Can You Read This Label?
Design Strategies for Prescription Medication Information

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In 2005, Target pharmacies reinvented the classic orange pill bottle with a new design that boasted color-coded rings, a relocated cap, and most importantly a larger, easy-to-read label. Bottles became easier to open, and medication became easier to identify and consume correctly.

Figure 1. Target pill bottles designed by Deborah Adler. Note the color-coded rings that allow families to identify which bottle belongs to each family member, the large, clear font, and uncluttered label (Adler).

Surprisingly, this innovation did not come from a pharmacist or a pharmaceutical company, but from an art student. Deborah Adler, a master's student at New York's School of Visual Arts, was inspired by an incident where her grandmother accidentally ingested her husband's medication (Adler). While her grandmother did not suffer any serious medical complications from the incident, Adler became aware of how easy it was for medication information on pill bottles to be misread or misinterpreted.

For example, warfarin is a common over-the-counter blood thinner taken by over 2 million Americans. However, when taken with aspirin, another common over-the-counter medication, it can drastically increase the risk of hemorrhaging and internal bleeding (Ho). Though they are benign when taken apart, mistakenly mixing them can cause adverse drug interactions and increase the risk of serious and sometimes fatal side-effects, decrease the effectiveness of other medications, and can lead to overdose. Unfortunately, errors like these are common. In 2007, a report from the American Institute of Medi-

cine reported that "1.5 million patients are injured each year by medication errors, of which more than one-third occur at home," where patients must read and interpret prescription information on their own (Jeetu).

Even with recent innovations like Adler's, there are still massive shortcomings in communicating important health information to the consumer. From a design standpoint, one of the biggest issues with prescription labels is readability–specifically, the font size, placement of the text, and the consistency of the overall label design. For example, a 2011 publication from Consumer Reports found that the average font size on a pill bottle is less than 14 point font, which is approximately 0.5cm tall, for a drug name, and can be as small as 8 point for important drug warning and dosage information (Consumer Reports). Both between different labels and within a single label, the typeface, capitalization, and bolding used are often inconsistent, as are the orientation and placement of text. In one extreme example, a warning label for internal bleeding was placed crookedly and read perpendicularly from the rest of the dosage information.

Figure 2. A typical pill bottle label. The small font, misaligned labels, and unclear color scheme make the instructions on how to properly take the medication confusing and difficult to follow (Consumer Reports).

This variation makes it difficult to locate, read, and process information, especially for persons with

limited or low vision.

Additionally, when pharmacies incorporate techniques like highlighting or underlining to separate information, they often do so excessively. CVS pharmacies, for instance, use blue highlight over black text for multiple sections. This "overwarning" does not prioritize information effectively and actually causes the brain to disengage with information due to overstimulation (Robinson).

The content on drug labels is also often unclear. For instance, vague dosage interval instructions like "take orally twice a day" may be interpreted differently by each consumer (Jeetu). Some may interpret this strictly as "once every twelve hours," while others may assume their medication can be taken anytime during their daily routines. This lack of clarity can result in improper dosage intervals, leading to a patient having too much or too little of the medication in their system at one time and increasing the risk of negative side-effects.

Another underlying issue is the ambiguity around the intended audience for drug labels. According to the FDA, the purpose of the prescription label is to "give healthcare professionals the information they need to prescribe drugs appropriately" ("An Introduction"). This contradicts insights from local pharmacist Frances J. Cheng, gathered in a recent interview. According to Cheng, most of the information on prescription medication labels is for the consumer, not the pharmacist, who can obtain all the necessary information from the small barcode on the side of the bottle instead of from the actual text (Macias). On both the federal and local levels, there is ambiguity with regards to the intended audience and purpose of the label. As a result, individual pharmacies are given control to invent their own systems of labeling, often at user expense.

The best example of this is perhaps Deborah Adler's new bottles for Target pharmacies in 2005. The new design increased readability and the user response was overwhelmingly positive. However, when CVS bought the Target franchise in 2015, the administration immediately discontinued the bottles, citing the high production cost of reproducing this bottle design across their 9000 pharmacies na-

tionwide (Taylor). The decision was met with immediate consumer backlash; for instance, one woman recalled digging through her trash to retrieve old Target bottles and another reported saving and reusing her old bottles at the risk of not remembering the expiration dates of her new medications (Taylor). Because of how easily companies can change their labeling standards, the user experience was once again neglected in the design process.

This is not the first time the public has expressed their desire for change. In an extensive survey administered by the California State Board of Pharmacy in May 2008 it was revealed that a majority of consumers felt drug labels should be easy to read and clearly indicate the purpose of the drug, and that neither of these needs were being met by current designs (Prescription Drugs). Therefore, any future design, whether an overhaul of the entire bottle or a simple label revision, must prioritize user experience via readability, organization, and content.

One way to accomplish this is to bring in user-experience designers who can reach out to consumers as well as pharmacists and doctors before implementing a new design (Babich). Pharmacists would be able to provide input on bottle and label design from a functional standpoint, and doctors would be able to offer valuable feedback and inform user experience designers of the most common medication errors among patients historically. Much of the current user interaction and user experience research is done retroactively, after the label's release; being proactive in the design process allows critical feedback from the user to drive product design.

Nonetheless, even if changes to the FDA's loose requirements are made, it can take years for the standard to be mandated across the United States ("An Introduction"). As a result, labels are variable, and even positive changes are not standardized within a reasonable length of time.

Label effectiveness has been well-researched, yet little has changed, implying that the problem stretches beyond physical design and may include societal and institutional factors. As mentioned previously, slow-moving FDA regulations make changes to label design difficult to standardize and detracts

from any incentive companies may have to alter labels. Even if the problem is well-researched, drastic changes, like less content on bottles, may not be an option for these nationally regulated (or semi-regulated) pharmaceutical industries. Health literacy is another contributor. Defined by the American Medical Association as "the ability to perform basic reading and numerical tasks required to function in the healthcare environment" (Weiss), health literacy can affect user interaction with prescription medication across different demographics. A study conducted by Northwestern University in five different cities across the United States found that adult patients who had completed less education had over twenty percent higher rates of misunderstanding label instructions compared to those who had completed more or higher levels of education (Davis). This study illustrates both how inaccessible design disproportionately harms vulnerable segments of the patient population and how difficult it is to convey health information to a wide range of consumers, all possessing different levels of health literacy.

In response, some institutions have proposed plans for a universal, human-centered design standard. In the same Northwestern study, researchers were able to improve comprehension of the most misunderstood label by over thirty percent by simply incorporating more explicit dosage instructions (Davis). The U.S. Pharmacopeia, the authority that sets voluntary standards for prescription medication, and the Institute for Safe Medicine Practices have also both proposed methods of improving and standardizing drug labels. These include the use of 12-point type, including the patient's name, drug name, and drug instructions on the label, and resolving ambiguity about drug and dosage ambiguity including images or descriptions of drug appearance and by eliminating leading zeros or confusing time periods for dosage intervals (Consumer Reports). However, the lack of enforcement mechanisms for these proposals means that pharmaceutical companies often treat them as suggestions, and ignore them in favor of our current design system.

Clearly, there is both a flawed system in place and a high demand for a better product from its user base. Future labels must change, but how might these changes actually occur?

Firstly, the purpose and function of the label must be well defined. A consensus must be reached at both the federal and local levels so that the purpose and intended audience of the label is understood. This could take the form of implementing a long-term plan for a universal pharmaceutical standard that reduces variability and therefore lessens the likelihood of misinterpretation. In the short term, reform at the federal level may be difficult and time consuming. However, in the long term, shortening the turnaround for new standards and permanently setting timelines for standard reform would ultimately increase user safety. Many reputable organizations like U.S. Pharmacopeia and the Institute for Safe Medicine Practices have already developed and proposed standards; these existing proposals can save time and money for the FDA and have the potential to be adapted and implemented at the federal level.

Finally, because labels are ultimately a communication issue, the pharmaceutical industry must find new ways to communicate important health information. Many pharmacies now have websites where consumers can learn more information about their prescription. However, with the addition of new technologies like QR codes and intelligent expiration dates, information can be delivered to the patient like never before. IDenticard security badges, for instance, are manufactured to develop a large red "X" twenty-four hours after they are activated (TEMPbadge). The development of intelligent expiration dates on bottles has the potential to be a valuable method of protecting consumers from expired medications. Although largely untested in other applications, using this material would not require the label or bottle to be redesigned. Instead, it incorporates technology into the physical label material, making the design more human-centered. While still in the research and development stages, intelligent expirations labels may also be an important stepping stone for incorporating other new technologies on prescription drug labels.

QR codes or "Quick Response" codes are a type of matrix barcode that, when printed, look like small, pixelated squares. QR codes were originally used to

scan and identify car parts but have since evolved from their original form and application (Uzun). Now, anyone with a smartphone can access this information. To obtain the encoded data, the user must download an app, many of which are free, and take a picture of the code. Then the code links the user to websites, stored texts, or sends an SMS message to their phone.

QR codes can store a considerable amount of data and are more versatile than traditional barcodes. For example, one QR code can store one hundred times more information than a barcode and can be read or scanned in any orientation ("QR"). It also has the potential to be printed in smaller formats than the barcode because it is a "two-dimensional" square that takes up less horizontal space.

QR codes could have vast implications in providing medical information to the consumer. On the bottle, or even on the lid, a small QR code could be printed and include all the information previously provided by the label. Imagine a patient walking into the pharmacy and scanning all their new medications with their smartphone. Immediately, they receive an SMS message with a warning for a possible adverse drug interaction, saving them from a possible deadly misstep. While human errors still would not be eliminated entirely, this new system would greatly reduce them.

QR codes can also be applied to assist populations with different accessibility needs or levels of health literacy. After one scan, an SMS message can be sent to the phone each time the user needs to take their next dosage of medication, thus eliminating vague dosage instructions for people with cognitive or memory issues. In other applications, this information can be scanned and then automatically read aloud for those who are visually impaired. Synthesizing these technologies gives users access to the most relevant information and decrease the probability of adverse drug interactions.

While a grandiose overhaul of the prescription medication label may be in order, other more practical and immediate solutions are also available. In the immediate future, revisions to labels must be designed with the user in mind and pharmaceutical companies must prioritize user experience across all levels of health literacy. Moving forward, the purpose of the label must be defined so that a safer standard can implemented at the federal level. Finally, the label must be free to evolve and find innovative new ways to convey information to the user. Unfortunately, today adverse drug events are commonplace, but moving forward with smart, human-centered design they are ultimately preventable.

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