Essay

Rethinking Physician, Pharmacist and Patient Power Structures to Inform Sustainable Prescription Packaging Design.

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1. Introduction

1.1 Area of Study

Pharmaceutical waste[1] results in adverse health and environmental outcomes.The amount of biohazardous waste in Singapore's hospitals and clinics increased from 4,400,000 to 5,700,000 kg between 2016 and 2020. In 2022, medications accounted for 17% of NUHS carbon footprint. (Minist. Health, n.d.-a)This increase is linked to more patients, complex treatments, and enhanced infection control measures. In Singapore, unused or expired medications should be returned to a pharmacy for safe and proper disposal, especially controlled and cytotoxic drugs. For general household waste, it is recommended to follow the specific instructions on the packaging or, if none are available, to first dissolve tablets or capsules in water, mix with an ingestible substance like detergent,and then seal the mixture in a bag before disposing of it in the general waste. (“Control of Biohazardous Wastes and Other TIW from Healthcare and Research Facilities," n.d.)

1.2 Impact of Pharmaceutical Waste on the Natural Ecosystem

Improper disposal of pharmaceutical waste poses ecological and public health consequences.According to the World Health Organisation (WHO), medication waste harms the environment through improper disposal, leading to contamination of water sources and soil. Pharmaceutical residues released into the environment can directly and indirectly affect living organisms and ecosystems, including toxicity levels, secretory disruption, changes to microbial communities, and the selection of AntiMicrobial Resistance (AMR). Although much of the research impacts aquatic organisms, there is also documentation of wider consequences. Sharp decline in bird species have been reportedly linked to the disruptions of key ecological functions. Humans are directly exposed to environmental risks through contaminated water and food.The exact dangers are still being studied, and these risks are made more complex by the indirect effects of ecosystem decline and the spread of antimicrobial resistance. (OECD 2019)

1.3 Impact of Pharmaceutical Waste on our Healthcare System

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[1] In this essay, 'pharmaceutical waste’ and ‘medication waste’ are used synonymously as both terms refer to the same type of waste.

Home Medication stockpiling is the excessive and inappropriate accumulation of prescription or nonprescription medicines in the home for future use. It is considered a public health concern that often leads to medicine wastage, potential safety hazards, and increased, unnecessary costs for patients and healthcare payers. Pharmacists across Singapore agree that the issue of wasted drugs is an increasing concern in Singapore's already costly healthcare system. Ms. Irene Quay, President of the Pharmaceutical Society of Singapore, declared that the cost of drug wastage detected during a pharmacist's home visit averaged SGD $663 per patient. ("Explainer: The Cost of Wasted Drugs, and Why It Matters - CNA," n.d.) For a heightened sense of security, patients may have the tendency to stock excess medication at home. Improper disposal by household sources contributes a significant amount of dispersed waste, with inventories of unused medication being held by approximately 95% of families. (Baroka 2025) Healthcare providers are many times unable to limit their patients from such behaviours. A senior pharmacist relates, "*Hoarding of medication is a more physiological issue. If I have many black dresses at home and I see a pretty black dress, I would still buy it."* This narrative is consistent with what another patient shared *"I don't understand people who don't hoard medication. What if something happens and you need it?"* As Singapore looks to contain its rising healthcare costs, we should look at ways to curb medication waste.

Traditional pharmaceutical packaging focuses on functionality but has neglected sustainability, patient needs, and its potential values for individuals, healthcare communities and the environment. In this essay, through observing the interactions between patient and healthcare providers, I explore how medication packaging can address issues in pharmaceutical waste. It also addresses broader themes of compliance, power dynamics, and care within the healthcare context, concluding with recommendations for future design and research.

2. Overview of Prescription Packaging and Waste In Ophthalmology

2.1 Drivers and Constraints

In the ophthalmology department, prescription eye drops play a central role for the management of chronic eye diseases.They commonly come in the form of single - use vials and multi dose bottles. The vials consist of higher dose items such as allergens that should

be administered up to 4 times a day. These bottles are designed to store medications that contain preservatives such as Benzalkonium Chloride which prevents decomposition by microbial growth or by undesirable chemical changes. The expiry date, often indicated on the packaging, guarantees the full potency and safety of the medication which usually lasts 28 days after opening and requires an air tight seal. The reuse or refilling of containers is typically prohibited, given the inability to ensure sterility outside of controlled manufacturing environments. Although several studies have demonstrated the safety of multidose preservative-free bottles under certain conditions, their implementation is constrained by apprehensions regarding legal accountability and the demands of rigorous regulatory adherence. (Seal 2005)

The period of time when medication is safe and effective to use is primarily called the shelf life. Ophthalmic drops are administered directly into the eye and pose a threat of infection or even blindness if the drug is expired.This confusion can lead patients to prematurely discard eye drop bottles, as they may mistake the 28 day usage window after opening for the actual expiry date, fearing the risks associated with using expired medication. Furthermore, patients lack a clear visual cue to indicate the end of this 28-day period, often relying on self-directed efforts like manual labeling to track safe medication consumption. Aside from prescription drops, many patients and medical facilities discard multi-use, preservative free eye drop bottles prematurely, often within 14 to 28 days of opening, even though they are generally safe to use until the manufacturer's expiration date. A study done in the Ophthalmology department of a Chicago clinic revealed that eye drop bottles were routinely tossed in the trash well before the Food and Drug Administration (FDA)-regulated expiration dates printed on the bottle.This common practice, driven by self-imposed, non-evidence-based, or overly cautious guidelines, leads to significant medication waste, with an average of 72% of the medication remaining in the bottle when thrown away. (“Improve Sustainability in Eye Clinics With This One Simple Trick,” n.d.)

3. Environmental Impact and waste management challenges

3.1 Waste Generation and recycling infrastructure

The entire life cycle of eye drop bottles, including the extraction of raw materials, manufacturing, packaging, global distribution, and eventual disposal, contributes to greenhouse gas emissions. Excessive packaging waste is produced due to standardised sizing in the packing process and poor dimensioning of the packaging sizes. During a

fieldwork in the main pharmacy, plastic ziplock bags were seen lined up to be packed. [2]To avoid prescription labels from unintentionally getting peeled off or destroyed, patients' information is directly printed on them. These ziplocks bags are not recyclable as they fall under Singapore's Personal Data Protection Act (PDPA)[3], the disposal of 'data waste'. (Lanois 2014) The hospital is legally required to ensure that personal data is rendered unreadable and irrecoverable, and they remain responsible for the data even when using third-party disposal services which makes disposal and recycling very challenging. Eye prescription drop bottles and single-use vials are generally not accepted in curbside recycling programs for several reasons, primarily due to the complex, mixed plastics they are made from, their small size and contamination risks. Healthcare facilities generate the highest volumes of pharmaceutical waste, with hospitals producing 1.15 kg daily, where specialized units contribute excessive amounts.

Furthermore, with industrialization, the use of automated sorting systems is being rapidly adopted in the hospital. In NUH, the automated sorting system packs medication in standardized white boxes with a small transparent slit that acts as a visibility window. Unfortunately, this eliminates the trademark of several medication packaging that differentiates them from the rest.[4]

3.2 Carbon Footprint Across Conditions

Ophthalmic patients require medication that is long term and will expire over time. Hence, this means a constant stream of waste is generated, and it is challenging because of the factor of time. While individually small, their cumulative environmental impact is substantial. For instance, in the context of dry eye disease, the annual carbon footprint of treatment for each individual has been estimated at 7 kg of CO2. A research article on dry eye treatments estimated that if 200 million people worldwide used single-dose vials of lubricating drops four times daily, this practice alone would generate 22,600,000 kg of plastic waste per month, highlighting the significant carbon footprint of ophthalmic plastics. (Govindasamy et al. 2022)

In parallel, glaucoma, an eye disease that affects 80 million people worldwide, requires long-term use of daily eye drops to control intraocular pressure. 20 million individuals make up just a quarter of this group. If each person uses a 5 mL bottle containing 2.5 mL of solution on both eyes every month, this adds up to 240 million plastic bottles used per year,

[2] Refer to Appendix Table 1 for Images of the NUH Main Pharmacy
[3] Refer to Appendix Table 2 for image of PDPA Packaging
[4] Refer to Appendix Table 1 for Image of standardised pill packaging

generating 720,000 kg of plastic waste annually. At a tertiary care level, an ophthalmologist with 40–60 glaucoma patients per week, would oversee the use of approximately 3000 plastic eye drop bottles every year, which results in roughly 6 to 9 kg of plastic waste annually. (Queen et al. 2016)[5]

3.3 The Role of Delivery Methods in Household Medicine Waste

While home delivery reduces crowding in hospitals, it often results in higher rates of accumulated medication compared to in-person pickups, partly due to over-ordering and, in some cases, less structured, automatic, or over-prescribed replenishment.The expansion of medication home delivery systems, particularly since the start of the COVID-19 pandemic, has significantly enhanced patient convenience and access, especially for those managing chronic diseases. However, this shift has also exacerbated the problem of pharmaceutical waste. Data suggests a high prevalence of unused or excess medication at home, with reports indicating up to 52.8% of patients in some areas experiencing this issue. (Olesen et al. 2026) While home delivery successfully reduces hospital overcrowding, it often leads to greater medication accumulation compared to in-person collection. This accumulation is frequently linked to factors such as over-ordering and the implementation of automatic, less carefully managed, or excessive prescription replenishment processes.

4. The Journey of Medicine

As part of a team of designers investigating ways to improve sustainability in NUH's Ophthalmology Department, I spent 8 months using various methods to identify opportunities to streamline workflows and redesign tools that can mitigate the impact of environmental waste. By mapping out a flow of the prescription journey, I am able to identify at which touch points the waste begins. [6]

[5] Furthermore, some glaucoma drops such as Xalatin and Zioptan are fridge items, making it hard for patients to keep track of remaining amounts as these liquid drops have shorter expiry dates.

[6] Refer to Figure 1 for the journey of medicine and Appendix for a blown - up version.

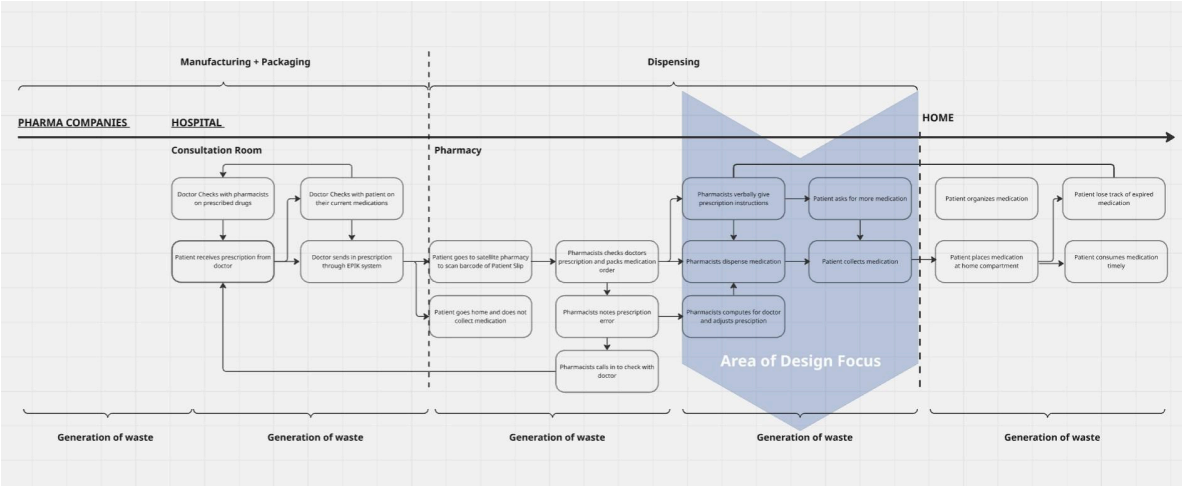


Figure 1. The figure shows categories of how medication travels in the hospital and where the majority of waste is produced

Pharmaceutical waste is generated throughout the journey of medicine through a hospital. From the extreme left of the diagram, patients first receive a prescription based on their diagnosis. However, the quantity the doctor prescribes may be inaccurate due to the patient's uncertainty of other medication they have at home. From that interaction, medicine waste happens as a result of no controlled baseline. Patients then head to the pharmacy to collect their physical prescriptions. At the collection counter, inconsistencies in patient comprehension, differing beliefs or healthcare provider communication often results in an excess of medication dispensed. Towards the end of the journey map, patients then bring home their medicine and several factors such as poor medication management behaviours add on the waste.

A patient who had picked up his medication shared how in the current medication delivery systems, he is able to pick between a ‘Medication Refill’ Option or ‘Repeat Prescription’ option through the NUHS app. The ‘medication refill’ option is sent into the pharmacy system where pharmacists are then able to check the balance and pack the remaining prescription accordingly which makes it easier to account for the waste. On the contrary, ‘repeat prescription’ orders are sent directly to the clinic and doctors usually review then spontaneously process a new prescription. Upon deeper analysis of the app, it clearly showed that repeat prescriptions were significantly easier to obtain as they require fewer steps than a refill.

As shown in the diagram, the core design focus is the physician-pharmacist-patient interaction specifically at the point of medication dispensing. Although events preceding and

following the pharmacy visit are considered, they are not the primary focus. This particular interaction point offers the greatest opportunity for impactful design because it is a relatively controlled environment yet lacks heavy constraints on the individuals involved. This stage of the medicine journey facilitates the most conversational exchange, providing ample space for design intervention. Crucially, all participants in this interaction share a common foundation for communication, the prescription and its associated outputs.

5. The Standard Model of a Prescription

A prescription, abbreviated as ℞ or Rx, is a formal communication from a physician or other clinicians to a pharmacist that authorizing them to dispense a specific medication to address individual patient diagnosis, and every prescription drug comes securely packaged. Prescription packaging refers to the specialized materials and containers, such as multi dose bottles, blister packs, and vials that are used to safely store, protect, and dispense medication. It ensures drug stability by protecting against moisture, light, and contamination while providing essential, regulated labeling for patient safety and compliance. (Walsh and Jones 2019) Prescription labels are an integral part of prescription packaging and overall drug labeling. The label is a crucial component affixed to the immediate container - a vial, bottle, or blister pack, and provides essential, legally required information for safety, such as drug identity, patient name, and dosage instructions. The prescription is more than just a downstream flow of instructions. They are central in the physician - pharmacist - patient relationship where physical packaging and labels serve as a communication tool at various stages of interaction. [7]

[7] Refer to Figure 2

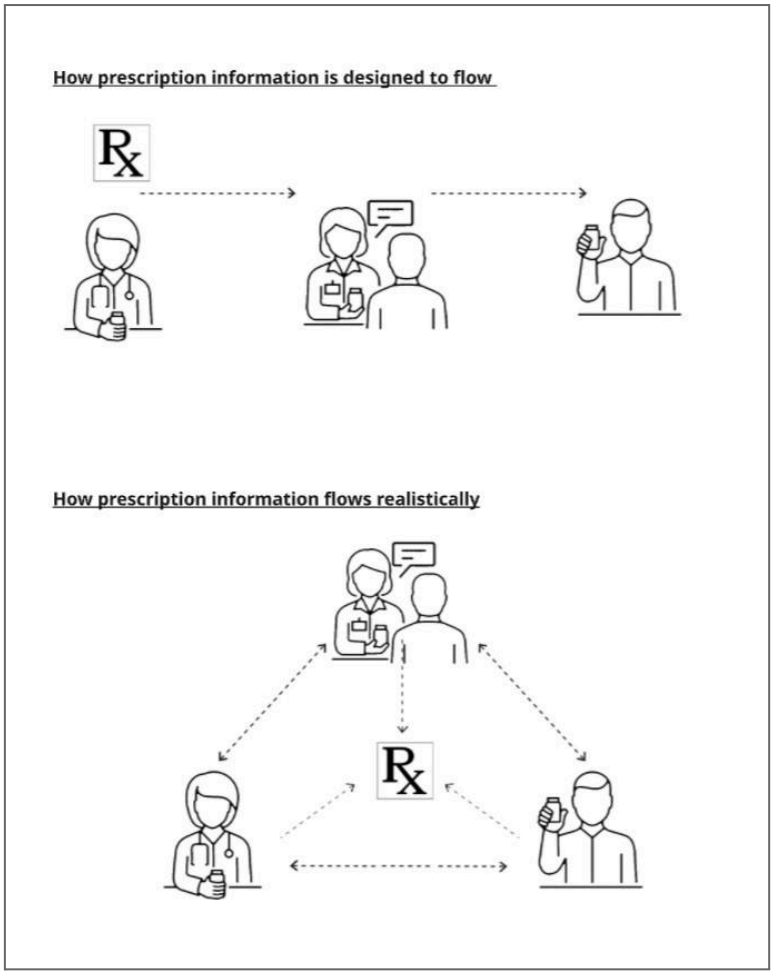


Figure 2. The figure depicts a theoretical diagram of how physical prescriptions move linearly through the doctor - pharmacist - patient relationship and simultaneously exist as a central touchpoint

6. Methodology

6.1 Ethnographic studies at the pharmacy

Observations were done at both level 17 and level 15 satellite pharmacies in NUH. A Satellite Pharmacy is a decentralised unit which operates similarly to the central inpatient pharmacy. Both provide specialised medication dispensing services for hospitalised patients. Each observation session lasted 2hrs, a total of 3 sessions spaced out between 3 weeks.

The exchange between pharmacist and patient reveals patient needs. Some queries I heard over the counter were " Do I have to put the eye drop in the fridge?" and "I'm here to collect 2 of my prescriptions but can I get a 3 month stock of refresh (lubricating) drops?" From these gestures and routines that surface, I categorised the questions into 10 description headings to construct a legend.[8] The descriptions consist of 'Over The Counter (OTC) Meds' referring to queries such as request of lubricant drops or purchase of other general medication items. Another description 'Safe RX' refers to whenever the pharmacist has to recheck with the doctor on prescription notes or clarify with patients on their other medication. With the data I collated, By using a checking system template, I was able to categorise the data and provide a binary score accordingly. I then crosscheck with a pharmacist to rank the difficulties of each task and arrange them on a self reporting Likert-type scale ranging from 1 to 10, with 1 being the least cognitive heavy task and 10 being the hardest. I then translated the data into a graph to see the frequency of commonly asked questions and evaluate the common pain points that generate medication waste. From the graph, I was able to deduce the 3 most challenging tasks pharmacists do daily. They consistently recalculate the 'bring - home' quantity of medication for the patients, repeat instructions verbally and clarify the unit cost of their medicine. These essential findings help pinpoint design flaws in the prescription packaging that could potentially contribute to medication waste.

[8] Refer to Appendix for Legend

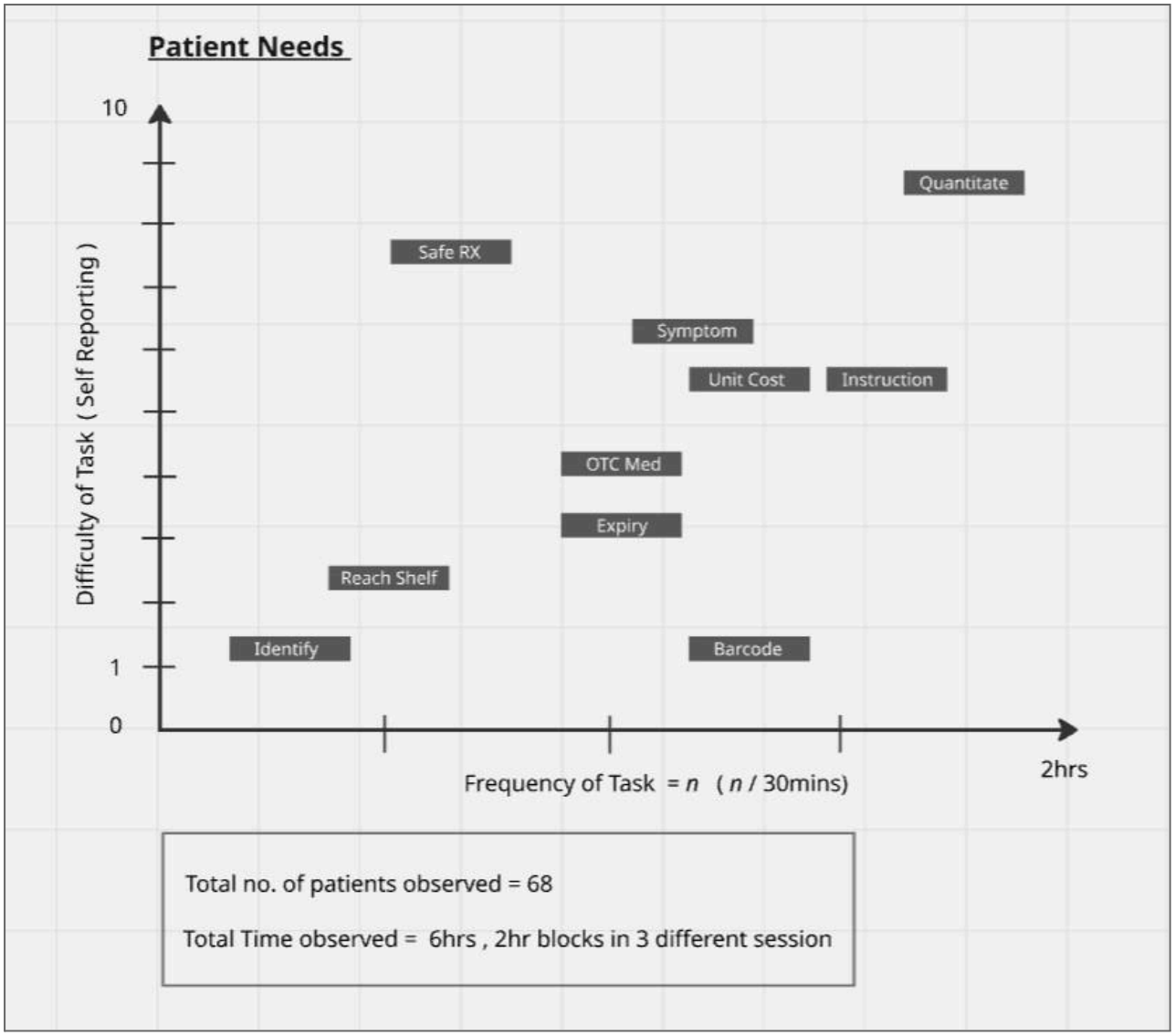


Figure 3. The graph above shows the difficulty and frequency of task in the medication dispensing process at the satellite pharmacy. [9]

[9] Refer to Appendix Tables 3 and 4 for more detailed data and breakdown of the graph

6.2 Shadowing sessions with the pharmacist



Figure 4. The sketch above shows a senior pharmacist using a folder and her laptop to conduct a medication reconciliation session at the benches in the clinic waiting area with a patient.

A session at the medication reconciliation (MTRC) sheds light on the pressing matter. In this scenario, pharmacist professionals operate like detectives, tapping on their observation skills and knowledge while running investigative tests. Medication reconciliation is a systematic process of producing a detailed list of active medications a patient is taking, to ensure precise and comprehensive medication information after their discharge from the hospital or when there is a change in their medication plan which requires them to discard the older prescribed drugs . It also has a positive influence on the patient's treatment plan, when the patient stays involved in the process. One of the documented experiences was of a diabetic

patient who was admitted to hospital due to hypoglycemia and experiences renal problems.. While the system suggested proper compliance, she complained about her condition worsening and showed that her feet were swelling, a symptom of her condition worsening. The pharmacist noticed that there had been a switch in the patient's treatment plan a few months ago. She also noticed that the patient had previously collected many tablets. Thus, she interviewed her to find out if he was correctly taking his medication."*To my surprise, she was remembering old doses by heart. This medication makes you go to the toilet a lot and as a driver, she found it disruptive to her job. She skips her warfarin pills, taking double the amount at night.*" she recounted. "*These issues are often picked up during our short 15 minute sessions. I collaborate closely with the prescribing physician to see if we can amend the dosing regimen, as well as provide thorough patient education and medication counselling. The key is to have good communication with physicians as well as patients." she added.* Technology is an asset in the reduction of medication waste but the human touch remains vital. Tracing patients' medication history is now much easier, because of efforts to unify electronic medical records nationwide. [10]. Despite these technological developments, there is still a need to check with patients and caregivers about their medications. They sometimes question, *"It's already in your system, why do you have to ask me?" A Pharmacist who works in the main building states It is easy to find information in the EPIC system or refer to the patient medication list, that is what we are formally trained to do. But they don't understand that my purpose is to evaluate their behaviour. It is much more difficult to get the 'truth' from the patient and their caregiver because we are dealing with people who have different personalities.* She has different approaches for this, including looking for non-verbal cues to arrive at a conclusion. For example, a patient who is not entirely forthcoming about their medication compliance may avoid eye contact or dismiss her questions. When assessing whether a patient is following their treatment plan, the pharmacist may note if they are able to verbalise their drug dosage and frequency, or indicate characteristics of a particular drug.

6.3 Interviews

Open-ended in-depth interviews were conducted to gain a better understanding of participants' experiences of prescription pain points and their challenges.The participants were asked questions such as (i) What would you say is the biggest factor to medication waste (ii) What processes do you think contribute to medication waste (iii) what are some

[10] The EPIC electronic medical record system is undergoing a change to streamline their workflow and ease the cognitive load of pharmacists and doctors. The reconfiguring meant more automated steps which lead to significant time savings for clinicians, as well as improve patient safety. (Default, n.d.)

challenges you face when communicating with patients / other healthcare providers. A total of 3 pharmacists, 3 doctors and 5 patients were interviewed to provide their perspectives. All interviews were conducted in English and recorded through pen and paper. [11]

7. Data Analysis

I began by reading the transcripts of the interviews several times to make sense of them.The transcripts were also supplemented by ethnographic observations that documented our sense of the situation, nonverbal cues, or environmental factors that were relevant to understanding the nuances of the interview. Key statements or phrases were highlighted and extracted from these transcripts and assigned a theme to describe the finding.The themes highlighted were clustered into the broader categories of workflow pain points related to prescriptions, organisational culture on prescribing habits, and agency for proper disposal of prescription packaging.

8. Debunking Confirmatory Bias Among Healthcare Providers

A consistent perspective across the interviews is the efficacy of prescription labels. These labels come with printed instructions processed through their system. While specific dimensioning of label sizes may vary based on the medication packaging, according to the Singapore Medicine (Labelling) Regulations, pharmacy label formats should use standard sizes such as 102 mm × 52 mm for large ones or 80 mm × 40 mm for smaller ones. They are required to have text with a minimum height of 1.5 millimetres to ensure legibility, with a common recommended font size of 12 point or higher for patient-centered information, often featuring a dedicated patient side for key instructions, using clear, sans-serif fonts like Arial. (“Medicines (Labelling) Regulations - Singapore Statutes Online,” n.d.) Several Key considerations to improve understanding for patients who are elderly are pictograms and bilingual features that can be produced in English and a second language such as Chinese, Malay or Tamil.[12] The pharmacists that participated in the study generally agree that the current sticker labels are already optimized for patients. I conducted an investigative task

[11] Refer to Appendix for Interview Transcripts
[12] Refer to Appendix for Images of the sticker labels

where 10 different participants were asked to perform 9 different tasks.[13] It involves finding the name of the product, number of times to administer the drops, and concluding the correct expiry date, etc. To reduce the outliers, participant eyesight capabilities and age range were considered. For it to be a fair study, individual time taken to complete the tasks were excluded. To ensure that all the patients are (i) using glasses with a spectacle degree higher than 400 (ii) above 35 years old, and (iii) proficient in English. This thorough product review reflects that patients still face difficulty at attempts to locate, read and comprehend instructions written on these labels.

Task	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Are you able to identify medication name	NO	YES	NO	YES	YES	YES	YES	YES	YES	YES
How many times to administer drops	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES
Are you able to identify which eye	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES
Are you able to identify expiry date	YES	NO	NO	YES	NO	YES	NO	NO	NO	NO
Are you able to read the information on the bottle	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES
Are you able to read information on packaging	NO	YES	YES	NO	YES	YES	YES	NO	NO	YES
Are you able to identify the use of the eydrops	YES	NO	NO	NO	NO	YES	YES	YES	NO	NO
Are you able to locate and use the QR Code	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES
Are you able to identify the proper storage method	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES

Figure 5. The Table above depicts the results of the investigative exercise in relation interrogating design gaps of a prescriptive eye drop packaging

9. Addressing Design Gaps

9.1 Co- Creating Session with the Pharmacist

Based on the investigative test, I could deduce that the 3 main issues patients face when handling medication packaging were (i) poor visibility of the expiry date (ii) important information being separate from the actual packaging and (iii) unclear instructions.Towards the ideation phase, I then utilised Design thinking principles to address these design gaps and sketched several archetypes of prescription packaging, prototyping simple probes to support this discussion. It pushed us to hypothesize that a label can come in many forms.[14] The aim of the sketches was to facilitate a session where she could experiment with different forms of labelling when the constraints of her job scope were lifted. As a pharmacist, she performs her duties under strict regulations and formalities. The co-creating session was an opportunity for her to share the thought process and preferences for certain iterations

[13] Refer to Appendix for image of the **Simbrinza** eye drop packaging used for this study
[14] Refer to Appendix for Sketches and probes used during the co-creating session.

without being burdened by these anchors. For instance, she commented how most ophthalmic patients are elderly and would not be tech savvy enough to appreciate digitised features or experience physical impairments due to their advanced age. They would rely more on sensorial design such as tactile and manual labelling methods.[15] This is a pertinent point on how patients have different preferences that need to be contextualised, tested and validated in the process of designing for them. The pharmacist also mentioned the time pressure of working at the pharmacy and how it may cause information to be transcribed wrongly. These key insights would not have been as explicitly mentioned from only verbal interviews.

9.2 Limitations

A limitation of this study was the sampling method, as the majority of participants were recruited from the National University Hospital, specifically the ophthalmology department located on level 17. Regarding the broader scope of research, the results from meta-analysis generally support the effectiveness of packaging interventions in reducing medication waste. However, the study on packaging interventions had its own limitations, including the exclusion of packaging types aside from pill boxes and eyedrop bottles, indications of publication bias, and primary study lack in reporting health outcomes and potentially unique moderating variables such as the number of prescribed medications or packaging volumes.

10. Individual Decisions as a Reflection of Collective Influences

In the supplementary reference essay, Cultural Issues in Medication Adherence: Disparities and Directions, healthcare professionals Elizabeth L. McQuaid and Wendy Landier discuss how medication adherence referred to as self management behaviour is the result of an interaction of the healthcare system, cultural and individual factors. (McQuaid and Landier 2018)Through this model of thinking, the issue of poor medication adherence can be understood not simply as a matter of patient responsibility but as a product of broader power structures within healthcare. Institutional policies, prescribing practices, and communication norms shape how medications are distributed and used, while cultural beliefs and personal circumstances influence whether patients continue or discontinue treatment.

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[15] A similar example outside of ophthalmology is the case of elderly renal patients who struggle to keep track of their *Warfarin,* a blood thinner used to prevent harmful blood clots. PWeekly schedules come as physical labels that are printed out and issued by the hospital. However,many pharmacists reported that patients often confuse the colour charting, lose the paper slip or even refer to the wrong weekly schedule.

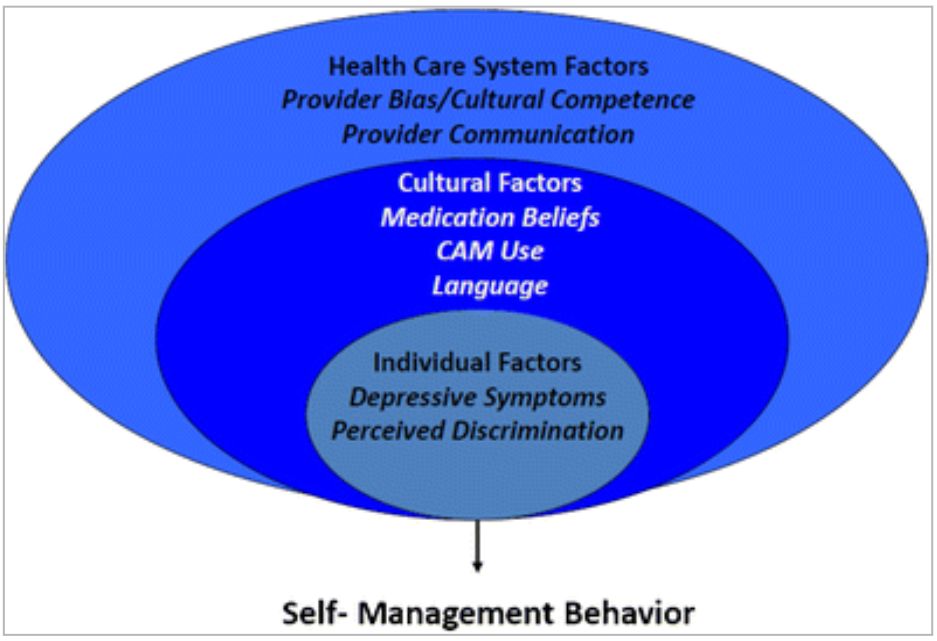


Figure 6.The diagram taken from the essay depicts how Interaction of factors across multiple levels predict patient behavior, inequalities in healthcare access and diverse health outcomes.

Drawing connection to the context of NUH, generations of pharmaceutical waste also prove to be nuanced and layered. Pharmaceutical companies hold significant, perhaps primary, power to reduce waste within their sector through control over the entire product lifecycle, from design and manufacturing to packaging and disposal. ("Tackling Plastic Waste: The Elephant in the Room of Pharma's Sustainability Drive," n.d.) In this sphere of influence, patients are structurally and communicatively erased.[16] Structure here refers to the institutional structures that regulate how medicine is manufactured, packaged, distributed and ultimately disposed of.

[16] Refer to Figure 7

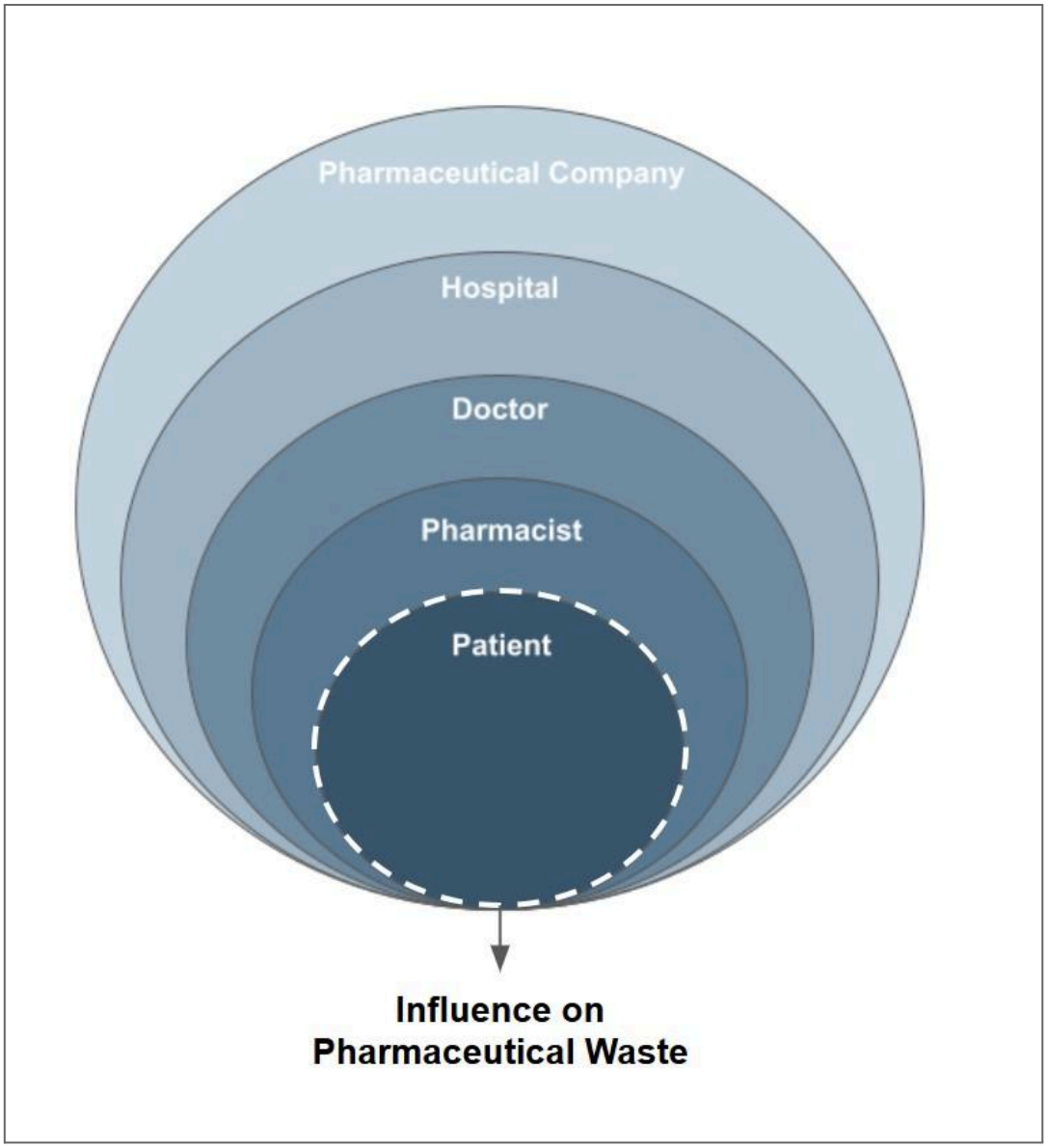


Figure 7. The concentric diagram above shows the sphere of influence in the landscape of pharmaceutical waste

My observations of patient behaviour and pharmacist - physician interactions in NUH and reflect this dynamic where decisions about medication use and disposal appear embedded in systemic expectations and hierarchies rather than arising solely from individual choices.

Michel Foucault, is a French philosopher, who was also an author, literary critic, political activist, and teacher. Foucault's theories primarily addressed the relationships between power in contrast to knowledge and autonomy, analysing how they are used as a form of social control through multiple institutions such as hospitals. (Sharma, n.d.) Power dynamics

refer to inherent structures and influences of power that exist between individuals and groups within a given context. This idea extends beyond mere authority or control, delving into more nuanced territories of influence, privilege, and communication styles.

The diagram demonstrates how medication waste is a symptom of a larger issue and attempts to reduce it are often unsuccessful when these complex dynamics are overlooked. In the section that follows, I provide a brief review of a number of key factors at the individual,medical practitioner, and healthcare system level that contributes to medication waste, using Foucault theories of power to analyse these relationships.

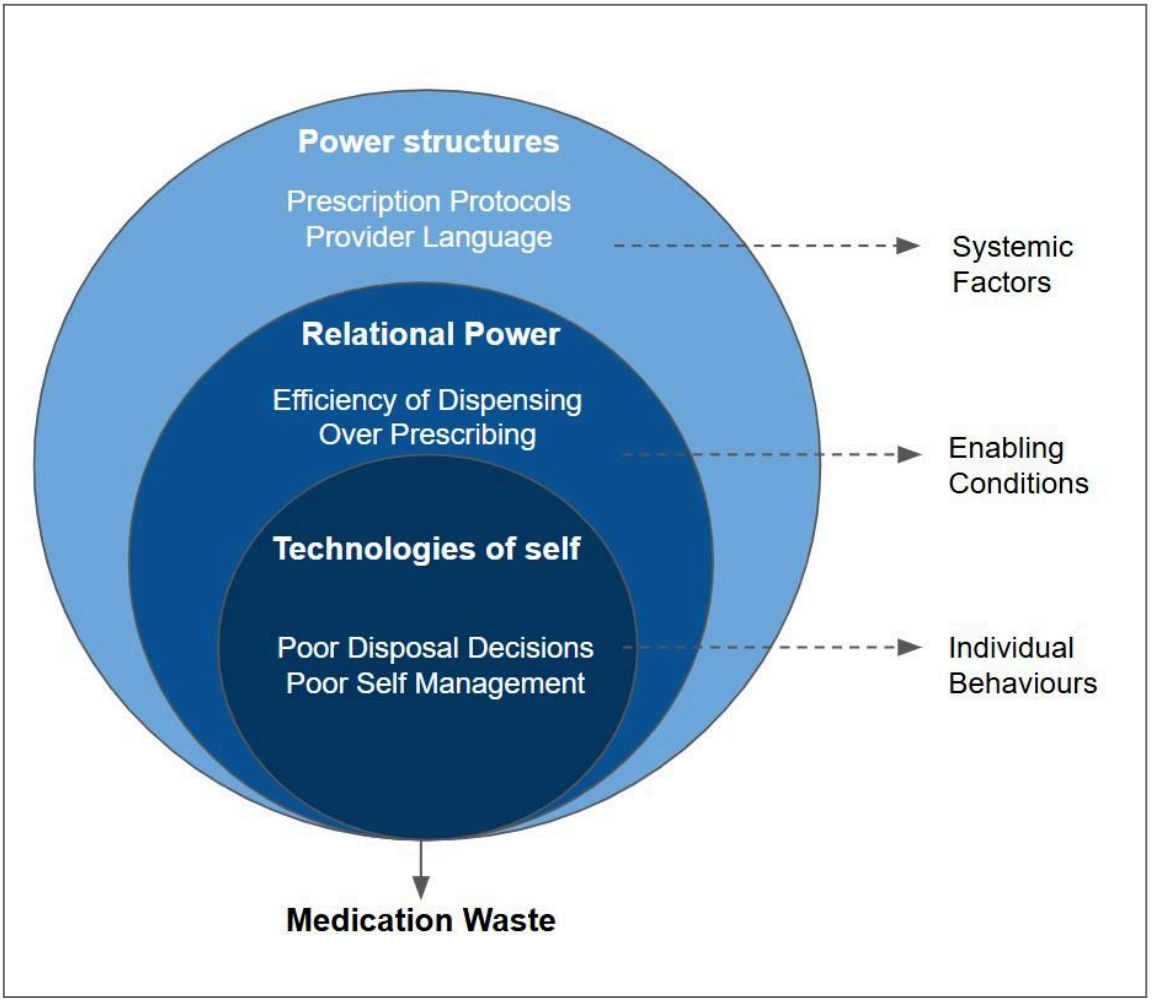


Figure 8. The diagram above shows a framework in modification of Dr Elizabeth's diagram to organise of the power dynamics in the discursive space through the lens of Foucault

11. Findings

11.1 Organisational Culture as a Structural Source of Waste

This section examines the role of organizational culture in shaping waste management practices.The generation of waste is influenced not just by procedural factors, but also by established habits and workflows. Medication waste is produced by deeper power structures embedded in medical language and institutional practice. Doctors and patients use different ways to refer to medication and these constraints lead to poor adherence levels and ultimately, medication waste. Doctors are trained to use clinical terms such as “milligrams”, “allergen”, and “cataract”, while patients use functional phrases such as “two drops”, ‘red bottle’ or ‘heart tablet.’ This insight was validated by Dr Chai’s interview where she mentions,’ “ *I find that patients can find it hard to communicate clearly. It takes so much time for them to explain and they tend to co-relate with the bottle instead of the drug name.”* These linguistic differences may create confusion at discharge or even duplicate prescriptions. As Foucault argues, power and knowledge are inseparable, implying that medical knowledge is not neutral as it produces authority and organizes reality. (Nwadinihu 2025) This naming system suggests that a doctor's language and use of clinical terms is tied to professional training while patients’ language are often dismissed as imprecise or a part of daily routine. It points towards Foucault's idea of discourse. When patients refer to drugs differently, the system often interprets this as ‘low literacy level’ or even as ‘forgetfulness.’ As a result, the patient's language becomes marginalised. They may feel less empowered and hesitate to ask clarifying questions. In response to this behaviour, doctors may overprescribe to compensate and repeat prescriptions are issued automatically. During an observation at the pharmacy, a patient refused to collect some pills and when questioned why, he insinuated that he could not remember the name but recognised the drug, and still had a steady supply at home. The doctor’s notes briefly mentioned that he displayed poor recall of his medication. With repeat prescriptions, patients find themselves accumulating unused drugs at home and ultimately leads to medication waste.

The flow of information from doctor to pharmacist to patient also makes the invisible power structures in healthcare visible. Through a study of the patient medication list, scanning patterns made visible the differing priorities healthcare professionals have. The hierarchy of information is often arranged in a manner that is more accessible for doctors as shown in the diagram below.

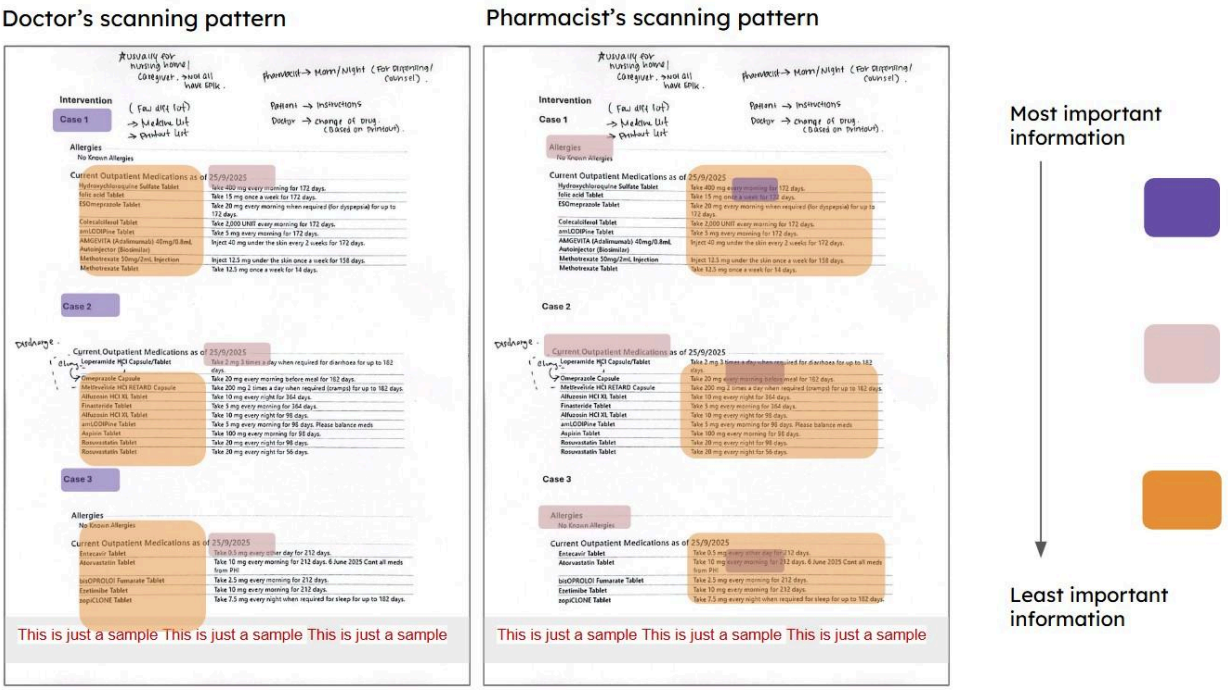


Figure 9. The scanned image above shows a duplicate of a medication list that contrasts a doctor's and pharmacist scanning pattern

Medication packaging is verified at multiple points by both pharmacists and doctors, often requiring re-checking, re-labelling, and, in some cases, disposal when packaging cannot be reconciled with electronic records. While doctors prioritise timely clinical intervention and pharmacists prioritise regulatory and packing accuracy, the organisation does not necessarily mediate between these priorities. Medication is considered safe only when digitally traceable so when material packaging diverges from documentation, it becomes unusable regardless of clinical viability. (Odukoya et al. 2014) An example is the medication *furosemide*. The doctor interprets blood test results depending heavily on whether a patient is compliant with his medication. This results in amending their current care plan and repackaging of PDPA medication resulting in waste to accumulate in this process.

Medication waste therefore emerges not from individual error but from an organisational culture structured around surveillance, risk management, and precise protocols. A study was done to examine how physicians and pharmacists understand and communicate patient-focused medication information with each other and how this knowledge can influence the design of electronic health records. (Mercer et al. 2018) The lack of overlap between information systems physician and pharmacist use, reinforces the siloed workflows of the two professions.

In Public hospitals, the standard contract to manufacturing companies usually lasts 2 years. The medication brands in public institutions will often keep changing. Once the 2 years are up, the pharmacy department will either continue receiving from them, or change to an alternative producer with a cheaper price or better proposal. In the case study of *Glipizide*, NUH initially received their stock from a manufacturer who produces the pills in a striking light blue colour, in an oval form.[17] They eventually did not renew the contract and switched to a cheaper alternative. The alternative, however, produces these pills in a generic white colour cut in round pieces. By 'stripping away' the iconic blue colour, patients experience difficulty to accurately identify their medication. [18]

[17] Refer to Figure 10

[18] Interestingly, Pharmacists have the authority to suggest, propose and advocate to pharmaceutical manufacturers on improving the products based on patient experience and their observations. An example is *Ezetimibe*, a medication used to lower high cholesterol. It is taken in full, half or even quarter doses. A pharmacist suggested that the company manufacture them as such to reduce the effort patients take to manually split the pills. The company took the recommendation and the redesigned packaging came in a peelable paper material with perforated lines that are easier to separate as compared to typical blister packaging or in Polyethylene bottles.



Figure 10. (Left to Right) 'Glipizide' pills from the current pharmaceutical manufacturer vs the previous pharmaceutical company

11.2 Prescription as a Site of Relational Power and Waste Production

When discussing unintentional waste, the dynamics in the hospital setting is an under explored component. Power, as conceptualized by Foucault is not a static possession, but a network of relations embedded within institutional routines, discourses of expertise, and material arrangements. (Sheridan, n.d.) In the hospital, prescribing power appears downstream and linear. Prescriptive authority is often perceived as a top - down process, occurring after a diagnosis has been made and clinical decisions finalized by healthcare providers. Doctor Chai, when questioned about the relationship between pharmacy and doctor, notes "*We have an established workflow. There is a lot of backend work between us as doctor errors can be quite high. Meaning, there is a high need for clarification. The ideal response to a prescription that needs to be changed would be to send it through the EPIC system or teams first*." This perspective is shared with a pharmacist technician who describes her role as someone who just dispenses medication and advises patients. She noted that *"Pharmacy doesn't have the deciding power, so it (the prescription) will go back and forth. The decisions are from doctors and as pharmacists, we go by demand and supply."* Such statements are a reflection of the daily reality of healthcare providers. Their decision-making processes are often restricted by the institutional framework, similar to

Foucault's notion of ‘panoptic’ power in which power operates in a ‘top down’ or structuralist context. (Sheridan, n.d.) Within this established workflow, pharmacists hold a significant influence over a prescription. When a doctor prescribes 5 months worth of medication, the pharmacist might quantitate and decide to dispense to the patient a 3 month stock. When probed about deprescribing initiatives, and who should spearhead said initiative, a pharmacist expressed that “ *If you want real impact and reduce waste, it needs to come from the doctor. The most logical approach would be to come to a consensus and work with the doctor to change prescribing habits, such as the appropriation of reducing single use eyedrops.*” In contrast to this, a senior doctor mentioned that reducing waste from a prescribing perspective should focus on designing tools and intervention that pharmacists can use to facilitate the process.

Pharmacists use their relational power to influence patient behavior. Many ophthalmic patients suffer from progressive and chronic diseases so they require the Medical Assistance Fund (MAF) to cope with the cost of medicine. (Minist. Health, n.d.-b) However, patients may use this to justify unsustainable behaviour such as excessively requesting for more medication. As part of standard protocol, a pharmacist quotes “*We can give less (medication) but we can't prescribe more. The adjustment is only by reducing.*” Patients however, have the authority to request for more medication. As a pharmacist mentioned, *“‘We respect the patient's decision.*” At the pharmacy, a patient had claimed to finish her previous supply of eyedrops.The pharmacist then reminded her the price of each box she would have to pay if she was purchasing it from another pharmacy. The patient then requested to return home to check if she actually needed more before collecting the next batch in 2 weeks. By evaluating the patient's needs, the pharmacist used her authority and used the visibility of cost to encourage the patient to be more cognisant of her wasteful habits. Following an assessment of the patient's needs, the pharmacist leveraged her authority and the transparency of costs, to encourage a patient to be more cognizant of, and address her wasteful tendencies. A conversation commonly observed at the counter is the pharmacist asking patients if they feel any discomfort with their eyedrops and the response would often be *“I’m not sure how to tell (define) if it is uncomfortable.*” She would then list out very detailed symptoms and may even recommend patients try a different brand of eyedrops or bring it up to their attending doctor to amend the prescription. This greatly reduces the amount of medication waste as a result of non compliant behaviour. Once, a lady asked the pharmacist to list the side effects of one of her steroid drops and after doing so, the pharmacist nudged her kindly, asking if she found any discomfort using the drops. The patient then hesitated and responded that she was actually infrequently administering her drops due to the stinging sensation she experienced and was just collecting her drops

because she was obliged to as per her doctor's instructions. Pharmacists move from the traditional dispensing role to become more actively involved in patient care (Guirguis et al. 2012)

A review of The Electronic Medical Record System (EMRS) in NUH[19] shows the relative influence patients play in prescribing habits. As seen on the interface, healthcare providers are able to roughly quantify how much medication a patient brings home after each consultation. The list is quantified monthly, every 4 to 6 weeks. The columns show the patient's name, drug name with specified instructions, quantity dispensed and the facility was dispensed from respectively. Interestingly, the third column commonly displays '56 days/ 60 tablets'. Ideally, the dispensed amount for the month of February to March would be '28 days/30 tablets. However, the quantity is doubled and this creates a surplus of medication where every month, the collective amount will keep rolling over to the next collection.

Doctors view this surplus as a necessary buffer. *"My patients may need to reschedule their appointment or they may even lose their pills.*" In this case, many Doctors struggle with having to err on the side of caution, especially when patients are not compliant. Furthermore, patients are not limited to only collecting from their healthcare provider and are able to purchase additional supplements or over the counter drugs from departmental stores or General Practitioner (GP) clinics. In the hospital, physicians and pharmacists have greater influence in prescribing authority but are still subject to formal protocols. Patients, however, with better awareness are able to significantly reduce how much medication is eventually brought home. As Chin Yin states, *"They can collect less, but the responsibility lies on the patient."* This reflects NUH'S simple but powerful ethos 'more isn't necessarily better'. It encourages **both** clinicians and patients to engage in open, thoughtful conversations about what best aligns with patients' goals and clinical needs. The focus on appropriateness helps strengthen trust, enhance patient care, and ensure good stewardship of healthcare resources. (NUH, n.d.)

[19] Refer to Figure 11 for image of the EPIC EMR system

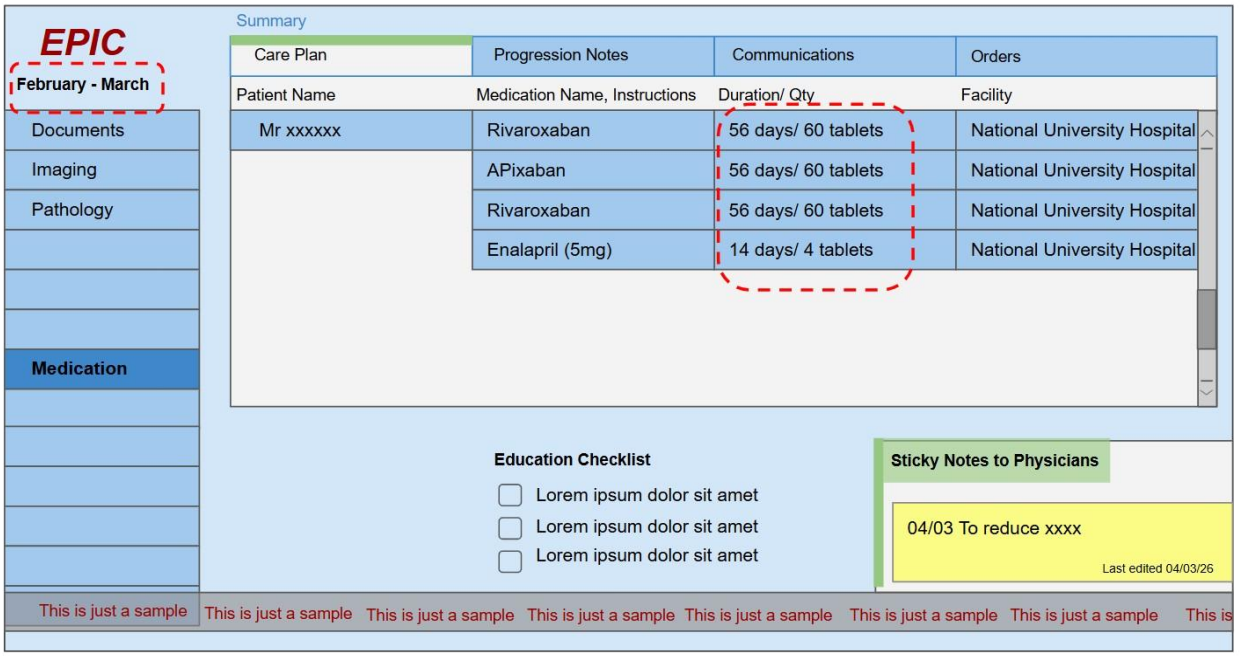


Figure 11. The superimposed image above shows the current EPIC EMR system to review and quantitate an estimate of current medication a patient has based on a doctor's prescription

11.3 Poor Disposal Decisions with Articulated Reasons

Medication waste should not be seen as a personal failure, but rather, the effect of poor design, or what we can refer to as 'enabling conditions.' Yan Ting, a pharmacist technician, notes that she urges all patients to keep the external boxes that come as part of the packaging for their prescription drops. Due to the current labels being in a sticker format, most of the patients personal information and tailored dosage instructions are printed onto the label. This label is then pasted onto the box and exists as a separate entity from the bottle itself. A present design implication to deal with this issue is the use of tail labels. Tail labels, often referred to as flag labels or piggyback labels, are specialised labelling solutions for specialized labeling solutions designed for small, cylindrical, or irregularly shaped containers like syringes, ampoules, and vials. (Med. Device Diagn. Ind., n.d.) They typically consist of an adhesive portion that wraps around the container and a non-adhesive 'tail' or 'flag' that extends outward to provide extra space for information without obscuring the medication.This is commonly used for liquid Augmentin[20] If the suspension is mixed by a

[20] Refer to Appendix A Table 2 for image of tail labels used on Augmentin bottles

pharmacy, it usually has to be discarded 7 to 10 days after preparation. The liquid formula cannot be used if it has passed the 10 day mark, even if it is 12 hours within that date However, this design cannot be applied to prescription drop bottles due to the sheer size difference which the bottles are manufactured in. Augmentin bottles generally come in 70ml bottles while prescription drops typically come in 10ml. That is a 7x difference in volume per bottle and inversely proportional to the amount of surface area available for the sticker labels to be pasted on. Under these circumstances, important information is placed separate from the actual eyedrop bottles and once a patient loses or discards these packaging, they also lose important information that is part of the dosing schedule.

Another constituent to poor handling of medication is the physical presentation of the prescription packaging. Eyedrops often come packaged in opaque bottles. This protects the substance from direct sunlight and heat. However, due to this physical barrier, it is a challenge for patients to accurately gauge just how much of the suspension liquid is still left inside of the bottle. A doctor mentions “Even the prescription bottles are opaque in colour and that makes it very hard for my patients to tell when it's finished or not. Sometimes I get them to bring back their boxes to see how much is left.” They struggle to tell when the bottle is empty and subsequently administer uncontrolled drop size. (Moore et al. 2014) At times, patients may even forget if an eyedrop is for the right, left or both eyes. The lack of sufficient visual cues, patients may become disorganised and have a disassociated understanding of their care plan. (Unforgettable EyeDEA, n.d.) For prescription drops, many of them come packaged in boxes with standardized graphics where the branding lean towards corporate identity. Patients require more cognitive effort to differentiate their medication. A pharmacist relates, “*One of the most shocking experiences I had with a patient was a lady who threw all of her white pills into a single bottle, and ate it like candy! She said all her daily pills looked the same to her.”* The pharmacist, in reference to that experience likened the design of prescription eye drops to ‘*a ‘fashion line, sometimes the only differentiating feature is the colour of the stripes*.’ [21] These physical barriers makes the task of distinguishing between similar bottles, or determining whether a medication remains safe to use after opening significantly harder.

[21] Refer to Figure 12



Figure 12. The superimposed image above shows the different types of prescription drops from Alcon- a pharmaceutical device company specializing in eye care products.

12. 'Technologies Of Health' as an Approach

A constellation of adverse factors on a systemic level such as provider language, protocols and poor design of resources work together to increase the risk for poor medication adherence, which falls under the innermost circle of individual habits and behaviours. Building on this framework, I narrow the focus toward the individual dimension of medication adherence.[22] To examine how patients internalise and enact expectations surrounding medication use and waste, I draw on the perspective of Michel Foucault, particularly his ideas about power operating through self-regulation and everyday practices.

In the essay on Michel Foucault's concept of Technologies of the Self, Sociologists Jason L. Powell and Sze-Yen Chen use Foucault's theory as a lens to discuss how geriatric patients can actively shape their own ageing when provided with supportive structures and resources. (Powell and Chen 2017) The article demonstrates how the ontology of disease is primarily constructed through professional discourses. Yet, Powell and Chen suggest that ageing is not just a biological process but also something shaped by social systems, knowledge, and institutional support. When patients' healthcare needs and resources, such as healthcare information, community services, assistive technologies, and supportive professionals are not curtailed simply because of their 'age', older patients are able to be positioned as subjects of purposeful action, gaining greater capacity to govern themselves and manage their wellbeing. With these resources, individuals adopt practices such as monitoring medication, diet, exercise, and routines that sustain wellbeing. Powell and Chen also point out that these systems can simultaneously empower and regulate people. This

[22] Refer to Figure 8

perspective is especially compelling when applied to an examination of the roles of the physician, pharmacist, and patient concerning the issue of medication waste. Anecdotal evidence documented in this essay validates this way of thinking, leading me to adopt this same approach to guide the design direction to understand and address pharmaceutical waste.

The principles of these perspectives create a tangible space where the least powered individuals, patients, are able to exercise their agency and power to define their lived experiences with medication waste. This reframes the ways in which we typically think about the influence patients should have on the design of prescription packaging. Objects do not live solely within the purposes designers assign to them. Instead, their meanings evolve through how people actually use them in everyday life. (Norman 2013) [23]. It pushes us to rethink medication packaging as more than just the by - product of a prescription but rather, as a physical extension of a doctor's and pharmacist's touch. I ask the following research question: **How can prescription packaging be designed more intuitively towards patient emotional needs and be used as a collaborative tool for healthcare providers to reduce medication stockpiling?**

13. Informed Principles of Design

13.1 Prioritising Clarity Over Convenience In Design

By analysing power structures and how they affect design in healthcare, we do not just improve tools but rather, change the logic that shapes them. Effective design influences and directs behavior. Packaging, when well-designed, simplifies the process for pharmacists to verify the correct dosage, usage, and potential interactions of medication. This significantly lowers the mental effort and time required for pharmacists to instruct patients on the proper way to use their medicine. (Conn et al. 2015) Designing for clarity is crucial since ‘health technologies’ shape how people understand their bodies, data, and medical decisions. If the design is unclear, people may misunderstand information, make poor decisions, or even feel alienated from their own health management. Pharmacists act as mediators by ensuring knowledge flows correctly in which the bottle packaging acts as an extension of their authority, embedding guidance on the physical product. This is evident from multiple patients

[23] In ‘The Design of Everyday Things’, Don Norman consistently explains that design strongly shapes human behavior mostly without people realizing it. While the book expounds mainly on key components about usability and human-centered design, a major theme is that the way things are designed influences how they think about a system relating to the object.

who presented hand written pharmacist notes or jottings on the packaging boxes during their interviews. Clearly designed packaging can help minimise waste as patients adherence levels will improve with higher levels of comprehension. (Mohammad et al. 2022) A doctor empathised with patients "*How do you know what you have if you can't even pronounce it?*" In a doctor's consultation office, I saw how she would google the images of medication on her phone and show it to patients to confirm if they are referring to the same one. Another doctor in the same subspecialty department even prepared a chart of the most commonly used medication to effectively communicate with patients as it helps them feel more assured. (Malhotra et al. 2022) Chin Yin, a medication reconciliation pharmacist, adopts a similar approach. [24] Clear labelling minimizes the gap between provider language and helps patients gain confidence to adhere to their intended therapy.

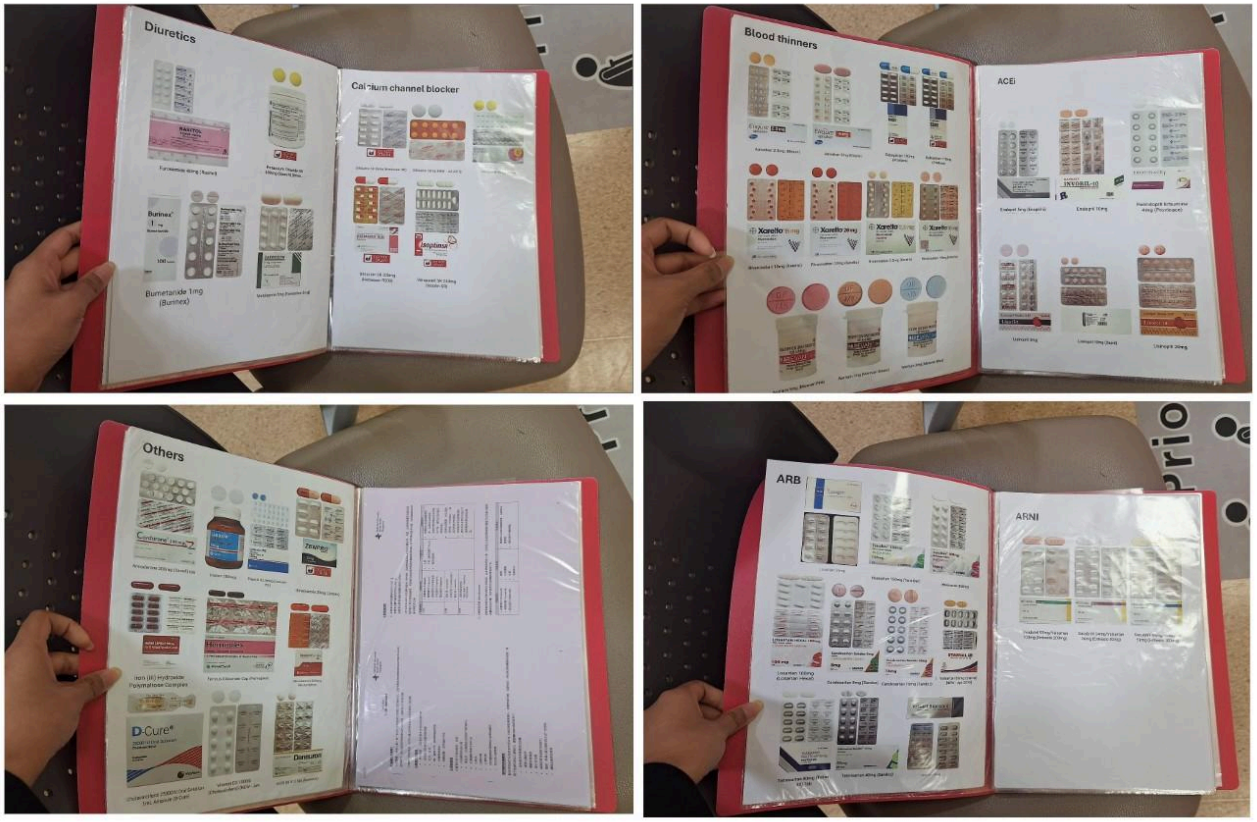


Figure 13. Images of a pharmacist self - printed folder with medication packing used as a tool to communicate with patients

13.2 Designing for Assurance

[24] Refer to Figure 13 for an image of a pharmacist's medication charts.

Designing for a sense of security is relevant to health ‘technologies’. It provides users with confidence, safety, and emotional reassurance when interacting with medical systems or health. In the essay, Powell and Chen argues that’health technologies’ are not used in neutral situations—people often interact with them when they are anxious, vulnerable, or uncertain about their health. Due to this, design must do more than simply function, it must reassure users that the system is reliable and that they are interpreting information correctly. From a patient’s perspective, intuitive reminders reduces mistakes and anxiety. Instigating a colour change on the bottle, for example, will explicitly help them gain confidence to adhere to their intended therapy. The difficulty for patients is challenging for patients to determine a visual difference between a used eyedrop that has been recently opened or one that has passed the 28 day potency period once it is removed from the packaging. They lack a clear visual cue to indicate the end of this 28-day period, often through self-directed efforts like manual labeling to help them note if the medicine is conducive to health. Instigating a colour change would explicitly expose the risk and could indicate prior use without doubt. A product design research was done to raise awareness on when to throw out and change non sterile syringes. (Wainwright 2013) These experiences inform relevant design principles for the designing of intuitive labels.

Physicians exercise power indirectly through prescription as a form of disciplinary effect. Taking logic from Foucault, packaging becomes a subtle agent of control. Patients can self regulate with tools that support these behaviours as they feel more at ease with visible support. and have a greater sense of security and reduce the need to stockpile on medication. A well indicative packaging helps doctors increase trust in their patients ability to adhere to their medication regime. Studies suggest a promising link between effective doctor–patient communication and increased medication adherence. (Zeng et al. 2024) This aligns a senior pharmacist’ summary of the reconciliation process,*“We are not trying to reproach them for non-compliance but rather, we work to ensure their safety by knowing what they are actually consuming,*” she explained.*“Showering them with concern helps them open up and be more willing to divulge the true reason for non-compliance.”* The prescription packaging exists as more than just a messenger of clinical instructions and becomes a familiar anchor in a patients’ emotional geography.

13.2 Designing for Continuity

To bear the burden of medication use, it is essential that design continues through to the point of implementation. Unfortunately, in the hospital, there is little to no standardised follow up for most of the services surrounding medication. Medication Reconciliation sessions, for

example, are described as a ‘touchpoint’. When asked if there are any ways to ensure patients heed the advice from the sessions, a pharmacist responded, “*No…the luxury of time, it’s not there*.” As Powell and Chen argue,‘health happens over time and not in isolated moments.’ Designing for continuity means building systems that support long term engagement, allowing users to display sustainable practices such as track progress, revisit data, and adapt the care over time. For ‘technologies’ such as standalone apps to not be abandoned, it is vital that design interventions integrate into everyday life, and support existing relationships. This aligns with Dr Charmaine’s point, “ *If something is too high tech, and is designed out of their usual routines, patients don't feel there's enough incentive to adopt it.”* The amalgamation of these design insights can be used as benchmarks, outlining a brief for future design implications.

14. Conclusion

The unassuming packaging of prescription drops offers a compelling case study in how intuitive design contributes to the larger discussion of healthcare systems and sustainability. It gestures toward a future where patients no longer need to question the safety of their medication, creating far-reaching impacts on treatments worldwide while promoting responsible stewardship of self and waste reduction practices. Drawing on Foucault’s concept, perhaps the solution in designing for an empowered patient lies not in simply refining the typical prescription label, but by observing the meaningful experiences and exchanges that unfold within the boundaries of a simple 70 mm × 30 mm box. It pushes us to reinvent and uncover different forms of labels not just for the ideal user but also to individuals who, despite limitations, assert influence within this ongoing dialogue.

[Words: 8101 excluding all captions, footnotes and citations]

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Appendix

Appendix

Table 1 - Photographed Images of NUH Main Pharmacy Fieldwork

Image	Description
	Excessive waste in the packing process where 3 pills are packed in standardized plastic sheets.
	Medication bottles of prescription pills where the caps are small in size and often hard to segregate in the recycling process.
	High volume of blister packaging used - about 200,000 medicine strips are prescribed in just NUH alone.
	Organization of commonly used drugs, most of them come in pre packed sets

	The taller yellow bin is where they drop in medication that has been returned to the pharmacy by patients with prescription items.
	Packaging with sensitive information or used syringes and vials containing that cannot be thrown out in the general bin or recycled
	Poor dimensioning of packaging size and packaged in standard white boxes, that go through the automatic sorting machine. .
	Piles of plastic, paper, other non recyclable materials as part of the packaging process.

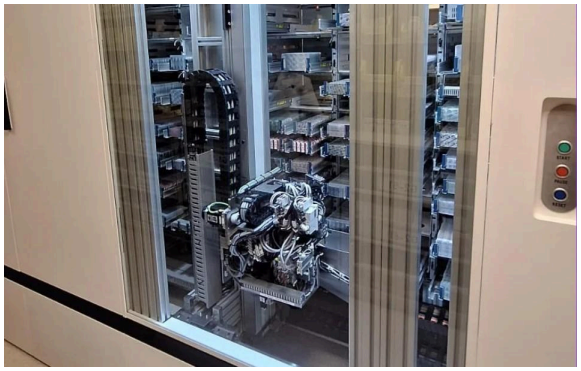
	Machine Jams that lead to defective products that are thrown out immediately.
 	Challenges in segregating and pre-cleaning before recycling, in case it is biohazardous or falls under cytotoxic drugs.

Table 2 - Existing Medication Packaging and Labels

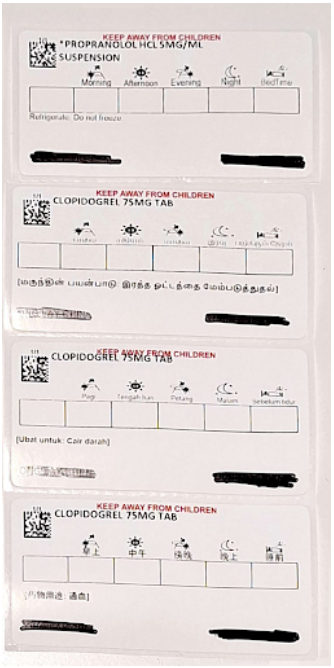
		
PDPA Packaging without patient information printed on	Special medication instruction labels with pictograms printed on in different languages	Tail Label used for Augmentin bottles, but are too large for prescription eyedrops. An alternative is pasting these sticker labels onto the external prescription boxes.

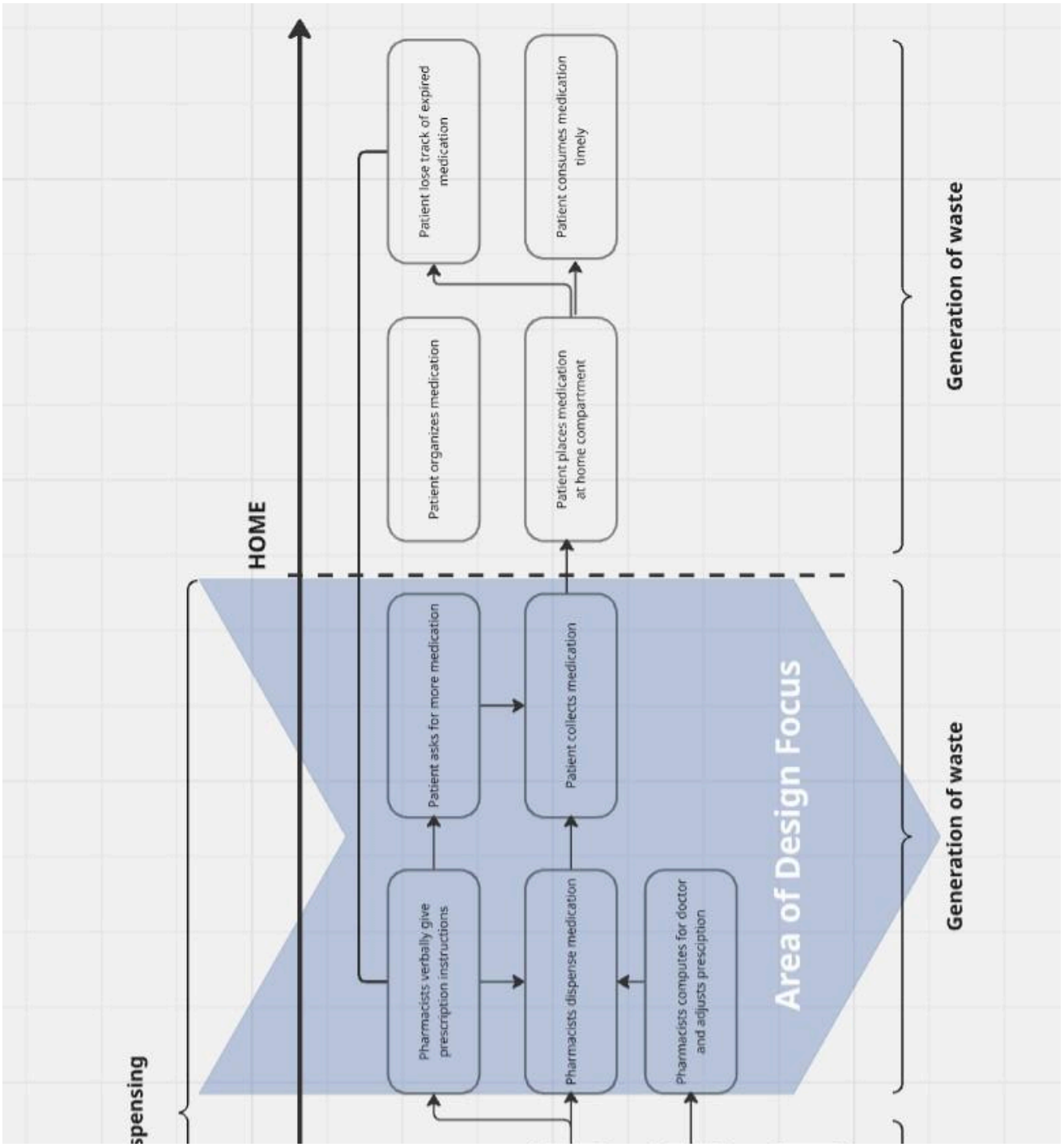
Table 3 - Satellite Pharmacy Checking List

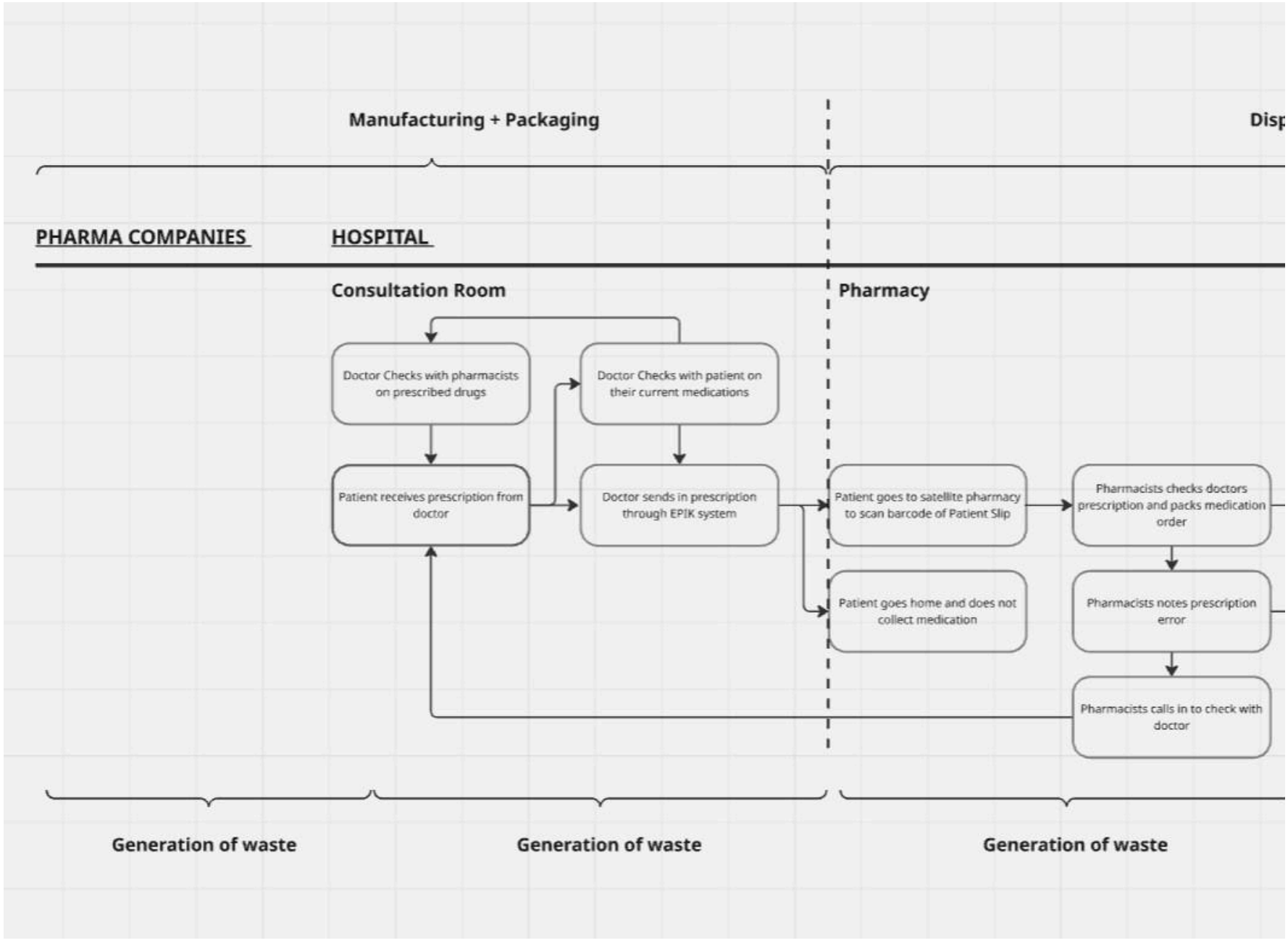
Task	Identify	Unit Cost	Reach Shelf	Expiry	OTC Med	Safe RX	Symptom	Quantitate	Instruction	Barcode
P1								✓	✓	✓
P2					✓					
P3		✓	✓					✓	✓	
P4							✓			
P5								✓		
P6							✓			
P7	✓	✓		✓					✓	
P8	✓			✓		✓				
P9								✓		
P10	✓							✓		✓
P11		✓		✓					✓	
P12								✓		
P13			✓		✓					
P14						✓	✓		✓	✓
P15				✓				✓	✓	
P16		✓						✓	✓	
P17				✓				✓	✓	
P18				✓				✓	✓	
P19				✓				✓		
P20		✓				✓				
P21					✓				✓	
P22		✓				✓				
P23					✓					
P24			✓			✓	✓	✓	✓	
P25	✓			✓		✓		✓	✓	
P26		✓		✓				✓		
P27		✓			✓					
P28				✓					✓	✓
P29					✓	✓				
P30				✓		✓	✓	✓		
P31		✓						✓	✓	✓
P32		✓						✓	✓	
P33		✓					✓			
P34		✓					✓			
P34		✓			✓	✓	✓			
P34	✓	✓					✓	✓	✓	✓
P35	✓						✓	✓		
P36		✓		✓	✓					
P37		✓					✓	✓	✓	
P38		✓						✓	✓	
P39		✓								
P40			✓		✓					✓
P41										
P42					✓					
P43		✓				✓	✓	✓	✓	
P44				✓		✓		✓	✓	
P45		✓	✓					✓		
P46					✓					
P47				✓					✓	✓
P48					✓	✓				
P49		✓		✓		✓	✓			
P50		✓							✓	
P51								✓	✓	
P52	✓	✓		✓				✓	✓	
P53	✓			✓	✓	✓		✓	✓	✓
P54									✓	
P55		✓								
P56		✓		✓				✓		
P57		✓	✓					✓	✓	
P58		✓								
P59				✓				✓		✓
P60		✓						✓	✓	
P61		✓		✓						
P62		✓								
P63		✓						✓	✓	
P64				✓				✓	✓	
P65				✓				✓	✓	
P66	✓	✓		✓					✓	
P67								✓		
P68			✓							✓

Table 4 - Legend of Patient Needs

Identify	- Patients clarifying which medication - Patients asking about use of specific eyedrop
Unit cost	- Asking about payment method - Asking about pricing
Reach shelf	- Pharmacist checking if medication is available - Ordering special medication request
Expiry	- Enquiry about expiry date - Clarifying 28 days and one time use
OTC Meds	- Request for lubricant drops - Purchase of level 3 general meds
Safe RX	- Re- checking with doctor on prescription notes - Clarifying with patients on their other medication
Symptom	- Patients unsure of symptoms - Patients request for a change of brand
Quantitate	- Backend packaging - Recalculating quantity to dispense
Instruction	- Verbally repeating instructions to patients - Writing down instructions on medication box
Barcode	- Patients unsure of how to collect medication - Patients unsure of how to use barcode

Blow Up Version of Medicine Journey Map




Manufacturing + Packaging
Disp
PHARMA COMPANIES
HOSPITAL
Consultation Room
Pharmacy
Doctor Checks with pharmacists on prescribed drugs
Doctor Checks with patient on their current medications
Patient receives prescription from doctor
Doctor sends in prescription through EPIK system
Patient goes to satellite pharmacy to scan barcode of Patient Slip
Pharmacists checks doctors prescription and packs medication order
Patient goes home and does not collect medication
Pharmacists notes prescription error
Pharmacists calls in to check with doctor
Generation of waste
Generation of waste
Generation of waste

PRODUCT STUDY



Packaging often discarded after use and not recycled.

Hierarchy of information unclear, many numbers that may appear confusing to patient

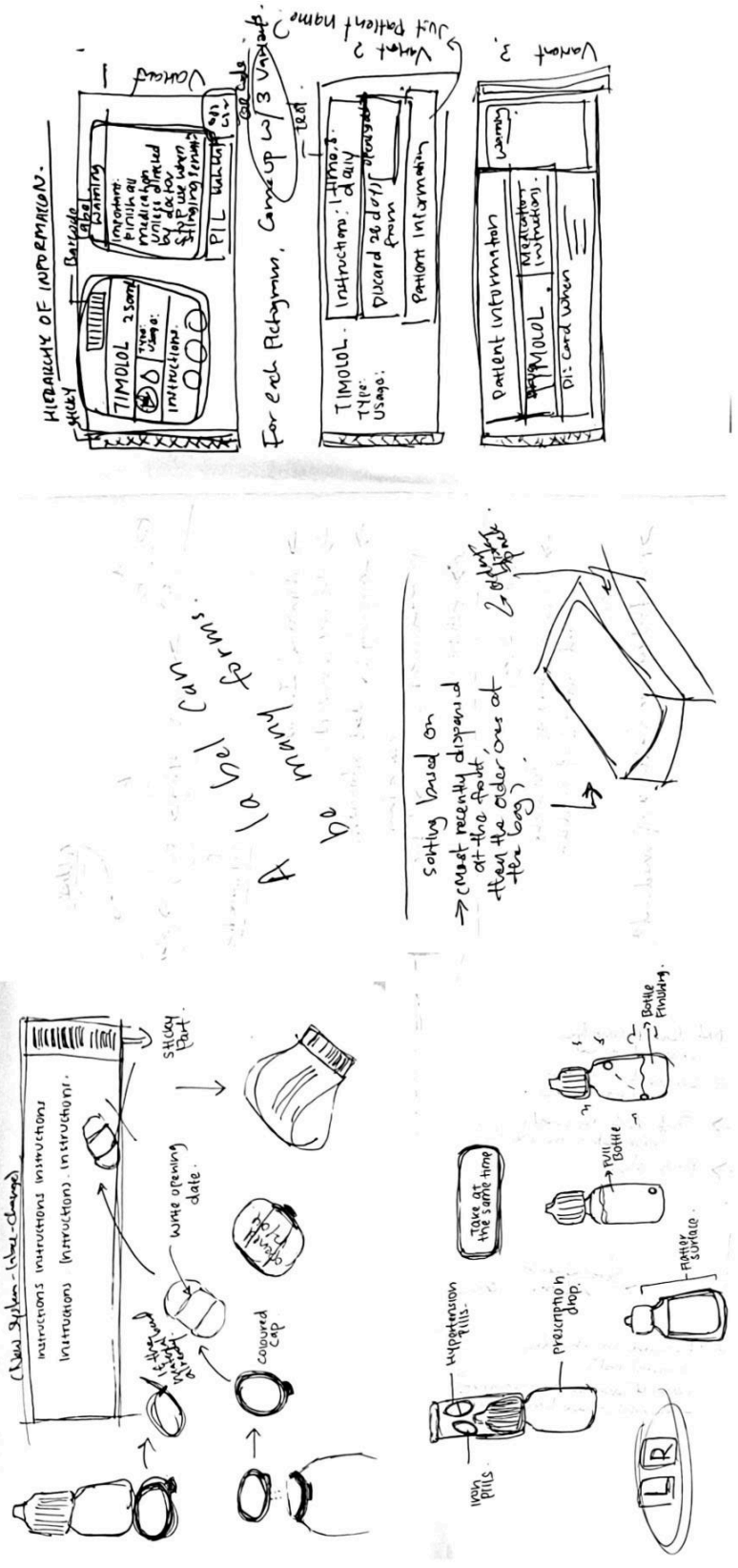
Current prescription label, temporary sticker and no indication of opening date

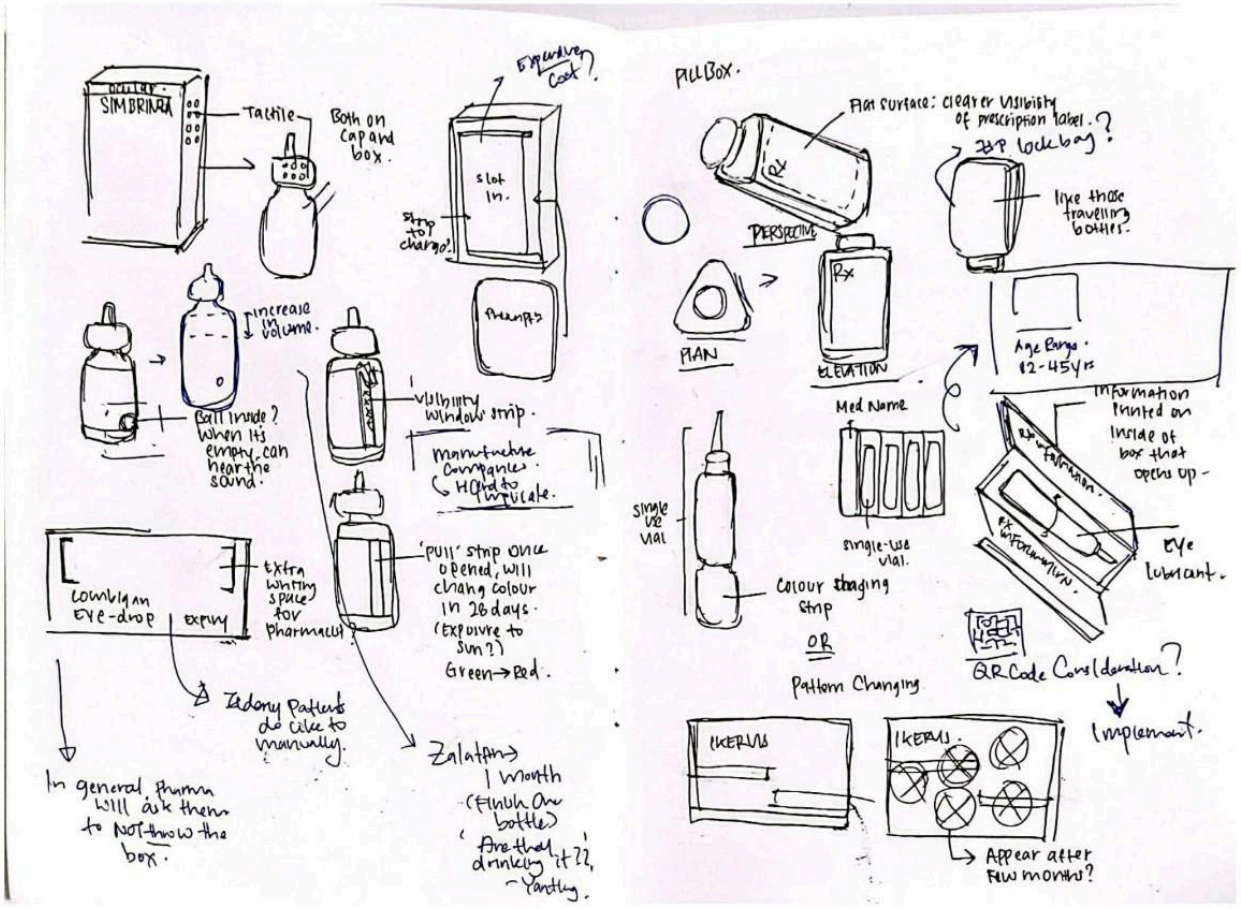
Patients experience slight difficulty in administering drops

Detachable cap to be discarded after opening eyedrop, could be better utilised ?

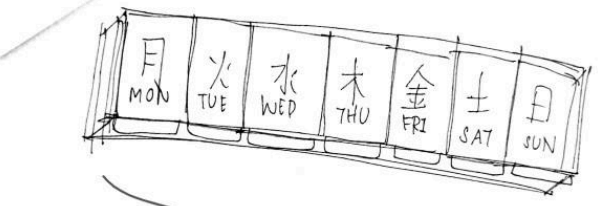
To protect substance from direct sunlight and heat, lack of visibility window and no clear indication / transparency to gauge volume inside bottle

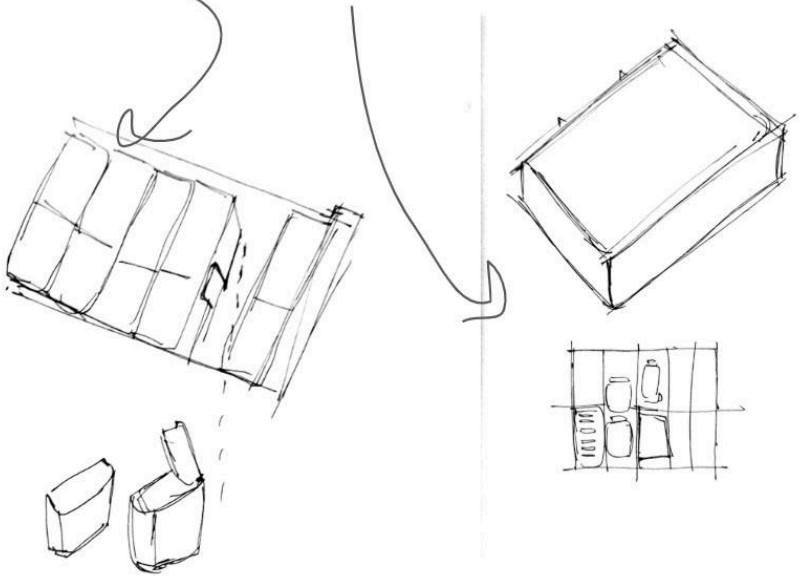
Sketches From Co Creating Session With Pharmacist

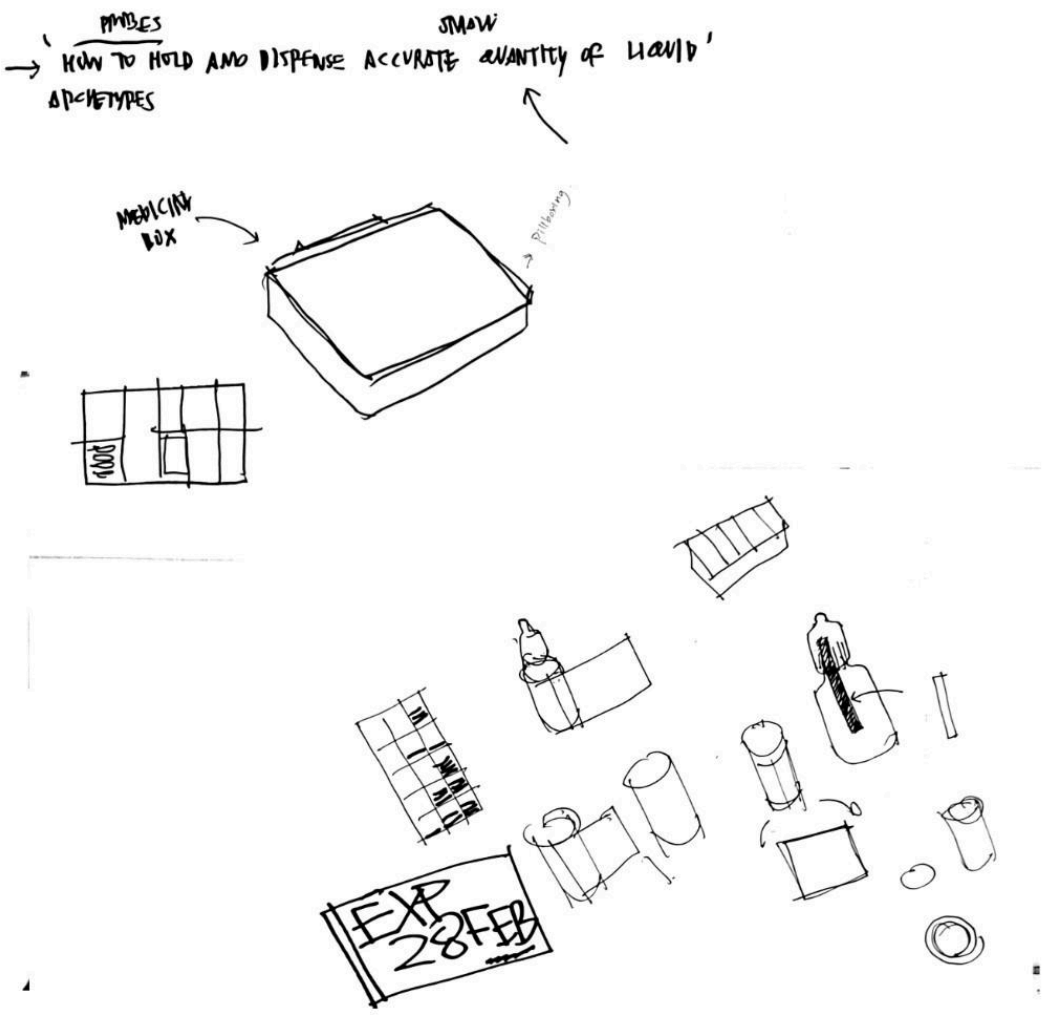


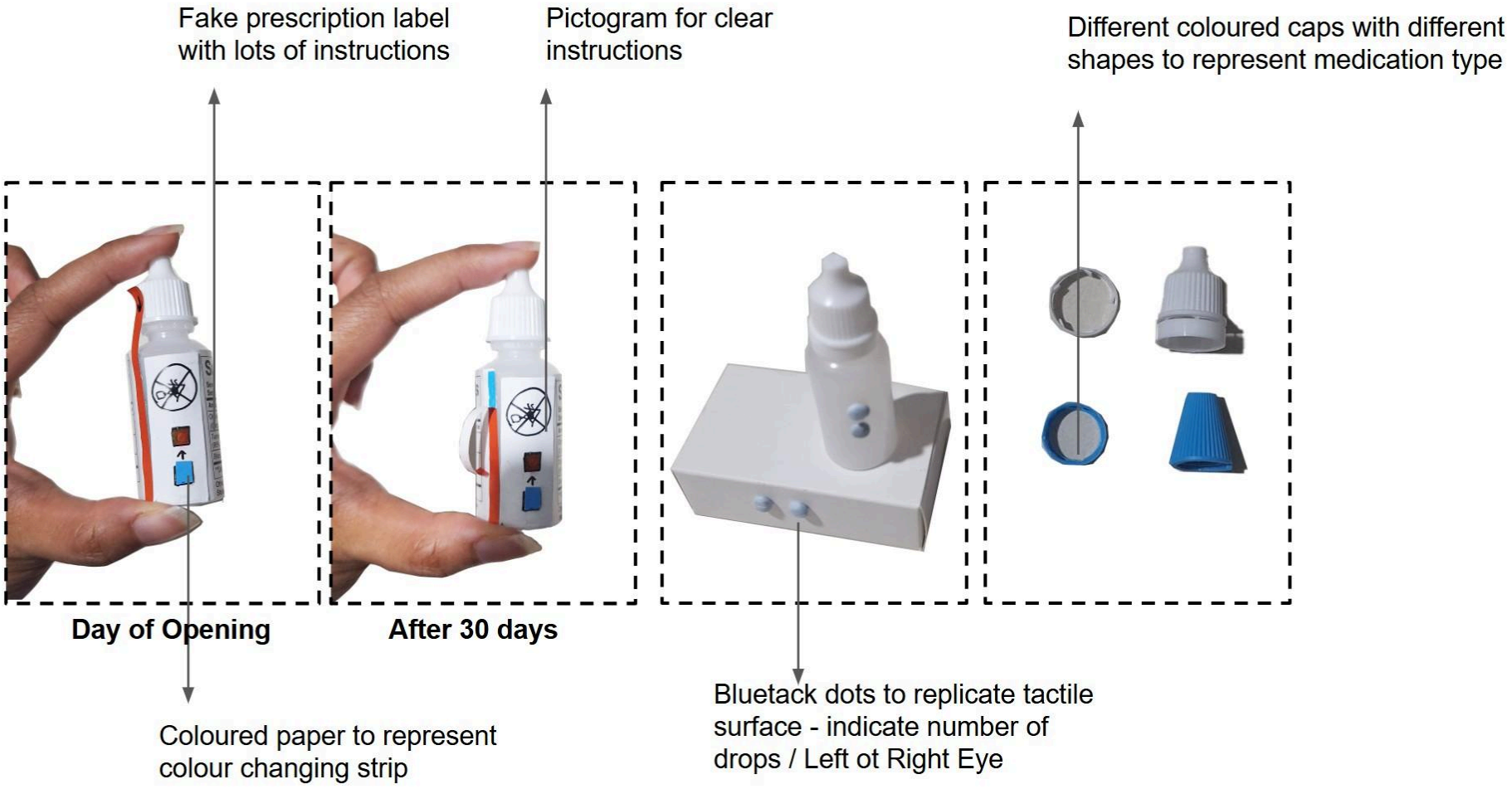

SIMBRINZA
Tactile
Both on cap and box.
Expensive cost?
slot in.
Stop to charge!
Prompts
increase in volume.
Still inside? When its empty, can hear the sound.
visibility window strip.
manufacture companies.
↳ Hard to differentiate.
comb/gan Eye-drop
expiry
extra writing space for Pharmacist
'Pull' strip once opened, will change colour in 28 days. (Exposure to sun?)
Green → Red.
Zadony Patients do like to manually.
In general, pharmacist will ask them to NOT throw the box.
Zalatan →
1 month
(Finish One bottle)
Are they drinking it??
- Yanling.
PILLBOX.
Flat surface: clearer visibility of prescription label.?
ZIP lock bag?
like those travelling bottles.
PERSPECTIVE
Rx
PLAN
ELEVATION
Age Range. 12-45yrs
Med Name
Information Printed on inside of box that opens up -
single-use vial.
single use vial
Colour changing strip
OR
Pattern Changing
Eye lubricant.
QR Code Consideration?
Implement.
IKEA
IKEA.
Appear after Few months?


→ Fridge Item.
Augmentin
Augmentin
TALL LABEL
Patient Information leaflet.
Not enough space on eye-drops bottle.
(No matter how you design, they still find human)


月
MON
火
TUE
水
WED
木
THU
金
FRI
土
SAT
日
SUN




PROBLEMS
'HOW TO HOLD AND DISPENSE ACCURATE QUANTITY OF LIQUID'
ARCHETYPES
SHOW
MEDICINE BOX
Pillbox
EXP 28FEB


Fake prescription label with lots of instructions
Pictogram for clear instructions
Different coloured caps with different shapes to represent medication type
Day of Opening
After 30 days
Coloured paper to represent colour changing strip
Bluetack dots to replicate tactile surface - indicate number of drops / Left ot Right Eye

Transcripts of Patient Interviews

Patient 1, 5 November 2025

Inda: ‘ Uncle, whats the condition you have?’

Mr Azman:‘ Diabetes, type 1. 2 months ago I did retina and glaucoma surgery. I also did cataract for both eyes’

Inda: ‘ What medications do you take?’

Mr Azman:‘ I don't remember the names of my medications. But I recognize (the medicine) from the bottles. Morning 1 time, another 2 at night. Both the same ... i think. Morning, 12pm, 6pm. My diabetes tablet I collect at (the) polyclinic. Sometimes stock for 2 weeks, or 3 months - depends on my blood test. Post - operation more drops. So now 3+2. It’s good - the medication is good. They told me to put it in the fridge but I forgot - it's the one with the green cap.’

Inda: ‘How do you cope with so much medicine?’

Mr Azman: ‘ My children help me. I like to put in transparent bag and boxes. I'm retired and travelling now too - so I have to keep extra. I'm going to Vietnam in December for 1 week.’

Inda:‘What do you do with any leftover medication ?’

Mr Azman: ‘I label and I report to my doctor when it's finishing. I always throw away (excess), in case (it is) expired. It's dangerous to keep it! The expiry date i cant really see so i just estimate’

Patient 2, 5 November 2025

Inda: ‘May I ask why you are visiting the hospital today?’

Mr Gabriel: ‘I have glaucoma as a result of post surgery complications. I had an accident really young - around 5 years old. I (have) been on the drops practically my whole life. From

6 years old to my 40s now. My dad has onset glaucoma too, as a result of ageing. He is in his 70s.'
Inda: 'What medications do you take?'

Mr Gabriel:' Im on (the) combigan prescription eye drops. Sometimes I get the tears free ones.'

Inda:'What routine do you have to take your medicine?'

Mr Gabriel: 'I put them on my bedside table. I have to take it once I wake up and once before I sleep. I do it this way so that it's easy to access. Frankly, it's (a)habit to me already. I know when to throw them out. I collect 4 bottles at a time usually, but I'm busy so I opt to arrange for delivery.'

Inda: 'What do you do with any leftover medication ?'
Mr Gabriel: '(I) Just throw. I don't like clutter. If there are any recycling plans, I'm interested to know more. I think I've gone through hundreds of bottles already '

Patient 3, 9 January 2026

Inda: 'Uncle, what's the condition you have?'
Mr Tan: 'I have glaucoma - been 10 years. I am here today for my follow up check. I just did the surgery for a glaucoma implant. Right now, it's terrible. I can't balance well.'
Inda: 'What medications do you take?'
Mr Tan: 'I I take 4 bottles that will last me 4 months. There is the 30 day expiry for my drops so every month I (will) throw. Sometimes (during) my review, I change my medication. So (I) must minimize the unused one. You know why? Because I also want to minimize cost.'
Inda: 'Does anyone help you with your medicine?'

Mr Tan: 'No, it's just me. It's a good habit to calculate and keep track. Actually, I don't really understand what the eyedrops are for. I just stick to what doctor tells me'
'What do you do with any leftover medication ?'
'Usually, if it's leftover, its because I misplace. Sometimes I move from (my) house then (to my) car. But I'm good at calculating. If not, I throw my other medication. My eyedrops usually use (until) finish. It's my other hypertension medicine that I will sometimes throw away.'

Patient 4, 9 January 2026

Ms Anya: 'Aunty,what brings you to the pharmacy today?'
I'm here to collect my eyedrops. (I) had surgery. Now (it's) very hard to see.'
Inda:'What kind of surgery?.'
Ms Anya: ' The one for my eye… Make it less blurry.'
Inda:'Cataract?.'
Ms Anya: "Yes, Cataract! '
Inda:"May I know what kind of medications you have?'
Ms Anya: "For my eye? Or…?'

Inda‘Yes, if you don't mind, may I see your eyedropbottles?’
Ms Anya: ‘ok, I have 3 (boxes) here.. 2 more at home. I think this one takes twice –the red one. The red one… actually 1 time.’
Inda:‘Do you have a hard time remembering which drop is for which eye?’
Ms Anya: ‘Ya… (it is) so difficult. But you see here, the pharmacist wrote down’
‘Oh… You mean the one on the box?’
‘Yes, so I put all (of it) here. This plastic container very useful.’’
Inda:‘Does anyone else help you with your medication?’
Ms Anya: ‘My helper, she helps me but..her English is not very good.’

Patient 5, 24 February 2026

Inda: ‘Uncle have you gone for your consultation today?’
Mr Boon:‘Not yet, so long the wait(ing) time.’
Inda: ‘What kind of health conditions do you have?.’
Mr Boon: ‘Heart condition and now my eyes too, (are) very poor.’
Inda:‘With these health issues, are you able to recognise your medication?.’
Mr Boon: ‘I have so much medication, how do you expect me to remember (them)?.’
Inda:‘ ‘For your eyedrops, do you use prescription ones?’
Mr Boon: ‘Is it the one in the plastic or the one I put in the fridge?’
Inda: ‘Those that have to be thrown away 28 days after opening.’
Mr Boon: I'm not sure… I don't know. Maybe you should ask the other (patients) here.’ ’

Transcript of Senior Pharmacists Interview

Senior Pharmacist Sarah, 2 December 2025

Sarah: ‘ yeah so like medication waste sorry medication waste per say, we treat it like a normal rubbish in the pharmacy because there's no guidelines on how you should be thrown away. We only care particularly about cytotoxic medications and controlled drugs. So controlled drugs are drugs that, um normally have abuse potential and we can get very deep into it yeah yeah it'll meet those kinds so um these ones if we want to throw away then we would have to do reports and then it's not just thrown away and in normal rubbish bin it's um we keep it back into our pharmacy store and then HSA themselves,health science authority – they will come in on a periodic period to help us witness to throw it away. So each and every medication that is considered controlled is accounted for. So just for example if the ward nurse just accidentally breaks and Etomidates that one, you all know?

Sarah: Then we would have to gather the liquid and then um basically write in the report what happened, how many vials were broken, who was there to witness that this happened yeah, actually the more administrative burden on you guys yeah correct yeah okay as much as possible we don't want to waste it also. yeah so so i've been on the pharmacy

sustainability for like uh many years now it been on my portfolio for many so uh yes i started with deborah um i would say it's been at least about three four years already so um we have explored quite a number of avenues, we do have a lot of uh blocks, like hindrance because it's um it's a very fine line between um patient safety,efficiency and waste and um unfortunately the waste always goes last because you would want to keep your patients alive.

Sarah: so there's always this issue so we have long identified for example this one you said excessive waste on the strips right so um this one i was here even before this machine came then we manually packed in ziploc bags um definitely you you can see that you know you we can because this one it's a pre-programmed for example just for example you have drug a and drug b um the the robot is not smart enough to know that the strip for drug a is smaller and the drug b strip is bigger so if i tell the robot i need 10 strips of drug a and b i can only standardize to the size that can fit both drug a and b so it would appear as if drug a would have a lot of wastage you understand what i mean because you're it's like a free size dress it's a free size dress so it doesn't matter what size you are i need to fit everyone in this so the tendency is you have a lot of wastage yeah so um and there's more to that so um so that one is the configuration of the machine another one would be if the patient changed their mind simply because the cost um for example initially they wanted to purchase six months supply they changed their mind i don't want too expensive i only want one month i cannot be rejecting that because if they cannot afford it i can't say no yeah so that's another one uh those are what we call we work some so i find that this particular machine the two factors that i have been trying to target this machine for a very long time because it's plastic but uh and furthermore we've looked into recycling the plastic on that one but we directly print medication name and patient's name on the ziploc yeah so hence i'm not sure if you all are aware but singapore we don't recycle plastic we incinerate them so that's one so we can't even you know throw it away properly and then it goes under pdpa waste as well so that's your privacy as well so again so those are thrown in comfy yeah yeah so there's a lot of uh like things that um we know it's a waste but it's like it's very hard to eliminate them yeah um okay then you go back to the ’Parata’ one. you got this one about the paratha. The bottles, the loose bottles, the tablets go inside. I've tried and tried to argue to say we can just reuse it but we can't because they argue that there's a minute amount of powders.

Sarah: once you fill it in you can't you can't reuse it so i argue with them at least you can reuse it for the same drug that is manually packed yeah yeah yeah so that we are doing but oh okay yeah but it's really it's very minute.it's a very small amount so that's one okay and then.. What else? okay, so in terms of the eye drops so um your focus is on the eye drops uh you say you don't want to a lot of them is one month once you open is one month it's not simply because of the manufacturer recommend is because of the um the preservative and the bottle uh it can it allows a certain percentage of bacteria to go inside so the moment you open it it basically starts to degrade and it starts to harbor bacteria so once it reaches the one month point the
preservative is no longer to keep no longer able to keep the bacteria at a percentage that is considered safe for the eye so hence, inadvertently, um ophthalmology would end up having a lot of wastage. so there's more to that so even there's um you said single use eye drops okay so there's a reason. why um eye drops they use single use eye drops because as you can imagine they have a lot of eye drops right so for example my left eye i got a lot of condition on my left eye i need to use three to four types of eye drops so if i use three to four

eye drops i put three to four if you accumulate all of that all of them have preservative a certain percentage will reach your eye and it has shown to cause like some uh side effects and even like wear and tear on your on your lenses so um a lot of the companies they prefer or rather they're uh formulating items that are single use because uh then that means that it's just a drug and water it doesn't have preservative so even if you use multiple times very very long period of time there's uh it's not gonna harm the eye in the long run and preservatives are not good for the eye yeah preservatives are not i mean they're okay to a certain extent but if you're using multiple eye drops they all have a certain amount of percent of percentage of um preservatives on them if you use them all on your eye at a certain point they're gonna you know yeah the percentage is gonna increase so um there's a lot of things that are playing to part yeah um in all this land so um if there's one thing that i would if you're particularly interested on project on ophthalmology.

Sarah: I think Dr Charmine was mentioning that looking into uh like changing the prescribing habits. Not deprescribing, but changing the prescribing habits like for example if the if the condition is like not so serious it's like it's just for normal dry eyes patient has no severe complications then maybe we can get the doctors to prescribe the bottles instead of the single-use eye drops because if you're not using you know any other eye drops it's not really gonna cost that much a little bit of preservative but unfortunately the prescribing habits plays a very big part in all of this so for example if my if i'm a doctor and i go to yeah and my go-to drug is the this which is like a preservative free then uh then uh yeah so um a lot of them their go-to is the single use preservative free um c-line eye drops so i think that's one project that you can look at, especially if dr chris is on board i know for a fact dr chris is very into sustainability as well. Then reduce the prescription of single use eye drops, not say reduce, about appropriation is probably the better term like oh like i don't. I think a lot of the doctors don't want to hear that we'll prioritize sustainability over the clinical appropriateness of the medication so I cannot put that as a point but it's very hard to um sway the prescribing habits yeah i think you can work on it with Dr Chris and Dr Chami they've already brought it up previously because i think they're not um blind to the fact that it has a lot of wastage

Sarah: but uh when it comes to like dry eyes they tend to er towards the single use which i kind of don't understand because not only is it more expensive yeah yeah it's more bulky as well so but like i said, it's prescribing habits yeah also like what do patients want right i don't think the patients know what they want because it's what is prescribed so if for example i have a patient who has a hearing loss so i first come here already initially you already prescribed me this one if i suddenly change it into something that is say with preservative it might appear as a substandard in my eyes then i would you know i mean so it's the doctors has a enough rapport with the patient to dictate and sway their opinions um i personally think that it it needs to be headspirited by the doctors yeah um i think pharmacy comes into play that we supply whatever the doctor prescribes i don't think it's very efficient workflow wise for me to actually initiate something like that because not say initiate but it's like it's it's inefficient for me to switch for example if you're the doctor if you prescribe say preservative free i drop i i personally think this patient don't require it yeah simple the bottle will be fine the doctor prescribes it and i don't think it's efficient and then i would have to go back into the workflow and then ask you to change it so that i can supply this to the patient so it's quite inefficient in that manner and it's not something that the current systems allow and it will require a lot of

rework yeah henceforth more more wastage in terms of the carbon footprint of reverts and whatnot so i think it's more a logical approach if we are able to come up with a consensus work together with the doctor on what should be the standardized prescribing habits.
Only they all can decide what they feel is acceptable to them and they're able to adhere to Pharmacy can support by saying that like we keep because we have a satellite pharmacy we can keep more of the certain items for them um but we go by demand and supply so if you prescribe more of this definitely and it's not more yeah it's just not practical to be the one because i think previously medicine clinic the recipe respiratory clinic i'm not sure if you're aware of the trying to discourage the cfc free MDIs. I can't stop them if they prescribe it then in the eyes of the patient it looks like i'm limiting their supply so it's uh i hope you all can see that it's uh it's very limiting in a sense that the doctors definitely need to play a very big part.

Inda: 'Yeah. I understand. And it's a very good insight, I have a question though, because like, from what I see during my time at eye clinic, the patients,we will follow from before they go into the room,and then sometimes when they are comfortable, then we follow them to pick up the medication,then they go home. The thing is that I noticed that when it comes to questions about their medication,they don't really ask the doctor. And then all of it kind of like spilled out in front of the pharmacies,at the satellite pharmacy. Then I just think that, because I understand from your professional opinion that the doctors will spearhead a lot of the decision making, but I was wondering if the role of the pharmacy can be greater when it comes to communicating with the patients?'

Sarah: Ah, yeah. So, because my job is to counsel the patient, so a pharmacist's job is to supply the medication based on what the doctor prescribed in a way that is clinically appropriate and also sound for the kind of indication that the patient has. So that means like, you got this problem, I will prescribe you this.Imean, the doctor prescribes you this medicine, then the pharmacist kind of pulls as a gatekeeper to make sure that this medication is appropriate within the dose.So, and then I act as a bridge to communicate to the patient how this medication is going to be used and what's its role on the, that's how the whole healthcare works.So, I think it makes sense that the patient will probably ask more questions because most of the conversation is done on my counter. Yeah. So, the doctor might not necessarily know this one needs to be kept in the fridge, for example, or how long it can be kept outside and whatnot. And of course, if I'm the one who's saying this to the patient, then the more practical questions will obviously spill out more at the counter. So, I wouldn't say that I particularly decide what treatment goes into the patient, but you kind of like to keep it. For example, this doctor wants to prescribe this antibiotic, then I check the patient's renal function.Renal function is not so good, we shouldn't be doing this dose. I call up the doctor, reduce the dose.So, that's, it's a clinically appropriate drug and the dose.Then, only then I call the patient, explain how to take the medicine. So, I don't, as you can see, I don't decide what the drug is, what drug to supply. I, at least not in our current,not in our current health care practices. There are some pharmacists who decides
and spearheads them, we call them prescribing pharmacists. So, there are those clinics. Yes, we've got gout, diabetes. We've got small clinics that are spearheaded by either nurses or pharmacists who are not doctors, who get to decide what to supply to the patient.
But most of the pharmacists in here are not really deciding what to give to the patient.
Yeah. So, the doctor decides, then I just, basically you're a checker lah, something like that.

Inda: ‘Then, I also have a question on when you're communicating with the patients. What do you feel is the biggest hindrance when it comes to getting them to adhere to their prescriptions?’

Sarah: ‘The biggest ah? I think there's a lot to play eh.Or like maybe a few factors that stuck with you, I guess.Cost is one. If they cannot pay for their medicine, they cannot adhere to it. It's obvious, right? So, it's like if I can't pay for my medicine, I don't see how I can follow.Another one would be the belief in my condition.So, for example, cholesterol. So, high cholesterol is not something that you can feel. Like if you have high cholesterol, you don't feel nauseous or you don't feel headache or whatever.It's just high cholesterol. But why do we want to reduce a person's cholesterol? It's because the cholesterol deposits on the heart. Deposits on the heart increase your risk of stroke.10 years survival rate reduces by a lot. So, we treat the cholesterol to reduce the cholesterol,but we're actually essentially protecting you from the next 10 years from all the,what we call the cardiac events. So, that means stroke. Why do we protect you from stroke? Because of stroke, then of course, you got fatality and also it reduces your quality of life.So, these are not very obvious. So, we bracket this in this thing called health literacy.So, a lot of the elder population, they don't really understand why, for example,cholesterol, I don't feel it or why I need to treat.But it's much easier to get someone to adhere on a medication for runny nose. Rather than to get someone to adhere on a medication for cholesterol, for example. because if I take medication for my runny nose, it stops.I feel it. But if I take medication for my cholesterol, (or) I don't take, no difference.It only shows in my blood test.Even on the blood test, it doesn't show many, many months later.Yeah.this is what we call health literacy it's something that a lot of our elderly population they're lacking I think younger generations probably our ages we are a bit more aware with the social media and everything we're a bit more familiar with all this love but the elderly is not so so if I don't believe in my drug I won't take it yeah then like there's another thing that

Inda: ‘I went to a few patient homes and then these are like images of how they store their medication and a lot of them say the same thing which is like they need like this sense of security or like they didn't know that they had to throw it out or like some of them have like bad habits of sharing medication with their family members or they say that the instruction not clear from the pharmacy something like that yeah then I was I was wondering if you think that as pharmacist like you can kind of like help patients from the we already use oh yeah to like kind of like minimize these unsustainable habits I guess like stop them from hoarding stop or kind of reduce the habit , If there is a way that you think that I could do so?’

Sarah: I’ll throw back the question, can you stop someone from buying too much clothes? it's it's a very rhetorical question,because um there's only so much you can advise, yeah like you already have a black dress but if I see a cute black dress I would want to buy it again so it's the same concept. we do have things in place to so-called like help these people who are seem to have a lot of medication but we look at it more from a patient safety point of view if you have many many drugs you don't know which one are you supposed to be taking maybe out of these 20 drugs you only need to take eight of them so we do have certain um programs in place called POP and UHS at home so they're all like health care workers so

mostly pharmacists and nurses who visit in the patient's home helps them pack up their medications to ensure that they're taking drugs one to ten you know correctly whether or not there's a program in place to stop people from hoarding I don't think so
that's what's okay yeah yeah but actually holding is a big issue not just medications yeah okay. it's just a compulsion just that sense of security for them when they have a lot of something that they think that they need you know and I mean I think sometimes it falls into like a kind of mental health it is it is issue so I've done a few social work in the past on hoarding is they they very uh they just this this is just a coin to you Tencent coin but to them they will go back and say no this one I got it from here it holds a memory to me so I mean like yeah it's just it's there's more to it than that it's not just as simple as yeah we wish we wish we acknowledge yeah but it's um I think there are like certain things mental health a bit harder to tackle right because everyone is different but I think like the more viable issues

Inda: What those that don't know how to store properly or pack properly like you said I I was thinking, maybe there's a chance where the pharmacist or the hospital can teach patients how to properly pack certain things, or how to store your medicine yeah medication because I did meet one patient then she had cancer before so she was saying that like last time she used to do this thing where they just throw everything in one box but after like her cancer then she got very like conscious about her health and then she went for this class online what medication can be like kept in the fridge what cannot and then she she felt that she said that the amount of medication that she wastes in the end reduced by a lot because her habits got better yeah so I was thinking could there be like an opportunity where maybe we can help patients to like properly store or we kind of like pack it for them because now, when the patients go to the satellite pharmacy a lot of them are looking at their bags for the medication. Do you feel like as a pharmacist there will be too much on your plate like helping them to pack for them

Sarah: ‘But there are already these things at hand, it's whether they want to go on board on this or not but I think many patients are not really aware of things like even recycling or disposing there is really a lack of awareness on packing medicine and like disposing in general .
A lot of projects is-- it's like they go-- we start and then a lot of it is very hard
because when you've got your patients into play, it becomes very retrospective.
I mean, there's a lot of other initiatives that was also quite good, like turning off
the computers and--Yeah. Recently, the labels, we also stopped printing out price labels and all that.I mean, there's a lot of like-- but they're all like really small efforts.
They're not exactly as staggering.

Inda: Yeah.

Sarah: You know, like, print the labels on the medication bottles,for example, or on the--rather than on the Ziploc.So then you can recycle the Ziploc.It's a legal requirement to have labels on the medication. I even went as far as, like, looking overseas,what they do sustainability-wise.
But you'll find that in terms of pharmacy,they do more recycling rather than reduction.
Actually, reduction is where the gains are.It is, definitely.So I don't like recycling, actually.

Because recycling means more money. Whereas if you do reduction, you--You actually save money and you cut down the waste. So that's where I want to target.But pharmacy is very hard. Because– dilution of the medication, you know, that– Some people say that instead of having to consider the dose,you dilute depending on whether the manufacturer even does it in such a manner.If I cannot find a drug company that does this, then--But we can dilute it also.But it comes as a single diluted thing. For example, your infusion, most of the time it comes in a vial with a powder.And with the– We call it the diluent to dilute it.
So you can argue that, "Why can't you just give me a bottle of diluent?" Then I put in the diluent myself. But if you purchase the drug, it comes like that.The company themselves does it. So that's where the difficult part is. You can tell me that this one box, the strip only like that.But why do I need such a big box? Then again, I ask you-The company does it like that.Yeah, that's where the design comes into play.
Have shifted to actually go directly to these companies and say, "Hey, actually--"
So for example, the size of the box is because of the manuals inside, called instruction manual.Actually, the whole equipment, medication side is actually very small.
But they had to design it to be very small.So, you know, it is that kind of thing, yeah.
But there's more and more companies now who are switching to QR codes.So that means they print out the QR code on the box itself.So less on the leaflet.
Again, that's where you save the money.Less paper, less printing.
It's good for them.But what are the issues?
Because if somebody says, "Oh, I don't have the code.I can't scan."
You know, that I cannot accept all this information.And then my family members are like--
You know, they also need to protect themselves, right?
I don't think it's very easy to tackle the oversupply.

Sarah: I think for starters you can like think of your objectives and what your end points for your project then maybe i can help you sort of like magnify which ones in pharmacy should you focus on because often i can tell you this one i don't think you're gonna get a clean clinically significant results okay from this yeah because oversupply is an ongoing issue not just on medicine yeah it's very difficult yeah you you're trying to find what what you want your end points to be or what goals you want to hit on because how long…

Inda:I mean, at the end of the next six months maybe there is a tool or something that the pharmacist can do to help to reduce this waste. Particularly pharmacists to spearhead because i feel that if it's the doctor, then a lot of the doctors say like they they are there for a medical need not like a supply need and then if it's a patient then the patients because medication is personal so everyone has different habits and everyone got different circumstances also so like the i guess the person that could kind of make the greatest impact would be the pharmacy.

Sarah: ‘Interesting thought, but okay I don't quite agree. you know but uh i mean definitely we can we can definitely play a role definitely and i'm very much on board. I think we can work with the doctors to decide what is the magic number that we're supposed to be generating so for example again going back to the salbutamol what is the usual amount that the patient should be getting in a six-month supply they also have that the patient should be getting in a six-month supply they're supposed to be two maximum two six months maximum two the campaign ,actually it's a prescribing thing you know on epic you can
you can put a stop to it so that means right if because um epic is a prescribing system so the

doctors go inside epic i basically prescribe there it flows into my system to dispense the medications if a doctor prescribes this particular salbutamol, is the ventolin — the cfc one
Inda: yeah

Sarah: if i prescribe six months one canister has 120 doses divided by four plus maximum for basically it's a math thing so six months will mostly end up with six canisters, but the doctors when at the point of prescribing they can put a quantity two instead or one instead of prescribing for duration so they prescribe that as per the duration because
for example if the patient's appointment is today right then i'm gonna see this patient say six months later so they would give six months of life because obviously for that six months
but this medication called salbutamol or ventolin is not good for you so they might not use it every day for that six months so if it's actually clinically viable for them to instead of putting in the duration they can put the quantity as two or one so that when i generate the script it will only generate one yeah if the patient asks me can i have more i will say no because the prescription only got one so yeah. So from this example, you can tell that if from the start it was already done as such, then the patient wouldn't have the chance to ask for more than they need. You're learning a lot, huh?

Inda: ‘Yes.’

Sarah: But I mean, the bad news for you also is that this is like looking to be a very difficult project. I think you need to pinpoint which you want to tackle. Because it's very large.

Inda: It is.

Sarah: You want to focus on, personally, I think it is on prescribing habits. You want data to show reduction, you go in the prescribing habits.Because if you can induce 10 doctors, 10 doctors sees, I don't know, like say 15 to 30 patients per day.In a span of, the data is there. Because pharmacy will just follow what is prescribed.If you want to particularly tackle pharmacy. Pharmacy, we can only see a reduction in the Ziploc bags or whatever. Sustainability in healthcare, it's a very big topic. You'll drown if you don't focus. You should try to pinpoint which one. I guess it's really to understand and of course, I don't expect you to know like, actually to understand the whole process, where the source of the problem is. And who can, who, who can influence that, that, you know, outcome, decision.But like, I think if you want the numbers to show,we can come up with media material with the patients on why they should prefer, for example, multiple-use drops instead of single-use drops. And we can even come up with a price chart for them to make it more significant for them.

Inda: Yeah.

Sarah: Because some doctors, they get very surprised.’Eh, this one's so expensive.’This one's only a few dollars.’ They don't know because they prescribe only once.
They don't know the price. But me, I'm a pharmacist..I tell the patient this one is cost like that. Then I get the hate because it's prescribed by, you know.Then they get angry.

Inda: Yeah.

Sarah: De-prescribing is a national project.There are many, many areas where you can de-prescribe.

Inda: Yeah, I saw (it) on the NUHS website.

Sarah: All the hospitals are trying de-prescribing.

Transcripts of Doctor Interview

Doctor Charmaine, 6 February 2026

Question: Could you tell me more about previous projects on reducing medication waste through sustainability efforts or improving patients compliance?

Response: The first project Vending machine to dispense OTC drugs beside the satellite pharmacy to reduce time spent checking medication stock. The second project was a medtech device for patients and doctors to measure remaining medication and prescribe more accurately.. Basically, how compliant they are to the medication.

Question: Could you tell me more about the process involved?

Response: Last time, we didn't have the satellite pharmacy yet, and doctors will have to travel down to the level 3 pharmacy to check if what they need is available. So we would stock and put it in the eye clinic. Some of those include the common eye products like the lubricating drops and the ones for post surgery care. I'm referring to, like, post op pillows, glasses or those niche items. With the pre pack sets, more waste is actually created. So having the machine located right at the pharmacy area of the eye clinic, patients are also able to purchase the item without travelling down to the level 3 pharmacy. Some of them get confused too about where some items should be purchased. If those items are not in the pharmacy formulary, then there is no push for it. Without that, patients aren't able to claim them and won't buy it in the end. For the medtech device, we wanted to improve on the compliance levels of patients. So, in the project experiment, the bottles itself could measure the volume. There was a whole equation that was calculated and trialed for it to work.So it's easier to see how much was actually left. Since the device was designed to be connected to an app, it shows doctors what the active medications are.

Question: What were the end goals of the projects? — Was it to reduce waste, or reduce the waiting time ?

Response: The Medtech device was really to assist patients properly handle their medication, especially those without a caregiver or need more support.As for

the vending machine, it was really about efficiency and making sure that patients have proper access to the medication they need.

Question: What would you say was successful in these projects?

Response: It was well received in the sense that, everybody recognized that there is a need for these interventions. Like for the drive I was telling you about, we even had the patent for it. That was how much development went into it. Even the dispensing one, something similar is implemented in some other clinics in NUH.

Question: What were the biggest pushbacks you experienced during the projects?

Response: For one, it's a lot of the administrative stuff in the hospital. Some of it is like finding the right type of machine, and a big factor is the finance that goes into it. For the device, to receive the stakeholder funding for such interventions are hard. Since the device, at that time was also an independent item, you would have to purchase it. Patients don't feel that there's enough incentive to it. And the other consideration is that the target demographic is older. But some of them may feel that it's too high tech for them, or didn't fit into their existing routines.

Question: As a doctor, what do you prioritize when prescribing medication to your patients?

Response: I may have the tendency to overprescribe, as I worry that my patient will use more than the prescribed amount. Or sometimes… I worry that they may run out of medication. So, in this case too much will mean (that there is) wastage. Too little, (they might) run out. Sometimes, their next appointment is in 3 months. So I would prescribe for 4 or 5 months. For myself, I don't find that many patients ask for more than they would need.

Question: What would you say is the biggest factor in medication waste? — Is it the patient, their environment or healthcare providers involved?

Response: I think there are many factors here. I can roughly tell how conscientious they are about their meds. For some patients, they can be quite disorganised. They struggle to communicate clearly. Since eye patients are majority older, definitely.. I think communication is a big barrier. So I try to use pictorial Representations. Many patients co-relate with the bottle instead of the drug name, Like, for myself I would just Google the pictures of the medication on my phone and show the picture and check with patients. 'Is this the one you are referring to?' Or some other doctors have a chart of commonly used medicine. They find that it is helpful to use in the consultation room.

Question: As a doctor, how would you describe your relationship with the pharmacy?

Response: I think for ophthalmology its good, mainly because we are close in physical proximity. Without a satellite pharmacy, it would be significantly harder for us to communicate. We have an established workflow. There is a lot of backend communication that happens between us doctors and pharmacists. So the

standard would be that they can drop me a ‘teams’, to check on a prescription. Yeah, we always ‘teams’ first. Everyone is very busy. Pharmacy helps with managing the prescriptions, so they compute for us. Since they are more familiar, I would say doctor errors are quite high, so there is a high need for clarification.

Question: What do you think would be the best way to support patients and reduce medication waste?

Response: To improve the patient compliance would be a big one. I mean, this is something I have been working on it as well.For some of them, compliance levels are poor. I would ask them to bring their medication, but they often don't bring it with them anyways. You're asking me about reducing the waste today… I think the tension really is about balancing efficiency with sustainability as well. These initiatives, like the ones I shared with you earlier, would take more cost. If you want to reduce the cost, then more manpower is required.But for clinicians, we have so many patients so it will definitely be hard for us to even think about reducing the waste. Still, I think it's an important subject to continue working on.