C-DRUG: A Medication Usage Control System

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Abstract—**This study proposes a new approach called C-DRUG (A Medication Usage Control System) is based on remote management technology aims to have a firm place in the middle of patient and doctor to exchange information. Nowadays, most of people do not follow their prescribed medications because of their busy life, memory problem, and laziness. In addition, patients generally forget to meet their doctors for the same reasons. Not using prescribed medications cause the recovery period to be longer or the patients fail to recover at all. Medicines have positive impacts as long as they are taken on time with exact dosage by patients. Otherwise, it has negative impacts to the patients both physical and mental terms. For the sake of a preliminary study two kinds of surveys are prepared for both doctors who write prescriptions and public who use medications in Turkey for this study. In addition to that, these surveys are broadcasted via papers manually and also internet with the survey's links to the society.**

As a C-DRUG scans the data entered by doctor, through database and send the signal to specially designed Intelligent Drug Container (IDC) in order to remind the patient using the prescribed medication on time. It also helps to track what medication has been taken by the patient. In other words, C-DRUG is a solution that prevents the non-compliance by providing precise information to the doctor. Among the other features, the solution establishes a secure connection channel between doctor and patient. Last but not least C-DRUG is an inevitable solution to prevent wasting in economy, resource and etc.

Keywords — Remote medication, drug dispenser, remote monitoring patient, e-health data management

I. INTRODUCTION

People, generally do not follow their medication because of their busy life, forgetfulness, or laziness. Not using prescribed medications cause the recovery period to be longer or the patients fail to recover at all. This slow recovery has vital effects not only on patients themselves but also on society as well. Late recovery has a permanent impact on patient both psychologically and physically terms. Extended recovery periods also disrupt relationships of doctors and patients relied mainly on confidence. Therefore, patients start to lose their faith in their doctors and diagnosis.

In addition, due to extended recovery periods, and ineffectiveness of the medication on the symptom is interpreted by the patient as the medications have no positive affect at all. This issue is widely known as the non-adherence and makes the prescribed medication wasted. Thus, unused or wasted medication has destructive economical results for both local and global economy. When the data for the year 2011 from Social Security Institution (SSI) in Turkey, given Table 1 [1], is analyzed, the seriousness of the issue from all perspectives becomes obvious.

	2008	2009	2010	2011	Rate of Change
Number of Prescriptions (K)[1]	302.412	327.001	306.461	339.617	10,82%
Invoice Amount (K, TL)	13.046.556	16.005.392	14.897.455	15.288.061	2,62%
Amount Per Receipt (TL)	43,14	48,95	48,61	45,02	-7,40%

[1] K represents a quantitative value of 1000.

Table. 1. Prescription Data Analysis, end of year 2011

The Ministry of Health of the Republic of Turkey and General Directorate of Pharmaceuticals and Pharmacy publish a declaration about of the medication waste. In this report, they indicated that "45/100 boxes of drugs are wasted unopened"[16]. With respect to the year 2011, the Ministry of Health of the Republic of Turkey has paid 6.750.000.000 TL for wasted and unused medication [1]. These reports of similar analysis are published by not only Ministry of Health of the Republic of Turkey, but also one of the international organizations, World Health Organization (WHO) as well. The data taken from reports drive the solution to focus on only one point which is C-DRUG.

II. IMPORTANCE OF PROBLEM

Patients are monitored for centuries by medical personnel.

The advances in technology help to improve communication and knowledge transfer between patient and doctors. The fundamental idea is to exploit the potential of the technology to enhance the quality of service by enhancing the communication between doctor and patient in terms of tracing the usage of prescribed medications in real time. Extending the medication usage time is dangerous and costly for patients. The key point is to establish a communication and a confidence between doctor and patient throughout treatment.

The doctor needs to analyze a usage frequency of prescribed medications of patient to determine responses of patient to the treatment. Furthermore, Ministry of Health of the Republic of Turkey indicates that %40 of total expenditure of Turkish Ministry of Health covers prescription expenditure [7] that was aforementioned. According to WHO publications, all other countries have the same rate of expenditure and distribution like Turkey. This information exhibits that economics are facing a hazardous and a crucial problem. Government officials, independent health facilities and medical doctors are aware of that problem. They follow up any possible solutions to remove the problem or minimize its effects.

At the end of 2012, SSI publishes a new manual and operational solution. They create a new job to solve solely this problem. This new job's name is Drug Inspectors. Drug Inspectors will go to every patient's home and they will gather information about number of unused medication they have. When related reports and statistics are evaluated, it is obvious that how much damage it causes. It dramatically effects to government and its' society [2].

Within the aim of this proposal, for the sake of a preliminary study two kinds of surveys are prepared for both doctors who write prescriptions and public who use medications. In addition to that, these surveys are broadcasted via papers manually and also internet including social medias which are Facebook, Twitter and LinkedIn using the survey's links. Surveys for doctors, surveys for public and their electronic links are presented in Appendixes part of the proposal.

Furthermore, 100 doctors and 1000 persons who use medications joined the surveys. This participation provides critical data to proposal. The completed data analysis on collected information from doctors is presented in Table 2. In Table 2, only 5 sample questions are selected by its importance from the doctors' survey. The table has 4 fields which are Question, Response, Response Symbol, and Highest Rates of Related Responses. Response field consists of the most preferred choices form the survey, and the rate of the selected choice is presented with Highest Rates of Related Responses field.

Nr.	Question	Response	Response Symbol	Response Rates
1	*How many prescriptions do you fill in a day?*	50-99	**A**	52%
2	*How many patients would contact you again, after examination?*	%5 - %19	**B**	92%
3	*All prescribed medications that you filled, is used by patient?*	No Idea	**C**	90%
4	*How closely you can follow the patient if the patient applies prescribed medication?*	Cannot follow	**D**	57%
5	*Do all patients follow the schedules that you fill in the prescriptions?*	Irregular medication use[2]	**E**	88%

Table 2. Some questions and responses of Survey for doctor

In Figure 1, the highest rate of the responses gathered from the survey is presented. The Response Symbol field in Table 2 is used for abbreviation in order to locate responses clearly in Figure 1.

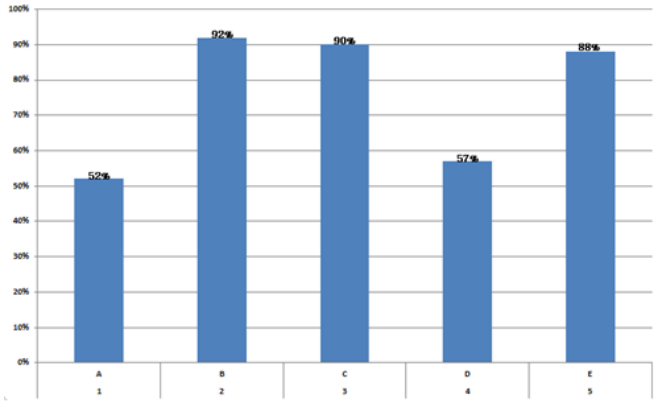

Fig. 1 Graph of response rates related of questions in survey for doctors

Only 9 sample questions are selected from the patients' survey according to their importance. Response field is consisting of the most preferred choices form the survey, and the rate of the selected choice is presented with in Highest Rates of Related Responses field.

Nr.	Question	Response	Response Symbol	Responses Rate
1	*How many unused medication do you have?*	5-20	A	73%
2	*Do you take medication without going to health care center or doctor?*	Rarely	B	54%
3	*How did you take medication without any prescription?*	Take same medication with prescription earlier	C	87%
4	*Do you exactly follow the schedules when you get prescriptions?*	Take the medication but not at the scheduled time	D	77%
5	*Do you consume all prescribed medications that you get for your treatment?*	Do not take medication when i feel better	E	68%
6	*What do you do with your ususued medications?*	Keep in medicine cabinet for future	F	56%
7	*How do you remind the period of medication to yourself for taking them?*	Trust my memory	G	95%
8	*Do you go to your doctor again for your status when you take all medication that you get?*	No, do not go there again	H	71%
9	*Do you think that your doctor follow your adherence of your prescription?*	I provide information however he does not take any note about my usage	I	88%

Table 3. Some questions and responses of Survey for person

In Figure 2, the highest rate of the responses assembled from the survey is presented. The Response Symbol field in Table 2 is used for abbreviation in order to locate responses clearly in Figure 1.

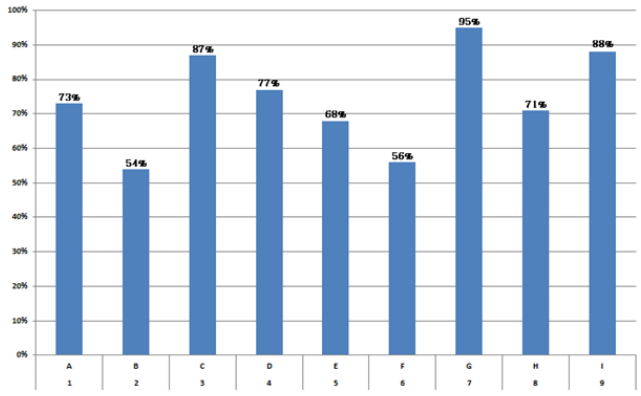

Fig. 2. Graph of response rates related of questions in survey for person

III. TECHNOLOGY BASED MEDICATION USAGE CONTROL SYSTEM

A. Proposed Approach

A Medication Usage Control System (C-DRUG) which will be based on remote management technology aims to have a firm place in the information flow between patient and doctor to exchange data. As a C-DRUG will scan the data which entered by doctor, through database and send the signal to specially designed Intelligent Drug Container (IDC) to remind the patient using the prescribed medication on time. It will also help to track what medication has been taken by the patients.

In other words, C-DRUG will be a solution that prevents the non-compliance. Among the other features, the system will establish a secure connection channel between doctor and patient. Thus, patient and treatment information would not be able to seen by anyone except his doctor or another authorized user. Therefore, within the scope of the proposal, the following objectives are presented for the system shown in Figure 3.

- Development of the Hospital Record System (HRS),
- Development of Patient Information System (PIS)
- Development of the Patient Tracking System (PTS)
- Development of the Notification System (NS)
- Development of Intelligent Drug Container (IDC)
- Development of Mobile Tracking System (MTS)

The word introduced here is an elaborated extension of the work called Remote Patient Monitoring System [23].

C-DRUG included all the current solutions and technologies and also complements their deficiencies. This research is intended to provide solutions for people who need long-term treatment to reduce significantly the difficulties of living with drugs. Besides, it provides the amount of the drug taking the treatment deemed necessary, instead of the amount needed to be taken outside the packages of drugs. In addition to this, both the patient himself/herself as well as the doctor monitors the pharmaceutical of the patient related to prescription for observing the treatment electronically and remotely. It allows the doctor to make an inquiry per prescription of backward dates concerning the patients.

Busy work schedule and forgetfulness influences people's drug use negatively. As a result, the healing process extends in a terrible rate and that causes a deep impact on individual and as well as society. Alongside, extended recovery affects humans' psychology abnormally. People are losing their trust to doctors and drugs, since they are starting to think that treatment with prescribed drugs or the diagnosis itself is wrong.

The drugs that are expired, not taken on time or not taken at all become wasted drugs. Waste causes to harm the economics of the individual itself and the government agencies or private health institution. This makes individuals spending a large portion of one of the most important expense of the state in the health sector by the garbage disposal indirectly. In the countries that are increasing the

number of insured citizens day by day causes health costs proliferating exponentially which limits the state budget that would be allocated for other institutions outside of the health sector. It also directly affects the citizen himself.

This research deals with exactly on the problem of non-adherence that is encountered in different parts of our society, the so-called health sector. With the help of technology, researchers aim to minimize the economic and social impact of this problem. Therefore, to follow the medication usage habit without creating an over-load of the patient's memory is to design an integrated monitoring system to extend the necessary help for all parties involved, including the diagnostic center (e.g., doctor's office) interested in tracking the treatment plan relevant to drug usage.

Last but not least, C-DRUG recognizes that the medication sold in the market would trigger which other medications would be used after. Moreover, C-DRUG is able to determine the intersection points of illnesses and their medications. Consequently, C-DRUG helps to collect crucial data about effects of the different medications on patients.

B. Design Issue

C-DRUG was proposed to prevent non-compliance problems. C-DRUG is a centralized system consists of four main components which are Health Record System (HRS), Patient Information System (PIS), Intelligent Drug Container (IDC) and Mobile Tracking System (MTS). PIS has also two sub components which are Patient Tracking System (PTS) and Notification System (NS). All patient related information is stored on PIS Server through HRS. HRS is a system shared with different hospitals, clinics and pharmacy. This structure provides an information sharing platform between patient service providers on PIS Server.

The doctors from different hospitals, clinics and pharmacies are able to monitor and modify the same patient's information. IDC which is the hardware system that provides drug to the patients monitors the drug usage and send them as feedbacks to the patient's related doctors. The last main component is MTS that exists for tracking patients' health status and scheduling alerts of using drugs

C. Architectural Design

The C-DRUG is designed to be a solution that would solve non-adherence by monitoring medication usage and sending notifications constantly to patients in a secured manner. Although the solution of the C-DRUG has common functions with the current solutions in market, the most of its functions are new, unique and have not proposed by the current solution yet such as IDC, NS, and etc.

The C-DRUG is a centralized system that contains three main components, HRS, IDC and MTS. HRS that is the heart of the system and sits upon the center of the C-DRUG which contains all the records of the patients, doctors, healthcare centers, drugs and etc. It consists of three sub-systems. Besides recording information, HRS manages the notification and monitors the patient information.

IDC is a hardware system that created with drug cartridges and used for managing, monitoring patient's medication usage and informing the patient. Lastly, MTS is designed as a mobile application that informs the patient's medication usage, treatment status, medication schedule, remaining drug amount and etc.

In Figure 3, the general structure outline of the C-DRUG and its connections to the environments can be seen such that HRS is the core system of the C-DRUG. HRS provides the Graphical User Interface (GUI) and database of C-DRUG. The web-based GUI of C-DRUG is designed to be used by Healthcare Center and pharmacy personnel. By using GUI, doctors, nurses and other personnel's of any Healthcare Center can create and manage patient records regarding their illnesses, treatment methods and prescriptions. Medication usages and treatment period of a patient could also be monitored by the related Healthcare personnel.

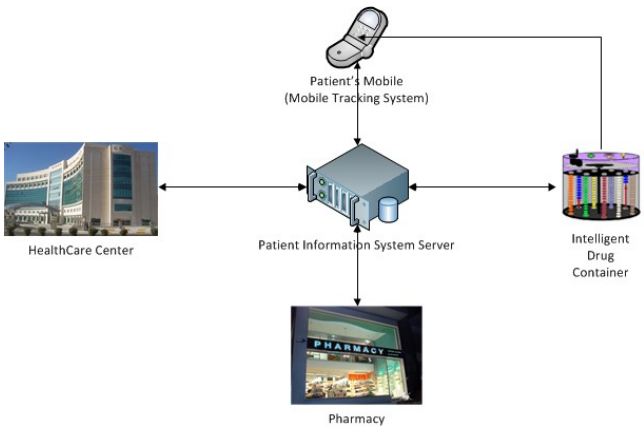

Fig. 3. Interaction of Components in Medication Usage Control System

During the process of the medication preparation, C-DRUG generates QR Codes for every kind of medication listed in the prescription by using system-recorded prescription id, medication unique code and the amount of the regarding medication given. These QR Codes also can be recorded in C-DRUG to be used and queried by patients IDC.

The tubes taken from the pharmacy would be inserted in the patient's IDC and IDC would use its one of the available connection methods and get scheduling information of the patient's medication by matching QR codes from the source

system which is PIS. This information would be transmitted on a secure-encrypted connection line.

C-DRUG also provides general monitoring information regarding patient's treatment periods. This monitoring information could be seen by related doctors from C-DRUG GUI and also by patients himself/herself from MTS. MTS would connect directly to the services provided by HRS for patients.

The Figure 4 puts forth integration of C-DRUG's components such as hardware and channels. C-DRUG has its own database server. All records are kept in that database. Beside that information, C-DRUG has also another server which runs web services application of C-DRUG.

Moreover, C-DRUG has e-mail and mobile services integrated with email server and mobile operator environment. Thus, it uses email server to send emails as a notification. Likewise, it also uses SMS Gateway to send and receive SMS via Mobile Operator Environment. SMS features are handled by contracted mobile provider.

Additionally, HRS and MTS which are components of C-DRUG, are published via secure Internet to its user from another web server in that scope. In the case of publishing this application to the Internet, Mobile Phone, PDA, Laptop, Personel Computer or Smart TV, furthermore IDC accesses to the C-DRUG via various connection layers such as Mobile Gateway (EDGE, 3G,4G), wired and wireless networks

Consequently, deployment and distribution of C-DRUG are effortless according to that architecture. One of the advantages of architecture is, to provide minimum complexity and dependency and also maximum productivity. Last but not least, system is ready to be separated easily whenever necessary.

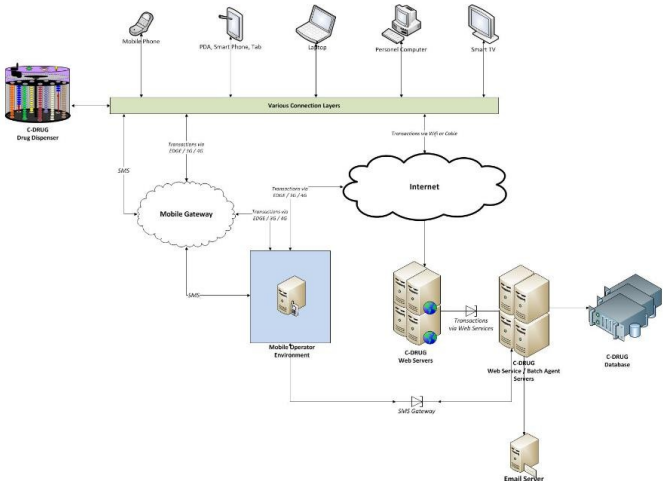

Fig. 4. Structural design of C-DRUG with all hardware and related channels

HRS

HRS is a center system of the three main components of the C-DRUG. HRS consists of three subsystems that are PIS, NS and PTS. In Figure 8, the outline structure of the HRS is shown abstractly. PIS is the database and the user-interfaced of HRS that contains patients records, doctors remarks, medication usage, medication amounts, hospital records, pharmacy records, HRS interface users, notification records, etc. and HRS interface used by doctors, personnel, pharmacy, etc. to manage the C-DRUG.

NS is a notification system that focuses to update the related patients' records and informs them about their medication usage by utilizing the available methods such as SMS, e-mail, etc. NS is designed as a software service and does not provide a user-interface. The communication between the NS and IDC system is a secure 128-bit SSL encrypted communication.

The last sub-component of the HRS is PTS. PTS is designed as a reporting system for MTS and HRS user-interface. Patient history, medication usage rates, patient status, medication schedule, remaining treatment info, etc. information is presented to the patient himself/herself or the related doctor by PTS to be controlled regularly by them

IDC

IDC is the hardware component of the C-DRUG that used for maintaining patients' drug usage by informing them. IDC system contacts with the NS that is sub-system of the HRS component over a secure line. In this connection, IDC system uses one of the available methods such as cabled, wireless or Edge/3G/4G networks respectively to inquiry the related information for medication by using QR Code stuck on the medication tubes. It should be noted that QR Code is generated by using the prescription id, drug id and amount of drugs while getting the medication tubes from pharmacy personnel.

IDC manages and monitors medication usage on the designated schedules and informs the patients to take their ready medication from the medication chamber.

The results of these operations will be always updated on HRS by using NS subsystem either as a successful or a failure. Also, IDC has its own notification systems that are voice alarm, notification led, and sending messages In case of a failure of a medication take out, IDC System automatically re-inserts the medication to its own tank by using control shaft. There should be a new order process by updating its own memory using mobile / smart application in order to take the medication out from its own tank.

Pseudo design of IDC is shown in Figure 5. It includes the parts which are Medication Chamber, Cellular Network(EDGE/3G/4G) embedded in SIM Card, LAN (Wired) and Wireless Adapter, Audio Notification, Light Notification, Control Shaft, Drug Cartridges, Adjust Spring, Weight Sensor, and memory chip.

Medication Chamber is used for holding medication which is taken out from IDC. Cellular Network embedded in SIM Card is used as one of the connection establishing methods with HRS to synchronize medication schedules and medication usage. LAN (Wired) and Wireless Adapter are alternative connection methods to synchronize data with HRS. Audio Notification and Light Notification are designed to alert patient directly on device. Unlike text notification to the mobile is managed by NS.

Furthermore, Control Shaft, Drug Cartridges, Adjust Spring, and Weight Sensor are used for managing medication inside IDC. Lastly, Memory Chip is a key point to make IDC as an intelligent device. Also, it coordinates parts of the device and provides the connection to HRS via web services programmatically.

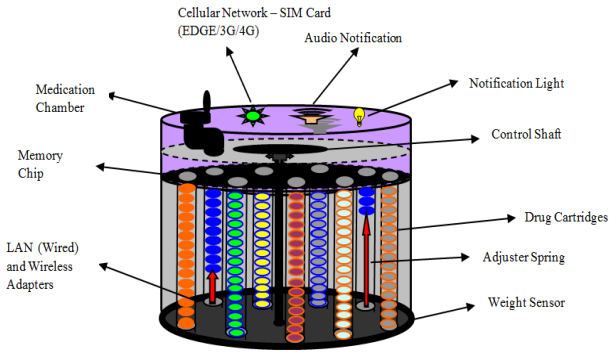

Fig. 5. Illustration of IDC and its own properties

MTC

MTS is designed as a mobile/smart application that helps the patient or a family member to tracks patient's treatment status by using pre-defined reports such as medication usage, remaining medication amount, hospital records, doctor remarks, patient history etc.

Furthermore, a patient has an update option to reschedule medication for untaken prescribed medication which is received back to IDC. It is designed as tracking system by using PTS sub-system of the HRS.

D. Functional Design

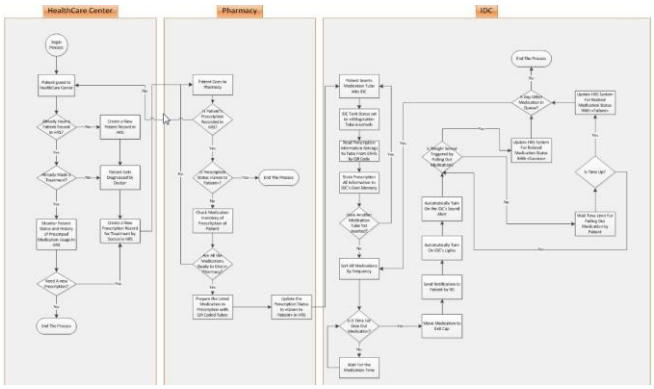

Fig. 6. General patient, doctor and drug dispenser relationship scenario in C-DRUG

The flow of recommended C-DRUG solution as shown in Figure 6 is expected to be the following; when a patient gets ill, the patient would go to a hospital or a clinic to get a treatment. In the Healthcare Center, the patient firstly is checked that he/she already has a record on HRS. If it is the first time for the patient who is coming to a Healthcare Center, personnel on duty would create a new record for a patient in HRS by using patient basic personal information such as name, surname, ID number, date of birth etc.

Therefore, if the patient already has a record in the system, the patient would be check for if he/she comes for re-examination. After the creation of the patient record, the patient would be directed to the related doctor by personnel on duty to get diagnosis. If the patient comes to the Healthcare Center to get re-examined, the patient would be directed to his/her doctor who is responsible. Then, the doctor would re-examine the patient, monitor the status of the patient and the history of the prescribed drugs usage by querying the data and report in PTS subsystem. After the re-examination, if the doctor does not deem necessary, the doctor encourages the patient to continue the usage of prescribed drugs and pursue existing treatment.

If it is not the first time for the patient who is coming the Healthcare Center for his/her illness, the patient would be directed to be examined by the related doctor. After examination or re-examination, if the doctor deem necessary, he/she would prescribe the drugs required to treat the illness of the patient. The usage frequency and the amount of drugs would be recorded to the HRS by doctor. The drug codes, detailed names are used for drug identification within these drug records.

Afterwards, the doctor would guide his/her patient to a pharmacy nearby or the patient could choose any pharmacy

included in HRS. When the patient is gone to the pharmacy, the pharmacy personnel would check the prescription and its content by using Prescription ID of the prescription given by the doctor or identity/citizenship number of the patient. If the prescription is not recorded in HRS or its status is not "Given to Patient", the pharmacy personnel would not give the intended drugs and urges the patient to contact to the healthcare center.

In case, it is a valid and correct prescription, the pharmacy personnel would control the inventory for the patient's prescription. If the drugs requested are not enlisted in the inventory, the pharmacy personnel send the patient to another pharmacy nearby. If the drugs requested are enlisted in the inventory, the personnel prepare them to deliver the patient. These drugs would be prepared as in tubes and only by the required amount. In the process of preparation, unique QR Code is generated for drug tubes by using prescription id and drug code located in HRS. Later on they stick these QR Codes to the respective tubes to differentiate. After the preparation of drugs and deliver it to the patient, the personnel would update the prescription status to "Given to Patient" in HRS and prevents it to be given in another pharmacy. Then, the patient would go to his/her personal IDC to insert drug tubes in and start to use the drugs.

Afterwards, the operation would run automatically by IDC system. To summarize the flow of operation after the drug tubes inserted, IDC system would start the operation by setting its respective status of tank which is used by drug tubes to the "Medication Tube Inserted" and lits it's led. And then, IDC system would read the QR Code on the drug tubes and store these QR Codes to its system. After that, IDC system would try to connect to PIS subsystem of HRS by using one of the available connection methods such as cabled internet, wireless internet or 3G internets respectively. After the connection is established, IDC system would read all information regarding the drug tube such as amount of drugs, frequency and time of its usage, etc. by using QC Code that are created by using prescription id and drug code. Furthermore, this information is stored in the IDC system and if there is more than one drug tube, the operation would be repeated for each and stored in the IDC system.

As soon as the drug tubes are inserted and their information is inquired and stored to the IDC system, IDC system orders all drugs to give them out according to the frequency and time information of the drug tube comparing with the current time.

After the ordering operation, the IDC system enters in waiting state. In this state, IDC system uses the system time, check and compares it to the first scheduled drug to take it out. At the scheduled time to take the drug out, IDC system would move its control shaft and move the tank that has the scheduled drug in to its Medication Chamber.

After the completion of the moving process, IDC system would put required amount of the drug to its Medication Chamber and change its "In Medication Chamber". In this state, IDC system would send text notifications such as SMS or E-Mail by using NS subsystem in order to inform the patient. Besides the text notifications, IDC system also would use sound alerts and led lightings to inform the patient.

The medication chamber of IDC system has a weight sensor and a time sensor together. While the moved out drug waited on the medication chamber, IDC system would check constantly its weight sensor if the sensor is triggered by pulling out the drug and waits for the time configured in the system previously. If the drug would not be pulled out by the patient in the time, IDC system would update HRS for related drug by using QR Code of the drug tube and set the drug status to "Failure". While updating drug status in the HRS, IDC system moves the required drug to its predetermined tank and lit tank's led into the red to show its failure state.

In the case of the weight sensor of the IDC System is triggered by the patient by removing the drug from the Medication Chamber in the pre-configured time, IDC System would update the drug status on the Medication Chamber to the "Success" in the ERHS by using the QR Code on the related tube. Besides the status, IDC System also would decrease the remaining amount of the related by the taken amount. Then, IDC System would change the related tanks led to green to show its success.

After these operations are finished, IDC system would control if there is any other drug is waiting for the medication chamber. If there is one, IDC system would repeat the operation for the other drug by starting to move tank to the medication chamber. If there is not, IDC System would re-order the drug tank by comparing drugs' scheduled time with the current time.

In the flow above, it has been tried to summarize the solution of drug wasting by using the C-DRUG briefly.

IV. Conclusion

The one of the major problems of the healthcare center are the non-adherence problems. To solve these problems, new methods and programs on specific areas such as simplifying dosage regiments and delivering, educating the patient, communicating with the patient, and modifying the patients' behavior are being developed in the last years. Some of these require direct doctor attention and some of them include drug dispenser tools.

C-DRUG is a complete solution by including all recent solutions to address the non-adherence problems. C-DRUG would track every phase of the prescribed medicine picked up from the pharmacist until it is taken the medicine by the patient by using its application based HRS, MTS and device based IDC.

To solve the non-adherence problems, a solution has to make sure that patients are taking their medicine without wasting or forgetting them and this information could be tracked by the doctors at any moment.

In conclusion, C-DRUG by combining current solution and completing their missing points presents a complete solution for a critical problem, patients' non-adherence problem and prevent the medicine waste that causes economic harm to the individual itself and the government agencies or private health institution.

V. ACKNOWLEDGMENT

We extend our appreciation to professionals and citizens participating in this study anonymously.

VI. REFERENCES

[1] SSI Republic of Turkey, 2011, Annually Statistics, http://www.sgk.gov.tr/wps/portal/tr/kurumsal/istatistikler/sgk_istatistik_yilliklari

[2] SSI Republic of Turkey , 2011, Monthly Bulletins, http://www.sgk.gov.tr/wps/portal/tr/kurumsal/istatistikler/aylik_istatistik_bilgileri

[3] TUB, 2011, Non-prescription drugs and non-drug products, Published Reports

[4] TUB, 2011, Monthly Bulletins, http://www.teb.org.tr/?modul=raporlar

[5] WHO, 2012, Annually Publications Data and Statistics Files, http://www.who.int/research/en/

[6] Notifications and Circulars of Ministry of Health of the Republic of Turkey, 2012, http://www.sb.gov.tr/TR/Genel/HaberListesi.aspx

[7] Liang Ye, 2010, E-health networking, digital ecosystems and technologies, remote monitoring system of drug safety information, Suzhou Vocational University, Department of Computer Engineering

[8] ACC, 2009, Pharmaceutical waste report in Turkey

[9] EMMA, 2012, Remote Drug Monitoring Products, http://www.inrangesystems.com/

[10] IMS, 2011, Health Report and Statistics, http://www.imshealth.com/portal/site/ims/

[11] MEDAPPS, 2012, Remote Drug Monitoring Products, http://www.medapps.net/

[12] PMA, 2011, Medication Report, http://www.ieis.org.tr

[13] Ahmet Rasim Küçükusta, 2011, Advice to SSI for prevention of wasting medication, Cerrahpaşa University, Faculty of Medicine

[14] Burçak Deniz Dedeoğlu, 2011, How to stop the wasting of medication, SSI, Directorate of Pharmaceuticals and Pharmacy Branch

[15] Erdoğan Çolak, 2011, Medication wasted at full throttle, TUB, Pharmacist Conference

[16] Hanefi Özbek, 2011, Terrible waste of medicine in Turkey, ministry of health-annually report, Republic of Turkey Ministry of Health.

[17] Hulusi Gürel,2011, Country of wasting medication is Turkey, Ordu University, Faculty of Medicine

[18] Hale Zerrin Toklu and Gul Ayanoglu Dulger, 2011, Rational drug use and the role of the pharmacist, Marmara Pharmaceutical Journal

[19] IMAP, 2011, Pharmaceuticals and biotech industry global report, healthcare report

[20] WHO, 1987, Rational use of drugs report of the Conference of Experts

[21] OECD, 2011, How does Turkey compare, health data

[22] Mehmet Top, Menderes Tarcan, 2004, Turkish medication economy and medication expenditures, 1998-2003 term evaluation, Liberal Dusunce Magazine

[23] E. Ermisoğlu, 2011, Simulation of Mobile Treatment Monitoring System, UALR, Little Rock, Department of Computer Sciences

[24] Yusuf Çelik and Andreas Seiter, 2008, Turkey : Pharmaceutical Sector Analysis, Hacettepe University, Faculty of Economics and Administrative Sciences Department of Health Care Management and Assoc., Health, Nutrition and Population The World Bank

[25] Hasan Ayyıldız, Kursat Özkan, 2011, Turkey Pharmaceutical Industry Sales, Estimated Survey, Karadeniz Teknik University, Osmangazi University, IIBF Management Department, IIBF Journal

[26] Yuanli Liu, Yusuf Çelik, and Bayram Sahin, 2005, Drug Expenditures in Turkey and Pharmaceutical Reimbursement Policy, ISBN 975-00370-0-6, Harvard University, Hacettepe University, School of Public Health, Faculty of Economics and Administrative Sciences Department of Health Care Management, Faculty of Economics and Administrative Sciences Department of Health Care Management, 2005

[27] UCCET, 2008, Turkey Pharmaceutical Industry Sector Report, Turkey Pharmaceutical Industry Council

[28] Web Service, http://en.wikipedia.org/wiki/web_service, 2012

[29] HTML5, http://www.w3schools.com/html/html5_intro.asp, 2012

[30] Mehedi Masud, Member, IEEE, M. Shamim Hossain, Senior Member, IEEE, and Atif Alamri, Member, IEEE, Data nteroperability and Multimedia Content Management in e-Health Systems, IEEE Transactions on information technology in biomedicine, vol. 16, no.6, 2012