Adoption Of m-Health Initiatives by Pharmaceutical Companies in Chronic Disease Management: A Literature Survey

Keyur K. Jathal

Ph.D scholar at Institute of management Nirma University.
keyur.jathal@gmail.com

Abstract

Proliferation of mobile devices, affordable internet connectivity and mobile applications are enabling healthcare providers in reaching out to patients at various stages of treatment or trials. There is an emphasis on outcome-based healthcare by major stakeholders such as patients, payers, health care providers, pharmaceutical companies and policy makers, in the healthcare value chain. Trends such as mHealth, eHealth, digital health adopted by pharmaceutical companies are influencing patient engagement. Prescription non-adherence, especially in chronic disease management is a major factor influencing treatment outcomes. This results in prolonged symptoms leading to recurrence of the disease, for the patient and revenue losses for the pharmaceutical companies. Various studies have documented the impact of non-adherence both for patients, payers and providers.

It is to counter this issue that certain pharmaceutical firms and health care organizations are using technology interventions such as mHealth initiatives for monitoring adherence as well as promoting awareness. The objective of this paper was to study the work done in this context thru a literature survey. The area of interest being, triggers and impact of these digital initiatives in the chronic disease domain. Post undertaking a literature survey it was found that while work is done in terms of establishing a relationship between mhealth initiatives and medication adherence, there is little scholarly work done in the Indian healthcare setting. Also, scant work is done in order to document the results from the efforts undertaken by pharma companies in terms of launching mhealth initiatives for adherence and awareness. If there is a positive relationship established between mHealth initiatives and adherence, the use could be broad based in order to achieve better outcomes

Keywords: m-health, mhealth, e-health, digital health, adherence, awareness, chronic diseases, pharmaceuticals, healthcare providers

Introduction

Outcome based healthcare is an emerging theme globally. Healthcare providers are taking up initiatives which would lead to better outcomes. According to Hird (2016), "the convergence of technology and medicine has pushed healthcare to the brink of a major disruption that pharma has, until recently, been slow to

recognize". With the proliferation of data on the web and digital social networks, the patient is becoming more aware about the treatments, medications, side effects, etc and has thus become more empowered while participating in treatments. It is in this context that patient engagement which is a critical component in impacting outcomes, has undergone a change. Digital initiatives around clinical trials/patient enrolments, drug/disease awareness, digitised patient records and prescription adherence are being adopted for the perceived benefit of better patient engagement, leading to better outcomes.

One of the major challenges impacting outcomes has been non-adherence to prescriptions, especially for chronic diseases. Prescription or medication non-adherence is a highly critical problem in healthcare, resulting in a heavy financial impact on all stakeholders. In terms of quantification of loss, the New England Healthcare Institute, in 2009, estimated that medication non-adherence was responsible for $290 billion in "otherwise avoidable medical spending" in the US alone every year. As per Forissier (2011)Revenue loss for the global pharmaceutical markets, as per an estimate in 2011 was USD 564 Billion, which was almost 59% of the market size.

In the Indian scenario, the estimates around revenue loss for pharmaceutical companies have not been made, however, non-adherence in chronic diseases such as type 2 diabetes, chronic kidney disease, HIV, etc has been studied. Mobile health (m-Health) initiatives have been reported to impact non-adherence in a positive manner by certain studies which have been done globally. Mobile enabled tools and technologies are increasingly being used in health care and public health practice for communication with patients, monitoring and facilitating medication adherence to chronic treatments. Hamine (2015). The researcher specifically, observed a lack of research in terms of the impact of m-health initiatives undertaken by pharma companies, on adherence and business objectives of these pharma companies.

Understanding Terminology: m-health (m-health)

As per Abidi (2015), "mHealth (also written as m-health) is an abbreviation for mobile health, a term used for the practice of medicine and public health supported by mobile devices." Also, as per Cipresso (2012), "the term is most commonly used in reference to using mobile communication devices, such as mobile phones, tablet computers and PDAs, and wearable devices such as smart watches, for health services, information, and data collection". The theme of mHealth or mobile health field has emerged as a sub-segment of eHealth. The usage of information and communication technology (ICT), like computers, mobile phones, communications satellite, patient monitors, connected health devices, etc, for health services and information. Germanakos (2005) mentioned that mHealth applications consist of the usage of mobile devices in collecting clinical health data, delivery of healthcare related information with doctors, researchers, and patients, real-time monitoring of patient vital signs, and direct provision of care (via mobile telemedicine). Adherence is defined as "the extent to which a patient acts in accordance with the prescribed interval, and dose of a dosing regimen" (Cramer, 2008). Further, HER is defined by Centers for Medicaid and Medicare services in its website, which is the official website for United States government as "an Electronic Health Record (EHR) is an electronic version of a patient's medical history, that is maintained by the provider over time, and may include all of the key administrative clinical data relevant to that persons care under a particular provider, including demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports". The paper has explanations around other constructs as well which appear as per a logical flow.

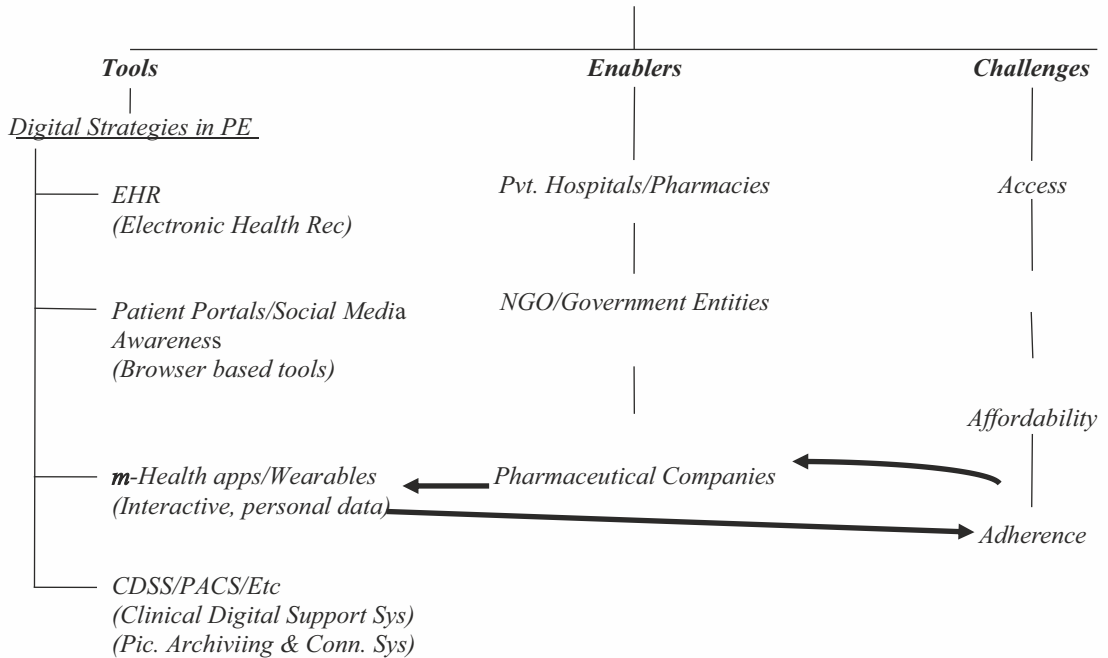**Literature Survey Objectives**

The objective of the literature survey was to seek an understanding about mhealth initiatives in the chronic

disease management domain. The aspects of study were related to exploring research done in establishing a relationship between mhealth initiatives and factors such as medication adherence and awareness. The scope was limited to the mhealth initiatives taken up by pharmaceutical companies. Research done in the context of Indian pharmaceutical industry would have added a localized perspective and hence, this was explored. Identification of research gap in existing research alongwith proposed directions for further research was eventually taken up.

Method

There are three major steps being followed while working on this paper. Exploring databases and journals for relevant papers being the first step. Defining the constructs which appear on the studies, being the second followed by filtering the study based on the work done in terms of documenting the impact of m-health initiatives (by pharma companies) in chronic disease management. The study ends with identifying research gaps and certain observations. The following has the concept map which acted as a framework for conducting the literature survey.

The Concept Map: Figure 1

Outcome Based Treatment in Chronic Diseases

| *Tools* | *Enablers* | *Challenges* |

Digital Strategies in PE

EHR
(Electronic Health Rec)

Pvt. Hospitals/Pharmacies

Access

Patient Portals/Social Media
Awareness
(Browser based tools)

NGO/Government Entities

Affordability

m-Health apps/Wearables
(Interactive, personal data)

Pharmaceutical Companies

Adherence

CDSS/PACS/Etc
(Clinical Digital Support Sys)
(Pic. Archiviing & Conn. Sys)

In order to achieve better outcomes from prescribed treatments, there are various digital tools available at the disposal of health-care providers and pharma companies towards patient engagement (PE). These tools help to mitigate the challenges faced by patients and providers. The researcher is keen to explore the issue of non-adherence to prescribed medication. The focus is to study the trigger and impact of m-health initiatives undertaken by pharmaceutical companies aimed at improving adherence and do these initiatives impact the business objectives of these pharma companies.

Identification and Inclusion/Exclusion of Secondary Sources of Data

While exploring the relevant content from scholarly journals, certain Boolean search terms such as patient engagement, digital strategies, non-adherence, m-health, mhealth, e-health, pharma companies, impact, chronic disease, India, Indian and adherence were used. Research papers published prior to 1990 and which were not in English language were excluded.

Search Results

Based on the Boolean search, inclusion and exclusion criteria there are around 320 research articles which are having the search terms. These articles are then filtered specifically around the topic of impact of m-health initiatives on adherence in chronic disease. The articles around non-adherence as a challenge in chronic disease management are also retained. Focus is also to retain research articles which are done with a view point of pharmaceutical companies. The diseases which are included in the study are, tuberculosis, Hypertension, Bronchitis/Lung related, cardiac diseases, HIV, chronic kidney disease and diabetes.
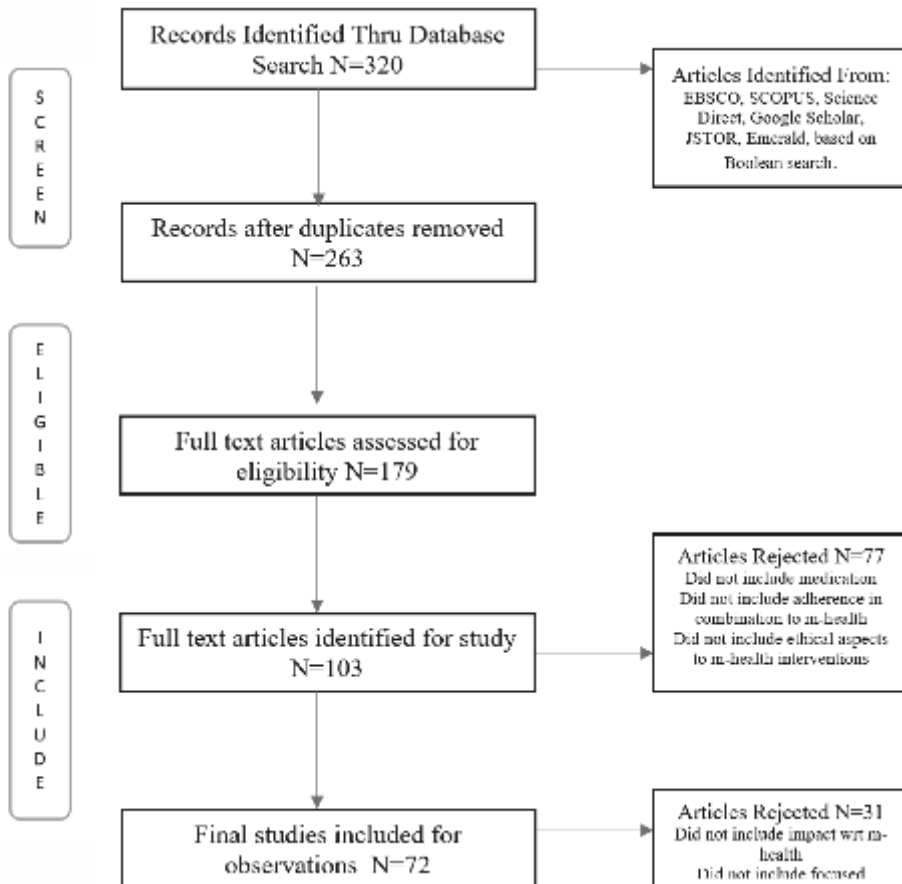
Filtration Process Depiction

Figure 2.1 – Prisma Flow Diagram

Research which focused on diseases/incidences such as weight reduction, anti-natal/post-natal care, child survival, sleep apnea, are filtered out. The final count of the relevant papers was then at 72.

Outcomes from literature survey

The survey included the following aspects,

1. Digital initiatives in patient engagement

2. Impact of medication adherence in chronic disease management.

3. m-health initiatives impacting adherence in chronic diseases.

4. m-health and adherence in the Indian context.

5. Evidence of impact from a point of view of pharmaceutical companies.

6. Identify gaps in existing research and propose future areas of research.

The following sections elaborate the findings on these areas of interest.

Digital Initiatives in Patient Engagement:

Post introduction of the mobile phone and proliferation of internet, leading to social networking and interactive mobile applications, the dynamic of patient engagement has changed. While, patient engagement (PE) is not a new concept, it is undergoing a transformation. As per Higgins (2017) Patient Engagement can be defined as "the desire and capability to actively choose to participate in care in a way uniquely appropriate to the individual in cooperation with a healthcare provider or institution for the purposes of maximizing outcomes or experiences of care". There are around 12 research/survey articles and a systematic review (on impact of IT on patient engagement) identified around the importance of PE toward outcome-based health care. PE is now extensively using digital technologies as a tool to derive efficacy.

The impact of IT on PE, can be summarized from a systematic review undertaken by Schnall (2016) which states that "out of 170 articles which met the inclusion criteria and were reviewed in detail. Overall, 88.8% (151/170) of studies showed positive impact on patient behavior and 82.9% (141/170) reported high levels of improvement in patient engagement. Only 47.1% (80/170) referenced specific behaviour theories and only 33.5% (57/170) assessed the usability of IT platforms. The majority of studies used indirect ways to measure health outcomes (65.9%, 112/170)." In general, the review has shown that IT platforms can enhance patient engagement and improve health outcomes

From and industry perspective, Patient engagement is no doubt on the radar of the Pharma Industry. An Accenture survey from 2016 (https://www.accenture.com/us-en/patient-services-survey-pharma) discovered that almost 91% of pharma companies plan to provide six or more patient-centred services in the next 2 years. Platforms for Patient Engagement are as follows:

1. Mobile Health Technologies, or mHealth/m-health/eHealth initiatives.

2. Patient Portals refer to secured websites patients use to access their electronic health records and related services to their care.

3. Online Patient Engagement Platforms, such as online communities and social media networks, offer pharmaceutical companies an opportunity to engage directly with patients and create the dialogue today's patients expect.

Prescription adherence in chronic diseases:

There are numerous factors around accessibility, affordability, awareness, efficacy and adherence, which impact treatment outcomes. The researcher is interested in studying the prescription adherence aspect towards the treatment of chronic diseases. The diseases to be included in the study are tuberculosis, diabetes, hypertension, HIV, chronic kidney disease, mental health and bronchitis/asthma related diseases. The literature survey resulted in a list of around 14 research articles which gave an idea about the extent of non-adherence being an important contributor impacting outcomes. Of these articles, there were around 5 research papers citing non-adherence to chronic diseases in the Indian context. As per DL (1989), Medication nonadherence is defined as "the number of doses not taken or taken incorrectly that jeopardizes the patient's therapeutic outcome".

The impact of medication non-adherence:

As mentioned by Bond WS (1991) Nonadherence to prescribed therapy had been reported in the range of 13% to 93%, while having an average rate of 40%. It was understood that the problem was witnessed in all ages as well as ethnic groups. It was estimated that 43% of the general population, 55% of the senior citizens, and 54% of children and teenagers were found to be non-adherent. Rates of nonadherence varied with different diseases and their stages. For an example, as per a report from a task force for compliance in US (1994) the non-adherence rate for hypertension was reported to be around 40%. In case of arthritis, it had been found to range between 55% and 70%. Blandford (1999) mentions that non-adherence rates were specifically high in patients suffering from chronic diseases. Smith (1996) mentions that prescription non-adherence is a significant public health problem. As per Smith, this has been termed as an invisible epidemic.

From a quantifiable aspect, based on research done by Donovan (1992, 1995), Haynes (1997) and Morris (1992), Therapy and prescription non-compliance resulted in a considerable commercial burden upon existing health care systems. The financial burden was estimated at around100 billion dollars each year in USA. While the above facts are from research done prior to the year 2000, there is enough evidence about the extent of non-adherence from research and surveys done in recent past. Taking an instance of Type 2 diabetes adherence, as per research done post 2000, by Osterbers (2005), "On average, 50% of new medication users will fail to consume at least 80% of prescribed doses during their first year of therapy". From a study done by Fischer (2010) in 2014 of around 1.95L e-prescriptions in the US, it was found that non-adherence was frequently observed in medications which were newly prescribed and were in the domain of treating chronic conditions like hypertension (28.4%), hyperlipidemia (28.2%), and diabetes (31.4%).

The impact of non-adherence has been felt in the industry and there have been surveys done to quantify the impact. The impact on revenue was a quantifiable measure to understand the gravity of medication non-adherence. As per a survey by Forissier (2014) "the US pharmaceutical industry alone loses an estimated $188 billion annually due to medication non-adherence. This represents 59% of the $320 billion in total US pharmaceutical revenue in 2011 and 37% of the $508 billion annual *potential* total revenue. Extrapolated to the global pharmaceutical market, revenue loss is estimated to be $564 billion, or 59% of the $956 billion in total global pharmaceutical revenue in 2011 and 37% of the $1,520 billion annual *potential* total review"

Non-adherence in the Indian context:

In the Indian context, there is research done around understanding adherence in chronic diseases. This is done for HIV, Chronic Kidney Disease, Unipolar Depression and Diabetes. Globally the adherence for treatment of diabetes is at 50%, and it is far lesser in developing countries such as India.(diabetes mellitus fact sheet, 2002). The scarce documented studies available on diabetes care in India reveal that "50-60% of diabetic

patients do not achieve the glycemic target of HbA1c below 7%. (Kavita Venkataraman, 2009) non-adherence to medication could be the reason.

For unipolar depression, non-adherence to treatment is well documented. As per WHO the burden of disease is fourth largest globally. In India, the extent of non-adherence is not documented. However, as per research done in a tertiary hospital in Kolkata, India by Banerjee (2013), it was found that out of an aggregate of 239 patients having unipolar depression were interviewed out of which 66.9% (160) were found to be non-adherent and 33.1% (79) were found to be adherent to treatment. As per Ahlwat, (2016), for chronic kidney disease (CKD), a high level of adherence to prescribed medication is required to get desired outcomes. While research in India is scarce, as per a research paper and an output of a controlled study of 150 patients, only 22% of the patients had high adherence to medications.

M-Health as an intervention to increase medication adherence in chronic disease management:

The researcher is keen to understand whether m-health initiatives have a positive impact on medication non-adherence in the context of management of chronic diseases. Should there be a positive impact, are pharmaceutical companies adopting these initiatives and are they getting a business benefit.

Defining m-health, ehealth, digital health was important as these terms are used in various ways in research literature. While there are many more terms pertaining to the convergence of digital platforms and health care, the researcher has defined the terms which are relevant in context of the research topic. The terms that are not elaborated are healthcare IOT, health-IT, EHR , PACS etc.

Digital health is an overall theme wherein there are digital tools/applications which are used to improve outcomes of treatments. As per Sengupta et al (2016) this can be defined as "Convergence of digital and genomic technologies with health, healthcare, living, and society to enhance the efficiency of healthcare delivery and make medicines more personalized and precise. The discipline involves the use of information and communication technologies to help address the health problems and challenges faced by patients. These technologies include both hardware and software solutions and services, including telemedicine, web-based analysis, email, mobile phones and applications, text messages, and clinic or remote monitoring sensors. Generally, digital health is concerned about the development of interconnected health systems to improve the use of computational technologies, smart devices, computational analysis techniques and communication media to aid healthcare professionals and patients manage illnesses and health risks, as well as promote health and wellbeing."

Impact of m-health interventions towards medication adherence in chronic disease management:

Having defined digital health and m-health, the researcher explored articles which established linkages between medication adherence and m-health initiatives. There were more than 15 articles apart from systematic reviews which were studied for the same. In a systematic review titled "Impact of mHealth chronic disease management on treatment adherence and patient outcomes: a systematic review" By Hamine (2015), Around 107 articles were shortlisted and studied in this review. SMS (short message service) was the most commonly implemented tool in the context of medication adherence. This was observed in 40.2% (43/107) of studies. The important aspects for SMS tool such as user-friendliness, feasibility of the tool, and its acceptability or patient preferences for mAdherence interventions were studied and it was found that in 57.9% (62/107) of studies this was generally high, indicating acceptance. Also, there was an aggregate of around 27 studies which deployed randomized controlled trial (RCT) methods to evaluate the impact on medication adherence behaviours, and significant improvements were revealed in 15 of those studies (56%). Of the 41 RCTs that measured impact on disease-specific clinical outcomes, significant betterment among groups were

reported in 16 studies (39%).

From the above research, one can surmise that the impact of mhealth is significant, in the context of medication adherence.

One more systematic review done in 2016 in university of Hidelberg, Germany, published by BMC Medical Informatics and Decision Making, studied research articles related to the impact of SMS and voice based interventions on medication adherence in chronic diseases. There were 14 research papers identified and analysed. The findings by Yasmin (2016) showed "evidence of improved adherence, as well as health outcomes in disease management, using mobile Short Message Systems and/or Voice Calls. Significant improvement has been found on adherence with taking medicine, following diet and physical activity advice, as well as improvement in clinical parameters like HbA1c, blood glucose, blood cholesterol and control of blood pressure and asthma."

Role of m-health interventions towards healthcare outcomes:

Having established a significant impact of m-health interventions on medication adherence in chronic diseases, the researcher also explored the overall role of m-health interventions towards treatment outcomes. The following excerpts are in that context.

In research done in the University of Germany, titled Taxonomy of Health IT and Medication Adherence, authors are trying to get an understanding of what features health IT offers and how these address poor medication adherence, they examine existing health IT targeting medication adherence. Here, health IT is a super set of m-health interventions and the researchers have mapped 16 different types of health IT offerings on 7 different dimensions. A core finding by Mrosek (2015) is that communication technology in the form of mobile devices and services is gaining in importance in context of adherence and almost all health IT offerings can use mobile technology.

In an analysis by Waleed (2017) of worldwide scientific literature in mobile-health from 2006 till 2016, the role of m-health intervention in health-care was studied. During the study period, a total of 5465 documents were published, giving an average of 496.8 documents per year. This indicates significantly active research across the decade. The research concluded that "Given the large volume of citations received in this field, it is expected that applications of m-Health will be seen into various health aspects and health services. Research in m-Health needs to be encouraged, particularly in the fight against AIDS, poor medication adherence, glycemic control in Africa and other low income world regions where technology can improve health services and decrease disease burden." Waleed (2017)

Medication non-adherence in the Indian context:

The researcher identified around 8 research articles highlighting the factors responsible for non-adherence to medication in chronic diseases. Among these, there were 4 articles focusing on non-adherence in the Indian context.

In a research article published by Manipal University and conducted in Andra Pradesh, around 140 patients were enrolled and were observed for medication adherence to diabetes treatment. The overall medication adherence rate was found to be 47.85%. It was concluded that the factors contributing to non-adherence were lack of finance, forgetfulness, being busy, medicines inaccessibility and side effects of drugs. (Ravi Kumar Medi, 2015). Among other studies done in India for diabetes medication, it was identified that "cost of treatment, need for lifelong medication, coupled with limited availability of anti-diabetic medications in the public sector and cost in the private sector are important issues for treatment compliance." (Kavita

Venkataraman, 2009)

In a separate research done for CKD (Chronic Kidney Disease) by Ahlawat (2016), it was found that causes such as forgetfulness, pill burden, literacy, reimbursement, medication by caregivers were found to be significantly affecting the medication adherence.

In a research done for identifying the factors contributing to non-adherence in antiretroviral therapy (HIV) by Nischal (2005), it was observed that "lack of trust between clinician and patient, active drug and alcohol use, active mental illness (e.g. depression), lack of patient education and inability of patients to identify their medications, lack of reliable access to primary medical care or medication are considered to be predictors of inadequate adherence."
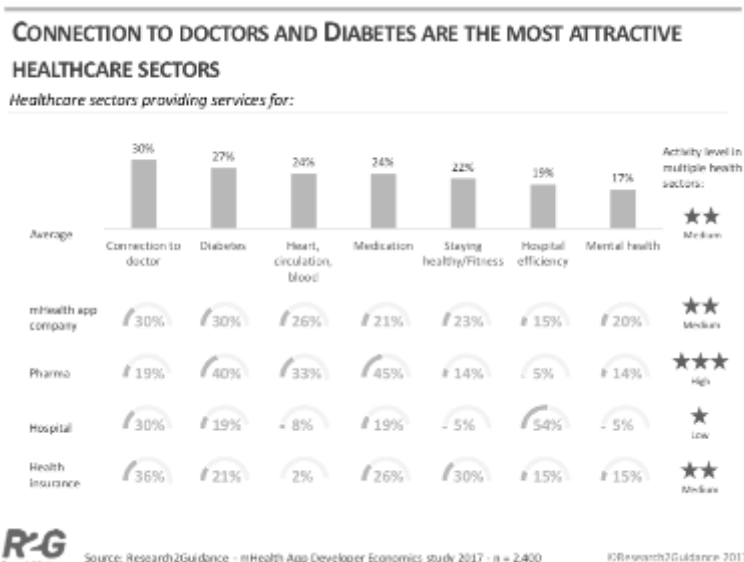
The m-health applications market:

With importance assigned to m-health initiatives and its impact established, there are various firms both from within and outside the regular pharma/healthcare industry, which have invested in developing applications around medication adherence and awareness.

The researcher, studied the journals from the industry and came across articles which surveyed the m-health application market. This was important to understand the magnitude of response from the industry towards an emerging theme which the academicians had researched.

Market Size: mHealth market was estimated to be USD 54.21 Billion in 2022. The global mHealth market size is expected to surpass around US$ 243.57 billion by 2030 and is poised to grow at a noteworthy CAGR of 18.2% from 2021 to 2030 (mHealth Market Size to Surpass Around US$ 243.57 Bn by 2030, 2022). Investment funding received by mhealth startups and other organizations was at USD 57.2 Bn, in 2021. This was a growth of 79% YoY. (State of Digital Health 2021, 2022)

Availability of m-Health applications: From an industry research spanning 15000 participants, since 2010 and involving around 2400 decision makers, we understand that in 2017, there were 3.25L health apps available. In 2017, in one year, there were 78,000 health apps added. An estimated 3.7 Billion apps were supposed to be downloaded in 2017.(Research 2 Guidance, 2017).

Figure3:

CONNECTION TO DOCTORS AND DIABETES ARE THE MOST ATTRACTIVE HEALTHCARE SECTORS

Healthcare sectors providing services for:

Source: Research2Guidance - mHealth App Developer Economics study 2017 - n = 2,400 ©Research2Guidance 2017

As per the chart above, Telehealth companies are offering way above average services for "connection to doctors" and "heart, circulation, blood" and IT/Tech companies for "hospital efficiency" and "medication" . Here it is important to note that medication (medication adherence) as an important area of focus. Also, pharma companies are most active in multiple segments whereas hospitals are highly specialized, and the least active in multiple segments. This shows that there is a case for pharma companies to be active in m-health initiatives around medication.

mHealth initiatives in the Indian health care system:

This section focuses on understanding about Indian pharmaceutical industry's position in the global context, in terms of market size. mHealth initiatives taken up by pharmaceutical companies operating in India were also studied. Government spending and initiatives towards improving health care and treatment outcomes were an area of interest as well, in order to understand the overall trend towards digitalization of healthcare. The study also covers research done in the context of understanding challenges in implementing mHealth initiatives in a broad based manner in the Indian health care setting.

Indian pharmaceutical industry in global context:

In the global context India is the largest provider of generic drugs. Indian pharmaceutical sector supplied over 50% of global demand for various vaccines, 40% of generic demand in the US and 25% of all medicine in the UK. Globally, India ranked 3rd in terms of pharmaceutical production by volume and 14th by value. The domestic pharmaceutical industry included a network of 3,000 drug companies and ~10,500 manufacturing units. (Pharmaceuticals Industry Report, 2022). In terms of chronic disease management, presently, about 80 percent of drugs used globally to combat AIDS are supplied by Indian pharma firms. Around 90 percent of Anti-retroviral (ARVs), Anti-malarial and Anti-tubercular permissions are given to India.(IBEF, 2018)

It is important to note that Indian pharma industry is mainly controlled by leading foreign companies having subsidiaries in India due to the availability of cheap labour in India at low cost. Pharma industry mainly controlled by global firms having affiliates in India due to the availability of labours at cheap rates. The above implies that pharmaceutical companies operating in India are major influencers towards chronic disease management globally. Hence, it becomes important to study their adoption of m-health initiatives.

mHealth Initiatives by Indian pharmaceutical companies:

Evidence of m-heatlh initiatives undertaken by pharma companies: The researcher, from industry reports gathers that the following companies have initiatives around medication efficacy or adherence.

1. Sun Pharmaceuticals has launched a mobile app "RespiTrack" for asthma patients and to ensure them a right treatment

2. GSK has strengthened the webinars, video dialogue, information portals and platforms like 'Viva' for physicians but has also equipped its power with devices like iPad's for real-time monitoring

3. Abbott India has also launched a fitness app and Genie, a heart and liver app. They have envisaged a blend of home based telehealth remote patient surveillance system with heart-failure medicines.

4. Novartis has launched an app specifically designed for eye patients to participate in ophthalmic clinical trials

5. Sanofi is making serious efforts to digitize its clinical trial process. Alongwith, TriNetX they announced that they will be using patient EHRs to optimize recruitment, streamline trial investigators and workflows.

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Indian government's initiatives around building a digital health roadmap:

A large gap between health care professional, patients and the growing cost of health care, were certain triggers for the government to look at digital initiatives in public health care. Investing in technology to enable health-care delivery was the stimulus to digitalize public health in India. The use of digital health interventions in primary care had provided positive results in maternal health education, addressing mental health issues, and maintaining vaccine supply chains, thus making digitalization of public health imperative in India. (Nachiket Gudi, 2021)

National Digital Health Blueprint:

As a first step towards creating a digital health roadmap for public heath, the government formed a national digital health blueprint. As defined by ministry of health and welfare, "The National Digital Health Blueprint (NDHB) provides an approach to establish foundational IT components that will enable the Health ecosystem to streamline information flows across players in the ecosystem while keeping citizens, their privacy and confidentiality of data at the forefront". This was an initiative proposed by Niti ayog in 2018, and was floated in public domain in the year 2019, to elicit views and comments.

National Digital Health Mission (NDHM) and the opportunities for capacity building:

The NDHM was intended to be a complete digital health ecosystem with personal health IDs for every Indian. This would include digitization of health records as well as a registry of doctors and health facilities across the country. The following table depicts the components that would comprise the NDHM ecosystem. The table also shows the opportunities around capacity building.

NDHM components	Capacity building areas
Health ID	Promoting digital health literacy among both patients and providers to enhance communication channels. This promotion should focus on overall digital literacy and should be based on a competency-based framework[21]
PHR	Promoting private health-care enterprises to actively engage in early adoption of the same as evidence suggests that the private providers have often taken a back seat in reporting of Health Management Information System and Integrated Disease Surveillance Program[12]
EMR web applications	Evidence suggests that EMRs have not been well accepted among the health-care professionals globally owing to high patient volumes and poor change management mechanism.[23,24] This warrants a strategy to foster a smooth transition from paper-based medical records to web-enabled applications at a country level taking diversity and infrastructural limitations into consideration[25]
Digital doctor platform (doctor's directory)	Indigenous and traditional medicines require careful integration into the National Digital Health Architecture and in doing so India will be truly able to demonstrate interoperability[26,27]
Health Facility Registry	The Health Facility Registry should provide information to patients about all the possible diagnostic tests and services available for different schemes such as CGHS, Ayushman Bharat, and other government-initiated schemes because empaneled hospitals are dissatisfied with low tariffs and sometimes do not offer the required service to the patients. This would ensure transparency among the stakeholders (patients, providers, and the government)[28]

Table 1: NDHM components and capacity building areas. (Nachiket Gudi, 2021)

Ayushman Bharat Digital Mission:

The NDHM would become a catalyst for government's holistic digital health outreach, branded as Ayushman Bharat. As per government sources, "Ayushman Bharat Digital Mission will connect the digital health solutions of hospitals across the country with each other. The Mission will not only make the processes of hospitals simplified but also will increase ease of living. The Digital Ecosystem will also enable a host of other facilities like Digital Consultation, Consent of patients in letting medical practitioners access their records, etc. With the implementation of this scheme, old medical records cannot get lost as every record will be stored digitally." (https://www.india.gov.in/spotlight/ayushman-bharat-digital-mission-abdm)

Challenges in deployment of mhealth initiatives in India:

India is a vast country and of a varied terrain. Digital infrastructure is still at a developing stage. Digital literacy and familiarity with smart phone apps and English as a language pose a challenge towards deployment of mhealth initiatives. Internet connectivity in rural areas is still under a development stage. One more aspect was, the lack of trained workforce for handling health information and health information systems, digital platforms working in silos due to limited interoperability, noncompliance to standards, and lack of data governance frameworks. Training regarding the regulatory aspect of data handling was found to be deficient. (Nachiket Gudi, 2021)

Hence, geography, demography, nascent regulatory framework, and lack of trained resources in data handling, were posing a challenge to the implementation of mhealth initiatives in India.

Literature Review Summary:

In summary, the literature survey served well to provide an understanding of the criticality of chronic disease management. The survey documents the prevalence of medication non-adherence at the global as well as national level and its consequences. In order to mitigate factors adversely impacting treatment outcomes, mHealth and other digital initiatives in the health care domain are gaining prominence and scholarly evidences have been cited. It is now known that there is increasing evidence of mHealth influencing patient engagement. There is research done in the context of establishing an impact of these initiatives as well, though in most cases, these studies have been in the form of randomized control trial, in a government/NGO sponsored setting. The survey also points out aspects pertaining to the Indian pharmaceutical industry, the mHealth initiatives taken up by pharma companies operating in India, as well as Indian government's initiatives towards creating a digital platform for providing health care to masses. The survey also touches upon challenges which impact the deployment of mHealth initiatives in India.

The Research Gap and Future Areas of Research:

While conducting the literature survey, the researcher did not come across a critical mass of research done to quantify the effect of m-health interventions initiated by pharma companies in real world settings. Most of the research towards establishing impact of m-health intervention on medication adherence were around controlled trials. These initiatives were undertaken by health-care providers or NGOs who administered medication as a part of health-care programs for chronic diseases. This gap of not establishing an impact has been also mentioned by other researchers who mentioned that "there is a lack of robust research on the risks of implementing these technologies and their cost-effectiveness has yet to be demonstrated, despite being frequently promoted by policymakers and "techno-enthusiasts" as if this was a given" (Ashly D. Black, 2011). There is little scholarly work done in the Indian context in terms of studying the impact of m-health initiatives driven by pharma companies to mitigate non-adherence and increase awareness.

Table 2 has a matrix which captures the names of authors who have contributed to the research in the relevant context. This matrix depicts the gaps as well. The objective if the table is to depict the areas where there is little work done in terms of scholarly research. It may be noted that these areas are well covered in other forms of media. The list is not exhaustive and is representative. The number in certain boxes mentions the number of articles that are included in this table.

Table 2: Literature Review Summary:

	Patient Engagement	Digital Health/Health IT	Non-adherence to medication – chronic	m-Health initiatives by healthcare providers	m-Health initiatives by Pharma Companies
Concept	(1)Tracy Higgins, Elaine Larson, Rebecca Schnall.	Rafel Mrosek, Tovias Dehling, Ali Sunyaev,	(2)Smith DL, Elaine Lehane, Geraldine McCarthy	Joshua D. Cameron, Arkalgud Ramaprasad, Thant Syn.	
Dynamics/Trends	(3)Juan Pablo Domecq,Gabriela Prutsky, Tarig Elraiyah, McKinsey,Peter F. McLaughlin, Serena Barello, Geundalina Graffigna, Accenture, Angela Coulter	(4)Deborah Lupton, Michael Fitzgerald, Nina Kruschwiz, Didier Bonet, Deloitte, Nick Hird, Samik Ghosh, Ritu Agarwal, Guodong Gao, Ashish K. jha.	(2)Meera Viswanathan, Carol E Golin, Christine Jones, Lyndsay Nelson, Shelagh Mulvaney, Tabeb Gebretsadik.	(3)Quinn Grundy, Fabian Held,Research 2 guidance, Waleed M Sweileh, Samah W. Al-Jabi, Adham S.,	Economic Times, Negligible Scholarly Articles
Impact on medication adherence or outcomes	(4)Holger Woehrle, Michael Arzt, Andrea Grami, Lina Bofill, Maria Lopez, Analia Dorigo,Mohamad Al-Tannir, Fahad AlGahtani,Gadhi Bartur Katherin Joubran.	(3)Basit Chaudhry, Jerome Wang, Shinyi Wu, Margaret Maglione, Ashly D. Black, Josip Car, Claudia Pagliari, Caroline Lubick Goldzweig, Ali Towfigh.	NO OVERLAP	(6)Fred Stephen Sarfo, Frank Treiber, Sachin Patel, Irene Vidyanti, Brian Wu, Mario Lozano, Lydia Martin, Iluminada coripio, Eva Grasa, F Yasmin, B. Banu, S.M. Zakir, Saee Hamine, Emily Gerth.	Holger Woehrle, Michael Arzt, Andrea Grami. Lesser Scholarly Content
Indian Context	Negligible scholarly content	Arenur Venkataswamy Reddy, Bandlamudi Rao, Dr Hempel Network (website)	(5)K.C. Nishchal, Uday Khopkar, Rajiv Ahlawat, Pramil Tiwari, Sohini Banerjee, Ravi Verma, Kavita Venkataramanan, A.T. Kannan, Ravi Kumar Medi, Uday Venkat Mateti	Negligible scholarly content	Negligible Scholarly Content
Impact on Pharma Companies/Pharma Context	Negligible Scholarly Content	Ulrica Sehlstedt, Nils Bohlin, Fredrik de Mare, Nick Hird, Samik Ghosh	Thomas Forrisier, Katrina Firlick.	Negligible Scholarly Content	Negligible Scholarly Content

Proposed Area of Research –

Future Areas of Research:

During the course of conducting the literature survey, it was discovered that three major areas in the digital health domain, were good candidates for future research. HIT design, implementation, and meaningful use, secondly, the measurement and quantification of HIT payoff and impact and also an aspect dealing with extending the traditional realm of HIT.(Agarwal, 2010)

With emergence of medical devices, there is now a need for regulation and little research has been undertaken to highlight the importance of having a regulator for medical devices.

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