Epilepsy: Beyond the Brain

by

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Abstract:

This work addresses the diagnoses, treatment, and study of epilepsy critically. The purpose is to propose that the focus on the brain in the biomedical approach to epilepsy is insufficient for treating the epileptic, and for understanding his or her lived experience. To mitigate this problem, biomedical physicians should look beyond pharmaceuticals and biological pathways to find a more encompassing approach to healing as suggested by the lens of medical anthropology. This approach could lead to novel treatments and a more holistic understanding of the body. Which in turn could help mitigate the suffering of the estimated 70 million people with epilepsy 30% - 40% of whom are resistant to drug therapy.

Introduction

Epilepsy in biomedicine is diagnosed, treated, and understood as a disease of the brain. It is defined pathologically as neurons misfiring in the brain causing seizures that affect body (NIH, n.d.). In the same way, a conductor pulls leavers and changes gears to alter a train's movement forward and backward, the brain is assumed to manipulate the body in a unidirectional fashion. In the same way that a train may not directly impact the operator, the silent body does not directly impact or manipulate the brain (and therefore diseases of the brain). If patients or their loved ones report symptoms outside of the brain itself, it is only possible because the brain, misfiring, is abnormally activating these parts of the body through the central nervous system. Because of these facts, a hierarchy of grey and white matter over the body that encapsulates it takes precedence in diagnosing, treating, and studying epilepsy in much of biomedicine.

This view can be limiting. Epilepsy is much more complicated than treating the over (or abnormal) activity of the conductor in a machine. The brain and body work together dynamically which make diseases like epilepsy very complicated to treat. The purpose of this work is to: address how epilepsy is currently being treated in biomedicine[1], examine biomedicine's shortcomings in the treatment of epilepsy, critically explore the theoretical framework that may be limited to traditional biomedical treatment, and suggest how perspectives in medical anthropology and social theory could lend a helping hand in understanding and treating epilepsy. I will also discuss alternative treatments that have had promising results in clinical trials for patients with refractory epilepsy (non-responsive to

[1] I am referring to medicine as biomedicine (medicine based on the application of the principles of the natural sciences and especially biology and biochemistry), (Merriam-Webster, 2017) throughout to clearly address that tradition specifically as opposed to other forms of medicine such as: Chinese medicine, spiritual healing, Ayurveda, etc.

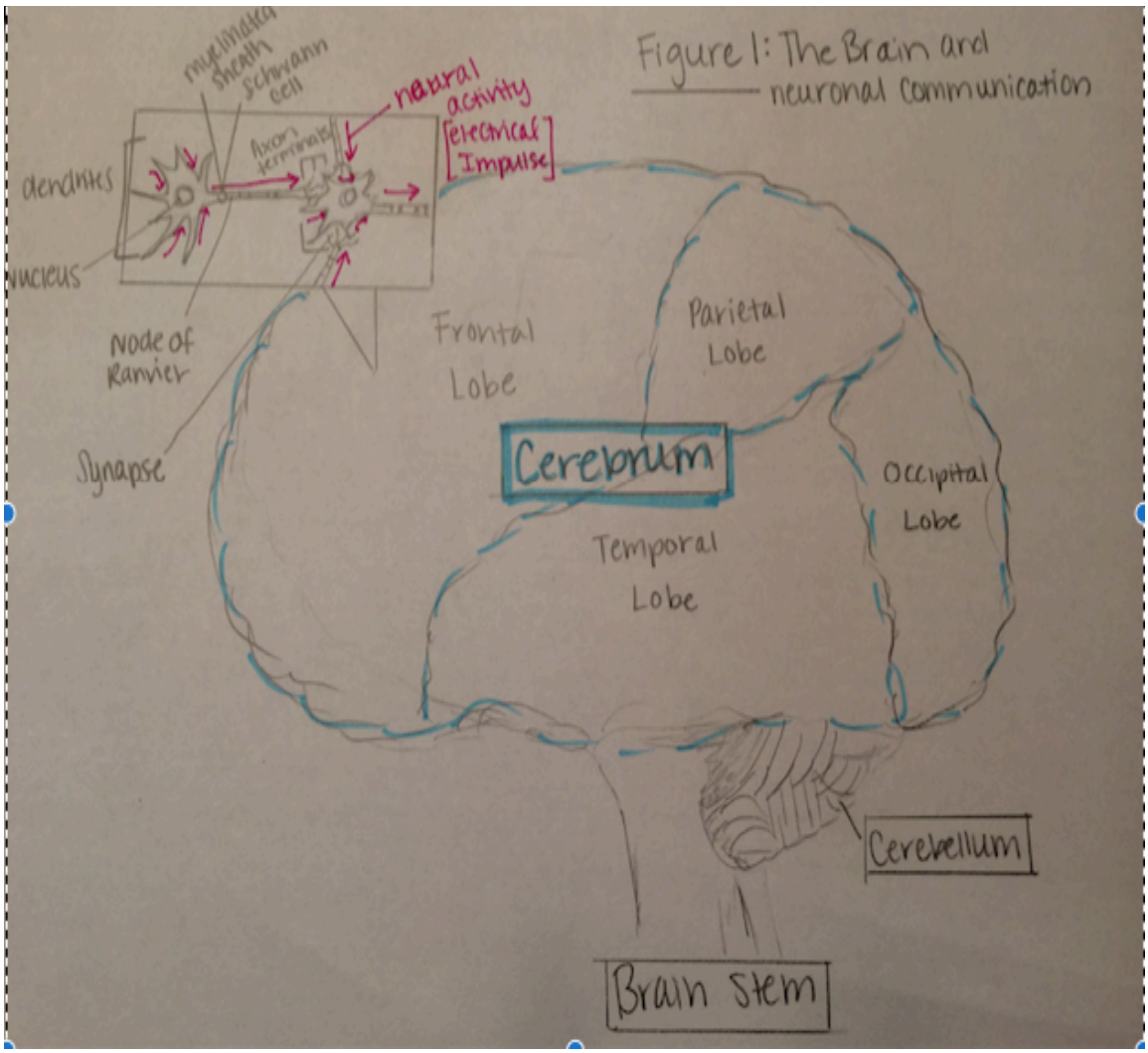
traditional biomedical treatment) that have come into being by patient-led initiatives that look beyond the narrow, dualist mindset of biomedicine.

What is Epilepsy in Biomedicine?

I begin with an overview of epilepsy in biomedicine. Epilepsy is a disease that is characterized by over-activity in the brain, more specifically the cerebrum, leading to seizures. Seizures are typically characterized by sudden jolts of abnormal electrical activity in the brain that cause a change in behavior. Seizures can cause damage to the brain and neuronal death, which can lead to a decline in cognitive or other abilities. The occurrence/extent of damage is dependent on both the frequency and severity of seizures; as well as, the area in the cerebrum that is affected. Having intense seizures frequently can cause damage by continually over-stimulating neurons until they can no longer respond to stimuli appropriately. (Sherwood, 2010)

The cerebrum is the largest region of the human brain. It is responsible for a variety of functions and traits like: sensory perception, language, voluntary control of movement, personality traits, and sophisticated mental events like decision making, creativity, memory, self-consciousness, and thinking (Sherwood, 2010). Figure 1 identifies the location of the cerebrum and electrical impulses between nerve cells (neurons).

Figure 1: The Brain and Neuronal Communication



Nerve cells are specialized cells that conduct electrical impulses to and from other cells (maybe neuronal or not). In order to do this, neurons have developed axons and dendrites to relay information from an incoming to an outgoing neuron. Neurons are influenced by electrical impulses from other cells (action potentials) and neurotransmitters. Neurotransmitters are chemicals that are released at the end of a synapse (gap between the axon of one and the dendrite of another cell), which causes the transfer of the impulse to

another neuron (although not limited to, can transfer to muscle or other cells) (Sherwood, 2010).

Seizures, a surge of communication between neurons (activity between neurons can be over or under excited during a seizure, causing an imbalance in activity leading to a surge of electrical activity in the brain and thus a seizure), are classified into two types, general and partial. A patient experiencing a general seizure will display abnormal firing of neurons across the cerebrum. While during a partial seizure, a patient experiences neuronal hyperactivity in one specific region of the cerebrum (Epilepsy Foundation, 2017). Tables 1 and 2 describe general and partial seizure subtypes and symptoms associated with them.

Table 1: Generalized Seizure Types

Seizure Types	Symptoms
Tonic-Clonic (Grand Mal)	Initiates with limb stiffening (tonic), followed by uncontrollable muscle reaction (clonic) (i.e. limb jerking)
Myoclonic	Very quick twitch in the muscles of the arm or leg (normally only one appendage)
Atonic	Abrupt dropping of the head or falling unexpectedly
Absence	Staring for a few seconds

Table 2: Partial Seizure Types

Seizure Type	Symptoms
Simple Partial	Essentially any movement, sensory, or emotional symptom can occur as part of a partial seizure, including complex visual or auditory hallucinations. However, consciousness is retained.
Complex Partial	Essentially any movement, sensory, or emotional symptom can occur as part of a partial seizure, including complex visual or auditory hallucinations. Loss of consciousness.

How is Epilepsy Diagnosed?

Epilepsy is typically diagnosed with two forms of scans, electroencephalogram (EEG) or magnetic resonance imaging (MRI). EEGs, which are primarily used to diagnose seizure disorders, are performed by reading the output from electrodes placed on the scalp of the patient. An EEG reads postsynaptic potential activity[2] of the dendrites and cell bodies of the cortical layers (the outer layer of the cerebrum) under the reading electrode. These scans are able to detect abnormal activity in the brain. Evidence of seizures, characterized as large

[2] Postsynaptic potentials are changes in the electric polarization of the membrane of the neurons, which can lead to the creation of a new impulse, or electrical signal. In this case, they are happening in the outer layer of the cerebrum under the electrodes (Encyclopædia Britannica, 2008).

groups of neurons undergoing synchronic, yet abnormal, action potentials can be seen on these scans (Sherwood, 2010).

An MRI is a scan that looks at brain structure and functioning. MRIs are performed by placing the patient into a long cylindrical tube between two strong magnets that force all the protons within the area of their body that are being scanned to align with the field. A radiofrequency is then sent to the patient's body. This stimulation allows the once aligned protons to spin, causing a strain on the magnetic field. The radiofrequency is then turned off and the MRI machine is able to read the amount of energy expelled and time taken for protons to try to align back in the field. This reveals clues about abnormalities in bodily tissues, which can indicate damage due to seizures and can help, locate a position of repeat damage (NIH, n.d.).

How Is Epilepsy Treated?

In biomedicine, medication, normally in the form of anticonvulsant (anti-seizure medication), is the first line of treatment for epileptic patients[3] (Schachter, Shafer, & Sirven, 2013). These drugs can be divided into two major groups: EIAED ((liver) enzyme-inducing antiepileptic drugs) and NEIAED (non-enzyme-inducing antiepileptic drugs). The two drug types work differently in the body. EIAED drugs are known to increase a patient's risk of nutrient depletion in the short and long-term while NEIAED drugs are not known to have these effects. Low levels of vitamins and minerals, such as vitamin B6, calcium, sodium, and magnesium, are common in most epilepsy patients and can be worsened by EIAED drugs (Schachter, 2006) (Soltani, Ghaffar Pour, Tafakhori, Sarraf, & Bitarafan 2016). Depletion of

[3] The goal of anticonvulsant drugs is to prevent seizures from happening. The goal then of these drugs is to regulate activity in the brain through four targets: sodium ion channels, calcium channels, the GABA system and receptor agonists, and glutamate receptor agonists (Epilepsy Society, 2017).

B vitamins, zinc, and copper has been well documented in epilepsy patients taking EIAEDs (Fraser, Burneo, & Fraser 2015) (Soltani et al. 2016). Because of the depletion of key nutrients, there is an increased risk of osteoporosis, osteopenia, osteomalacia, rickets, and increased bone fractures (because of the reduced absorption of calcium in the digestive tract). The mechanism by which these medication types work is extremely important to the health and well-being of the patient. These drug pathways can also be affected by nutritional status, and thus affect susceptibility to disease, throughout life (Soltani et al. 2016).

In addition to nutritional stress, epileptic patients treated with medications face, at times, unacceptable side effects. While it is noted that different patients experience medication side effects differently; for example, some may be bothered more by stomach upset than a headache while others are more troubled by a headache than stomach pain. However, some side effects from anticonvulsant or anti-seizure medications are debilitating and can interfere with the patient's independence and quality of life. For example, suicidal ideation, inability to drive, somnolence (drowsiness), hyperthermia, psychomotor slowing, and metabolic acidosis are possible side effects of many anticonvulsant drugs. There is also an added layer of difficulty when the patient is female and of childbearing years. There are risks of congenital malformations, cleft lip and/or palate, and neural tube defects in unborn children, which may be intolerable to the patient because of the risk of the life and well being of their unborn children. The decision about which medication to take is therefore not only impacting the patient but their families on a biological level. Table 3 is a brief list of anticonvulsant medications used to treat epilepsy, their class (EIAED, or NEIAD), which seizure types they treat, and some of the side effects experienced. All drug names listed are common, not brand names of the molecule (Carl, Weaver, Tweed, and Edgerton, 2008)

(FDA, 2009) (FDA, 2009) (FDA, 2009) (FDA, 2013) (FDA, 2013) (Novartis & FDA, 2009) (Drugs.com & FDA, 2017), (Novartis & FDA, 2009) (Daily Med, & NIH, 2014) (FDA, 2009) (Sirven & Shafer, 2014).

Table 3: Anticonvulsant Drugs

Class	Drug	Seizure Type(s)	Side Effects
EIAED	Carbamazepine	Generalized Seizures, Partial Seizures, and Tonic-Clonic Seizures.	Increased Suicidal Thoughts, Toxic Epidermal Necrolysis (TEN), Stevens-Johnson Syndrome, Aplastic Anemia, Agranulocytosis, and Congenital Malformations in Pregnancy.
EIAED	Phenobarbital	Lennox-Gastaut Syndrome (LGS), Rasmussen's Syndrome, Temporal Lobe Epilepsy, Clonic Seizures, Complex Partial Seizures, Refractory Seizures,	Respiratory Depression, Apnea, Circulatory Collapse, Nausea, Vomiting, and Headache.

		Secondarily Generalized Seizures, Simple Partial Seizures, Tonic Seizures, and Tonic-Clonic Seizures.	
EIAED	Pregabalin	Partial Seizures	Increased Suicidal Thoughts, Dizziness, Blurry Vision, Weight Gain, Somnolence, Cognitive Impairment, Swelling of Hands and Feet, and Dry Mouth.
EIAED	Topiramate	Tonic-Clonic Seizures, and (LGS).	Increased Suicidal Thought, Glaucoma, Oligohidrosis, Hyperthermia, Metabolic acidosis, Cognitive Dysfunction, Cleft Lip and/or Palate during Pregnancy, Kidney stones, and Hypothermia.
NEIAED	Valproic Acid	Complex Partial, Simple and	Increased Suicidal Thoughts. Congenital Malformations, Neural Tube Defects in

		Complex Absence Seizures.	pregnancy, Increased risk of Hypothermia, and Thrombocytopenia.
NEIAED	Gabapentin	Partial Seizures	Increased Suicidal Thoughts, Dizziness, Somnolence, Hyperactivity (children), Headache, Increased Rate of Viral Infection, Fever, Nausea and/or Vomiting, Abdominal Pain, Diarrhea, Convulsions, Confusion, Insomnia, Rash, and Acne.
NEIAED	Levetiracetam	Partial Onset, Myoclonic, and Primary Generalized Tonic-Clonic Seizures.	Increased Suicidal Thoughts, Coordination Difficulties, Behavioral Abnormalities, and Somnolence.
NEIAED	Zonisamide	Refractory Partial Onset Seizures	Increased Suicidal Thoughts, Psychomotor Slowing, Metabolic Acidosis, Somnolence, As well as, cardiovascular defects, and embryo-fetal deaths during pregnancy.

While drugs are the common medical practice of epilepsy treatment, 30%-40% of the 70 million people with epilepsy are resistant to drug therapy (Wu, Zhang, Yang, Roa, Miao, & Lu, 2016). Until recently, there were few other options available. Surgery is sometimes used in patients who are unresponsive to drug therapy. The aims of these procedures are to remove the lesions and seizure-prone areas with the goal of ending seizure activity. The area and extent of the procedure depend on the patient's seizure type and the damage done by previous seizure activity (Cosgrove & Cole, 2005). Nerve stimulation therapy, which involves electronic stimulation of the vagus nerve[4], is an experimental procedure that may prove to be an alternative to brain lesioning when the patient is unresponsive or cannot tolerate the medication. This therapy involves surgery to implant a device to help regulate electrical activity in the brain through controlled and timed electrical impulses. A few clinical trials have demonstrated in a reduction in seizure number and severity of seizures in patients implanted with these devices. Unfortunately, both alternatives are best known for treating partial seizures (Molina Healthcare 2014). This leaves little help for those who have generalized seizures that are not controlled well-using medication.

Biomedical Shortcomings

Biomedical treatment can be ineffective in treating seizures when the patient is unresponsive to drug therapy. According to the Epilepsy Foundation, only 47% of patients become seizure free with the first medication, with a second drug an additional 14% of patients become seizure free. If a patient does not become seizure free after the addition of two drugs their likelihood of accomplishing seizure control is greatly diminished (Schachter,

[4] The vagus nerve is the most complex and longest of the cranial nerves. It runs through the brain, through the face and thorax to the abdomen (Encyclopædia Britannica, 2015).

Shafer, & Sirven, 2013). At times, biomedical professionals seem oblivious to these limitations. However, there are many cases where biomedical treatments are not enough. This can be tragic when treating refractory epilepsy, as Anne Fadiman described famously in her book, *The Spirit Catches You And You Fall Down*.

In this book, Anne Fadiman recounts the story of Lia Lee, a young girl who is epileptic[5]. Lia's family are refugees from Laos who came to America. However, Lia was born in the United States and began suffering from seizures when she was 3 months old. She was brought to Merced Community Medical Center (MCMC) in Merced, California. Upon their first encounter with the healthcare providers at MCMC, none of Lia's family was able to speak English and no translator was available. By the time Lia had arrived at the hospital and was seen by a physician her seizure had subsided and she was only running a fever and presented with cold symptoms. The resident on call prescribed antibiotics and sent the Lees home. Lia continued to have severe seizures and was eventually placed under the care of Drs. Peggy Philp and Neil Ernest, two of the best, highly regarded physicians at MCMC[6]. After many trips to the hospital, prescription combinations, meetings with social workers, Dr. Philp and Dr. Ernest felt that Lia's family were improperly caring for her and felt that it was in Lia's best interest that she be placed with a foster family that was both willing and able to care for her "properly" (Fadiman, 1998).

There are undertones of racism and elitism from some doctors at MCMC. Saying that they needed to teach the Hmong community a lesson and that they were ignorant to the needs of their children. Dr. Neil Ernest stated: "…I felt that there was a lesson that needed to be

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[5] *The Spirit Catches You and You Fall Down* by Fadiman is a famous novel that brought shortcomings in biomedical epileptic treatment into the public eye.

[6] Lia was later diagnosed with Lennox-Gastaut Syndrome (LGS) and suffered many Grand Mal Seizures in the course of her early childhood (Fadiman, 1998).

learned. I don't know if this is a bigoted statement, but I am going to say it anyway. I felt it was important for these Hmong to understand that there were certain elements of medicine that we understood better than they did and that there were certain rules that they had to follow with their kids' lives. I wanted the word to get out in the community that if they deviated from that, it was not acceptable behavior." (pg. 79). The author does not directly address this but the undertones and quotes she gives illuminate elitism of the biomedical system at this hospital among Hmong refugees (Fadiman, 1998).

Lia was placed on a better medication schedule with her foster family and because of this; it's thought that some of her seizures were prevented. However, under foster care, Lia was hospitalized four times because of her seizures, this is more than she had had with her parents. The emotional toll that was placed on Lia and her family nearly killed her parents and put her at a higher emotional stress which caused more seizures, even with a better medication schedule. Lia was eventually placed back into the care of her family under strict monitoring by doctors and social workers from MCMC. At the age of 4, Lia went into status epilepticus, meaning she seized for a long time without stopping or without much of a break between seizures. Lia seized for nearly 2 hours straight, normally any tonic-clonic seizure lasting longer than 5 min, having more than one seizure in 30-minutes, or having a second seizure before regaining consciousness from the first is considered status epilepticus (Schachter, Shafer, Sirven, 2013). Medications were not able to stop her from seizing she then fell into a coma and eventually awoke having lost higher level cognitive functioning. Her massive seizure had permanently damaged much of her brain and Lia's biomedical caregivers predicted her death to be imminent. It is suspected by Dr. Hutchison, the pediatric neurologist at Valley Children's Hospital that cared for Lia during her time there, that her

brain was destroyed by septic shock, which caused her status epilepticus event, not vice versa. Lia presented a high amount of *Pseudomonas aerguginosa* bacillus in her blood which, had she not had seizures, would have produced a coma and shock, leading to the same outcome, regardless of her seizure disorder. The drug she was taking Depakene, is known to lower the patient's immune system and may have contributed to the infection. Dr. Hutchison tells the author: "Go back to Merced, and tell the people at MCMC that the family didn't do this to the kid. We did." After much negotiation, Lia was allowed to go home and "die" with her family. To the surprise of many, Lia's parents were able to care for her better than anyone could have imagined and kept her alive and healthy until the age of 30 (Los Angeles Times, 2012) (Fadiman, 1998).

Struggles between the biomedical community and the Lees, began when Dr. Ernest and Dr. Philp prescribed a multitude of anticonvulsant medications to Lia (which her parents did not administer precisely). The idea that medication should be given continually had not been the Lee's experience with biomedicine (vaccines and antibiotics in refugee camps and the U.S. were their initial exposure to biomedicine). Foua Yang and Nao Kao Lee interpreted Lia's condition differently than her doctors. Lia's parents, on the other hand, did believe that they cared for their daughter in the best way that they could have. Foua Yang and Nao Kao Lee were able to keep their daughter alive and amazingly healthy for 26 years after her status ecliptics event, which left her unable to do higher cognitive tasks. Lia's parents believed that the medication that the doctors gave Lia were too strong and were making her sicker (side effects and her continuing to have seizures with the medications). Her parents also had a very different understanding of Lia's illness and the reasons as to why she had gotten so sick. In Foua Yang and Nao Kao Lees background, epilepsy is created

when a dab (malevolent spirit) captures one's soul and makes someone sick. Children are especially prone to this because their souls are not firmly rooted yet and can be taken easily. This is what the Lees believe initially caused Lia's seizures[7]. They also believed that she went into a coma and lost a lot of her mental functioning because the medication that the doctors prescribed Lia was too strong. They blamed Dr. Ernest and Dr. Philp because they were out of town when Lia went into status epilepticus and when she was transferred to another hospital, which in their eyes was not as skilled as they had been at stopping Lia's seizures (Fadiman, 1998).

Lia's story is a tragedy of cultural miscommunication. It is clear that cultural diversity and variation between a patient and their caregiver adds another level to the complexity that a certain disease can possess. Lia and her lived experience being both an epileptic patient and an immigrant (although born into the U.S. biomedical system her families decisions were based on their lived experiences with biomedicine and epilepsy in Laos) to the biomedical system is not a rarity. In 2014, there were 42.4 million immigrants, the highest in the history of the United States, comprising 13.3% of the total U.S. population, the highest percentage in almost 100 years. From 2010 to 2014, new immigrants (and births of children to immigrant parents) increased the number of American residents by 8.3 million, equaling 87% of the total U.S. population growth (Camarota & Zeigler, 2016).

Many of these people immigrating to the U.S. are not from countries or communities that use exclusively or even mostly biomedical treatments, yet there is a great need for caring for these patients. It is not outrageous to think that biomedicine may be limited in its

[7] In Shamanistic Hmong culture, someone who has epilepsy often becomes a Shaman later in life because it is believed that they, because of their seizures, are better able to access the spirit world during their "trance/seizure" than others (Fadiman, 1998).

philosophical background and, because of this Achilles heel, is sometimes unable to care for both patients who are privileged enough to have been exposed to biomedicine as their primary form of healing and those who have not (which we are seeing to be a larger and larger percentage of the U.S. population).

In recent history biomedicine has been the dominating force of healing in much of the world. As European Countries, and later The United States, dominated other countries economically or politically, they incorporated biomedicine as the only acceptable form of healing, which lead to biomedicine's global presence and power today (Wiseman, 2004). As biomedicine continues to be a major colonial force in the world, caring for millions if not billions of patients it has a responsibility to address these limitations and work towards creating a better system that is flexible enough to address the multiplicity of a disease such as epilepsy that affects so many individuals.

Addressing the multiplicity of lived experiences of people affected by epilepsy is crucial. My purpose is to also assess/suggest how medical professionals can better care for epileptic patients, particularly with backgrounds differing from their own and whose bodies have experience disease differently. Epilepsy is a chronic illness. According to the World Health Organization, chronic disease accounts for 60% of the deaths in 2005 (World Health Organization, 2017). With epilepsy being the fourth most common chronic disease in the world, it is easy to assume that physicians practicing both inside and outside of the U.S. will come into contact with epileptics in their career regardless of specialty (National Centers for Biotechnology Information (NCBI), 2012). Because there is a high epileptic patient load throughout the world and because biomedicine is the dominant form of medicine,

understanding how this disease exists in its multiplicity is key to providing the best treatment possible.

A disease does not merely exist in a one-size-fits-all way for every patient in every situation. It exists inside of the person that is experiencing it, who can perceive and experience disease differently than another. This complexity expands greatly when variation in lived experience and patient background are taken into consideration. Therefore, the treatment of epilepsy cannot be standardized and expected to be successful for every individual. In order to properly care for patients we must take epilepsy in the multiplicity that it is within a diverse human population.

Healing begins when both parties are able to understand each other. Although we may never be an expert on another's culture or fully understand another person's lived experience we can still try our best to learn and to build the most important bond between physicians and patient, trust. Without trust, a cooperative and meaningful relationship cannot be formed.

While cultural competency, prejudice, lack of understanding/empathy played a role in Lia's case it does not change the fact that epilepsy, especially refractory Lennox- Gastaut syndrome is extremely difficult to treat and can be deadly even when a patient receives "proper care" (Autry, Trevathan, Van Naarden Braun, & Yeargin-Allsopp, 2010). It is clear that in addition to the tragic cultural miscommunication lessons from *The Spirit Catches You And You Fall Down* that new treatments for refractory epilepsy are greatly needed. *The Spirit Catches You and You Fall Down* helps reframe the questions about how we better care for refractory epilepsy patients. Fortunately there have been new advancements in the treatment of epilepsy, which are proving successful (like CBD oil, ketogenic and other diets,

and connections with the many diseases, including epilepsy with modifications in the gut flora) that may have greatly helped Lia and may have prevented her tragic outcome (Schmachtenberger, 2011) (The Charlie Foundation For Ketogenic Therapies, 2017) (Wu et al., 2016). These new treatments emerged outside of biomedicine and have been pursued by patients searching answers; these treatments exemplify the benefit of searching beyond mind-body dualism and support my argument that epilepsy dose indeed exist beyond the brain.

Beyond Mind Body Dualism

Curing patients is so much more than just finding a drug that treats the lesion or the affected physiological pathway. The body is far more complex. It is not consistent, or statistically predictable. It is not a machine. We are both impacted and an active participant in our world. We are fluid. Human beings have tried to control and predict nature since the advent of modernity, in order to understand, or "fix" the world around us. This is true in many fields but is best exemplified by biomedicine. What can medical anthropology offer? First, it can help us think through the theoretical assumptions of biomedicine and offer suggestions that go beyond its narrow theoretical framework.

René Descartes (1596-1650) formulated a mind-body dualism at the heart of his philosophical work, arguing that the mind and the body are two distinct, separate entities; that the mind is who the person actually is and the body is the machine that unquestioningly reacts to the mind's commands. There is no mutual communication or interplay/feedback between these two entities, no collaboration. Cartesian mind-body dualism has spread into modern philosophy, medicine, education systems, and other bodies of knowledge (Skirry, n.d.)(Grosz, 1994).

There are many problems with Cartesian dualism in the medical field. One is that medical professionals and scholars assume that science is immune to the prejudices of culture, history, or societal pressures. But, an examination of ones history will reveal that science has changed through time with the culture it is embedded in, not necessarily by learned facts of research (for example, homosexuality being a mental disorder in the Diagnostic and Statistic Manual For Mental Disorders (DSM) II (American Psychiatric Association, 1968)) (Gordon, 1988). Today the scientific community does not consider homosexuality pathological. This example clearly demonstrates the impact that a culture can have on what is deemed pathological or what a disease is. Science is not immune to the culture or history that it inhabits which can greatly impact the quality of care that can be provided by biomedicine within its own cultural boundaries.

It is common practice for biomedical physicians to keep these two pieces separate; to treat the body with drugs and or procedures and leave the other aspects of what makes this patient an individual separate, to standardize. What does it mean to heal a human being? It must be more than sterile double-blind studies. It must consider the person as a whole. This responsibility cannot be taken lightly. Healing is not something that can happen quickly in an examination room. It is a relationship that involves trust between both participants.

In order for there to be trust, both parties must believe that the other is within the same plane as the other, equals, both striving toward a common goal. Trust however is not the only problem for delivering adequate care. The ownership of power and knowledge between the patient and the physician is a problem in biomedicine. The oversimplification that Descartes offers about the relationship of the mind to the body created by Cartesian dualism has presented medicine a problem concerning their own narrative of progress. It

also creates an oversimplification of relationships between the physician and patient, leaving total power in the hands of the "logical" biomedical practitioner and little to none in the hands of the "superstitious" "untrained" patient. Both have experience and knowledge, however, due to Cartesian dualism, these ways of knowing and understanding disease are not understood as compatible or comparable. This philosophy has prevented many from treating the entire person as one entity that is affected by their environment (social, culture, physical, etc.), of which they are impacted and can impact. How might we then treat a person and not a body? We must break from dualism.

Anne Fadiman: *The Spirit Catches You and You Fall Down* directly addresses the idea of control within biomedicine. It is important in western medicine to control the care of the patient. Patients who do not get well initially are difficult. Lia Lee was a difficult patient; she had refractory epilepsy whose seizures were not well controlled with pharmaceuticals. When patients are difficult, more and more treatments must be given that are not otherwise used because of their strength, side effects, etc. Lia was on many medications whose side effects negatively impacted her behaviorally. The final anticonvulsant Lia took was Depakene, which weakened her immune system and contributed a serious infection of a common pathogen that caused her final seizure. When physicians prescribe such treatments, they are healing the patient to the best of their knowledge but this lends itself to frustration between the patients, caregiver, and the physician for the wellbeing of the person. An imbalance of power then arises between parents/caregivers and the greater healthcare system. One consequence of mind-body dualism is the belief that doctors have total knowledge and patients are entirely without any experience in their own bodies. The side effects that Lia's family saw with her medications concerned them, therefore they did

not continue to give her these medications multiple times a day. They were concerned with her personality changes and thought that these medications were making her sick. This is not far from the truth. Lia's final seizure can be attributed to an anticonvulsant medication. Her final seizure event was created by an infection in the body. Therefore, the assumption that seizures are only caused by electrical misfiring's in the brain and are not impacted by the body is false. Epilepsy is far more complicated than mind body dualism can account for.

Mind body dualism and the assumption of total knowledge in the hands of biomedicine leads to the empowerment of doctors and their institutions over patients; this is the tragedy of ... *First Do No Harm.* This film is a compilation of many different patient experiences, but is mostly based off of the lived experience of Jim Abrahams who helped create this film after his son, Charlie, was diagnosed with refractory epilepsy. ... *First Do No Harm* recounts a very similar experience as that of Lia Lee in *The Spirit Catches You and You Fall Down*. In ...*First Do No Harm* the doctors had done all that they knew to do to treat a child with severe refractory epilepsy except an invasive surgery that would remove portions of the brain that they feared were the cause of the child's seizures. The parents feared that this could kill their child and decided to send him to Johns Hopkins to try the ketogenic diet, which the parents had read about from older medical journal publications. The hospital almost took away the parent's custody of their child because they tried to leave, albeit in a dangerous way. The possibility for epilepsy to be treated with a diet seemed absurd to the biomedical practitioners and, to the doctors, made the parents seem irresponsible and foolish. However, in the film, it was clear that using dietary therapy was the most effective treatment for the child as it had been for Charlie. Adding an additional layer of complexity in the treatment and understanding of epilepsy.

In the greater biomedical system, the hospitals, doctors, nurses, are the rational mind (Beckett & Abrahams, 1997). Parents are an extension of the patient, in the doctor's view, irrationally reacting to the condition of the patient's body. Again, the separation between these two entities mirrors Descartes mind-body dualism. One of these agencies is considered the logical authority and the other is irrational, animal-like, and impulsive, even though both want the best for the patient and are using their best judgment to make that decision.

Because of the binary created by western philosophy, parents (especially those who are not embedded into western thought, like many Hmong patients and Lia's family in *The Spirit Catches You and You Fall Down)* are stripped of all authority for their child's care. And, due to cultural standards, they are bad parents for questioning the "all knowing" medical system. The medical system is correct and is the only entity capable of healing. Holding all control defuses the ability for family members to contribute to the wellbeing of the patient (Fadiman, 1998). The great lessons from ...*First Do No Harm* are that the loss of power happened to a family who lives in and belongs to the culture of western medicine. Another fascinating lesson is that the most effective treatment for the patient was dietary therapy (Beckett & Abrahams, 1997). The ketogenic diet was not considered to be a legitimate therapy by the biomedical community at that time because the diet targeted the gut and not the brain; completely transcending mind body dualism.

In a scientific and analytical perspective, the environment (social, physical, etc.) impacts all creatures, both biologically and psychologically. Why then are human beings different? We are impacted by simple physical constraints on our environment and social rankings like other living beings. Therefore, why is it so far-fetched to believe that a person's

mind, social system, biological/physiological background, and culture impact the foundation of who we are and our health?

Gilles Deleuze, an extremely influential French philosopher, is most well known for his works on the history of philosophy and the arts. He considered himself a "pure metaphysician" meaning that he was most interested in fundamental questions like, the concepts of reality and existence (Smith & Protevi, 2015). In *Spinoza: Practical Philosophy* Deleuze urges us to think like Spinoza[8], to be all part of a plane of immanence[9], to think across boundaries, beyond essentialism. He invites us into an anthropological perspective to examine other perspectives of the body. We impact and are impacted by each other (Deleuze, 1970). It is known in molecular biology that chromosomes begin to fray in children who have been abused, versus staying tightly coiled in children who haven't (Nemeroff, 2016). That stress can weaken our immune system (American Psychiatric Association, 2006), and that patients with a mental health disorder are at a higher risk for developing a physical one and vice versa (Canadian Mental Health Association, n.d.). Our minds, our culture, and our environment must then greatly impact our biology. We are not static beings who exist in a linear, one-dimensional one-size-fits-all way, we impact and are impacted in a multitude of ways. Therefore, as physicians, who have been charged with healing people, we must address the multiple in which humans and their bodies exist, when assessing health.

Mind-body dualism seems so long ago. It seems that this philosophical understanding of the world and our bodies as separate entities would have been more critically examined and rejected in modern medicine. Yet, like a golden calf we, as the

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[8] Spinoza (1632-1677) was also a metaphysicist who focused much of his work in epistemology and religion (Nadler, 2016).

[9] Deleuze discusses a plane of immanence as a field where all things (i.e. humans, society, nature, God/higher power, ect.) exist in the same plane. Where we all impact and are impacted by each other, inseparable and interconnected (Deleuze, 1970).

medical field, have followed it. The body and the human being are the very same, and inner connection with each other in ways that we, western medicine, still do not understand. An example of this, that I will discuss later, is the brain-gut connection. Researchers are now suspecting that gut microbes could play a role in depression, anxiety, autism, epilepsy and many other illnesses. Having the right balance of microbiota greatly impacts health and digestion, as much of our immune system is housed in our gut. The gut and brain are also in constant direct communication through the brain-gut axis (Sharon, Sampson, Geschwind, & Mazmanian, 2016). This is a clear and direct example that our body is both impacted by our environment and our biology. The human body is immensely complex and we may never fully understand all of its inner workings. But, to say that our bodies, minds, and environments do not affect health is narrow-minded and foolish. Science and nature are vaster than we currently understand.

The purpose of this work is to propose that the narrow-minded focus on the brain that dominates the biomedical understanding of epilepsy is insufficient for treating the epileptic and for understanding his or her lived experience. To mitigate this problem, biomedical physicians should look beyond pharmaceuticals and narrowly defined biological pathways to find true healing (as many patients already have) through the lens of medical anthropology and alternative therapies.

The incredible thing about the power that biomedicine has is that when it realizes its own shortcomings it has a tremendous ability to organize and to effect change. Like other regimes of knowledge, it is both impacted by and can impact change in the culture and social structures of what it is around (Foucault, 1979).

Philosophy and Medical Anthropology: Mol, Foucault, and Latour

The Body Multiple by Annemarie Mol will be the focus of the theoretical section of this work; she is able to help us move beyond the brain only model of epilepsy. Her contribution is important because she has a background both in philosophy and medicine, which she uses to re-think the nature of disease as understood within biomedicine from both backgrounds (Mol, 2002).

The Body Multiple builds upon a framework of many philosophers, but the two that I would like to focus on are Michel Foucault and Bruno Latour. Briefly, Foucault examines the emergence of a system of knowledge and regimes of power in many fields. Such as medicine (*The Birth of The Clinic*), disciplinary systems (*Discipline and Punish*), and sexuality (*The History of Sexuality*). In *Discipline and Punish* Foucault explores the transformation in penal systems that occurred between classical era physical public punishments to modern techniques of control and discipline. Foucault address paradigm shifts in bodies of knowledge and how knowledge is then produced. He rejects the progressivist Enlightenment view that modern society gradually approaches total truth. Power is not a repressive force but a constructive one. Power does not originate from the state but circulates in the "capillaries of power", through institutions and practices. Each society operates within a regime of truth and the body exists within a regime of power (Foucault, 1975).

Bruno Latour is a French anthropologist, sociologist, and philosopher. Much of his work focuses on science and technology in society. Latour breaks away from positivism, scientific inquiry as an asocial and rational process, and disproves the idea that science is immune to culture or history (Tesch, 2015). "Whatever they do, Westerners bring history

along with them in the hills of their caravels and their gunboats, in the cylinders of their telescopes and the pistons of their immunizing syringes. They bear this white man's burden sometimes as an exalting challenge, sometimes as a tragedy, but always a destiny." (Latour, 1993, p. 97). It seems that biomedicine has taken upon its self the job of colonizing the non-biomedical world. In its own right, biomedicine has taken up the "white man's burden" of educating and dominating medical practice in all of the western and non-western worlds through medical colonialism. Forms of knowledge that are not "based on double-blind studies" are abandoned and discredited. Much the same way that social science is seen as less rigorous than natural sciences and native or "alternative medicines" are discredited by biomedicine. These divides come from the dualistic thought that penetrates many areas of western philosophy, especially medicine. According to Latour, we assume that there is an "us"- the modern, intelligent, agnostic, rational, individual, and then there is "them" - primitive, naïve, religious, superstitious, communities. Latour attempts to show that all societies, all people live and think in similar ways.

The philosopher Bruno Latour focused similarly on the construction of knowledge to power. In *We Have Never Been Modern*, he wrote about the divide that western philosophy creates between, modern and primitive, physical and social science, Nature (Truth) and Social (Culture). Latour also claims that modernity and believing in one correct understanding of Nature reinforces power. Nature is described as being something that is outside of society and culture. These understandings lead to certain assumptions about the human body and disease. Because of the First Great Divide (Nature and Society), a Second Great Divide is created (Us, and Them). Leaving total knowledge and power with "Us" in the western world and "Them" as the rest (Latour, 1993).

Annemarie Mol takes the work done by both Foucault and Latour and applies them practically to medicine. Her work is particularly relevant to this project. She begins by introducing "hospital Z", a university hospital in a medium-sized town in the Netherlands, and the problem of atherosclerosis. She hopes to examine the hospital, patients, and illness not epistemologically, as a question of knowledge, but ontologically, as a question of being. How "knowledge and styles of knowing are handled inside present-day allopathic medicine." She argues that inside a hospital in western medicine there are multiple ways of knowing. There are pathologists who stain, cut, and empirically determine disease once a patient is dead. There are clinicians who interpret information presented by the patient and judges courses of action. There are surgeons who decide which veins are worth using for bypasses or how an artery should be opened (through inserting a balloon or scrapping lumen). There are technicians who measure arterial pressures of the patient through a doppler or an angiogram. Although the clinician, surgeon, pathologist, technician, etc. may share a single diagnosis their ways of understanding and working with atherosclerosis differ. They "enact" a different condition. One sees a patient in pain who has difficulty walking, the other sees clogged arteries in need of bypassing or cleansing, the other sees calcification on a slide. These realities can coincide but they do not always. One could see a patient suffering greatly and show no blockage of blood flow in the vessels using a doppler or angiogram. The other could see a patient who passed away, not complaining of leg pain, and find almost complete calcification of her vessels across her body upon autopsy. Therefore the truth of a disease is that it is multiple, not a singular. Mol states that we cannot continue to separate disease and illness, just as we cannot separate the clinic and technical (and other) perspectives. (Disease has been defined in the past through medicine as the physical pathology experienced by the

body and illness was described through the social sciences as encompassing patient experience into the narrative.) We must be aware of the great complexity of what medicine and medical treatment are (Mol, 2002).

Mol's *The Body Multiple* is a great launching point for addressing the complexity of epilepsy and suggests how other forms of medicine and treatment could help accommodate and treat this disease. If we are freed to move beyond the confines of an over-simplistic dichotomy, we may increase the positive impact and mitigate suffering experienced by many who are unresponsive to "conventional" biomedical treatment or who could benefit immensely (emotionally, physically, financially, spiritually, etc.) from a medical system can better care for diversity of their lived experience and the multiplicity that is human.

To be clear, I am not trying to discredit the work of biomedicine or depict health care professionals as puppets of a system who do not genuinely care about their patient's well-being. I am simply pointing out the philosophical framework for this medical system that constrains our approaches to treatment. In this work, I hope to suggest that by using the ideas of Latour, Foucault, and Mol that we could better care for patients, especially those suffering from a wide spread and difficult to treat disease such as epilepsy.

Mol to Epilepsy

Annemarie Mol argues that a disease is a multiplicity. It is experienced and exists in a multiplicity. Therefore disease is experienced differently depending on the situation and particular patient at hand. An epileptic patient and his/her seizures are perceived different by the general practitioner, neurologist, clinician, emergency room physician, an MRI technician, an EEG machine operator, or a surgeon. In each of these settings, epilepsy is

slightly different. In the general practitioner's office, the patient comes in with symptoms of seizures initially, or maybe not even that. Perhaps the patient and their loved ones enter saying the patient has been falling lately, has times where they seem absent, or has even presented symptoms of a grand mal seizure. Later, the patient is usually diagnosed (through lab tests) with one (or more) of the many types of seizure disorders and sent to a neurologist. To a neurologist, the same symptoms presented to the general practitioner are tested further and the patient's symptoms are usually permanently managed throughout the patient's life. There are many types of seizures and epileptic disorders that all present differently, some can be experienced fatally. In an emergency situation, an epileptic patient can be in grave danger. The patient requires oxygen, sedatives, and anti-consultants, among other medications until the seizure stops. Epilepsy in an emergency sense can be extremely dangerous and the disease is often a matter of life and death.

In the MRI, or EEG reading rooms epilepsy is read as abnormalities in brain waves or electrical activity in the brain (Sherwood, 2010). These abnormalities can help better identify locations of the brain that are seizing or damaged. In some cases, epileptic patients undergo surgery to remove the lesioned segment of their brain that is causing them to have seizures or that has been destroyed by seizures. In this case, epilepsy is a "sick" or "damaged" part of the brain that, like cancer should be pruned away.

In each of the cases above, from the symptoms described in a clinic, to a life or death disaster, or abnormal image, or finally a lesion is all the ways that epilepsy is described. But, even these fail to account for the complexity that this disease is experienced by the patient and their loved ones. Many patients experience problems with their treatments (adverse drug reactions or are unresponsive to conventional treatment). There are many different forms of

epilepsy even within biomedical framing, including: generalized seizures (affecting multiple sections of the brain) such as tonic-clonic (grand mal), myoclonic, atonic, and absence seizures; as well as, partial seizures that include simple and complex seizures (Epilepsy Foundation 2017). These categories, although they help us name and understand some of this disease they are not all-inclusive. There are many patients who fall through these cracks who have multiple seizure types and who are not responsive to traditional drug therapies.

The patients and their families often undergo a large financial burden paying for medical care. It is stressful for a family to care for a sick member and be available to care for all of its other members properly. Epileptic patients and their families also face social isolation, which puts them at higher risk of developing mental health disorders like anxiety and depression. These disorders can only compound the frustration and difficulty for people with this disease who are trying to find support and belonging to people who do not have epilepsy. As a family member or caregiver of someone with epilepsy, it is difficult to watch someone you love in pain. It is difficult to help them when you are unsure how and it is extremely difficult to not be able to connect with them when they are in pain or be able to sympathize with them unless you yourself have undergone the hardships of an epileptic.

It is an understatement to say that epilepsy is a disease experienced in a multitude of ways. What has been discussed thus far, also only accounts for epileptic treatment and modes of being that exists inside biomedicine? There are other medical traditions that examine and treat this disease quite differently. Therefore, as the disease exists in a multiplicity, therefore so should its treatment. Pretending that a one-size fits all or even one-size fits most ways of treating epileptic patients will lead to failures and more tragedies, especially when, as the dominant form of medicine, biomedicine cares for more patients than

any other tradition. Caring for patients all over the world, with backgrounds differing from their own, creates a multiplicity of disease in biomedicine into an exponential nightmare quickly. How do we then deal with this problem? How do we deal with so many variables? Or better yet, how can we account for this dynamic experience that is the human epileptic experience? Awareness of other medical traditions and the limitations of our own is definitely where we should begin. A multiplicity of treatment and awareness of individual patient experience is the only way that we, as a biomedical system, can better care for suffering patients.

Promising New Treatments for Epilepsy

In reaction to drug intolerance and out of sheer desperation, many have taken alternative routes for the health and well being of the patient. Because of this, many alternative treatments for epilepsy have become popular and patients have pushed for new therapies and alternatives. Some of these treatments include, but are not limited to, are: ketogenic, MCT (medium chain triglycerides), and modified Atkins diets (The Charlie Foundation for Ketogenic Therapies, 2017), and CBD (cannabidiol) oil (Schmachtenberger, 2011). These new treatments, which have shown promise and less extreme side effects where pharmaceuticals have failed, are crucial to re-evaluating epilepsy as both a disease and its treatment.

To begin, I will introduce the theoretical framework that eventually paved the way for the ketogenic diet. The ketogenic diet evolved from ancient Greek medicine, which understood epilepsy as a disease that was not simply confined to the brain.

Ancient Greeks

Broadly, ancient Greeks (500 B.C.E.-300 B.C.E) understood illness in the body as either an issue that has natural, topographical (environmental pollution), or as supernatural (malevolent spirits that were negatively impacting the body) causes. Each disease would be evaluated and treated based on this diagnosis (Longrigg J. 2000).

Epilepsy, a disease that embodies both supernatural and natural causes, was open for treatment from both areas (Longrigg J. 2000). Epilepsy was understood as a complex disorder, not as mere misfiring or overactivity in the brain, but as something encompassing all facets of the person's life and whose treatment would reflect this complexity.

Hippocrates was one of the first to suggest a non-supernatural cause for epilepsy. He wrote in *On the Sacred Disease* that fasting benefitted epileptic patients. Hippocrates suggested that by fasting the patient was able to clean "pollution" from his or her body (Bailey, E. E., Pfeifer, H. H., & Thiele, E. A., 2005).

Summary from *On The Sacred Disease* by Hippocrates (400 B.C.E)

Ancient Greeks, before Hippocrates *On The Sacred Disease*, believed that epilepsy was sacred and unique. They believed that it had both natural and supernatural properties. Hippocrates was the first to claim that this disease (referring to epilepsy) is not unlike any other. During the time of the ancient Greeks, a mixture of purifications and incantations were used to treat epilepsy. Some purification techniques include abstaining from hot baths and food "unwholesome to men in disease." Some of these foods include surmullet, blacktail, mullet, eel, goat, stag, sow, dog, chicken, turtle, bustard, mint, garlic, and onion. Many of these foods were considered too strong and would disorder the bowels. Some

incantations that many epileptics would partake in were: abstain from black robes (black= death), sleep on or wear, goatskin, and put one foot or one hand above the other. Diagnosis would also be made by depriving that person of food, drink, medicine, and not overheating them with baths, to prove the cause of the disease (the fault of the god's or the person). Hippocrates questions this knowledge and counters that if these incantations were true that Libyans (who lived with goats skin as their main source of furniture and clothing) would not suffer from this. But, Hippocrates did state that diet modification and deprivation was beneficial and could heal the "Sacred Disease." He then states that if modifications in the diet (not incantation) are indeed the cure for epilepsy, then others who had similar ideas later could help, not divinely but through human intervention (Hippocrates, 400 B.C.E.).

Hippocrates claimed that epilepsy is like many other diseases, in that it is hereditary. In ancient Greek humoral theory, if a patient had a phlegmatic, bilious, phthisical, or spleen disease etc. that they would be born with this and it would be passed down to the offspring. The brain is mentioned as a cause of epilepsy. The brain was understood to be like that of other animals and has a thin membrane that divides the middle of the organ. He explains that pain can, therefore, be spread across the brain or remain in specific sections. The veins (two large ones that connect the brain to the liver and spleen) can therefore also be affected. These and other veins run through the entire body. The left vein associated with the liver runs downward through the kidneys, psoas muscles, inner thigh, to the foot (vena cava). The right vein (hepatic vein) associated with the spleen runs upward by the lungs, divides into branches for the heart and right arm, clavicle, neck, (this vein is superficial and can be seen, near the ear it is hidden) the vein then divides into the brain, right eye, right ear, and nostril.

A vein from the spleen also distributes blood to the left side, like that of the liver but is smaller and weaker than the one in the liver (Hippocrates, 400 B.C.E.).

Hippocrates then describes the process by which air is brought through our bodies by these veins and then exhaled out. He states that the breath cannot be stationary and must move fluidly through the body. The air first goes to the brain (purest air) then the rest of the body, administering the will of the brain to the rest of the body. This process can be altered by compression during sitting or lying, which can lead to numbness. He goes on to say that this affects phlegmatic people. This disharmony begins in utero during brain development; if the fetus is exposed to more or less impurity or pollution that is "proper" the person could suffer from hearing voices, temperature sensitivity. If the brain is exposed to more pollutants than necessary it will become phlegmatic. Children with this condition will have ulcers across their bodies, excess saliva and mucus. The excess amount of phlegm experienced by these children was not properly removed when they were born. However, if the opposite were true the child could suffer from seizures (Hippocrates, 400 B.C.E.).

A defluxion (downward flow) of phlegm affects the heart, lungs, and curvature of the spine. The phlegm is also described as cold, chilling the blood. This then can palpate the chest, and the person can experience difficulty breathing. Because of this, the person can experience epileptic fits because of the stagnant inflammation in his or her body. If this defluxion, inflammation, phlegm, stay stagnant in the veins then the person loses speech, chokes, foams at the mouth, with clenched teeth, and can suffer from other symptoms. This can happen on each side of the body or on both sides. Difficulty speaking and loss of mental clarity occurs because phlegm thickens the veins, and deprives the brain of air. This deprivation of air leads to palpating in the breath and forming of the mouth. Consequently, if

this occurs that person will evacuate their bowels. The suffocation is also a consequence of the liver and stomach falling into the diaphragm with the stomach and mouth being shut. This is because the breath is not entering the mouth. Violent kicking during an epileptic event can be a result of the air in the lungs not finding an outlet, leading to a rushing of blood throughout the body causing pain and convulsions. Cold phlegm passing through warm blood congeals and stops it thereby stopping respiration and the person will die unless the warm blood can overcome the phlegm (Hippocrates, 400 B.C.E.).

Hippocrates then discusses this disease among children. He states that because of the smallness of the veins of children that they are less able to overcome the thickness of phlegm. Phlegm must be in smaller amounts for the child to survive but that many produce marks of the disorder (mouth, hand, neck drawn to the side, because phlegm creates a loss of integrity and is weakened). Children who are able to obtain longer intervals between episodes are more likely to survive and no longer have attacks. Many children whose heads are heated by the sun, fire, or fever cause a melting of phlegm into the body. Others develop this disease because the "south wind quickly succeeds to the northern breezes" causing the brain to relax and weaken creating an abundance of phlegm in the body. The southern (humid, moisturizes, melts, and diffuses the wind, affects/penetrates all things) and northern (condenses air and separates it from muddy things, makes the air cleaner, these winds are from the oceans) winds are described as the strongest winds that most oppose each other. Another possible cause of seizures is fear, especially in children. When a person is startled and cries in a way that they can not catch their breath, this causes the body to shiver and become speechless because they can not catch their own breath. Children over the age of twelve are not typically overcome with the disorder because the blood is warm and brain well

developed by this time. However, if a child experiences seizure before this age, they are more likely to experience fits when there are changes in winds (especially southern) and are less likely to ever have their seizures subside. Southern winds allow the brain to become more humid than normal and create an overabundance of phlegm (gives examples of brains of animals, especially goats, which are afflicted with the disease have moist brains with a foul smell when dissected). This is what Hippocrates defines as the origin of the disease in children (Hippocrates, 400 B.C.E.).

In adults, seizures are not considered fatal and will not create deformities in the body because their veins are larger and produce more warm blood than children. In elderly people seizures are considered fatal because the veins are empty of viscous blood (theirs is described as thin and watery), meaning older people will become paralyzed because of this. Older people are at an increased danger if the phlegm is copious during the winter, due to an increase in cooling and thus coagulation of blood. They are more likely to choke, be paralyzed, or die from epileptic episodes. Elderly people can also be frightened into a seizure, but are most likely put into an epileptic state during fevers, cold, or when cold and then is overheated by fire (or by the sun in summer) (Hippocrates, 400 B.C.E.).

The brain is like any other organ. It can create joy, sorrow, and all the range of emotion and experience between. It can be affected by imbalances in moisture, dryness. When the brain is at rest the person experiences health. But when there is an excess of bile and phlegm the brain and body experience disharmony. Bile can create malignant and improper terrors and fears in the brain. This is created by excess drainage in the brain to the rest of the body, caused by the hot properties of bile. This cools the brain (beyond normal) after it is warmed by bile (the person experiences fear until the brain is heated back up again;

this is linked with screams at night because the brain is heating back up suddenly). The brain therefore controls and impacts all of the body and is impacted by many internal and external factors; the brain is integrated into the body. This interconnectivity is what makes diseases of this type the most deadly and difficult to cure. Hippocrates recommends then that a physician should cure this disease by increasing or decreasing their treatment to starve the disease (give which opposes it, cold, dry) within the proper seasons and times for the person (Hippocrates, 400 B.C.E.).

Ketogenic Diet

Fasting and dietary "cures" for epilepsy were mentioned and inspired by Hippocrates and later in 1911 by Drs. Gulep and Marie were the first modern physicians to suggest starvation as a treatment for epilepsy. They began with a very small cohort of 20 adults and children, although not much is know about experimental parameters, Drs. Gulep and Marie reported a decrease in seizure severity. After this study, others became involved in fasting research; including Dr. Cobb and Dr. Lennox at Harvard Medical who found that severity of seizures was lessened after 2-3 days of fasting. From this knowledge, Dr. Russell Wilder at the Mayo Clinic developed the ketogenic diet in 1921. The purpose of the diet was to mimic the effects of starvation that could be used more consistency without depriving the patients of all nutrients. After Wilder's original discovery Dr. Petterman developed a formula for the proper ratios of nutrients for each patient. Petterman suggested that: per each kilogram of body weight a patient should have 1 gram of protein, limit carbohydrate intake to 10-15g per day, and all other calories consumed should be from fat. This formula closely matches that of modernly prescribed ketogenic diets (Wheless, 2008).

The ketogenic diet mimics fasting in the body by removing almost all carbohydrates, forcing the body to break down fat as its main source of energy (Wheless, 2008). A typical American diet consists mostly of carbohydrates (50.5% men and 47.9% women out of total daily caloric intake), then proteins (15.9% men and 15.5% women), and lastly fats (33.6% men and 33.5% women) (Wright &Wang, 2010). The ketogenic diet is almost the reverse of what most Americans eat, exempting carbohydrates in the diet.
By doing this, doctors are forcing the body into ketosis, which breaks down fat into energy when carbohydrates are not present. Mimicking the body's natural fasting state (Maughan, Fallah, Coyle, 2010).

After attention turned to pharmaceutical drugs in 1938, the ketogenic diet lost momentum, physicians stopped prescribing it despite promising results. Despite the success that the diet experienced, it was difficult to monitor in young children and with the increased availability of pharmaceutical treatment the diet lost momentum and was rarely used in the treatment of epilepsy from the 1940's until the 1990s (Wheless, 2008). Of the high numbers of epileptic patients who are unresponsive to drug therapy, and caregivers (and patients themselves) have begun doing their own research and have advocated for the implementation of the ketogenic diet. The ketogenic diet was revived when it became nationally known because of a film *(...First Do No Harm,* 1997) and foundation (The Charlie Foundation for Ketogenic Therapies, 2017).

In the 1990's after film director, Jim Abrahams' son was diagnosed with refractory epilepsy (difficult to control) the ketogenic diet came back into the public eye. Charlie Abraham (son of Jim) was placed on the ketogenic diet and became drug and seizure free within one month. Because of the immense success that Charlie had with this diet, his father

directed and produced the film ....*First Do No Harm* in 1997 and began the "Charlie Foundation for Ketogenic Therapies" in 1994. Jim Abrahams also promoted training seminars through The Charlie Foundation and promoted clinical trails for the ketogenic diet (The Charlie Foundation for Ketogenic Therapies, 2017) (Vogelstein, 2010).

After rekindling the ketogenic diet, other versions of ketogenic diet came about. They also seek to put the body into a state of ketogenesis, but try to help mitigate some of the negative side effects (kidney stones, and constipation) ((Kossoff, McGrogan, Blumi, Pillas, Rubenstein, Vining, 2006) and make it easier for families to follow the diets (Medium-chain triglyceride (MCT) oil diet was discovered by Dr. Peter Huttenlocher in 1971. (Wheless, 2008). The diet is generally less restrictive, it allows patients to have a higher daily allowance of carbohydrates and protein and incorporating MCT instead of long-chain triglyceride oils. MCTs are known to break down more readily into ketones in the body, lessening a number of fat patients ingest (The Charlie Foundation for Ketogenic Therapies, 2017).

MCT (medium chain triglycerides) Diet

The medium chain triglyceride diet was created in 1971 to serve the same purposes as the ketogenic diet (putting the body into a fasting state) yet be easier to administer and be less restrictive. This diet entails ingesting MCT oils at meals, these oils are absorbed quickly into the body and can take the patient into a more rapid ketosis. This means that the patient could consume more carbohydrates, and protein, as well as less fat. A study conducted in 1985 saw 29% of their study cohort become nearly seizure-free, 29% saw significant seizure reduction, and 48% saw no significant change. Although this study took place in a small

patient size (17), other studies have yielded similar results. The diet seems promising but does have gastrointestinal drawbacks like diarrhea, vomiting, and abdominal cramping. This diet, like ketogenic and modified Atkins, is promising in aiding children with drug-resistant epilepsy but has to be done under the supervision of professionals who are well trained in treating epileptic patients (Bailey et al., 2005).

Modified Atkins Diet

The modified Atkins diet is another variation of the ketogenic diet, like the MCT diet. One of the first studies of the modified Atkins diet was tested by Johns Hopkins as a diet that could help mitigate seizures in both children and adults that is easier to maintain than the ketogenic diet. Dietary instructions: carbohydrates were restricted to 10 g/daily, fats (heavy whipping cream, clear carbohydrate-free fluids were encouraged, a low-carb multivitamin and calcium were given daily. Seizures were monitored daily, weight weekly, and urinary ketones bi-weekly (because side-effects of high-fat diets are kidney stones), complete metabolic profile, blood count, and fasting lipid profile were monitored at 1, 3, and 6 months, medications were not altered during the first month of the clinical trial. The modified Atkins diet has been tested less than ketogenic but, according to Dr. Eric Kossof, a pediatric neurologist at Johns Hopkins Children's Center, the diet seems to have a bright future. From September 2003 until May 2005, a small cohort of 20 children suffering from all seizure types, a minimum of 3 seizures weekly, age range: 3-16 years, sex: 11 female, 9 male, average age of seizure onset: 3.5 years, average AEDs (anticonvulsive medications) taken before trial enrollment: 6.5, Patients with a VNS (Operational Vagus Nerve Stimulator): 3. Patients were enrolled in the diet from 1 to 6 months. Nineteen patients successfully

completed the first month, 18 completed three months, 16 completed six months. After the first month, 70% (14) showed greater than 50% seizure improvement and 20% (4) showed greater than 90% seizure improvement. Following the third month, 78% (14) showed greater than 50% seizure improvement and 28% (5) showed greater than 90% seizure improvement. After six months of treatment, 75% (12) showed greater than 50% seizure improvement and 38% (6) showed greater than 90% seizure improvement. Average seizure frequency was reduced to 40 per week (163 originally) after six months of the modified Atkins Diet. Four patients were seizure free after 6 months of treatment. BMI among patients varied from an average of 18.5 to 18.1, height increased in all but two of the older (13-year-old) patients, urine-calcium-to-creatine ratio was elevated in 8 patients (were started on polycitrates to prevent kidney stones), however, no participants developed kidney stones, one patient developed acidosis but continued the diet. Overall, more research needs to be done in larger cohort studies, however, the modified Atkins diet seems to be a promising diet for patients with otherwise unmanaged seizures and may be better tolerated than the ketogenic diet (Kossoff et al., 2006).

How can we understand the tremendous success of the ketogenic and other similar diets? Some interesting developments and recent research in microbiology may illuminate answers. Through clinical research, there seems to be a connection between disorders (both brain and others) and the gut microbiome (Li & Zhou, 2016).

Brain Gut Connection

According to epidemiological data that are more than 70 million epileptic patients throughout the world. However, a clear understanding of epilepsy's etiology is still

unknown. Some have suggested that there is a genetic basis for epilepsy but these studies have been countered with studies in twins with classic benign rolandic epilepsy[10] that have not found this to be the case. There are also only 20 AEDs licensed globally and, ignoring significant difficulties with these medications, 30%-40% of the 70 million people with epilepsy are resistant to drug therapy. Eight-five percent of all epileptic patients live in poverty, suggesting a non-inherited environmental basis for epilepsy contraction. In the current research, idiopathic seizure disorder has presented autoantibodies; other forms of epilepsy have also co-occurred with autoimmune disorders. Raising the question of epilepsy being autoimmune in nature. Therefore, the ability for the gut microbiome to both prevent and potentiate autoimmune diseases such as type I diabetes and MS (multiple sclerosis) and the incredible association of epilepsy and other autoimmune disorders introduces the possibility for composition of an individual's microbiome affecting susceptibility to epilepsy and decrease disease progression (Wu et al., 2016).

In recent history, more work has been done evaluating possible connections between the brain and gut. This research supports the necessity of going beyond the brain and into the gut to treat epilepsy. The gut and microbiome (viruses, bacteria, fungi, archaea) that resides within it is known to have a symbiotic relationship with human development and evolution. These microbes play important roles in our bodies. Many know that much of our immune system resides in our gut. The presence or absence of key microbes can either alleviate or promote the development immunological disease like type I diabetes, IBS (irritable bowel syndrome), asthma (Sharon et al. 2016). The gut microbe, environmental factors, and host genetics are also known to play a large role in diabetes, obesity, and metabolic disorders

[10] Classic benign rolandic epilepsy is a common form of childhood epilepsy that is normally resolved as the child grows (Epilepsy Foundation. 2017).

(Ussar, Fujisaka, & Kahn, 2016).

In rat studies, it was seen that mice deprived of symbiotic microbes (GF, germ-free) displayed: learning and memory deficiencies, increased risk-taking behaviors, impaired BBB (blood brain barrier) function, increased myelination in the pre-frontal cortex. There are also studies being conducted, revealing a connection between depression, anxiety, autism spectrum (ASD), schizophrenia, Parkinson's disease (PD), and Alzheimer's disease (AD) with microbes (Sharon et al., 2016).

Neurological development and maturation happen throughout the lifespan. At gestational week (GSW) 3, neurogenesis begins, before GSW 13 microglia begins to populate the brain, GSW 14 cortical layering begins, GSW 23-26, BBB development and 50% of neurons undergo apoptosis, GSW 36-40 glycogenesis peak. During gestation (and all of life) the fetus comes into contact with many microbes, but Actinobacteria (gut) and *Lactobacillus* (vagina) seem to be the ones in abundance (in this Proteobacteria will be the phylum discussed). The same can be seen throughout the life cycle. From birth to 1 year of age, the child will come into contact with: *Bifidobacterium, Enterococcus, Escherichia/Shigella, Streptococcus, Bacteroides,* and *Rothia*. From years 1 through 3, the primary bacteria are: *Clostredium, Ruminococcus, Veilonlla, Roseburia, Akkermansia, Alistipes, Eubacteria, Prevotella*. From years 2 through 3, the brain reaches 90-95% of adult volume; there is also peak synaptic density and myelination. From 3 years of age until adulthood the child will come into contact with *Bacteroidetes* and *Firmicutes*. During ages 12 through 18, there is reduced synaptic density, from years 20 through mature adulthood the person has reached a mature adult brain and experiences ongoing myelination. As the person ages, (65 years and older) *Proteobacteria, Bacteroides, Alistipes, Parabacteroids,*

become dominant (Sharon et al., 2016).

Because of the extreme complexity of neural and brain development and its relationship to the gut (bi-directional, called microbiota-gut-brain axis), there may be a causal link between environmental factors, and the populous of microorganism in the gut with epilepsy susceptibility and severity (Li et al., 2016). Therefore, the ancient Greek interpretation of epilepsy as a complex disease that can treated with changes in diet and obtaining from certain foods may not be far-fetched. Modern microbiologists and other researchers are discovering that many diseases may be much more complex that initially understood, proving that epilepsy is much more than a disease of the brain.

In addition to dietary therapy, patients have pushed for new treatments with less adverse side effects that can effectively lessen the severity or completely control their seizures. One of the novel treatments that have also been hugely successful is the use of CBD oil (Cannabidiol, non-psychoactive medical marijuana).

CBD and Medicinal Marijuana

Another patient driven therapy for refractory epilepsy is CBD (Cannabidiol) which is a known non-hallucinogenic anticonvulsant. The use of CBD as a treatment for refractory epilepsy is in itself effective, produces very little side effects, and is holistic. CBD is active and works throughout a large potion of a patients body, not simply in the brain (Mechoulam, Peters, Murillo-Rodriguez, & Hanuš, 2007). The effectiveness of CBD in refractory epilepsy treatment also demonstrates the need to go beyond the brain in epilepsy treatment.

Historically found in Central and South Asia, cannabis[11] has been used extensively for purposes as broad as clothing, paper, livestock feed, recreation, religious ceremony, and medicine. Marijuana has been used medicinally for the treatment of menstrual disorders, gout, malaria, rheumatism, and constipation in China for at least 5,000 years. Islamic practitioners in medieval times (1401 C.E. -1500 C.E.) used it for nausea, vomiting, inflammation, pain, fever, and epilepsy. In biomedicine, marijuana was used for glaucoma, pain, nausea, vomiting, muscle spasms, insomnia, anxiety, and epilepsy in the 1800s. During this time, English neurologists Gowers and Reynolds used marijuana for treating epilepsy, however, since this time it has not been used to treat epilepsy. In recent history, clinical trials have demonstrated its efficiency in treating HIV associated sensory neuropathy, chronic pain, chemotherapy-induced nausea and vomiting, as well as spasms with MS (multiple sclerosis) patients (Devinsky, Cilio, Cross, Fernandez-Ruiz, French, Hill, Katz, Di Marzo, Jutras-Aswad, Notcutt, Martinez-Orgado,Robson, Rohrback, Thiele, Whalley, & Friedman, 2014).

Marijuana was placed under the Marijuana tax in 1937 (taxed for medicinal use) and was still given as a prescription by physicians until it was removed from the U.S. Pharmacopeia (formulary) in 1942. It was banned for medicinal use because it was suspected of creating violence, crime, and mental illness (much the same as alcohol was in the U.S. during prohibition 1920-1933). During this time marijuana was labeled as a schedule I drug (same class as heroin and LSD), meaning it had no medicinal value, whereas cocaine was banned for recreational use but was still thought to have medicinal value at the time (a schedule II drug is a drug that does not have any medicinal value and has a strong

[11] Hemp and marijuana are both in the same genius (Cannabis) of flowering plants. They have a different chemical makeup, growing conditions, and applications. Hemp is low in THC, requires minimal care to grow, and is used more industrially than marijuana (West, 1998).

potential for abuse and addiction (opium, morphine, and cocaine)). After approximately 15 Americans had been given marijuana for special investigative purposes in the 1980s and after the chief administrative law judge of the FDA proposed that marijuana is changed to a schedule II drug, the Bush administration in 1989 decided that marijuana for investigative purposes should be reviewed. They wanted to make sure that no one got the "wrong idea" that marijuana had any medicinal value (Schmachtenberger, 2011). Thus leading to the illegal nature of marijuana, the lack of medicinal use/research until recent years, and stigma.

In the 1970s four studies were conducted, analyzing the effectiveness of CBD in treating seizures. Unfortunately, all four had methodological flaws and experimental confounds. Sadly, there has not been a significant enough body of knowledge created at this point. Most of the movement for using marijuana (mostly CBD) for epilepsy treatment has been patient-driven. More studies need to be conducted to determine marijuana's therapeutic effects and make it available for patients who are unresponsive or who unable to tolerate the side effects of anticonvulsant drugs (Devinsky et al., 2014).

CBD and THC (Tetrahydrocannabinol) are the two known anticonvulsant molecules in marijuana. THC is known to be psychoactive and create a "high" by those who use it, whereas CBD does not create this high. CBD is used mostly for medicinal versus recreational purposes (this is because CBD does not create a "high" by those who consume it). Cannabis, in the human body, acts on two G-protein coupled receptors[12], cannabinoid type I and II, (CB_1 and CB_2 respectfully). Both of these receptors are highly expressed in the hippocampus and the central nervous system (CNS), however, they function quite differently. CB_1 receptors inhibit synaptic transmission by altering voltage-gated calcium and potassium

[12] G-protein coupled receptors are bound across the cell membrane that bind to guanine nucleotides (GTP and GDP) to carry out communication from outside of the cell to cause changes inside (InterPro, 2017).

channels, affecting seizure activity. CB_2 receptors express themselves mostly in the immune system that affects the CNS very minimally (Wetly, Leubke, & Gidal, 2014). Both of these receptors are activated by THC and are minimally activated by CBD. CBD instead of binding directly with either CB_1 or CB_2 receptors stimulates their activities, because of this CBD is active across the body in cells with either of these receptors, creating a systemic, not local, effect (Mechoulam, Peters, Murillo-Rodriguez, & Hanuš, 2007). Therefore it can be assumed that CBD is effective in treating refractory epilepsy because instead of targeting the brain only, CBD affects the entire body, therefore better healing a disease that has been misunderstood for so long as a disease of the brain.

In a survey of parents who had given their children CBD, by Hussain, Zhou, Jacobson, Weng, Cheng, Lay, Hung, Lerner, and Sankar in 2015 found that in 117 epileptic pediatric patients (53 had infantile spasms and/or Lennox-Gastaut syndrome) 85% saw a reduction in seizure frequency, 14% report complete seizure freedom. The median duration of CBD treatment was 6.8 months, the median dosage was 4.3mg/kg/day, and the median number of failed anticonvulsant treatments was eight. Side effects were: increased appetite (30%), improved sleep (53%), alertness (71%), and improved mood (63%).

A study conducted in Israel on intractable pediatric epilepsy with 74 patients (age range 1-18 years) that were resistant to at least 7 anticonvulsant drugs. Of these patients, 66% failed the ketogenic diet, vagal nerve stimulator[13], or both. Patients in this trial remained for at least 3 months, while the average time was 6 months. The formula used for treatment was a 20:1 ratio of CBD to THC in olive oil. CBD dosages ranged from 1-20 mg/kg/1 day. Eighty-nine percent of patients reported a reduction in seizure frequency.

[13] An electrical device that is impacted in the chest, a wire from this device is wound around the vagus nerve in the neck. This wire sends regular mind electrical signals to the brain through the vagus never can help mediate regular electrical activity in the brain. This device can also be used to stop a seizure if a special magnet is placed near the implant to activate the nerve stimulator (Schachter & Sirven 2013).

Thirteen (18%) reported 75-100%, 25 (34%) reported 50-75%, 9 (12%) reported 25-50%, 19 (26%) reported less than 25% reduction in seizure frequency. For many, improvement in overall behavior, alertness, language, communication, motor skills, and sleep were reported. However, five patients withdrew from the study because of adverse side effects like fatigue, somnolence, gastrointestinal disturbances, and irritability (Tzadok, Uliel-Siboni, Linder, Kramer, Epstein, Menascu, Nissenkorn, Yosef, Hyman, Granot, Dor, Lerman-Sagie, & Ben-Zeev, 2016).

There are a variety of ways that CBD can be administered. It can be smoked, like that of recreational cannabis, it can be vaporized, or created into an aerosol; or it can be taken orally through food or just ingested as an oil, oral-mucosal/sublingually through sprays or lozenges, or transdermally. Ingesting CBD through vaporization or smoking (although was considered unsuitable by some authors) seems to be the best mode of delivery, it activates in the bloodstream quicker and has a more predictable metabolism rate than ingesting CBD in any other way. Although this mode seems to be the best, each of these must be investigated further to determine the proper mode of administration (and if the different ways are better for certain illnesses or patients) (Devinsky et al., 2014).

In the limited amount of clinical trials and self-reports, CBD seems to be an extremely safe treatment. In many patients, there have been no CNS, mood, or vital sign side effects. Some suspect that CBD could have some immunosuppression but there is a lack of longitudinal studies investigating this. In animal studies CBD did not seem to create negative side effects when administered with AEDs, however, dosages were adjusted when CBD was administered (Devinsky et al., 2014).

Conclusion:

Success experienced in novel epilepsy treatments through the use of diet modification and CBD can only be explained through broadening our understanding of epilepsy beyond the brain (through explanations like, but not limited to, those offered by new research regarding the connection between the brain and gut).

The body according to Gilles Deleuze is kinetic and dynamic, has a capacity for being affected and affecting. This kind of body, inspired by Benedictus Spinoza, takes us into a plane of immanence that moves beyond Cartesian dualism. According to Deleuze, bodies should therefore be defined by their longitude (speed) and latitude (effects and affects) not by their essences, organs, structures, or by some higher order/ hidden code (like that of DNA-RNA-Proteins) because to define a body in this way overlooks and reduces them to a form that is not the dynamic reality (Deleuze, 1970). In doing this, we reduce the multiplicity that the body and disease can exist. If we are able to break from the rigidity that currently defines biomedicine, we will be able to better care for all patients. By studying and critiquing the system of biomedicine we are continuing Annemarie Mol's work studied the "politics of what", critiquing a medical system, and not the "politics of who", critiquing the people within the system. By studying biomedicine and critiquing it as a system we are preventing the creation of a new dualistic divide (patient vs. doctor or disease (biological) vs. illness (patient experience)) (Mol, 2002). By examining the "politics of what" we are able to resolve the "politics of who" issues, in examining the biomedical system we are able to properly understand the power discrepancies between patients and physicians, and the insufficiencies of the "brain only model" in treating epilepsy.

How then will we move past these shortcomings in biomedicine? I believe that the best way to mitigate these problems are to incorporate a cross disciplinary, including disciplines like medical anthropology, approach to medical treatment and education. Not adding to the work already required, but a system and philosophical change (to incorporate holistic practices and move beyond the "brain only" models for the understanding and treatment of epilepsy) to the courses that are already being taught. This change is starting slowly but surely in pre-medical and medical education.

The new MCAT (Medical College Admission Test), as of April 2015, now has one of its four sections on "The Psychological, Social, and Biological Foundations of Behavior" (Princeton Review, 2017). This change is happening slowly, I believe that many in biomedicine are aware of the shortcomings are slowing making policy changes to address these issues. This awareness is also evident in the merging of MD (allopathic) and DO (osteopathic) medical schools. Allopathic medicine and osteopathic medicines are both forms of biomedicine that are both fully licensed in the United States. Allopathic physicians combat disease with remedies such as medication and/or surgery (Merriam-Webster, 2017). However, osteopathic medicine "emphasizes a whole-person approach to medicine" and "Osteopathic physicians focus on prevention, tuning into how a patient's lifestyle and environment can impact their wellbeing. DOs strive to help you be truly healthy in mind, body and spirit -- not just free of symptoms." (American Osteopathic Association (AOA), 2017).

The American Osteopathic Association (AOA), American Association of Colleges of Osteopathic Medicine (AACOM) and the Accreditation Council for Graduate Medical

Education (ACGME) are working to create a single accreditation system for medical education in the U.S. by 2020 (AOA, 2017).

As far as medical education, I am not suggesting that we add new courses to the already immense work required of medial students. I am however, suggesting that an integration of the social sciences and work outside of biomedicine when discussing the disease pathology and treatment is crucial. It is time to move past Cartesian dualism to create a more holistic understanding of the body, disease, and treatment. We must take into account the large number of patients (specifically epileptic) who are not being properly cared for under the current biomedical system and how we can better care for them.

I am not suggesting to completely do away with the "brain only model" of epilepsy, but rather that there are limitations to the strict brain only model to understanding, treating, and studying a complex disease like epilepsy. We must reach beyond dualism into holism to account for the complexity and multiplicity that characterize disease and our bodies. Being the best investigative scientists we can involves accounting for multiplicity. This will help usher in new breakthroughs in the treatment of epilepsy.

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