ΠΑΝΕΠΙΣΤΗΜΙΟ ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ

ΣΧΟΛΗ ΔΗΜΟΣΙΑΣ ΥΓΕΙΑΣ

ΤΜΗΜΑ ΠΟΛΙΤΙΚΩΝ ΔΗΜΟΣΙΑΣ ΥΓΕΙΑΣ

UNIVERSITY OF WEST ATTICA

SCHOOL OF PUBLIC HEALTH - DEPARTMENT OF PUBLIC HEALTH POLICY

POSTGRADUATE COURSE

MSc in Leadership, Innovation, and Value Based Health Policies

Specialization: Decision making and health policy planning

2020 - 2022

DIPLOMA THESIS

Review of the latest developments and applications in value-based health care and implementation proposal (case study) of a model neurosurgical center in Greece

NIKOLAOS A. PAIDAKAKOS (Reg.: mlead20021)

Athens, September 2023

ΠΑΝΕΠΙΣΤΗΜΙΟ ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ

ΣΧΟΛΗ ΔΗΜΟΣΙΑΣ ΥΓΕΙΑΣ

ΤΜΗΜΑ ΠΟΛΙΤΙΚΩΝ ΔΗΜΟΣΙΑΣ ΥΓΕΙΑΣ

UNIVERSITY OF WEST ATTICA

SCHOOL OF PUBLIC HEALTH - DEPARTMENT OF PUBLIC HEALTH POLICY

POSTGRADUATE COURSE

MSc in Leadership, Innovation, and Value Based Health Policies

Specialization: Decision making and health policy planning

2020 - 2022

DIPLOMA THESIS

Review of the latest developments and applications in value-based health care and implementation proposal (case study) of a model neurosurgical center in Greece

NIKOLAOS A. PAIDAKAKOS (Reg.: mlead20021)

Supervisor: Professor Nikolaos Maniadakis

Athens, September 2023

ΠΑΝΕΠΙΣΤΗΜΙΟ ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ

ΣΧΟΛΗ ΔΗΜΟΣΙΑΣ ΥΓΕΙΑΣ

ΤΜΗΜΑ ΠΟΛΙΤΙΚΩΝ ΔΗΜΟΣΙΑΣ ΥΓΕΙΑΣ

ΠΜΣ ΗΓΕΣΙΑ,ΚΑΙΝΟΤΟΜΙΑ & ΠΟΛΙΤΙΚΕΣ ΑΞΙΑΣ ΣΤΗΝ ΥΓΕΙΑ

ΤΙΤΛΟΣ ΜΕΤΑΠΤΥΧΙΑΚΗΣ ΔΙΠΛΩΜΑΤΙΚΗΣ ΕΡΓΑΣΙΑΣ

Ανασκόπηση του τελευταίων εξελίξεων και εφαρμογών στην υγειονομική περίθαλψη με βάση την αξία (value-based health care) και πρόταση εφαρμογής (case study) ενός πρότυπου νευροχειρουργικού κέντρου στην Ελλάδα

.....

Μέλη Εξεταστικής Επιτροπής συμπεριλαμβανομένου και του Εισηγητή

ΝΙΚΟΛΑΟΣ ΜΑΝΙΑΔΑΚΗΣ - ΑΛΚΙΒΙΑΔΗΣ ΒΑΤΟΠΟΥΛΟΣ - ΑΓΓΕΛΙΚΗ ΛΙΑΡΙΓΚΟΒΙΝΟΥ

Η μεταπτυχιακή διπλωματική εργασία εξετάστηκε επιτυχώς από την κάτωθι Εξεταστική Επιτροπή:

Α/α	ΟΝΟΜΑΤΕΠΩΝΥΜΟ	ΒΑΘΜΙΔΑ/ΙΔΙΟΤΗΤΑ	ΨΗΦΙΑΚΗ ΥΠΟΓΡΑΦΗ
1	Νικόλαος Μανιαδάκης	Καθηγητής	Nikolaos Maniadakis Digitally signed by Nikolaos Maniadakis Date: 2023.09.26 20:31:22 +03'00'
2	Αλκιβιάδης Βατόπουλος	Ομότιμος Καθηγητής	Alkiviadis Vatopoulos Digitally signed by Alkiviadis Vatopoulos Date: 2023.09.29 18:27:31 +03'00'
3	Αγγελική Λιαριγκοβινού	ΕΔΙΠ Α’	Angeliki Liarigkovinou Digitally signed by Angeliki Liarigkovinou Date: 2023.09.26 13:33:27 +03'00'

ΔΗΛΩΣΗ ΣΥΓΓΡΑΦΕΑ ΜΕΤΑΠΤΥΧΙΑΚΗΣ ΕΡΓΑΣΙΑΣ

Ο κάτωθι υπογεγραμμένος Νικόλαος Παιδακάκος του Αντωνίου, με αριθμό μητρώου …… φοιτητής του Προγράμματος Μεταπτυχιακών Σπουδών ΠΜΣ ΗΓΕΣΙΑ,ΚΑΙΝΟΤΟΜΙΑ & ΠΟΛΙΤΙΚΕΣ ΑΞΙΑΣ ΣΤΗΝ ΥΓΕΙΑ του Τμήματος Πολιτικών Δημόσιας Υγείας της Σχολής Δημόσιας Υγείας του Πανεπιστημίου Δυτικής Αττικής, δηλώνω ότι:

«Είμαι συγγραφέας αυτής της μεταπτυχιακής εργασίας και ότι κάθε βοήθεια την οποία είχα για την προετοιμασία της, είναι πλήρως αναγνωρισμένη και αναφέρεται στην εργασία. Επίσης, οι όποιες πηγές από τις οποίες έκανα χρήση δεδομένων, ιδεών ή λέξεων, είτε ακριβώς είτε παραφρασμένες, αναφέρονται στο σύνολό τους, με πλήρη αναφορά στους συγγραφείς, τον εκδοτικό οίκο ή το περιοδικό, συμπεριλαμβανομένων και των πηγών που ενδεχομένως χρησιμοποιήθηκαν από το διαδίκτυο. Επίσης, βεβαιώνω ότι αυτή η εργασία έχει συγγραφεί από μένα αποκλειστικά και αποτελεί προϊόν πνευματικής ιδιοκτησίας τόσο δικής μου, όσο και του Ιδρύματος.

Παράβαση της ανωτέρω ακαδημαϊκής μου ευθύνης αποτελεί ουσιώδη λόγο για την ανάκληση του πτυχίου μου».

Επιθυμώ την απαγόρευση πρόσβασης στο πλήρες κείμενο της εργασίας μου για χρονικό διάστημα 12 μηνών μέχρι 30/09/2024 και έπειτα από αίτηση μου στη Βιβλιοθήκη και έγκριση του επιβλέποντα καθηγητή.

Ο Δηλών

Νικόλαος Α. Παιδακάκος

Ψηφιακή Υπογραφή Επιβλέποντα

καθηγητού Νικολάου Μανιαδάκη

Nikolaos Maniadakis

Digitally signed by Nikolaos Maniadakis
Date: 2023.09.26 20:31:42 +03'00'

This thesis was prepared within the framework of the requirements of the Postgraduate MSc Program in Health Services Administration of the Department of Public Health Policy of the University of West Attica. Its approval does not necessarily imply acceptance of the author's views by the Department of Public Health Policy.

I certify that this thesis is the result of my own work, and it is not a copy product. In the published or unpublished sources that I cite I have used quotation marks where required and cited their sources in the bibliography section.

Signature: *Nikolaos A. Paidakakos*

ABSTRACT

Value-based health care is a transformative approach that aims to revolutionize the healthcare system by putting the focus squarely on patient outcomes, cost-effectiveness, and patient experience. While the transition to value-based health care has been met with enthusiasm and support, it also presents challenges and complexities. Implementation of value-based health care requires significant organizational and cultural changes, as well as alignment of incentives among various stakeholders, including healthcare providers, payers, policymakers, and patients.

In the context of neurosurgery, a complex, resource-intensive, and costly specialty that deals with a variety of life-altering conditions affecting the brain, spine, and peripheral nerves, the application of value-based health care principles is vital to improve quality, efficiency, and appropriateness of care, and ensure optimal patient outcomes.

To date, neurosurgical implementations of value-based health care are scarce, as highlighted in the literature review section of this study, especially in Europe. Even in the USA, a paradigm of a fully implemented action is rare to find, since health care providers do not usually adopt value-based health care as a comprehensive strategy. In Greece, there has been no attempt to date to establish a value-based health care neurosurgical pathway, even partially.

This study attempts to promote the implementation of a value-based health care agenda in the Greek neurosurgical landscape. We designed a pilot case study, with a focus on patients with low back pain, trying to navigate around the nuances of the Greek health sector. This pilot is expected to become a blueprint for actual implementation of the model and serve as a strategic tool and guidance for pioneers. It provides valuable lessons and insights for expanding in more clinical conditions and pathways, scaling up value-based health care neurosurgery locally or across other hospitals or regions.

Keywords: value-based health care, patient-centered care, patient-reported outcomes, time driven activity-based costing, bundled payments, neurosurgery, spinal neurosurgery

TABLE OF CONTENTS

List of tables

List of figures

Abbreviations

APMs	Alternative Payment Models
BPCI	Bundled Payments for Care Improvement
CEA	Cost-Effectiveness Analysis
DRG	Diagnosis-Related Groups
EHR	Electronic Health Records
EIT	European Institute of Innovation & Technology
EQ-5D	EuroQol-5D
GGH	Athens General Hospital ‘Georgios Gennimatas’
HRQoL	Health-Related Quality of Life
ICHOM	International Consortium for Health Outcomes Measurement
ICPs	Integrated Care Pathways
IPUs	Integrated Practice Units
IT	Information Technology
LBP	Low Back Pain
MDT	Multi-Disciplinary Team
MIPS	Merit-based Incentive Payment System
NPA	NeuroPoint Alliance
NPRS	Numeric Pain Rating Scale
ODI	Oswestry Disability Index
PROMs	Patient-Reported Outcome Measures
PROs	Patient-Reported Outcomes
QALYs	Quality-Adjusted Life Years
QOD	Quality Outcomes Database
QPP	Quality Payment Program
TDABC	Time-Driven Activity-Based Costing
VBHC	Value-Based Health Care

CHAPTER 1: Introduction

1.1 Introduction to Value-Based Healthcare

Value-based healthcare (VBHC) is a transformative approach that aims to revolutionize the healthcare system by putting the focus squarely on patient outcomes, cost-effectiveness, and patient experience. Unlike the traditional fee-for-service model that incentivizes volume and quantity of care, VBHC shifts the paradigm towards delivering high-quality, patient-centered care while optimizing resource utilization. At its core, value-based healthcare seeks to improve the health of populations, enhance patient experiences, and achieve better health outcomes at a sustainable cost. (1,2)

The concept of VBHC gained momentum in response to the growing recognition of the need for a more sustainable and efficient healthcare system worldwide. Rising healthcare costs, variations in care quality, and concerns over patient safety prompted healthcare stakeholders to reevaluate the existing models and seek alternatives that prioritize value over volume. As a result, VBHC emerged as a transformative approach that aligns incentives with the delivery of quality care, incentivizing providers to focus on prevention, coordination, and improved patient outcomes.

The key principles of value-based healthcare revolve around patient-centeredness, care coordination, data-driven decision-making, and continuous quality improvement. In VBHC, patient preferences and needs are placed at the center of care delivery, with the aim of creating personalized treatment plans that resonate with each individual's unique circumstances. The approach also emphasizes care coordination, where multidisciplinary teams collaborate to provide comprehensive, seamless, and well-coordinated care across various settings and specialties.

Data and evidence play a pivotal role in VBHC, as the model relies on performance measurement and outcome data to inform decision-making and improve care quality. Robust data analytics and health information technology are crucial components of VBHC, facilitating the collection, analysis, and sharing of data to drive continuous quality improvement efforts.

While the transition to value-based healthcare has been met with enthusiasm and support, it also presents challenges and complexities. Implementation of VBHC requires significant organizational and cultural changes, as well as alignment of incentives among various

stakeholders, including healthcare providers, payers, policymakers, and patients. Measuring value, defining appropriate performance metrics, and developing effective payment models are among the complex issues that need to be addressed to fully realize the potential of VBHC.

1.2 The six pillars of the value agenda

The "Six Pillars of the Value Agenda" (figure 1.1) is a framework proposed by Michael E. Porter and Thomas H. Lee to guide healthcare organizations and policymakers in their journey towards transforming their care delivery models and achieving value-based healthcare. (2) These pillars represent essential components that contribute to the delivery of high-quality, patient-centered care while optimizing costs and outcomes. By addressing each pillar systematically, organizations can achieve better patient outcomes, enhance patient experiences, and achieve more sustainable healthcare costs, ultimately improving the overall value of healthcare services.

1.2.1 Organizing into Integrated Practice Units

The first pillar emphasizes the importance of organizing healthcare delivery around Integrated Practice Units (IPUs). IPUs are specialized teams that bring together the necessary expertise and resources to deliver comprehensive care for specific medical conditions or patient populations. By structuring care delivery into IPUs, healthcare organizations can improve care coordination, streamline processes, and ensure that patients receive the right care from the right providers at the right time. IPUs focus on delivering optimal outcomes and reducing variation in care, enhancing the overall value of healthcare services.

1.2.2 Measuring outcomes and costs for every patient

Accurate measurement of outcomes and costs for every patient is central to the value agenda. Healthcare organizations must establish robust data collection systems that capture patient outcomes and the associated costs of care throughout the entire care journey. Outcome measurement goes beyond clinical indicators and includes patient-reported outcomes (PROs) to assess the impact of care on patients' quality of life and overall well-being. This data-driven approach enables providers to identify areas for improvement, track progress, and make informed decisions to enhance the value of care delivered.

1.2.3 Moving to a value-based payment model

Shifting from traditional fee-for-service reimbursement to value-based payment models is a critical pillar in the value agenda. Value-based payment aligns financial incentives with the delivery of high-quality care, focusing on outcomes rather than the volume of services provided. Payment models such as bundled payments, shared savings, and pay-for-performance arrangements encourage providers to deliver efficient, effective care that meets patient needs while controlling costs. Value-based payment models promote collaboration among providers, reduce fragmentation, and reward value-adding activities.

1.2.4 Integrating care delivery across settings

To deliver seamless and patient-centric care, healthcare organizations must integrate care delivery across different settings and levels of care. This includes enhancing care coordination between primary care providers, specialists, hospitals, and post-acute care facilities. By fostering better communication and collaboration among care teams, patients experience more coordinated care transitions and improved care continuity. Integrated care delivery reduces duplicative services, prevents medical errors, and optimizes resource utilization, all contributing to improved value for patients and healthcare systems.

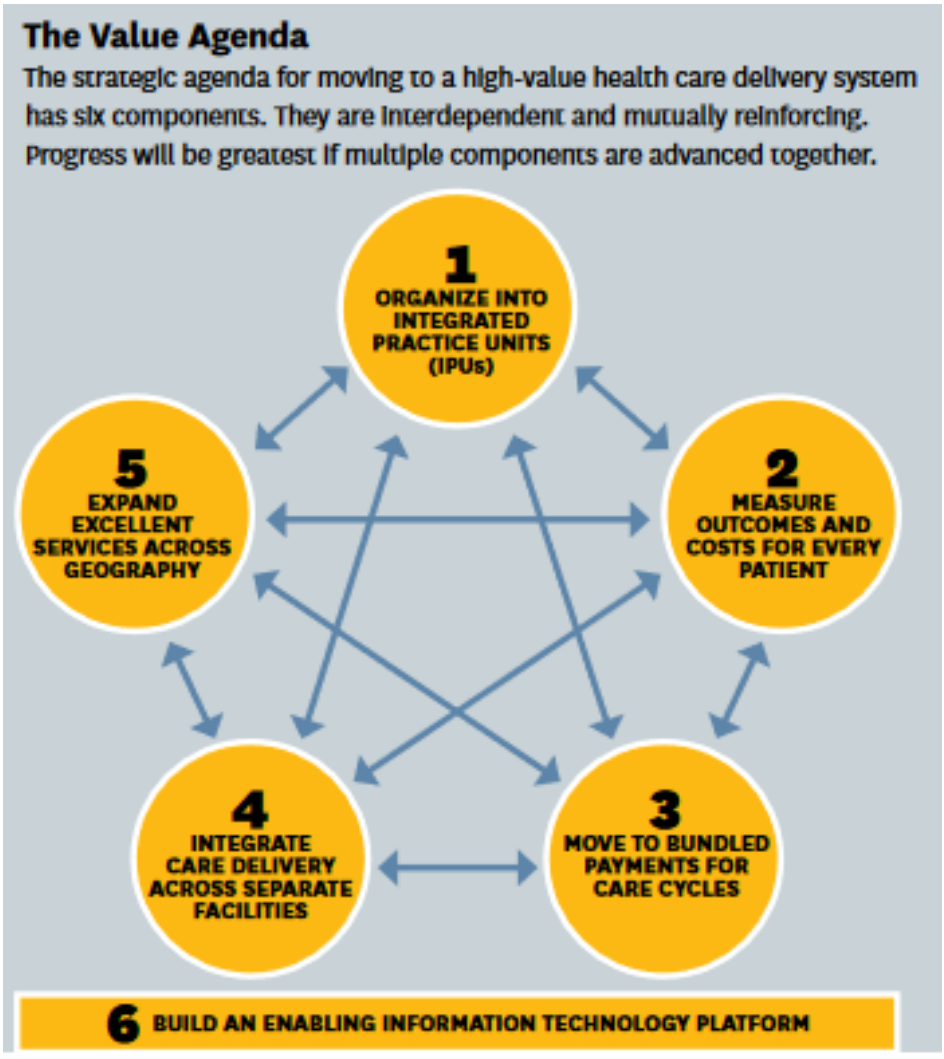
1.2.5 Expanding geographic reach

Expanding geographic reach in value-based health care means extending the delivery of high-value care to patients in different regions or countries, beyond the local market. This can help organizations achieve several objectives, such as increasing their patient volume and market share for specific medical conditions or service lines, leveraging their expertise and reputation to attract patients who seek the best available care for their needs, diversifying their revenue sources and reducing their dependence on local payers or regulators, and enhancing their learning and innovation capabilities by accessing new data, knowledge, and best practices from different markets.

1.2.6 Building an enabling Information Technology platform

Building an information technology (IT) platform that enables data collection, analysis, and sharing among providers and patients is crucial for supporting decision-making, quality improvement, and research efforts. An IT platform is a set of integrated software and hardware components that provide the infrastructure and functionality for data management and processing. A well-designed IT platform should have the following features: scalability, security, interoperability, and usability.

Figure 1.1 The six pillars of the value agenda (2)



CHAPTER 2: A Comprehensive Narrative Review of the Literature on Value-Based Health Care in Neurosurgery

2.1 Introduction

Value-based health care has gained prominence as a transformative approach to healthcare delivery, aiming to optimize patient outcomes while controlling costs. It represents a paradigm shift in healthcare delivery, emphasizing the importance of aligning healthcare efforts with the value they create for patients.

Neurosurgery is a complex and costly specialty that deals with a variety of complex and life-altering conditions affecting the brain, spine, and peripheral nerves. Neurosurgical patients often have multiple comorbidities, require long-term follow-up, and experience variable outcomes.

In this highly specialized field, the application of VBHC principles is vital to improve quality, efficiency, and appropriateness of care, and ensure optimal patient outcomes. This review aims to explore the various facets of value-based health care in neurosurgery, shedding light on its significance and implications for both patients and healthcare providers.

2.2 Definition and Principles

Value in healthcare is measured by the health outcomes achieved for a patient over the entire course of their treatment, divided by the total costs incurred for the patient's condition (figure 2.1). Therefore, value incorporates efficiency as well. (1) Value-based health care centers around the idea of delivering high-quality care that maximizes patient outcomes relative to the cost of that care. In the context of neurosurgery, VBHC principles necessitate the measurement and evaluation of patient outcomes, the incorporation of patient preferences in decision-making, the alignment of financial incentives with desired outcomes, and continuous improvement based on data-driven insights. The concept of value in neurosurgery encompasses not only clinical effectiveness but also patient experience, safety, and resource utilization. (1,3,4)

Figure 2.1 What is value in health care (5)

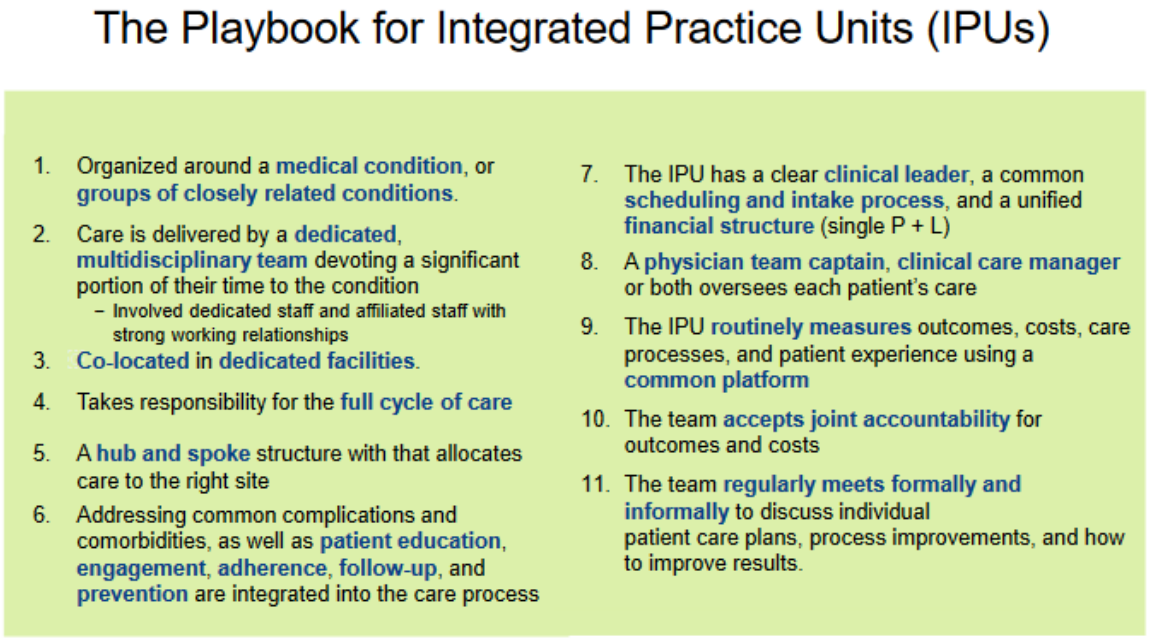
2.3 Organizing Integrated Practice Units

Integrated Practice Units are a model of care delivery that aims to improve patient outcomes and enhance value by organizing multidisciplinary teams around specific medical conditions or patient populations. An IPU is a team of health care professionals who work together to deliver value-based care for a specific medical condition or patient population. IPUs have the potential to optimize care coordination, standardize treatment pathways, and foster collaboration among healthcare professionals. (2)

What are the main attributes of IPUs (figure 2.2)? IPUs consist of a diverse team of healthcare professionals from different specialties, including physicians, nurses, specialists, therapists, pharmacists, and social workers. These professionals collaborate closely to provide a holistic approach to patient care, ensuring that all aspects of a patient's health and well-being are addressed. Each IPU is dedicated to delivering care for a specific medical condition or patient population. This disease-specific focus allows the IPU to develop expertise and specialized knowledge, leading to better patient outcomes and more efficient care delivery. IPUs are responsible for coordinating all aspects of patient care across the entire care journey, from diagnosis to treatment, recovery, and follow-up. Care coordination ensures that patients receive seamless and integrated care across different healthcare settings and providers. IPUs develop evidence-based and standardized care pathways that outline the best practices for diagnosing, treating, and managing specific medical conditions. These care pathways help ensure consistency and quality of care across all patients treated within the IPU. IPUs prioritize patient-centered care, considering each patient's unique needs, preferences, and treatment goals. Shared decision-making with patients and their families is a hallmark of IPU-based care, empowering patients to be active participants in their care plans. IPUs place a strong emphasis on measuring patient outcomes to continuously assess and improve the quality of care delivered. Outcome measurement includes both clinical indicators and patient-reported outcomes to capture the true impact of care on patients' health and well-being. IPUs are committed to continuous quality improvement, regularly reviewing performance data and outcomes to identify areas for enhancement. This data-driven approach enables IPUs to adapt and refine care processes to achieve better patient outcomes and higher value. IPUs focus on optimizing resource utilization while delivering high-quality care. By streamlining care processes, avoiding unnecessary tests

or treatments, and reducing variations in care, IPUs contribute to cost-effectiveness and value creation. IPUs are often led by physician champions who have expertise in the specific medical condition or patient population. Physician leadership is essential for driving clinical excellence, engaging care teams, and advocating for patient-centric care. IPUs provide patient education and support programs to help patients and their families better understand their medical conditions, treatment options, and self-management strategies. Patient education fosters patient empowerment and adherence to care plans.

Figure 2.2 The main attributes of IPUs according to Porter (6)



Neurosurgical IPUs are IPUs that focus on neurosurgical conditions such as brain tumors, spinal disorders, cerebrovascular diseases, or epilepsy, bringing together neurosurgeons, neurologists, neuro-radiologists, neurointensivists, radiotherapists, neuro-oncologists, nurses, therapists, and other specialists to coordinate care for specific patient segments or conditions.

The implementation of IPUs in neurosurgical practice involves reorganizing care teams to create dedicated neurosurgical service lines focusing on specific neurological conditions or

procedures. For instance, a neurosurgical IPU might focus on conditions like brain tumors, spinal disorders, or cerebrovascular diseases. (7)

Despite the potential benefits, implementing IPUs in neurosurgery presents certain challenges. Creating effective multidisciplinary teams requires overcoming existing silos and fostering a culture of collaboration among specialists with diverse backgrounds and expertise. Resource allocation and financial considerations can also pose challenges, as the IPU model may require upfront investments to establish and sustain the integrated care teams. At the moment, the implementation of IPUs is very limited and is, by far, the most underdeveloped element of the VBHC framework. (8)

Acknowledging that transforming university hospitals into IPUs can be costly and time consuming, and that it can involve significant changes in the organization and culture of care delivery, the European University Hospital Alliance suggested a similar approach, in the form of integrated care pathways (ICPs). (9) They advocate that a first step could be to reorganize the care process according to clinical conditions and to promote continuity of care across different units. This could foster the IPU mentality among staff through mutual visits and collaboration.

Some examples of neurosurgical IPUs can be found in major USA hospitals:

The Brain Tumor Center at Massachusetts General Hospital, which provides multidisciplinary care for patients with primary and metastatic brain tumors, using advanced diagnostic and therapeutic technologies. (10)

The Spine Center at Cleveland Clinic, which offers comprehensive and coordinated care for patients with spinal disorders, using evidence-based protocols and outcome measures. (11)

The Cerebrovascular Center at New York-Presbyterian Hospital, which integrates neurosurgery, neurology, neuroradiology and neurocritical care for patients with cerebrovascular diseases such as stroke, aneurysm, or arteriovenous malformation. (12)

The Epilepsy Surgery Program at Johns Hopkins Hospital, which combines neurosurgery, neurology, neuropsychology, and neurophysiology for patients with medically refractory epilepsy, using state-of-the-art surgical techniques and devices. (13)

In Europe, there are currently no implementations of neurosurgical IPUs, although IPUs dealing with other conditions have become to emerge in various countries and setups. (14) The Martini-Klinik prostate cancer care implementation is probably the oldest and most prominent European example of a true VBHC setup. (14,15) The Amsterdam University Medical Center have recently published their approach for implementation of value-based healthcare, (16) Some neurosurgical sub-specialties have successfully created ICPs in Europe. However, their design is often unclear, and their evaluation is weak, including a lack of patient input. (17) The European University Hospital Alliance and the European Institute of Innovation & Technology (EIT) Health have provided roadmaps for the implementation of VBHC in European Hospitals, (9,14).

2.3.1 Implementing Shared Decision-Making

Shared decision-making is a cornerstone of value-based health care, particularly in neurosurgery, where treatment decisions often involve high stakes and complex considerations. Engaging patients in the decision-making process empowers them to make informed choices aligned with their values and preferences. Neurosurgeons, as well as other members of the healthcare team, must effectively communicate risks, benefits, and alternatives to enable patients to participate actively in the decision-making process. Shared decision making in neurosurgery is however an underexplored topic in the literature, suggesting that the conventional 'doctor prescribes solution' approach still prevails. Although shared decision making may have positive effects, its impact on treatment choices, outcomes and patient satisfaction remains unclear. (18)

Studies have shown that shared decision-making not only improves patient satisfaction but also enhances treatment adherence and patient-reported outcomes. (18,19) Patients who participate in shared decision making may feel more satisfied with their care, as they have more control, autonomy, and involvement in their treatment choices, may have better outcomes, such as lower complication rates, shorter hospital stays, higher quality of life and lower mortality, and may have less decisional conflict, such as uncertainty, regret, or guilt, about their treatment options.

Clinicians and patients who practice shared decision making may have a stronger relationship, based on trust, respect and mutual understanding. (18,20)

Naturally, change is not straightforward. Some possible barriers to shared decision making in neurosurgery are unavailability of time and resources, lack of knowledge and skills, scarcity of tools and support, absence of patient involvement, prognostic uncertainty, or even lack of ethical clarity. (18,21)

Clinicians may face time constraints, workload pressures, resource limitations and competing priorities that hinder their ability to engage in shared decision making with their patients. Clinicians and their patients may be unable to understand the evidence, communicate the risks and benefits, elicit preferences and values, and reach a consensus. They may lack supportive tools, such as decision aids and guidelines or support, such as training, feedback, or incentives. Patients may have low levels of involvement due to health literacy, low self-efficacy, low trust, high anxiety, or cultural differences. Clinicians may face difficulties in providing accurate and reliable prognostic information to patients, due to the complexity and variability of the condition and its outcomes. Finally, clinicians may encounter ethical dilemmas or conflicts in shared decision making, such as respecting patient autonomy versus beneficence, balancing patient preferences versus best interests, or dealing with surrogate decision makers versus advance directives.

2.3.2 Patient-Centered Quality Improvement

An integral component of VBHC in neurosurgery is the commitment to continuous quality improvement. (22) Engaging in ongoing quality assessment and feedback loops enables institutions to identify areas for improvement, reduce variations in care, and enhance patient safety. Regular audits, morbidity, and mortality conferences, as well as patient satisfaction surveys, provide valuable data for quality improvement initiatives. Clinical registries are useful tools to identify, evaluate, and improve the quality of health care. (23) To enhance overall satisfaction without compromising costs, local initiatives within individual departments are also necessary along with national efforts. (24) Moreover, fostering a culture of continuous learning and collaboration among healthcare providers contributes to the success of VBHC in neurosurgery.

2.4 Measuring Outcomes in Neurosurgery

The accurate and standardized measurement of outcomes is a fundamental aspect of VBHC implementation in neurosurgery. (25) Michael E. Porter has organized patient outcomes into a hierarchical structure, providing a comprehensive approach to measuring the value delivered by healthcare services. (1,26) This outcome hierarchy goes beyond traditional clinical metrics and incorporates patient-reported outcomes (PROs) to assess the true impact of healthcare interventions on patients' lives and well-being. The outcome hierarchy consists of three levels:

Level 1: Health Status Outcomes

At the base of the outcome hierarchy are health status outcomes. These outcomes focus on the changes in patients' medical conditions and physical health resulting from healthcare interventions. Health status outcomes include clinical indicators such as disease remission, mortality rates, and improvement in physiological markers. These measures are essential for understanding the effectiveness of medical treatments and interventions in addressing specific medical conditions.

Level 2: Functional Outcomes

The second level of the outcome hierarchy comprises functional outcomes, which assess the impact of healthcare interventions on patients' ability to perform daily activities and functions. Functional outcomes evaluate how well patients can manage their symptoms, perform essential tasks, and maintain their quality of life. These outcomes are often measured through validated assessment tools that capture patients' functional abilities and limitations.

Neurosurgical functional outcome measures are tests that evaluate the patient’s physical, cognitive, or behavioral abilities after a neurosurgical intervention. Functional outcome measures can be used for conditions such as stroke, traumatic brain injury, or spinal cord injury. Some examples of functional outcome measures are the Modified Rankin Scale, the Glasgow Outcome Scale, the Barthel Index, or the Functional Independence Measure. (27)

Level 3: Patient-Reported Outcomes (PROs)

The top level of the outcome hierarchy is dedicated to patient-reported outcomes (PROs), which directly reflect patients' perspectives and experiences with their healthcare. PROs assess patients' perceptions of their physical, mental, and social well-being, as well as their overall satisfaction with the care they receive. PROs provide valuable insights into patients' preferences, values, and treatment goals, allowing healthcare providers to tailor care plans that align with individual patient needs.

Patient-reported outcome measures (PROMs) provide valuable insights into patients' perceptions of their health and quality of life after surgery. PROMs are questionnaires that assess the patient's health status, quality of life, and satisfaction from their own perspective. PROMs can be used for various neurosurgical conditions, such as brain tumors, spinal disorders, epilepsy, or cerebrovascular diseases. Some examples of PROMs are the EuroQol-5D (EQ-5D), the Oswestry Disability Index (ODI), the Quality of Life in Epilepsy Inventory, and the Stroke Impact Scale. (28) PROMs define the outcomes that really matter to patients.

The outcome hierarchy of Porter (1) in value-based healthcare emphasizes the significance of patient-centered care and the importance of considering patients' voices in evaluating healthcare quality and value. By incorporating patient-reported outcomes at the top level of the hierarchy, healthcare organizations can gain a deeper understanding of the outcomes that matter most to patients. This patient-centric approach supports shared decision-making, enhances patient engagement, and helps align care delivery with patients' individual goals and preferences.

Measuring outcomes at each level of the hierarchy enables healthcare organizations to evaluate the overall impact of healthcare interventions on patients' health status, functioning, and well-being. It provides a comprehensive picture of the value delivered by healthcare services, beyond traditional clinical metrics. By focusing on the outcome hierarchy, healthcare providers can continually improve care delivery, enhance patient experiences, and ultimately deliver higher-value healthcare services.

Developing and utilizing standardized outcome measures for common neurosurgical conditions, such as stroke, brain tumor, spinal cord injury, etc., and collecting them in registries or databases facilitates meaningful comparisons between different interventions and institutions, enabling more informed decision-making. (28–30) Outcomes should be measured by medical condition,

not by specialty, procedure, or intervention. (26) In this context, there is also need for disease-specific PROMs to be validated in neurosurgical patients and for neurosurgery-specific PROMs to be developed. (28)

A huge effort to standardize patient-centered outcome measures is made by ICHOM. (31) ICHOM stands for the International Consortium for Health Outcomes Measurement, which is a non-profit organization that aims to standardize and improve the measurement and reporting of health outcomes across different medical conditions and patient populations. The ICHOM sets are reference guides that specify the core outcomes, indicators, and instruments that should be collected and reported for a specific condition or population. Some examples of ICHOM sets that are relevant to neurosurgery are:

The Stroke Standard Set, which covers patients with ischemic or hemorrhagic stroke. The set includes outcomes such as mortality, functional status, quality of life, cognition, mood, and satisfaction. (32)

The Parkinson's Disease Standard Set, which covers patients with Parkinson's disease. The set includes outcomes such as motor symptoms, non-motor symptoms, complications of therapy, health-related quality of life, and caregiver burden. (33)

The Low Back Pain Standard Set, which covers patients with chronic low back pain. The set includes outcomes such as pain intensity, physical functioning, emotional functioning, health-related quality of life, and work productivity. (34)

2.5 Measuring costs in neurosurgery

In the realm of VBHC, an effective method for assessing costs is Time-Driven Activity-Based Costing (TDABC). (8,35) This methodology involves meticulously measuring the real costs associated with providing care to a patient with a specific medical condition. It delves into the intricacies of a patient's treatment journey, scrutinizing each step and pinpointing the precise costs linked to each process. This granular approach to cost analysis is vital for gaining a comprehensive understanding of resource utilization and expenditure within healthcare delivery.

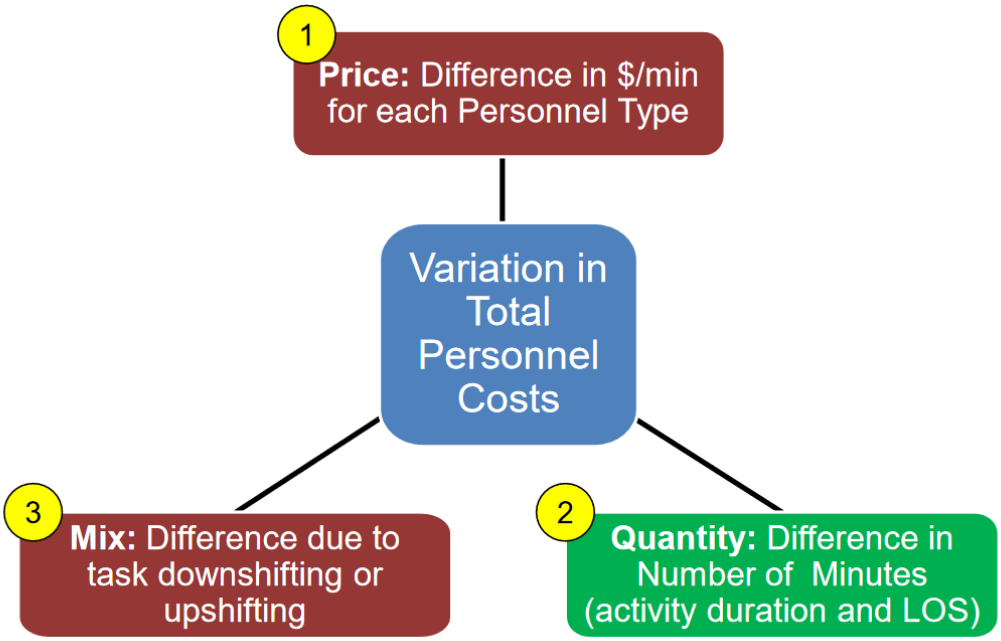
TDABC differs from traditional costing methods in several ways. (36) Firstly, it considers all the costs related to the manufacturing and non-manufacturing activities; traditional costing methods do not include non-manufacturing costs. In addition, TDABC is based on two factors: the cost per unit of time for each resource and the time required for each activity; traditional costing methods include all related factory overheads. Furthermore, TDABC is more accurate than traditional activity-based costing when traceability of resources to activities is high and activity traceability to products is low. TDABC is easier to implement and update than activity-based costing, as it requires less data collection and estimation.

In health care, the cost measurement process according to TDABC is based on two steps. First, estimate the cost per unit of time for each resource involved in care delivery, such as personnel, equipment, facilities, etc. Second, measure the time spent by each resource on each patient over the complete care cycle. (35) Various methodologies have been proposed for implementing TDABC in health care settings. (35,37,38) In 2011, Robert Kaplan and Michael Porter presented a seven-step approach to the application of TDABC in health care settings (Figure 2.3). (35,39) This model has generally been reflected in the various TDABC applications in health care settings. (40) Personnel time and productivity cost variances are important interrelated factors that may affect the overall cost in a favorable or unfavorable way. (39) This means that by streamlining workflow and reducing the time required to perform a task, even a higher average cost per minute may result in a lower total cost. In addition, assigning appropriate tasks to different personnel type with a lower average cost per minute, may reduce the total cost, while obtaining the same result (Figure 2.4). (39)

Figure 2.3 The seven steps of TDABC implementation for health care organizations (35,39,40)

Step 1	Select the medical condition
Step 2	Define the care delivery value chain, i.e. chart all key activities performed within the entire care cycle
Step 3	Develop process maps that include each activity in patient care delivery, and incorporate all direct and indirect capacity-supplying resources
Step 4	Obtain time estimates for each process, i.e. obtain time estimates for activities and resources used
Step 5	Estimate the cost of supplying patient care resources, i.e. the cost of all direct and indirect resources involved in care delivery
Step 6	Estimate the capacity of each resource and calculate the capacity cost rate
Step 7	Calculate the total cost of patient care

Figure 2.4 Benefits from variance analysis (39)



TDABC offers numerous advantages when applied within the VBHC framework. By providing a holistic view of costs incurred across the continuum of care, it enables healthcare organizations to make well-informed decisions on resource allocation. This bottom-up methodology ensures that costs are accurately attributed to the specific processes and activities associated with patient care, avoiding the pitfalls of traditional cost allocation methods that can be less precise. (40)

Moreover, TDABC serves as a powerful tool for identifying potential areas of cost reduction. By scrutinizing the processes and activities that contribute to overall costs, healthcare providers can uncover inefficiencies, redundancies, and areas where resource utilization can be optimized. This insights-driven approach empowers organizations to streamline workflows, enhance process efficiency, and ultimately reduce the financial burden associated with care delivery.

In the context of setting prices for medical procedures, TDABC plays a crucial role. By thoroughly dissecting the various components of care, this methodology aids in determining an appropriate price that reflects the genuine costs involved in delivering a procedure. This not only ensures that healthcare organizations receive fair compensation for their services but also promotes transparency in pricing, benefiting both providers and patients. Best practices that have been found to be key to success in cost measurement are process mapping, expert input, and observations. Practitioners should use these practices when applying TDABC to estimate costs. (41)

Reports on TDABC implementation in neurosurgical practice are scarce. One study described how TDABC was applied to one neurosurgery pilot at University of California Los Angeles Health. It reported the average cost capacities for different staff roles and the potential savings from reducing non-value-added time. (42) Another study at Virginia Mason Franciscan Health evaluated how TDABC and lean methodologies can identify variability in the time and cost of spine fusion surgery. It showed that there is significant variability across surgeons, patients, and phases of care, and suggests ways to reduce it. (43) Finally, a study from the Rothman Institute at Thomas Jefferson University Hospital in Philadelphia utilized TDABC to determine the true cost of anterior cervical spine fusion. (44) While there is limited literature specifically focusing on TDABC in neurosurgical practice, the concept has been applied to other medical specialties and healthcare settings, and its principles can be adapted to evaluate the cost of neurosurgical procedures and related activities.

2.5.1 Cost-effectiveness analysis and value-based health care

Cost-effectiveness analysis (CEA) and VBHC are both methods to measure the value of health care interventions based on their outcomes and costs. However, they differ in several ways. CEA compares different interventions for the same health problem, using a common outcome measure, such as quality-adjusted life years (QALYs), to compare different types of health benefits, while VBHC compares different providers or teams for the same intervention, using multiple outcome measures that are relevant to the patient's condition. (1,45) Furthermore, CEA compares different ways of diagnosing or treating health problems based on their value from a societal or health sector perspective (Δ costs/Δ effectiveness), while VBHC approaches, despite being similar in concept, are patient-centered (outcomes that matter to patients/total costs of care). (46,47) This means that cost-effectiveness analysis is used to inform policy decisions at a population level, that is to decide what services to cover for a group or population, and VBHC is mainly used to inform clinical decisions at an individual level, that is to decide what services to offer for each patient. A comparison of cost-effectiveness analysis to VBHC is seen in Table 2.1. (46)

Criticisms related to CEA are represented by three main concerns. (45) QALYs may not be an ideal way to measure health benefits, because they may be biased against some groups of people or some types of health problems. CEA does not consider how to distribute health resources fairly among different people or groups, especially those who are worse off or have more needs. Finally, CEA does not capture all the values that matter to people, such as dignity, autonomy, or social justice.

CEA and VBHC should align better to provide the best possible care at the lowest possible costs for patients. (46) There are various ways the two approaches can intersect and integrate. Using CEA to identify high-value interventions that should be prioritized and incentivized and using VBHC to monitor and improve their delivery and outcomes, (45) using VBHC to generate data on patient-reported outcomes and costs that can be used as inputs for CEA, or using CEA to evaluate the cost-effectiveness of implementing VBHC models in different settings and populations. (47)

Table 2.1 Comparison of cost-effectiveness analysis and value-based health care (46) [modified]

Variable	Cost-Effectiveness Analysis	Value-Based Health Care
Formula	Δ costs/Δ effectiveness	Outcomes that matter to patients/ total costs of care
Primary current uses	In several countries, as a basis for coverage decisions; in the United States, considered in a qualitative sense but seldom used explicitly as a basis for coverage decisions	By clinicians and health systems to eliminate areas of waste and inefficiencies in providing care Aims to improve outcomes and decrease total costs of care for health delivery systems and for individual patients
Most common perspective	Societal, health care sector (with or without inclusion of time costs), or payer	Patient
Time horizon	Often long-term or lifetime, with future costs and benefits discounted to their present value	Often short-term (e.g., for an episode of care)
Costs generally included	Medical costs, time costs accrued by patients and caregivers, transportation costs, productivity costs, and other non-health care sector costs	Resource use and patient out-of-pocket costs
Outcomes considered	Multidimensional, but can be combined into a single number (QALYs)	Multidimensional construct that cannot be combined into a single number
Modeling	Simulation models (e.g., Markov models) commonly used	Costs increasingly modeled using state-of-the-art accounting methods, such as time-driven, activity-based costing
Uncertainty (sensitivity) analyses	Single-variable and multivariable sensitivity analyses routinely conducted and presented	Often conducted in the context of evaluating areas of overuse or variation
Limitations/challenges	Difficulty capturing generally unmeasured/intangible costs and benefits Challenging to gain a foothold in the current U.S. political climate	Generally cannot precisely measure the "value" of a given intervention because of its personalized nature and the multidimensionality of the construct

Neurosurgical interventions can be resource-intensive, and optimizing resource utilization is essential to provide high-value care. Conducting cost-effectiveness studies for various neurosurgical procedures allows healthcare stakeholders to identify interventions that offer the best outcomes relative to their costs. Such analyses enable policymakers and administrators to

make informed decisions about funding, reimbursement, and the adoption of new technologies. Cost-effectiveness studies have been conducted for various neurosurgical interventions, but there is low comparability of economic evaluations between studies and many interventions have yet to prove their cost-effectiveness. (48,49) This underscores the importance of having consistent and transparent methods for measuring and reporting cost and cost-effectiveness in neurosurgery. (50) However, this need to be consistent with VBHC principles as well, to avoid negative feedback at the patient level. (46)

2.5.2 Cost reduction opportunities

There are various ways to reduce costs in health care and neurosurgery. (26) Reduce process variation that wastes resources and does not improve outcomes. Discard of low-value or unnecessary services or tests that are driven by protocols or billing necessities. Streamlining redundant administrative and scheduling units. Use expensive resources like physicians, staff, space, and facilities more efficiently by avoiding duplication and service fragmentation. Reduce the use of highly resourced facilities and highly skilled staff for simple or routine services. Reduce the time spent on each step of the care cycle. Optimize the total cost of the care cycle rather than focusing on individual services. Increase the awareness of costs among clinical teams.

2.6 Implementing value-based payment models

Value-based payment models are alternative payment methods that reward providers for delivering high-quality care at lower costs, rather than paying for the volume of services. Value-based payment models aim to improve the outcomes and efficiency of health care delivery, as well as to reduce unnecessary spending and variation. These payment models align with the principles of value-based health care, emphasizing improved patient outcomes and resource optimization. (1,2,8,51)

Paying for health care based on the quantity of services, not the quality or efficiency, is flawed. So is paying providers fixed annual budgets that don't reflect the actual needs of patients during the year. The use of either of these systems, fee-for-service or fixed annual budgets, leads to long waits for nonurgent care and pressure to increase budgets every year. (51)

A better way to pay for health care is one that rewards providers for delivering better health outcomes at lower cost. This is called "value-based reimbursement" and it is becoming more common. "Value-based reimbursement", however, can mean two radically different payment methods, capitation and bundled payments. In capitation, the health care organization gets a fixed payment per year for each person it covers and must take care of all their health needs. In bundled payments, on the other hand, providers are paid for the care of a specific medical condition for a patient over the whole care cycle – that is, everything that is used to treat a patient with, for example, heart failure, a hip that needs to be replaced, diabetes, or a brain tumor. (51) Value base payments can be achieved with various strategic changes, such as implementing accountable care organizations, hospital value-based purchasing programs, and clinically integrated networks. (52)

Value-based payment models offer several advantages for neurosurgery. They align the incentives of payers and providers to improve the quality and efficiency of care, rather than paying for the volume of services. This can lead to better outcomes and satisfaction for patients, as well as lower costs and risks for payers and providers. (53,54) Value-based payment models also encourage healthcare providers to adopt evidence-based practices, to establish more innovative and integrated approaches to care delivery, such as leveraging technology, analytics, communication, and coordination, to standardize treatment protocols, and to invest in care coordination to improve patient outcomes. This can enhance the patient experience, reduce

errors and waste, and optimize the use of resources. (53,55) Furthermore, such models can foster collaboration among neurosurgeons, specialists, and healthcare institutions, driving continuous quality improvement efforts. Finally, such models support the goal of improving population health management, by generating data on patient populations, addressing health disparities, and focusing on prevention and wellness. This can help reduce the burden of chronic diseases, improve health equity, and promote public health. (56,57)

The benefits of well-designed bundled payments have now been proven. (51,52,56,58) However, in the context of neurosurgical practice, the transition to such models faces several challenges, which can be significant barriers to successful adoption. Neurosurgery involves a diverse range of neurological conditions and procedures, each with unique patient needs and outcomes. Developing standardized metrics to assess the value of care across this heterogeneous patient population can be challenging. (28) Determining meaningful and relevant outcome measures in neurosurgery is also complex. Some neurological conditions may have long-term and multifaceted outcomes that are challenging to quantify accurately. Identifying appropriate PROMs can also be difficult. Neurosurgery patients may have complex medical histories and comorbidities that can influence treatment outcomes. Designing payment models that account for these complexities is also a significant challenge. Accountability for outcomes is another significant inhibitor.

The complexity and fragmentation of the current value-based payment landscape creates confusion and an administrative burden for providers and payers. There are multiple programs, models, measures, and reporting requirements that vary across different payers, settings, and populations. This makes it difficult for providers to participate in multiple value-based payment models and to align their incentives and goals. (56)

Implementing value-based payment models requires robust data collection and sophisticated infrastructure to track patient outcomes, costs, and resource utilization accurately. Many healthcare institutions may face obstacles in gathering and managing the necessary data. Resistance to change is another key inhibitor. Shifting from traditional fee-for-service models to value-based payment systems may encounter resistance from providers who are accustomed to the status quo. This resistance could be due to concerns about financial risk, uncertainty about

changes in reimbursement, or fear of reduced income. (51,58) Some providers may also prefer the fee-for-service model that rewards volume over value. (56)

Providers remain nervous about the financial risk associated with value-based payment models. If financial incentives are tied to outcomes, providers might worry about the potential for financial losses due to factors beyond their control, such as absence of reliable cost data at the condition level. (2) In addition, VBHC models usually require a considerable upfront investment to set up, and certain procedures and interventions may be resource-intensive, making it challenging to balance cost-effectiveness with the delivery of high-quality care. The lack of comprehensive and reliable benchmarking data for neurosurgical procedures can hinder the establishment of fair and appropriate payment models.

In addition, neurosurgical care often involves coordination with other specialties, and value-based payment models need to provide adequate incentives for seamless collaboration among healthcare providers. Lastly, value-based payment models often require additional administrative work to collect and report outcome data, leading to increased administrative burden for healthcare providers and institutions. (58) Some providers may face barriers such as insufficient data, infrastructure, or expertise to measure and improve quality and efficiency. (56)

Overcoming these challenges requires collaboration among healthcare stakeholders, innovative data management systems, reliable outcome measurement tools, and a commitment to continuous improvement. Additionally, policy and regulatory support are vital to address financial risk concerns and facilitate the successful adoption of value-based payment models in neurosurgery. (56,58)

Some examples of value-based payment models that are relevant to neurosurgery are:

The Quality Payment Program (QPP), which is a program established by the Medicare Access and CHIP Reauthorization Act of 2015 that affects Medicare payments for neurologists and other clinicians. The QPP has two tracks: the Merit-based Incentive Payment System (MIPS) and the Advanced Alternative Payment Models (APMs). MIPS adjusts payments based on performance in four categories: quality, cost, improvement activities, and promoting interoperability. Advanced APMs offer higher incentives for participating in innovative payment models that require taking on financial risk and meeting quality criteria. (59)

The Bundled Payments for Care Improvement (BPCI) initiative, which is a voluntary program that tests four models of bundling payments for episodes of care that begin with a hospitalization or an outpatient procedure. Providers can choose from 48 clinical episodes, including several related to neurosurgery, such as spinal fusion, craniotomy, or lower extremity joint replacement. Providers receive a single payment for all services within the episode and share in the savings or losses based on their performance on quality and cost measures. (56)

The Quality Outcomes Database (QOD) of the NeuroPoint Alliance (NPA), formerly known as National Neurosurgery Quality Outcomes Database, is a national registry that collects clinical data on neurosurgical procedures and outcomes. The QOD allows neurosurgeons to benchmark their performance against national standards, identify areas for improvement, and demonstrate their value to payers and patients. The QOD also supports the development of risk-adjusted predictive models that can inform clinical decision making and payment negotiations. (60,61)

Implementing value-based payment models in neurosurgery is an essential step towards optimizing patient outcomes and healthcare value. By incentivizing high-quality care at lower costs, these models encourage care coordination, standardization of care, and collaboration among healthcare providers. Overcoming challenges and aligning payment incentives with meaningful quality measures are key to the successful implementation of value-based payment models in neurosurgery. Continuous research and innovation in this domain hold the potential to revolutionize the way neurosurgical care is delivered, ultimately benefiting patients and healthcare systems alike.

2.7 Integrating care delivery across different settings and levels of care

Integrating care delivery across various settings and levels of care in neurosurgery involves coordinating healthcare services and fostering collaboration among providers to ensure a seamless and continuous patient care experience. This integration aims to optimize outcomes and efficiency of care for patients with neurological conditions, improve patient experience, and enhance resource utilization. (30,62)

According to Porter, system integration is the process of organizing health care delivery around the full cycle of care for each patient's medical condition, rather than around the specialties or services of individual providers. (2) To achieve system integration, organizations must make four interrelated sets of decisions:

Defining the scope of services: This means deciding which medical conditions and patient segments to serve, and which ones to exclude. This helps organizations focus on their areas of expertise and avoid spreading their resources too thin. (2,63) Defining the patient population and segmenting them based on their needs, preferences, and risk factors can help tailor the care delivery to the specific characteristics and goals of each patient group. (26)

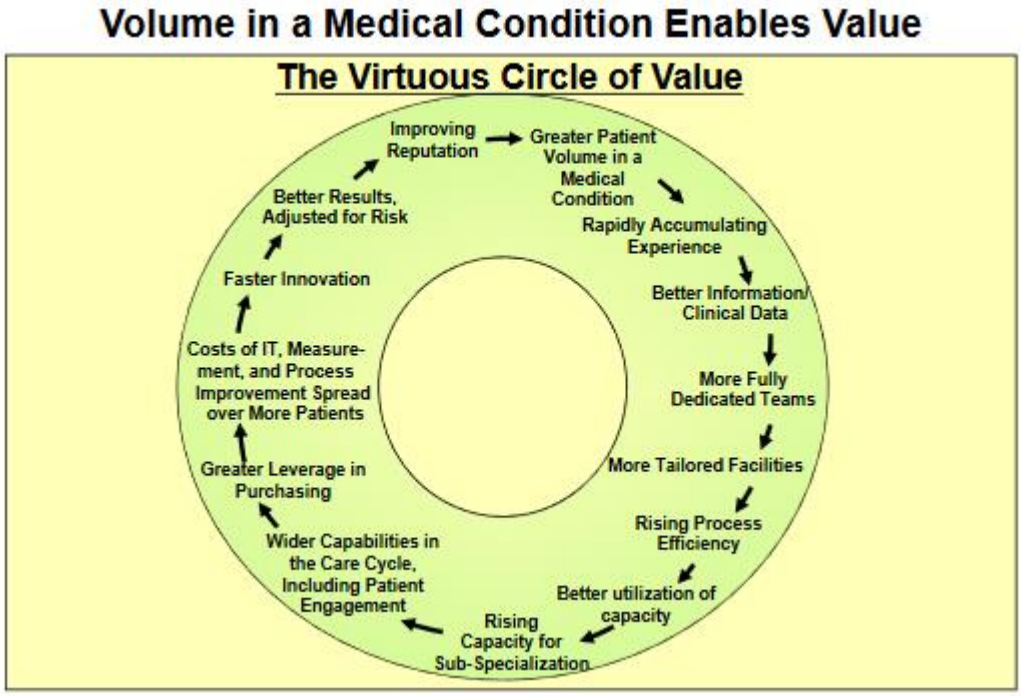
Concentrating volume in fewer locations: This means consolidating the delivery of care for each condition in a few high-volume locations, rather than dispersing it across many low-volume ones. This helps organizations achieve economies of scale, improve quality and outcomes, and reduce costs. (2,63) Volume matters for value for a particular medical condition, according to many studies. Providers who have treated many patients with that condition are more likely to achieve lower costs and better outcomes. (2,26)

Choosing the right location for each service line: This means selecting the optimal type and level of facility for each service line, based on the complexity and severity of the condition, the availability of resources, and the preferences of patients. This helps organizations match the needs of each patient with the most appropriate and efficient location of care. (2,63)

Integrating care for patients across locations: This means coordinating and standardizing the care delivered by different providers across different locations, using information technology, protocols, and incentives. This helps organizations ensure continuity and consistency of care, reduce errors and duplication, and enhance patient satisfaction. (2,4)

University College London Partners, an alliance of six well known teaching hospitals, concentrated stroke care and relative resources in one unit and has seen 25% decrease in mortality while achieving a 6% cost reduction. (2) According to Porter, higher volume leads to better outcomes, lower costs, and greater market share, which in turn leads to higher volume. This creates a positive feedback loop that enhances the value proposition of the provider, in the so called 'virtuous circle of value' (Figure 2.5). (6)

Figure 2.5 The virtuous circle of value (6)



Integrating care involves empowering patients with education and information about their condition and treatment options. Engaged patients are more likely to actively participate in their care. For example, providing educational materials and engaging patients in discussions about treatment plans can improve patient satisfaction and adherence to treatment. Engaging patients and their families in shared decision making and self-management, as well as providing them with peer support and navigation services can help enhance patient satisfaction, empowerment, and adherence to care plans. (62)

Integration also relies on seamless communication and health information exchange among providers. Electronic health records (EHR) and health information exchange platforms enable real-time access to patient information. For example, a centralized electronic health record system allows neurosurgeons, neurologists, and other specialists to access and update patient data across sites and locations. Telemedicine and remote monitoring technologies can facilitate virtual consultations, follow-up appointments, and remote patient monitoring in neurosurgery. For example, telemedicine can be used for post-operative follow-up and remote consultations for patients residing in remote areas. (63)

Quality improvement initiatives such as morbidity and mortality conferences and performance audits are essential components of integrating care delivery in neurosurgery. These activities help identify areas for improvement and foster a culture of continuous learning and excellence. Considering the broader population health context is essential in integrating care across settings. Population health management strategies can help identify at-risk populations, implement preventive measures, and optimize resource allocation. For example, targeted preventive measures for neurosurgical conditions, such as implementing stroke prevention programs, can reduce the burden of neurological diseases in a community. (62)

Integrating care delivery across different settings and levels of care in neurosurgery is vital for optimizing patient outcomes and enhancing the patient experience. By fostering collaboration among multidisciplinary care teams, leveraging technology, and implementing standardized care pathways, healthcare systems can create a more seamless and efficient care experience for neurosurgical patients. Empowering patients through shared decision-making, patient education, and engagement further contributes to improved treatment outcomes. Continuous quality improvement initiatives and population health management strategies ensure that the integration of care in neurosurgery aligns with patient-centered, evidence-based, and resource-efficient principles.

2.8 Expanding geographic reach

Expanding geographic reach in VBHC means extending the delivery of high-value care to patients in different regions or countries, beyond the local market. Developing reference networks allows to identify where is the most advanced technology or specific expertise and to refer patients where the most effective care can be provided and the best possible outcomes obtained. (64)

Expanding geographic reach of VBHC IPUs can be achieved using various models, including the "hub and spoke" model and the "clinical affiliation" model. These models provide structured approaches to extending the principles of VBHC to new regions or healthcare systems. (2)

The hub and spoke model involves establishing a central hub of expertise and resources that serves as a focal point for coordinating and disseminating VBHC practices. The hub represents a higher level of care delivery and serves as a source of guidance, best practices, and specialized knowledge. The spokes, on the other hand, are the satellite facilities, clinics, or providers that are affiliated with the hub. The spokes are responsible for delivering less complicated care to patients and implementing VBHC principles based on the guidance provided by the hub, while more complex cases are referred centrally. They can be staffed partly by personnel of the parent organization, and some clinicians may rotate among sites. (2) MD Anderson Cancer Center, for example, has ‘spokes’ in the Houston region to provide pre- or post-operative chemotherapy and radiotherapy. (2,65)

Advantages of this model are centralized expertise, standardization, and resource allocation. The hub provides a centralized source of expertise, ensuring consistent implementation of VBHC practices. It can develop standardized care pathways and protocols, ensuring uniformity across spokes and specialized resources can be concentrated at the hub, optimizing resource utilization.

Challenges for the successful implementation of such a model are relevant to effective communication, coordination of care delivery and information exchange between the hub and spokes, and local adaptation of VBHC practices at the spoke level while maintaining consistency.

The clinical affiliation model involves forming partnerships or affiliations between different healthcare organizations or providers to collectively implement VBHC principles. Affiliated

organizations collaborate to share knowledge, resources, and best practices while maintaining their autonomy. This model encourages a sense of shared responsibility for patient outcomes while allowing each entity to contribute its unique strengths. (2) The Cleveland Clinic's Heart, Vascular & Thoracic Institute has been a pioneering IPU in cardiac and vascular care, with 19 hospital affiliates on the Eastern seaboard. (2,66)

Advantages of this model are local expertise, autonomy, and resource sharing. Affiliated organizations can leverage their existing knowledge of the local healthcare landscape. Each affiliated entity retains its independence while benefiting from collective efforts. Collaborative partnerships can pool resources for more effective implementation of VBHC.

Challenges in establishing clinical affiliation VBHC setups are associated with ensuring that all affiliated entities align their practices, establishing clear leadership and governance structures, and integrating workflows and information systems across different entities.

When using these models to expand VBHC's geographic reach, it's important to tailor the approach to the specific context of the new region or healthcare system. This might involve considering factors such as local regulations, cultural norms, available resources, and the existing healthcare infrastructure. Regardless of the model chosen, successful expansion requires strong leadership, effective communication, continuous collaboration, and a commitment to delivering high-quality, value-based care to patients across different regions.

Even without a proper affiliation between institutes, referral networks can be established to allow neurosurgeons to collaborate and coordinate with other providers in different settings and regions, such as primary care physicians, emergency physicians, radiologists, or neurologists. These networks streamline patient referrals and can facilitate the triage, diagnosis, treatment, and transfer of patients who need neurosurgical care, as well as the sharing of resources, expertise, and best practices. The University of California San Francisco Spine Service Referral Network, connects university neurosurgeons with community providers in Northern California, using a web-based platform to facilitate referrals, consultations, imaging reviews, and surgical planning for patients with complex spine disorders. (67)

Another interesting approach in expanding geographic reach is through telemedicine, which provides a way of increasing access to specialized neurosurgical care for patients in remote or underserved areas, or in resource-scarce times, such as during the recent global pandemic.

Telemedicine allows neurosurgeons to provide consultations, evaluations, follow-ups, and education to patients and providers in distant locations, using videoconferencing, mobile applications, or web-based platforms. For example, telemedicine can facilitate preoperative consultations for complex neurosurgical cases, enabling patients and local healthcare providers to interact with a neurosurgeon before the actual procedure. This can reduce travel time and costs, improve patient convenience and satisfaction, and enhance quality and safety of care. (68,69) The University of Miami Health Specialty Virtual Clinics telehealth platform offers virtual visits to patients with various neurosurgical conditions, such as brain tumors, spine disorders, or epilepsy. (68,70) The Mayo Clinic Telestroke Network connects stroke experts at Mayo Clinic with community hospitals in several states, using telemedicine technology to provide timely and accurate diagnosis and treatment of stroke patients. (68,71)

Expanding geographic reach through referral networks or telemedicine is crucial for increasing access to specialized neurosurgical care, particularly for patients in remote or underserved areas. The integration of telemedicine and referral networks further enhances access to specialized care and improves patient outcomes. By leveraging these technologies and collaborative approaches, healthcare systems can address geographical disparities and provide equitable neurosurgical care to all patients.

2.9 Building an enabling Information Technology platform

Building an IT platform that enables data collection, analysis, and sharing is a key step for any organization that wants to leverage data-driven insights and decision making. An IT platform is a set of integrated software and hardware components that provide the infrastructure and functionality for data management and processing. (2,6)

A well-designed IT platform should have the following features: (6)

Scalability: the ability to handle large volumes of data and support the growth of data sources and users over time.

Security: the ability to protect data from unauthorized access, modification, or loss, and comply with relevant regulations and standards.

Interoperability: the ability to exchange data with other systems or platforms, using common formats and protocols. It should intercommunicate within networks, electronic medical record platforms, and health insurance software. It needs to leverage mobile technology for scheduling, data collection, patient monitoring, access to notes and patient education.

Usability: the ability to provide user-friendly interfaces and tools for data collection, analysis, and sharing, and support the needs and preferences of different users and stakeholders. The data should be captured during the workflows.

Data collection: the ability to capture and store structured information on patient characteristics, outcomes, costs, processes, and experiences of care, using standardized and validated measures and tools, across the full cycle of care.

Data analysis: the ability to process, interpret and export the collected data, using statistical and computational methods, to generate insights and evidence that can inform clinical practice, policy, and innovation.

Data sharing: the ability to disseminate and exchange the data and analysis results among different stakeholders, such as providers, patients, researchers, or policymakers, using secure and user-friendly platforms.

The Mayo Clinic Neurosurgery Quality Dashboard is an excellent example. It collects and displays data on various quality indicators for neurosurgical procedures, such as mortality, morbidity, readmission, length of stay, or patient satisfaction. The dashboard allows neurosurgeons to compare their performance with their peers and benchmarks, and to identify areas for improvement. It helped the department to get competitive contracts, like bundled care arrangements, from employers and insurers. Patient referrals from payers increased by comparing patient outcomes to national standards, which increased the department's volume. Besides descriptive analytics that help clinicians track changes, it uses a predictive tool called "the neurosurgical risk calculator". The calculator uses current evidence to predict the surgical risk for a specific patient profile, which can then be used in the process of informed consent and shared decision making. (72,73)

In conclusion, building an IT platform that enables data collection, analysis, and sharing among providers and patients plays a pivotal role in data-driven healthcare. Integrating electronic health records, clinical decision support systems, patient portals, and research data warehouses empowers healthcare providers and patients to make informed decisions, supports quality improvement initiatives, and facilitates innovative research. By leveraging these technologies and collaborative approaches, healthcare systems can harness the power of data to deliver high-quality, patient-centered care and drive continuous improvement in healthcare practices.

2.10 Building a Culture of Value-Based Health Care

VBHC is understood and applied differently in local hospital settings. While most hospitals follow the ideas of Porter & Teisberg (4) and use outcome measurements, healthcare costs measurements or IPUs, they do not adopt VBHC as a comprehensive strategy. Very likely, there is limited attention for the managerial aspects of the process of change. (47)

A crucial step in implementing VBHC would be to foster a culture of value-based healthcare within healthcare organizations. This involves creating an environment that encourages continuous quality improvement, patient engagement, and shared decision-making. It requires aligning incentives and values across all stakeholders, including clinicians, administrators, payers, and patients, to prioritize patient outcomes and value creation. Obtaining buy-in for change is a crucial step in ensuring the success of any organizational change initiative. (73) Buy-in is usually achieved and maintained by communicating the vision and goals clearly, involving all the stakeholders, providing training and coaching, identifying change champions, rewarding achievements, and celebrating milestones along the way.

Finally, VBHC should be embedded in medical education. Elizabeth Teisberg, one of the pioneers of VBHC along with Michael Porter, (4) has suggested that medical schools should incorporate the principles of VBHC as a taught subject of their undergraduate curriculum to prepare future physicians to lead the transformation. (74) Austin's Dell Medical School (University of Texas) is a pioneer in teaching VBHC concepts to their undergraduate and postgraduate students. (74)

2.11 Conclusion

Value-based health care represents a promising paradigm shift in the field of neurosurgery, aligning the delivery of high-quality care with patient preferences and optimized resource utilization. While challenges exist in its implementation, efforts to address them through collaborative research and initiatives are ongoing. Despite these challenges, numerous studies highlight the positive impact of VBHC initiatives on patient outcomes and healthcare efficiency. As the healthcare landscape continues to evolve, the integration of VBHC principles in neurosurgery is expected to foster better patient experiences and improved clinical outcomes, and drive positive changes in the field of neurosurgery, ultimately enhancing overall healthcare value.

CHAPTER 3: Pilot design of a value based neurosurgical implementation

3.1 Introduction

While the transition to value-based health care (VBHC) has been met with enthusiasm and support, it also presents challenges and complexities. Implementation of VBHC requires significant organizational and cultural changes, as well as alignment of incentives among various stakeholders, including healthcare providers, payers, policymakers, and patients. Measuring value, defining appropriate performance metrics, and developing effective payment models are among the complex issues that need to be addressed to fully realize the potential of VBHC at a sustainable cost.

Neurosurgery is a complex and costly specialty that deals with a variety of complex and life-altering conditions affecting the brain, spine, and peripheral nerves. Neurosurgical patients often have multiple comorbidities, require long-term follow-up, and experience variable outcomes. In this highly specialized field, the application of VBHC principles is vital to improve quality, efficiency, and appropriateness of care, and ensure optimal patient outcomes.

Neurosurgical implementations of VBHC are scarce, as we have highlighted in the literature review section of this study, especially in Europe. Even in the USA, a paradigm of a fully implemented action is rare to find, since health care providers do not usually adopt VBHC as a comprehensive strategy, that is, actioning for all the 6 core concepts of the value agenda contemporaneously, rather than sequentially or partially. In Greece, there has been no attempt to date to establish a VBHC neurosurgical pathway, even partially.

3.2 Purpose, goals and expected results

The purpose of this study is to promote the development of VBHC in the Greek neurosurgical landscape by proposing a sustainable implementation roadmap that could be used as a strategic tool and guidance for pioneers. We propose a pilot case study of how to implement a model neurosurgical center in Greece. A pilot VBHC neurosurgical center would be a unit within a hospital that implements VBHC elements for a selected group of neurosurgical patients (i.e., one condition).

The various components and phases of the model will be discussed and a roadmap for full implementation will be proposed including strategy, preparation, design, building, evaluation, and improvement. The pathway should include ways to prepare hospitals for value-based healthcare implementation and explore the most effective ways to turn patient pathways into a process that results in high-value care.

It is expected that our pilot design forms a blueprint for actual implementation of the model and provides valuable lessons and insights for expanding in more clinical conditions and pathways, scaling up VBHC neurosurgery locally or across other hospitals or regions.

Based on the current design and its implementation, a further long-term study would test the feasibility and effectiveness of VBHC in neurosurgery, and evaluate its impact on patient outcomes and costs, by comparison to more traditional setups, in the same or other hospitals.

3.3 Choosing the condition

There is no definitive answer to which neurosurgical condition would be ideal for establishing a pilot VBHC pathway, as different conditions may have different challenges and opportunities for measuring and improving value. However, some possible criteria for selecting a condition are being common and/or having a high burden of disease; having well-defined and measurable outcomes that matter to patients; having variation in practice patterns, outcomes and costs across providers or regions; and having potential for improvement in quality, efficiency, or innovation.

Within the neurosurgical realm, spine care and spine surgery are under heavy scrutiny, given the very high and constantly rising costs of treatment. This puts a lot of pressure on health systems, providers, and patients, who must pay more for health care services. Worldwide, spine care is at the center of the effort to reduce healthcare costs and move toward a value-based healthcare system. Thus, it makes much sense to address spine pathology in terms of a VBHC initiative. Within the spectrum of spinal disease, we have chosen to address low back pain (LBP), because it meets all the above criteria. (75) More specifically, this study will address LBP due to degenerative lumbar conditions in adults.

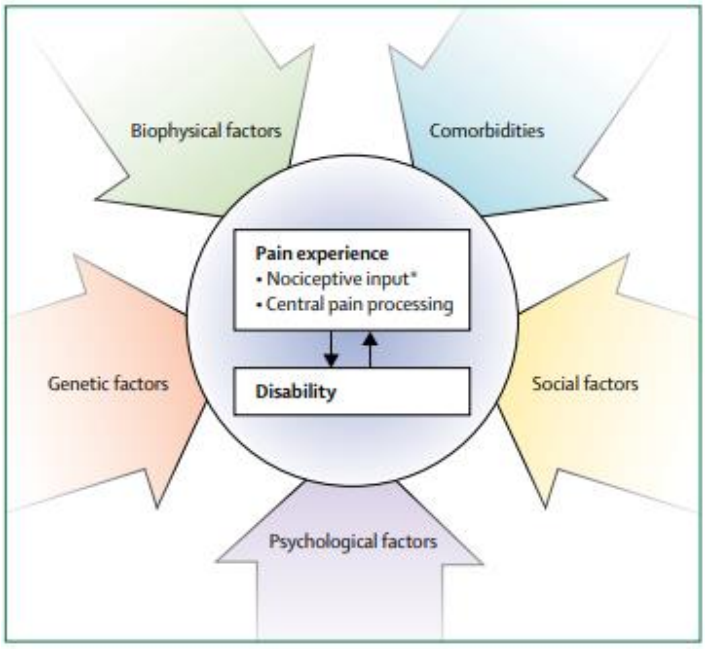
3.3.1 Low back pain

LBP is a very common condition that affects people of all ages and regions. In 2020, LBP affected 619 million people globally and it is estimated that the number of cases will increase to 843 million cases by 2050, driven largely by population expansion and ageing. (76) LBP is the single leading cause of disability worldwide and the condition for which the greatest number of people may benefit from health care. (76) LBP has a significant impact on the health and well-being of individuals and societies. It can cause pain, reduced mobility, psychological distress, and lower quality of life. LBP can also lead to chronic disability, work absenteeism, reduced productivity, and increased health care costs. Studies in European countries indicate the total costs associated with LBP varies between 0.1-2% of gross domestic product. (77)

LBP can be caused by various factors, such as mechanical, inflammatory, infectious, traumatic, degenerative, or neoplastic conditions, but in most cases (nearly 90%) the specific cause is unknown. Multiple contributors to both the pain and associated disability have been identified,

including psychological, social, biophysical, and genetic factors, comorbidities, and pain-processing mechanisms (e.g., central sensitization) (Figure 3.1). Lifestyle factors, such as smoking, obesity, and low levels of physical activity, relate to poorer general health and have also been associated with LBP. (77,78)

Figure 3.1 Contributors to low back pain and disability (78)



In terms of outcome, there are various established measures that can be used to assess the quality and value of LBP care, such as pain intensity, functional status, disability, patient satisfaction, health-related quality of life, return to work, health care utilization, and costs. However, these outcome measures are not always standardized, validated, or comparable across different settings and populations. There is a need for more consistent and comprehensive measurement and reporting of LBP outcomes to enable benchmarking and improvement. (28,79)

Because of the multifactorial nature of LBP, there is uncertainty and inconsistency in clinical decision making and practice. There is a large variation in the diagnosis, treatment, and outcomes of LBP across different settings and countries. LBP can be treated with various interventions, such as medication, physical therapy, surgery, or complementary therapies, but

the evidence for their effectiveness and safety is often weak or conflicting. This leads to overuse or underuse of certain interventions, such as inappropriate imaging, overtreatment, or low-value care. The variability and complex nature of chronic LBP care provides ample opportunities to enhance care coordination, reduce unnecessary interventions, identify the most effective treatments, and improve overall patient outcomes. Therefore, there is a great potential for improving the efficiency and quality of LBP care by applying VBHC principles.

3.3.2 The index condition: low back pain due to degenerative disease

Considering all the above, it has been decided to target LBP due to adult degenerative lumbar diseases which represent by far the greatest part of all lumbar pathologies. These pathologic entities include degenerative disc disease, disc herniations, lumbar stenosis, lumbar spondylolisthesis, degenerative scoliosis, and non-specific acute or chronic LBP (back pain without a clear etiology, also termed mechanical or axial pain). Degenerative disc disease refers to the gradual aging with dehydration and loss of height of the intervertebral disc, which is a known pain generator due to the presence of nociceptors and associated vertebral body oedema. A disc herniation is a bulging or rupture of the intervertebral disc that causes narrowing of the spinal canal and foramina. Lumbar stenosis is usually caused by a combination of facet (articulations between vertebrae) hypertrophy, ligamentum thickening, osteophytes, and disc protrusion. Spondylolisthesis is the slip of a vertebra over the adjacent one and is a sign of instability. Degenerative scoliosis refers to the coronal malalignment and deformity of the spine caused by a combination of several degenerative changes that come with aging.

These pathologic processes can cause back and/or leg pain and limited range of motion, as well as neurological symptoms in the form of neurogenic claudication (reduced walking ability), weakness, loss of sensation, loss of reflexes, or even perianal sensory changes or bladder symptoms in the event of cauda equina syndrome. Depending on presentation, severity, and temporal course, they can be managed either conservatively (physical therapy, chiropractic therapy, medications, injections, interdisciplinary rehabilitation with a cognitive/behavioral emphasis) or surgically (discectomy, decompression, or spinal fusion with or without deformity correction).

Operative intervention is only offered to patients where surgery is expected to improve the results of the natural course of the disease. In these patients, disability is great, no indication of non-surgical recovery is suggested by history, and pain is refractory to conservative treatment including cognitive/behavioral rehabilitation. Another important component to consider in terms of patient selection for surgery is the presence of psychosocial or work-related stressors, which can represent negative prognostic factors of good recovery.

The multidisciplinary team required to manage these conditions, the outcome measures, the process mapping, and the treatment pathways are common, which is why they have been grouped together. In fact, the other causes of LBP, i.e., spinal infection, spinal tumor, spinal fractures, traumatic dislocation, congenital scoliosis, and pathology in age ≤ 18 years have been excluded from the index condition that this pilot study addresses, exactly because they would require a different pathway setup.

3.4 Context and setting

In the Greek National Health System, medical insurance is compulsory for all citizens, provided by the National Social Insurance Agency, (80) with contributions paid by both employers and employees. Care is delivered by public and private health care providers. Payment of public hospitals is provided based on a partially implemented and inefficiently structured diagnosis-related groups (DRG) system (81) in combination with a prospective global budgeting system. The patient is not required to contribute. The current system does not reflect costs accurately and hospitals rarely adhere to budget restrictions. In the public sector, the government often covers the extra cost retrospectively, subsidizing providers' deficits, while in the private sector private insurances or the citizens (out-of-pocket) contribute a large part of the costs. Currently, a major effort is underway to implement a proper DRG system on which to base compensation, (82) again however without using VBHC principles, as outcome measurement, TDABC, and bundled payments.

Neurosurgery services are provided by large university and teaching hospitals, as well as smaller hospitals that cannot attract an appropriate volume of patients or perform complex surgery. There are no affiliations between different hospital providers, or structured referral pathways between hospitals or from primary care. Referrals from primary and secondary settings are based on the on-call system (which hospital is on call on a given day), rather than expertise. Information technology tools are not adequately deployed, but efforts are underway to introduce integrated and interconnected EHR platforms, which is promising in terms of implementing VBHC setups.

This pilot study will be based within the Department of Neurosurgery at the Athens General Hospital 'Georgios Gennimatas' (hereinafter GGH), a major teaching hospital and the second largest hospital country wide. (83) The Department of Neurosurgery has the biggest and more complex case load in Greece, addressing almost the full range of neurosurgical pathologies, and providing reference center services and expertise for several rare and complex brain and spinal disease entities, such as skull base tumors, brain tumors, brain aneurysms and arteriovenous malformations, pituitary adenomas, spinal column and spinal cord tumors, spinal column and spinal cord injury, Chiari malformation, craniovertebral junction anomalies. More than 1200 surgeries are performed each year. The total number of spinal surgical cases is more than 350.

A large number of patients present with LBP to seek a first or second opinion. Approximately 1200 patients with degenerative spinal disease are seen in outpatient clinics and the emergency department each year, 250 of whom require surgery; two thirds of this cohort complain of LBP.

This pilot study recognizes and is built around the GGH environment, assets, resources, operations, and processes. It could however be easily implemented in a different setting, with appropriate modifications. It also tries to navigate the peculiarities of the Greek health system.

3.5 Phasing the implementation process

Our implementation project is based on the most common framework for implementing VBHC, which consists of five phases, as can be seen in Figure 3.2. (9,16)

Figure 3.2 The five phases of the implementation process

3.5.1 Preparation

This phase involves assessing the readiness and feasibility of VBHC implementation, identifying the stakeholders and resources involved, and defining the scope and goals of the project. The regional health authority and the department of health are important players that need to endorse and support the project. The vision and goals need to be communicated clearly to obtain buy-in for change of the culture of care. The board of directors plays a crucial role in this phase as they need to create the strategic umbrella for implementation of the plan. Starting with a pilot rather than aiming for substantial change across the whole organization is easier and safer. It is expected that the pilot develops into a sustainable model for scaling VBHC up. At this stage a specific condition or set of conditions is chosen, leadership for the project and multidisciplinary participation is ensured, and a draft of the care structure is drawn. The baseline situation is evaluated and charted, available for future comparisons. In addition, patient representatives can be selected; they can contribute to the later phases, such as design or implementation in daily practice.

3.5.2 Design

This phase involves forming a multidisciplinary team, selecting the relevant outcomes and indicators to measure, and developing an action plan for VBHC implementation. The IPU

format, facilities, requirements, and modus operandi is designed in detail; an appropriate outcome set is specified, if possible, using standardized tools; the final care pathways with process mapping of the various activities for the whole cycle of care are developed, and ideally time estimates for each process are obtained. Planning, surveys and initializing collaboration for care integration and geographical expansion also occurs during the design phase. An IPU web page will be designed (within the hospital's website) to explain the formation, mission and vision of the project, as well as provide educational material and a point of contact and/or referral for patients, staff, and medical personnel alike.

3.5.3 Building

This phase involves integrating the outcome set into daily practice, by creating data collection and reporting systems. IT staff need to develop the platform required for data capture, storage, sharing, and benchmarking and integrate it into the hospital's electronic health record system. Improvement dashboards or other such tools are also built during this phase. Guidance on best practice should be embedded on the IT platform, making it readily accessible for all team members. The platform must allow dedicated secure access to out-of-house providers. The web page needs to be built during this phase and be online prior to the implementation phase. Finally, the IPU physical facilities should be built or prepared, and equipped appropriately.

3.5.4 Implementation

The various elements of VBHC are now incorporated in the care process of the selected patient group. The IPU is launched, and affiliations and referral patterns are being formed and established. Patient reported outcomes are being measured in a standardized fashion. Costing wise, the capacity of each resource and cost capacity rates needs to be estimated. TDABC would be the golden rule and the finance department needs to be fully on board. This phase also includes continued support (training and coaching) of the staff and patients on VBHC principles and practices, registering and reporting the outcomes and costs, and monitoring and evaluating the VBHC performance. Prior to launching a one-day training session on VBHC is held for all project members but also open for all hospital staff to increase awareness.

3.5.5 Evaluation and continuous improvement

This phase involves analyzing the data and feedback, identifying the gaps and opportunities for improvement, testing and validating the VBHC model, and implementing changes to optimize it. Continuous improvement could be achieved through systematic “Plan Do Check Act” cycles. The entire team should meet periodically to assess the outcomes and plan actions for improving them. Results should be communicated with transparency among the IPU team, the patients, the board members, the rest of the organization, and external stakeholders. There will be a dedicated section on the IPU’s webpage. Advocacy for VBHC continuous.

3.6 Organizing a low back pain integrated practice unit

An integrated practice unit (IPU) should focus on a condition or set of closely related conditions that require the same resources. (7) The latter is the case of our pilot design, with a set of degenerative conditions causing low back pain (LBP) being the target. The features of an IPU are summarized in Table 3.1. (7)

Table 3.1 Features of an IPU (7)

1. An IPU is organized around a medical condition or set of closely related conditions. (In primary care, which is by its very nature holistic, IPUs are organized around defined patient segments in terms of their primary and preventive care needs, such as weight loss, atherosclerosis risk reduction, chronic condition management, or smoking cessation.)
2. Care is delivered by a dedicated, multidisciplinary team whose members devote a significant portion of their time to working together to care for the medical condition.
3. Providers identify themselves as part of a common organizational unit and distinct from their specialty department.
4. The team takes responsibility for the full cycle of care for the condition (encompassing outpatient, inpatient, and rehabilitative care) and the supporting services needed for the condition, such as nutrition, social work, and behavioral health. IPUs also take responsibility for preparing patients before and after procedures or consultations and are experienced in recognizing variation among patients in their needs and their clinical complexity and adjusting care accordingly.
5. Patient education, engagement, monitoring, adherence, and follow-up are integrated into team composition and the care model.
6. The IPU has a single management and scheduling structure.
7. To the extent feasible, the team is colocated in dedicated facilities tailored to the care processes and technology needs.
8. A physician team captain or a clinical care coordinator (or both) is responsible for overseeing each patient's overall care process across time and locations of care, including the patient's home.
9. The team measures patient outcomes, care processes, and overall costs for each patient using a common measurement platform.
10. The team meets formally and informally on a regular basis to discuss outcomes, processes, and technology and employs a structured approach to improving results.
11. The team accepts joint overall accountability for outcomes and costs.

Patients with degenerative conditions and LBP present similar needs in terms of assessment, management and follow up. It is obvious, however, that each patient has their own characteristics and needs, and many patients suffer from more than one disease. There is no uniform group of patients or a single team that can provide all the necessary care for every possible patient with a certain medical condition. That is why having experience and good connections with colleagues who have different skills is very important for creating the IPU model.

3.6.1 The multidisciplinary team

The multidisciplinary team (MDT) is formed by:

1. Two neurosurgeons with spinal surgery interest and expertise, on a part time basis, alternating their presence
2. A rehabilitation physician, on a part time basis
3. A pain specialist physician, on a part time basis
4. Two physical therapists, on a part time basis, alternating their presence
5. A psychologist, on a part time basis
6. A social worker, on a part time basis
7. A dedicated nurse, on a full-time basis, that would assume the role of care coordinator
8. One administrative assistant, on a full-time basis

The neurosurgeons hold additional interests, and their role in the IPU would not fill their whole timetable anyway, so their contribution will be in a part time basis, but they will assume responsibility for all LBP patients of the IPU, including performing surgery if required. In the outpatient setting they would see patients that are triaged as potential surgical candidates (but not as a primary encounter) and postoperatively when required but at least at the first postoperative follow-up.

One of the two neurosurgeons along with the nurse practitioner would assume the role of clinical champions and lead the group. The neurosurgeon assuming the role of clinical champion will be responsible for organizing and chairing MDT meetings. These should be held on a regular basis, at least twice a month, to discuss issues, progress, and requirements and evaluate opportunities for possible change. They will also include morbidity and mortality analysis. Informal ad hoc meetings may happen as required by the circumstances. In addition, patient care plans would be discussed at these meetings and decisions taken in a multidisciplinary fashion. Interim meetings to evaluate the progress of the implementation of the pilot study and plan further actions or changes should be held every three months. Finally, patient representatives can also participate in these meetings to increase transparency and feedback from the patient perspective.

The nurse would assume the role of care coordinator on a full-time basis. She/he should have experience with spinal patients; hence she/he would ideally come from the neurosurgery

department. Her/his office will be located at the premises of the IPU, and she/he will be responsible for patient care during the whole care cycle, including when the patients are at home, being the point of contact for patients and referrers, making sure that standardized processes are followed and data is collected, organizing further tests (laboratory tests, imaging), and being the liaison between the various MDT members or with other specialists when needed.

The nurse coordinator will be assisted on a full-time basis by an administrative assistant, responsible for scheduling the appointments, clerking the patients, digitalizing data if necessary, keeping the IPU calendar, forwarding patient requests as appropriate, and aiding the MDT members.

The rehabilitation physician and pain specialist would be involved on a part time basis and together would form the primary point of physician encounter with the patient. All the patients are to be seen initially by both these specialists together in a joint session. Together they would be able to decide if there are any red flags (Table 3.2) that warrant further investigations like imaging or immediate surgical consultation, or if a patient may require surgical evaluation even for a less threatening degenerative condition.

The rehabilitation physician would also have other interests in their department but would oversee physiotherapy or other rehabilitation approaches that are instructed to the IPU patients in liaison with and supplying advice to the physical therapists.

The pain specialist would be able to assess the degree of disability from pain, provide a medication regime or schedule and perform injections (injections are held in theatres, rather than in dedicated IPU facilities). In GGH, the pain specialist is an anesthetist working in the operating theatres as well as in the pain clinic. As such, she/he would be able to perform preoperative anesthesiologic evaluation of the patients scheduled for surgery. In the current setting, it would be difficult to systematically provide anesthesia for all the IPU patients. Within the department of anesthesia however, there is already an established interest for elective spinal surgery by three consultants.

The physical therapists would be involved on a part time basis, alternating their presence in clinics, but overtaking the care of all patients that are referred to the physiotherapy team for rehabilitation (physiotherapy sessions are held in the hospital's rehabilitation center gym, rather than in dedicated IPU facilities). During the clinical appointments they would also see all

patients to ensure outcome measure collection, even after a medical consultation. As said before, a medical consultation would always happen at the first encounter and first postoperative visit. In other occasions, a patient may only be seen by a physical therapist who would decide if a medical consultation were also required. This process highlights the importance of the physical therapist role, as at times they may be the sole point of contact for the patients for the greater part of the care cycle. Even more so, they need to be in constant contact with the physicians and surgeons of the MDT.

Table 3.2 Red flags and possible causes for low back pain (84)

Red flags	Possible cause
Duration > 6 wk	Tumor, infection, rheumatologic disorder
Age < 18 y	Congenital defect, tumor, infection, spondylolysis, spondylolisthesis
Age > 50 y	Tumor, intra-abdominal processes (such as an abdominal aortic aneurysm), infection
Major trauma, or minor trauma in elderly	Fracture
Cancer	Tumor
Fever, chills, night sweats	Tumor, infection
Weight loss	Tumor, infection
Injection drug use	Infection
Immunocompromised status	Infection
Recent genitourinary or gastrointestinal procedure	Infection
Night pain	Tumor, infection
Unremitting pain, even when supine	Tumor, infection, abdominal aortic aneurysm, nephrolithiasis
Pain worsened by coughing, sitting, or Valsalva maneuver	Herniated disc
Pain radiating below knee	Herniated disc or nerve root compression below the L3 nerve root
Incontinence	Cauda equina syndrome, spinal cord compression
Saddle anesthesia	Cauda equina syndrome, spinal cord compression
Severe or rapidly progressive neurologic deficit	Cauda equina syndrome, spinal cord compression

The psychologist would also be involved on a part-time basis. She/he would not be routinely present in the IPU setting but would be available for consultation if called in by one of the physicians or physical therapists, when a patient is identified as possibly suffering from depression or when cognitive therapy needs to be incorporated to the rehabilitation program. If necessary, they would see the patient during the same clinical appointment.

The social worker would also be engaged as required when social or work stressors complicate the course of disease and recovery. She/he can provide counselling and advocacy between the patient and their families or employers.

3.6.2 Cycle of care

Defining the care delivery value chain will allow to map and track the entire cycle of care from first clinical visit to discharge and to evaluation of tier 1, 2 and 3 outcomes (Figure 3.3). The cycle of care could last from 3 months to 2 years, in accordance with the planning of outcome measurement collection. Patients that improve rapidly with conservative measures will be followed up at least once at 3 months in order to collect outcome measures, but this can be done remotely by phone, teleconference or sending the questionnaires out. A typical pathway of an LBP patient can be seen in Figure 3.4, representing either conservative or surgical interventions.

Figure 3.3 The care delivery value chain (38,39)

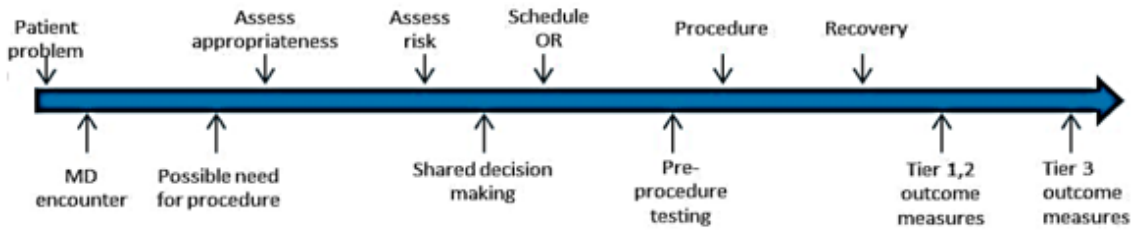
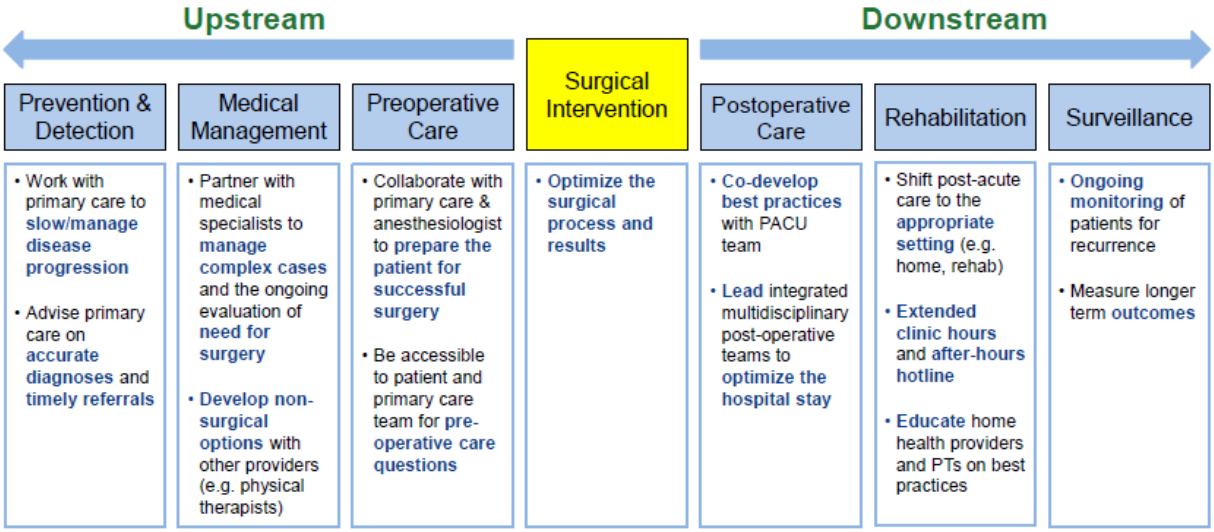


Figure 3.4 A typical path of patient care (35)

Surgeons should play an integrative role across the care cycle, rather than limiting their intervention in the surgical phase. They need to work both 'upstream', that is during the pre-operative phases, and 'downstream', in the post-operative period. (6) The possible contributions they can offer during the cycle of care are visualized in Table 3.3.

Table 3.3 The role of surgeons beyond the operating room (6)



3.6.3 Estimated workload

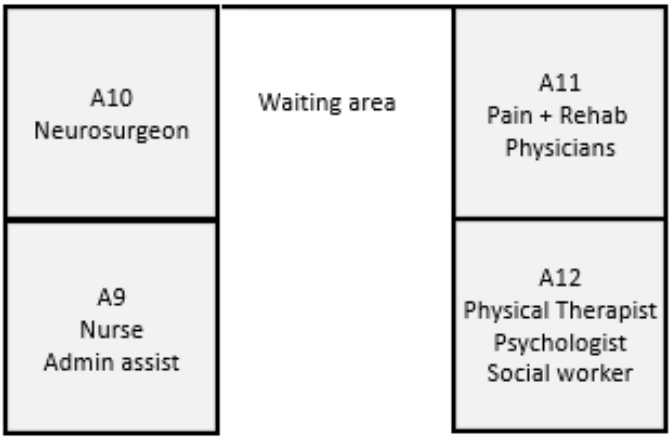
The pilot IPU would initially need to accommodate approximately 800 new patient visits per year. Around 170-180 of these patients would require surgery and need to be seen twice in the postoperative year. The rest would be treated conservatively and could require 1-3 follow-up visits in the following year. Patients that improve rapidly will be followed up at least once at 3 months in order to collect outcome measures, but this can be done remotely by phone, teleconference or sending the questionnaires out. Summing all this activity up would account for about 1500 visits yearly: 800 new visits requiring 30-minute encounters, and 700 follow-ups lasting 15 minutes each. This would require around 600-700 clinic hours yearly, which translates into two clinics sessions per week. Naturally, the aim would be to increase volume and hence capacity with time and through the value transformation.

3.6.4 Physical facilities

In GGH the various specialties are located in different buildings of the same campus. Neurosurgery is located in building 1. The neurosurgical ward and offices are located on the 4th floor, operating theatres are on the 3rd floor, and outpatient clinics are located on the ground floor. Anesthetists work between building 1 (operating theatres and pain clinic) and building 2 (operating theatres and offices). Rehabilitation physicians have offices in building 3 and ward in building 2. The physical therapy gym is in building 3. It becomes clear that structural integration in terms of physical facilities is an absolute requirement.

The ideal space has been identified on the ground floor of building 1, in the outpatient department. It is near the central entrance of the building and has easy and facilitated access. The usual neurosurgical consultation room is room A9, and adjacent and opposite to it rooms A10, A11, and A12 can be found. Between the rooms a waiting area can be found. A floor plan of the area can be found below (Figure 3.5). Room A9 would be designated as office space, while rooms A10-A12 would be examination and consultation rooms. Radiology is also located on the same floor of the building, which would be beneficial if a scan was booked prior to the visit. This setup facilitates the quick and easy turnover of patients and eliminates wasted time when a patient needs to see several members of the team, as would be the case more often than not.

Figure 3.5 IPU premises in the outpatient department of GGH, building 1, ground floor



3.6.5 Patient engagement and education

A very important part of the IPU agenda is patient engagement and education. (35) Patients need to be educated about several things, among which the importance of exercise, weight reduction, smoking cessation, and proper nutrition; the meaning of their diagnosis and the expected outcomes (prognosis); risks and benefits of surgery; expectations for recovery and importance of rehabilitation; importance of their compliance and adherence to the management pathway. Informed consent should be taken as part of the engagement and education process.

3.6.6 Management and leadership structure

The IPU model requires clear overall leadership that will be provided by the clinical champion neurosurgeon, who must ensure that value is a shared goal of the entire MDT. He should have decision-making priority over the other team members, but also assume responsibility for actions and accept accountability. (7) Ideally, an IPU should be a single integrated profit-and-loss center, without dependencies from legacy departments (e.g., neurosurgery) whose goals may differ. (7) However, this may be difficult to establish in the current setting, as the traditional managerial structure is very strong, and chairmen prefer keeping members of their departments under their control.

3.7 Outcome measurement

As previously discussed, the accurate and standardized measurement of outcomes is a fundamental aspect of VBHC implementation in neurosurgery. (25) For the aim of the project, outcomes that reflect the full cycle of care, are multi-dimensional, include the results that are most relevant to the patients, and include assessment of a baseline to allow for evaluation and risk adjustment are required. (26) Regarding low back pain due to degenerative spine conditions in adults, the International Consortium for Health Outcomes Measurement (ICHOM) has already published a standard set of metrics to measure tier1, 2 and 3 outcomes, (34) which is widely accepted and contains tools that have already been validated in clinical practice worldwide. It covers both conservative and surgical therapy. Thus, the ICHOM standard set will be used for outcome evaluation.

3.7.1 The ICHOM standard set for low back pain

The ICHOM studies outcomes in six domains: function, pain, health-related quality of life (HRQoL), work status, medication requirements, and treatment complications. (85) This can schematically be seen in Figure 3.6. Function and disability are tracked via the Oswestry Disability Index (ODI), back and leg pain are evaluated via the Numeric Pain Rating Scale (NPRS), and HRQoL is tracked via the EuroQol-5D (EQ-5D) questionnaire. (85) A detailed explanation of the various measurement tools used can be found in Table 3.4, in which questions, possible answers and time frame for capturing are illustrated.

Treatment complications including need for reoperation are clinically reported, while the rest of the domains are covered by patient-reported outcome measures (PROMs). Treatment complications include operative mortality, nerve root injury including cauda equina, deep wound infection, pulmonary embolus, wrong site procedure, vascular injury, dural tear, other, and need for rehospitalization.

Furthermore, a set of case-mix variables are collected at baseline, representing baseline characteristics and risk factors required for fair and meaningful calculations and analyses. This information covers four categories: demographics, baseline clinical status, baseline functional status, and previous treatments. (34) Data is either clinical or patient reported (Table 3.5).

Figure 3.6 Outcome domains covered by the ICHOM standard set (85)

Figure 3.7 illustrates when the outcome set variables need to be collected from patients and clinical sources. (86) 3-month and 5-year collection is optional as per the set definition. For the purposes of this study, outcomes will be collected at 3 months to capture early response to therapy.

According to Porter's hierarchical structure, (1) there are three levels of outcomes for any medical condition. The highest level is usually the most important and the lower levels depend on achieving the higher ones. Each level has two sublevels, each with one or more different outcome aspects. For each aspect, success is evaluated by using one or more specific measures. (1) The ICHOM low back pain standard set aligns very well with Porter's hierarchical framework of health outcomes, as can be illustrated in the figure below (Figure 3.8). (26) This

is another reason why the ICHOM set has been chosen as the preferred outcome evaluation method.

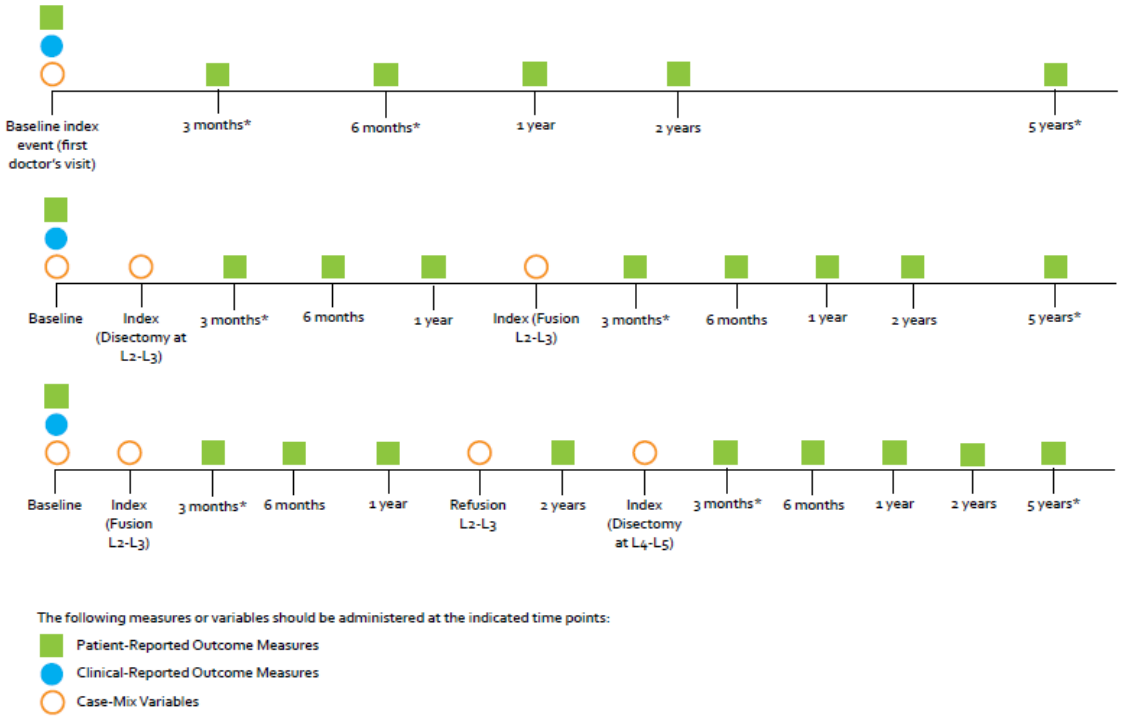
Table 3.4 Patient reported outcome measures (34)

Outcome	Measurement tool	Definition/wording	Answer options	Time frame for capturing
Pain	Numeric pain rating scale	• How would you rate your average back pain over the last week?	0 (no pain) – 10 (worst pain imaginable)	Baseline, index event(s), 6 months, 1 year, 2 years
		• How would you rate your average leg pain over the last week?	0 (no pain) – 10 (worst pain imaginable), verbal or visual (horizontal)	
Disability	Oswestry disability index	• Pain intensity • Personal care (washing, dressing, etc.) • Lifting • Walking • Sitting • Standing • Sleeping • Sex life (if applicable) • Social life • Traveling	6 options for each domain, ranging from no problem to severe impairment	Baseline, index event(s), 6 months, 1 year, 2 years
Quality of life	EQ5D-3L	• Mobility • Self-care • Usual activities • Pain/discomfort • Anxiety/depression	3 options for each domain, ranging from no problem to severe impairment	Baseline, index event(s), 6 months, 1 year, 2 years
	EQ-VAS	• Indicate on this scale how good or bad your health is today	Vertical visual analog scale: 0 (worst imaginable health state) – 100 (best imaginable health state)	
Work status		• What is your current work status?	Working full time, working part time, seeking employment (I consider myself able to work but can't find a job), not working by choice (retired, student, homemaker, etc.), unable to work due to problem other than my back and/or leg pain, unable to work due to back and/or leg pain	Baseline, index event(s), 6 months, 1 year, 2 years
		• Are you working at a physically less demanding job now because of your back and/or leg pain?	Yes, no, N/A	
		• How long after you received treatment for low back pain did you return to work? (if applicable)	< 3 months, 3–6 months, 6–9 months 9–12 months, 1–2 years, > 2 years	6 months, 1 year, 2 years
Analgesic use		• Do you take non-narcotic pain relieving medication or tablets for your back problems?	Yes regularly, yes sometimes, no	Baseline, index event(s), 6 months, 1 year, 2 years
		• Do you take narcotic pain relieving medication or tablets for your back problems?	Yes regularly, yes sometimes, no	

Table 3.5 Case-mix variables (86)

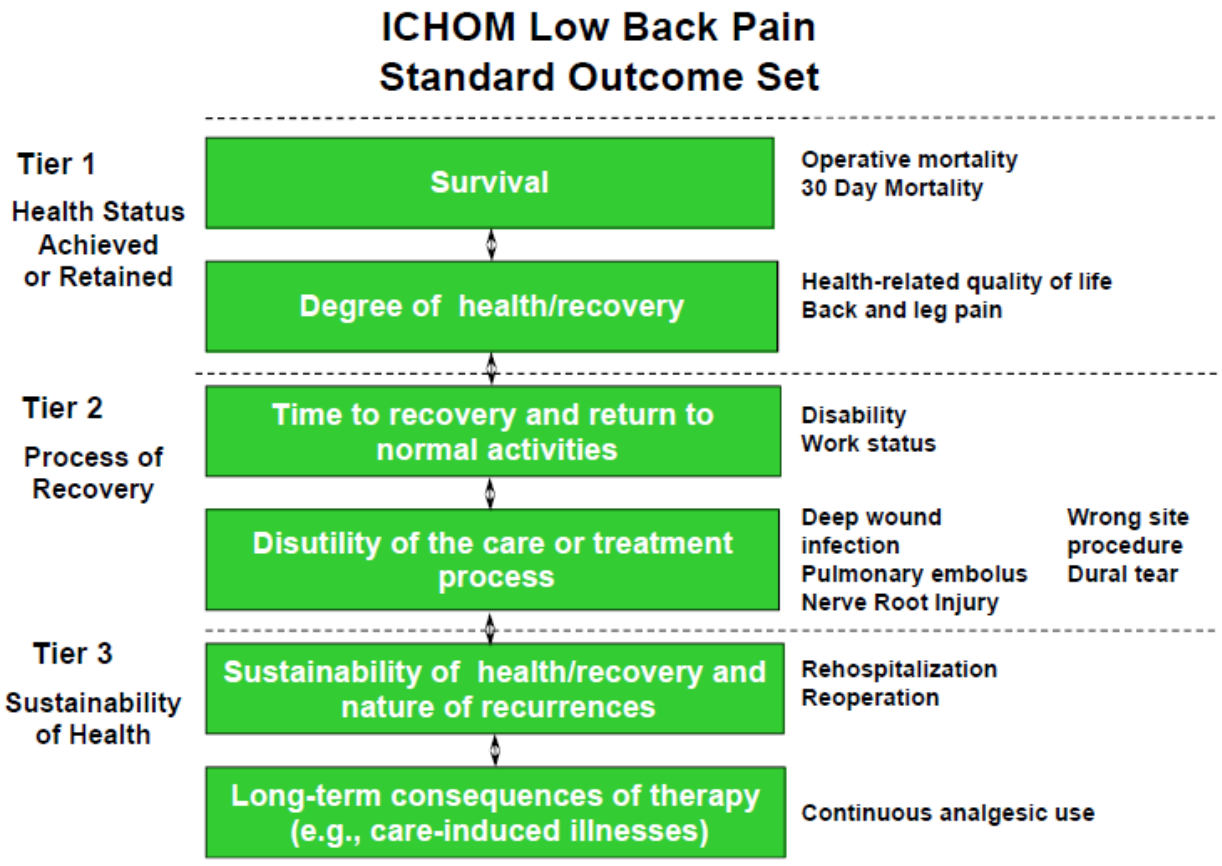
Patient Population	Measure	Timing	Reporting Source
Demographic Factors			
All patients	Age	Baseline	Clinical
	Sex		
	Educational level		Patient-reported
Baseline Functional Status			
All patients	Work status	Baseline	Patient-reported
	Duration of sick leave		
	Baseline patient-reported disability		
	Baseline patient-reported back and leg pain		
	Baseline patient-reported health-related quality of life		
Baseline Clinical Factors			
All patients	Smoking status	Baseline	Patient-reported
	Comorbidities		
	Duration of back/leg pain		
	Body mass index		Clinical
	Diagnostic classification		
Surgically treated patients	Morbidity state		
	Indication for surgery		
Prior treatments			
All patients	Need for continuous analgesic use	Baseline	Patient-reported
	Prior interventions		Clinical

Figure 3.7 Follow-up timeline (86)



In terms of actual data collection, two iPads will be used by clinical staff and patients to capture the data. Initially, the excel file for data collection prepared by ICHOM shall be used. (87) This may require support by the nurse coordinator or the administrative assistant, especially for elderly patients. As a future plan, it is expected to develop an application that will include all the measures to be collected in a very user-friendly interface. The application should communicate with the hospital EHR system (currently in phase of implementation) to transfer and archive the data. The data collection interface should be embedded into the EHR platform. This will be designed by the IT engineers.

Figure 3.8 Hierarchical classification of the ICHOM standard LBP set outcomes (26)



3.8 Cost measurement

3.8.1 Time driven activity-based costing

As previously described, in VBHC terms, an effective method for assessing costs is time-driven activity-based costing (TDABC). This methodology involves meticulously measuring the real costs associated with providing care to a patient with a specific medical condition. It considers all the costs related to the manufacturing and non-manufacturing activities and is based on two factors: the cost per unit of time for each resource and the time required for each activity. This project aims to follow Kaplan's approach, which includes determining the care process (including who performs which activity and how long does it take), calculate the cost rates, account for consumables and allocate indirect costs, (39) in order to estimate the true overall costs. The total cost derives from the sum of the costs of the various activities.

The overall care cycle will be mapped by the clinical team. High-level activity maps will showcase in detail which member of the team performs each step of the process and the time required for each step. To make an example, the time spent on getting an imaging study includes the time of the nurse checking the patient in, of the technician performing the examination and of the supervising physician. Moreover, the actual cost per unit of time for use of the imaging equipment and of the premises need to be included in the calculations.

An assigned staff member of the financial department will work with the accounting, budgeting, payroll, and quality departments at GGH and at Health Region level to obtain the information needed to calculate the capacity cost rates for all the personnel, space, and equipment used in the IPU's various activities. To determine equipment cost, the relevant spaces hosting the equipment need to be catalogued (for occupancy cost calculation) and financial data for each equipment type needs to be collected. She/he will also account for the consumables required for the whole cycle of care and allocate indirect/overhead costs.

Direct costs include compensation for employees, depreciation or leasing for equipment, consumables, medical supplies, pharmacy cost, operating expenses, capital costs. These costs represent tier 1 costs in the hierarchy of costs to analyze as part of TDABC, (38) as can be seen in Table 3.6. Capturing tier 1 and 2 costs is necessary for a successful TDABC, but tier 1

represents the most relevant cost category. People account approximately for 65% of the overall costs. (6) Ideally, tier 3, 4 and 5 costs need to be inserted in the equation, but this may be very difficult in the GGH setting, given the lack of an already established chart of costing interactions between the various departments (i.e., how much of the cost of each support department in the hospital can be accounted to the IPU). The apportionment of overhead expenses is not clear in the current setting, because the concept of cost centers is not fully implemented in the Greek reality, and only part of the overall costs is allocated specifically, mainly the direct costs. Hence, accounting for tier 3-5 costs may lead to errors.

Table 3.6 Hierarchy of costs in TDABC (38)

Hierarchy of costs to analyze as part of TDABC	
Tier 1	Cost of direct patient care
Tier 2	Ancillary clinical services (e.g. lab, radiology)
Tier 3	Patient support departments (e.g. housekeeping)
Tier 4	Departments that support front line staff (e.g. HR and IT)
Tier 5	Indirect costs (e.g. Senior Administration)

3.8.2 Cost-capacity rates

The cost capacity rates are calculated by dividing the resource cost by the resource capacity. The resource cost of a person includes associated with having a staff member available (not only salary, but also cost of space occupancy, technology and support relevant to that person, supervision costs, etc.). The capacity refers to the time that is actually available for patient care, that is net of weekends, vacations or sick days, meetings, education, training, and scheduled daily breaks. For equipment, this needs to be calculated once again considering the time it is actually available for clinical use and the cost of leasing of the equipment or the depreciation thereof if already purchased.

To make an example, the actual cost for a nurse should not be just her/his salary, but also the cost of her supervisor's activity related to her/him, space costs as a function of occupancy of hospital space, IT costs based on the individual's use of computer and IT resources, etc. (35) The costs on top of the salary will be provided by the financial department, but let's assume that the overhead costs are €5.000. The annual salary is €18.000 (including contributions), and hence the annual total cost for the nurse is €23.000, which equals €1917/month. The time actually available for the nurse to provide patient care can be seen in Table 3.7. As illustrated, the monthly availability for patient care is 125 hours a month, and this is the figure to be used when calculating the cost capacity rate, rather than 160 hours/month as is the traditional notion (based on a working week of 40 hours). Based on these numbers, the cost-capacity rate for a nurse practitioner is 1917/125 = €15.34/hour = €0.256/minute.

Table 3.7 Nurse practitioner actual time availability

ACTUAL TIME AVAILABLE FOR PATIENT CARE: NURSE PRACTITIONER	
Total days	365 days/year
- weekend days	104
- vacation days	20
- sick days	5
- training days	5
actual availability	231 days/year = 19.25 days/month
Total hours	8 hours/day
- breaks	0.5
- meetings	1
actual availability	6.5 hours/day
Actual availability (6.5 x 19.25)	**125 hours/month**

Naturally, these ratios need to be individualized, since not every member of staff of the same qualification has identical salaries and overhead costs. For example, a more senior nurse may

have a higher salary, but a lower supervision cost. They also need to be calculated for every member of staff that takes part in the clinical activities that regard the IPU patients.

3.8.3 Process mapping

A general plan of the care cycle can be seen in Figure 3.9 and includes various segments that will be mapped individually in detail, to obtain accurate time estimates for the various resources used. For example, mapping the initial patient visit can be schematically visualized Figure 3.10. Mapping the surgery segment can be seen in Figure 3.11. In the same way, all the parts of the process will be mapped, including the preoperative evaluation visit, the various follow-up appointments, imaging sessions (if performed within GGH), pain clinic sessions, rehabilitation sessions, etc.

Figure 3.9 Processes of the cycle of care

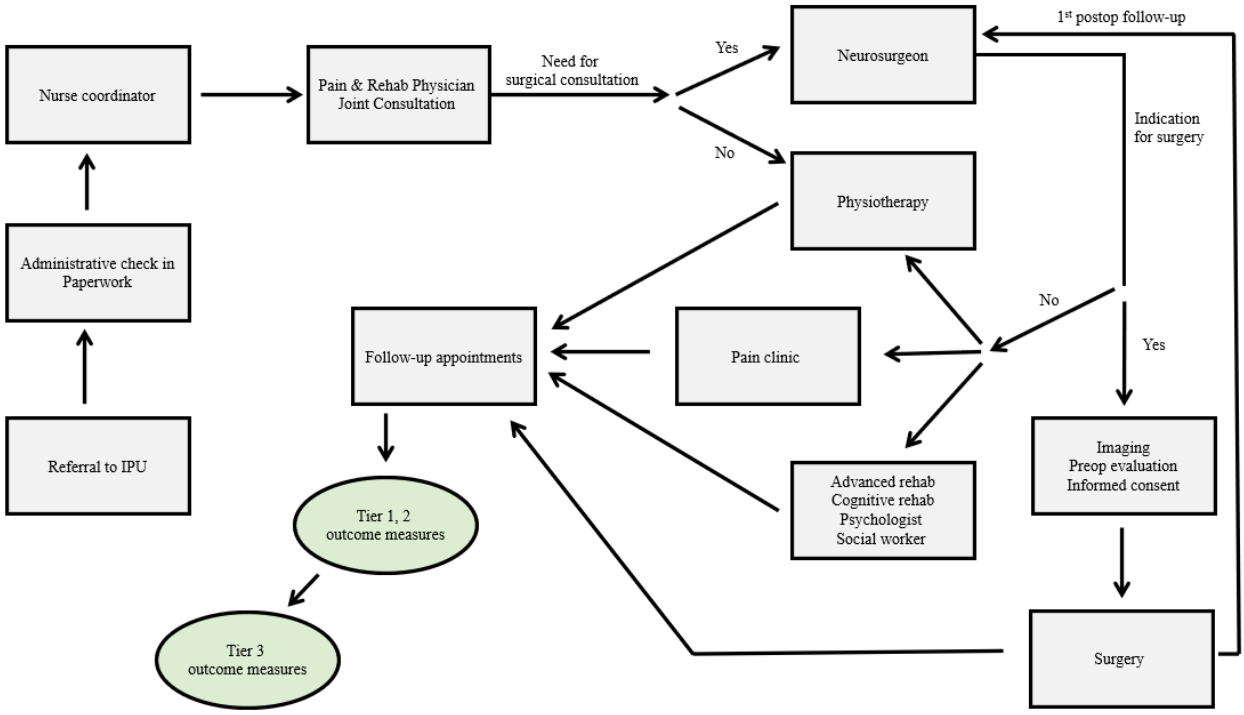


Figure 3.10 Mapping of the initial visit segment of the care process with estimated times required at each point

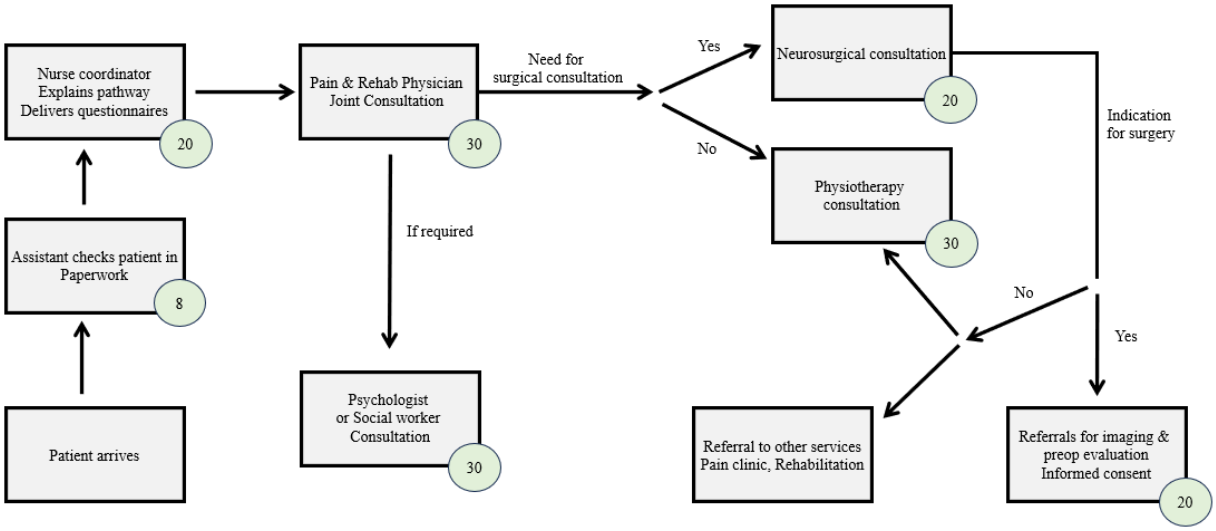
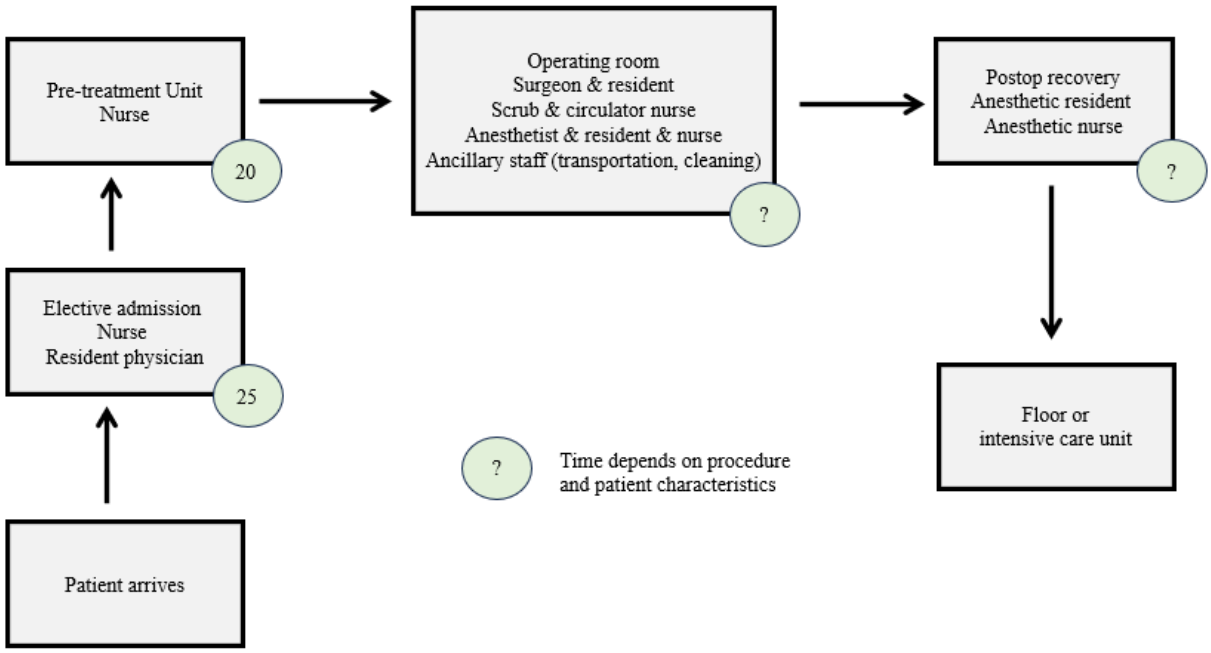


Figure 3.11 Mapping of the surgical segment of the care process with estimated times required at each point



The figures above illustrate the human resources required at each step of the process, but not the equipment used. The use of equipment used also needs to be accounted for (e.g., during surgery, surgical microscope, intraoperative neuromonitoring, spinal navigation, bone scalpel, x-ray machine, anesthetic monitors, suctions, diathermies, etc.). The same goes for consumables and medical supplies that are required to perform each clinical activity (e.g., during surgery, anesthetic drugs, antibiotics, implantable devices, prosthesis, etc.).

It is obvious that calculating the costs meticulously in this way is a very copious exercise and may not even be completely precise. However, it approximates the actual costs more accurately than the methods that have been used to date, such as departmental, charge-based, or relative-value unit costing. (6) Cost is created using resources during a patient's care (people, facilities, equipment, supplies), and costing should not be based on arbitrary allocations. It should be based on time and actual cost of resource use.

3.9 Bundled payments

Value-based payment models are alternative payment methods that reward providers for delivering high-quality care at lower costs, rather than paying for the volume of services. Bundled payments cover the full set of services over a care cycle, taking account of condition-specific outcomes including complications and rehospitalizations, thus emphasizing improved patient outcomes and resource optimization. Implementing them requires sophisticated infrastructure and data collection, that usually require a considerable upfront investment to set up. More importantly, however, it requires the freedom to negotiate payment regimes between healthcare providers and payers/insurers. This is not possible in the Greek health sector and renders the project proposal for a bundled payment a theoretical exercise. Even in the USA, where the push for bundled payments started back in 2011, implementation of such payment models in spinal surgery has only recently started to emerge. (88)

For the purposes of this case study, two bundles have been designed: one for the conservative treatment pathway and one for the surgical route (Table 3.8). Costs that will inform bundled remuneration contracts should be calculated according to the methods described in the previous section. The payments should be built around the new Greek DRG system, currently in phase of implementation, but with some modifications. DRGs, and bundled payments, need to be adjusted for variations between indications, operative factors, or patient comorbidity burden, (89) otherwise, they tend to disincentivize the care of complex conditions, screening out the patients with the greatest needs.

Table 3.8 Low back pain bundles

CONSERVATIVE BUNDLE	SURGICAL BUNDLE
Initial multidisciplinary IPU visit	All of conservative bundle +
Physiotherapy sessions	
Social worker sessions	Pre-op evaluation / investigations
Psychology sessions	Surgery and related hospital stay
Imaging	Medications
Laboratory examinations	Inpatient rehabilitation
Follow up appointments at 3, 6, 24 months	Prosthesis
Pain clinic sessions	Rehospitalization and revision surgery
All physician and staff fees and costs	Responsible for re-admissions within 2 years

3.10 Integrate care delivery across facilities

Integrating care delivery across various settings and levels of care in neurosurgery involves coordinating healthcare services around the full cycle of care for each patient's medical condition and fostering collaboration among providers to ensure a seamless and continuous patient care experience. In this pilot study the target population are patients with low back pain due to degenerative conditions, a condition for which the GGH holds expertise and is already dealing with a high volume of cases. This is one single-campus hospital; there are different departments, but there are no satellite facilities elsewhere, nor primary care structures directly affiliated to GGH. However, initial referrals are spread among various specialties, including neurosurgery, orthopedics, pain clinic, internal medicine, and physical and rehabilitation medicine. The two formers receive the majority of patients complaining of back pain.

Neurosurgery will take care of all patients, at various levels of care. Down the conservative pathway, they can offer initial advice, prescribe medications, request imaging, or refer to physiotherapy, rehabilitation medicine and/or the pain clinic. If surgery is required, preop investigations are planned by the neurosurgical department and surgery is performed by them, from simpler to the most complex. There are no outgoing referrals for surgery, since any kind of procedure can be performed at GGH, both in terms of specialization and equipment. Orthopedics may guide patients through conservative management and will refer possible surgical candidates to neurosurgery. The same applies to the pain clinic, internal medicine, and physical and rehabilitation medicine, although they receive a very low input of initial encounters. Specialties without surgical experience may however under- or over- estimate the need for surgical consideration.

Hence, in this setting, concentrating volume is only applicable within the hospital itself, but it is equally important. To increase volume, achieve economies of scale, improve quality and outcomes, and reduce costs, it is important to refer all patients with low back pain that reach the hospital to the low back pain IPU. Sourcing patients is a difficult exercise, and all the hospital personnel need to be educated, including medical, paramedical, and administrative staff. Outpatient clinics employees book the appointments at GGH, serving as the first line of contact between the patients and the hospital, and need to be trained appropriately in order to triage correctly and facilitate intake of patients. To serve this goal, prior to launching the IPU, a one-

day training session will be held for all project members and all hospital staff that are related to the IPU function. Educational material will also be available at the IPU's webpage.

Integration of care also means standardizing the care delivered by different providers using information technology, protocols, and incentives. This will help ensure continuity and consistency of care, reduce errors and duplication, and enhance patient satisfaction. Standardization of care is described in the other sections of this project.

Furthermore, integrating care involves empowering patients with education and information about their condition and treatment options. Well informed and consenting patients are more likely to comply with their care plans. Educational material on low back pain and what patients should expect during the various management pathways will be designed and provided (leaflets) and will also be available on the IPU's webpage.

Integration also relies on seamless communication and health information exchange among providers. As described in detail afterwards (sections expanding regarding geographic reach and building an enabling information technology platform) all relative information (EHR, imaging, outcomes, etc.) will be readily available through the project's IT platform, which will provide secure and dedicated access to in- or out-of-hospital certified providers.

Finally, quality improvement initiatives such as morbidity and mortality conferences and performance audits are essential components of integrating care delivery in neurosurgery. These activities help identify areas for improvement and foster a culture of continuous learning and excellence and will be an integral part of the team meetings, as they have been described in a previous section on IPU organization.

Integrating care delivery across different settings and levels of care in neurosurgery is vital for optimizing patient outcomes and enhancing the patient experience. By fostering collaboration among multidisciplinary care teams, leveraging technology, implementing standardized care pathways, and empowering patients this implementation can create a more seamless and efficient care experience for neurosurgical patients.

3.11 Expand geographic reach

In the Greek reality and considering legislative barriers it is impossible to form a proper hub-and-spoke model between different hospitals that share the same patient cohort and divide the delivery of care depending on complexity. This can be proposed to the Department of Health but would take a considerable amount of time to implement even as a pilot. It can represent a future perspective of this effort, but it may be more worthwhile to carry out a VBHC project locally in a faster way, that, if successful, could represent a driver for further change.

As a note, the actual structure within GGH resembles a hub-and-spoke model, with a main location for the IPU and other hospital facilities that participate in the patients' care, as is the imaging department, the physical therapy department, or the neurosurgical ward and operating theatres. The patients refer to the IPU centrally, which assumes responsibility of organizing care and following the patient throughout the care cycle, but an important part of their management happens outside the IPU setting, albeit by IPU staff. Naturally, this increases integration of services, rather than geographic reach; it can, however, promote a collaboration culture, which might prove valuable when outreach expansion becomes feasible.

Clinical affiliations with shared responsibility for the patients and implementation of the same care principles are also not straightforward. It would be necessary to align practices between hospitals, establish shared but clear leadership and governance structures, and integrate workflows and information systems across different entities. However, even without a proper affiliation between institutes, referral networks can be established to streamline patient referrals, source patients, and increase volume. This will take place at three different levels: primary care, secondary hospitals within the Athens region, and secondary hospitals outside the metropolitan area of Athens.

The primary care physicians will be informed of the possibility to refer patients to a dedicated IPU via communications to their parent society, that can outreach to all of them, and the press. They benefit from privileged access to a dedicated part of the IPU's webpage, where they can find educational material for them and their patients, as well as referral information and a web-based referral portal. If necessary, a physician-to-physician encounter via phone or tele-conference can be organized between the general practitioner and a physician member of the IPU team.

Secondary care hospitals, both within Athens and outside, already refer to GGH for emergencies or complex cases. There will be communication of the project to all these hospitals, and they will be encouraged to refer low back pain patients directly to the IPU. The same as with primary care physicians, they will also have dedicated access to the website and a straightforward referral pathway, rather than needing to engage in conversations with multiple staff before being able to refer a patient.

Especially for out of area institutions, the plan is to use telemedicine for every encounter that can be done remotely. Nowadays, with the advent of 5G and new augmented reality technologies, we can accommodate an array of services that would have previously required the patient's physical presence. Patients and providers in remote or underserved areas, or in resource-scarce times, such as during the recent global pandemic, can be facilitated by virtual consultations, follow-up appointments, and remote monitoring.

Where hospitals can guarantee the presence of a trained physician, who can provide a proper history and physical examination, and has the ability and willingness to collect the requested data as per the ICHOM standard set, initial and follow up consultations can be done remotely if appropriate. These physicians, after being trained and certified (via web-based training sessions), will have not only dedicated access to the website but also remote access to the IPU's IT platform, with dedicated login that allows viewing, insertion, and elaboration of data. A formal invitation for participation in the project will be extended to the boards of these hospitals.

Telemedicine can also be used in case out-of-area patients need counselling or guidance. In these cases, a teleconference with the nurse coordinator can be organized to evaluate the situation. If needed, an appointment can be booked, either at a local collaborating hospital or at GGH.

It is obvious, that telemedicine allows neurosurgeons to provide consultations, evaluations, follow-ups, and education to patients and providers in distant locations, using videoconferencing, mobile applications, or web-based platforms. This can reduce travel time and costs, improve patient convenience and satisfaction, and enhance quality and safety of care.

3.12 Built an enabling integrated Information Technology platform

Building an integrated Information Technology (IT) platform that enables data collection, analysis, and sharing is a key step of the project. A full-time health systems engineer will be assigned to the IPU, by the IT department. She/he will oversee the design, building, implementation and continuous evolution of the required platform and all other relative resources.

IT staff need to develop the platform required for data capture, storage, sharing, and benchmarking and integrate it into the hospital's electronic health record (EHR) system. Outcome measures need to be an integral part of this platform and data needs to be collected in a structured way (not free text), to eliminate incoherences. The ICHOM standard set will be used as the basis for information capture, but other types of data may be embedded as the project evolves. Costs need to be integrated in the data collection system, to be able to have meaningful analysis of the cycle of care effectiveness. The platform needs to allow communication with external providers and remote communication. Improvement dashboards or other such tools and guidance on best practice will be embedded on the IT platform. The medical records and outcome measures will be made available to patients enrolled by the IPU via secure login.

The GGH EHR system is currently in phase of implementation. This can prove advantageous, since the IPU platform can be engineered as an integral part of the system from the beginning, rather than needing to actuate several stages at a second stage. On the other hand, it will take some time before the system goes live, and this represents an issue regarding integration in the meantime. It has been decided to proceed without waiting for full system integration (IPU platform – EHR). However, future compatibility needs to be assured early on.

Even before having the IT platform operational, the ICHOM excel sheet and other clinical documents as per current use can be used for data collection. Excel allows for data collection and analysis in a very straightforward fashion, hence waiting for a full-blown platform should not become a barrier to initiating the project. Rather, initiating the project may provide significant feedback to optimize the implementation process.

The web page will be built to be active prior to the implementation phase. As said before, this will include educational material, dedicated access for providers, a web-based referral portal

and a special section on results and outcomes. It will provide a point of reference and contact for patients and health professionals alike.

The IPU facilities also need to be equipped appropriately, in terms of hardware, software, internet connectivity, access to the hospital network and the hospital imaging server. In terms of actual data collection, two iPads will be used by clinical staff and patients to capture the data. As mentioned before, initially, the excel file for data collection prepared by ICHOM shall be used. As a future plan, it is expected to develop an application that will include all the measures to be collected in a very user-friendly interface. The application should communicate with the dedicated IPU platform and hospital EHR system (currently in phase of implementation) to transfer and archive the data.

Chapter 4: Discussion

This study summarizes a blueprint for VBHC development and implementation in a Greek hospital (GGH). It describes the steps required to set up a pilot neurosurgical IPU, specifically aimed at low back pain. It could be used as a strategic tool and guidance for scaling up VBHC neurosurgery locally (to include more conditions) or across other hospitals or regions.

A paradigm of a fully implemented action is rare to find globally, since health care providers do not usually adopt VBHC as a comprehensive strategy. In Greece there has not been any effort to date to establish a VBHC neurosurgical pathway, even partially. Hence, this is the first known attempt to build a pilot VBHC center of excellence.

It has been decided to start the process through a well-designed pilot focusing on one condition, rather than trying to implement VBHC operations throughout the entire hospital or even for the entire neurosurgical department. This allows to initiate a proper understanding of the process and evaluate risks and opportunities on a smaller and more manageable scale. On the other hand, it might not reveal all the challenges that might be encountered in the case of larger implementations.

The first important step is to overcome the barriers to change; it is vital to mobilize the internal forces within the organization. VBHC faces opposition and doubt from different stakeholders. To implement it successfully, leaders from both clinical and administrative backgrounds need to collaborate, using their medical and managerial skills, and taking on the risks involved in changing the status quo. Despite only addressing the hospital perspective in this study, successful and meaningful implementation of the project requires VBHC principles to be embedded in the larger healthcare ecosystem.

This pilot design foresees actioning all the 6 core concepts of the value agenda contemporaneously, rather than sequentially or partially. This, however, will very likely face several obstacles in the current environment, due to legislative, health policy, resource, and cultural restrictions in Greece.

Establishing the IPU multidisciplinary team, care pathways and protocols, establishing and measuring outcomes, and building the data platform require considerable effort and resources, as well as significant cultural change and buy-in, but most likely represent the components that are easier to become readily operational. The major requirement for this is personal dedication to the project and internal support. Given that people involved in the project are already salaried

by the hospital, and the facilities already exist, the most conspicuous financial investment in this context is represented by the deployment of the integrated IT infrastructure.

Cost measurement, on the other hand, is very arduous. The GGH accounting system is department- rather than patient-based. Costs remain largely a blind spot for hospital managers, who base costing on charges rather than actual costs. Through TDABC, applied on the entire cycle of care at the patient level, costing could become more accurate; however, strong data on overheads, indirect costs, capital costs, medical equipment costs, and occupancy costs are lacking. Calculation of the cost capacity rates requires going beyond the salary of a person or the price of an equipment, but the financial department at GGH does not have any structured algorithm to calculate supervision or occupancy costs for a member of staff.

Care integration (hub-and-spoke type interconnected hospitals and hospital affiliations) and geographical expansion (centers of excellence as referral centers) can theoretically be implemented but require government involvement to obtain clearance and support to alter the operational status quo. Government involvement in care organization is crucial for VBHC implementation. Providers face too many challenges to create value-based systems on their own, due to their historical and conflicting interests, but are also limited by the boundaries of legislation.

At this point a note of a potential issue needs to be made. As expected, optimizing care pathways, integrating and concentrating care, and expanding geographic reach will increase volume, which in return will enhance value. However, on practical grounds, increased volume will require more resources and capacity, especially surgical. This conflict may represent a considerable challenge for GGH, that would either need to expand on site, or transfer parts of the care process in the referring or other local hospitals that have unused capacity, e.g., for physiotherapy treatments, or even surgery. Models of care integration like this require governmental input, drive, and support.

The most difficult core concept of the value agenda to implement seems to be the establishment of bundled payments. There are various barriers at this level that require central policy reforms to be overcome. First, the true overall costs need to be reimbursed. Leaving aside the difficulty of accurate costing as previously described, a peculiarity of the Greek system consists in the fact that hospitals don’t pay personnel salaries; they come from the central government. Hence, it is

not straightforward how to include human costs, that account for about 65% of the overall costs of the care cycle, (6) in the bundle. Second, negotiations between hospital providers and payers are not free; such financial relations are dictated centrally. Especially for public hospitals like GGH, services are reimbursed by the National Organization for Provision of Health Services (EOPYY), (90) that cannot offer customized payment agreements to any provider. Third, reimbursement is based on DRGs currently under implementation. Cost weights have not been finalized and so these DRGs might not offer adjustment for any variation. Spinal patients demonstrate extreme variations in terms of costs of an episode or a cycle of care. Three studies have evaluated bundled payments for spinal surgery and none of them has demonstrated cost reduction. (91–93) Possible explanations include the influence of unadjusted DRGs, the incomplete implementation of the VBHC agenda in the settings where the studies where performed, or the nature of spinal surgery itself, that incorporates high cost and surgical decision-making variability. Fourth, agreeing upon and facilitating a full payment for a bundle of services can be logistically challenging for providers and payers alike. Lastly, bundled repayment models are a costly intervention that may strain health care systems upfront, until optimized and refined. (88)

As can be easily understood, implementing VBHC, even if not on a substantial scale, requires a significant overall investment in human, economic, capital, and technological resources, which may frighten and discourage providers. To assess the value of investments, however, we should consider their expected return. Health care organizations face a trade-off between clinicians' mission to improve patient outcomes and senior management's goal to control costs. VBHC investments accommodate both needs, striking a balance between mission and margin.

CHAPTER 5: Conclusion

The Greek health care system, like other systems around the world, has failed to deliver value and reorganize care, due to many obstacles that have maintained an outdated structure in health care delivery. These obstacles have hindered the formation of patient-centric and value-driven pathways and discouraged the innovation of clinicians who want to enhance patient care.

This study attempts to address the need to inaugurate the implementation of a VBHC agenda in our country, with a specific focus in neurosurgery, a complex, resource-intensive, and costly specialty. By introducing a pilot case scenario, it aims to attract attention of the various stakeholders at local, regional, and national level and initiate the transformational cascade.

This pilot design is expected to form a roadmap for actual implementation of the model and provides valuable lessons and insights for expanding in more clinical conditions and pathways, scaling up VBHC neurosurgery locally or across other hospitals or regions.

Bibliography

1. Porter ME. What Is Value in Health Care? N Engl J Med. 2010 Dec 23;363(26):2477–81.

2. Porter ME, Lee TH. The Strategy That Will Fix Health Care. Harvard Business Review [Internet]. 2013 Oct 1 [cited 2023 Aug 7]; Available from: https://hbr.org/2013/10/the-strategy-that-will-fix-health-care

3. Porter ME. Value-Based Health Care Delivery. Ann Surg. 2008 Oct;248(4):503–9.

4. Porter ME, Teisberg EO. Redefining health care: creating value-based competition on results. Boston, Mass: Harvard Business School Press; 2006. 506 p.

5. SIRA. Value-Based Healthcare at SIRA [Internet]. [cited 2023 Aug 20]. Available from: https://www.rtwmatters.org/upload/RTWMatters%20Value-Based%20Healthcare%20Presentation%20-%2029%20November%20%281%29.pdf

6. Porter PME. Value-Based Health Care Delivery: Core Concepts. 2020; Available from: https://www.isc.hbs.edu/Documents/pdf/2020-intro-vbhc-porter.pdf

7. Porter ME, Lee TH. Integrated Practice Units: A Playbook for Health Care Leaders. NEJM Catal. 2021 Jan;2(1):CAT.20.0237.

8. Mjåset C, Ikram U, Nagra NS, Feeley TW. Value-Based Health Care in Four Different Health Care Systems. Catal Non-Issue Content [Internet]. 2020 Nov 10 [cited 2023 Aug 8];1(6). Available from: https://catalyst.nejm.org/doi/full/10.1056/CAT.20.0530

9. Cossio-Gil Y, Omara M, Watson C, Casey J, Chakhunashvili A, Gutiérrez-San Miguel M, et al. The Roadmap for Implementing Value-Based Healthcare in European University Hospitals—Consensus Report and Recommendations. Value Health. 2022 Jul;25(7):1148–56.

10. Massachusetts General Hospital [Internet]. [cited 2023 Aug 8]. Brain Tumor (Stephen E. and Catherine Pappas Center for Neuro-Oncology). Available from: https://www.massgeneral.org/neurosurgery/treatments-and-services/brain-tumor-center

11. Cleveland Clinic [Internet]. [cited 2023 Aug 8]. Spine Health: Sciatica & Scoliosis Stenosis. Available from: https://my.clevelandclinic.org/departments/neurological/depts/spine

12. NewYork-Presbyterian [Internet]. [cited 2023 Aug 8]. Cerebrovascular Disease | NewYork-Presbyterian Brooklyn Methodist Hospital. Available from: https://www.nyp.org/brooklyn/cerebrovascular-disease

13. The Epilepsy Center | Johns Hopkins Neurology and Neurosurgery [Internet]. [cited 2023 Aug 8]. Available from: https://www.hopkinsmedicine.org/neurology_neurosurgery/centers_clinics/epilepsy/

14. Implementing-Value-Based-Healthcare-In-Europe.pdf [Internet]. Available from: https://eithealth.eu/wp-content/uploads/2020/06/Implementing-Value-Based-Healthcare-In-Europe.pdf

15. Porter ME, Deerberg-Wittram J, Marks C. Martini Klinik: Prostate Cancer Care. Available from: https://www.hbs.edu/faculty/Pages/item.aspx?num=56450

16. Heijsters FACJ, Van Breda FGF, Van Nassau F, Van Der Steen MKJ, Ter Wee PM, Mullender MG, et al. A pragmatic approach for implementation of value-based healthcare in Amsterdam UMC, the Netherlands. BMC Health Serv Res. 2022 Dec;22(1):550.

17. Lee KS, Yordanov S, Stubbs D, Edlmann E, Joannides A, Davies B. Integrated care pathways in neurosurgery: A systematic review. Farag E, editor. PLOS ONE. 2021 Aug 2;16(8):e0255628.

18. Corell A, Guo A, Vecchio TG, Ozanne A, Jakola AS. Shared decision-making in neurosurgery: a scoping review. Acta Neurochir (Wien). 2021 Sep;163(9):2371–82.

19. Légaré F, Witteman HO. Shared Decision Making: Examining Key Elements And Barriers To Adoption Into Routine Clinical Practice. Health Aff (Millwood). 2013 Feb;32(2):276–84.

20. Karpin T. Shared decision making: a vital aspect of everyday care in all healthcare settings [Internet]. Students 4 Best Evidence. 2021 [cited 2023 Aug 7]. Available from: https://s4be.cochrane.org/blog/2021/12/23/shared-decision-making-a-vital-aspect-of-everyday-care-in-all-healthcare-settings/

21. Waddell A, Lennox A, Spassova G, Bragge P. Barriers and facilitators to shared decision-making in hospitals from policy to practice: a systematic review. Implement Sci. 2021 Dec;16(1):74.

22. Rolston JD, Han SJ, Parsa AT. Quality Improvement in Neurosurgery. Neurosurg Clin N Am. 2015 Apr;26(2):xiii–xiv.

23. Asher AL, Parker SL, Rolston JD, Selden NR, McGirt MJ. Using Clinical Registries to Improve the Quality of Neurosurgical Care. Neurosurg Clin N Am. 2015 Apr;26(2):253–63.

24. Yang I, Ung N, Nagasawa DT, Pelargos P, Choy W, Chung LK, et al. Recent Advances in the Patient Safety and Quality Initiatives Movement. Neurosurg Clin N Am. 2015 Apr;26(2):301–15.

25. Porter ME, Larsson S, Lee TH. Standardizing Patient Outcomes Measurement. N Engl J Med. 2016 Feb 11;374(6):504–6.

26. Porter PME. Value-Based Health Care Delivery: Implications for Neurosurgeons [Internet]. 2013. Available from: https://www.hbs.edu/ris/Publication%20Files/Website_VBHCD%20Mayo%20Neurosurgery%205.19%20117pm_170a06cd-15ee-4ec7-bc2a-89336c647c4f.pdf

27. Pohl J, Held JPO, Verheyden G, Alt Murphy M, Engelter S, Flöel A, et al. Consensus-Based Core Set of Outcome Measures for Clinical Motor Rehabilitation After Stroke—A Delphi Study. Front Neurol. 2020 Sep 2;11:875.

28. Ghimire P, Hasegawa H, Kalyal N, Hurwitz V, Ashkan K. Patient-Reported Outcome Measures in Neurosurgery: A Review of the Current Literature. Neurosurgery. 2018 Oct 1;83(4):622–30.

29. Theodosopoulos PV, Ringer AJ. Measuring Outcomes for Neurosurgical Procedures. Neurosurg Clin N Am. 2015 Apr;26(2):265–9.

30. Ahmed AK. Neurosurgical Value in Health-care Reform, Reconciling Quality and Safety | AANS Neurosurgeon [Internet]. 2015 [cited 2023 Aug 7]. Available from: https://aansneurosurgeon.org/neurosurgical-value-in-health-care-reform-reconciling-quality-and-safety/

31. ICHOM. Patient-Centered Outcome Measures [Internet]. [cited 2023 Aug 7]. Available from: https://www.ichom.org/patient-centered-outcome-measures/

32. Salinas J, Sprinkhuizen SM, Ackerson T, Bernhardt J, Davie C, George MG, et al. An International Standard Set of Patient-Centered Outcome Measures After Stroke. Stroke. 2016 Jan;47(1):180–6.

33. De Roos P, Bloem BR, Kelley TA, Antonini A, Dodel R, Hagell P, et al. A Consensus Set of Outcomes for Parkinson's Disease from the International Consortium for Health Outcomes Measurement. J Park Dis. 2017 Aug 8;7(3):533–43.

34. Clement RC, Welander A, Stowell C, Cha TD, Chen JL, Davies M, et al. A proposed set of metrics for standardized outcome reporting in the management of low back pain. Acta Orthop. 2015 Sep 3;86(5):523–33.

35. Kaplan RS, Porter ME. The big idea: How to Solve the Cost Crisis in Health Care [Internet]. Available from: https://hbr.org/2011/09/how-to-solve-the-cost-crisis-in-health-care

36. Kaplan RS, Anderson SR. Time-Driven Activity-Based Costing. Harvard Business Review [Internet]. 2004 Nov 1 [cited 2023 Aug 8]; Available from: https://hbr.org/2004/11/time-driven-activity-based-costing

37. Da Silva Etges APB, Cruz LN, Notti RK, Neyeloff JL, Schlatter RP, Astigarraga CC, et al. An 8-step framework for implementing time-driven activity-based costing in healthcare studies. Eur J Health Econ. 2019 Nov;20(8):1133–45.

38. The time driven activity-based costing (TDABC) project starter kit [Internet]. [cited 2023 Aug 8]. Available from: https://www.isc.hbs.edu/Documents/pdf/2020_TDABC_Project_Starter_Kit.pdf

39. Kaplan RS. Time-Driven Activity-Based Costing in Health Care.pdf [Internet]. 2020. Available from: https://www.isc.hbs.edu/Documents/pdf/2020-cost-measurement-kaplan.pdf

40. Keel G, Savage C, Rafiq M, Mazzocato P. Time-driven activity-based costing in health care: A systematic review of the literature. Health Policy. 2017 Jul;121(7):755–63.

41. Leusder M, Porte P, Ahaus K, Van Elten H. Cost measurement in value-based healthcare: a systematic review. BMJ Open. 2022 Dec;12(12):e066568.

42. McLaughlin N, Burke MA, Setlur NP, Niedzwiecki DR, Kaplan AL, Saigal C, et al. Time-driven activity-based costing: a driver for provider engagement in costing activities and redesign initiatives. Neurosurg Focus. 2014 Nov;37(5):E3.

43. Sethi RK, Drolet CE, Pumpian RP, Shen J, Hanson K, Guerra S, et al. Combining time-driven activity-based costing and lean methodology: an initial study of single-level lumbar fusion surgery to assess value-based healthcare in patients undergoing spine surgery. J Neurosurg Spine. 2022 Nov 1;37(5):639–45.

44. Schroeder GD, Hilibrand AS, Kepler CK, McKenzie JC, Nicholson KJ, Stawicki C, et al. Utilization of Time-driven Activity-based Costing to Determine the True Cost of a Single or 2-level Anterior Cervical Discectomy and Fusion. Clin Spine Surg Spine Publ. 2018 Dec;31(10):452–6.

45. How Does Cost-Effectiveness Analysis Inform Health Care Decisions? AMA J Ethics. 2021 Aug 1;23(8):E639-647.

46. Tsevat J, Moriates C. Value-Based Health Care Meets Cost-Effectiveness Analysis. Ann Intern Med. 2018 Sep 4;169(5):329–32.

47. Van Staalduinen DJ, Van Den Bekerom P, Groeneveld S, Kidanemariam M, Stiggelbout AM, Van Den Akker-van Marle ME. The implementation of value-based healthcare: a scoping review. BMC Health Serv Res. 2022 Mar 1;22(1):270.

48. Droeghaag R, Schuermans VNE, Hermans SMM, Smeets AYJM, Caelers IJMH, Hiligsmann M, et al. Methodology of economic evaluations in spine surgery: a systematic review and qualitative assessment. BMJ Open. 2023 Mar;13(3):e067871.

49. Ryu WHA, Yang MMH, Muram S, Jacobs WB, Casha S, Riva-Cambrin J. Systematic review of health economic studies in cranial neurosurgery. Neurosurg Focus. 2018 May;44(5):E2.

50. Zygourakis CC, Kahn JG. Cost-Effectiveness Research in Neurosurgery. Neurosurg Clin N Am. 2015 Apr;26(2):189–96.

51. Porter ME, Kaplan RS. How to Pay for Health Care. Harvard Business Review [Internet]. 2016 Jul 1 [cited 2023 Aug 8]; Available from: https://hbr.org/2016/07/how-to-pay-for-health-care

52. Menser T, McAlearney AS. Value-Based Payment Models. In: Daaleman TP, Helton MR, editors. Chronic Illness Care [Internet]. Cham: Springer International Publishing; 2018 [cited 2023 Aug 8]. p. 505–16. Available from: http://link.springer.com/10.1007/978-3-319-71812-5_41

53. Savi B. Understanding the Benefits of Value Based Payment Models [Internet]. SAVI Group. 2022 [cited 2023 Aug 8]. Available from: https://www.billingsavi.com/blog/understanding-the-benefits-of-value-based-payment-models/

54. What is VBP? [Internet]. The Value Based Payments Blog. [cited 2023 Aug 8]. Available from: https://www.thevbpblog.com/what-is-vbp/

55. https://www.facebook.com/verywell. Verywell Health. [cited 2023 Aug 8]. Value-Based Payment Systems Reward Doctors for Efficiency. Available from: https://www.verywellhealth.com/what-is-pay-for-performance-1738536

56. Penn LDI [Internet]. 2021 [cited 2023 Aug 8]. The Future of Value-Based Payment: A Road Map to 2030. Available from: https://ldi.upenn.edu/our-work/research-updates/the-future-of-value-based-payment-a-road-map-to-2030/

57. Snively E. Relias. 2023 [cited 2023 Aug 8]. What You Need To Know About Value-Based Payment Models. Available from: https://www.relias.com/blog/what-you-need-to-know-about-value-based-payment-models

58. Leao DLL, Cremers HP, Van Veghel D, Pavlova M, Groot W. The Impact of Value-Based Payment Models for Networks of Care and Transmural Care: A Systematic Literature Review. Appl Health Econ Health Policy. 2023 May;21(3):441–66.

59. Value-based Care [Internet]. [cited 2023 Aug 8]. Available from: https://www.aan.com/practice/value-based-care

60. Technology C. CODE Technology | We Collect Patient Reported Outcomes. 2015 [cited 2023 Aug 8]. National Neurosurgery Quality Outcomes Database (N2QOD). Available from: https://www.codetechnology.com/blog/n2qod-outcomes-database/

61. Neuropoint [Internet]. [cited 2023 Aug 8]. NeuroPoint Alliance | Transforming Data into Quality Patient Care. Available from: https://www.neuropoint.org/

62. Baxter S, Johnson M, Chambers D, Sutton A, Goyder E, Booth A. The effects of integrated care: a systematic review of UK and international evidence. BMC Health Serv Res. 2018 Dec;18(1):350.

63. Porter PME. Value-Based Health Care Delivery: Systems Integration & Growth. 2020; Available from: https://www.isc.hbs.edu/Documents/pdf/2020-system-integration-porter.pdf

64. Team E. EHMA. 2022 [cited 2023 Aug 9]. Transforming care delivery in the spirit of value-based healthcare: how can a community of practice give inspiration? Available from: https://ehma.org/transforming-care-delivery-in-the-spirit-of-value-based-healthcare-how-can-a-community-of-practice-give-inspiration/

65. MD Anderson. MD Anderson Cancer Center. [cited 2023 Aug 9]. Our Locations. Available from: https://www.mdanderson.org/about-md-anderson/our-locations.html

66. Cleveland Clinic [Internet]. [cited 2023 Aug 9]. Miller Family Heart, Vascular & Thoracic Institute. Available from: https://my.clevelandclinic.org/departments/heart

67. Refer [Internet]. [cited 2023 Aug 9]. Available from: https://www.ucsfhealth.org/Clinics/Spine Center/Refer

68. Eichberg DG, Basil GW, Di L, Shah AH, Luther EM, Lu VM, et al. Telemedicine in Neurosurgery: Lessons Learned from a Systematic Review of the Literature for the COVID-19 Era and Beyond. Neurosurgery. 2021 Jan;88(1):E1.

69. A New Era of Practice: COVID-19 and Neurosurgical Care via Telemedicine | AANS Neurosurgeon [Internet]. 2021 [cited 2023 Aug 9]. Available from: https://aansneurosurgeon.org/feature/a-new-era-of-practice-covid-19-and-neurosurgical-care-via-telemedicine/

70. UHealth Virtual Clinics [Internet]. [cited 2023 Aug 9]. Available from: https://umiamihealth.org/treatments-and-services/virtual-clinics

71. Harahsheh E, English SW, Hrdlicka CM, Demaerschalk B. Telestroke's Role Through the COVID-19 Pandemic and Beyond. Curr Treat Options Neurol. 2022 Nov;24(11):589–603.

72. Mayo Clinic's 8 lessons on using data to improve surgical outcomes [Internet]. [cited 2023 May 9]. Available from: https://www.advisory.com/daily-briefing/2021/10/05/surgical-outcomes

73. Bydon M, Meyer F. Lessons from the Mayo Clinic on Using Data to Improve Surgical Outcomes. Harvard Business Review [Internet]. 2021 Sep 30 [cited 2023 May 9]; Available from: https://hbr.org/2021/09/lessons-from-the-mayo-clinic-on-using-data-to-improve-surgical-outcomes

74. Teisberg E, Wallace S, O'Hara S. Defining and Implementing Value-Based Health Care: A Strategic Framework. Acad Med. 2020 May;95(5):682–5.

75. Karhade AV, Bono CM, Makhni MC, Schwab JH, Sethi RK, Simpson AK, et al. Value-based health care in spine: where do we go from here? Spine J. 2021 Sep;21(9):1409–13.

76. Low back pain [Internet]. [cited 2023 Aug 19]. Available from: https://www.who.int/news-room/fact-sheets/detail/low-back-pain

77. The Global Burden of Low Back Pain [Internet]. International Association for the Study of Pain (IASP). [cited 2023 Aug 19]. Available from: https://www.iasp-pain.org/resources/fact-sheets/the-global-burden-of-low-back-pain/

78. Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. The Lancet. 2018 Jun;391(10137):2356–67.

79. Beighley A, Zhang A, Huang B, Carr C, Mathkour M, Werner C, et al. Patient-reported outcome measures in spine surgery: A systematic review. J Craniovertebral Junction Spine. 2022;13(4):378.

80. e-ΕΦΚΑ | Ηλεκτρονικός Εθνικός Φορέας Κοινωνικής Ασφάλισης [Internet]. [cited 2023 Aug 20]. Available from: https://www.efka.gov.gr/el

81. Κλειστά Ελληνικά Νοσήλια - Υπουργείο Υγείας [Internet]. [cited 2023 Aug 20]. Available from: https://www.moh.gov.gr/articles/health/domes-kai-draseis-gia-thn-ygeia/kwdikopoihseis/kleista-enopoihmena-noshlia/

82. Greek DRG Institute [Internet]. ΚΕ.ΤΕ.Κ.Ν.Υ. [cited 2023 Aug 20]. Available from: https://instdrg.gr/

83. Γενικό Νοσοκομείο Αθήνας [Internet]. [cited 2023 Aug 20]. GNA G. Gennimatas. Available from: http://www.gna-gennimatas.gr/

84. Consultant360 [Internet]. 2013 [cited 2023 Aug 26]. Acute Low Back Pain: Recognizing the "Red Flags" in the Workup. Available from: https://www.consultant360.com/article/acute-low-back-pain-recognizing-%25E2%2580%259Cred-flags%25E2%2580%259D-workup

85. Low Back Pain – ICHOM Connect [Internet]. [cited 2023 Aug 24]. Available from: https://connect.ichom.org/patient-centered-outcome-measures/low-back-pain/

86. ICHOM. ICHOM Low_Back_Pain_Reference_Guide [Internet]. [cited 2023 Aug 24]. Available from: https://connect.ichom.org/wp-content/uploads/2023/03/21-Low_Back_Pain_Reference_Guide_2023.4.1.0.pdf

87. Low-Back-Pain-Data-Dictionary-2023.4.1.0.xlsx [Internet]. [cited 2023 Aug 24]. Available from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fconnect.ichom.org%2Fwp-content%2Fuploads%2F2023%2F03%2F21-Low-Back-Pain-Data-Dictionary-2023.4.1.0.xlsx&wdOrigin=BROWSELINK

88. Hines K, Mouchtouris N, Getz C, Gonzalez G, Montenegro T, Leibold A, et al. Bundled Payment Models in Spine Surgery. Glob Spine J. 2021 Apr;11(1_suppl):7S-13S.

89. Karhade AV, Bono CM, Makhni MC, Schwab JH, Sethi RK, Simpson AK, et al. Value-based health care in spine: where do we go from here? Spine J Off J North Am Spine Soc. 2021 Sep;21(9):1409–13.

90. Ε.Ο.Π.Υ.Υ. - Εθνικός Οργανισμός Παροχής Υπηρεσιών Υγείας [Internet]. [cited 2023 Aug 28]. Available from: https://www.eopyy.gov.gr/

91. Martin BI, Lurie JD, Farrokhi FR, McGuire KJ, Mirza SK. Early Effects of Medicare's Bundled Payment for Care Improvement Program for Lumbar Fusion. Spine. 2018 May 15;43(10):705–11.

92. Jubelt LE, Goldfeld KS, Blecker SB, Chung WY, Bendo JA, Bosco JA, et al. Early Lessons on Bundled Payment at an Academic Medical Center. J Am Acad Orthop Surg. 2017 Sep;25(9):654–63.

93. Bronson WH, Kingery MT, Hutzler L, Karia R, Errico T, Bosco J, et al. Lack of Cost Savings for Lumbar Spine Fusions After Bundled Payments for Care Improvement Initiative: A Consequence of Increased Case Complexity. Spine. 2019 Feb 15;44(4):298–304.