In fact, those patients with higher levels of functional capacity and adaptation to their environment at the time of injury, experienced improved long-term functioning and longevity.

Further, the findings from Study 2 (see Chapter 6) replicated the findings from Study 1 indicating the differential outcome associated with gender. Findings from Study 2 indicated that whilst male individuals are more likely to develop a CSDH, female patients are at risk of poorer outcome after injury. In addition to this evidence, the findings also suggested that those patients with a history of poor cardiac health also demonstrated poorer outcome post-CSDH. On further examination of existing literature, a link may exist between these two important variables. According to a meta-analysis conducted by Camm, Camm, and Savelieva (2017) female gender is a significant risk factor for stroke associated with atrial fibrillation. According to the literature, there is increasing evidence suggesting an interaction between poor cardiac health and stroke among women. Females who experience a stroke also appear to have a pre-existing history of poor cardiac health, including atrial fibrillation and heart disease. This potential link has significant implications for the findings from this thesis.

According to the results in Study 2 (see Chapter 6), patients with poor cardiac health and patients of female gender, are more likely to experience poorer outcome post-CSDH.

Whilst the differential outcome of male and female CSDH patients has not been explained in the literature, these findings may suggest an underlying component of poor cardiac health that contributes to poorer outcome among women. This is a novel conclusion and warrants further investigation.

As discussed, the findings from Study 1 (see Chapter 4) suggested a non-significant relationship between Subjective Positive Health and outcome after CSDH. To further explore this relationship, Study 2 (see Chapter 6) extended and refined the domain of Subjective Positive Health to better understand the relationship between psychological, emotional and physical well-being, and outcome after CSDH. Despite the non-significant findings from Study 1, Subjective Positive Health was hypothesised to contribute to a positive outcome post-CSDH. The hypothesis was only partially supported and only variables relevant to the subdomain of emotional well-being were found to contribute to a positive outcome. Specifically, optimism was shown to decrease the risk of long-term recurrence post-injury. The relationship between optimism and disease prevention is well-documented in the literature, particularly among the elderly (Boehm et al., 2011a; Ikeda et al., 2011; Kim et al., 2017; Kim et al., 2011; Scheier et al., 1989). Similar to the findings from the current study, the literature suggests that optimism protects against the development of disease and illness, whilst simultaneously buffering against cognitive decline and mortality. The findings from the current study support this relationship and add to potential directions for future research.

The contributions of this thesis to the breadth of knowledge surrounding outcome after CSDH are invaluable. The specific contributions are three-fold. First, this research program is the first to document the biological, functional, and subjective outcome of CSDH patients. As discussed in Chapter 3, no current study exists whereby the functional or subjective outcome of

CSDH patients are considered as primary outcome variables, and of the information that does exist, conclusions are hindered by a lack of standardised research.

Second, this thesis is the first to document variables that significantly predict a positive outcome after CSDH. The findings from this research suggest that variables relevant to gender, cardiac health, functional capacity, and emotional well-being significantly reduce the long-term risk of recurrence, morbidity, and mortality after CSDH. Currently, no research exists to investigate variables relevant to the successful long-term outcome of CSDH patients.

Finally, the evidence provided in this program of research offers the first indication of empirically supported targets for future intervention. The findings from this research suggest a focus on cardiac health, functional independence, and emotional well-being during the acute post-operative period may directly contribute to a positive long-term outcome. Currently, no rehabilitation programs or patient-centred interventions exist to manage CSDH patients, therefore the findings from this study provide a potential direction for evidence-based intervention.

7.3. Implications of a Positive Health Framework for the Understanding of Disease

This thesis has presented a program of research that was both theoretically based and empirically applied. A novel theoretical perspective of Positive Health was developed to significantly extend existing knowledge pertaining to outcome after CSDH. The first empirical study demonstrated the potential of a Positive Health framework in determining factors relevant to a successful outcome after CSDH. The novel framework proposed significantly extended existing Positive Health structures and provides an inclusive and empirically measurable framework for use in health research. The potential of the novel framework was further demonstrated in the second empirical study and findings from this research greatly

extended what is known about recovery after CSDH. Importantly, the novel contributions of this program of research are not restricted to outcome after CSDH.

Similar to existing CSDH literature, a large proportion of research investigating outcome after brain injury and disease alike, remains governed by the biomedical and biopsychological models of health. Therefore, existing health literature suffers from the same consequence observed in CSDH research. There is a lack of research investigating outcome beyond disease-focused, negative determinants of health (Álvarez et al., 2012; Antoni & Lutgendorf, 2007; Beecher, 2009; Bitton et al., 2008; Engel, 1977; Wade & Halligan, 2004; Zigmond, 1976). As suggested by Wade and Halligan (2004) the current disease-focused approach to understanding disease does not explain many forms of illness and an understanding of disease must arise from an appreciation of an individual's personal, social, and environment well-being.

The novel Positive Health framework proposed in this thesis provides a potential solution to the shortcomings observed in current health research. The approach and structure of the novel framework is relevant to all forms of disease and as demonstrated in the findings from Study 1 (see Chapter 4) and Study 2 (see Chapter 6), the use of this framework to understand other diseases may yield significant findings not yet documented in the literature. Hence, the contribution of this program of research is not only relevant to outcome after CSDH but may be of further use to understanding disease beyond conventional health models.

7.4. Limitations of Current Research

This thesis acknowledges the potential boundaries and limitations of the approach and empirical investigations discussed in this thesis. The first entails the difficulties associated with a novel approach of Positive Health to existing health literature. As discussed in Chapter 3, an

attempt was being made to re-analyse existing health literature for variables relevant to a good recovery after illness or disease. This approach aims to identify positive health assets in literature largely governed by a disease-focused, biomedical model approach. Hence, this thesis acknowledges the boundaries of this method of mining existing literature for relevant Positive Health variables and subsequently recognises the largely explorative approach required for interpretation.

The second limitation of this program of research refers to the sample size used in both empirical studies. The relatively low participant numbers in Study 1 and Study 2 are a result of the reduced capacity of CSDH patients to participate and the attrition rates associated with the decline in health associated with the condition. The reduced sample sizes affect the generalisability of the data and require replication. However, it is this finding that contributes to one of the strengths of the research. The finding that CSDH patients experience a dramatic decline in cognitive capacity and overall health is a novel finding in CSDH literature, despite this resulting in smaller sample sizes. Whilst only a minority of patients were capable of completing the self-report assessments included in this research, this evidence exemplifies the urgent need for patient-centred care for CSDH patients, particularly during the acute post-operative period.

The cognitive limitations of CSDH patients further contributed to the content-related evidence for validity in this research. The collection of data relevant to Subjective Positive Health was disproportionate to the sources of data available for Biological or Functional Positive Health and a large proportion of patients were not able to complete the self-report assessments relevant to Subjective Positive Health (see Chapter 6). This limitation was not

initially predicted and although the current results were affected, this information will be useful for the development of more comprehensive assessments in future research.

7.5. Directions for Future Research

Future research could address the specific limitations of this thesis. First, the relationship between functional independence and long-term recovery requires cross-validation. Ideally, this should incorporate a randomised control trial using evidence-based interventions focused on improving independence in activities of daily living and cognitive recovery. The research would benefit from a longitudinal approach in which patients were randomised to an evidence-based intervention during the acute post-operative period, and assessments be conducted to infer long-term outcome. Potential interventions can be identified in occupational therapy literature, suggesting the beneficial outcome of interventions focused on improving functional independence among patients with cancer, stroke, or mild cognitive impairment (Corbetta, Imeri, & Gatti, 2015; Friedmann et al., 2015; Pergolotti, Deal, Lavery, Reeve, & Muss, 2015). Moreover, a sufficiently large sample would enable the application of regression analysis to predict the relationship between intervention and outcome.

Second, the interaction between cardiac health and gender among CSDH patients needs to be investigated. Despite the common presentation of this condition, the disease aetiology is not well-documented and there is a lack of evidence explaining the differential outcome associated with female CSDH patients. The empirical findings discussed in this thesis provide the potential evidence for this relationship and if successful, future research may be able to uncover the gender-specific mechanisms behind CSDH development and outcome.

Third, there is a need to explore the capabilities of CSDH patients and the appropriate measures to be included in the methodological design. The findings from the empirical

research discussed in this thesis highlighted the incapacity of CSDH patients to complete self-report assessments. Therefore, the results of the current research cannot clarify the true relationship between psychological, emotional, or physical well-being and outcome after CSDH. Future research should explore other means of collecting data relevant to Subjective Positive Health. Currently, available measures used to assess psychological, emotional, or physical well-being are predominately self-report assessments as a means of collecting data. Although the use of self-report assessments can provide invaluable information, the use can result in bias, inconsistent results due to social desirability, malingering, or selection bias due to the required cognitive capacity of participants, as is demonstrated in the current research (Stone, Bachrach, Jobe, Kurtzman, & Cain, 1999). There is evidence suggesting the beneficial use of clinician-rated or informant-rated assessments to measure conditions such as schizophrenia, Huntington's disease, or depression. Recently, there have been suggestions to include the use of clinician-rated assessments to measure well-being among clinical samples (Carlozzi et al., 2018; Krieger et al., 2014; Luther, Firmin, Lysaker, Minor, & Salyers, 2018). As discussed in this thesis, CSDH patients experience a dramatic decline in cognitive capacity, therefore future research may greatly benefit from the inclusion of clinician or informant means of assessing Subjective Positive Health among patients.

Finally, future research should not negate the importance of negative determinants of health in recovery after disease. Whilst the limitations of existing medical models have been discussed in detail, this thesis does not aim to discredit the understanding of disease pathogenesis, but rather highlights the importance of understanding the entire spectrum of health as it relates to recovery after brain injury and disease prevention.

Therefore, it is suggested that the future direction of health research aim to develop a single health model that incorporates both the biomedical model and Positive Health theory. As defined by World Health Organization (WHO), health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (*Constitution of the World Health Organization*, 1948). This thesis has focused on the first premise of this clause, however it should be noted that the absence of illness and disease is still paramount to the overall health of an individual.

The conclusions of this thesis have provided a basis for Positive Health and the potential of a future Positive Health model. If found to be effective, it is the suggestion of this thesis that existing biomedical models and a new Positive Health model be combined, to inform a single health model aimed at determining causal factors as they relate to the spectrum of health.

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APPENDIX A Retrospective Study National Ethics Application Form (NEAF)

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APPENDIX B Retrospective Study Information Sheet

JAMES COOK UNIVERSITY AUSTRALIA

Queensland Government

Information for Participants

Project Title: Chronic Subdural Haematoma Assessment and Recovery Management (CHARM)

It is widely considered that a chronic subdural haematoma (bleeding or blood clot around the brain) is a condition that is easily treatable, and which, following treatment, has no lasting or subsequent problems. This study aims to follow-up patients who were admitted to the Townsville Hospital and received treatment for a chronic subdural haematoma (CSDH). We are hoping that the information we learn from the CHARM project will help us to better understand the outcomes and recovery of individuals after experiencing a CSDH and the needs that these individuals have, which would help us develop appropriate health services to support those needs.

If you agree to be part of the CHARM project, you will be invited to participate in an initial telephone interview, where we will ask you some questions about yourself, your experience of a CSDH, including recovery, as well as some other general knowledge and thinking tasks. Following this telephone interview, we would invite you to attend a face-to-face visit, along with follow-up telephone and in-person interviews in 12 months.

At each face-to-face visit you would see a neurosurgeon and a psychologist for a range of medical and psychological assessments. The medical assessment would involve a brief medical and neurological examination. We will also perform a brain scan (either CT or MRI). During the psychological assessment, you will be asked to complete a group of different psychological tasks and questionnaires. Some questions will be about how you have been feeling in the last few weeks, any concerns you have, and any needs you might have for health services. Other tasks will be like puzzles and games, and we will ask you to try and solve different problems, remember shopping lists, and copy some diagrams.

The telephone interview will take about 30-40 minutes, while the face-to-face visits would take about 60-90 minutes. Being a part of the CHARM project is your choice, so you can change your mind and withdraw or drop out at any time. This will not have any effect on your medical treatment or care.

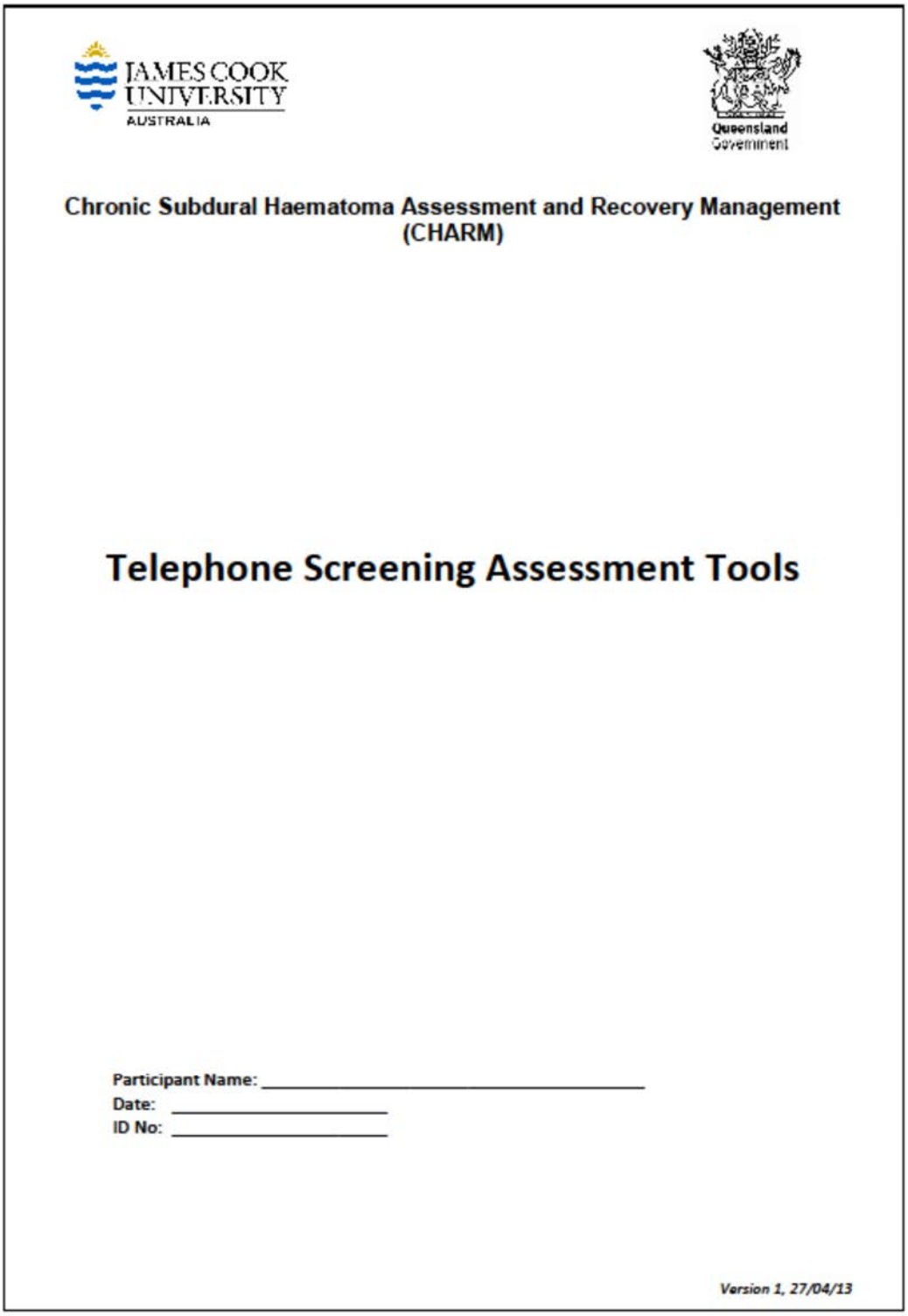
The research is bound by privacy and confidentiality guidelines that Queensland Health and James Cook University follow. The CHARM researcher will have access to your Queensland Health medical records. Any information collected during CHARM will be confidential and used for research purposes only. Any personal information will not be released and will only be available to the CHARM researchers. The information we collect will be destroyed five years after the completion of research. Any data published will refer to group results, with no individual or identifying information included.

We will give you a call in the next week or so to see if you are interested in participating. If you would like to ask a few questions before deciding, please feel free to contact us on (07) 4781 3280.

If you have any concerns regarding the ethical conduct of this study, please contact: The Ethics Coordinator, Medical Administration, The Townsville Hospital, PO Box 670, Townsville QLD 4811.

Version 2, 27/04/13

APPENDIX C Retrospective Study Participant Protocol



JAMES COOK UNIVERSITY
AUSTRALIA

Queensland Government

Chronic Subdural Haematoma Assessment and Recovery Management (CHARM)

Telephone Screening Assessment Tools

Participant Name: _____
Date: _____
ID No: _____

Version 1, 27/04/13

APPENDIX D Retrospective Study Between-Groups Descriptives and Statistical Significance

Variables	CSDH	ICH	Controls	*p*	*Effect size*
Biological					
Admission days	14.23±14.77, 1-76	25.9±24.3, 1-97	-	.62	-
Smoking	13.7%	38.1%	5.8%	.00**	-
Alcohol-use	66.7%	66.7%	68.1%	.853	-
Functional					
FAQ	3.08±4.51	3.03±4.1	.47±.92	.00**	.29
mRS	1.00	3.00	-	-	-
COGTEL-PM	2.52±3.48	3.88±3.66	1.03±2.55	.00**	-
COGTEL-VSTM	2.83±1.38	2.7±1.6	3.1±1.7	.63	.11
COGTEL-VLTM	3.1±1.6	3.3±1.7	3.59±1.6	.34	.13
COGTEL-WM	5.7±1.9	5.6±2.1	5.58±1.97	.95	.03
COGTEL-VF	5.2±1.9	4.76±1.8	4.9±1.13	.52	.11
COGTEL-IR	6.36±3.0	6.1±3.4	7.67±3.4	.07	.20
COGTEL-Total	25.7±8.7	26.2±8.2	25.8±8.1	.97	.03
MHC-SF SWB	13.1±5.5	10.45±5.7	17.0±5.4	.00**	.44
Subjective					
MHC-SF EWB	11.78±3.0	10.7±3.6	12.9±2.5	.00**	.29

Variables	CSDH	ICH	Controls	*p*	*Effect size*
MHC-SF PWB	21.7±6.1	19.6±6.2	23.8±5.6	.01**	.28
MHC-SF Total	46.6±12.4	40.7±13.4	53.7±12.1	.00**	.40
GDS	2.89±2.6	4.0±3.5	1.38±2.12	.00**	.37

**NB: Cohen's f statistic was calculated for between-groups effect sizes for independent variables with more than two levels. ^Mode provided due to ordinal variable. ** denotes sig. at the level <.001.* Abbreviations: CSDH=chronic subdural haematoma patients, ICH=intracranial haemorrhage patients, *p*=p-value, FAQ=Functional Activities Questionnaire, mRS=modified Rankin Scale, COGTEL=Cognitive Telephone Screening Instrument, PM=COGTEL-Prospective Memory subscale, VSTM=COGTEL Verbal Short-term Memory subscale, VLTM=COGTEL Verbal Long-term Memory subscale, WM=COGTEL Working Memory subscale, VF=COGTEL Verbal Fluency subscale, IR=COGTEL Inductive Reasoning subscale, MHC-SF=Mental Health Continuum Short Form, SWB=Social Well-being Subscale, EWB=Emotional Well-being subscale, PWB=Psychological Well-being subscale, GDS=Geriatric Depression Scale

APPENDIX E Retrospective Study: Within-Groups Correlational Analyses and Statistical Significance

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Age at the time of CSDH																
2.	Age at assessment	**.99****															
3.	Total comorbidities	**.37****	**.40****														
4.	COGTEL-PM	-.04	-.01	.09													
5.	COGTEL-VSTM	**-.21**	-.21	**-.30****	**.39***												
6.	COGTEL-VLTM	-.26	-.24	-.17	**.32***	**.58****											
7.	COGTEL-WM	.03	.08	-.17	-.12	.14	.20										
8.	COGTEL-VF	.02	.04	-.02	**.45****	.07	**.24***	.11									

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
9. COGTEL-IR	-.04	-.04	**-.33****	.22	.22	**.43****	**.39****	**.42****								
10. COGTEL Total	-.11	-.08	-.16	**.71****	**.53****	.67**	**.44****	**.60****	**.75****							
11. FAQ Total	**.30***	.26	**.26***	**-.37***	-.07	-.23	-.12	**-.38****	**-.33****	**-.33****						
12. SWB MHC-SF	**-.38***	.34*	.04	.00	.04	.14	.18	.18	.14	.11	**-.23***					
13. EWB MHC-SF	.20	.21	.08	-.07	-.00	.07	.15	.10	**.25***	.10	**-.23***	**.56****				
14. PWB MHC-SF	-.31*	-.30*	-.09	-.14	-.02	-.00	.12	.12	.00	-.03	**-.35****	**.61****	**.56****			
15. MHC Total	-.10	.03	-.02	-.14	.01	.08	.07	.15	.11	.05	**-.32****	**.89****	**.78****	**.88****		
16. GDS Total	**.38***	**-.38****	.12	-.28	-.18	-.10	-.19	**-.29***	**-.40****	**-.36****	**.23***	**-.32**	**-.57****	**-.33****	**-.42****	

*Denotes sig. at the level <.01. ** denotes sig. at the level <.001.* Abbreviations: CSDH=chronic subdural haematoma patients, ICH=intracranial haemorrhage patients, *p*=p-value, FAQ=Functional Activities Questionnaire, mRS=modified Rankin Scale, COGTEL=Cognitive Telephone Screening Instrument, PM=COGTEL-Prospective Memory subscale, VSTM=COGTEL Verbal Short-term Memory subscale, VLTM=COGTEL Verbal Long-term Memory subscale, WM=COGTEL Working Memory subscale, VF=COGTEL Verbal Fluency subscale, IR=COGTEL Inductive Reasoning subscale, MHC-SF=Mental Health Continuum Short Form, SWB=Social Well-being Subscale, EWB=Emotional Well-being subscale, PWB=Psychological Well-being subscale, GDS=Geriatric Depression Scale

APPENDIX F Prospective Study: Human Research Ethics Committee Amendment Form

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APPENDIX G Prospective Study: Participant Information Sheet and Consent Form

Townsville Hospital and Health Service

Queensland Government

PATIENT/PARTICIPANT INFORMATION SHEET

PROTOCOL NAME: The pathophysiology of chronic subdural haematomas: factors affecting operative recurrences, a male predisposition and factors influenced by corticosteroid co-administration. Prospective assessment of physical and mental outcome.

INVESTIGATORS: Dr Laurence Marshman, Dr Maria Hennessy, Ms Claire McMillan

Introduction
Chronic subdural haematoma (CSDH) ('blood clot') is one of the most common neurosurgical conditions encountered: however, its cause is not known. The standard treatment is to drain the CSDH through two holes drilled in the skull, and to leave in a plastic drain for 2-3 days.

What is the purpose of this research?
It is not known why some patients have a good response to just one operation, and why others require a second (or even third) operation. It is also not known why some patients continue to produce excessive CSDH fluid for some days, while others produce little. Some of you will be receiving medication called 'corticosteroids' as part of this study: it is not known whether these affect further bleeds (and further operations), or CSDH fluid composition.

What does participation in this research involve?
You can participate in this study if you are over 18 years old, if you are of either sex, not pregnant, and if you have symptomatic CSDH diagnosed on a brain scan. You will undergo surgery with two burr holes drilled into you skull using antibiotic 'cover'. A drain coated with antibiotics will be left for 2-3 days after operation to release CSDH fluid which continues to form. Everyone will receive drugs to stop epileptic fits, whilst some of you with receive 'corticosteroid' drugs as part of the study. The thick coat which surrounds the brain (the 'dura mater') must be opened to release the CSDH fluid: this is usually just cut and diathermied. However, we will also take some of this to look for chemicals implicated in re-bleeds, and to see why CSDH are so much more common in males.

The fluid drained is usually just measure for amount and then discarded: however, we intend to measure a number of chemicals and 'markers' within fluid which may help to answer some of all of the questions above. A one-off sample of blood (less than a teaspoonful) will also be taken from your arm in the course of a routine 'blood' specimen: this is to measure some chemicals, as well as a gene which we suspect may make some CSDH bleed more than others.

APPENDIX G Prospective Study: Participant Information Sheet and Consent Form

We will also be asking you to complete some short puzzles and tasks about attention and memory, along with some short questionnaires about how you have been thinking and feeling lately.

Does the participant have to take part in this research project?
Being part of this study is you choice, and you can change your mind and withdraw or drop out at any time. This will not have any effect on your medical treatment or care.

What will happen to information about the participant?
The study is bound by the privacy and confidentiality guidelines that Queensland Health follows. The researchers will have access to your Queensland Health medical records. Any information collected during out study is confidential and will only be available to the researchers. We will not be releasing any individual or personal information about you. The information we collect will be destroyed seven years after the completion of the research. Only group results will be presented in any written reports, and no information that could identify individuals will be reported.

Are there any general benefits to being part of this study?
We are hoping that the information we learn about CSDH from this study will help us to understand better the needs that people have after experiencing a brain injury.

Who is conducting this study?
The study is being conducted by Dr Laurence Marshman who is a Consultant Neurosurgeon at The Townsville Hospital. His research team includes Dr Maria Hennessy who is a Clinical Neurpsychologist at James Cook University, and Ms Claire McMillan who is a Ph.D. research student at James Cook University.

Research Contact Person:
Name: Dr Laurence Marshman
Position: Consultant Neurosurgeon
24-Hour Phone: Neurosurgery Registrar on-call (Dect phone: 3584)

This project has been reviewed and approved by the Townsville Hospital and Health Service Human Research Ethics Committee. For concerns relating the conduct of this project contact:
HREC Chairperson
Phone: 07 4433 1440
Email: TSV-Ethics-Committee@health.qld.gov.au

APPENDIX G Prospective Study: Participant Information Sheet and Consent Form

This administrative form has been removed

APPENDIX H Prospective Study: Participant Protocol

Chronic Subdural Haematoma (CSDH) Prospective Assessment

Questionnaire Booklet

Thank you for filling out our questionnaires.

We appreciate your time and effort.

If you have any problems, please ask for help.

APPENDIX H Prospective Study: Participant Protocol Cont.

Demographic Questionnaire

Participant ID:_____

1) CSDH Prospective Study Demographics Questionnaire

Name:_____ URN:_____

Address:_____

Age: _____

Gender: 1. Male 2. Female

1) In which country were you born? _____

2) Is English your first language?

☐ 1. No

☐ 2. Yes

3) Are you of Aboriginal or Torres Strait Islander origin?

☐ 1. No ☐ 3. Yes, Torres Strait Islander

☐ 2. Yes, Aboriginal ☐ 4. Both

4) What is your marital status?

☐ 1. Single ☐ 3. De-facto ☐ 5. Separated

☐ 2. Married ☐ 4. Divorced ☐ 6. Widow

5) Which of the following best describes the setting in which you live?

1. Living on own
2. Living with parents
3. Living with friends
4. Living with partner
5. Boarding accommodation
6. Rehabilitation Facility
7. Nursing home
8. Other

6) What is the highest level of education you have completed?

1. Postgraduate Degree 5. Year 11 – 12

APPENDIX H Prospective Study: Participant Protocol Cont.

2. Bachelor Degree
3. Diploma
6. Year 8 – 10
7. Primary Education

7) Certificate / Trade
8. Other

8) Are you currently in paid employment?

1. Full Time
2. Part Time
3. Self-employed
4. Unemployed
5. Student
6. Retired
7. Home based Carer / Parent

9) Which type of occupation best describes your most recent job? If you do not work, please tell me the job you had before you finished.

Occupation:

1. Service Work
2. Clerical and Administrative Work
3. Community and Personal Service Work
4. Technicians and Trade based work
5. Professional
6. Manager
7. Labourer
8. Machine Operation / Driver
9. Other

10) Which income bracket best describes your household?

1. Pension
2. Less than $35,000
3. $35,000 - $65,000
4. $65,000 - $95,000
5. More than $95,000

Now I have some brief questions related to your medical history and subdural haematoma.

11) Have you ever experienced a subdural haematoma prior to this admission?

1. No
2. Yes – please describe:

12) Have you ever had any other head injuries, or been concussed previously?

1. No
2. Yes – please describe:

APPENDIX H Prospective Study: Participant Protocol Cont.

13) Do you have any other current medical concerns or conditions?

1. No
2. Yes – please describe:

14) Do you take any prescription medication?

1. No
2. Yes – please describe:

15) Are you a smoker?

1. No, never
2. No, but I used to
3. Yes I am a current smoker

No. of cigarettes per day:

16) Do you drink alcohol?

1. No *(go to Question 16)*
2. Yes *(please answer the following questions)*

15a) If yes, how often do you have a drink?

1. Once a week or less
2. 2-3 times a week
3. 4-5 times a week
4. Daily or almost daily

15b) What kind of drink do you prefer to have?

15c) How many standard drinks would you normally have in one sitting?

17) Do you take any other non-prescription medication, including vitamins, over the counter medication (i.e. aspirin), or other substances?

1. No
2. Yes – please describe (include type and frequency):

18) Do you have any hearing difficulties?

1. No
2. Yes – please describe:

APPENDIX H Prospective Study: Participant Protocol Cont.

19) Do you have any difficulties with your vision?

1. No
2. Yes – please describe:

Now I just have some different thinking questions for you, and then some other questions about how you have been feeling and thinking lately. Do you have any difficulties holding a pencil?

APPENDIX H Prospective Study: Participant Protocol Cont.

Australian Government
Department of Veterans' Affairs

Alcohol Screen (AUDIT)

Full Strength Beer 285ml 4.8% Alcohol	Low Strength Beer 425ml 2.7% Alcohol	Pre-mix Spirits 275ml 5% Alcohol	Wine 100ml 13.5% Alcohol	Spirits 30ml 40% Alcohol	Full Strength Beer Can or Stubbie 375ml 4.8% Alcohol
					

*This guide contains examples of **one standard drink**.*

A full strength can or stubbie contains ***one and a half standard drinks***.

Introduction

Because alcohol use can affect health and interfere with certain medications and treatments, it is important that we ask you some questions about your use of alcohol. Your answers will remain confidential, so please be as accurate as possible. Try to answer the questions in terms of '**standard drinks**'. Please ask for clarification if required.

AUDIT Questions Please tick the response that best fits your drinking.

						Score	Sub totals
	Never	*Monthly or less*	*2 - 4 times a month*	*2 - 3 times a week*	*4 or more times a week*		
1. How often do you have a drink containing alcohol?	☐ Go to Qs 9 & 10	☐	☐	☐	☐	☐	
	1 or 2	*3 or 4*	*5 or 6*	*7 to 9*	*10 or more*		
2. How many standard drinks do you have on a typical day when you are drinking?	☐	☐	☐	☐	☐	☐	
	Never	*Less than monthly*	*Monthly*	*Weekly*	*Daily or almost daily*		
3. How often do you have six or more standard drinks on one occasion ?	☐	☐	☐	☐	☐	☐	☐
4. How often during the last year have you found that you were not able to stop drinking once you had started?	☐	☐	☐	☐	☐	☐	
5. How often during the last year have you failed to do what was normally expected of you because of drinking?	☐	☐	☐	☐	☐	☐	
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?	☐	☐	☐	☐	☐	☐	☐
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	☐	☐	☐	☐	☐	☐	
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?	☐	☐	☐	☐	☐	☐	
	No		*Yes, but not in the last year*		*Yes, during the last year*		
9. Have you or someone else been injured because of your drinking?	☐		☐		☐	☐	
10. Has a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested you cut down?	☐		☐		☐	☐	☐
						TOTAL	

Supplementary Questions	*No*	*Probably Not*	*Unsure*	*Possibly*	*Definitely*
Do you think you presently have a problem with drinking?	☐	☐	☐	☐	☐
	Very easy	*Fairly easy*	*Neither difficult nor easy*	*Fairly difficult*	*Very difficult*
In the next 3 months, how difficult would you find it to cut down or stop drinking?	☐	☐	☐	☐	☐

D0718 - 8/09 - P1 of 2

APPENDIX H Prospective Study: Participant Protocol Cont.

Cognitive Telephone Screening Instrument (COGTEL) Version B

Now I'm going to be asking you some different thinking questions. Some of these questions can be difficult over the telephone, so please let me know if you would like me to clarify or go over anything.

1. Prospective Memory

At a later point in time during these questions there will be a task where I will ask you to name as many different kinds of furniture as you can in 1 minute. So, when I later say "*Please try to name as many different kinds of furniture as possible during 1 minute"*, at that time please tell me your year of birth. Do you have any questions?

Score: (0 = incorrect; 1 = correct) _____

2. Verbal Short-Term Memory (Word Pairs)

Now I will read out a list of word pairs to you. Some of the words are not necessarily associated with each other, so some of the pairs may seem random. After I read out the list, I will say the first word in the pair, and I want you to tell me the second word. For example, if I said *"east–west"* then when I later say *east* you would say *west*. And then if I said "*gold–walk*", when I later say *gold*, you would say *walk*. Any questions? I can only read out the list once, so please listen carefully.

(Read out word pairs 1 second in between each pair)

- Tool – hammer
- Brush – paint
- Sofa – cheese
- Music – eagle
- Beverage – juice
- Gulp – car
- Animal – fish
- Oak – scissors

Which word was associated with . . .?

(5 seconds for response; provide correct answer/feedback for recall task)

- animal (fish) _____
- gulp (car) _____
- beverage (juice) _____

APPENDIX H Prospective Study: Participant Protocol Cont.

- brush (paint)_____
- oak (scissors)_____
- tool (hammer)_____
- music (eagle)_____
- sofa (cheese)_____

Later, I will ask for these word-pairs once again, so don't forget them.

Score: (1 point each correct pair; max 8) _____

3. Working Memory (Digits Backwards)

Now I will read out some numbers to you. When I am done, I want you to tell me the numbers, but in reverse order. For instance, if I said *2–8*, then you would say (*let the participant give the answer*). (If the participant does not say 8–2): No, I said 2–8, so you should say 8–2.

I can only say the numbers once, so please listen carefully.

Let's try some more. *(Discontinue after both trials in a sequence are incorrect.)*

	Sequence	**Correct**	**Response**
1)	6, 3	3, 6	
2)	1, 5	5, 1	
3)	3, 9, 4	4, 9, 3	
4)	6, 2, 5	5, 2, 6	
5)	4, 1, 8, 3	3, 8, 1, 4	
6)	5, 9, 6, 1	1, 6, 9, 5	
7)	2, 5, 9, 2, 6	6, 2, 9, 5, 2	
8)	6, 2, 5, 8, 4	4, 8, 5, 2, 6	
9)	6, 8, 2, 5, 1, 9	9, 1, 5, 2, 8, 6	
10)	4, 6, 9, 1, 3, 8	8, 3, 1, 9, 6, 4	
11)	8, 2, 1, 9, 3, 5, 4	4, 5, 3, 9, 1, 2, 8	
12)	5, 6, 3, 9, 2, 1, 8	8, 1, 2, 9, 3, 6, 5	

Score: (1 point for each correct answer; max 12) _____

APPENDIX H Prospective Study: Participant Protocol Cont.

4 Verbal Fluency (Executive Functioning)

Letter Fluency: Now please try to say as many words as possible that start with the letter "**S"** during 1 minute. You should not repeat any words and you should not say any names of people, for instance, the name Steven would not be counted.

Any questions? Are you ready? Go (begin timing)

Responses (1 point each correct answer):

Number of correct words: _____

Number of proper names: _____

Number of repeated words: _____

Letter Fluency Score: _____

Category Fluency: Now please try to tell me as many different **kinds of furniture** as possible during 1 minute. You should not repeat any words and you should not name any words in a different form. For instance, if you say *chair*, then the word *chairs* is not counted.

(Allow time for participant to respond to prospective memory cue)

(Prospective memory) Participant named his/her year of birth: ___

Any questions? Are you ready? Go (Begin timing)

Responses (1 point each correct answer):

APPENDIX H Prospective Study: Participant Protocol Cont.

Number of correct words: ____

Number of repeated words: ____

Category Fluency Score: _____

Total Verbal Fluency score: (Letter Fluency + Category Fluency) _____

5. Inductive Reasoning (Number Series)

Now I will say some number sequences. Each sequence follows a specific rule. I will say the numbers in the sequence then you tell me which number would come next. For instance, if I said the sequence 1–2–3–4–5, then the rule would be +1 and the next number would be 6. Do you have any questions? I can repeat the sequence one more time.

*(Read each sequence, 1 second per digit; then ask participant **"What comes next?"**)*

	Sequence	**Next**	**Response**
1)	2, 4, 6, 8, 10	12	
2)	4, 7, 10, 13, 16	19	
3)	3, 5, 8, 12, 17	23	
4)	9, 11, 14, 18, 23	29	
5)	22, 21, 19, 16, 12	7	
6)	11, 3, 12, 6, 13	9	
7)	26, 14, 28, 17, 30	20	
8)	64, 92, 66, 95, 68	98	

Score: (1 point each correct answer; max = 8) _____

6. Verbal Long-Term Memory (Word pairs long delay)

APPENDIX H Prospective Study: Participant Protocol Cont.

A short while ago, I read some word pairs to you. Now, I will say the first word of each pair and you tell me the second word of the pair.

Which word was associated with . . .?

(10 seconds for response)

- oak _____ (scissors)
- brush _____ (paint)
- tool _____ (hammer)
- music _____ (eagle)
- beverage _____ (juice)
- sofa _____ (cheese)
- animal _____ (fish)
- gulp _____ (car)

Score: (1 point each correct pair; max score = 8) _____

End of COGTEL

COGTEL Scoring:

Subtest	**Score**	**Formula**	**Scaled Score**
Prospective Memory (PM)		7.2 X PM	
Verbal Short-term Memory (VSTM)		1.0 X VSTM	
Verbal Long-term Memory (VLTM)		0.9 X VLTM	
Working Memory (WM)		0.8 X WM	
Verbal Fluency (VF)		0.2 X VF	
Inductive Reasoning (IR)		1.7 X IR	
		Sum of Scaled Scores	

APPENDIX H Prospective Study: Participant Protocol Cont.

Activities Questionnaire

Below are ten statements which ask you to rate ***your current*** ability from normal, to requiring assistance. Please tick the box which best describes your agreement with each statement.

	Normal 1	Have some difficulty but can still do this on my own 2	Have a great deal of difficulty and need some assistance 3	Am totally dependent on others to do this 4	Never did activity but could do now 5	Never did activity and would have difficulty now 6
1. Writing cheques, paying bills, or balancing a bankbook.	☐	☐	☐	☐	☐	☐
2. Assembling tax records, business affairs, or important papers.	☐	☐	☐	☐	☐	☐
3. Shopping alone for clothes, household goods, or groceries	☐	☐	☐	☐	☐	☐
4. Playing a game of skills, or working on a hobby/interest.	☐	☐	☐	☐	☐	☐
5. Heating water, making a cup of coffee/tea, turning off stove/over after use.	☐	☐	☐	☐	☐	☐
6. Preparing a balanced meal.	☐	☐	☐	☐	☐	☐
7. Keeping track of current events.	☐	☐	☐	☐	☐	☐
8. Paying attention to, understanding, or discussing TV shows, books, movies, or newspapers.	☐	☐	☐	☐	☐	☐
9. Remembering appointment, family occasions, holidays, or medications.	☐	☐	☐	☐	☐	☐
10. Travelling out of the neighbourhood, driving or arranging to take public transport.	☐	☐	☐	☐	☐	☐

APPENDIX H Prospective Study: Participant Protocol Cont.

Physical Symptoms Checklist

Listed below are some questions about your current physical symptoms. Using the 1-7 scale below, please indicate ***how often*** you have experienced each of the following symptoms ***during the last day or so.***

Not at all 1	Rarely 2	Occasionally 3	Sometimes 4	Usually 5	Frequently 6	Very Frequently 7

_____ **1.** How often have you experienced **headaches?**

_____ **2.** How often have you experienced **coughing** or a **sore throat?**

_____ **3.** How often have you experienced **shortness of breath?**

_____ **4.** How often have you experienced **stiff** or **sore muscles?**

_____ **5.** How often have you experienced **chest** or **heart pain?**

_____ **6.** How often have you experienced a **runny** or **congested nose?**

_____ **7.** How often have you experienced **faintness** or **dizziness?**

_____ **8.** How often have you experienced **acne** or **pimples?**

_____ **9.** How often have you experienced **stomach** or **ache pain?**

_____ **10.** How often have you experienced **hot** or **cold sweats?**

_____ **11**. How often have you experienced **numbness** or **tingling?**

_____ **12.** How often have you experienced **nausea** or **upset stomach?**

_____ **13.** How often have you felt **weak** in parts of your body?

APPENDIX H Prospective Study: Participant Protocol Cont.

Modified Rankin Scale

(To be completed by researcher)

Score description

0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Deceased

TOTAL (0-6): _____

APPENDIX H Prospective Study: Participant Protocol Cont.

GD Scale (*Short Form*)

Circle the answer that best describes how you have felt on average ***during the past day***.

1.	Are you basically satisfied with your life?	Y	N
2.	Have you stopped many of your activities or interests?	Y	N
3.	Do you feel that your life is empty?	Y	N
4.	Do you often get bored?	Y	N
5.	Are you in good spirits most of the time?	Y	N
6.	Are you afraid that something bad is going to happen to you?	Y	N
7.	Do you feel happy most of the time?	Y	N
8.	Do you feel helpless?	Y	N
9.	Do you prefer to stay at home, rather than go out and do things?	Y	N
10.	Do you feel that you have more problems with memory than most?	Y	N
11.	Do you think it is wonderful to be alive now?	Y	N
12.	Do you feel pretty worthless the way you are now?	Y	N
13.	Do you feel full of energy?	Y	N
14.	Do you feel that your situation is hopeless?	Y	N
15.	Do you think that most people are better off than you are?	Y	N

Total score: ___ / 15

APPENDIX H Prospective Study: Participant Protocol Cont.

Health Continuum (*Short Form)*

Please answer the following questions about how you have been feeling ***during the past day.***

During the past month, how often did you feel…	Never 1	Once or twice 2	About once a week 3	About 2 or 3 times a week 4	Almost every day 5	Every day 6
1. Happy.	☐	☐	☐	☐	☐	☐
2. Interested in life.	☐	☐	☐	☐	☐	☐
3. Satisfied.	☐	☐	☐	☐	☐	☐
4. That you had something important to contribute to society.	☐	☐	☐	☐	☐	☐
5. That you belonged to a community (like social group, or your neighbourhood).	☐	☐	☐	☐	☐	☐
6. That our society is becoming a better place for people like yourself.	☐	☐	☐	☐	☐	☐
7. That people are basically good.	☐	☐	☐	☐	☐	☐
8. That the way our society works makes sense to you.	☐	☐	☐	☐	☐	☐
9. That you liked most parts of your personality.	☐	☐	☐	☐	☐	☐
10. Good at managing the responsibilities of your daily life.	☐	☐	☐	☐	☐	☐
11. That you had warm and trusting relationships with others.	☐	☐	☐	☐	☐	☐
12. That you had experiences that challenged you to grow and become a better person.	☐	☐	☐	☐	☐	☐
13. Confident to think or express your own ideas and opinions.	☐	☐	☐	☐	☐	☐
14. That your life has a sense of direction or meaning to it.	☐	☐	☐	☐	☐	☐

APPENDIX H Prospective Study: Participant Protocol Cont.

PWB Scale

Please answer the following questions about how you have been feeling ***over the past day***. Please tick the box which best describes your agreement with each statement.

	Strongly Disagree 1	Disagree 2	Slightly Disagree 3	Neither agree nor disagree 4	Slightly agree 5	Agree 6	Strongly Agree 7
1. I don't have many physical complaints.	☐	☐	☐	☐	☐	☐	☐
2. I don't think that I have a heart condition.	☐	☐	☐	☐	☐	☐	☐
3. I have a good appetite for food.	☐	☐	☐	☐	☐	☐	☐
4. I have aches and pains.	☐	☐	☐	☐	☐	☐	☐
5. I am in good shape physically.	☐	☐	☐	☐	☐	☐	☐
6. I think my health is deteriorating.	☐	☐	☐	☐	☐	☐	☐
7. I don't get tired very easily.	☐	☐	☐	☐	☐	☐	☐
8. I can stand a fair amount of physical strain.	☐	☐	☐	☐	☐	☐	☐

APPENDIX H Prospective Study: Participant Protocol Cont.

MDE Scale

Using the 0-4 scale below, please indicate the *greatest amount* that you have experienced each of the following feelings ***during the past day.***

Not at all	A little bit	Moderately	Quite a bit	Extremely
0	1	2	3	4

_____ **1.** What is the most **amused, fun-loving,** or **silly** you felt?

_____ **2.** What is the most **angry, irritated**, or **annoyed** you felt?

_____ **3.** What is the most **ashamed, humiliated**, or **disgraced** you felt?

_____ **4.** What is the most **awe, wonder,** or **amazement** you felt?

_____ **5.** What is the most **contemptuous, scornful,** or **disdainful** you felt?

_____ **6.** What is the most **disgust, distaste,** or **revulsion** you felt?

_____ **7.** What is the most **embarrassed, self-conscious,** or **blushing** you felt?

_____ **8.** What is the most **grateful, appreciative,** or **thankful** you felt?

_____ **9.** What is the most **guilty, repentant,** or **blameworthy** you felt?

_____ **10.** What is the most **hate, distrust,** or **suspicion** you felt?

_____ **11**. What is the most **hopeful, optimistic,** or **encouraged** you felt?

_____ **12.** What is the most **inspired, uplifted,** or **elevated** you felt?

_____ **13.** What is the most **interested, alert,** or **curious** you felt?

_____ **14.** What is the most **joyful, glad,** or happy you felt?

_____ **15.** What is the most **love, closeness,** or **trust** you felt?

_____ **16.** What is the most **proud, confident,** or **self-assured** you felt?

_____ **17.** What is the most **sad, downhearted,** or **unhappy** you felt?

_____ **18.** What is the most **scared, fearful,** or **afraid** you felt?

_____ **19.** What is the most **serene, content,** or **peaceful** you felt?

_____ **20.** What is the most **stressed, nervous,** or **overwhelmed** you felt?

APPENDIX H Prospective Study: Participant Protocol Cont.

CIT-OPT Scale

Below are three statements with which you may agree or disagree. Think back over the last day or so. Please tick the box which best describes your agreement with each statement.

	Strongly Disagree 1	Disagree 2	Slightly Disagree 3	Neither agree nor disagree 4	Slightly agree 5	Agree 6	Strongly Agree 7
1. I am optimistic about my future.	☐	☐	☐	☐	☐	☐	☐
2. I have a positive outlook on life.	☐	☐	☐	☐	☐	☐	☐
3. I expect more good things in my life than bad.	☐	☐	☐	☐	☐	☐	☐

APPENDIX I Positive Health Assets and Health-Related Outcomes: Descriptive Information for Survival and Morbidity

Measures	Mortality (Discharge)	Mortality (6mths)	Recurrence
Biological Positive Health: Dynamic Biological Assets			
n	2	12	11
Age	69.2±12.7	76.0±7.6	78.12±11.7
Gender M/F	43/9	2/1	19/7
History of Trauma *n*,(%)	2, (100.0%)	10, (90.9%)	8, (72.7%)
Time since injury	2.0±1.0	29.5±23.8	27.6±20.9
IHD *n*,(%)	2, 100.0%	5, (41.7%)	3, (27.3%)
Diabetes *n*,(%)	1, (50.0%)	11, (91.7%)	2, (18.2%)
Hypertension *n*,(%)	1, (50.0%)	11, (91.7%)	8, (72.7%)
Stroke *n*,(%)	0, (0.0%)	1, (8.3%)	0, (0.0%)
Dementia *n*,(%)	0, (0.0%)	4, (33.3%)	2, (18.2%)
CSDH Laterality			
Unilateral/Bilateral	2/0	12/0	8/3
CSDH Site			
Left/Right			
Midline Shift	12.1±.14	8.11±4.57	7.8±3.9
Intracranial Pressure *n*,(%)			
Low	0, 0.0%	1, 11.1%	1, 14.3%
Moderate	0, 0.0%	6, 66.7%	6, 85.7%
High	1, 100.0%	2, 22.2%	0, 0.0%
Nakaguchi Class			
Homogenous	100.0%	50.0%	40.0%
Laminar	0.0%	50.0%	20.0%
Separated	0.0%	0.0%	20.0%
Trabeculated	0.0%	0.0%	20.0%

APPENDIX I Positive Health Assets and Health-Related Outcomes: Descriptive Information for Survival and Morbidity Cont.

Measures	Mortality (Discharge)	Mortality (6mths)	Recurrence
Total Haematoma Volume	130.95±18.4	119.75±42.4	110.04±38.9
Atrophy (Oishi Index) *n,* (%)			
None	0, 0.0%	0, 0.0%	0, 0.0%
Mild	0, 0.0%	0, 0.0%	1, 9.1%
Moderate	0, 0.0%	1, 9.1%	3, 27.3%
Severe	1, 100.0%	10, 90.9%	7, 63.6%
Biochemical targets			
TTBK-1 (ng/ml)	.75±.13	.54±.40	.69±.45
Total tau (pg/ml)	116.67±110.63	333.78±638.0	127.64±154.35
Amyloid beta (pg/ml)	78.84±33.71	82.86±24.37	82.65±24.24
Albumin (pg/ml)	44.5±14.85	28.0±12.96	21.13±11.48
S100B (ug/ml)	1.75±0.0	.47±.61	.61±.66
Biological Positive Health: Dynamic Biological Assets			
Anticoagulant medication			
Statins	1, (50.0%)	4, (33.3%)	1, (9.1%)
Current Smoker *n,* (%)	1, (50.0%)	1, (8.3%)	3, (16.7%)
Alcoholism	1, (50.0%)	1, (8.3%)	2, (18.2%)
AUDIT			
Consumption Score	0.0±0.0	0.0±0.0	7.0±2.8
Dependence Score	0.0±0.0	0.0±0.0	.50±.71
Problems Score	0.0±0.0	0.0±0.0	.50±.72
MG *n,* (%)			
Grade=0	0, (0.0%)	3, (27.3%)	9, (81.8%)
Grade=1	1, (50.0%)	7, (63.6%)	2, (18.2%)
Grade=2	0, (0.0%)	0, (0.0%)	0, (0.0%)
Grade=3	0	0, (0.0%)	0, (0.0%)
Grade=4	1, (50.0%)	1, (9.1%)	0, (0.0%)
GCS	13.5±.71	13.83±1.11	14.54±.69

APPENDIX I Positive Health Assets and Health-Related Outcomes: Descriptive Information for Survival and Morbidity Cont.

Measures	Mortality (Discharge)	Mortality (6mths)	Recurrence
Functional Positive Health: Cognitive Assets			
COGTEL			
Prospective Memory	0.0±0.0	0.0±0.0	3.6±5.1
VSTM	0.0±0.0	3.0±0.0	3.5±3.5
VLTM	0.0±0.0	0.0±0.0	2.3±3.2
WM	0.0±0.0	1.6±0.0	5.2±1.7
VF	0.0±0.0	3.0±0.0	4.5±.42
IR	0.0±0.0	1.7±0.0	4.3±3.9
COGTEL Total Score	0.0±0.0	9.3±0.0	23.3±16.7
Functional Positive Health: *Prosocial Assets*			
MHC-SF SWB	0.0±0.0	0.0±0.0	6.0±1.4
Functional Positive Health: *Person-Environment-Fit*			
FAQ Total score	0.0±0.0	26.0±0.0	4.0±0.0
Preoperative Independence *n*,(%)			
Independent	1, (50.0%)	9, (75.0%)	9, (81.8%)
Family/Carer	1, (50.0%)	2, (16.7%)	1, (9.1%)
Residential Home	0, (0.0%)	1, (8.3%)	1, (9.1%)
Nursing Home	0, (0.0%)	0, (0.0%)	0, (0.0%)
Subjective Positive Health: *Psychological Well-being*			
MHC-SF PWB	0.0±0.0	0.0±0.0	12.2±1.4
GDS	0.0±0.0	0.0±0.0	2.0±4.5
Subjective Positive Health: *Emotional Well-being*			
MHC-SF EWB	0.0±0.0	0.0±0.0	4.35±2.1
mDES	0.0±0.0	0.0±0.0	11.0±4.2
CIT-Optimism	0.0±0.0	0.0±0.0	13.0±2.8

APPENDIX I Positive Health Assets and Health-Related Outcomes: Descriptive Information for Survival and Morbidity Cont.

Measures	Mortality (Discharge)	Mortality (6mths)	Recurrence
Subjective Positive Health: *Physical Well-being*			
PWB Physical Well-being Subscale	0.0±0.0	0.0±0.0	34.0±2.8

Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX J Positive Health Assets and Patient Survival: Statistical Significance

Measures	Mortality (Discharge)			Mortality (6mths)		
	Statistical value	*p*	*Effect size*	*Statistical value*	*p*	*Effect size*
Biological Positive Health*: Static Biological Assets*						
Age	$F_{(1,112)}$=.187	.666	-	$F_{(1,111)}$=5.31	.023*	.704
Gender M/F	χ^2=.711	.399	-	χ^2=.711	.399	-
History of Trauma	χ^2=.585	.444	-	χ^2=.585	.444	-
Time since injury	$F_{(1,76)}$=1.72	.193	-	$F_{(1,76)}$=.086	.770	-
IHD	χ^2=.940	.332	-	χ^2=.595	.441	-
Diabetes	χ^2=1.629	.202	-	χ^2=.690	.406	-
Hypertension	χ^2=.254	.614	-	χ^2=3.849	.05*	-
Stroke	χ^2=.308	.579	-	χ^2=.285	.594	-
Dementia	χ^2=.357	.550	-	χ^2=3.514	.061	-
CSDH Laterality Unilateral/Bilateral	χ^2=.608	.435	-	χ^2=.3.862	.49*	-
CSDH Site Left/Right	χ^2=.601	.438	-	χ^2=3.780	.05*	-
Midline Shift	$F_{(1,83)}$=1.522	.221	-	$F_{(1,83)}$=.303	.583	-
Intracranial Pressure Low Moderate High	χ^2=3.556	.059*	-	χ^2=3.556	.06	-
Nakaguchi Class Homogenous Laminar Separated Trabeculated	χ^2=1.512	.219	-	χ^2=6.662	.010**	-

*Statistical significance: **denotes sig. at p<.01, ***denotes sig. at p<.001. level*
Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX J Positive Health Assets and Patient Survival: Statistical Significance Cont.

Measures	Mortality (Discharge)			Mortality (6mths)		
	Statistical value	***p***	***Effect size***	***Statistical value***	***p***	***Effect size***
Total Haematoma Volume	$F_{(1,112)}$=.177	.675	-	$F_{(1,111)}$=.145	.704	-
Atrophy (Oishi Index)						
None						
Mild	χ^2=.543	.796	-	χ^2=3.814	.00***	-
Moderate						
Severe						
Biochemical targets						
TTBK-1 (ng/ml)	$F_{(1,93)}$=.315	.576	-	$F_{(1,93)}$=.511	.476	-
Total tau (pg/ml)	$F_{(1,93)}$=.071	.791	-	$F_{(1,93)}$=.707	.402	-
Amyloid beta (pg/ml)	$F_{(1,96)}$=.126	.723	-	$F_{(1,96)}$=.129	.720	-
Albumin (pg/ml)	$F_{(1,94)}$=5.443	.022*	1.667	$F_{(1,93)}$=1.408	.238	-
S100B (ug/ml)	$F_{(1,78)}$=.010	.920	-	$F_{(1,78)}$=.128	.722	-
Biological Positive Health: *Dynamic Biological Assets*						
Anticoagulants	χ^2=.308	.857	-	χ^2=.335	.846	-
Statins						
Current Smoker	χ^2=1.629	.202	-	χ^2=.690	.406	-
Alcoholism	χ^2=6.20	.102	-	χ^2=6.187	.103	
MG						
Grade=0						
Grade=1	χ^2=18.037	.00***	-	χ^2=15.266	.00***	-
Grade=2						
Grade=3						
Grade=4						
GCS	$F_{(1,112)}$=.825	.366	-	$F_{(1,111)}$=1.745	.189	-

*Statistical significance:, **denotes sig. at p<.01, ***denotes sig. at p<.001. level*

Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX J Positive Health Assets and Patient Survival: Statistical Significance

Measures	**Mortality (Discharge)**			**Mortality (6mths)**		
	Statistical value	***p***	***Effect size***	***Statistical value***	***p***	***Effect size***
Functional Positive Health: *Person-Environment-Fit*						
FAQ total score	-	-	-	$F_{(1,15)}$=12.870	.003***	-
Preop. Independence						
Independent						
Family/Carer	χ^2=.499	.48	-	χ^2=.471	.492	-
Residential Home						
Nursing Home						

*Statistical significance: **denotes sig. at p<.01, ***denotes sig. at p<.001. level*

Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX K Positive Health Assets and Patient Morbidity: Statistical Significance

Measures	Morbidity (Recurrence)		
	Statistical value	***p***	***Effect size***
Age	$F_{(1,112)}$=.040	.842	-
Gender M/F	χ^2=3.964	.046	-
History of Trauma	χ^2=.172	.678	-
Time since injury	$F_{(1,76)}$=.279	.599	-
IHD	χ^2=.104	.747	-
Diabetes	χ^2=1.629	.202	-
Hypertension	χ^2=.254	.614	-
Stroke	χ^2=1.845	.174	-
Dementia	χ^2=.103	.749	-
CSDH Laterality Unilateral/Bilateral	χ^2=.125	.724	-
CSDH Site Left/Right	χ^2=.138	.710	-
Midline Shift	$F_{(1,83)}$=.077	.781	-
Intracranial Pressure Low Moderate High	χ^2=.999	.317	-
Nakaguchi Class Homogenous Laminar Separated Trabeculated	χ^2=.188	.665	-
Total Haematoma Volume	$F_{(1,112)}$=.045	.832	-
Atrophy (Oishi Index) None Mild Moderate Severe	χ^2=.001	.975	-
Biochemical targets			
TTBK-1 (ng/ml)	$F_{(1,93)}$=.438	.510	-
Total tau (pg/ml)	$F_{(1,98)}$=.282	.596	-
Amyloid beta (pg/ml)	$F_{(1,101)}$=.046	.830	-
Albumin (pg/ml)	$F_{(1,94)}$=.13	.65	-
S100B (ug/ml)	$F_{(1,78)}$=.125	.725	-

APPENDIX K Positive Health Assets and Patient Morbidity: Statistical Significance Cont.

Measures	**Morbidity (Recurrence)**		
	Statistical value	***p***	***Effect size***
Biological Positive Health: *Dynamic Assets*			
Anticoagulants	χ^2=1.845	.398	-
Current Smoker	χ^2=.986	.321	-
Alcoholism	χ^2=3.221	.359	-
MG			
Grade=0			
Grade=1	χ^2=28.262	.01**	-
Grade=2			
Grade=3			
Grade=4			
GCS	$F_{(1,112)}$=.674	.413	-
Functional Positive Health: *Cognitive Assets*			
COGTEL			
Prospective Memory	$F_{(1,12)}$=.114	.742	-
VSTM	$F_{(1,12)}$=.030	.865	-
VLTM	$F_{(1,12)}$=.007	.936	-
WM	$F_{(1,12)}$=.303	.593	-
VF	$F_{(1,12)}$=.080	.783	-
IR	$F_{(1,12)}$=.074	.790	-
COGTEL Total Score	$F_{(1,12)}$=.033	.860	-
Functional Positive Health: *Prosocial Assets*			
MHC-SF SWB	$F_{(1,12)}$=1.597	.230	-
FAQ total score	$F_{(1,15)}$=.159	.696	-
Preoperative Independence			
Independent			
Family/Carer	χ^2=1.342	.719	-
Residential Home			
Nursing Home			

APPENDIX K Positive Health Assets and Patient Morbidity: Statistical Significance

Cont.

Measures	**Morbidity (Recurrence)**		
	Statistical value	***p***	***Effect size***
Subjective Positive Health: *Psychological Well-being*			
MHC-SF PWB	$F_{(3,12)}$=3.659	.076	-
GDS			
Subjective Positive Health: *Emotional Well-being*			
MHC-SF EWB	$F_{(3,12)}$=2.302	.151	-
mDES	$F_{(1,10)}$=2.774	.127	-
CIT-Optimism	$F_{(1,10)}$=8.986	.013**	-
Subjective Positive Health: *Physical Well-being*			
PWB Physical Well-being	$F_{(1,10)}$=3.588	.087	-

*Statistical significance: **denotes sig. at p<.01, ***denotes sig. at p<.001. level*
Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX L Positive Health Assets and Health-Related Outcomes: Descriptive Information for Global Functioning

Measure	mRS (6mths)						
	0	1	2	3	4	5	6
n	n=39	n=33	n=12	n=11	n=5	n=1	n=12
Biological Positive Health: *Static Biological Assets*							
Age	67.9±12.5	72.8±12.2	72.4±12.4	83.8±6.2	77.2±13.6	91.0±0.0	81.3±10.4
Gender M/F	29/10	26/7	8/4	10/1	2/3	1/0	10/2
History of Trauma *n*, (%)	26, (30.2%)	27, (31.4%)	8, (9.3%)	9, (10.5%)	5, (5.8%)	1, (1.2%)	10, (11.6%)
Time since injury	34.4±21.2	26.6±20.5	27.4±33.9	34.6±26.9	55.4±26.5	10.0±0.0	29.5±23.8
IHD	8, (20.5%)	9, (27.3%)	4, (33.3%)	6, (54.4%)	3, (60.0%)	1, 100.0%)	5, (41.7%)
Diabetes	3, (7.7%)	9, (27.3%)	2, (16.7%)	3, (27.3%)	1, (20.0%)	0, (0.0%)	1, (8.3%)
Hypertension	22, (56.4%)	25, (75.8%)	6, (50.0%)	6, (54.5%)	4, (80.0%)	1, (100.0%)	11, (91.7%)
Stroke	1, (2.6%)	5, (15.2%)	2, (16.7%)	3, (27.3%)	3, (60.0%)	0, (0.0%)	1, (8.3%)
Dementia	1, (2.6%)	3, (9.1%)	1, (8.3%)	3, (27.3%)	4, (80.0%)	1, (100.0%)	4, (33.3%)
CSDH Laterality							
Unilateral/Bilateral	28/11	28/5	8/4	8/2	3/2	0/1	12/0
Midline Shift (mm)	8.2±4.5	7.8±3.8	10.3±6.1	5.5±3.4	12.0±8.3	0.0±0.0	9.0±4.3

APPENDIX L Positive Health Assets and Health-Related Outcomes: Descriptive Information for Global Functioning Cont.

Measures	mRS (6months)						
	0	1	2	3	4	5	6
Intracranial Pressure *n*, (%)							
Low	2, (7.1%)	2, (20.0%)	1, (20.0%)	1, (14.3%)	1, (25.0%)	0, (0.0%)	1, (11.1%)
Moderate	22, (78.6%)	16, (80.0%)	4, (80.0%)	4, (57.1%)	1, (25.0%)	1, (100.0%)	6, (66.7%)
High	4, (14.3%)	1, (5.3%)	0, (0.0%)	2, (8.6%)	2, (50.0%)	0, (0.0%)	2, (22.2%)
Haematoma Appearance							
Homogenous	7, (25.0%)	4, (16.0%)	2, (25.0%)	3, (30.0%)	3, (100.0%)	0, (0.0%)	5, (50.0%)
Laminar	9, (32.1%)	6, (24.0%)	2, (25.0%)	3, (30.0%)	0, (0.0%)	0, (0.0%)	5, (50.0%)
Separated	5, (17.9%)	9, (36.0%)	1, (12.5%)	3, (30.0%)	0, (0.0%)	1, (100.0%)	0, (0.0%)
Trabeculated	7, (25.0%)	6, (24.0%)	3, (37.5%)	1, (10.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)
Total Haematoma Volume	103.3±49.6	108.5±60.1	125.3±61.7	147.0±96.8	111.1±32.4	117.5±0.0	119.8±42.4
Atrophy (Oishi Index) *n*, (%)							
None	1, (2.6%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)
Mild	5, (12.8%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)
Moderate	19, (48.7%)	13, (39.4%)	4, (33.3%)	2, (18.2%)	0, (0.0%)	0, (0.0%)	1, (9.1%)
Severe	14, (35.9%)	20, (60.6%)	8, (66.7%)	9, (81.8%)	5, (100.0%)	1, (100.0%)	10, (90.9%)

APPENDIX L Positive Health Assets and Health-Related Outcomes: Descriptive Information for Global Functioning Cont.

Measures	mRS (6months)						
	0	1	2	3	4	5	6
Biochemical targets							
TTBK-1 (ng/ml)	.62±.30	.62±.43	.71±.28	.54±.26	.63±.32	.46±0.0	.54±.40
Total tau (pg/ml)	296.0±582.7	58.1±61.1	208.3±564.7	287.6±560.2	31.3±.15	31.2±0.0	333.8±638.0
Amyloid beta	105.3±.12	85.5±37.0	91.7±21.0	85.2±23.4	84.5±25.2	102.8±0.0	78.8±33.7
Albumin	31.53±9.7	31.9±6.5	29.3±8.8	31.0±4.1	32.8±4.6	24.0±0.0	28.0±13.0
S100B	.68±.64	40.4±199.7	.74±.66	.67±.72	.22±.23	.23±.0	.47±.61
Biological Positive Health: *Dynamic Biological Assets*							
Anticoagulant medication	0, (0.0%)	5, (10.4%)	1, (10.0%)	5, (17.2%)	2, (14.3%)	1, (100.0%)	0, (0.0%)
Statins	7, (17.9%)	16, (48.5%)	4, (33.3%)	4, (36.4%)	3, (60.0%)	1, (100.0%)	4, (33.3%)
Current Smoker *n*, (%)	7, (17.9%)	7, (21.2%)	1, (8.3%)	2, (18.2%)	1, (20.0%)	0, (0.0%)	1, (8.3%)
Alcoholism	2, (5.1%)	3, (9.1%)	2, (16.7%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	1, (8.3%)
AUDIT							
Consumption Score	4.7±3.4	3.8±4.3	0.0±0.0	5.0±0.0	0.0±0.0	7.0±0.0	0.0±0.0
Dependence Score	.78±1.6	.50±1.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Problems Score	.11±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0

APPENDIX L Positive Health Assets and Health-Related Outcomes: Descriptive Information for Global Functioning Cont.

Measures	mRS (6months)						
	0	1	2	3	4	5	6
MG							
Grade=0	38, (97.4%)	28, (84.8%)	8, (66.7%)	8, (72.7%)	4, (80.0%)	0, (0.0%)	3, (27.3%)
Grade=1	0, (0.0%)	5, (15.2%)	3, (25.0%)	3, (27.3%)	0, 0.0%)	1, (100.0%)	7, (63.6%)
Grade=2	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)
Grade=3	1, (2.6%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	1, (8.3%)	0, (0.0%)	0, (0.0%)
Grade=4	0, (0.0%)	0, (0.0%)	1, (8.3%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	1, (9.1%)
GCS	15.0±0.0	14.7±.50	14.6±.70	13.9±1.51	13.6±1.6	14.0±0.0	13.5±.71
Functional Positive Health: *Cognitive Assets*							
COGTEL							
Prospective Memory	4.1±3.8	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
VSTM	3.6±2.0	6.0±0.0	3.0±2.6	6.0±0.0	0.0±0.0	0.0±0.0	3.0±0.0
VLTM	2.2±1.4	5.4±0.0	1.9±1.1	2.7±0.0	0.0±0.0	0.0±0.0	0.0±0.0
WM	5.4±1.7	4.0±0.0	.46±.27	5.6±0.0	2.4±0.0	0.0±0.0	1.6±0.0
VF	4.5±1.2	7.6±0.0	2.3±1.33	3.8±0.0	1.4±0.0	0.0±0.0	3.0±0.0
IR	6.3±3.9	3.4±0.0	2.9±1.7	5.1±0.0	0.0±0.0	0.0±0.0	1.7±0.0
COGTEL Total Score	26.1±11.3	26.4±11.3	7.1±4.14	23.2±0.0	3.8±0.0	0.0±0.0	9.3±0.0

APPENDIX L Positive Health Assets and Health-Related Outcomes: Descriptive Information for Global Functioning Cont.

Measures	mRS (6months)						
	0	1	2	3	4	5	6
Functional Positive Health: *Social Well-being*							
MHC-SF SWB	11.7±7.2	0.0±0.0	8.3±3.2	10.0±0.0	20.0±0.0	0.0±0.0	0.0±0.0
Functional Positive Health: *Person-Environment-Fit*							
FAQ Total score	4.78±5.1	0.0±0.0	0.0±0.0	2.3±1.5	17.7±9.1	0.0±0.0	0.0±0.0
Preoperative Independence *n*, (%)							
Independent	37, (94.9%)	29, (87.9%)	11, (91.7%)	4, (36.4%)	3, (60.0%)	0, (0.0%)	9, (75.0%)
Family/Carer	2, (5.1%)	3, (9.1%)	1, (8.3%)	6, (54.5%)	1, (20.0%)	0, (0.0%)	2, (16.7%)
Residential Home	0, (0.0%)	1, (8.3%)	0, (0.0%)	1, (9.1%)	1, (20.0%)	0, (0.0%)	1, (8.3%)
Nursing Home	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	1, (100.0%)	0, (0.0%)
Subjective Positive Health: *Psychological Well-being*							
MHC-SF PWB	20.3±7.1	18.5±9.1	20.0±0.0	26.0±0.0	17.0±0.0	0.0±0.0	0.0±0.0
GDS	4.2±2.3	5.0±0.0	2.0±0.0	2.0±0.0	4.0±0.0	0.0±0.0	0.0±0.0
Subjective Positive Health: *Emotional Well-being*							
MHC-SF EWB	8.1±4.8	9.8±6.4	9.0±0.0	12.0±0.0	12.0±0.0	0.0±0.0	0.0±0.0
mDES	19.7±10.1	20.3±6.8	13.0±0.0	19.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
CIT-Optimism	16.4±3.6	18.3±.58	18.0±0.0	21.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0

Subjective Positive Health: *Physical Well-being*							
PWB Physical Well-being	39.4±5.2	37.7±1.2	35.0±0.0	41.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0

Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX M Positive Health Assets and Health-Related Outcomes: Descriptive Information for Healthcare Utilisation

Measure	Discharge destination					
	Home	Family	Rehabilitation	Other Hospital	Nursing Home	Death in Hospital
n	n=52	n=3	n=26	n=29	n=2	n=2
Biological Positive Health: *Static Biological Assets*						
Age	69.2±12.7	76.0±7.6	78.1±11.7	75.2±11.9	92.0±1.4	69.5±14.8
Gender M/F	43/9	2/1	19/7	19/10	2/0	1/1
History of Trauma *n*, (%)	36, (41.4%)	3 (3.4%)	21, (24.1%)	23, (21.8%)	2, (2.3%)	2, (2.3%)
Time since injury	37.6±23.5	16.3±8.1	29.2±27.6	28.7±21.9	24.5±5.0	1.0±0.0
IHD	13, (25.0%)	2, (66.7%)	12, (46.2%)	8, (27.6%)	1, (50.0%)	0, (0.0%)
Diabetes	29, (55.8%)	3, (100.0%)	21, (72.4%)	21, (72.4%)	1, (50.0%)	1, (50.0%)
Hypertension	5, (9.6%)	1, (33.3%)	7, (26.9%)	5, (17.2%)	0, (0.0%)	1, (100.0%)
Stroke	5, (9.6%)	0, (0.0%)	6, (23.1%)	4, (13.8%)	0, (0.0%)	0, (0.0%)
Dementia	3, (5.8%)	0, (0.0%)	5, (19.2%)	9, (31.0%)	0, (0.0%)	0, (0.0%)
CSDH Laterality						
Unilateral/Bilateral	43/9	3/0	17/8	20/9	2/0	2/0
Midline Shift (mm)	8.2±4.3	6.4±1.5	8.57±4.7	8.14±5.4	4.8±2.1	12.1±.14

APPENDIX M Positive Health Assets and Health-Related Outcomes: Descriptive Information for Healthcare Utilisation Cont.

Measures	Discharge Destination					
	Home	Family	Rehabilitation	Other Hospital	Nursing Home	Death in Hospital
Intracranial Pressure *n*, (%)						
Low	5, (12.8%)	0, (0.0%)	1, (6.7%)	2, (11.8%)	0, (0.0%)	0, (0.0%)
Moderate	28, (71.8%)	0, (0.0%)	13, (86.7%)	12, (70.6%)	1, (100.0%)	0, (0.0%)
High	6, (15.4%)	0, (0.0%0	1, (6.7%)	3, (17.6%)	0, (0.0%)	1, (100.0%)
Haematoma Appearance						
Homogenous	9, (22.5%)	1, (33.3%)	5, (25.0%)	8, (42.1%)	0, (0.0%)	1, (100.0%)
Laminar	11, (27.5%)	1, (33.3%)	8, (40.0%)	3, (15.8%)	2, (100.0%)	0, (0.0%)
Separated	7, (17.5%)	0, (0.0%)	5, (25.0%)	7, (36.8%)	0, (0.0%)	0, (0.0%)
Trabeculated	13, (32.5%)	1, (33.3%)	2, (10.0%)	1, (5.3%)	0, (0.0%)	0, (0.0%)
Total Haematoma Volume	111.4±63.1	73.7±27.1	118.2±66.5	115.9±48.3	123.8±14.0	131.0±18.4
Atrophy (Oishi Index) *n*, (%)						
None	1, (1.9%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)
Mild	4, (7.7%)	0, (0.0%)	0, (0.0%)	1, (3.4%)	0, (0.0%)	0, (0.0%)
Moderate	22, (42.3%)	1, (33.3%)	9, (23.1%)	7, (24.1%)	0, (0.0%)	0, (0.0%)
Severe	25, (48.1%)	2, (66.7%)	17, (65.4%)	21, (72.4%)	2, (100.0%)	1, (100.0%)

APPENDIX M Positive Health Assets and Health-Related Outcomes: Descriptive Information for Healthcare Utilisation

Measure	Discharge Destination					
	Home	Family	Rehabilitation	Other Hospital	Nursing Home	Death in Hospital
Biochemical targets						
TTBK-1 (ng/ml)	.68±.38	.67±.23	.57±.32	.54±.30	.57±.64	.75±.13
Total tau (pg/ml)	169.0±411.5	649.6±941.5	230.1±539.0	210.1±503.4	78.2±94.5	116.7±110.6
Amyloid beta	86.4±36.4	70.5±26.3	84.3±24.3	90.9±21.0	81.0±38.0	78.8±33.7
Albumin	32.2±9.2	29.0±4.6	39.7±7.2	29.3±8.0	30.0±8.5	44.5±14.8
S100B	.69±.65	.41±.32	.54±.61	.56±.24	.50±.57	1.7±0.0
Biological Positive Health: *Dynamic Biological Assets*						
Anticoagulant medication						
Statins	16, (30.8%)	3, (100.0%)	8, (30.8%)	11, (37.9%)	1, (50.0%)	1, (50.0%)
Current Smoker *n,* (%)	10, (19.2%)	0, (0.0%)	3, (11.5%)	5, (17.2%)	0, (0.0%)	1, (50.0%)
Alcoholism	2, (3.8%)	0, (0.0%)	2, (7.7%)	3, (10.3%)	0, (0.0%)	1, (50.0%)
AUDIT						
Consumption Score	4.7±3.7	0.0±0.0	4.33±4.0	2.8±3.1	0.0±0.0	0.0±0.0
Dependence Score	.78±1.6	0.0±0.0	.67±1.15	0.0±0.0	0.0±0.0	0.0±0.0
Problems Score	.11±.33	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0

APPENDIX M Positive Health Assets and Health-Related Outcomes: Descriptive Information for Healthcare Utilisation Cont.

Measure	Discharge Destination					
	Home	Family	Rehabilitation	Other Hospital	Nursing Home	Death in Hospital
MG						
Grade=0	49, (94.2%)	3, (100.0%)	18, (72.0%)	18, (62.1%)	1, (50.0%)	0, (0.0%)
Grade=1	3, (5.8%)	0, (0.0%)	6, (24.0%)	9, (45.0%)	1, (50.0%)	1, (50.0%)
Grade=2	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)	0, (0.0%)0	0, (0.0%)
Grade=3	0, (0.0%)	0, (0.0%)	0, (0.0%)	2, (6.9%)	0, (0.0%)	0, (0.0%)
Grade=4	0, (0.0%)	0, (0.0%)	1, (4.0%)	0, (0.0%)	0, (0.0%)	1, (50.0%)
GCS	14.6±.55	15.0±.00	14.0±1.7	13.8±1.3	13.5±2.1	13.5±.71
Functional Positive: *Cognitive Assets*						
COGTEL						
Prospective Memory	4.1±3.8	0.0±0.0	0.0±0.0	2.4±4.2	0.0±0.0	0.0±0.0
VSTM	3.6±2.0	0.0±0.0	3.0±3.0	2.7±3.1	0.0±0.0	0.0±0.0
VLTM	2.2±1.4	0.0±0.0	1.8±3.12	2.4±2.3	0.0±0.0	0.0±0.0
WM	5.4±1.7	0.0±0.0	2.67±1.22	4.3±2.0	0.0±0.0	0.0±0.0
VF	4.5±1.2	0.0±0.0	4.0±3.2	3.5±2.0	0.0±0.0	0.0±0.0
IR	6.3±3.9	0.0±0.0	1.7±1.7	5.1±4.5	0.0±0.0	0.0±0.0
COGTEL Total Score	26.1±11.3	0.0±0.0	13.17±11.8	20.3±15.8	0.0±0.0	0.0±0.0

APPENDIX M Positive Health Assets and Health-Related Outcomes: Descriptive Information for Healthcare Utilisation Cont.

Measures	Discharge Destination					
	Home	Family	Rehabilitation	Other Hospital	Nursing Home	Death in Hospital
Functional Positive Health: *Social Well-being*						
MHC-SF SWB	8.4±4.4	0.0±0.0	15.5±6.4	15.5±8.8	0.0±0.0	0.0±0.0
Functional Positive Health: *Person-Environment-Fit*						
FAQ total score	4.8±5.1	0.0±0.0	15.0±13.5	3.0±3.2	0.0±0.0	0.0±0.0
Preoperative Independence *n*, (%)						
Independent	48, (92.3%)	3, (100.0%)	18, (69.2%)	23, (79.3%)	1, (50.0%)	1, (50.0%)
Family/Carer	3, (5.8%)	0, (0.0%)	6, (23.1%)	4, (13.8%)	1, (50.0%)	1, (50.0%)
Residential Home	1, (1.9%)	0, (0.0%)	2, (7.7%)	1, (3.4%)	0, (0.0%)	0, (0.0%)
Nursing Home	0, (0.0%)	0, (0.0%)	0, (0.0%)	1, (3.4%)	0, (0.0%)	0, (0.0%)
Subjective Positive Health: *Psychological Well-being*						
MHC-SF PWB	17.9±6.9	0.0±0.0	24.5±2.12	22.0±7.4	0.0±0.0	0.0±0.0
GDS	5.0±3.3	0.0±0.0	2.5±.71	3.2±2.2	0.0±0.0	0.0±0.0
Subjective Positive Health: *Emotional Well-being*						
MHC-SF EWB	6.8±4.4	0.0±0.0	13.5±2.1	11.4±3.9	0.0±0.0	0.0±0.0
mDES	18.6±8.3	0.0±0.0	23.5±6.4	18.0±10.0	0.0±0.0	0.0±0.0
CIT-Optimism	16.9±3.5	0.0±0.0	19.5±2.1	17.3±2.1	0.0±0.0	0.0±0.0

Subjective Positive Health: *Physical Well-being*						
PWB Physical Well-being	38.7±4.5	0.0±0.0	39.0±2.8	38.0±5.6	0.0±0.0	0.0±0.0

Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX N Positive Health Assets and Global Functioning and Healthcare Utilisation: Statistical Significance

Measures	Global Functioning			Discharge Destination		
	Statistical value	***p***	***Effect size***	***Statistical value***	***p***	***Effect size***
Biological Positive Health*: Static Biological Assets*						
Age	$F_{(5,107)}$=4.87	.01**	.305	$F_{(5,107)}$=3.146	.01	.611
Gender M/F	χ^2=.096	.397	-	χ^2=2.718	.099	-
History of Trauma	χ^2=3.534	.06	-	$\chi^{22.61}$	.106	-
Time since injury	$F_{(5,71)}$=1.309	.265	-	$F_{(5,72)}$=1.163	.336	-
IHD	χ^2=5.634	.018**	-	χ^2=.246	.620	-
Diabetes	χ^2=.005	.941	-	χ^2=2.198	.138	-
Hypertension	χ^2=3.485	.062	-	χ^2=2.113	.146	-
Stroke	χ^2=2.639	.104	-	χ^2=.334	.563	-
Dementia	χ^2=.18.130	.001***	-	χ^2=7.676	.01	-
CSDH Laterality Unilateral/Bilateral	χ^2=1.159	.282	-	χ^2=1.098	.295	-
CSDH Site Left/Right	χ^2=1.24	.266	-	χ^2=1.058	.304	-
Midline Shift	$F_{(5,79)}$=1.439	.229	-	$F_{(5,79)}$=.636	.673	-
Intracranial Pressure Low Moderate High	χ^2=.300	.584	-	χ^2=.493	.482	-
Nakaguchi Class Homogenous Laminar Separated Trabeculated	χ^2=7.655	.006***	-	χ^2=5.145	.023	-

*Statistical significance: **denotes sig. at p<.01, ***denotes sig. at p<.001. level*
Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX N Positive Health Assets and Global Functioning and Healthcare Utilisation: Statistical Significance Cont.

Measures	Global Functioning			Discharge Destination		
	Statistical value	***p***	***Effect size***	***Statistical value***	***p***	***Effect size***
Total Haematoma Volume	$F_{(6,106)}$=.930	.477	-	$F_{(5,108)}$=.370	.868	-
Atrophy (Oishi Index)						
None						
Mild	χ^2=16.969	.001***	-	χ^2=7.676	.006***	-
Moderate						
Severe						
Biochemical targets						
TTBK-1 (ng/ml)	$F_{(6,88)}$=.337	.916	-	$F_{(5,89)}$=.674	.645	-
Total tau (pg/ml)	$F_{(6,88)}$=.882	.511	-	$F_{(6,88)}$=.882	.511	-
Amyloid beta (pg/ml)	$F_{(6,91)}$=.900	.499	-	$F_{(5,92)}$=.333	.892	-
Albumin (pg/ml)	$F_{(6,88)}$=.486	.817	-	$F_{(5,90)}$=1.540	.185	-
S100B (ug/ml)	$F_{(6,73)}$=.346	.910	-	$F_{(5,74)}$=.669	.648	-
Biological Positive Health: *Dynamic Biological Assets*						
Anticoagulants	χ^2=.111	.739	-	χ^2=.009	.923	-
Current Smoker	χ^2=.722	.396	-	χ^2=.014	.906	

*Statistical significance: **denotes sig. at p<.01, ***denotes sig. at p<.001. level*
Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX N Positive Health Assets and Global Functioning and Healthcare Utilisation: Statistical Significance Cont.

	Global Functioning			Discharge Destination		
	Statistical value	***p***	***Effect size***	***Statistical value***	***p***	***Effect size***
Alcoholism	χ^2=1.606	.205	-	χ^2=.180	.672	-
MG						
Grade=0						
Grade=1	χ^2=19.95	.001***	-	χ^2=19.953	.00***	-
Grade=2						
Grade=3						
Grade=4						
GCS	$F_{(5,108)}$=3.198	.010**	-	$F_{(6,106)}$=5.560	.000***	-
Functional Positive: *Cognitive Assets*						
COGTEL						
Prospective Memory	$F_{(4,12)}$=2.308	.146	-	-	-	-
VSTM	$F_{(4,12)}$=.851	.531	-	-	-	-
VLTM	$F_{(4,12)}$=.971	.474	-	-	-	-
WM	$F_{(4,12)}$=1.827	.217	-	-	-	-
VF	$F_{(4,12)}$=.936	.490	-	-	-	-
IR	$F_{(4,12)}$=.637	.650	-	-	-	-
COGTEL Total Score	$F_{(4,12)}$=1.027	.449	-	-	-	-
Functional Positive Health: *Social Well-being*						
MHC-SF SWB	$F_{(5,108)}$=.727	.559	-	$F_{(5,108)}$=2.327	.144	-

*Statistical significance: **denotes sig. at p<.01, ***denotes sig. at p<.001. level*
Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being

APPENDIX N Positive Health Assets and Global Functioning and Healthcare Utilisation: Statistical Significance Cont.

	Global Functioning			Discharge Destination		
	Statistical value	***p***	***Effect size***	***p***	***Statistical value***	***p***
Functional Positive Health: *Person-Environment-Fit*						
FAQ total score	$F_{(5,11)}$=6.707	.004***	-	$F_{(2,14)}$=3.438	.061	-
Preop. Independence Independent Family/Carer Residential Home Nursing Home	χ^2=12.271	.00***	-	χ^2=5.599	.018	-
Subjective Positive Health: *Psychological Well-being*						
MHC-SF PWB	$F_{(5,108)}$=.232	.914	-	$F_{(2,13)}$=1.080	.368	-
GDS	$F_{(4,11)}$=.306	.868	-	$F_{(2,13)}$=1.015	.389	-
Subjective Positive Health: *Emotional Well-being*						
MHC-SF EWB	$F_{(4,11)}$=.242	.908	-	$F_{(2,13)}$=3.310	.069	-
mDES	$F_{(3,8)}$=.166	.916	-	$F_{(2,9)}$=.280	.762	-
CIT-Optimism	$F_{(3,8)}$=.787	.534	-	$F_{(2,9)}$=.557	.592	-
Subjective Positive Health: *Physical Well-being*						
PWB Physical Well-being	$F_{(3,8)}$=.372	.775	-	$F_{(2,9)}$=.035	.965	-

*Statistical significance: **denotes sig. at p<.01, ***denotes sig. at p<.001. level*
Abbreviations: CSDH=Chronic subdural haematoma, IHD=Ischemic heart disease, TTBK-1=tau tubulin kinase-1, S100B=S100 calcium binding protein, AUDIT=Alcohol Use Disorders Identification Test, MG=Markwalder's Neurological Grading System, , GCS=Glasgow Coma Scale, COGTEL=Cognitive Telephone Screening Tool, MHC-SF=Mental Health Continuum-Short Form, MHC-SF SWB=Mental Health Continuum-Short Form Social Well-being Subscale, MHC-SF PWB=Mental Health Continuum-Short Form Psychological Well-being Subscale, FAQ=Functional Activities Questionnaire, GDS-SF=Geriatric Depression Scale, CIT=Comprehensive Inventory of Thriving, PWB=Perceived Well-being