



## Recent advancement in Patient convenience and Medication Adherence

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### ABSTRACT

The conventional packaging of medicine has some limitations like chances of non-medication adherence, overdosing and other common regular life mistakes. This review covers inventions which can help to improve patient medication adherence using approaches like making advancement in dispensing containers, using dispensing strategies and combination of them. Improvement in medical adherence in patients leads to better healthcare outcomes. Advancement in dispensing systems will help to reduce loss due to medication non-adherence worldwide.

**Keywords:** Medication non-adherence (MNA), Advances in dispensing containers, Electronic dispensers, Strategies of dispensing.

### I. INTRODUCTION

Packaging stands a very important place in pharmaceutical industries. It protects, transport and manages formulation doses. Without packaging, the drug product gets degraded and can't be used for treating the disease. But in this era of living lifestyle only transporting medication safely to the patient is not enough. The need of the current scenario is to improve patient adherence and reduce global cost of prescription non-adherence. So, the packaging system should be like that, that can remind patient about taking medication every time by visual or audible indications. So, the patient cannot skip any medication non-intentionally. Nowanother problem is, a patient who intentionally skip their medications, they should be handled by different means. That type of patients should be forced to follow their medication through various strategies. These type of medication systems are mainly for patients who forgets to take their medications or mentally challenged and fail to follow their prescription. Majority of the population either forget or skip their medication due to so many various reasons. So that could result in a relapse of disease and patient need to take more medication to cure from that stage of the

disease. This would increase the cost of the treatment and ultimately makes the patient suffer more. So, to reduce this kind of events patient need a device which manages the doses and reminds the patient about the time of administration and overwatch the activity of patient regarding the medication intake. The other options are to invent a device that can do all the things like a robot to maintain the prescription of the patient and improve prescription adherence of special group of patients.

### 1.1 Need of the Invention

The main purpose of this kind of container system is to improve the prescription adherence, which ultimately improves the patient health and reduce the chances of relapse of disease like infections. By completion of the therapy, chances of relapse can decrease, and medication becomes more effective for the short and long-term therapy due to continuous dosing without interruption of any kind. To overcome the problem like prescription non-adherence and overdosing, this kind of medication dispensing systems would be helpful. It also reduces the annual costing used after the patient who fails to follow the dose regimen.

Nowadays peoples are living a very stressful lifestyle which make them forget about daily medicine regimen either by mistake or intentionally. Mostly geriatric patients are more prone to skip the dose or take an overdose of the medicine to counter previous skipped dose. Also, a patient with low memory power is more likely to forget about the medication. This type of routine may cost more due to not following the medication properly. According to the data provided by regulatory committees shows the loss of in some billions per year in USA, which ultimately cost the patient more. How to overcome this type of problem and how can we encourage the patients to follow and complete their medication? Answer to this problem should be a system that reminds the patient about the medication. The In current

scenario patients are reminded by family members or other caretakers, but this requires so many efforts and after some time it becomes annoying, so it might not end so well, for the patient and also for the caretaker.

### 1.2 Ideal Dispenser should be

The ideal dispensing system should be handy, low power consuming, economic and easily available to all the needy patients. Nowadays there are so many dispensing systems available to fulfill this a kind of requirements. The devices or dispensing systems allow the user to set time for medication or prepare a schedule of the medication for a week or a month. The device should be very low power consuming, so it can be operable using button cell power source. The device should not contain any rarely available parts which add up the cost of the device. Thus, it gets available in the market with an affordable costing.

Another advancement could be like that, the device might be modified by adding robotic features that can react with patient condition and give proper advice to a patient. Device could be further modified by adding a feature like patient counseling by using previous another patient experience. This type of feature might add up ultimate cost and that might become a limitation of the device. But on other hand, as a result, the patient can get better use experience from that. So, a higher price might get worthy experience.

### 1.3 What Statistics say<sup>1,2</sup>

Prescribed medications are not taken by approximately 50% of people. This is a phenomenon known as “MEDICATION NON-ADHERENCE” (MNA) and it is the cause of huge amount of unnecessary financial loss, premature deaths and physical and emotional suffering, and that ultimately cost too many people precious time that they could have with their family & loved ones. As MNA impact number of people with zero awareness, another term for medical non-adherence could be “THE SILENT KILLER”<sup>1</sup>

In today's scenario, MNA leads to approximately 1.25 lacs preventable deaths every year, and about \$0.3 trillion in avoidable healthcare costs. In the current scenario, due to MNA people are dying about 10 times greater than dying from homicide and in case of a person with age of over 50, it is 30 times greater which is a tremendous loss of life due to this silent killer.<sup>1</sup>

Drug adherence sets aside extra cash as well. One scientist found that each 10% change in

pharmaceutical adherence diminishes medicinal services costs by up to 29%. In another vast examination performed with a huge number of individuals, Walgreens found that each 1% change in adherence spares about \$50 in medicinal services spending. For patients with perpetual conditions like hypertension or diabetes, patients who are accepting their drugs as recommended spared somewhere in the range of \$4,000 and \$8,000 every year on human services costs, all things considered. In another investigation by a large employer, enhancing adherence was found to enhance worker profitability by \$18,000 yearly.<sup>2</sup>

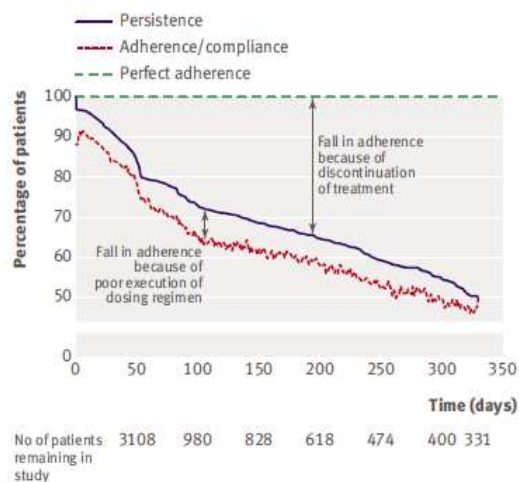


Figure 1: Statistical Graph of Percentage of patient adhere to treatment V/S Time in Days (Vrijens B, Kristanto P, Urquhart J, Burnier M. Adherence to prescribed antihypertensive drug treatments : doi:10.1136/bmj.39553.670231.25)

Figure (1) shows a case study data performed on 3108 patients for finding out actual adherence of patient in therapy. As the data shows, at the end of a year, only 331 patients are stick to the therapy, which is only 10% of the starting population on the patient. This study only shows Medication non-adherence of one disease (Hypertension). There are so many other diseases present, which causes more damage to the patient health and increase the mortality in that specific disease.<sup>3</sup>

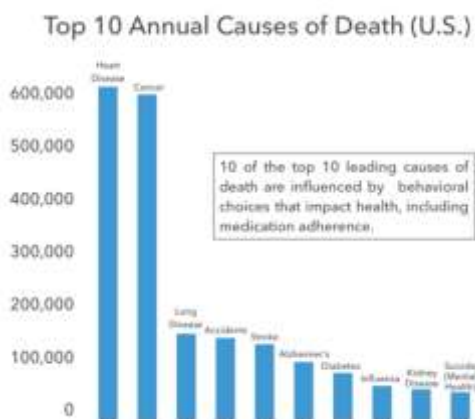


Figure 2: Graph of Number of deaths V/S Disease (www.pillsy.com)

As shown in Figure (2), the topmost cause of death are hearth disease and cancer, which are increased due to non-adherence of therapy. By considering Figure 1 and 2, if 80% of patient are failed to follow their treatment, the number reaches to the lacs of patients who die due to just not following their prescriptions. So, prescription non-adherence is a major problem of the society which causes great damage to finance and health of community very silently.<sup>1</sup>

By considering all these stats, we could conclude that there is greater need of mechanism by which we can make patient adhere to their medication regimen. Over the time some of the ideas did hit the market which we shall discuss in next section.

## II. ADVANCEMENTS IN DISPENSING CONTAINERS

### 2.1 Device for Storing & Dispensing Drug Doses (US Patent:4526474)<sup>4</sup>

This device is very simple, handy. It can be stored in a small place like a handbag or a regular bag pack. The figure 3 shows a schematic representation of the innovative dispensing pack. The strip has a controlling device and a circuit on the back side of the strip. The controlling device possesses a light indicator, an audio device, a digital display, a time setting unit and a gap for attachment of strip. The light indicator blinks at a time of drug administration. The speed of blinking shows the urgency of taking the medicine. High-speed blinking shows that the time has passed for medication. An audio device makes the noise of a particular pattern to alert the patient to take medication.

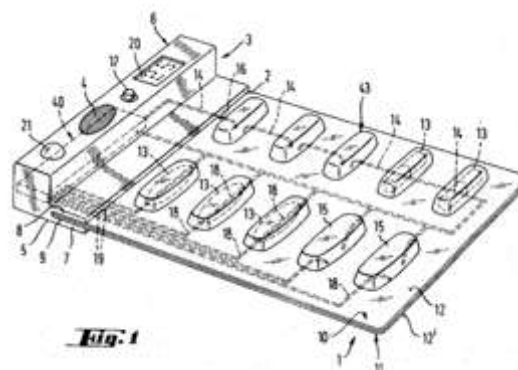


Figure 3: Device for Storing & Dispensing Drug Doses(<https://www.google.com/patents/US4526474>)

This both mechanisms can help Patients with hearing and vision disabilities respectively. Digital display shows time remaining for the next dose. Time setting unit allows the patient, to manually set time for the next medication. The gap in the controlling device facilitate the refilling of the medicine and give control over the strip by holding the circuit strip. The circuit strip possesses 3 layers. In which first is for holding the tablet or the capsule, second is a multipath circuit and third is a normal protective layer. The first layer is transparent and allowsthe user to view the color of medicine in case of multiple medications. The second layer of the multipath circuit is for observing the dispensing of medication. The multipath circuit allowsthe user to takeout medication without following a zig-zag pattern. The controlling device can note the time for removal of medication from the first takeout by any part of the strip. This type of packaging system help patient to remember about medication and improve the prescription adherence, which ultimately improves patient health and reduce the cost added by over/under medication.

#### 2.1.1 Limitation

The device can only refill for 10 doses. So, for one-month medication, the patient need to purchase 3 circuit pack of that medication, which is not economical for the patient. The dispenser is not reusable and needs to discard after one use, which also increases the electronic waste. For the pharmacist, there is an additional step of stapling of the strip to program the controlling device for proper dispensing time reminder. Dispensing limit, single-use, and the cost is a major limitation of the device.

## 2.2 Automatic Pill Dispenser<sup>5,6</sup>

Automatic pill dispenser is a very handy device which is also easy to use. As shown in figure 4, it possesses a display panel on the center which shows date, day, time of drug administration and how many doses are remaining in the dispenser or time for a refill. The transparent container is helpful for viewing the remaining doses to ensure all the medication are taken at particular time. The container also rotates to place right slot on the dispensing window of the dispenser, to facilitate the dispensing. On the front, there is a dispensing window with a locking mechanism which only allows a user or a person with a key to open it. This feature makes the dispenser temper proof and assures the safety of the patient. Alarm system alerts the patient about the medication time. MED-E-LERT® provides time showing adjustable strips which guide patient for doses time like morning, evening and night just to ensure that if the patient has skipped the previous dose then he/she will not take the wrong dose in multiple medication regimen.



Figure 4: Automatic Pill Dispenser  
(<http://www.medelert.net/>)

### 2.2.1 Limitations

Sometimes the size of the dispenser could be problematic. It is very handy while using at home or office, but while traveling it may cause some problem like acquire more storage space. The other thing is its key security, it is possible to misplace the key with geriatric patients, so at the time of medication patient first, need to find the key and only then they can take medication. A modification like a fingerprint lock system can be applied to solve this kind of problems.

## 2.3 Bottle Cap Reminder Device<sup>7</sup>

This is a very simple and useful device to remember medication. The device is a cap which fits on any size of the bottle. The device possesses a digital display and an audio alarm system, which alert the user for dosing time. Figure 5(left) Shows a product named TIMERX, which shows time remaining for the next dose. Figure 5(right) device have a modification, it shows the time at which the bottle was opened. So, the patient can remember whether the dose has been taken or not. Both the devices have an alarm system for the reminder of dosing time. One other uniqueness of the device is that it can be fitted on any size and kind of bottles by using provided attachments. That makes this device more convenient and easier to use.



Figure 5: Left: TimerX, shows time remaining for next dose. Right: Shows the time at which bottle was last opened (Left:[https://images-na.ssl-images-amazon.com/images/I/71S2GO8FEnL.\\_SY550\\_.jpg](https://images-na.ssl-images-amazon.com/images/I/71S2GO8FEnL._SY550_.jpg); Right:<https://sep.yimg.com/ay/epill/e-pill-timecap-simple-pill-timer-8.png>)

### 2.3.1 Limitations

There is a limitation with the device shown in Figure 5 (right); every time, the time of the cap gets reset when the patient opens the cap. So, when a patient or other person open the cap to just to check how many doses are there, the time gets reset. And that cause the miscalculations in dispensing time. This will lead to over or under medication in geriatric patients, and sometimes cause severe toxic effects in patients. The other thing is this device does not possess the system which can measure whether the dose is taken out or not.

## 2.4 Medicine Container with An Orientation Sensor<sup>8</sup>

Measuring doses and remembering refill date might be difficult for the aged patient and it is

also annoying for a caretaker to remember refill dates in daily busy life. So, there is a need for a system or a device which can measure remaining doses and alert the patient/caretaker at least 2 to 3 days before the date of refill. Medicine container with an orientation sensor looks like a possible solution to this issue. The device has counting sensors which count the remaining doses after each withdrawal. Sensor count doses when the container stands in a fixed vertical position. But every time it is not possible to put the container in vertical position, for example when it is in a handbag or in a travel bag, orientation changes and that affect the counting pattern of the sensor which ultimately results into counting error. So, to solve this problem innovator has put an orientation sensor in the container which informs orientation of container to the counting sensor. Combination of these two sensors results in the more accurate counting of the remaining doses in any position of the container. After calculating the correct number of doses, this device communicates with a remote server to inform about the refill date to the patient or a caretaker. There is also an alerting system which informs the patient if the medication is not taken in predetermined time and insists the patient to take the medicine. There is a visual alert LED light system for a patient with a problem of hearing. There is also a touchscreen to manage the dosing program and other functions of the device. There is also a USB input device slot to connect with the wired network and other input devices like keyboard and mouse to manage the system configuration.

#### 2.4.1 Limitations

The major disadvantage is power consumption due to so many functions of device it consumes a large amount of power to keep the device in working condition. It should be provided with constant electric supply by battery or power adapters. No major disadvantages are there for this device.

#### 2.5 Pill Bottle Time Indicator Lid<sup>9,10</sup>

This innovation uses no electric power, it only possesses mechanical parts (figure 6) which shows time for next dosing. The device can be fitted on any kind of bottles. This device has a dial for time indication which has markings at 30 mins interval for 12 hours. In the center of the device, there is AM/PM slider which helps to differentiate between morning and evening periods. To set time, the patient needs to lift outer rim and twist to the next dosing time. The main advantage of this

device is, it does not use any kind of power source and can be used until any physical breakage.

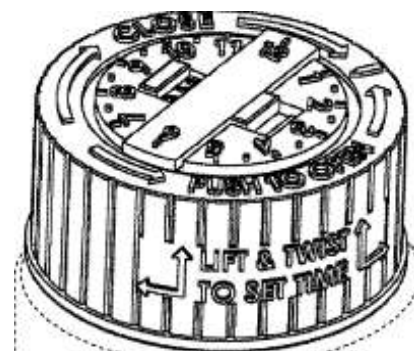


Figure 6: Pill Bottle Time Indicator Lid  
(<https://patents.google.com/patent/US20140291279>)

#### 2.5.1 Limitation

The device does not have any kind of alert mechanism to remind the patient about the next dose. The patient has to see or check the device to know if the time arrived for medication, which may cause dose skipping or cannot successfully make patient to stick to the regimen.

#### 2.6 INTELLIGENT PILL BOX<sup>11,12</sup>

As shown in figure 7, this device comes with so many specifications like slot flashing light, sound alert, sim card slot, live tracking of dosage regimen, any time supervision of patient's prescription adherence, four-time slots for every day for 7 days and reset button for another week regimen. This device also possesses a remote management system which allows a patient caretaker to change schedule and observe daily intake of the patient via a smartphone application. Each and every compartment possess a flashlight which gets on when dosing time arrives. So, the patient can check if the time for medication arrived or not, just by looking at the device, even from some distance. Every compartment has a sensor to check whether the dose is taken or not, if the dose is not taken then device communicate with patient's caretakers or appointed person to inform about the missed dose and insist to contact patient and tell them to take a dose. The company also call the patient or caretaker to concern about missed or skipped doses.



Figure 7: Intelligent Pill Box (MedMinder® maya)  
(<https://www.medminder.com/pill-dispensers-2/maya-pill-dispenser/>)

### 2.6.1 Limitations

The only limitation of this device is, it does not come with a power source. The patient needs to plug it into the electric plug. The device cannot be used while traveling. Weight and size of the device are also big. It is not a handy device and consumes some space on the table. The patient needs to come to a place where the device is kept, after getting alert from the device.

### 2.7 YOUR meds<sup>®13,14</sup>

This marketed medicine pack is a well-maintained and cost-effective product. The size and shape of this product are very handy and contain almost all essential functions. At the top of the container, there is a digital display which shows the time and the date of the next dose. The LED indicator blinks at the time of the administration. An audio alarm system is also available for visually impaired patients.

As shown in figure 8, this pack contains 7 days medication for 4 times a day. The device possesses 4 columns and 7 rows, where columns are for the morning, noon, evening and night and rows are for individual days. The other advantage of this is it can be taken anywhere without bothering about storage problem, due to its very compact size, it can be placed even in a handbag. The product contains numbering on every dose so there is no chance of taking other medication from any other compartment of the strip and display shows a number of doses which should be taken at a time. It reduces the chances of mistakes while taking medicine. Another advantage of this product is that it can be refilled very easily, the patient only needs to change the strip pack over the display panel.



Figure 8: YOURmeds<sup>®</sup>  
([http://www.yourmeds.net/sites/default/files/2017-10/Prev\\_MS-1024036-singleF%26B.png](http://www.yourmeds.net/sites/default/files/2017-10/Prev_MS-1024036-singleF%26B.png))

### 2.7.1 Limitations

This device does not possess any kind of communication feature that can alert guardian/caretaker whether the dose is taken or not by the patient.

### 2.8 Locked pill bottle with time dispensing limits<sup>15,16</sup>

Substance abuse is a major problem with the patients of insomnia and other sleeping disorders and also for seizures patients. This type of patient needs to take narcotic medication which is normally habit forming and produce dependence of medicines. Sometimes patients also forget to take medication on time and that can produce life-threatening conditions in that kind of particular patients. So, there is a need for a dispensing system which can limit the dispensing and also remind the time of medication. There is a patent available for this kind of dispensing system which can limit dispensing as well as remind the patient to take the medication at right time. Patent no.: US9636279B2 shows the invention for this kind of need. The prototype of the device has a very simple and handy shape, which can be stored and handled very easily. This device mainly possesses parts like fingerprint scanner to make sure that only patient can remove pill from dispenser, a dispensing window and internal complex dispensing system which dispense a drug at a programmed time. Fingerprint scanner allows the user to safely remove a pill from dispenser without allowing another person to remove pill in case of narcotic drugs. Another advantage of this container is that it is intact and can't be open without a registered

person, so there is no chance of drug abuse by patient or non-patient. The alarm system let patient remind the time of medication and will continue until the drug is taken. This could be the very useful and handy device for a patient with a disorder which needs narcotic medication. (Prototype belongs to Johns Hopkins University (Figure 9))

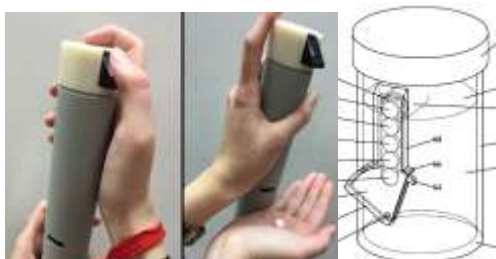


Figure 9: Prototype of device & Schematic diagram of device  
 (https://patents.google.com/patent/US9636279)

### 2.8.1 Limitation

This device possesses so many expensive features which makes it costly. The major limitation is the cost of the device which gets added up with every extra feature added. The minor disadvantage is its battery usage, it might be possible that due to the higher functioning of device it causes more use of power and should be charged every day.

### 2.9 MedCenter Monthly Pill Organizer<sup>12,17</sup>

This device is designed for monthly dispensing. As shown in figure 10, it possesses 31 slots in which boxes with four compartments for morning, noon, evening and night. Every box has numbering over it, which shows the date at which patient need to take medicine. The device has one digital display and 4 buttons for setting alarm, stopping the alarm, one for a light for dispensing at night. One other function is that called “talk”. By pressing it, the visually impaired patient can know the current time and time for the next medication.

### 2.10 Medication Packaging and Labeling System<sup>18</sup>

This dispensing system possesses label which contains the time of drug administration, a dose of the drug, the name of drug, pharmacological effect of the drug, Quantity of doses at the time of beginning, the expiry date of drug and cautions & warning if there is any. Every single container contains medication of one kind which should be taken at the particular time. The

number of container and label increases if there is multiple medications at the same time. For example, figure 10 shows the label of one prescription in which there is medication for morning time and bedtime. In addition, there is a modification for weekly medicine, in which at the top of the label the name of the day is written. Each and every medicine are in separate, so there are no chances of mismedication.



Figure 10: Packaging and labeling system for pharmaceutical dispensing (Patent no. US 8,025,314 B2(Sheet 5 of 9, Figure No. 7))

### 2.10.1 Limitation

For every medication, the patient required a separate compartment and as a number of medications increases, the number of compartments are also increases. So, for multiple medication the patient required a greater number of boxes. Up to 3 to 4 medication it can manage by the patient, but with the high number, there is other problem like storage of the containers arises. To solve this kind of problem we need a modification in which doses of multiple medications of one time are being managed in a single packet or sachet. So, it reduce the size of the container and facilitate the dispensing for the patient.

### 2.11 Multi-dose medication dispenser<sup>19-21</sup>

Multi-dose medication dispenser system is also known as pill pack which belongs to Amazon Company. As shown in figure 11, it is a box type container which possesses a sachet roll printed with time, day, date and content of the particular sachet. The patient needs to remove a sachet, open it and take medication at the particular time. This is very useful in case of multi medication, in which chances of mismedication is higher than normal single medication prescription. Date and time allow the user to check about the medication, like whether the drug is taken or not. Another major advantage is its price, compare to other dispensing device its cost is very low and affordable to most of

the population. Due to its lower cost, it can be very useful for middle-class people to use it. Another advantage of this device is it does not use any kind of power source to make it in working condition.



Figure 11: Amazon Pill Pack Box

([https://fm.cnbc.com/applications/cnbc.com/resources/img/editorial/2018/06/28/10530051015302004338901275960\\_557008554355069\\_1105575951\\_o.720x405.jpg](https://fm.cnbc.com/applications/cnbc.com/resources/img/editorial/2018/06/28/10530051015302004338901275960_557008554355069_1105575951_o.720x405.jpg))

### 2.11.1 Limitations

The only limitation of this pack is it can't remind the patient about the time of medication via any kind of alarm alert system. But that can be overcome by smart mobile application to remind the patient about medication via notification scheduled as per patient need. This could be the solution for the patient who wants to use the same facilities provided by other devices at higher cost.

## III. ADVANCEMENT IN DISPENSING STRATEGIES

Dispensing strategies are other option for improving prescription adherence of patients. This is done by changing the communication system of patient and physician/pharmacist/dispensing authority. Addition of techniques like code generation, SMS alert system, single dose container with random unique code which should be submitted to the automatic computerized system (ANN artificial neural network) which will analyze prescription adherence of a particular subscribed patient. This type of modification in the system will double check whether the patient is taking medication or not and insist the patient or guardian to adhere to the prescription by calling or messaging the individual one. This will reduce the costing of the procedure and make it affordable to most of the population.

### 3.1 Android Application Alert System<sup>22</sup>

The easiest and free solution for non-adherence of prescription is smartphone applications. It can be programmed as per the need

of the patient. Applications are designed to give a reminder at a specific time which was programmed as per patient prescription. The main advantages of this type of reminder system are that it does not require any kind of storage space, extra maintenance and there are no charges of using it (except for paid versions). This kind of approach can also manage multiple medications in case of a patient with two or more prescriptions at a time. There are some applications available online, for example, My therapy, Medisafe med & pill reminder, Medication alarm, Medlist pro, Dosecast, Medicine time!, True minder, My pillbox, and other Free/Paid applications. The user can download most of them without paying a penny and that is the main advantage of an approach like this.

### 3.1.1 Limitations

By using an approach like this patient cannot be tracked whether he/she is actually taking medication or not. One can not check that whether the medication is taken out or not of the package itself. Therefore, to solve this kind of problem, there is a need of adding a feature like patient need to update profile online to database as a proof of medicine administration, which can help to reduce the tracking problem of this approach.

### 3.2 Competition Driven Health Management<sup>23</sup>

In this, a patient or team of the patient can subscribe to compete for personalized health-related tasks and actions. In this patient need to sign up for social networking and from there a person can participate in the particular competition. A person or team gets points for every task completion and after gathering predetermined points they will get a reward or bonus for their work. It can also be used for improving prescription adherence of patient by giving lure of rewards and gifts. In this type of management system patient need to update the profile of oneself by going online to the website, every time they take medication, which could be a very tedious process and not possible for everyone to go online every time just to update or change information. This type of management system needs an update like the automatic uploading of data by the system itself.

### 3.3 Gamification in Dispensing<sup>24</sup>

Now a day people like online gaming and getting rewards from the same. This can be used for the improvement of prescription adherence for the patient who likes to play games and take new rewards. The patient needs to follow the full prescription for given time to get eligible for gift or



reward or cashback. If the patient fails to follow the prescription, he/she will be disqualified for the reward. The temptation of the reward will make patient follow prescription and make patient complete their medication. This idea of gamification was patented (patent no. US20180197260A1) by jeff stollman who has provided different methods for gamification in the medicine dispensing like point gaining system, competition between patients and teams, organizing competition between a specific group of patients, giving chance to play online games and so many other methods are mentioned. This will ultimately improve health outcome and improve patient condition. These methodologies can be used with advanced container systems. This could be used as a better option for improving prescription adherence by using less cost and with better results. The other advantage of this system is that it can update drug usage without bothering patient, just by getting information from dispensing containers. It allows the user to make a record of administering medicine without even bothering about updating the user profile. The only challenge for this, is organizer need to come up with a new idea to attract patient for longer therapy. And it is very difficult to come up with a new idea every time for the organizer team. This might be a limitation for the investor to carry this program forward.

#### IV. COMBINATION OF AUTOMATIC DISPENSER & ADVANCED DISPENSING STRATEGIES

This could be a revolutionary step toward the health management and improving prescription adherence of patient. This type of management system needs an ANN (Artificial Neural Network) which helps to overwatch the patient activity, can communicate with patients and also remind the patient about the time of medication or even offer medication at the time of administration. This type of system required mini robot which possesses all the functions of dispensers discussed early and also possess strategies which makes patient follow their prescription. The robot should be very nice looking and with a very sweet voice by which it interacts with the patient. Other things like animations on the screen can be added to make conversation with robot more interesting. Some device like this are available in the market which can do all this stuff, some popular one is discussed in this section.

#### 4.1 Mabu: The Healthcare Companion<sup>25</sup>

Mabu or Mabudachi is a Japanese word, which means Best Friend. "It is the very correct name for this device because it helps particular group patient to take their medications, talk through their challenges in doing so, and connect them with their pharmacist when beneficial. Mabu (figure 12) isn't mobile but can make eye contact while carrying on a conversation with someone and is capable of simple gestures with her head and eyes. Mabu holds a tablet-like screen in front of her that she uses during conversations to convey additional information. Mabu usually makes eye contact to capture patient's facial emotions and analyze for a better experience in the future. It will help mabu to improve the individual patient experience and to manage patient more nicely. Mabu can talk to the patient, can message or call the patient to remind about the medication and even send a progress report to the pharmacist or physician.



Figure 12: Mabu: A personal healthcare companion (<https://2nznub4x5d61ra4q12fyu67t-wpengine.netdna-ssl.com/wp-content/uploads/2017/03/Mabu-robot.jpg>)

##### 4.1.1 Limitation

This device can only remind and consult the patient about medication but can't dispense it by itself. Therefore, it requires another container to store the drug that makes this device only for consultancy and patient management. So, the need of the device is generated which can consult and manage patient & also dispense proper medication at the predetermined time.

#### 4.2 Pillo: Personal Healthcare Companion<sup>26,27</sup>

This device named as PILLO (figure 13) is a multifunctional device. Pillo can do all the work which is done by MABU, but in addition pillo can dispense medicine, manage medicine, contact to physician /pharmacist even by video

calling using internet connection, make a call to friend, can play radio, inform patient about current day medication plan, can answer any question using internet, can make patient remember about schedules other than daily medication by texting or calling, can communicate with patient with voice recognition technology and give reply to patient questions, in advance patient can discuss problem of disease condition and get proper consultancy from experience database of pillo. Pillo has a camera on the top for video calling and its big screen have a face animation which makes patient comfortable talking to pillo. Below the device, there is a dispensing container which holds the medication, once the medication is dispensed. After getting a reminder of taking medicine, the patient needs to tell topillo, to dispense medication in the dispensing apparatus. This innovative device also comes with a backup power supply, so whenever there is power cut-off, the patient can get their medication without any interruptions. The only limitation of this device is that it needed to be fixed at one place, so this device cannot travel along patient in long route traveling. Another option of this for home and office is that patient can purchase two devices which can be fully synchronized with each other to share information about patient medication schedule. The patient can get medication whether he/she is at home or at the office.



Figure 13: PILLO: Personal healthcare companion (<https://www.pillohealth.com/>)

## V. CONCLUSION

By using mechanisms like above, it is possible to improve the medication non-adherence of patients. Improvement in MNA results into a reduction in drug usage and reduction in cost therapy which ultimately cause a reduction in patient suffering and treatment costing. So, use of these devices and strategies together, one can

improve the medication adherence and eventually it results into better health patient/community.

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