Economics of Non-Adherence in TB and Impact of Adherence Solutions

By

Akanksha Saxena

Dissertation submitted for the partial fulfillment of the

MBA Hospital and Health Management

Academic year, 2016-2018

The IIHMR University, Jaipur

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INSTITUTE OF HEALTH MANAGEMENT RESEARCH
(WHO Collaborating Centre for District Health System Based on Primary Health Care)

IIHMR UNIVERSITY

TO WHOMSOEVER MAY CONCERN

This is to certify that Dr Akanksha Saxena, student of MBA Hospital and Health Management from The IIHMR University, Jaipur has undergone internship training at CAREDOSE STARTUP, Delhi from February 5th, 2018 to May 4th, 2018.

The Candidate has successfully carried out the study designated to her during internship training and her approach to the study has been sincere, scientific and analytical.

The Internship is in fulfillment of the course requirements.

I wish her all success in all her future endeavors.

Dean, Academics and Student Affairs
The IIHMR University, Jaipur

14/5/18
Professor
TheIIHMR University, Jaipur

CAREDOSE.COM
YOUR MEDICATION - SORTED

To Whom It May Concern:

This is to certify that Dr. Akanksha Saxena has completed a 3-month internship at CAREDOSE.

She has successfully completed her project/ dissertation on "Economics of non-adherence in TB and impact of adherence solutions" under the guidance of Mr. Kinshuk Kocher. The exact period for her internship was from February 5, 2018 to May 4, 2018.

Akanksha comes across as a committed, sincere and a diligent person who has a strong zeal for learning. Everyone at CAREDOSE wishes her all the best for her future endeavors!

Warm regards,

Kinshuk Kocher
Co-founder & COO,
CAREDOSE

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CIN: U74999DL2016PTC300005
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THE IIHMR UNIVERSITY, JAIPUR

CERTIFICATE BY SCHOLAR

This is to certify that the dissertation titled**Economics of non-adherence in TB and impact of adherence solutions** submitted by Dr Akanksha Saxena Enrolment No- **IIHMR-U/01/2016-18/0375** under the supervision of Dr Ruchi Garg, Associate Professor, The IIHMR University, Jaipur for award of MBA in Hospital and Healthcare Management of the University carried out during the period from February 5, 2018 to May 4, 2018 embodies my original work and has not formed the basis for the award of any degree, diploma associate ship, fellowship, titles in this or any other institute or other similar institution of higher learning.

Signature

ABSTRACT

Objective: The aim is to study the economic effect of non-adherence on TB patients and the impact of tech solutions on medicine adherence.

Methodology: A comprehensive literature search was performed to study the impact of non-adherence on TB patients and costs related to it from research articles and the information provided by DOTS centres and private hospitals of Delhi. Study majorly focuses on the sputum positive TB patients who are non-adherent with the TB treatment course.

Results: After the comprehensive study of the non-adherence in TB patients based on the literature review and data collected from the DOTS centres and private hospitals of Delhi, it showed that non-adherence to the treatment can cost around 590 times higher than the adherence cost to the patient.

Conclusion:

Non-adherence may lead to the number of complications and conversion of TB to MDR-TB because of the resistance developed by the bacterial strain due to the discontinuation of dosage. Non-adherence may lead to an increased burden on a patient and an increased cost to the healthcare system in terms of increased length of stay, increased no of dosages and increased cost of medications. In this study, the cost of the treatment has been extracted under two heads: Direct cost and Indirect cost. Direct cost includes the medical and non-medical cost and Indirect cost includes the cost incurred in travelling, lodging and food for the accompanying person. In the above findings, non-adherence has led to increased expenses and loss of wages due to illness, which could have been saved if the patient had been adherent to the prescribed regimen and had completed the required tenure of the treatment. To accomplish this, a solution-CAREDOSE will be provided to patients that will help them to be adherent to the treatment. They will receive pre-organized dose pouches with all relevant details around frequency, food directions, time and date of dose. Every time the dose will be due, they will receive a reminder on their phones to take the dose. According to WHO, more than 50% chronic patients are non-adherent to their medicine intake and close to 70% of these do not communicate this to their caregivers. Given non-adherence is a behavioural problem, CAREDOSE is tackling the problem with a behavioural solution, which will lead to a substantial decrease in the cost of the treatment as patients will now adhere to their prescribed medication.

ACKNOWLEDGEMENT

I am immensely grateful to all those who have been involved in my dissertation. My dissertation would not be possible without the kind support and help of many individuals in organization.

I would like to express my special thanks to **Mr. Ashok Kaushik** (Dean, IIHMR University) and **Mr. Hem Bhargava** (Placement & Training Head, IIHMR University) for giving me the golden opportunity to pursue my dissertation at **CAREDOSE, New Delhi**.

I am highly thankful to **Mr. Kinshuk Kocher (Co-Founder and COO)** for his aspiring guidance, invaluably constructive suggestions and friendly advices during my tenure at CAREDOSE. I am sincerely grateful to him for giving me incredible opportunities to gain knowledge about management of a healthcare organization. I am also grateful to him for sharing his valuable experiences and giving truthful and informative views on several issues related to management.

I express my warm thanks to **Ms**. **Gauri Angrish (Founder and CEO)** and **Mr. Shrivatsa Somany (Co-Founder and CTO)** for their constant support and guidance throughout my conduct at CAREDOSE.

I would also like to thank my project internal guide **Dr. Ruchi Garg** (Asso. Professor, IIHMR University) for her constant supervision and support in completing the project.

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CAREDOSE

INTRODUCTION:

CAREDOSE is a technology & product ecosystem for both patients & healthcare entities that helps ensure, automatically track & optimise patient care. A simple and cost-effective system to help ensure and automatically track medicine adherence in Chronic patients (in real-time), whilst creating big data for private and public health entities.

GOALS OF INTERNSHIP:

- To understand the ecosystem of corporate setting.
- To gain insight about the overall functioning of organization
- To gain understanding and assistance in day-to-day operations.
- To gain practical knowledge and skills to handle managerial issues.
- To assist in carrying out different projects.
- To learn the existing culture and acquiring soft skills.

SERVICES PROVIDED BY THE ORGANIZATION:

Medicine adherence is a behavioural problem for patients that impacts both patients and caregivers. There is a need for an automated system that is convenient for multi-dose prescriptions and doesn't require any input from patients. Additionally, a comprehensive system that allows every stakeholder across the supply chain to not only communicate efficiently but also optimise their tasks and services.

The technology provides various components:

A. <u>For patients:</u>

1. <u>Smart Dispenser</u>

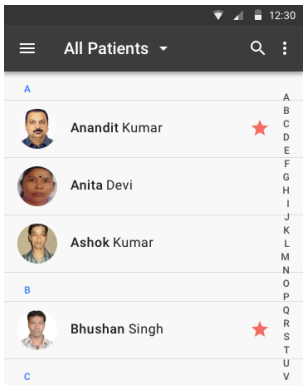
Multi-dose packaging: Medicines are delivered pre-organised & labelled by dose, in a portable dispenser (Image A, 1). Each pouch contains all the medicines needed by that patient in one dose (Image A,2). This ensures that the patient always takes the right medicines at the right time, without any errors or confusion.

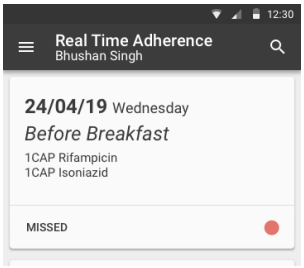
Image A,1

Image A,2

User friendly labelling: The labels are available in various vernaculars (Image A,3). This allows patients to read medicine names and dosage directions with ease and therefore leads to faster adoption

Smart dispensing & tracking: The dispenser (Image A,4) dispenses the relevant dose automatically and alerts the patient (light & sound) to take the dose. It also automatically tracks when the patient does or does not take the dose, in real-time





Data sharing: This data is automatically shared in real-time, without any effort by the patient, with the appointed caregivers. This allows relevant actions to be taken and optimises resource management. These alerts and screens can be integrated with existing systems, platforms & APPs

B. For patients: Automated Reminders

Dose reminder alerts: Patient is reminded to take each dose via SMS, call or APP alert (Image B, 1). The open APIs allow CAREDOSE to integrate with existing APPs and route alerts through them.

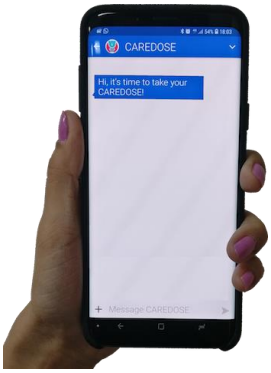
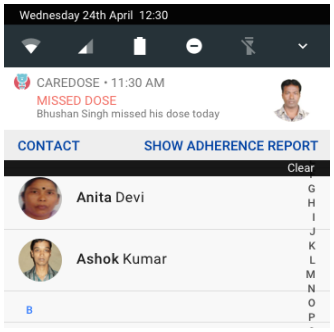


IMAGE: B,1

Negative adherence alert: It is essential to know when the patient has not taken their required medicine. If patient doesn't take the dose (tracked by Smart dispenser), an alert is triggered (Image B,2) to selected caregivers or doctors

IMAGE: B,2



C. For patients: Refills

Refills are managed automatically for each patient so that they are delivered on time, every time, in cartridges that easily fit into the dispenser (Image C)

IMAGE: C

D. For patients: Awareness & education

Lack of knowledge about medication and importance of adherence are major reasons for patients discontinuing their medication. Space on the refills along with SMS alerts and other initiatives are used to carry out simple, interactive and informative campaigns.

E. For Health Facilities: E-Prescription service

Once the patient's prescription image is shared on the CAREDOSE system, it is digitised and made into an E-Prescription. This data is collected and saved as an electronic health record

F. For Health Facilities: Automated patient wise multi-dose dispensing (DoseDroid)

Dispensing: DoseDroid (Image F) is an automated multi-dose dispensing robot that cuts medicine strips (while retaining manufacturer's packaging), sorts, packages and labels each patient's medicines according to prescribed doses.

Tracking: DoseDroid tracks manufacturer information along with exact location of each pill in the pouches for complete traceability

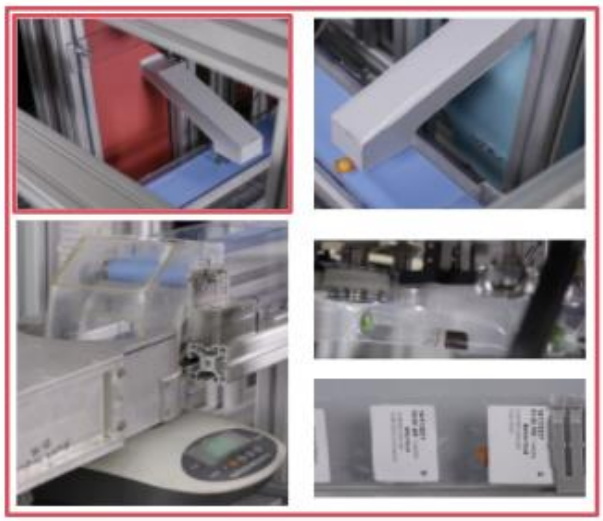


IMAGE: F

G. For Health Facilities: Softwares & Dashboards

Public and Private Health facilities will be able to track the journey of a pill from its purchase to consumption (in real time) via various modules of the CAREDOSE ecosystem. Softwares and dashboards (Image G) tailored to the needs of Public and Private Health Facility caregivers will enable:

- smoother process management
- more efficient supply chain management
- improved inventory stocking
- improved patient care
- real time patient adherence tracking
- actionable data driven insights for more efficient care delivery

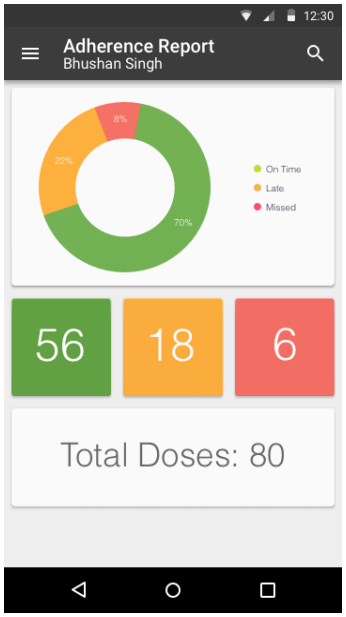


IMAGE: G

As highlighted above, CAREDOSE is a comprehensive ecosystem for tackling medicine non-adherence. It is completely customisable and can be integrated with existing platforms/ APPs that the Health Facilities are using

DISSERTATION

INTRODUCTION:

Tuberculosis is a major health problem globally. It is second leading cause of death from infectious disease in world. Estimated 9 million cases of TB and 1.5 million people died of TB worldwide, in 2013. There were around 210,000 deaths from MDR-TB as compared to 480,000 incident cases of MDR-TB. With highest burden of disease, India remains on top in countries with MDR-TB. WHO has recommended direct observation therapeutic regimen for global control of TB which is accepted worldwide. DOTS aim to increase treatment completion and India's Revised National TB Control Program (RNTCP) made India second largest DOTS provider.

Non-adherence is an important consideration in public health, as it affects the health outcomes and health care costs.

Adherence and compliance are often used interchangeably, where adherence is defined as the degree to which patient adheres to the prescription regimen and health advice.

Compliance refers to the process in which patient willingly follows the advice of the care providers. The other term which is also very frequently used is persistence. **Persistence** is the time from the initiation of the medicines till the discontinuation of the therapy.

Non-adherence:

Non-adherence is the non-fulfilment of the prescribed medicines. It can be either intentional or unintentional, that may lead to over or under use of medicines.

Reasons for non-adherence:

- Low literacy
- Side effects
- Financial reasons
- Complex regimen
- Multiple dosage
- Forgetfulness
- Lack of awareness about the disease
- Barriers to access to care
- Inadequate follow-ups
- Missed appointments
- Lack of trust in physician

Intentional Non-adherence:

When the patient decides to not take the prescribed medicines or follow providers advice, this is referred to as intentional non-adherence. It can be because of distinct reasons like, lack of information to the patient, patient may doubt the treatment because of the side-effect or delayed effect of medicines, occurrence of other complications, financial burden, stigma to the patient, lack of family support or motivation.

Unintentional Non-adherence:

Unplanned withdrawal from the prescribed regimen. It may be due to forgetfulness, complex dosing regimen or not knowing how to use the medication, missed appointments, no follow-ups.

Consequences of Non-adherence:

Case example: A patient diagnosed with open pulmonary TB, failed to continue the course after discharge from the hospital and completed only 2 months of TB course. He misconceived his wellness as a cured disease and didn't complete the full course of prescribed medication. This eventually turned into Pott's disease (tuberculous spondylitis) and he was hospitalised for treatment of the same but again, he failed to follow-up and discontinued the treatment. The patient was finally admitted into the acute care infectious disease hospital and was declared too sick for any rehabilitation activity.

LITERATURE REVIEW

Medication adherence is an important part of any treatment. It impacts the outcome of a treatment and decides further progress of the current treatment. For effective and efficient outcome of the treatment and adherence to the medical regimen, communication between the patient and provider is important. That forms the base of the treatment and imparts positive attitude to the patient. [1]

There is a certain degree of overlap in the categorization of non-adherence. The primary non-adherence is the one in which the medication is never filled or initiated after the prescription is being written. It is also known as non-fulfilment adherence. [2]

The other type of non-adherence is the Non-persistence. In this, the patient stops taking medication after initiating it, without the consent of doctor or any health professional. It is

rarely intentional and occurs because of the miscommunication between provider and patient. On the other hand, unintentional is because of the resource limitations for the patient. [3]

Non-conforming is the third type of non-adherence, where patient does not take medicine as prescribed. This may range from skipping the doses to taking medications at wrong time or wrong dose, to overuse of the prescription. There is lot of variation in range of non-adherence and has been recorded as low as 10 % to as high as 92%. [4]

The extensive study in developed countries showed the adherence average about 50%. [5,6] Adherence rate are low in patients with chronic conditions as compared to the patients suffering from acute conditions. Studies have shown that patients with chronic diseases take only ~50% of prescribed medications. [7,8,9]

Poor adherence to prescribed regimen in the COPD patients leads to emergency hospitalization. [10,11]

What influences medication adherence?

Non-adherence is a behavioural problem and reasons ranges between and within individuals, across time and diseases. [12]

Poor provider-patient communication, scarce medicine knowledge and its use, lack of belief in the treatment, adverse drug events, long treatment time, complicated regimen are some of the factors which influence the adherence. [13]

The studies done have shown compliance rate in elderly patients ranges from 38% to 57% with an average of less than 45%. [14,15]

Decreased patient satisfaction due to patient-provider discordance is a major reason for non-adherence. [16]

After 10-80 minutes of the information provided, 40-60% of the patients cannot comprehend correctly what was expected from them. [17]

60% patients interviewed just after the visit to the physician, misunderstood the directions of the prescription. [18]

The rate of non-adherence increases when patients are symptom free. [18]

Other key factor is the literacy level of the patient. Difficulty in understanding the instructions results in decreased adherence rate. [19]

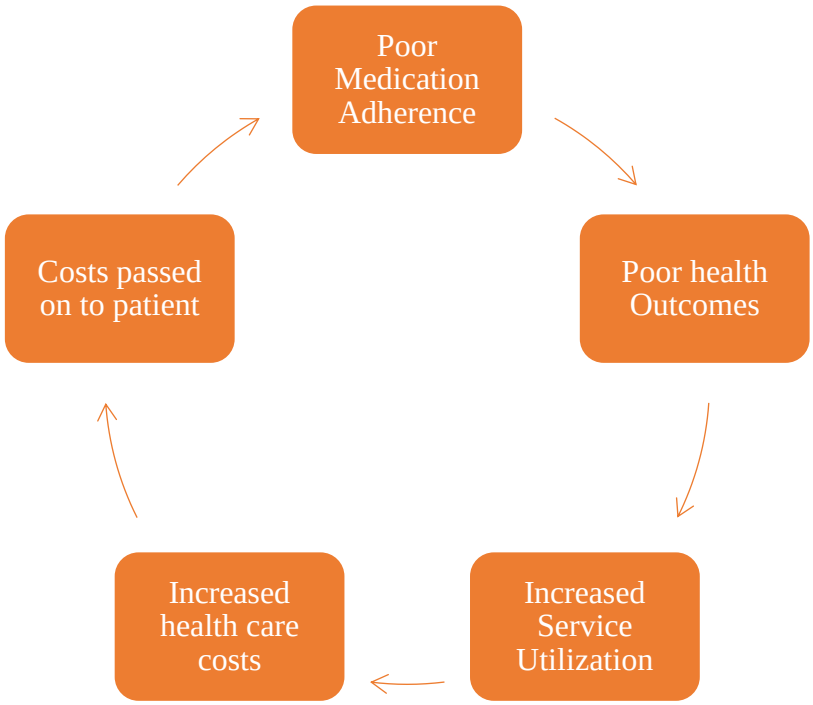
DIMENSIONS IDENTIFIED:

WHO has identified five dimensions of medication adherence, healthcare providers forming an integral part of the dimensions. The five dimensions identified are: [20]

- Health system factors
- Socio/economic factors
- Medical condition related factors
- Therapy related factors
- Patient behaviours

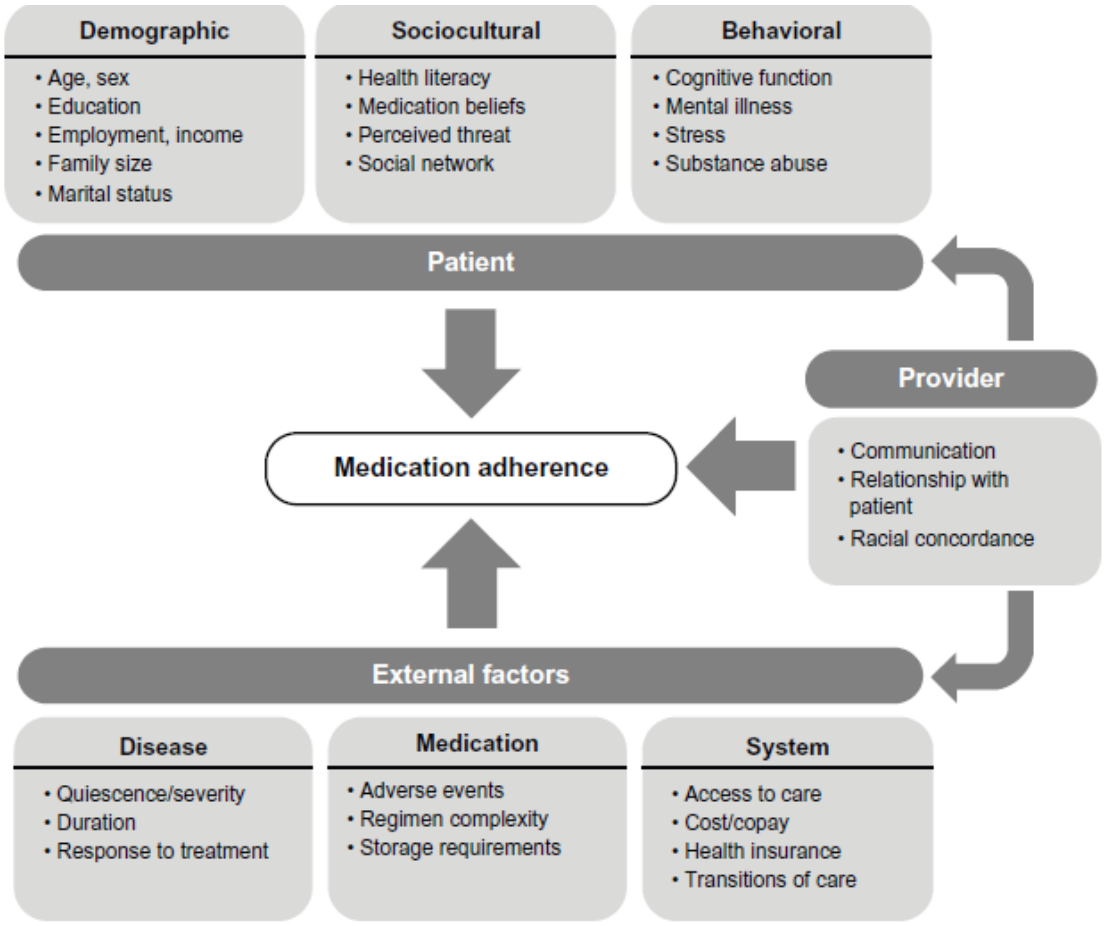
Poor outcome decreased benefits, vague assessment of therapeutic effectiveness are all results of poor adherence to prescribed medication. According to the studies done, non-adherence accounts to about 30% to 50% of failed treatments [21]. Non-adherence leads to consequences like worse treatment outcome, higher and avoidable hospitalization rates, institutionalization of elderly, increased out of pocket expenditure to the patients and increased healthcare costs to the system. [21,22,23]

MEDICATION ADHERENCE AND HEALTH CARE COSTS:



Non-adherence and cost share a strong association. Non-adherence leads to poor outcomes which leads to increase utilization of healthcare services and overall increase in healthcare cost. Because of the partial medical coverage, the financial burden is passed on to the patients. This increase in burden leads to negative impact on adherence level. Apart from the above-mentioned reasons, there are other more important drivers of non-adherence such as impact of productivity, absenteeism and increased disability on employers or society. Health-related productivity loss cost is 2.3 times higher than the direct health care cost.

DETERMINANTS OF NON-ADHERENCE:



The most commonly reported for non-adherence is the “forgetting”. 24% forgetfulness, 20% perceived side-effects, 17% high medicine cost and 14% perception that the medicine has insignificant effect on disease were the most commonly reported reasons in the survey conducted for 10,000 patients.

Many studies have shown that for optimizing adherence to the prescribed medications physicians play an integral role. Two-way communication and trust between the physician and the patient leads to better adherence rates to prescribed therapy and overall care satisfaction [24]. This leads to positive acceptance of new medications, intention to follow physician instructions, perceived effectiveness of the care and improvement in health status.

Based on the meta-analysis of patient and physician communication and adherence to the treatment regimen, there is 19% higher risk in patients of non-adherence who communicate poorly with the physicians as compared to the patients who communicate well with the provider. Training physicians for the communication leads to substantial and significant improvements in adherence, the rate of non-adherence is 1.62 times higher when physician

receives no training [25]. In one of the studies, it was shown that non-adherence forms the contributing factor for around 20% of preventable adverse drug events among older patients in ambulatory care.

STATISTICS:

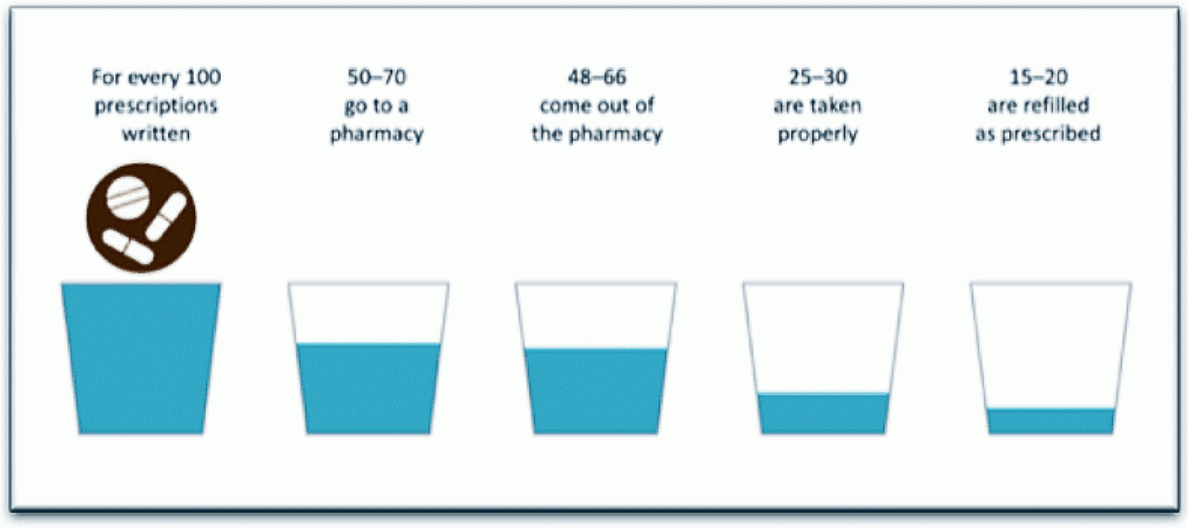
Non-adherence is estimated to cause 125,000 deaths annually [26]

20% to 50% patients are non-adherent to medical therapy [27]

Patients with chronic conditions take about half of prescribed medications. [28]

Regardless of WHO and Institute of Medicine (IOM) efforts, there is no change in the rate of adherence in last 3 decades.

Long waiting times or long follow-up periods leads to increased drop in adherence. [29]



Gap Between a Written Prescription and Actual Medication Use
[Source: National Association of Chain Drug Stores, Pharmacies: Improving Health, Reducing Costs, July 2010. Based on IMS Health data]

The economic burden caused because of the non-adherence accounts about $100 to $300 billion per year. [30]

Annually it costs around $2,000 per patient in clinic visit. [31]

10% to 25% hospital and nursing home admissions are because of non-adherence. Risk of hospitalization, rehospitalization or premature death increases to about 5.4 times in chronic disease patients. [32]

CONCLUSION:

Medication non-adherence is a major global problem. There are many reasons for the concern. Patient education, use of compliance aids, motivation and family support has shown to increase the adherence rate. It should be a multi-disciplinary approach that involves all the stakeholders of the healthcare system. Physicians forming an integral part of the system have maximum responsibility and may form the base for increasing compliance rates.

RATIONALE

Adhering to the prescribed regimen is difficult for patients of chronic diseases, as the tenure of treatment is long with multiple follow-ups. This results in poor management and control of

diseases. It may also be the reason of suboptimal clinical benefit. The overall results may include medical and psychosocial complications of disease, reduce patient's life quality and avoidable wastes of health care resources. These reasons lead to impairment of the health care systems and make it difficult to achieve the population health goals. The other factors that are contributing to non-adherence may include patient related factors, characteristics of diseases and treatment course, healthcare system and service delivery.

There are many factors contributing to non-adherence, some of these are patient-related, disease characteristics and treatment, attributes of the health care system and service delivery. This problem has been overlooked by stakeholders since decades and now has emerged as a significant issue leading to increase in disease burden.

METHODOLOGY

RESEARCH QUESTION:

1. To explore the reasons for non-adherence in TB patients and to analyse the economic burden caused by non-adherence.
2. How tech solutions can impact the adherence rates?

RESEARCH DESIGN:

A comprehensive secondary research was conducted for articles or studies describing the reasons for non-adherence in TB patients. It is a descriptive study conducted for three months period from February 2018 to May 2018.

Population, Interventions, Comparators, Outcomes, Study Design for TB

PICOS for TB	
Population	Individuals suffering from TB and MDR-TB
Interventions	CAREDOSE Dispenser- Tech solution
Comparators	DOTS therapy and conventional hospital treatment
Outcomes	• Adherence • Decreased financial cost • Decreased disease burden
Study Design	• Systematic Reviews • Retrospective analysis of prescriptions of patients and articles

RESEARCH PROCEDURE ADAPTED:

- Sample of 142 prescriptions of patients (including newly diagnosed, follow-up TB patients, MDR-TB patients) in private hospital of Delhi in 5 months period from December 2017 to April 2018 was taken to analyse the trend and reasons for non-adherence. The prescriptions were reviewed regarding the date of diagnosis, start date of treatment, follow-up dates, tenure of prescription, progression of disease and complications, if any.
- A systematic review of articles was conducted to identify the reasons and dimensions for non-adherence in TB.
- Cost to per patient of non-adherence in private hospital was calculated and compared with the cost to per patient in case of adherence and to cost of CAREDOSE services.

SAMPLE SIZE – 142 patients

STUDY SETTING

The study was carried out in CAREDOSE, a MedTech Start-up, Mohan Estate, Delhi

INCLUSION CRITERIA:

Data for patients with positive sputum results for pulmonary tuberculosis and patients with MDR-TB in 5 months period from December 2017 to April 2018 was analysed in the study.

DATA ANALYSIS PROCEDURE:

The data was collected and analysed in the MS excel sheets using functions and formulas.

FINDINGS

The findings are based on the research questions stated above. The main aim of the study is to analyse the economic impact on patients with pulmonary tuberculosis because of the non-

adherence to the treatment and to analyse the impact of CAREDOSE services in improving the adherence. For answering the research questions, the data was collected from the research articles already published in this concern which includes the reasons of the non-adherence, methods to improve it, measure of non-adherence, factors related to non-adherence. The data related to costing was collected from one of the private hospitals of Delhi, which is working in collaboration with CAREDOSE to improve the adherence rates and from the DOTS centre, Sarita Vihar, Delhi.

The data collected was under 2 heads:

- Direct cost
- Indirect cost

The **direct cost** is again divided into

- Medical cost
- Non-medical cost

The **medical cost** includes:

- Consultation fees
- Investigation fees
- Medicine expense

The **non-medical cost** includes: (for accompanying person)

- Travel
- Lodging
- Food

The **indirect cost** includes: (Only for employed patients)

- Loss of wages due to illness
- Decreased earning ability
- Long term disability leading to work change

ASSUMPTIONS TAKEN:

- Average upper middle HH income as R 10,00,000/- (Mckinsey Report- Bird of Gold)

- Average HH size of India
- Income of individual per annum = Average HH income

  Av HH size
- Income per day = Income of individual/annum X no of days missed due to illness

  (22*12) - (12+8) (define these)

FOR TB PATIENTS:

- Consultation fees
- Diagnosis
- Medicine expense

FOR MDR-TB PATIENTS:

- **Direct cost:**
  - Medicines
  - Injections
  - Consultation
  - Investigation
  - Stay
- **Indirect cost:**
  - Travel
  - Food for accompanying person
  - Stay for accompanying person

- MDR-TB patients are the complicated cases of the non-adherent TB case, which generally requires hospitalization ranging from 3 days to 10 days.
- The direct cost assumed for the MDR-TB patients includes the costing of stay according to per day charges which includes all the services provided to the IPD patients such as bedding charges, nursing charges, food charges etc.
- For TB patients, who are not hospitalized and are for consultation, costing has been considered according to the per visit charges.

CAREDOSE SERVICES:

- CAREDOSE is a MedTech solution which works on medicine adherence and aims at increasing the adherence rates in the country, by decreasing the disease and financial burden.
- A simple and cost-effective system to help ensure and automatically track medicine adherence in Chronic patients (in real-time), whilst creating big data for private and public health entities.
- CAREDOSE provides an automated system that is convenient for multi-dose prescriptions and does not require any input from patients. It allows stakeholders in the supply chain to not only communicate but also optimize their tasks and services.
- It is an ecosystem that helps ensure, automatically track and optimize patient care. It works with the help of various components:

A. For patients: Smart Dispenser

Multi-dose packaging: A portable dispenser is used to deliver pre-organised and labelled doses of medicines. To make it convenient for the patient, all medicines of one dose is placed in one pouch, this therefore, assures that patient will take the right medicine at right time.

User friendly labelling: The labels are available in various vernaculars. This allows patients to read medicine names and dosage directions with ease and therefore leads to faster adoption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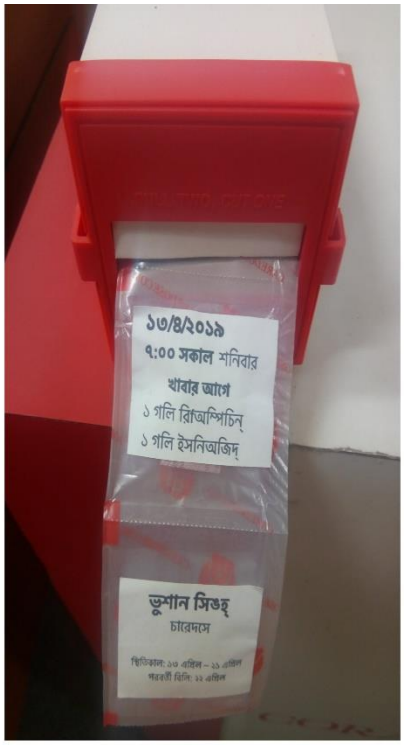
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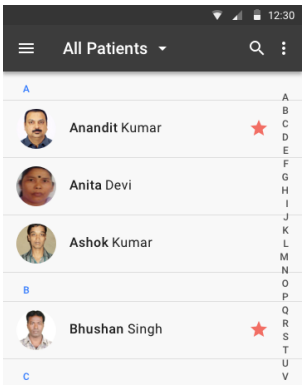
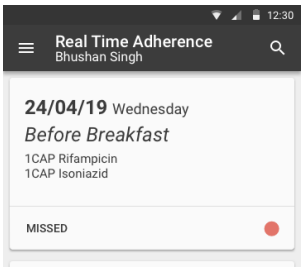
ভুশান সিঙহ্
চারদসে


1 Cap Rifampicin
1 Cap Isoniazid
13/04/2018
7:00AM Saturday
After Food
1 Cap Rifampicin
1 Cap Isoniazid
Bhushan Singh
CAREDOSE
Tenure: 13 Apr – 21 Apr
Next Refill: 22 Apr

Smart dispensing & tracking: In smart dispenser, the dose is dispensed automatically and alerts the patient (light & sound) to take the dose. It also helps in tracking the missing doses of the patients.

Data sharing: Tracking helps in sharing data automatically with the appointed caregivers and allows to take relevant actions and optimizes resource management. This can be integrated with existing systems, platforms and Apps.

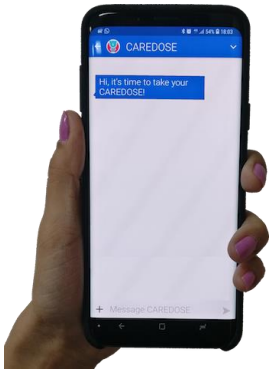




B. For patients: Automated Reminders

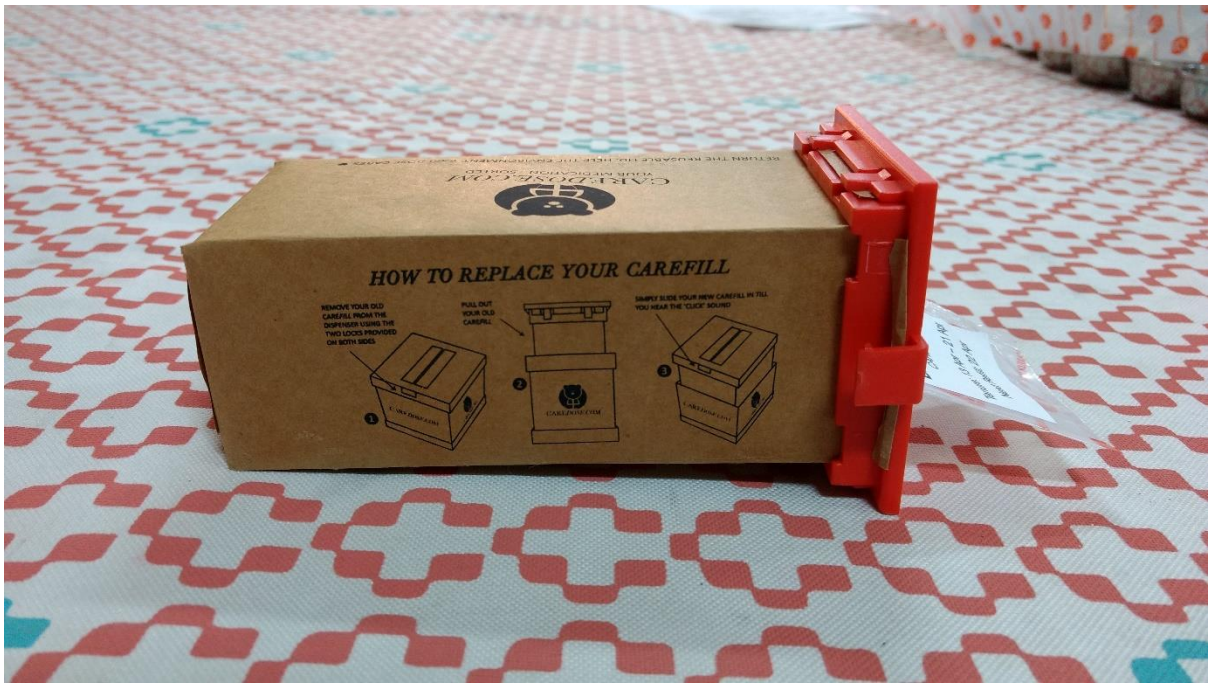
Dose reminder alerts: With the help of SMS, Call or App alert patients are reminded for the doses. The open APIs allows to integrate with existing Apps and route alerts through them.

Negative adherence alert: Smart dispenser tracks missing doses which is an essential part of the system and triggers an alert to the selected caregivers.



C. For patients: Refills

Data recorded automatically in the system helps in managing the refills that are delivered on time in catridges that can be easily fitted into the dispenser.



D. For patients: Awareness & education

With SMS alerts and other informative, simple and interactive campaigns, CAREDOSE is focusing on the area which is important for adherence i.e. knowledge about the medication and importance of adherence.

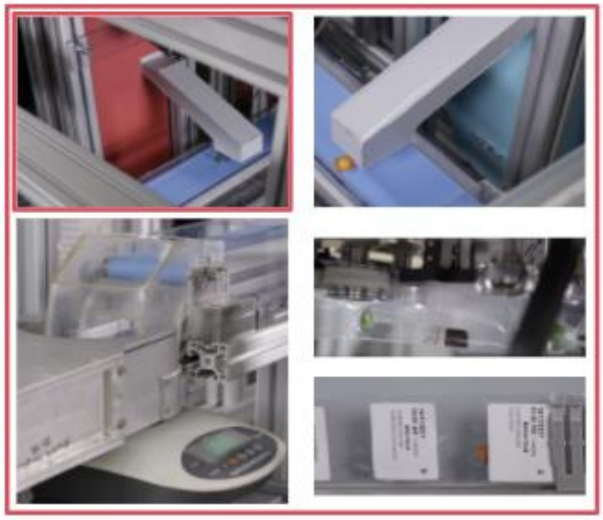
E. For TB Health Facilities: E-Prescription service

The shared prescription of the patient is digitised and made into an E-prescription. This is saved as an electronic health record.

F. For TB Health Facilities: Automated patient wise multi-dose dispensing (DoseDroid)

Dispensing: DoseDroid is an automated multi-dose dispensing robot that cuts medicine strips (while retaining manufacturer's packaging), sorts, packages and labels each patient's medicines according to prescribed doses.

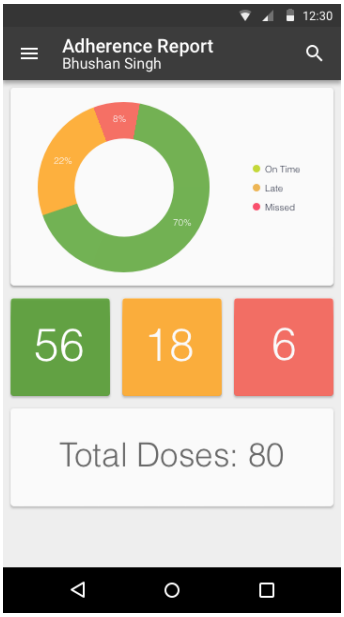
Tracking: DoseDroid tracks manufacturer information along with exact location of each pill in the pouches for complete traceability



G. For TB Health Facilities: Softwares & Dashboards

CAREDOSE ecosystem uses various modules that can be used by the TB health facilities to track the journey of a pill from the point of origin to the point of consumption (in real-time). Softwares and dashboards will enable caregivers with:

- smoother process management
- more efficient supply chain management
- improved inventory stocking
- improved patient care
- real time patient adherence tracking
- actionable data driven insights for more efficient care delivery


12:30
Adherence Report
Bhushan Singh
8%
22%
70%
On Time
Late
Missed
56
18
6
Total Doses: 80


12:30
Adherence Overview
Bhushan Singh
April 2019
SUN MON TUE WED THU FRI SAT
30 1 2 3 4 5 6
7 8 9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30 31 1 2 3
18
3
3

COSTING

MDR TB		
HOSPITAL TYPE	**PRIVATE**	
ROOM TYPE	**ECONOMY**	**SINGLE**
COST OF TREATMENT (IN INR)		
DIRECT COST:		
MEDICINES (PER MONTH)	660	660
INJECTIONS (PER VISIT)	42,000	42,000
CONSULTATION (PER VISIT)	28,000	28,000
INVESTIGATIONS (ONE TIME)	2000	2000
STAY (PER VISIT)	50,000	1,30,000
	28,97,840	**48,17,840**
INDIRECT COST (PER VISIT)		
TRAVEL	4000	6000
FOOD FOR ADDITIONAL MEMBER	7000	10000
STAY FOR ADDITIONAL MEMBER	2000	6000
TOTAL	**13,000**	**22,000**
WAGES LOST	2,94,912	2,94,912

TB		
CONSULTATION	300	1800
DIAGNOSIS	2100	2100
MEDICINES EXPENSE	660	3960
TOTAL	960	7860

INCOME	
AVERAGE UPPER MIDDLE CLASS HH INCOME IN INDIA	**10,00,000**
HH SIZE	4
INCOME OF INDIVIDUAL	2,50,000
INCOME PER DAY	1024.590164
LOSS OF INCOME DUE TO ILLNESS (3 DAYS STAY)	3073.770492
5 DAYS STAY	5122.95082
10 DAYS STAY	10245.90164

COST OF CAREDOSE SERVICES	
DISPENSER (ONE TIME)	300
SERVICE COST (PER MONTH)	350
TOTAL COST	8700

TOTAL EXPENSE	32,05,752	51,34,752
TOTAL SAVINGS	31,89,192	51,18,192

DISCUSSION

As per analysis and findings, the result obtained shows that use of CAREDOSE dispenser will help increase the adherence rates as well as decrease the financial burden of the patient. The main aim of this study is to gain insight into the current expenses that the patients are bearing from time of consultation and diagnosis to entire tenure of treatment which is up to 24 months in case of MDR-TB. Increase in the percentage of non-adherence rates because of several reasons, results in a higher conversion of TB patients into MDR-TB. Irregular dosing, wrong dosing or missed follow-ups lead to increase in disease burden for individual as well as for the community. If this pattern of non-adherence persists, it will be difficult for the healthcare system to manage the disease and its outcome. And will lead to more utilization of resources which can otherwise be used for other events. Increasing hospitalization, decreasing patient to bed ratio, unavailability of services, delayed treatment, increasing morbidity and mortality are caused by failed treatment because of the non-adherence to the medication. The adherence level largely depends on the patient's belief and attitude. Lack of trust in treatment or physician, illiteracy, lifestyle habits, unawareness about the complications of disease, no family support, societal stigma: these are some of the reasons which lead to medicine non-adherence in patients.

TB is a chronic disease which can be cured if treated properly. This can be important from the physicians as well as from patient's perspective. Physicians are equally responsible for encouraging patients to adhere to the prescribed regimen as patients themselves. There are several methods which have been used in past and still are used which has helped in some improvement of adherence rates. The introduction of innovative technology with sorted medicines according to the time, dose and frequency can improve adherence multiple times. CAREDOSE is one such example that can help private and public health entities in eradicating TB and increasing the adherence rates.

CONCLUSION

Non-adherence may lead to several complications and conversion of TB to MDR-TB because of the resistance developed by the bacterial strain due to the discontinuation of dosage. Non-adherence leads to an increased burden on a patient and an increased cost to the healthcare system in terms of increased length of stay, increased no of dosages and increased cost of medications. In this study, the cost of the treatment has been extracted under two heads: Direct cost and Indirect cost. Direct cost includes the medical and non-medical cost and Indirect cost includes the cost incurred in travelling, lodging and food for the accompanying person. In the above findings, non-adherence has led to increased expenses and loss of wages due to illness, which could have been saved if the patient had been adherent to the prescribed regimen and had completed the required tenure of the treatment. To accomplish this, a solution- CAREDOSE will be provided to patients that will help them to be adherent to the treatment. They will receive a pre-organized dose pouches with all relevant details around frequency, food directions, time and date of dose. Every time the dose will be due, they will receive a reminder on their phones to take the dose. According to WHO, more than 50% chronic patients are non-adherent to their medicine intake and close to 70% of these do not communicate this to their caregivers. Given non-adherence is a behavioural problem, CAREDOSE is tackling the problem with a behavioural solution, which will lead to a substantial decrease in the cost of the treatment as patients will now be adhered to their prescribed medication.

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