Pillsy: Using vision recognition algorithms to perform remote pill counts with smartphones

Research Idea

Manual pill counts are considered to be the gold standard for measuring medication adherence among patients who are taking oral solids. However, pill counts that are performed manually are time-consuming and they cannot be performed as often as would be desired. In addition, many patients are managed remotely. Today, it's common practice for specialty pharmacists and other healthcare professionals to ask patients to count pills themselves while they are on the phone. This practice leaves room for error or dishonesty on the part of the patient.

If there was a technology solution that made it more cost effective and practical, patients who are taking opiods or other Schedule II narcotics could be required to perform remote pill counts as part of the pain management contracts they have in place with their prescribing doctor. Such a capability could be used to help ensure that patients are taking the right number of medications at the right time. However, the barriers mentioned above make this impractical, even when done remotely using off-the-shelf video chat tools like Skype and Facetime.

Our idea is to develop software platform to enable remote, automated pill counts, with a system for sending this information back to their healthcare team. Patients who deviate from their prescription patterns will be flagged in realtime, so their healthcare team can determine the appropriate intervention. This information could be used to help deter opiod addition before it begins

Here is a an example use case:
Manny, a 45-year old electrician, receives a prescription for Oxycodone from his pain management clinic for persistent back pain. His pain management contract requires him to use our technology to perform a pill count once per week, to ensure that he does not start abusing his prescription.

Every Sunday, Manny dumps his remaining pills onto a special scale that was provided by his doctor and takes a photo of the pills using our smartphone app. There are 35 pills remaining. The scale weighs the pills and sends that information to the app via Bluetooth 4.0. Because the weight of each oxycodone pill is known, the app uses this information to "count" the number of pills. A photo of the pills is also sent to our cloud-based platform, for a vision recognition algorithm verifies that the pills are indeed Oxycodone, and that there are 35 pills remaining.

Based on his prescription, the algorithm predicts that there should be 55 pills remaining. Because the variance is so high, Manny is flagged to his pain management clinic as a potential abuse case. The clinic then calls him to follow up. By catching this situation early they are able to develop a new plan that prevents Manny from developing a more serious addiction to opiods.

Our idea is to first develop this capability. We will then test this with a pharmacy or pain management clinic to help determine if this system can be used to identify prescription opiate abuse. Eventually, we would like to demonstrate that it can be an effective deterrent to opiate abuse.

Technical Competence

Our team has experience developing complex software and biological products for large corporations and startups backed by top-tier venture capital firms. As founders of an early-stage medication adherence startup called "Pillsy", we are already familiar with the needs of this space, and have several collaboration partners. Our company has received investment from 500 Startups, a top tech accelerator and SOSV, the parent organization to IndieBio.

Chuks Onwuneme – Prior to founding Pillsy, Chuks worked for 9 years at Nokia, where he helped to develop the Symbian mobile operating system, which eventually became the most widespread mobile operating system in the world. He has also worked for several other startups.

Otto Sipe – Prior to Pillsy, Otto worked on the Windows team at Microsoft. Previously, Otto worked on m connected devices for the military at MIT Lincoln Lab and on mobile software development at Wisely.

Jeff LeBrun – Prior to founding Pillsy, Jeff was co-founder and VP of Product Development at Algal Scientific, a VC-backed biotech company that commercialized a new immune-activating ingredient. Prior to that Jeff was one of the first employees at Sakti3, a battery technology company that developed products for smartphones, wearable devices and other applications. Jeff hold a B.S. in Biology from University of Puget and M.S. and M.B.A. from University of Michigan, where he was also a mentor for the NSF i-Corps/Lean Launchpad program.

In addition, we have access to consulting and advice from Ryan Hansen, a professor of pharmacy at University of Washington. We've also consulted with David Richmond, PhD, regarding vision recognition algorithms. David is a member of the Image Analysis lab at Harvard and has volunteered to provide guidance on selecting the best image recognition algorithms. We have also discussed partnership with IBM Watson, which also has image recognition capabilities built into their developer API.

Product Description

Our plan is to develop a system that will enable automated pill-counting to be performed remotely by image recognition software. Patients will be provided with a smartphone app that is able to identify and count pills using machine vision technology. Pill shapes, colors and identifications will be recognized by comparing to a known database of images using vision recognition algorithms. Initially, these images will be a limited subset of prescription painkiller medications. Eventually, it could be expanded to include all drugs that have images stored in the NIH Pillbox database, which has images that can be accessed using an open API. (https://pillbox.nlm.nih.gov/pillimage/search.php)

Using our app, and vision recognition algorithms, pills will be identified and counted automatically. An image of the pill count will be stored securely in the cloud, where it may be manually examined by a pharmacist or pharmacy technician.

In some cases, patients may also be provided with a sensitive, wirelessly-connected scale that can be used to weigh and count the pills. This could provide an additional data point with which to count the pills and to automatically push data to the cloud. If a patient didn't have a smartphone then they could be provided with a low-cost, $50 Android phone, such as a smartphone we have already tested with Pillsy that is made by BLU.

The prototype of our product will consist of a mobile app, a HIPAA-compliant system for storing and sharing personal health information, and a vision recognition algorithm. The vision recognition algorithm will use a machine learning algorithm will be trained against known examples of the pill that is being recognized.

For example, we will train the algorithm to recognize Oxycodone by showing it hundreds of images of Oxycodone in different lighting situations. We will then show the algorithm hundreds of images of other types of pills while providing feedback that these pills are not Oxycodone. Several well-tested open source vision-recognition software libraries already exist, so it's a matter of identifying the appropriate library and building it into our system rather than building such image recognition capabilities from scratch. Once deployed, pharmacy technicians will review score a subset of the images to provide continuous feedback to our learning algorithms. With this system architecture, the power and capability of the pill image recognition system will actually improves with more use. Over time, this fully automated pill-counting capability could be used for other applications, such as with adherence monitoring of specialty drugs and even in clinical trials.

We have already developed an iOS app, Android App, and HIPAA-compliant web application for monitoring medication adherence as part of our core product, Pillsy. However, we have not yet built the image recognition capabilities into Pillsy. Funding from this competition would be applied towards initial work needed to develop this additional capability into our medication adherence platform. Some funding may also be used to retain a consultant who can help us to obtain SBIR funding.

Methods to Determine Target Audience Demand and Willingness-to-Pay

We have already discussed with several pharmacists and doctors who have indicated that this product would be valuable in it's ability to prevent opiod abuse. These qualitative discussions provided us with enough positive encouragement to believe that this application is worth pursuing.

In order to better measure the product market fit we will conduct a more rigorous market study where we reach out to a larger number of people within the healthcare ecosystem. We will aim to survey at least 10-20 influencers or decision-makers at each of the following types of organizations:

- Pain management clinics
- Accountable care organizations
- Drug rehabilitation centers
- Employer health plans

We will then ask questions like the following:

- Do you think this product would be useful and why?
- What would you pay for this product?
- How many patients do you have that would be a good fit for this product? What percentage of your overall patients is this?
- Do you believe that this product or service would be covered by payors?
- Are you aware of any CPT codes that this service could fall into?
- Would you be interested in piloting this product if it was free to pilot?
- Would you be interested in piloting this product if it cost money to pilot?

Based on feedback from these discussions, we believe that we would be likely to find certain places within the healthcare system where this product is more likely to be adopted quickly.

In healthcare, barriers to adoption quite often barriers to adoption have nothing to do with the usefulness of the product and have more to do with availability of reimbursement codes. However, with our core product we have found that Accountable Care Organizations are often

more flexible as long as they believe that the solution will result in better patient outcomes and a reduction in preventable healthcare costs. We may begin the survey with the hypothesis that pain management clinics operating within Accountable Care Organizations will be the best point of initial adoption. The results of this survey could be used to validate or invalidate this hypothesis. If the hypothesis is validated, then we would aim to interview more stakeholders within this segment to learn more about the nuances of their needs and value drivers. At the end of the process, our objective would be to ask for letters of interest (LOIs) that would indicate an interest in piloting our solution. These LOIs would be useful in proving our business case to potential investors, and potentially for an SBIR grant application.