Discussion

My hypothesis was supported by all of the data. According to the data found in Figures 1 and 2, PIGD patients always had worse nonmotor characteristics and worse motor characteristics than TD patients. Also, the PIGD group data always had greater standard deviations than the TD group when it came to motor characteristics. This fits very well with my hypothesis that the PIGD subtype would have worse gait, turning, cognitive, and disease characteristics, which was overwhelmingly supported by the data, where every single variable and sub-variable gave better marks to TD patients. This trend is also supported by the literature discussed earlier. This is specifically true where Herman et al. (2014) discussed the problems that patients with the PIGD phenotype had with stride length and stability. This is precisely true with my data, where the PIGD patients had a shorter stride length than the TD patients in both dual task and single task. The instability mentioned is shown in all of the non-motor variables tested, where the PIGD patients always had worse attributes than those with TD.

In terms of the methodology used, there were many strengths. For one, we had access to spreadsheet data from hundreds of PD patients, so our sample size was quite large. We also used a plethora of different measures for each of the characteristics tested, (gait, turning, cognition, and disease), which gave convincing evidence for each. The inertial sensors used for non-motor testing also provided a lot of input on what exactly was going on with the patient's body during gait and turning. However, our methodology wasn't perfect by any means. We only had two different ways of testing cognition during the dual task motor tests; if we had more it would have certainly helped with giving more for the patient to focus on during said tests. Also, we weren't able to test heel cord length in patient gait, which would've been more helpful than the foot strike angle variable we tested. This is because it would tell us whether

the striking angle was as small as it was because of how they walk, or simply because they couldn't lift the foot any higher because of their heel cord.

In terms of what these results mean for the study of Parkinson's disease as a whole, they are quite important. These two groups are quantitatively different when it comes to non-motor and motor characteristics, to say the least. This shows that the TD and PIGD aren't just groups divided by a ratio from the MDS-UPDRS--they actually are different types of PD that express themselves in very different ways and might possibly be treatable in their own specific ways as well. This is something that has been shown many times before in other past studies, but this simply adds more support to that hypothesis. A specialization of treatment, when and if it were possible, would greatly contribute to the treatment of Parkinson's disease. In the future, we might test heel cord length and other new motor variables to see if they also support this hypothesis and show why the foot strike angles of most patients are the way they

Discussion

I found that the RS4i+ was cheaper than the majority of both drug types and all but one of the opioid painkillers. This supported my original hypothesis that the RS4i+ would, chiefly, be cheaper than the drugs I researched. However, the relatively similar prices for many of the muscle relaxants does not follow my hypothesis, as the RS4i+ fell in the middle of the price range of those drugs. This could be attributed to the smaller sample size, since many of the muscle relaxants came in irregular forms and so could not be included.

Certain drugs (including a significant part of the muscle relaxants) had irregular forms like injectables or patches. For these drugs, I either used the tablet/capsule form or just excluded the drug completely. This was because patches and injectables did not have consistent dosage and pricing data with the other drugs, and so would be difficult to compare. My mentor wanted me to just focus on drugs taken orally, as that was the type of drug that the RS4i+ was in direct competition with.

There were several issues that made this research difficult, the first of which was finding a reliable pricing source. I originally used GoodRx, which gave an average retail price, specific pharmacies' prices, and discounted price of the drug. This data was reliable and exactly what I was looking for, but I quickly found that they only had the prices of select drugs, brands, and doses. As I tried to create an extremely extensive and comprehensive spreadsheet, I could not continue to use such a limited source, and decided to look elsewhere. I then researched how drugs are priced in an attempt to find the most reliable pricing method. I found that the price of drugs depends on the manufacturer, distributor, pharmacy, patient, hospital, and most

importantly, insurance. As a result, not only are drug prices extremely variant depending on the patient's situation, they are also rapidly changing.

Despite this, it was necessary to find a pricing method for the drugs, as my data collection would be obsolete without prices. I began to research how drugs are priced and found that it is anything but simple. First Databank, another website for drug information, found that the AAC (Average Acquisition Cost) based prices are the most reliable to compare. (AACs are the costs that pharmacies pay to acquire the drugs). I then searched for available AACs for the drugs that I was researching, but they were not readily available on the internet, so I continued my research into other pricing methods. I found a fairly simple overview of how drugs are priced on drugcostfacts.org, which essentially stated that there was no simple price that patients pay for prescriptions. The price varies depending on many factors, which made finding a steady and reliable price for opioid painkillers extremely difficult.

When I explained this to my mentor, he recommended that I find a single credible source by which to find the prices, so that they were consistent. Then, if and when the data was questioned, we could point to a single source for the prices. I decided to use Drugs.com, which gave a detailed description and discounted price for each drug. The discounted price was hardly a problem, however, since the device was cheaper than a discounted price, which only further validated our point.

I plan to continue this research by creating quantitative evidence that while the RS4i+ gets cheaper and cheaper per year of use, drugs continue to rise in cost. This is because the price per day of using the RS4i+ that I calculated is based off of the first year of use, which includes the actual purchase of the device itself, which drastically affects the price per day. In the second

year and beyond, the price per day is based off of the upkeep of the device, which is much cheaper than the acquisition of it. As many patients will continue to use the device over a number of years to deal with their pain, expanding the time period gives a more accurate representation of the daily cost of using the RS4i+.

Conversely, the price of taking opioid painkillers gets consistently more expensive over time because the body builds up a tolerance of the medication, and so needs higher and stronger doses in order for the drug to have an effect. Every time the patient moves to a stronger dose, the medicine gets more expensive. In the future, I would like to continue my research to show those trends in pricing for the RS4i+ and several opioids, to further the conclusion that the RS4i+ is a much more responsible option than opioid painkillers. This, coupled with the fact that electrotherapy is much healthier for patients, as discussed in my Literature Review, should help doctors and patients alike realize the superiority of electrotherapy to opioid treatment options (Murphy, 2018).

Discussion

According to the data, our hypothesis that primary production and methane concentrations would decrease as distance from the inlet increased was supported. Chlorophyll α and methane concentrations mirrored each other in the epilimnion across the lake, and The variations across the sites and depths were much larger than the variation at the 6 m SLOPE-SHI site leading us to believe there is a correlation between primary production and methane.

There is another possibility as to the origins of the methane in the epilimnion. Most of the methane found near the surface should come from ebullition as diffusive methane is more likely to be oxidized as soon as it reaches the oxycline. This means that there is a possibility that the the methane we detected above the epilimnion could be from this exchange and not affected by the concentration of chlorophyll α and primary production. However, the highest concentration of chlorophyll α was near just above the thermocline, and the methane concentrations also increased there (see Figure 2., Figure 4.). This strengthens the claim that primary production is causing the elevated methane levels.

There were a few problems during this study. When we took several samples from the 6 m depth SLOPE-SHI site, all the water samples came from one Van Dorn catch instead of pulling a different sample of water each time. This means that the variation we measured was within one sample of water instead of the variation at that depth. Further, after taking the water samples back to the lab, we found some of the samples had air bubbles, which may have affected the measurements detected by the GC and therefore the results of the study. Also, we did not measure primary production, but chlorophyll α, meaning that we do not know the actual amount of primary production occurring at each of the sites.

These results adhere to the observations of other studies. Studies by Whiting & Chanton (1993), and West, Creamer, & Jones (2015), suggested that primary production plays an important role in regulating CH_4 emissions from reservoirs. The positive correlation seen in this study supports these claims though other possible explanations exist. A study done on a mesotrophic lake in Switzerland which stratifies but is oxic through all layers found that 90% of the CH_4 emissions come from processes that occur in the top 5 m of the lake (Donis et al., 2017). However, they concluded that the CH_4 levels in the metalimnion only correlated with water column stability and did not contribute to epilimnion concentrations. They further argue that comparing CH_4 concentrations to other variables such as chlorophyll α is not as accurate as using the rates of production.

Future steps include determining whether exchange between the water and ebullitive methane near the surface could account for the levels of methane found in those areas and sampling the sites over a long period of time to get a better understanding of the temporal variation of CH_4 fluxes. More work needs to be done on the processes which lead to CH_4 production in the metalimnion and epilimnion and how those affect overall CH_4 fluxes in lakes.