

# PD-Toothbrush Team

BMEN 3151 Medical Device Practicum

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## Clinical Problem

- Nearly one million people live with Parkinson's in the US and approximately 60,000 Americans are diagnosed with PD each year.
- More than 10 million people worldwide are living with PD.
- Men are 1.5 times more likely to have Parkinson's disease than women.
- Patients with Parkinson's usually live for 10-20 years after diagnosis. PD doesn't kill people, but it does decrease the quality of life in the patient.
- Early warning signs: tremors, small handwriting, loss of smell, trouble sleeping, trouble moving or walking, constipation, soft/low voice, facial masking, dizziness/fainting, and stooping/hunching over
- Symptoms: rigidity, tremors, balance instability, slowness of overall movement
- Treatments include supportive therapies (physiotherapy), medication, and surgery (for some people).
- Parkinson's disease is caused by a loss of dopaminergic nerve cells in the part of the brain called the substantia nigra. Nerve cells in this part of the brain are responsible for producing a chemical called dopamine. Dopamine acts as a messenger between the parts of the brain and nervous system that help control and coordinate body movements. If these nerve cells die or become damaged, the amount of dopamine in the brain is reduced. This means the part of the brain controlling movement cannot work as well as normal, causing movements to become slow and abnormal. The symptoms of Parkinson's disease usually only start to develop when around 80% of the nerve cells in the substantia nigra have been lost.
- Most people with Parkinson's disease eventually need a medication called levodopa. Levodopa is absorbed by the nerve cells in your brain and turned into the chemical dopamine, which is used to transmit messages between the parts of the brain and nerves that control movement. With the use of levodopa, increasing the levels of dopamine usually improves movement problems. It's usually taken as a tablet or liquid, and is often combined with other medication, such as benserazide or carbidopa.

## Medical Device Solution

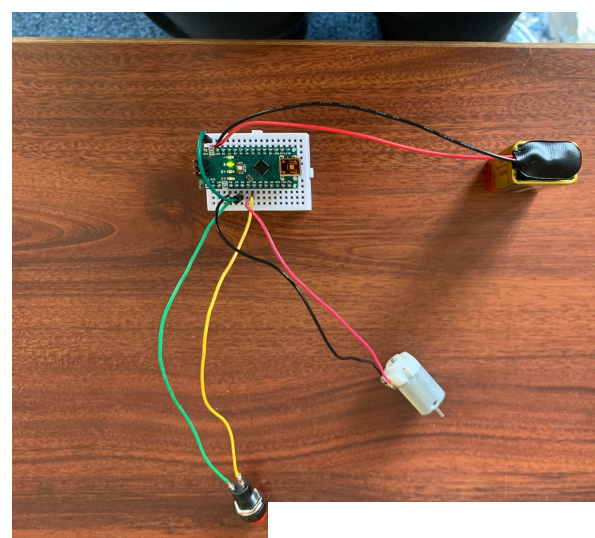
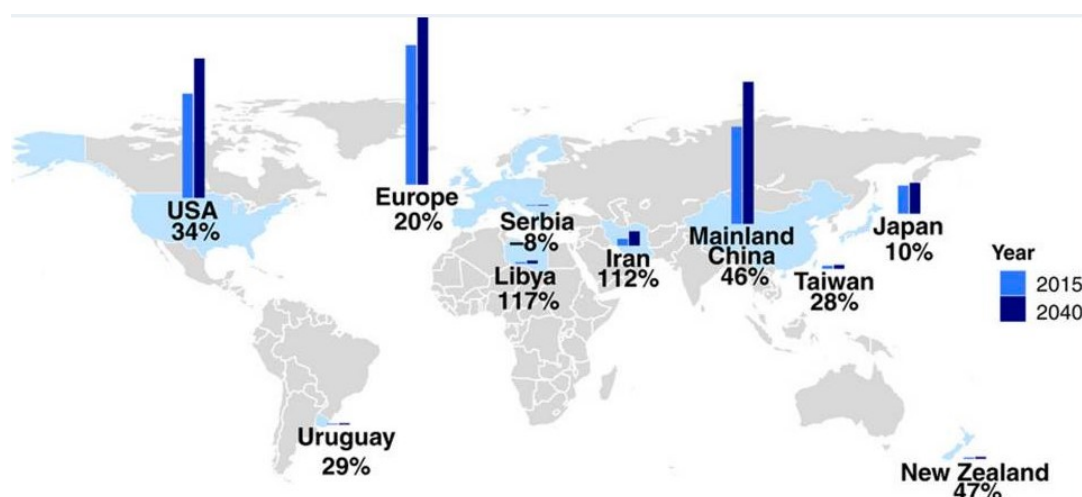
Our solution for PD patient's inability to perform their own oral hygiene is an electric toothbrush with a custom built 360 degree brush-head. The toothbrush is push-button activated. Once pressed, the arduino nano controller within the handle will delay the activation of the motor by 2 seconds in order to give the user time to get the brush in their mouth. After activation, the controller will deactivate the motor after 2 minutes, to ensure that the user is given a thorough cleaning without having to keep track of time themselves. If the user wishes to pause the toothbrush while they are brushing, all they have to do is press the button once more, and the controller will deactivate the motor until they are ready to resume brushing and press the button a third time. The battery is easily replaceable via the hinged cover at the bottom of the handle. The 360 degree brush head minimizes the fine motor movement that the user must perform to brush their teeth. They don't need to articulate their wrist or fingers, all they have to do is hold onto the handle (built with a thick rubber grip that's easy to hold) and move their forearm to move the brush.

## Needs Statement

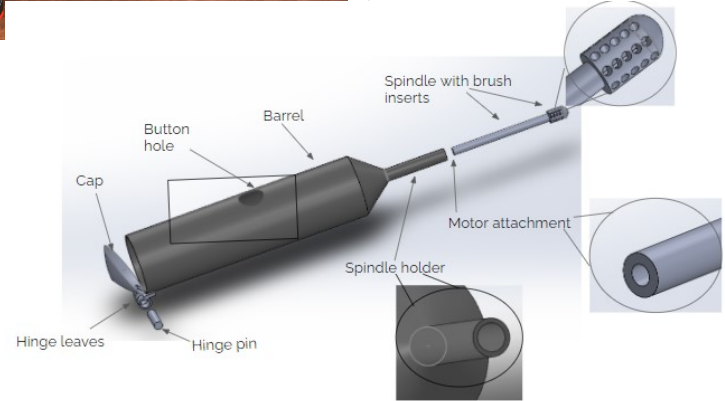
**Parkinson's patients need a device that provides increased dexterity for the daily task of brushing their teeth that is both efficient and cost-effective.**

## Market Analysis

Our target market is patients with Parkinson's Disease as well as patients who experience trouble with fine motor movements. This could include patients with ALS, MS, and Spinal Muscular Atrophy. The current landscape of the market includes many options of electric toothbrush. These toothbrushes range in price from \$20-270 dollars. Our goal is to make a toothbrush that is cheaper and more effective for PD patients. The approximate number of patients in the market is 12 million with a potential of being higher including adults who struggle with fine motor control. The market is currently growing with many studies citing that the number of patients with PD will double between 2010 and 2040. The number of patients with ALS will also double between 2005-2030. With a growing market, the profit may be larger than originally anticipated.



```
toothbrushCode2
1 const int Button = 2; //initiates button
2 const int Motor = 5; //initiates motor
3 int long StartTime; //initiates variable
4 const int long StopTime = 120000;
5 int long AccumulatedTime;
6 int long PausedTime;
7 //ISR
8 void buttonPressed()
9 {
10  if (digitalRead(Motor)==LOW && AccumulatedTime < StopTime)
11    {delay(2000);
12     digitalWrite(Motor, HIGH);}
13  else
14    digitalWrite(Motor, LOW);
15  } //end of ISR
16
17 void setup()
18 {
19  pinMode(Button, INPUT); //sets motor pin to be adjusted
20  pinMode(Motor, OUTPUT);
21  attachInterrupt(digitalPinToInterrupt(Button),buttonPressed,CHANGE); //inserts interrupt
22 }
23
24 void loop() {
25  if (digitalRead(Motor)==HIGH)
26    {StartTime = millis();
27     AccumulatedTime = 0;
28     PausedTime = 0;}
29  while ((StartTime > 0) && (digitalRead(Motor)==LOW))
30    PausedTime = millis() - StartTime;
31  while ((digitalRead(Motor)==HIGH) && (AccumulatedTime <= StopTime))
32    AccumulatedTime = millis() - StartTime - PausedTime;
33  if (AccumulatedTime > StopTime)
34    digitalWrite(Motor,LOW);
```



## Team Photo

