Outdated Ventriculoperitoneal Shunts and their Effects on Quality of Life: An Interdisciplinary Study

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Abstract

Though many people in the medical field are aware of patients having a low quality of life from ventriculoperitoneal shunts not having updated material and technology, many choose to look at the problem through only one disciplinary perspective. In light of this issue, the sole purpose of this study was to use an interdisciplinary perspective on how outdated ventriculoperitoneal shunts affect quality of life as well as express technology advancement recommendations through this type of analysis. This study involved extensive interdisciplinary work on the causes and symptoms of intracranial pressure, types and advancements of shunt valves, and surgery outcomes and lasting effects. The research in these areas of study identified why ventriculoperitoneal shunts are out of date, as well as the affects on quality of life in a patient from multidisciplinary perspectives. The literature review included previously established biopsychology, physiology, and technology discipline analysis to better understand the issue. This study reviewed these three disciplines and used an interdisciplinary approach to expand and organize their individual perspectives to properly analyze how outdated ventriculoperitoneal shunts affect quality of life. Through interdisciplinary analysis, the information developed in the research of multiple disciplines produced the proposal of adding biopsychology to improve overall treatment plans, and enhance the manufacture of technological advancements for ventriculoperitoneal shunts and, most importantly, create a better quality of life for patient with hydrocephalus.

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Chapter One: Understanding the Problem

Introduction and Background

A good majority of patients who need ventriculoperitoneal shunts have hydrocephalus. Hydrocephalus is a lifelong condition that affects 4 to 6 people per 1000 and accounts for 30,000-33,000 shunt procedures annually (Ventriculoperitoneal Shunts 2022). The large amount of procedures are from initial installments and shunt replacements. Unfortunately, one of many institution studies on ventriculoperitoneal shunt revision and surgery complications found that "40%-50% of shunts fail within the first year" (Reddy 2013). It is evident through these percentages that it is common for shunts to fail. Furthermore, "within the first thirty days of post operation surgery, 40% of shunt operations have perioperative complications" (Mansoor 2020). These complications are typically caused from additional shunt procedures. Ultimately, with a 98% failure rate after 10 years, the current outdated shunts are unable satisfy the everchanging needs of patients' lifelong condition of hydrocephalus (Ferras 2020). In response to these issues, patients have a low quality of life because Ventriculoperitoneal shunts do not use updated material and technology. The lack of material and technology upgrades in the medical field perpetuates a multifaceted pain cycle for many shunt users. Sivashanmugam Dhandapani, a professor from National Institute of Nursing Education in Chandigarh, India said that "patients who had undergone VP shunt for HCP face various health-related problems in different domains and low QOL" (2018). The quality of life issues include physical pain in surgical areas and other afflicted origins, intellectual deterioration, and emotional damage from social struggles and alienation. A patient's quality of life plummets when repetitive medical alterations are done on a shunt and no solution increased ICP is found.

Since hydrocephalus affects approximately 1 million Americans, it is important for there to be treatments, like ventriculoperitoneal shunts, in place for this condition for overall survival and increased quality of life (20 Powerful Hydrocephalus Facts 2022). The shunt's purpose is to regulate the abundance of cerebrospinal fluid (CSF) and thus maintain the intracranial pressure (ICP). Increased ICP due to an abundance of CSF fluid can be devastating for this patient population. Venessa Pinto, a professor assistant at Baylor College of Medicine, states that "the causes of increased intracranial pressure (ICP) can be divided based on the intracerebral components causing elevated pressures" (2021). This is called the Monroe-Kellie Doctrine: the sum of volumes of cranium, intracranial blood and CSF is constant, and the increase on one should cause a decrease in one or both remaining components. Mutable CSF volume and exterior pressures easily cause this disruption of intracranial pressure and in turn inflicts a variety of discomforts upon the individual with the condition, including severe headache, altered mental status, seizure and, if not controlled death. These issues create a need for a treatment plan that will mechanically control the intracranial pressure by allowing for a way to drain excess CSF. The advanced use of technology, pertaining to the mechanical valve functions, in the physiological field, this being the body's biological functions, could help diminish the amount of distress a patient is put through from intracranial pressure-technology. It should be noted that "despite the advancement in the technical and manufacturing aspects of CSF, the shunts remain prone to numerous complications" (Kanodia 2017). To update the existing ventriculoperitoneal shunt technology, engineers will need to tailor its development based on what scientists show is physiologically required to fulfill patients' needs and overall safety and medical goals.

Many researchers have found that "50% of shunts fail within the first year" (Reddy 2013). Avinash Kanodia, a professor in the Department of Radiology at Ninewells Hospital in

Dundee, United Kingdom, believes that "shunt failure is defined as a shunt complication requiring revision or replacement" (Kanodia 2017). Other researchers like Pinto and Foltz would agree with this statement involving those key words. Shunt failure is a painful complication for this patient population, more so if they are needing multiple revisions. Furthermore, the limited valve settings on the technology causes poor CSF drainage which results in a very agonizing experience for the patient. Since the valve settings must be adjusted manually by a device with a coded magnetic field, the settings are changed on certain occasions not according to immediate change in ICP. Furthermore, "it was shown that after approximately 24 months, over 50% of shunts need revisions" (Apigo 2017). This statement supports the conclusion that the manual adjustment settings the current shunt models have are not sufficient for what is medically needed.

Another reason why ventriculoperitoneal shunts need to be updated is because "infection remains the most serious complication of VP shunt placement" (Sacar 2006). Infections can result in a multitude of serious health concerns including but not limited to hemorrhage, seizures, and infections which are challenging to treat due to the blood-brain barrier and limited antibiotics which are effective. Infection, and all it entails, is not the only surgery outcome that can cause discomfort. These surgery complications are far from rare. Insufficient technology will not only create further damage on a compromised ventricular system but will also negatively affect the individual's life in multiple domains. James Fowler, a doctor from Desert regional Medical Center, gives a list of several other complications that included "malposition…shunt breakage at any point…shunt overdrainage…shunt obstruction" and many other common surgery issues that hurt the patient (Fowler 2021). These extensive lists prove that "surgical complications cause significant medical and social burden" (Reddy 2013). The high rates of complications and the

seriousness of complication types exemplifies the magnitude of medical burden as well as the need for a more efficient ventriculoperitoneal shunt.

Undoubtedly, the technology and physiology disciplines, and all that they delineate, have found a way to amalgamate but fall short when biopsychology, a study pertaining to biological effects on mental and emotional domains, is added. In response to this problematic cohesion, ventriculoperitoneal shunt patients remain in a state of discomfort. This has been a long-term problem as well as a large hampering on an individual's quality of life. In one pediatric study, "low QOL was reported by the children who had undergone multiple surgeries and have received care for more than 8 hours per day" (Dhandapani 2018). The problems with the technology caused their experiences to be unpleasant. In addition to that, 42% of children who have ventriculoperitoneal shunts experience constant migraines, generalized pain, and fatigue from the shunt's frequent malfunctions (Dhandapani 2018). Haytham Eloqayli, from the Jordan University of Science and Technology, noted in his research that physical pain is not the only factor that patients deal with. He said that a decrease in "cognitive function [was] possibly due to associated brain damage" and "social function decline [was] probably due to the patients' awareness of their disability" (Eloqayli 2019). Social-emotional and cognitive deficits do occur from this exhaustive, undesired lifestyle. No one should have to endure these unpleasant conditions.

Furthermore, it is noticeable that technology and biopsychology do not interact with one another frequently, so it makes the process of adjusting technology to a single person's health a little more difficult. Technology and physiology do not consider a patient's behavioral neuroscience whereas biopsychology does. Most studies on this subject disregard research on quality of life and only conduct research over technology and physiology. Consequently, the

little research that is available from the biopsychological perspective creates a gap in knowledge as far as understanding the effects shunts have on patients physically, mentally, and emotionally. By incorporating biopsychology into the technology and physiology realms allows an understanding of how physiological pain affects more than just the body; it affects the mental and emotional state of the patient as well. Additionally, it increases awareness on how those physical complications, caused by outdated technology, affect quality of life. By bringing these disciplines all together, it creates a dynamic that is sufficient in all areas of research. As of now, "further strategies are necessary to improve the long-term treatment of [patients] with hydrocephalus" (Merkler 2016). The fact of the matter is that these shunts are only being updated enough to meet the minimum functional requirements. Many understand updates to this technology are long overdue and needs to improve. Including biopsychology into this topic's research is this study's overall goal to do what other studies have not: use interdisciplinary methods to elaborate and organize a concept on how outdated ventriculoperitoneal shunt technology negatively affecting a person's quality of life.

An Interdisciplinary Analysis

This interdisciplinary study's purpose is to use technology, physiology, and biopsychology to construct a neo-interdisciplinary perspective on outdated ventriculoperitoneal shunts and their effects on quality of life. To begin, biopsychology is a discipline that creates a framework for behavioral neuroscience. This mainly focuses on the brain, environment, and behavior. The concept of quality of life stems from behavioral neuroscience which focuses on how biological disturbances can affect your mental state. This can pertain to the emotional and physical pain that shunt complications like revision work, bacterial infections, and intracranial

pressure can cause on a person's mental state. Technology is another discipline used in this study. This discipline helps delineate the specific workings of the ventriculoperitoneal shunt device such as the valve settings and the tubing for drainage. Lastly, physiology contributes considerably to the study. Physiology is a subcategory of biology that discusses the organic functions of living organisms and their inner workings. The physiology in this topic is commonly used in the medical realm to specifically discuss areas like the cranium and the biology surrounding ventriculoperitoneal shunt tube tract. This discipline acts as a bridge between the other disciplines because it describes the biological functions for biopsychology, and it is what the technology is built to maintain for the patient. By including biopsychology more into the physiological and technological realms of this study, a conclusion may be reached. The amalgamation of these three disciplines supports the notion of updating ventriculoperitoneal shunts to enhance the quality of life in patients who have them. Combining these disciplines will give patients who have these shunts a voice. It allows the patient to express their personal issues with the topic such as their cognitive, social, and emotional challenges.

Chapter Two: Literature Review

To fully understand this topic, it is imperative to have a foundation on what has been said in the scholarship; particularly on the topics of causes and symptoms of intracranial pressure in hydrocephalus patients, types and advancements of shunt valves, and surgery outcomes and lasting effects of ventriculoperitoneal shunts. These themes are progressive; the subjects will inform people first on the detailed information about ventriculoperitoneal shunts then express a more holistic point of view on how those details of the ventriculoperitoneal shunts affect the patients' quality of life. This review gives a clear depiction on how much of the current research in this topic focuses on technology and physiology and how little biopsychology is included in previous studies.

Causes and Symptoms of Intracranial Pressure in Hydrocephalus Patients

To start, causes and symptoms must first be delineated in these scholars' findings. Researchers used the scientific method to help identify each stage of the issue and, as a result, developed lengthy scholarship. Intracranial pressure is the most prominent cause for hydrocephalus, and thus needs to be better examined. By observing the causes and symptoms of intracranial pressure, the first phase of the scientific method is exercised. After starting at the root of the problem, it is imperative to research what can be found on the subject.

Causes

In conjunction with that statement, many researchers such as Gurgul, Pinto, Foltz, Kanodia and Fowler had several similar ideas on the causes of intracranial pressure. Kanodia, as well as many other authors, first give a description of the brain's physiological basics to create a

platform when talking about intracranial pressure. Pinto, for example, proclaimed that "if flattened gyri or narrowed sulci, or compression of the ventricles, is seen, this suggests increased ICP" (2021). She also explained how the adjustment of pressure in the cranium works: an increase of volume in one of the three components of the cranium results in a decrease in volume of both or one of the other components. Many of the authors believed that intracranial pressure stems from an increased amount of cerebrospinal fluid pressing on the brain or an absence of cerebrospinal fluid in the cranium (Kanodia 2017). Kanodia talked specifically about how this occurs. In fact, Kanodia stated that intracranial pressure happens when shunt obstruction, or underdrainage, transpires. He felt this also applied to shunt over-drainage. In the medical world, these two conditions are called intracranial hypotension and hypertension. Of course, these two conditions are not the only results that the authors say come from intracranial pressure. Pinto, for example, categorized her thoughts on the different causes of increased intracranial pressure. Pinto's list consisted of mass effect brain injuries, increase in cerebrospinal fluid, decreased reabsorption of cerebrospinal fluid, increase in blood volume, and other miscellaneous causes like skull deformations or intracranial hypertensions (2021). It is apparent that there are many overlaps with what a lot of the authors think are the causes of fluctuations in intracranial pressure.

Some authors, like Gurgul, Herbowski, and Pinto, expressed viewpoints on atmospheric pressure correlations with intracranial pressure while others did not have any evidence on it. Gurgul expressed at length the sciences behind atmospheric pressure. In Gurgul and Herbowski's articles, they outline research studies on how much atmospheric pressure it takes for it to affect intracranial pressure. Gurgul specifically chose fourteen patients who had normal pressure hydrocephalus and evaluated "the influence of atmospheric pressure and ambient temperature on

parameters of intracranial volume-pressure homeostasis including intracranial pressure and cerebral perfusion pressure as well as on blood pressure and body temperature" (2008). Gurgul's study found that both temperature and atmospheric pressure does in fact change the intracranial pressure (2008). Pinto's article aims more towards the pressure measurements of the optic nerve, ventricular drain, and the lumbar puncture area. Foltz also adds to this topic in saying that even the simple movement of laying down to sitting up causes intracranial pressure. His article outlines a study where a patient went from a laying down position to an active position with the result being a dramatically lower intracranial pressure level, also known as intracranial hypotension (1988). Both Pinto and Gurgul alluded to environmental pressures, like climate and elevation, having an influence on intracranial pressure but neither of the sources have sufficient evidence on the subject.

Symptoms

Additionally, Pinto, Foltz, and Fowler give incredibly detailed symptoms of the condition as well. Each source agrees that headaches, vomiting, visual problems, and disturbances in mental status are definite symptoms of intracranial pressure. Pinto, however, covers symptoms over visual impairments and mental status more than the other authors. Foltz talked more about nausea and dizziness considering the supine/active study he executed. Foltz felt that the symptoms were so severe that they disabled his patients when they were doing simple activity (1988). Other authors, like Fowler and Pinto, also brought up causes and symptoms relating to other conditions that often come with or are versions of hydrocephalus. Fowler referenced "Congenital Hydrocephalus…tumors…Communicating Hydrocephalus…Myelomeningocele…Craniosynostosis…Dandy-Walker Syndrome…Idiopathic

Intracranial Hypertension…and Arachnoid Cysts" (2021). Lots of these conditions are present from growth problems or abnormal cerebrospinal fluid flow. Gurgul and Kanodia, however, do not talk about the symptoms of intracranial adjustment at all in their articles since Gurgul is research based and Kanodia discusses the causes and etiology of intracranial pressure.

Overall, Gurgul, Fowler, Kanodia, Foltz, and Pinto all had an assortment of information on intracranial pressure. Kanodia, Pinto, and other professionals from the Cleveland clinic directed their readers' attention towards the condition of abnormal cerebrospinal fluid amounts pressing on the brain and how that affects hypertension. Pinto, Foltz, and Gurgul's articles aligned themselves on the subject of atmospheric pressure adjusting intracranial pressure. Fowler, Foltz, and Pinto were the main authors that listed the symptoms of intracranial pressure as well as other conditions connected to hydrocephalus. All the authors agree on their shared findings, however, the only discrepancy found was that some researchers covered certain material while others did not. This could be the reason ventriculoperitoneal shunts are not efficient. The fact that there is more research in some areas than others could contribute to the technology being constructed a particular way and it not properly working according to the brain's physiological system. This is all particularly important background information to attain when understanding why ventriculoperitoneal shunts need to be updated. Regardless, by outlining where the problem originates and what damages it creates, researching causes and symptoms can help identify what technology devices would be the best to use and fix the number of problems inflicted on the patient.

The Types and Advancements of Shunt Valves

Once researchers have a substantial amount of information on the physiological side of the problem, they can advance into how the technology will interact with the biology of the brain. It is first important to describe what kind of devices are available and where the device is installed within the body. Many researchers discuss the mechanics of the device in length. This helps give a better depiction of how the current shunts are supposed to function in response to hydrocephalus.

Types of Shunt Valves

To elaborate, authors Lollis, Kanodia, researchers from URMC, and Fowler give extensive description on location of where the ventriculoperitoneal shunt valve is and where the two tubes go in the body. Over all the others, Kanodia and professionals from Neurotexas Brain and Spinal Surgery website spent the majority of their article talking about where the shunt belongs in the brain, how the ventricular catheter needs to be placed inside the ventricle, and where the distal tube/catheter needs to deposit the draining cerebrospinal fluid. Fowler also gives extensive text on the equipment needed for the shunt, the procedure, the personnel needed for the surgery, the preparation for the surgery, and a lengthy description of how to do the procedure. Additionally, URMC researchers and Lollis talk about what programmable shunts can do when there is over-drainage and underdrainage occurring in the brain. Both authors explain that non-programmable shunts have a permanent setting on how much cerebrospinal fluid to drain while programmable shunts, the newer technology, can alter their settings with special help from a device with a coded magnetic field (URMC 2022, Lollis 2010). All the sources agreed that the

largest difference in shunts is the type of shunts used and if they are programmable or non-programmable.

With that in mind, Lollis and Krause had the most information about the types of shunts available to European and American neurosurgeons. Krause comes from a European source while Lollis is an American article. Both agreed that the Aesculap Miethke proGAV, developed in Germany; Codman Hakim, developed in Massachusetts; Medtronic Strata, developed in Minnesota; and Sophysa Sophy SM8, developed in France, are currently the most reliable programmable shunt valves (Krause 2022, Lollis 2010). In addition to these findings, Krause went into more detail about five other programmable valves and three non-programmable valves. When discussing all the diversities, he spent a lot of the article discussing how much Tesla a shunt can manage as well as which were cleared to go through a Magnetic Resonance Imaging (MRI) machine. Lollis also talked about the surveillance of the shunt after an MRI, but he went into more detail about each of the shunts' settings as well as their pressure levels for each setting rather than the effects magnets had on the device. Both sources made it a point to express that there are limited settings on these devices, and they must be manually changed. The main settings only operate on low, medium, or high and cannot adjust to sudden changes in pressure.

Advancements

Aligning with that, Apigo, Getzoff, Soler, and Lollis focused more on the advancement of ventriculoperitoneal shunts while the Cincinnati Children Hospital, Taxakalidis, and Unal professionals focused on an alternative to shunts. Many sources outside of these eight briefly mention that "despite the advancement in the technical and manufacturing aspects of CSF, the shunts remain prone to numerous complications" (Kanodia 2017). Lollis adds that even though

technology has come a long way, shunts need to be adjusted and replaced repeatedly (2021). Out of all the articles for this topic, Apigo, Soler, and Getzoff are the only ones that had any information on a current innovation with shunts. Apigo and Getzoff talked about a MEMS capacitive sensor that can detect and forecast blockages in the shunt. Apigo expressed that the "sensor provides quantitative data on the dynamics of the cerebrospinal fluid, it can help test new therapies and work toward understanding hydrocephalus" (2021). Since the device can detect pressure and flow of the cerebrospinal fluid, it can identify debris or blood that causes occlusion. Apigo explains that although there are great efforts for this to become a commonly used addition to shunts, there are no studies on if it would work efficiently when applied (2017). Additionally, Soler discussed recent attempts to manufacture "a device capable of noninvasive measurement of internal shunt fluid flow in real time" (2018). The sensor device has been tested in the lab through many conditions and will continue to be worked on but is not released for use. There is also a current surgical procedure that is a treatment for hydrocephalus that Cincinnati Children Hospital, Taxakalidis, and Unal discuss. Endoscopic third ventriculostomy creates a bypass through the third ventricle of the brain for the CSF to flow through and discharge in the fluid chambers at the base of the brain. It then flows over the brain and is reabsorbed into the bloodstream. This alternative to shunts has a "lower complication rate and has significant advantages compared to other CSF diversion techniques" (Unal 2017).

In short, Kanodia and Fowler dedicate a lot of their writing to what the ventriculoperitoneal shunt is and where it needs to go in the cranium. URMC researchers and Lollis also help give more background by explaining what the difference between a programmable and non-programmable kind of shunt is. While Lollis and Krause, on the other hand, narrow the scope a little more by talking about the different types of shunts there are

within the two kinds of shunts. Apigo, Soler, and Getzoff conclude by educating readers about new sensor technology that is being tested for patients with ventriculoperitoneal shunts, and the Cincinnati Children hospital, Taxakalidis, and Unal professionals elaborated on a shunt alternative. All this information provides important insight on how problems can occur in treating hydrocephalus with these technological devices. Also, slow and minute shunt advancement can result from the absence of progressive research. There is no disagreement on the fact that shunts are outdated, so scholars agree that there needs to be a change but are unsure of where to start when there are very few progressive studies. Apigo and Getzoff, however, suggest that technologically advancing the shunt valve could help the efficiency of the shunt. It is very probable that the way ventriculoperitoneal shunts are built is the reason for low quality of life.

Surgery Outcomes and Lasting Effects

Once there is a clear understanding of the ventriculoperitoneal shunt and everything that pertains to its functionality, scholars then determine the effects it has on the patient. Surgery outcomes have a direct effect on a plethora of areas in a patient's life. Many of the areas such as physical and mental domains are infringed upon and can negatively affect an individual's quality of life. These diverse outcomes have a strong influence on the patient's future. In fact, there were many sources that had information on the outcomes of getting a ventriculoperitoneal shunt. URMC researchers, Fowler, Merker, Mansoor, Sacar, Reddy, and Dhandapani had specific details about the complications of getting a ventriculoperitoneal shunt. They also had extended information on how it affects children and adults as well as the long-term effects and impact on quality of life the ventriculoperitoneal shunt surgery has. In fact, all sources gave out extensive

statistics on the different complications of the surgery, percentages of patients who had issues with the shunt, demographics, and other countless connections to the surgery. All the authors recognized that the current surgery outcomes are because the device and surgery procedure need to be updated (Merkler 2016).

Complications

Moreover, URMC researchers, Fowler, Mansoor, and Sacar all talk extensively about how "infection remains the most serious complication of VP shunt placement" (Sacar 2006). URMC researcher's article, for example, explains that the tubing is a foreign object that may contract bacteria in the body (2022). Fowler adds that skin flora and exposure of the system can increase the likelihood of infection (2021). Additionally, Sacar and Fowler agree that fever, headaches, lethargy, nausea, seizures, topical deterioration, and many other symptoms can be present during malfunction or infection. Bleeding problems such as blood clots and swelling are also profoundly serious, common risks Minagar says. Additionally, Merkler and Mansoor proclaimed that "most VPS complications occurred within the first year after VPS insertion" (Merkler 2016). Sacar, Mansoor, and Reddy also found that risks and complications are dependent on age, type of shunt implanted, etiology of hydrocephalus, and surgeon experience.

Long-term complications

On the other hand, Merkler, Mansoor, Dhandapani, and Reddy spent their time talking about the patients' long-term complications that they must deal with day-to-day. Merkler and Mansoor both said that "complication rates in adults are poorly established, with a reported range from 17% to 33%" (Merkler 2016). Reddy and Dhandapani were the only two sources that

talked about the reported problems of the surgery like cognitive impairment, epilepsy, and headaches. Merkler, Mansoor, Dhandapani, Reddy, and Kanodia agreed that shunt failure was quite common and that revisions often occur during the first year (Mansoor 2021). The higher revision rate, the higher chance of infection and other complications (Mansoor 2021). Interestingly, Merkler, Mansoor, Reddy, Dhandapani, and Kanodia make it a point that "despite the advancement in the technical and manufacturing aspects of CSF, the shunts remain prone to numerous complications" (2017). Kanodia, Paff, and Reddy identified different complications like obstruction, valve failure, insufficient drainage, and other medical burdens. Some articles, like Neurosurgery, relayed how the shunts can mechanically dysfunction such as shunt disconnection. Merkler and Mansoor also explain that complications have been a constant problem with shunts for the past fifty years (Mansoor 2021). There is evidence that revision and complication rates have not decreased, but there is still no research on if the ventriculoperitoneal shunt problems have increased.

Age groups

Furthermore, Mansoor, Reddy, Sangeetha, and Dhandapani are the authors that talked about age being a factor of surgery complications. Merkler, Mansoor, and Reddy said that "pediatric patients had significantly greater rates of shunt revision than adult patients" Reddy 2013). Mansoor and Sangeetha, however, were the only ones that stated there was more of a probability in pediatric patients to have revisions increase the risk of further infection (Sangeetha 2019). Dhandapani did the most research on how revisions, complications, and having a shunt in general would affect the quality of life for children. Dhandapani had statistics on the most common problems children had experienced with a ventriculoperitoneal shunt. Fatigue in the

limbs, blurred vision, fever, seizures, difficulty walking, and infection at shunt site were just a few that were mentioned. Dhandapani's article highlighted how "Low QOL was reported by the children who had undergone multiple surgeries and have received care for more than 8 hours per day" (2018). Dhandapani also said that a huge part of the decrease in quality of life was the emotional burden of the condition (2018).

Quality of life

Unfortunately, it is extremely hard to find any information on quality of life regarding patients with hydrocephalus. Dhandapani, Eloqayli, and Mitchell are the few sources that discussed the impact hydrocephalus has on a patient's quality of life. All three authors did give a general rundown of the physical complications that can transpire with a ventriculoperitoneal shunt. Also, Dhandapani and Eloqayli both did a data collection on children and their quality of life following the installation of a ventriculoperitoneal shunt. In both case studies, it was found that quality of life was low. The results for all two articles showed that the cognitive domain had the lowest quality of life which was "possibly due to associated brain damage" and Social-emotional domains were second (Eloqayli 2019). Since these were children's studies, both cases also considered the caregivers' concern on quality of life for their child. It was found that cognitive deficits were the most important to caregivers and affect their parental burden and neuropsychological symptoms being a close second (Eloqayli 2019). Mitchell, on the other hand, focused more on the physical and psychosocial burdens of having a shunt device and talked extensively about the case study procedure and quality of life measurements that she did. Mitchell stated that even if an individual does not subscribe to having a low quality of life, they still had to modify their lifestyle somehow (2021). In Mitchell's article, she states that "several

studies have previously been published on the clinical burden of shunted hydrocephalus, the humanistic burden of the shunts themselves have not being examined in these studies" (2021). All three sources agreed that more advancements need to transpire to decrease physiological, socio-psychological, and cognitive issues.

In total, authors from URMC, Fowler, Mansoor, Minagar, and Sacar had their article's main points on the complications of having ventriculoperitoneal shunt surgery. They explained that even though risk of infection is the most common complication, there are many other risks that can be more severe such as seizures (Fowler 2021). Merkler, Mansoor, Reddy, Sangeetha, and Dhandapani are the authors that split the surgery outcomes into two different subcategories of an age demographic. Out of this set of articles, Reddy, Paff, and Mitchell had the most information about ventriculoperitoneal shunt surgery outcomes for adults as well as long-term studies. Dhandapani and Eloqayli, conversely, spent their time explaining their statistics they found on children's quality of life after their experience with having a ventriculoperitoneal shunt surgery. Merkler, Mansoor, Reddy, Dhandapani, and Kanodia stood out the most from all other authors by stating that "despite the significant advances in shunt technology and treatment approaches in neurosurgery, many patients with hydrocephalus experience relatively high rates of shunt failure and must undergo a shunt revision or replacement" (Reddy 2013). Even though it was difficult to find sources on quality of life, Dhandapani, Mitchell, and Eloqayli gave case studies on their findings that shunts can negatively affect a patient's quality of life. All the sources work together to show that the surgery outcomes are possibly the reason for low quality of life.

The following chapters will take the concepts the researchers in the literature review discussed and break them down even further to find conflict and common ground. The results

will then be integrated using interdisciplinary methods. Once complete, the interdisciplinary analysis and literature review will conjoin to build a well-educated recommendation.

Chapter Three: Methods

Despite great advancements of research in the technology field of medicine, ventriculoperitoneal shunts are still having a negative effect on a patient's quality of life because of their outdated material usage and technology programming. Researchers from the University of Rochester Medical Center, BioMed Central, Hydrocephalus Association, Jordan University of Science and Technology and others from medical, technology, and psychology articles were used as eligible resources. A review of research used for this study was found by using key words or phrases including ventriculoperitoneal shunt, intracranial pressure, hydrocephalus, types of ventriculoperitoneal shunts, programmable shunts, ventriculoperitoneal shunt technology advancements, ventriculoperitoneal shunt technology, ventriculoperitoneal shunt complications, ventriculoperitoneal shunt surgery, outcomes of ventriculoperitoneal shunt surgery, ventriculoperitoneal shunts quality of life, quality of life, and hydrocephalus patient's quality of life. This search produced a plethora of information to use in this study. Each concept and ideology proposed was then dissected into their relevant physiology, technology, and biopsychology disciplines. Through an interdisciplinary scope, the disciplines were further analyzed into conflict and common ground themes.

Identifying Conflict

Increasing the quality of life in patients who have ventriculoperitoneal shunts seems to be a non-existent concept in the medical field. The conflict lies within the fact that the physiological and biopsychological disciplines want to update the technology but differ in their reason why

advancements need to occur. Even though the physiology and technology disciplines have learned over time to work together, and the biopsychology and physiology disciplines both dabble in the sciences, they struggle to find common ground because of their lack in interdisciplinary methods. Many medical researchers explain that there needs to be a substantial advancement in shunt technology because of the device's high complication rate. This comment, however, does not account for the psychological problems that come with the complications. The physiology side recognizes the mechanical problems of the technology, but not the infliction it has upon the patient. Technology does not have much of a view when it comes the problem at hand. This discipline simply identifies and responds to what the physiology discipline requires of it. Biopsychology, on the other hand, has an extraordinarily strong opinion on the impact ventriculoperitoneal shunts have on a patient's behavioral neuroscience. This discipline is genuinely concerned with how much a patient's quality of life decreases with implanted, outdated technology. These disciplines have the same goal of updating the technology but do not have the same reason for why it needs to be done.

Identifying Common Ground

Identifying common ground is a little more complicated when it comes to creating connections across disciplines. Out of the four ways to find common ground, this study will use extension and organization methods. Extension will help in enlarging the scope of what the disciplines discuss. This expansion beyond the disciplines' original domain inevitably involves a form of modification. The concept of outdated technology having a negative impact on a patient will be the point of expansion through the two other disciplines. The other interdisciplinary method this study will use is organization. This approach clarifies how certain ideologies interact

thus finding commonality among meanings and reorganizing them to reach common ground. With these two methods, this study will cultivate a neo-interdisciplinary perspective on how outdated ventriculoperitoneal shunts impact patients and hopefully find a way for the technology to improve a patient's quality of life. The integration of these disciplines could propel the creation of advanced ventriculoperitoneal shunts. The following paragraph will show how various parts of these topics correspond with one another.

Achieving Interdisciplinary Understanding

Interdisciplinary understanding of the outdated ventriculoperitoneal shunt functions and the impact it has on an individual's quality of life transpires when all the disciplines amalgamate. A proper analysis of the disciplines by way of a literature review is what achieves this. The literature review expounded on a lot of physiological concepts as well as how technology plays a part in bodily functions. The study also properly analyzed all that the researchers had to offer in the biopsychology discipline on the humanistic side of the concept. Once all the categories were pronounced in their own teachings, they were then integrated using interdisciplinary measures and formulated into a comprehensive understanding. This interdisciplinary comprehension is shown in chapter four.

Chapter Four: Interdisciplinary Analysis

Having identified all the research that currently exists for ventriculoperitoneal shunts, there is a strong focus on technology and physiology while there is a minuscule amount of research done through biopsychology. This astronomical imbalance leads to an overwhelming conclusion: there needs to be an interdisciplinary view articulating biopsychology in how ventriculoperitoneal shunts affects a patient's quality of life. Using biopsychology in this research topic gives patients a voice. It allows patients to express problems that cannot necessarily be quantified such as their emotional, cognitive, and social challenges they face daily. Without this voice, no impact of attention is drawn to this serious problem.

Unfortunately, the medical field acknowledges that ventriculoperitoneal shunts need to be updated in response to their subpar mechanical functionality but disregards the impact it has on a patient's quality of life. Furthermore, there has been few advancements to adjust the device for even mechanical reasons. As mentioned in the literature review, Soler and Apigo are the few authors that discussed their current strives to adjust the mechanical format of the device to better respond to physiological issues such as occlusions and flow rate. Many authors in the literature review expound on countless issues involving intracranial pressure, shunt valve's limited adjustments, and ventriculoperitoneal shunt complications regarding the physiology and technology disciplines. Conversely, there is very little research on how the technology affects a patient's quality of life. In fact, there are many case studies like Foltz, Mansoor, and Sacar's where they analyze the medical results, but very few cases like Dhandapani's where the patient's biopsychological information is considered.

Since there is little research in the biopsychological domain, this could be the reason for the lack of proper ventriculoperitoneal shunt advancement. It is possible that this disconnect is that "there is limited data from patients' perspective regarding the impact of shunt devices on quality-of-life" (Mitchell 2021). Many authors from the literature review like Mansoor and Merkler agree that despite natural advancements in the device, there has been no change in revision rates in the past five decades (Mansoor 2021). In turn, Dhandapani's case study shows how the stagnant state of shunt advancement negatively affects children's quality of life via physical, socio-emotional, and cognitive domains (2018). Sources like Reddy also discuss how "surgical complications cause a significant medical and social burden" (Reddy 2013). Overall, the purpose of this research was to affirm that an interdisciplinary approach should be used to help gain a better understanding of ventriculoperitoneal shunts and, more specifically, a patient's low quality of life as well as the topic's need for better technology.

Conclusion

Unfortunately, with how little biopsychology is involved in ventriculoperitoneal shunt research, it has become a noticeable problem. Using the interdisciplinary approach can help expand the three disciplines and help organize their overlap. The biopsychology discipline could be the key in helping create better quality of life for these patients who suffer with hydrocephalus. Humans are more than just their physiology; they experience life through other domains than just the physical. By adding this discipline to the research process, it will make it easier to not only identify quality of life, but also help find a way to increase it in patient's lives.

Additionally, an interdisciplinary approach can also help create better treatment plans for patients with hydrocephalus. The lack of new and better treatment for patients with

hydrocephalus needs to change. By creating better treatment plans, it can push the medical and technology industry to find ways to benefit the patient's health. Treatment plans need to involve biopsychology for the enrichment of the patient's life and help guide the physiological and technological field when doing their research. This discipline integration allows for the opportunity of treatment plans to be personalized for each patient. Biopsychology especially would make it easier to provide a treatment plan that is better fit for the patient using it.

In conjunction with the previous statements, an interdisciplinary approach also can bring awareness to the flaws in a ventriculoperitoneal shunt research topic. It is made clear that there needs to be more technology and medical advancements in this field. Using interdisciplinary methods will first help identify what kind of advancements there are currently. Then, it can integrate research and ideas to create a large platform of knowledge on this subject. And lastly, it can reveal what kind of advancements need to take place. These advancement delineations should be in congruence with not only the technological discipline, but also the physiological discipline and especially the biopsychological discipline to make sure that the advancement will not decrease an individual's quality of life.

Limitations

There are, however, many obstacles in executing an experiment that evaluates how outdated shunts affect a patient's quality of life via complications and revisions; and furthermore, producing a better ventriculoperitoneal shunt for hydrocephalus patients. One of these limitations is resources. The type and availability of resources can cause some limitations on developing a more improved shunt. It is especially important to make sure that the material being used to construct this device does not irritate the patient's body. Making sure the tubing and casing is an

anti-bacterial material is imperative to preventing infections in the cranium as well as the tube tract. Allergic reactions can also take place if the patient is allergic to the type of material used. Silicone and latex, for example, are a few materials that people can be allergic to. Availability of needed resources is also a possible limitation in this category. Material shortages happen everyday and can affect what or how much of a material is available to produce a more advanced shunt. This factor correlates with other limitations such as cost.

Additionally, material cost and research finances can hinder the invention of a better ventriculoperitoneal shunt. The manufacturing of some materials, especially involving technology, can be quite costly. The size and precise detail of the device can cause the price of product to increase. Furthermore, research and experiments involving this device is an expensive undertaking in respect to the duplication of the material and the case studies. There are many moving parts to case studies that require monetary assistance such as equipment, researchers, materials, lab work, etc.

When it comes to case studies, there are other limiting variables in addition to finances. There could be challenges in the collection and analysis of data. In case studies that involve biopsychological applications, some of the collected data can stem from outside factors not involving the shunt. For example, a data collection that includes cognitive, socio-emotional, and physical domain responses can be skewed by other conditions that can affect those domains. There could also be some limitations in follow-up case studies. Long-term case studies involve the interference of time. Based on what happens between the time the initial case study is executed, and the follow-up case study will affect the end analysis. Some information could also be lost in that period.

Recommendations

Although there are some case studies currently at work in resolving some physiological issues the ventriculoperitoneal shunt creates, there needs to be more research done in developing a device that does not affect a patient's quality of life. In congruence to this interdisciplinary study, it would be the author's recommendation that future research be done using an interdisciplinary approach while exercising expansion and organizational methods. It is possible that expanding the scope of what the fields of study discuss could help in introducing new directions on how to construct an optimal ventriculoperitoneal shunt. Allowing the disciplines to overlap can also aid in identifying and interpreting new or existing concepts. The cohesion of these complex fields could then become the foundation for many case studies and result in the production of a highly functional and technologically advanced ventriculoperitoneal shunt or other beneficial treatment plans.

The author recommends conducting a case study that surveys individuals who have a ventriculoperitoneal shunt for their hydrocephalus condition. The survey should disregard gender and race as factors but categorize age into adult and adolescence since there is an age factor in correspondence to an adult's body response verses a child's body response to an implanted foreign material, infection, and physical and mental stress. Identify what the patients believe their quality of life level is regarding having a ventriculoperitoneal shunt. It is imperative for the survey to ask the patients what kind of factors, involving their ventriculoperitoneal shunt, affect their quality of life. Causes can include, but are not limited to, surgery operation, shunt mechanical malfunction, limited shunt settings, shunt breakage, shunt infection, financial

difficulties, emotional hinderances, physical disablements, social challenges, and symptoms (headaches, nausea, blurred vision, dizziness, fatigue, numbness, etc.). It is important to also ask how often each hinderance occurs, if at all. Eliminate bias by randomizing questions and adding questions that do not pertain to the purpose of the survey. It is recommended to use a 200-500 population size to properly imitate the actual population as well as collect an adequate sample study. By following the scientific method, one should repeat the experiment with other patients as well as execute follow-ups. Several sample groups should be tested at the same time to sustain population data accuracy. Additionally, follow-up surveys should use the same volunteers for each following survey as well as have the same format as the previous survey to optimize consistency in the results. Follow-up surveys should also be done in a timely manner. The author recommends doing these follow-up surveys at a six-month, year, three-year, five-year, and ten-year benchmark for consistent data progression. In all, this study's intention is to research and analyze how outdated ventriculoperitoneal shunts affect a patient's quality of life.

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