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Preventing Accidental Overdoses by Innovating a Restrictive Prescription Pill Dispenser Vial (RPPDV)

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Abstract: Rather than attempting to prevent all overdoses, the Prescription Pill Dispenser Vial (RPPDV) aims to prevent accidental overdoses by controlling how many pills a user can access within a twenty-four hour period. The RPPDV is much like a traditional pill vial. The body is similar to a conventional pill vial; however, it is modified to prevent the cap's opening without a special screw. The cap is heavily modified and uses a CR2032 or CR2025 coin cell battery to power a gate and the unlocking of the pill cap. The RPPDV works first when the user clicks the red button on the cap of the RPPDV, which opens the pill gate and opens space into a pill container section. This section is large enough for only one pill (or two if multiple pills are required simultaneously). Once a tablet has entered the pill container section, the button must be pressed again to close the pill gate. The user cannot open the lid to the pill container section until the pill gate is closed (see Fig 1.4.1). The RPPDV is similar to an escrow service, with the pill holder section acting as a middleman. The size of the pill holder container prevents access to multiple pills at the same time. The number of times the user presses the button is recorded and timed with a 555 timer set for twenty-four hours. For example, if a drug has a maximum dose of three pills per day, the button could be capped at four cycles or eight total pushes (to allow a grace cycle if a tablet is broken or stuck). Similarly, the gate cannot be opened unless the lid to the pill container section is closed.

The production price of the RPPDV is significantly higher than a traditional pill vial and can get higher depending on the additional features added to the RPPDV. The necessary components to function include CR2032 or CR2025 lithium batteries, a 555 timer, and a coin battery holder, along with plastic and metal molds. The base model alone produces an estimated average cost per unit of $1.33 USD (see Fig 4.2.1). Additional features include adding a Bluetooth Low Energy (Bluetooth LE) component to customize the number of unlocks per day and RFIDs for storage and tracking. Prices vary depending on the specifications of the RPPDV.

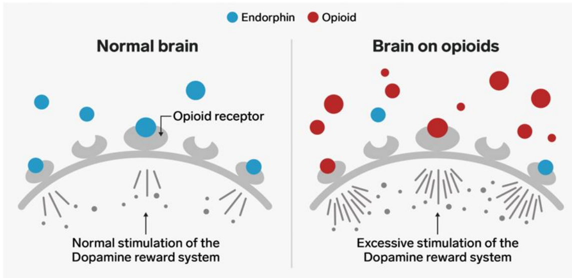
I. INTRODUCTION

The inception of prescription opioid painkillers in the United States brought the promise of reducing severe pain levels down to a manageable level. Prescription opioids also sought to increase the quality of life of those suffering from chronic pain due to injury or disease. Opioids are depressants and work to depress the body's nervous and respiratory systems. Anesthesia is a typical example of how opioids are used to depress the nervous system. The misuse of opioids is known to cause tolerance, a phenomenon in which the body requires a higher dose of medication to offer the same effect. Prolonged use of opioids can cause a physiological or psychological dependence upon the opioid[1]. If the use of opioids is stopped, an individual can experience withdrawal symptoms, including anxiety, perceived restlessness, fever, increased blood pressure, seizures, and in some cases, death. The depressive effects of opioids also explain the common side effects of confusion due to depressed mental activity, constipation due to depressed control of bowel muscles, and a slowed respiration rate due to a depressed respiratory system[2].

Endorphins are the body's natural opioids. Prescription opioids mimic the function of the naturally occurring opioid, endorphin. When endorphins bind to an opioid receptor located in the central nervous system or peripheral nervous system, neurons release the neurotransmitter dopamine responsible for pleasure[3]. The release of dopamine activates the reward system of the body and encourages behavior. Rats placed in a cage that contained a lever that activated the hypothalamus' reward center were found to prefer pushing the lever to activate their body's reward system rather than satisfy their thirst or hunger[4]. Any mechanism designed to target the body's reward system is highly addictive. However, when released in the 1990s, pharmaceutical companies were insistent that opioids were not addictive[5]. As a result, medical institutions and physicians increasingly prescribed opioids for lower thresholds of pain.

Prescription opioids bind to the same receptors as endorphins produced by the body. Opioids taken by pill or injection are present in much higher concentrations relative to opioids naturally produced by the body. Statistically, an increase in the density of opioids increases the likelihood of binding to more opioid receptors. With more opioid receptors activated, the release of dopamine is more substantial relative to a release expected with naturally produced opioids[6].

Fig. 1.1 Comparing the Dopamine Release Between Naturally Released Endorphins and Opioids on Dopamine Production



Source: Business Insider[7]

With increased levels of dopamine, the user may experience a state of euphoria. As a result of a larger dopamine release, the body's reward system is more likely to seek opioids to reward itself. Prolonged use of prescription opioids causes decreased production of endorphins and may result in a physiological dependence upon prescription opioids to deal with any pain level.

Opioids' targeted attack on the reward system is the reason opioids are addictive; the misuse of opioids provides the body with a more substantial reward than using responsibly. Nearly 10.1 million individuals misused an opioid prescription, with over 93,331 people accidentally dying from an opioid overdose in 2020[8].

Finding a solution to decrease the temptation to abuse the body's reward system may be resolved through changes made by plastic prescription vials, containers distributed by hospitals and pharmacies with the purpose of storing prescription pills.

II. SPECIFICATIONS AND FEATURES OF THE RPPDV

The RPPDV in stock form as a pill dispensary is functional but has limited features. Because the number of pills required for an overdose is different for each drug, RPPDVs need different programming codes to accommodate a drug's daily dosage. It would require distinct assembly lines to produce exclusive RPPDV for each drug or modifying the motherboard to customize unlocks per day. While the stock RPPDV's features are limited, it provides an effective solution to accidental overdoses. In the following segment, several different options will be discussed to increase the functionality and user experience of the RPPDV.

A. Connection with Technology

The introduction of technology as a mediator in medicine can help advance the functionality of the RPPDV. Modern urbanization and the widespread adoption of technology have made smart devices much more accessible to the general public. Being able to take advantage of the technology revolution helps enhance the functionality of the RPPDV to prevent accidental overdoses. Note that the external application of implementing a software app model connecting the RPPDV to a smartphone device increases functionality and requires the secure storage of data in compliance with Health Insurance Portability and Accountability Act (HIPAA) laws.

B. Connecting RPPDV To Technology Using Bluetooth

Considering how cheaply plastic prescription cap vials can be created, adding a Bluetooth Low Energy (Bluetooth LE) chip to enable Bluetooth connection to compatible devices will drastically increase user functionality. However, it is undoubtedly impractical for large-scale production with Bluetooth LE chips ranging from .50¢ when bought in bulk. With most prescription pill containers coming in at less than .50¢, adding Bluetooth capability to improve the user interface doesn't make economic sense but does improve user functionality.

It is unlikely that pharmaceutical companies will adopt the implementation of a Bluetooth connection. On the contrary, the Bluetooth connection enables connection to devices like smartwatches, smartphones, tablets, and other handheld devices. Still, it offers the ability to create specialized timers that notify the user when to take their pills, time left until the next dose, and the number of doses taken within twenty-four hours. The Bluetooth connection also allows for an adaptive method of setting timers on the

RPPDV. Assuming a hospital's app can incorporate the user's medication status, physicians can select custom unlock numbers depending on the patient's specific condition. Like much of medicine, one size for medication doesn't fit all; adding a Bluetooth component would allow customization of the time lengths between dispensing pills.

Adding a Bluetooth component to the RPPDV allows for notification reminders to take pills, set custom unlock numbers, and notifications about their prescription cycle in real-time, along with so many more benefits. Generally, adding a Bluetooth component doesn't make economic sense and shouldn't be implemented in all situations; however, it may be beneficial for users to understand their prescription more.

C. Incorporating RFID Tracking For Storage And Distribution Methods

RFID tracking tags are inexpensive tags that are used for tracking, storing, and categorizing pill dispensers. Specifically, if the RPPDV doesn't have a Bluetooth LE component and the timers on the RPPDV are automated and specified to a single drug, including an RFID on the RPPDV is a great way to track which RPPDVs are for a particular drug rather than making a stylistic change to the RPPDV (e.g., a white cap for Xanax, a green cap for Adderall). Additionally, RFIDs can ease documentation in a clinic or pharmacy by providing information on the number of RFID RPPDVs available or out for use through computer databases. While RFIDs don't offer any user use, it includes tracking and an accessible way to identify RPPDVs at a low price to the manufacturer at around .07¢ per RFID and cheaper if bought in bulk. Generally, spending the extra cents to tag each RPPDV with an RFID increases the organization of the stock of RPPDVs and decreases add-ons required to differentiate RFIDs when Bluetooth isn't used.

In the case of using Bluetooth, an RFID may still be helpful for keeping stock or for tracking; however, because it can connect to a smart device, unlock numbers can be set remotely, allowing all RPPDV units to be completely identical.

D. Conceptualizing a RPPDV That Monitors The Number of Pills Taken

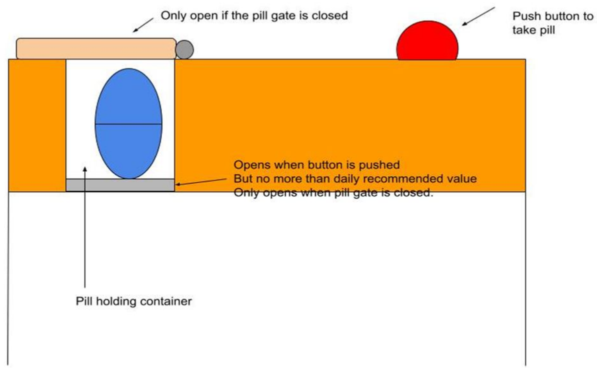
To maximize the number of pills that can be stored in the body of the tablet container, only slight modifications will be made to the container itself, like customizing a special screw that can only unlock the cap of the RPPDV with a pharmacy-produced screwdriver. Instead, the lids of the RPPDV will be modified. The RPPDV works to prevent accidental overdosing rather than the misuse of tablets. Nothing is stopping an individual who is addicted to an opioid from taking their medication. While this implementation does increase the average price per unit, it does help prevent accidental overdose of tablets.

Due to the changes made to the cap, it shouldn't be used with traditional pill body containers because nothing stops the user from unscrewing the cap whenever discomfort is experienced. Instead, a body container should complement the cap itself with screws on either side of the cap and body, preventing the opening without a special screwdriver. Having a unique device that can unscrew the lid is a great way to prevent misuse at a basic level. Again, there is no foolproof plan to protect every user from an overdose. If a user is desperate enough, desperate measures will be taken regardless of the restrictions against them. However, this will stop the average person from overdosing.

The cap will have a section where users can open the lid to access their medication but only when the pill gate is closed. The space between the pill gate and the cap lid is the size of a single pill. This prevents multiple prescriptions from being accessed at the same time. If multiple pills are required, include space for the exact number of pills needed. To open the pill gate, the user must push a red button located on the cap of the RPPDV. This button activates a motor that moves the pill gate, allowing medication(s) to enter the holding container. After the gate is closed (by pressing the same button), the cap lid unlocks, and users are welcome to access their pills. The RPPDV keeps track of how many times the button is pressed within twenty-four hours using a 555 timer. Depending on the prescription, different dosages may be required. It may be a good idea to allow an extra cycle beyond the necessary medication to accommodate for broken or jammed tablets. If a pill is accidentally destroyed before consumed, a user can grab another pill. This also allows freedom when taking prescriptions. For example, instructions like, take a tablet after eating breakfast, lunch, and dinner are variable depending on the person. Sometimes the intervals between each meal are longer or shorter between different people. This places more freedom on the user.

For example, the painkiller drug Advil® has a maximum recommended dosage of six tablets within twenty-four hours. In our case, the RPPDV's button would stop functioning after 12 clicks (6 to open and 6 to close the pill gate) or 14 if the pharmaceutical company places a grace tablet in case of damage.

Fig 2.4.1 An Implementation of a RPPDV Cap Focused Approach



Using a 555 timer can time a period of twenty-four hours, while an external component is responsible for counting the number of times the button is pushed. The button will no longer work after the set number of clicks has been passed.

E. Filling and Refilling of Prescription Medication And Replacing Batteries In The RPPDV

After a prescription has been completed, the pharmacy will have the custom screwdriver (not found on the market) necessary to unlock the cap from the body. Ideally, after their prescription is finished or needs to be refilled, they will be able to go to the pharmacy to receive a refill, and the cap to the RPPDV will be openable. The clinic can quickly refill the prescription and check the battery levels of the RPPDV. Pharmacies should replace batteries if power is low or won't last another prescription cycle. Patients will not be able to replace or refill their prescription, as a modification to the RPPDV will result in a tampering fine.

F. Dealing with the Draining Of The RPPDV'S Battery in the Middle of a Prescription Cycle

Batteries should be tested on each prescription cycle to decipher how much energy is remaining. If the pharmacist believes that the battery will not last (depending on different models), the pharmacist should replace the battery. This prevents batteries from dying in the middle of a prescription. If the batteries die in the middle of a prescription cycle and a local clinic or pharmacy is unavailable, the user has no option but to break the prescription vial. This may cause injury to a patient. Batteries should always be checked during prescriptions and replaced. Broken RPPDVs resulting from a dead battery are the clinic's fault, and the user should not be charged for breaking or modifying the RPPDV as a result of a dead battery. If a user has a prescription that takes months to finish, ensure that the chosen battery has a high enough capacity to last that long.

III. IMPLEMENTING AN APPLICATION IN CONNECTION WITH THE RPPDV

Implementing a mobile, et, and smartwatch application to communicate information about the RPPDV is much more effective than a website application. The application should correlate heavily with whether Bluetooth LE is installed within the RPPDV. A non-Bluetooth RPPDV has no reason to have an application because medication reminders can be set through calendars or reminder apps and refilling prescriptions already has its own system.

A. The Administration of Applications in Medical Clinic or Pharmacies With Legal Storage Of Patient Health Files in Accordance With The HIPAA Law

Implementing an application to deal with Bluetooth-enabled RPPDVs should be done through a pharmaceutical company or medical clinic's application rather than creating a separate application. Keeping the RPPDV data alongside patient files is already how prescription details are recorded but may also allow a user's doctor to monitor or change a user's prescription timings. This also ensures that if the patient's files are already kept in standard with HIPAA laws, there is no reason to create a separate encrypted database with the information the RPPDV provides as it isn't cost-efficient.

If a pharmaceutical company or a medical clinic cannot make their RPPDVs, they can purchase RPPDVs from a pharmaceutical company that produces the units. Additionally, they may expand their company's application to connect to the RPPDV and store information securely in the patient's profile.

1) *The Administration of Applications by For-Profit Companies Not Affiliated With Patient Health Files:* Non-medical companies with the sole intention of gaining profit by working without medical facilities or pharmaceutical companies severely limit the functionality of the Bluetooth component due to Health Insurance Portability and Accountability Act (HIPAA) laws. Legally, a clinic is not violating the HIPAA law if they are sharing medical information for the sake of treatment, payment, and/or healthcare operations[9]. However, unless a medical clinic is willing to partner with the profiting company, they are unlikely to gain any benefits from Bluetooth, like having their doctors set custom unlock times, monitor a patient's refill history, and provide feedback. For-profit companies intending to implement a RPPDV may attempt to collect basic, volunteered medical information from the user, designed to help provide the application with more functionality. For example, basic questions may include the name, sex, age, weight, prescription, date of prescription assignment, an optional reason why the user was assigned a prescription, etc. Companies will need to securely store this information to comply with HIPAA laws as it does contain a patient's personal, sensitive information. Users may not want to fill out all the fields, which limits functionality. Some people may feel uncomfortable, which is why either associating with a user's medical clinic or pharmacy is the best way to approach applications using a Bluetooth RPPDV.

B. *Recommendations on What The RPPDV Application Should Include*

Ideally, an implementation of a mobile application should have some key information detailed within the application. Due to the nature of the RPPDV, it is straightforward to count the number of pill cycles the bottle has been through. Because the RPPDV's anti-jam feature only allows one pill in the holding container, identifying how many pills are left in the bottle and how long the prescription is estimated to last. Information about the pills can be communicated to the application, depending on the number of clicks of the button. Knowing how many pills are left in the bottle allows the user to request a refill ahead of time. Requesting refills can be easily integrated into the application. This is already done online or through phones anyway and can be implemented in the application as well.

Fig 3.2.1 Application Mock-up of Hypothetical Pharmaceutical Company "Grey Plus Medical"

The above mock-up is an example of a hypothetical pharmaceutical company named "Grey Plus Medical" that has integrated the RPPDV (Bluetooth LE edition) into their existing application. This is an excellent option because the user can access their primary medical information and current medical prescriptions while also being allowed to talk with their primary physician about their current medications. While looking at the mock-ups, there are several noticeable changes made. First, the app recommends how much time is left until their next prescription, how many tablets are left in their prescription cycle, and an option to refill the user's prescription. The application also allows messaging the doctor regarding the current medication and advice on getting another prescription or ending the prescription. In this case, the drug is Metformin, so it's unlikely it would get unprescribed so easily; however, for addictive drugs, this is a great feature. The app also allows users to see their prescription history for the particular drug, which is also viewable by the user's primary physician, used to determine how long a patient has been on a drug and if they should leave. If a user also has multiple prescriptions with the RPPDV, they will be able to access their information.

This mock-up also has a unique feature that wasn't discussed previously. The user has the option to dispense an emergency pill to deal with any unpredicted pain. Every time the user needs an extra tablet, they can do so. However, this feature auto-locks after the patient has used their daily allowance of tablets as per their doctor. The auto-lock feature helps prevent overdoses and the misuse of tablets.

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IV. POWER SPECIFICATIONS WITH DIFFERENT CONFIGURATIONS OF THE RPPDV

There can be several different ways to power the RPPDV; choosing the method to power the RPPDV's pill dispensation comes with two main ideas in mind: a rechargeable battery or including batteries.

A rechargeable battery will not be covered; it's impractical as the user is expected to charge the RPPDV, and rechargeable batteries lose their efficiency over time. Unfortunately, batteries are the most expensive component of the RPPDV. Even without including any external features, the RPPDV needs some form of power input to keep track of its timer and gate opening. Generally, the fewer features included with the RPPDV, the longer the battery life will last. This will positively impact the cost of maintaining a RPPDV as the batteries don't have to be replaced as often.

Assuming non-rechargeable cell batteries are being used, the CR2032 batteries provide much more battery life at a compact 2cm diameter. Considering that the diameter of the RPPDV cap is much larger than 2cm, multiple CR2032s can be stored to increase the life of the RPPDV before batteries need to be replaced. The CR2032 is similar to the CR2025. The CR2025 sacrifices power for the sake of decreasing price.

Depending on the type of additional features added to the RPPDV, the battery life will be significantly decreased. Most RFIDs can function independently for ten to twenty years, depending on the quality of the RFID. Deciding to use RFID stickers to the RPPDV will not impact the battery life of the RPPDV.

If the RPPDV is using Bluetooth, a battery indicator can be communicated through Bluetooth through the RPPDV's application. If the RPPDV doesn't have Bluetooth capabilities, having a battery indicator is essential for notifying users when their RPPDV will run out of batteries. A red light during low power will do.

In the case of dead or malfunctioning batteries, neither the gate nor Bluetooth will be functional. Assuming this occurs when the user's clinic or pharmacy is open, the batteries can be replaced, and the RPPDV will be functional. However, if the problem occurs when the clinic or pharmacy is closed, the user will be required to break the RPPDV to access their medication.

Hypothesizing the battery life was determined using the following equation:

$$Battery\ Life\ =\ \frac{Battery\ Capacity}{Load\ Current} \times Battery\ Efc.$$

In general, the battery efficiency depends on the environment, type of battery (lithium vs. alkaline), the shelf life of the battery, and other external factors. In the real world, as a result of the second law of thermodynamics, the battery efficiency isn't going to be 100% (1.0), external factors and battery type are extremely likely to decrease the efficiency at varying levels, however, assuming a lithium battery is used (most energy-efficient yet expensive battery) efficiency can be as high as 95% from the battery alone and up to 80% (0.8) accounting for any possible external factors. Alkaline batteries have efficiency as high as 80% and up to 70% (0.7) efficiency when exposed to external factors. Alkaline-based coin cells will not be calculated in this analysis as they are around the same price as lithium coin cells but lose 10% efficiency. Calculating the battery life for both the CR2032 and CR2025 for lithium or alkaline-based battery looks like:

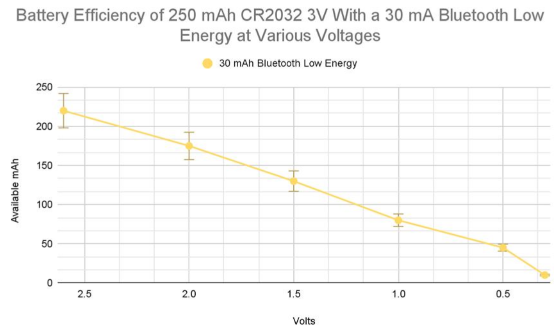
$$Battery\ Life\ =\ \frac{Battery\ Capacity}{Load\ Current} \times 0.8$$ (indicates 80% efficiency)

$$Lithium\ CR2032\ =\ \frac{250\ mAh}{Load\ Current} \times 0.8\ \ Lithium\ CR2025\ =\ \frac{170\ mAh}{Load\ Current} \times 0.8$$

The load current depends on whether Bluetooth is implemented.

To create an economically efficient yet stable configuration for the RPPDV, it is advisable to pair the CR2032 with Bluetooth. If Bluetooth is not used, pair the RPPDV with a CR2025. The CR2032 is an expensive coin battery but can provide extra power if needed for Bluetooth. While the CR2032 can also be used without Bluetooth, it isn't a better option because, while it will last longer than a CR2025 battery, it will constantly discharge its entire life (because it lasts longer than a CR2025, which also discharges, more energy will be lost if the CR2032 discharges over a longer timer period). If the RPPDV is not using Bluetooth, using a CR2025 is both energy efficient and economically efficient. If the RPPDV is using Bluetooth, combine it with a CR2032.

Fig 3.1 Battery Efficiency of a RPPDV using Bluetooth LE with CR2032 Batteries



Bluetooth Low Energy (BLE or Bluetooth LE) isn't particularly efficient. Even at full capacity, it's 73.3% efficient with a 3V battery. This efficiency doesn't include the energy requirements needed to open the pill gates and constant discharge over time. Bluetooth LE shouldn't always be on but should periodically ping the device it is connected to every hour or more or immediately when the mobile application is opened. When Bluetooth LE isn't actively communicating data, it barely uses any power. Strategically activating Bluetooth LE should improve battery life. This will significantly improve battery time.

The battery life is more economically friendly if the Bluetooth component is removed. The RPPDV no longer has a reason to ping a Bluetooth device, so the remaining power can be redirected to dispensing the pill capsules. Removing the Bluetooth component also decreases the cost of the RPPDV by nearly 50%+.

V. CALCULATING THE AVERAGE PRICE PER UNIT OF A RPPDV BY INVESTIGATING DIFFERENT MANUFACTURING OPTIONS

The price of the unit depends heavily on several factors besides the features included in the RPPDV. Determining the process of manufacturing is key to understanding the average cost per unit of the RPPDV.

A. Comparing the Average Price per unit Though Automation vs. Manual Labor

The price of the RPPDV also depends on the method of manufacturing. To ensure the lowest possible price, items should be ordered in bulk and assembled using an assembly line rather than manual labor assembly.

There are many advantages to using an automated assembly line compared to using manual labor. While the initial total cost of an automated assembly line is much higher than employing manual labor, the average total cost (ATC is the cost per unit of output, RPPDV), or price per unit, of producing the RPPDV decreases significantly because more output is being made compared to manual labor. If the barriers to entry are too high to enter an autonomous assembly line, labor should be used. Labor assembly lines generally decrease output and cause ATC to increase (This article doesn't consider the benefits of using a labor assembly to the general public, like increasing the number of individuals employed). Generally, choosing a solution that increases output is a great way to decrease the ATC. According to the law of economies of scale, the long-run average costs fall as output increases (up to a certain point until minimum ATC has been reached). Generally, achieving maximum output is reached easier with automation.

Maximizing the output of the RPPDV is the best way to decrease the average price per unit (ATC) and is generally reached easier if produced through automated services rather than labor assembly lines.

B. Determining the Price Per Unit Prior To Manufacturing Services

Prices vary heavily depending on whether the components are bought in bulk. Often, buying in bulk significantly decreases the price of a single component; for example, Bluetooth chips generally cost around $2.00USD when purchasing in smaller quantities but are around $1.00USD when bought in bulk. Depending on the vendor, the definition of bulk is different as they each have various discounts based on the number of items purchased.

Prices also depend on several functional components that cause drastic increases in prices. Calculating the price per unit of a RPPDV will assume components are bought in bulk order. This model also assumes the per unit cost of a RPPDV before a change in price due to automation or mass production.

Fig 4.2.1 Exploring the Various Costs of Different Configurations of the RPPDV

		RPPDV Item Options ($ Bought in Bulk)					Price ($)
		Bluetooth Chip	RFID Tracking	Plastic Mold (fitted to RPPDV)	CR2032 Lithium 3V	CR2025 Lithium 3V	
		2	0.07	0.5	1.5	0.83	
RPPDV Configurations	RPPDV With Bluetooth, RFID, and CR2032 Lithium 3V	2	0.07	0.5	1.5	0	4.07
	RPPDV With Bluetooth and CR2032 Lithium 3V	2	0	0.5	1.5	0	4.00
	RPPDV With RFID and CR2032 Lithium 3V	0	0.07	0.5	1.5	0	2.07
	RPPDV with CR2032 Lithium 3V	0	0	0.5	1.5	0	2.00
	RPPDV With Bluetooth, RFID, and CR2025 Lithium 3V	2	0.07	0.5	0	0.83	3.40
	RPPDV With Bluetooth and CR2025 Lithium 3V	2	0	0.5	0	0.83	3.33
	RPPDV With RFID and CR2025 Lithium 3V	0	0.07	0.5	0	0.83	1.4
	RPPDV with CR2025 Lithium 3V	0	0	0.5	0	0.83	1.33

The cheapest configuration is the RPPDV with a single lithium 3V CR2025 cell battery.

Depending on the prescription length cycle, multiple CR2032 or CR2025 batteries should be used. The prices calculated above only included one cell battery. Prescriptions that require a longer cycle should have multiple CR2032 or CR2025 batteries. While choosing a CR2032 or CR2025 battery, lithium batteries are around the same price as alkaline batteries. Still, they offer more efficiency and power, so there isn't a need to use alkaline batteries.

VI. PREVENTING POSSIBLE OVERDOSES

Both the Bluetooth and non-Bluetooth versions of the RPPDV use holders containing a single tablet. Users cannot gain access to a large number of pills in one attempt and accidentally cannot overdose beyond the daily limit. Additional timers can be set to prevent all of the tablets meant for twenty-four hours from being dispensed in a single sitting. Again, the purpose of the RPPDV is to prevent accidental overdoses, not prevent drug addicts from overdosing. Nothing may be stopping the individual from hoarding pills over time, but a fatal overdose would likely take multiple pill cycles and possibly days in hoarding pills to overdose. This gives the user plenty of time to convince themselves not to overdose. This allows family members or close friends to convince the user that their life matters. Essentially, restricting access to numerous pills prevents people from making momentaneous overdose decisions while also preventing accidental overdosing.

VII. PROPOSING A BUSINESS MODEL TO ENSURE THE INTEGRITY OF THE RPPDV

While the RPPDV only dispenses a single pill at a time, nothing prevents the user from breaking the RPPDV and overdosing on the contents within the RPPDV. Furthermore, damage to the RPPDV, depending on its features, is too expensive to be replaced by the hospital if the bottle is broken, lost, or stolen. To prevent pharmaceutical losses resulting from non reusable containers, hospitals or pharmaceutical companies should rent out the RPPDV by requiring the customer to submit a $5.00USD (or more depending on model, here clinic should get their money and a little extra for processing fees) deposit on the RPPDV unit before being handed the RPPDV. This proposal also allows non-affiliated, for-profit companies to provide clinics with RPPDV while not violating HIPAA and ensuring no loss. The deposit is returned once the clinic receives the bottle in the condition it was given. This places a limit on overdosing. While addicted people will gladly lose the deposit to gain access to the contents of the RPPDV, most people who otherwise would have been misusers of opioids are unlikely to damage the RPPDV and risk losing their deposit. The number of individuals who may potentially overdose on their medication, as a result, decreases. The pharmaceutical company may also implement progressive fines depending on the number of offenses a customer has committed. If a detectable pattern occurs with the destruction of RPPDV units, intervention, and communication with the patient about having a possible drug addiction are vital to preventing physiological dependence upon the drug or fatal overdoses.

VIII. MANIPULATING THE TEMPTATION TO ABUSE PRESCRIPTION OPIOIDS THOUGH THE VIOLATION OF SOCIAL NORMS

If the user is willing to lose money to overdose on pills, a different approach can be taken. Shame is a powerful tool and is the awareness that one has broken the social norms established by society. The effectiveness of shame works differently depending on the person, with some more capable of dealing with shame than others. However, shame works effectively by lowering the self-esteem of the shamed. When people express shame, they are unlikely to eat or drink in front of others, a way of communicating that they aren't worthy of eating. The manipulation of shame is an essential component that helped design the structure of the RPPDV. The RPPDV is constructed so pills can be periodically dispensed based on how often the medication must be ingested. As a result, the dispenser may be programmed to allow one dispensed pill every six hours, eight hours, or twenty-four hours. This makes it more difficult to overdose on drugs without storing them elsewhere. If an individual submits to their reward center and cannot contain their craving, the plastic RPPDV must be broken to receive the pills. Because the bottle is required for a prescription refill, a broken bottle is a tell-tale sign that someone could be misusing their pills. Both the pharmacist and user know that the pills may not have been used as intended. This provides the pharmacist with the decision to refill the prescription or confront the user about the broken bottle. A confrontation isn't necessary to bring guilt upon the user, as returning a broken bottle is an obvious sign that the user may have been abusing drugs. The abuse of drugs is a violation of a social norm and often leads to profiling and discrimination. Wishing to avoid profiling, destroying the RPPDV to gain access to medication may be prevented. Understanding how differently drug abusers are treated may be enough to prevent users from breaking the capsule. In this case, the RPPDV effectively prevents people from falling victim to their reward center by manipulating a potentially shameful scenario. The plastic prescription vial aims to prevent accidental overdosing and abuse of prescription medication by exploiting a potentially shameful stereotype placed on an individual.

IX. CONCLUSION

The primary purpose of the RPPDV is to prevent the accidental overdose of prescription medication by altering the properties of a traditional plastic prescription pill container. Using guilt techniques and manipulating social norms, some abusers may even prevent an attempt to overdose if the RPPDV is in use.

In an economic sense, having the cheapest possible RPPDV is the best way to ensure a higher production count while sacrificing some customizability. To cater more towards the user's needs, implementing Bluetooth LE may provide more accessibility to information about their doses but may limit the number of total RPPDVs produced.

Though the price of the RPPDV offers no benefit to for-profit companies, its inception is critical to help control the opioid crisis.

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