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Prescription packaging design for the impaired : a meta-analysis.

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Prescription Packaging Design for the Impaired: a Meta-Analysis

By

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a Meta-Analysis

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DEDICATION

This thesis is dedicated to my mother

Mrs. Cathy A. Clore-Kleitz

who has provided me with endless care and support throughout my personal, educational, and professional development for all my life. Her tireless care for my grandmother enlightened and inspired me to seek using design for a greater good, providing dignity and respect for all who may easily be forgotten.

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ABSTRACT

PRESCRIPTION DESIGN FOR THE IMPAIRED

Amber Kleitz

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This thesis is a critical analysis of the state of prescription drug packaging in the United States with respect to unresolved problems for users with visual, physical, and cognitive impairments. It begins with an anecdotal overview inspired by Deborah Adler's journey of prescription drug packaging for her grandparents and her design solution outlined by a case study. This case study focuses on the need for better prescription packaging for those with the aforementioned and neglected issues.

This thesis uses studies in user-centered design, packaging design, and industrial design among others in order to critically assess and question the current state of user experience for those with impairments.

The latter part of the thesis argues that a universal standard would be difficult to implement due to logistical challenges of the private sector of pharmaceutical companies.

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INTRODUCTION

One of the most essential parts of growing old is maintaining a healthy body. As natural decline creeps in on daily life, routine visits to a physician and careful attention to prescribed drugs become increasingly important and sometimes the central focus in life. The misuse of taking the necessary prescription medication to live a healthy life is a problem adults over the age of 65 in the United States face. Sadly, this is due to problems of a long history of poorly and inconsistently designed prescription packaging. For those who prefer to live independently from any home-care, assisted living, or family members, things that used to be simple suddenly become risks.

This thesis will address the main factors that affect the efficiency of a prescription design including, but not limited to, visual, physical, and cognitive impairment. All three of these factors currently affect adults in the United States. Adults over the age of 65 count for 30% of the United States pharmaceutical expenditures, although they only account for 13% of the total population. By researching the problems this population faces. Products that have hit the market in attempt to resolve these problems and I hope to propose a robust solution that may

be tested by pharmaceutical companies. A viable solution could lead to a national standard policy.

I am not the first to assume this is possible. In fact, another designer was faced with the same familial experience for her work with Target Pharmacy, Clear Rx. This case study was inspired by her grandparents taking each others' medicine by mistake. With the same first initial and last name and a similar looking bottle, the label was rendered useless if given little attention. This designer, Deborah Adler, created a system for her grandparents to quickly identify whose medicine they were looking for by simple use of a colored band around the top. In addition, she was able to address further concerns of the hierarchy of most necessary information and custom made iconography that lessened the need for phrases that would otherwise take up valuable space on such a small surface.

Despite the great design success that Clear Rx was, Adler wasn't finished. Adler Design partnered with CVS Pharmacy to recreate a new system for labeling the classic amber-colored pill bottles. This new labeling system features daily routine instructions by using a simple table utilizing color and iconography. Because this label did not need to change the physical design of the bottle, it was much easier for the large pharmaceutical company to adopt than if they had to change the physical production of the bottle itself.

Of these two case studies that will be explored later on, they address different inhibitors separately and without relation to another. Clearly there is no one-fix solution for all — at least not at this point in time. The goal is to evaluate what we know about the most common inhibitors of accurate prescription handling and theorize what we are currently able to test. If there is a solution or a system of small solutions that would be easy to adopt, the user experience of a daily routine could be seamless with as little mental pain points as possible.

There will be three outlined directions to address the issues I stated. The first concern is that of the most common visual impairments including refractive errors, cataract, glaucoma, diabetic retinopathy, and macular degeneration. The second concern will address physical impairments such as arthritis, limited dexterity of hands, carpal tunnel, cerebral palsy, and multiple sclerosis. The last impairment to be addressed is that of a cognitive nature. This impairment is too vast to address all aspects in focus, so I will only address the conditions in the stages before the patient is no longer able to independently perform daily activities. These conditions include types of amnesic and non-amnesic Memory Cognitive Impairment, Wernicke-Korsakoff Syndrome, and types of dementia including Alzheimers.

VISUAL IMPAIRMENT

The most commonly addressed problem in pharmaceutical packaging and the design community is visual impairment. Age-related vision loss is very common, and is responsible for a large amount of responsibility as a cause of medicine mis-adherence. Most common types of impairment include refractive errors such as near-sightedness, far-sightedness, and the like. These cases account for 42% of the total number of reported visual impairment cases. Following refractive errors, impairments such as cataracts, glaucoma, age-related macular degeneration (AMD), and diabetic retinopathy also cause a serious risk for mis-adherence.

Symptoms of blurry or patchy vision and clouding of the lens make it very difficult for a patient to read any words on a label. This label contains vital information that a patient needs to know to decrease risk or harm to themselves. The name of the patient, the prescription name, and the instructions are the most important parts of the label and if misread, the prescription is useless. There are solutions that are already being implemented or tested to address a number of these issues.

The first and most obvious solution would be the use of color. In a study with a population of 126 glaucoma patients, 65% claimed to use color as a way of organizing their medication (Brandt, 2015).

There are traditionally three main elements of a pill bottle that color can intentionally be used to mark special attributes to the medication - the cap, label, and bottle walls. Warning stickers also serve a purpose with colors that are meant to grab attention, like orange cautionary labels. Unfortunately, the color of the label blends in with the current standard amber bottles and a sticker added post-printing may obstruct important information for the patient.

A solution called Clear RX implemented colored rings helped to identify ownership in a multi-person household. The patient chooses one of six colors to be included on the neck of a bottle as a ring or as a sticker on a prescription that does not utilize a bottle design. This project was conceived by Deborah Adler for her masters thesis in collaboration with an industrial designer, Andrew Koch. There was significant research and user testing that went into this project as the patents are iterative and reveal much of the reasoning behind the design. However, there are a number of problems with resorting to only changing the color of the cap or ring of a medication. There are multiple approaches in the use of color on a

prescription bottle including time of day to take it, who the medication is for, and the type of medication. Different methods of color usage on a package make the system unreliable and creates inherent risk for patients.

Many older adults take more than one type of medication and the possibility of switching a cap is alarmingly common. Doctors can not trust that patients will always remember to only open one prescription at a time or to check labels in addition to the color, let alone know the correct spelling of the medication. In a study involving 102 participants of both doctors and patients, overall agreement on a color name was very poor. Four particular medications on a blue-green spectrum had less the 15% agreement rate. (Pujan, 2015)

Color blindness is a condition most common in males and has been linked to heredity. There are different spectrums of color blindness such as red-green and blue-yellow (National Eye Institute, 2015).

Glaucoma is a condition that increases in severity as time goes on, dulling and distorting colors. Eventually a color system will be rendered uses to these kinds of patients. Seeing as how there is no cure for glaucoma, these patients will start to rely on the next solution, pattern and texture.

FIGURE 1. CLEAR RX PACKAGING CONCEPT DESIGNED AND DEVELOPED BY DEBORAH ADLER IN PARTNERSHIP WITH ANDREW KOCH AND TARGET PHARMACY
IMAGE FROM **ADLER DESIGN**

A second solution involves the use of pattern and possibly texture. In addition to color, the use of pattern can supplement quick recognition of specific medications. For those that are unable to accurately read words without assistance especially in the cases of close-proximity, the use of a simple pattern would differentiate even for color-blind patients. The use of only triangles, squares, and circles might not be enough for patients that have more than three medications or three others in the household. However, the composition or repetition in a space would provide more combinations. For example, on two prescriptions that use circles in the pattern, one may have 5 circles in a single unit of the repeating pattern, but the other may have 10, making the second composition much different in how compact the circles are and their size, instantly differentiating them. Similarly, squares can be rotated at 45 degrees to create a diamond shape. In combination to texture, what would originally be a perceptual sensation becomes physical as well.

Textured patterns would be most helpful on cap design so as not to disrupt the important information on the label. It would also be more difficult to mass-manufacture a repeating pattern on a cylindrical surface as where a cap can be flat facing up in a 3D printing process. An example of this was conceptualized by two students, Ashley Ma and Alex Broerman at the University of Cincinnati in 2012.

FIGURE 2. "INCLUSIVE PILL BOTTLES FOR THE BLIND" PACKAGING DESIGN SYSTEM CONCEPT BY ALEX BROERMAN AND ASHLEY MA AT THE UNIVERSITY OF CINCINNATI, 2012 IMAGE FROM MA'S **PORTFOLIO SITE**

Though this design has not been implemented by any major pharmacies or private merchants, the concept won the "Innov8 For Health," competition sponsored by a variety of companies and institutions. They implemented eight unique textures for the top on a flip cap lid. It was important to note that not all visually impaired people read Braille, so they intended not to use this in the design system. Figure 2 shows the CAD model of their concept, showing six of the eight designs, including a view of the cap opening. The colors are vibrant while also being different enough in brightness and contrast from the other. The pattern is large enough for tactile recognition for a patients figures to easily differentiate.

TYPOGRAPHY

Typography could serve as a third solution with changes to typeface, size, and hierarchy. The typeface design and size of the wording would be considered a visual enhancement while the treatment and hierarchy should be considered a textual enhancement. The two are different in that one pertains more to how the eye processes shape and the other relays and interprets messages.

An example of visual enhancement is Maxular Rx, a typeface currently under development designed by Steve Skaggs at the University of Louisville. Maxular Rx is the first font ever to be produced specifically for people with macular degeneration. Macular degeneration affects central

vision, making crossing roads and reading difficult. Maxular employs the use of a bold stroke that is uniform in thickness in order to draw the eye to decipher parts of a letter which make it most recognizable. Additionally, avoiding sharp angles in the letterforms helps to avoid aggravated distortions associated with AMD. This typeface just finished clinical trials being tested against Times, Helvetica, Courier, and a new competing AMD typeface called Eido. So far, Maxular has performed well in the Reading Acuity (RA) test, the most valuable test point for a typeface to be used on a prescription label. Reading Acuity is the measurement of legibility at the smallest print size to be read. Critical Print Size (CPS) is the smallest print size for the best reading speed. Maximum Reading Speed is the measurement of time to speed read the text without the constraint of print size. These three categories of measurement are combined to create a MNRead test. This test showed that Maxular performed better than all other fonts in RA; in critical reading speed it was second to Courier. (Xiong, 2017). There was no significant benefit in the Maximum Reading Speed test. Maxular performed better than other typefaces due to the attention to the particular spacing between specific characters in a word, otherwise known as tracking. It also performed well due to generous x-height and ample line spacing.

Ligatures, or visually combined letters to create a single glyph, which is a single character, symbol, or

graphic used in word. Ligatures are carefully formulated for optimization between legibility and space. For example, the ligatures fi, ff, fl, and so on may connect at certain points that do not hinder the individual perception of a single letter. Figures 1 and 2 show examples of how some typefaces make a single glyph out of these letter combinations to the benefit or detriment of its legibility. Filson Soft and Myriad Pro are two san serif fonts that employ this strategy in different ways.

Word spacing breaks apart words and create negative space for the eye to rest and recognize the start of a new word. Maxular uses 150 units between words which helps as an extended typeface, helping to clearly separate words. This reduced crowding between words benefited Maxular in RA and CPS tests.

FIGURE 3. FILSON SOFT F-LIGATURES
WITH OPTIMAL KERNING AND 0 TRACKING.

FIGURE 4. MYRIAD PRO F-LIGATURES
WITH OPTIMAL KERNING AND 0 TRACKING.

An example of a textual enhancement using type would be Tall Man Lettering. A study at the University of Aberdeen sought to improve the relationship between proximity errors, time pressure, and a visual search of medication names (Irwin, 2012). The first thing to understand about the importance of readable and clear medication names is the history of why they look similar. Drug names that are visually similar have a characteristic called *orthographic similarity*. These visually similar words have nothing to do with the chemical make-up of the drugs, but rather the brand that created them. Understandably, this creates an adverse affect on recognition and memory.

Tall Man lettering was tested in this study to combat this effect, thus diminishing accidental medication mis-adherence. Visually similar non-targets (medications NOT to be taken) and targets (prescribed medication) were placed together in a controlled space to simulate theories of visual search. Stimulus properties include the capitalization of a particular letter, initial, or combination of letters that differentiate the target from other non-targets, drawing attention to the relevant information on the label.

The claim was found to be false after a study with participants that were not pharmacists. Data collected indicated that Tall Man lettering was an insufficient form of textual enhancement for medication labeling,

particularly under time pressure. Reaction time and error rate were relatively unaffected (Irwin, 2012). Though the pharmacist population in this experiment indicated this claim as true, it could be that the frequency of medication dispensed by the pharmacists contributed to their success rate. It is understood that further studies may be necessary to prove the performance of Tall Man lettering. Further studies could include the use of phonetic emphasis on words instead. Focusing on how a word sounds may prove more user-oriented than how it looks, however pronunciation of a word can differ from user to user especially if the word has never been used or heard before.

PHYSICAL IMPAIRMENT

Over 100 different types of arthritis affect approximately 30 million people in the United States according to the Georgia Tech Research Institute (2007). Other common physical disabilities that affect the ease of opening a prescription bottle include carpal tunnel, osteoporosis, and more generally hand dexterity limitations for 15.2 million Americans.

The prevalence of these physical impairments indicates that there is a strong need for inclusion when manufacturing the standard bottle and cap design for their prescription. The bottles that are meant to hold the medications to soothe their symptoms are the same devices that are inhibiting the patient from taking them.

The difficulty in opening the lids came from a need in the 70s and 80s for child resistant design and anti-tampering. Though this is important, only recently have there been proposed solutions in cap designs for those with limited dexterity of the hands. The Arthritis Foundation is a nationally recognized entity that supports and educates Americans that are affected by all different types of arthritis and evaluates companies in relation to how they stand up to their standards. The Ease of Use Commendation comes from a test endorsed by the Arthritis Foundation and

conducted by the Intuitive Design Applied Research Institute (IDARI) who helps companies develop products for people with limitations like arthritis (arthritis.org). The first step of getting the Ease of Use Commendation is for a manufacturer to send their product design to the Arthritis Foundation for evaluation. From there, the product will go through a series of “pass/fail” tests conducted by scientists at IDARI. User tasks such as when the bottle is removed from its packaging, how it is opened, and how the pills are removed from the bottle are assessed and evaluated though multiple uses. After that, a group of eight research participants are chosen with the criterion of grip, torque, and muscle strength for moderate to severe arthritis. Muscle strength is further evaluated for endurance, pinch force and range of motion. So long as seven of the eight participants can successfully open the bottle without pain, the design is approved and rewarded the Ease of Use Commendation.

The Aleve® Easy Open Soft Grip Arthritis Cap received the Ease of Use Commendation by the Arthritis Foundation. The cap is made of an easy-to-grip rubber-like material to provide traction for those that have arthritis. Though this medicine is not a prescription given by a pharmacist, the design could be implemented by manufacturers, such as Centor, that are used for that purpose.

The 1-Clic Packaging System by Centor also received an Ease of Use Commendation. The name 1-Clic comes from the a

audible “click” to indicate the closure has been secured correctly — a feature that encourages consistent and proper use. The closure is versatile with both child-resistant or non-child-resistant caps in the case that seniors and arthritic patients may have children around their medicine.

Although both of these products received the Ease of Use Commendation, they both require the patient to twist the cap or utilize their finger strength in some way. This is a pain point for most arthritis patients. Flip caps and push-to-open lids enable the patient to use other parts of their hand to open the bottle while still remaining child resistant. An example of this is shown in a conceptual design by Christine Chau. Her solution features a larger lid that can be opened in at least three ways: the side-palm of the hand pushing sideways, the bottom-palm of the hand pushing up vertically, and gripping the lid and pulling up. This helps arthritic patients with limited dexterity in their fingers and more strength in the wrist. In addition, the bottle opening allows enough room for the patient to reach two fingers into the bottle rather than pouring the pills out onto the palm. Pouring the pills can result in the patients accidentally dropping them onto the ground or into a sink and down the drain, thus creating an inconvenience and strong pain point. Another example of a flip cap and push-to-open concept is the previously mentioned work of Broerman and Ma. Their design implemented

a simple button that can be pushed by thumb, finger, or palm in addition to the beneficial visual elements.

Opening a bottle or compartment is just one stage of opening a prescription. For some, the opening of a bottle may be too narrow for thick fingers. Others, the size of the pill requires more dexterity or sensitively in the finger tips to grasp the bill within the hollow cylinder and pull or drag the pill out. Patients resort to pouring the medication into their hands or onto the counter, making the margin for error much greater with possibilities of spills.

There is potential now for automatic dispensers that implement voice control, proximity sensors, and biometric security. Speculatively speaking, sometime in the near future, there is a possibility that finger print sensors will be as common as they are a feature on our phones. Simple biometric algorithms could act not only as an unlocking feature to open a lid, but can also work as an identification feature for multi-person households and child-resistant packaging. Automatic dispensers are also closely related to multi-compartment medication devices, which are helpful for patients that also have early to middle stages of cognitive impairments. These devices will be explored in the next section that addresses cognitive impairments.

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FIGURE 5. ALEVE® EASY OPEN SOFT GRIP ARTHRITIS CAP
IMAGE FROM **ARTHRITIS.ORG**

FIGURE 6. 1-CLIC PACKAGING SYSTEM BY CENTOR
IMAGE FROM **ARTHRITIS.ORG**

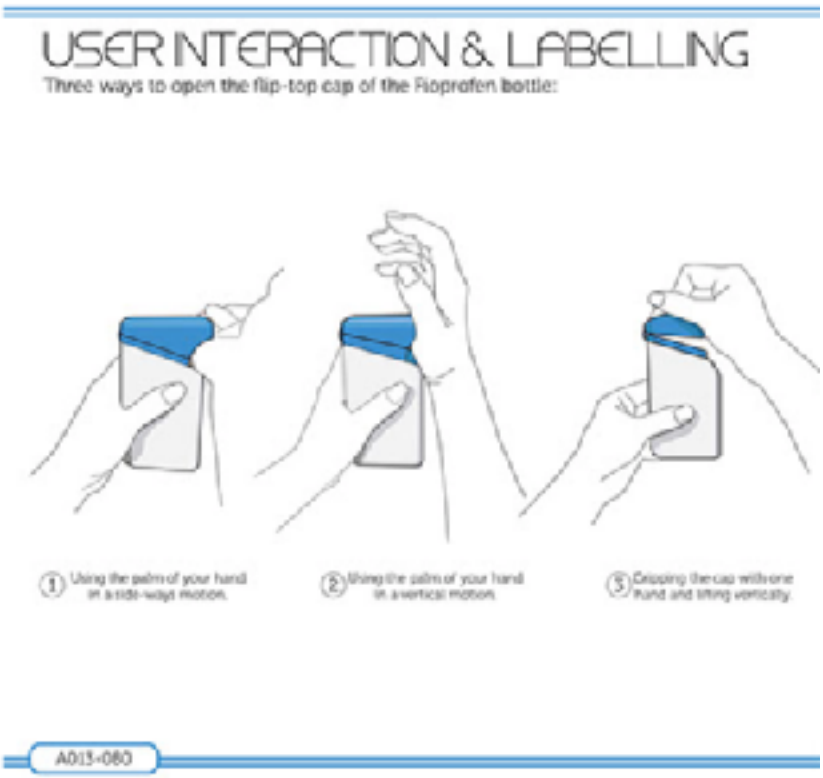


FIGURE 7. MEDICATION PACKAGING, INDUSTRIAL, AND PRODUCT DESIGN BY CHRISTINE CHAU
IMAGE FROM **BEHANCE**

COGNITIVE IMPAIRMENT

The list of cognitive impairments is vast and complicated, and that is why this thesis focuses on groups of adults that are still able to perform activities of daily life, or ADLs. The majority of targeted studies use focus groups of adults 65 and older and use on average four medications chronically. As we age, the possibility of a memory or cognitive impairment increases. Types of cognitive impairment most commonly include mild cognitive impairments and types of dementia.

Dementia with Lewy bodies, or DLB, accounts for 10 to 25% of dementia cases. Severity of confusion and alertness vary from day to day and may include changes in thinking and reasoning, visual hallucinations and delusions. Memory loss may be significant but its less prominent than in Alzheimers. Advanced DLB may cause memory problems in addition to its more typical effects on judgment, planning and visual perception.

Compared to Alzheimers, movement symptoms are more likely to manifest early in DLB than in Alzheimer's progresses to moderate and severe stages later. Up to 5% of the 5 million Americans with Alzheimers developed the the early-onset cognitive impairment before the age of 65. Early Alzheimers patients have trouble remembering recent

conversations and names or events, which can cause a serious mis-adherence in medication routines. Early on, individuals can use pill organizers, calendars, and other devices that can act as a reminder and prolong independence. Later stages of Alzheimers include impaired communication and difficulty speaking, which would make communication with a pharmacist or caregiver difficult. At that point in time, it is understood that variable required assistance will be needed to monitor and administer medication.

There are two different mild cognitive impairments, or MCIs. Amnestic MCI patients forget information like appointments, conversations, and recent events that would otherwise be recalled easily. Non-amnestic MCIs have difficulty in judging time, sequence of steps in a complex task, making decisions, and visual perception. Non-amnestic MCIs would be more common in adults that exhibit mis-adherence to medication routines. This can be supplemented with pill organizers, calendars and reminders.

If multiple medications have been prescribed for other serious health conditions, an organization system is essential to avoid missed or incorrect dosage that could lead to serious consequences (alz.org, 2017). A pill organizer depends on the patient to understand their medication direction from the pill bottle label and plan accordingly for the week ahead. For my grandmother, this is a problem as her mental health declines. My grandmother,

for example, may use a pill organizer but often forgets what day of the week it is. She believes she correctly took her Thursday medicine, but it is a Friday. This can seriously hurt her medication routine given that she may only take one medication every other day, but she accidentally ingests it two days in a row. For this reason, my mother is investing in a low grade multi-compartment medication device (MMD). From there, we will see if my grandmother is able to load her medication correctly herself.

It is common that elderly patients may be taking more than four medications, so the use of a MMD would come in handy. MMDs have been evaluated in multiple studies from usability to emotional experiences related to them. In a study done in the UK on MMD ease of use, researchers found that the most valuable criterion for a successful MMD would exhibit readable text, easily opened compartments including removal, and the ability to transport the device. In this study, nearly all participants lived on their own at home with five as the median number of medications prescribed. Three major commercial MMDs were evaluated against each other and summarized by a formulated score. The three MMDs were the Venalink®, the Dossett®, and the Nomad Clear® and they’re shown in a figure table from the published research document.

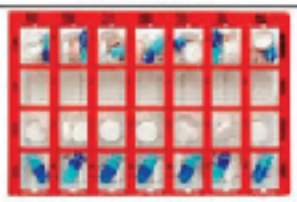
The Dosett®	The Nomad Clear®	The Venalink®
		
15cm Width x 10cm Height x 2cm Diameter Font size 16 for days of the week and 10 for times of the day (each compartment is also numbered with a font size of 16)	22cm Width x 17cm Height x 3cm Diameter Font size 20 for days of the week and times of the day	16.5cm Width x 24.7cm Height x 2.5cm Diameter Font size 14 for days of the week and 12 for times of the day

FIGURE 8. TABLE DATA AND IMAGES OF MMDS: THE DOSSETT, THE NOMAD CLEAR, AND THE VENALINK. FONT SIZES SUMMARIZED BELOW THEIR RESPECTIVE IMAGE.
TABLE AND IMAGES FROM ADAMS, 2013

The Venalink had reasonable text, but the reflective surface it was printed on took away from the clarity. Similarly, the Nomad and Venalink were agreed to have better visibility if printed on a different colored surface. Type size for the Nomad and Dossett were too small. The visual problems create complications before there is evidence of cognitive impairment.

Moreover, the most negatively reviewed MMD was the Vanalink because of ease of opening and removal of medication and was particularly worse with cognitively impaired patients. This study summarizes the main problem by claiming “healthcare professionals may need to be aware of such sensitivities when involving a patient in decision-making” (Adams, 2013). User testing is paramount when creating devices that patients use so often their lives may depend on its success.

Successful features can be seen in recent automatic dispensers. The MedReady by MedReady, Inc. incorporates a function that uses both a loud alarm as a reminder for up to four doses of medication per day. If the patient is hard of hearing or deaf, a bright red flashing light is an optional add on that will appear along with the alarm. The MedReady also uses a rechargeable battery that can generate power for 48 hours if unconnected from a power source in the event of traveling or a power outage.

FIGURE 9. MEDREADY MMD BY MEDREADY, INC. TOP-DOWN VIEW SHOWS THE PATIENT PERSPECTIVE, AN OPEN COMPARTMENT AND TIME DISPLAY ON LID. IMAGE FROM **MEDREADY, INC.**

If the patient is still unable to adhere to the regimen, the MedReady sends a message to the MedReady, Inc. data centers to notify the caregiver via text message, email, or an automated phone call. Although this device is not a beautiful design, it appears as a device that is not to be tampered with. By hindering the patient from tampering, this keeps them honest to the routine and safe from overmedicating. The only way to open the compartment is to have a key that unlocks the lid, which reveals the compartments and the functional buttons that control the time display and alarm systems. Problems with this design is that each dose takes up would be a compartment for another day. In other words, if a patient takes medication at four different times in the day, then each day takes up four compartments, not one. This creates a problem with the frequency in which the MMD needs to be planned and refilled. This would require the patient to accurately refill themselves or call on a caregiver more often to organize the MMD, thus minimizing the independence the MMD is meant to provide the patient.

There are more studies that need to be done on how the MMDs work for independent senior patients living at home. Adherence is directly dependent on not only memory or cognition of how, when, and where to take medication, but also on how the MMD is perceived such as how the text is read and how much the patient themselves can interact with the medication loading and dispensing (McGraw, 2004)

THE SOLUTION

Systemic change is possible, but can be expensive. Preparation, marketing, and regulations will make any solution involving the pharmaceutical industry and government a difficult one.

Manufacturers need to be prepared years in advance of release. Brand managers and product designers must communicate the color of medication class ahead of time so that they are prepared for what colors are used, the sequence, and the frequency of changes that will need to made during production. Multi-year stability experiments will need to take place to ensure the longevity and endurance of the solution. Stability testing is costly as well as the steps that precede it including, but not limited to, design, rapid prototyping, user testing, marketing and proposals. As mentioned before, IDARI offers ease of use testing, but a single design can cost upwards of $6,000. This may seem like a drop in the bucket for government spending, but there must be significant backing for a concept that will be released on a national scale and as eventual policy. After the product is released, there will more than likely be changes proposed, and system-wide modifications may be difficult to achieve. Safety and quality considerations must be balanced with cost

considerations, especially with concern to government if this is a product that will suggest a national standard with policy requirements.

DESIGN

Summarizing the perceived successes and failures of the previously mentioned case studies, completion the ideal design will be a long road to pave. There may not be an answer for a singular design that is accessible and feasible for all, but there are design choices that can be addressed and implemented across the board.

The ideal visual solution would use a typeface similar to Maxular Rx, perhaps a condensed version if possible. As for now, Maxular Rx is considered inefficient in terms of space and reading on a small surface. A condensed version would allow maximum readability at small sizes, even for those with signs of macular degeneration. Type size should generally not be smaller than 8 pt on a paper sticker label attached to a bottle, but should allow for efficient readability without turning the bottle. Color should be used in tandem with pattern, for quick identification and a failsafe for patients with color-blindness. Patterns that are able to be modeled into a 3D texture will further benefit patients that develop severely blurry or dark vision and are unable to read words or perceive shape and color. Speculative design thinking will lend itself to voice recordings that with the push of a button, voice what

medication it is, who it is intended for, how to take it, and if there are any messages such as if a refill is needed.

The ideal physical solution would have a variety of options seeing as how arthritis can effect specific parts of the hands and wrist, each different. Combinations that allow the user to push a small button for a flip cap would be ideal, especially if the lid can close with a “click”, informing the user that the cap is correctly secured for storage. Upon opening the bottle or compartment holding the prescription, the user is allowed enough room to reach into and grab a single pill, no matter the size. Better yet, the patient is able to dispense only a single pill that is released directly into their palm.

The ideal cognitive solution is multifaceted for reasons of convenience and severity of mental decline. Pill boxes, calendars, and organizers are not enough. MMDs are safe and efficient, but are unapproachable for the patient and do not have a friendly interface for the caregiver. An ideal MMD would have pill bottles dispense directly from the bottle, revealing the correct medication at the designated time and day. This would essentially eliminate “the middle man” that is specific to pill compartments. At the that the patient needs to take the prescription, the pill(s) would drop from the container(s) into a singular tray that is secured by the seniors biometric data (a fingerprint). The senior would hear a loud chiming sound,

notifying them that their prescription is ready. In addition, there are remote LEDs that can be placed around the living space that softly flash for a patient unable to hear. The senior that has a smart phone or tablet would also get a notification on their device notifying them of any important information. This UI would be reflected on the physical interface of the device, where they can see the name of the patient, the medication name, and any other notifications like if they need to re-fill their prescription. This option would allow the patient to automatically refill their prescription with the option of delivery to their home, and further assistance installing with the help of a pharmacy technician assistant. If an auto-refill is not approved, they have the option to video call their pharmacist, and leave a video message if there pharmacist is unable to answer.

The patient could come back to their device at another time, and see if there is a notification from their pharmacist saying the auto-refill is approved or not. The dashboard where the patient receives these notifications would also provide general information, instructions, and warnings that are also available on the patient pamphlet normally attached to the prescription packaging the bottle comes in.

PRODUCTION

Types of molds affect how cheap production would be for a systematic change for prescription bottle packaging design. This is a factor that could make or break the production of a solution, thus the knowledge of current manufacturing technology is helpful in pitching the concept.

Different manufacturing techniques include thermoforming, vacuum molds, extruded blow molding, and injection molds. Thermoforming is a manufacturing method that uses heat and pressure but can only be used to create solid or flat items. A functional derivative of this technique is vacuum molding. Vacuum molds work by heating a sheet of plastic to a forming temperature then stretching and forcing the material against the mold by a vacuum. These are usually used for protective coverings, but it is possible to create hollow shapes. An advantage of this method is that color changes are easy, but the simplicity of the shape made from this production technique is not right for prescription bottle or cap design at this time.

Another form of production is extruded blow molding. Fast production time makes for lower unit prices and tooling costs less than injection molding, but is still expensive. With extrusion blow molding, hollow parts are possible and there are a broad range of materials with the availability of different physical properties. This means that bottles are a possibility for both plastic and glass. The disadvantages are that both the tooling and machinery

are expensive, so there are large minimum orders. Long machine setups and production runs make color changes time consuming and expensive, thus extruded blow molding would not be the best route for a solution that relies on implementing bottle or cap color. In addition, the design is not as precise as injection molding, which would prevent the use of textural patterns for those with visual impairment.

Injection molding is the best solution for production. Injection molds work by using high pressure conditions and using heat softened materials (Zema, 2012). The material is shaped in a mold cavity that provides the most intricacy of any of the previously listed production methods. There is no need for water or solvents, making production cheaper. Continuous manufacturing makes production faster and more efficient, adding to the products scalability. The precision of the mold allows for versatility in design, making the use of pattern and texture feasible in the design. In regards to 3D printing, where rapid prototyping and intricate forms can be tested, the two complement each other in production. In this case, a cap or bottle can be used in user testing before ever hitting the market and if testing is successful, mass production can roll forward with injection molding. In mass quantity, a new design can be presented as low cost for the manufacturer and high quality for the patient.

A user interface that is constructed with an MMD would take years to execute in both terms of design, research, physical manufacturing, and software engineering. Existing technology may be obsolete by the time this is released, but transitional technology available now such as RFID tags, NFC chips, and biometric scanners are small enough to implement in so many different iterations. It is difficult to speculate what this product would look like, but further exploration would be beneficial in partnership with industrial designers, user experience designers, user interface designers, and service designers.

CONCLUSION

This thesis was meant to bring to attention the current stage of prescription design for the impaired and offer speculative design suggestions that may benefit both the patient and the healthcare industry as a whole. Medical mis-adherence is a serious problem that can be solved with the use of empathetic human-centered design, careful planning, and acceptance from the parties that control what is standard. With the possibilities that technology offers today, there are endless solutions waiting to be explored.

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