

PCAOK

Physiological Based Pain Medication Delivery Device

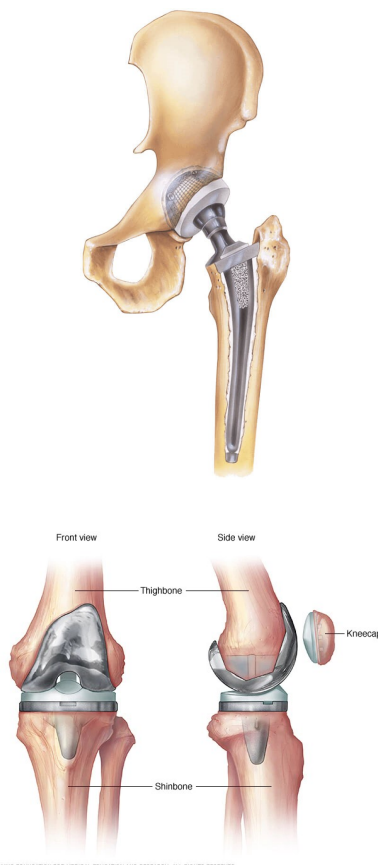
BMEN 3151 Medical Device Practicum

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Clinical Problem

In the elderly US population, 7.4% of individuals experience hip osteoarthritis and 12% of individuals experience knee osteoarthritis. Osteoarthritis is a common form of arthritis affecting the joints which occurs when the protective cartilage becomes worn down. As a result, many patients undergo total knee and hip arthroplasty which is the replacement of the arthritic joints. These are invasive surgeries that leave patients with moderate to severe postoperative pain treated with opioids or other pain medications. This leads to additional patient stress due to prolonged periods of pain, and costs clinicians time as they repeatedly tend to patients on an individual basis. When determining the amount and frequency of drug delivery, there is not currently a method that incorporates physiological pain indicators.



Medical Device Solution

Our solution to address problems with post operative pain management for patients receiving total hip or knee arthroplasty is a PCA drug delivery system that determines the necessity and amount of opioid administration based on physiological indicators. The drug delivery device utilizes patient heart rate data as a means to quantify pain.

The device can be categorized into the device housing and electronics, the patient remote interface, and the algorithm to categorize pain. Inside the device housing there is an Arduino that controls the LCD screen, the three LED indicator lights, the user input, and the pump itself. The peristaltic pump is encased in the device housing and connected to 1 relay and the Arduino, allowing it to deliver medication at a determined rate and duration. The patient remote interface allows the user to indicate when they are in pain by means of a button. It also contains the heart rate sensor and a dial where pain rating is inputted. A pole clamp was designed to interface with the back of the device and mount the device to an IV pole.

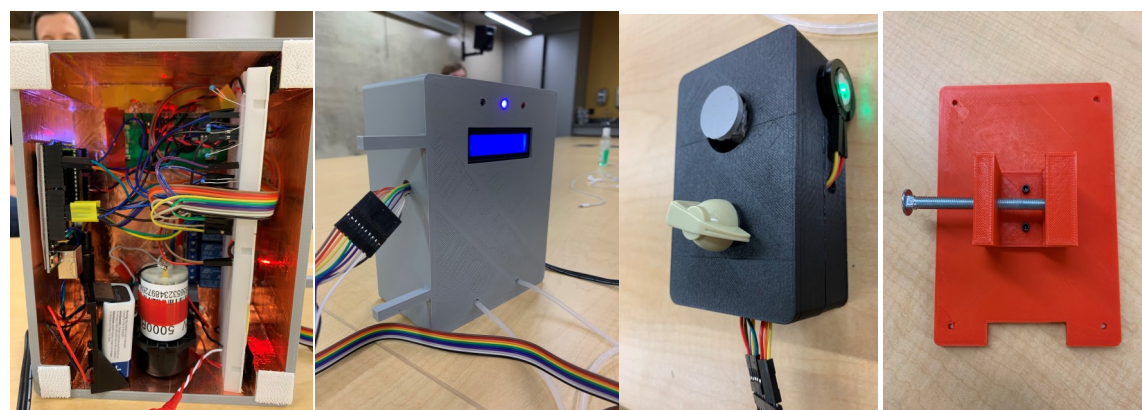
In its current form, the software performs a variety of tasks in pursuit of nuanced medication delivery. Upon device startup, baseline readings for user pain and heart rate are automatically initiated. After initial setup, whenever a patient requests medication via the hand remote button, the software acquires a pain rating and heart rate from the user, then performs a series of checks and calculations. These routines determine previous dosage history, appropriate dosage, time of current inquiry, and dosage to pump timing conversion. Depending on the aforementioned parameters, the software then decides whether to administer medication via pump actuation, or deny administration. In either case, relevant information about the request is stored for later reference.

Needs Statement

Adult patients with postoperative pain following knee or hip arthroplasty may have improved management of symptoms by monitoring physiological indicators of pain and responding with automated drug delivery.

Market Analysis

According to *The Journal of Bone and Joint Surgery*, approximately 1.52% of the US population undergo Total Knee Arthroplasty (TKA) and 0.83% undergo Total Hip Arthroplasty (THA) to treat osteoarthritis. Patient Controlled Analgesia (PCA) is a category of infusion pumps that allow for the patient to request an increase in pain relief medication with a touch of a button. According to a study published in *The Journal of Clinical Economics and Outcomes Research*, the cost of existing PCA devices to a hospital is on average approximately 45 USD for the pump mechanism, 21 USD for the tubing, and 33 USD for the medication at 16 to 21 USD per infusion. The aggregated cost of materials for the joint replacement surgeries per patient to the hospital are 196 USD for THA and 204 USD for TKA. The cost of errors and complications dwarf the cost of materials at approximately 450 USD per affected patient. Blue Cross Blue shield estimates that the cost to the patient of the procedures is 30 thousand USD for inpatient care for both Total Hip or Knee Arthroplasty. However AARP estimates the cost to be closer to 50 thousand USD. According to Fortune Business Insights the market size of Total Knee Replacement in the United States is valued at 5.05 billion USD.



Team Photo

