

Fostering Medication Adherence: An Application of Mental Models

By

Nada Boualam

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Faculty Advisor:

Jerry (Yoram) Wind

Lauder Professor, Marketing Department

THE WHARTON SCHOOL, UNIVERSITY OF PENNSYLVANIA

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## **Abstract**

Medication non-adherence is a public health issue that stems across therapeutic areas and worsens over time. Research suggests that patients and providers have various mental models or understandings of non-adherence, and that each understanding calls for different interventions. This qualitative analysis identifies ten mental models of medication non-adherence through a critical literature review; and uses semi-structured stakeholder interviews to recommend appropriate mitigation strategies for each mental model. Strategies that tackle more than one mental model are expected to be most effective in reducing non-adherence amongst patients, as they cast a wider net. In the long-term, a screening tool aimed at identifying patients' mental models could lead to more personalized, targeted, and effective interventions to increase adherence.

**Key words:** medication adherence, medication compliance, mental model, chronic treatment, behavior change

## **Introduction and Significance**

*“Drugs don’t work in people who don’t take them” – C. Everett Koop<sup>1</sup>*

20 As echoed by the thirteenth surgeon general of the United States, medication non-adherence often leads to worse health outcomes for patients. This public health issue corresponds to patients' propensity to fill, refill and take their medication as prescribed at least 80% of the time, and extends across therapeutic areas. It is especially prevalent amongst patients with chronic therapies, as it concerns 50% of chronically ill people<sup>2</sup> and 75% of all patients<sup>3</sup>. In particular, the World Health Organization determined that non-adherence to medication was the leading cause of failure to achieve blood pressure control among hypertensive patients<sup>4</sup>. Similarly, 25 to 50% of patients prescribed statins discontinue their treatment against their physician's recommendation within one year, and up to 75% of them discontinue their treatment within two years<sup>5</sup>. In the US alone, one to two thirds of all hospital readmissions are the direct result of poor medication adherence<sup>6</sup> and, along with other indirect costs of non-adherence, amount to between 100 and 300 billion dollars per year<sup>7,8</sup>. Moreover, increasing medication adherence amongst patients would improve their health outcomes more than any specific therapy<sup>9</sup>, and would result in positive social consequences such as higher workplace productivity<sup>10</sup>.

The purpose of this study is to identify patients' mental models (i.e. understandings) of medication adherence and the most prominent and effective mitigation strategies relevant to each

model. In particular, we have focused on mitigation strategies that seek to use and address, but not necessarily change, patients' respective mental models, in order to improve adherence.

## **Methods**

40 In order to identify the most prominent mental models of non-adherence and their associated mitigation strategies, we first conducted a literature review. Then, to assess the effectiveness of each mitigation strategy and the potential ways to combine them, we selected the most prominent organizations that conducted these interventions and reached out to stakeholders from each organization. It is important to note that the list of mitigation strategies mentioned below is not exhaustive, but instead represents a convenience sample of the most widespread and reachable stakeholders.

### ***Literature Review Methods***

Relevant literature was identified through the following PubMed search: (“medication adherence” OR “medication compliance”) AND “barriers” AND “chronic” AND “patient” AND (“understanding” OR “mental model” OR “perspective”) NOT “mental health” and limited to the past 10 years. Medication adherence and medication compliance were included in the PubMed search because they both relate to similar concepts, and mainly reflect a change in the healthcare field around perception of patients. In particular, “adherence” refers to patients' choice to take their medication whereas “compliance” points to patients' ability and propensity to follow healthcare providers' directions. The change in terminology thus reflects the evolution of the perception of patient autonomy; and both terms correspond to similar behaviors.

60 Moreover, “barriers” was included in the search, as mental models of non-adherence often manifest as explanations of barriers that prevent patients from taking their medication as prescribed; and “patient” was included to limit the search to patient related barriers to adherence. (“Understanding” or “mental model” or “perspective”) was included to limit the search to research articles that discuss not only the barriers to non-adherence but also the mental models or reasons behind them. Finally, “mental health” was excluded in order to avoid confusion with mental models; and the search was restricted to the past 10 years to obtain only the most relevant results. This search returned 35 results, and was manually complemented with recent pertinent publications from faculty members of the University of Pennsylvania.

### ***Interview Methods***

Semi-structured interviews of key experts in the field were then conducted to assess the initiatives mitigating medication non-adherence amongst patients and their corresponding mental models. In particular, the interview guide used (Appendix 1) consisted of open-ended questions about the key efforts mitigating medication non-adherence. We specifically surveyed a convenience sample of 14 interviewees (Appendix 2) from various organizations that tackle non-

adherence, and sought to identify the mental models each effort was targeted towards. We further offered interviewees the opportunity to elaborate on each of the mental models they mentioned as well as on their organization's corresponding efforts. The list of mental models identified through the literature review was given to 2 interviewees to prompt them to identify which model best corresponded to the mitigation efforts undertaken by their company. The other interviewees identified mental models of non-adherence and associated mitigation efforts without being prompted.

### ***Analysis Methods***

80 We used the mental models identified through the literature review to manually code the interviews and classify the mitigation strategies. Each strategy was associated with one or more mental model (Figure 2), and the different ways in which these models are tackled by each strategy are further discussed in the results section below.

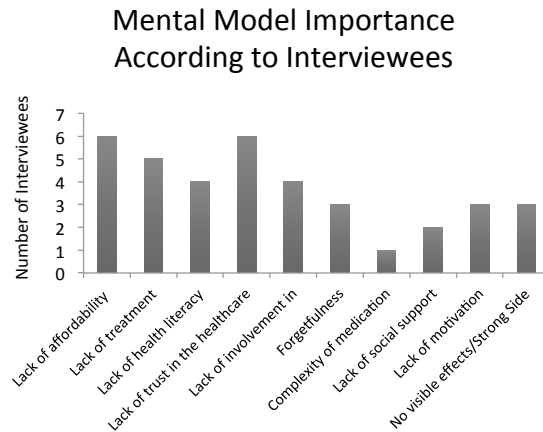
### **Results**

Firstly, the various mental models of non-adherence identified through the literature review and the stakeholder interviews are lack of affordability, lack of treatment coordination and continuity, lack of health literacy, lack of trust in healthcare providers, lack of involvement in medical decision making, forgetfulness, complexity of medication regimen, lack of social support, lack of visible effects of medication, and lack of motivation (Figure 1). The stakeholder interviewees (Appendix 2) also identified specific initiatives that tackle each of these mental models. In the discussion section below, we will first define each mental model of medication non-adherence, before diving into their associated efforts and inferring potential ways to combine them.

100 Secondly, 13 out of 14 interviewees identified patient non-adherence as a public health issue that should be addressed, which further endorses our literature findings. The one interviewee who did not have any knowledge of this issue was a concierge physician, who spoke out of experience with his patients. This could be attributed to specific socio-economic conditions of his patient population. Moreover, as shown in Figure 1, lack of affordability and lack of trust in the healthcare team were deemed important by the highest number of stakeholders (6 out of 14), while complexity of medication regimen was only identified as a mental model of non-adherence by one interviewee. Lack of treatment coordination and continuity was also reported by 5 interviewees, who discussed various ways of addressing this mental model such as the addition of health assistants to the healthcare team, the use of concierge medicine, the use of telehealth and the emphasis on pharmacists' role within the healthcare team.

Similarly, lack of health literacy and lack of involvement in medical decision-making were each reported by 4 interviewees, while forgetfulness, lack of motivation and lack of visible

effects of medication were identified by 3 interviewees. Finally, only 2 of the interviewees thought that lack of social support was a valid mental model of non-adherence for patients (Figure 1).



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*Figure 1: Number of interviewees Identifying Importance of Mental Model per Mental Model*

To further analyze this data, we have built a model relating the various mitigation strategies with their corresponding mental model(s) (Figure 2). The ways in which each mitigation strategy tackles its associated mental model(s) will be described in more detail in the discussion section below.

Mental Model	Mitigation Methods & Examples - Do these tackle the Mental Model?													
	Insurance Design (Copay/Coinsurance)	Telehealth	Holistic Approach to care	Healthcare Concierge	Educating Services	Scribe Technology	Decision Aids	Reminder Devices	Daily pillboxes	Virtual connections	Financial/Social Incentives	Concierge Medicine	Coupons	Gamification
	Wellcare	Geisinger Telehealth	Geisinger/Kaiser	Accolade	Noora Health	Augmedix	Merck	TimerCap/Take-N-Slide	PillPack	PatientsLike Me	Geisinger	Spitz, MD	Allergan	Allergan
Lack of affordability	Yes	No	Yes	No	No	No	No	No	No	No	No	No	Yes	No
Lack of treatment coordination and continuity	No	No	Yes	Yes	No	No	No	No	No	No	No	Yes	No	No
Lack of education and health literacy	No	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes
Lack of trust in the healthcare team	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No
Lack of involvement in medical decision making	No	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
Forgetfulness	No	No	No	Yes	No	No	No	No*	Yes	No	No	No	No	No
Complexity of medication regimen	No	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No
Lack of social support	No	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No
Lack of motivation	Yes	No	No	No	No	No	Yes	No	No	No	Yes	No*	Yes	Yes
No visible effects/Strong Side effects	No	No	Yes	No	Yes	No	Yes	No	No	Yes	No	No	No	No

\*Anecdotal evidence goes against research findings

Figure 2: Mental Models and Associated Mitigation Strategies

## Discussion

### *Lack of Affordability and Access*

The lack of affordability and access mental model suggests that patients forgo taking their medications because they lack the financial or geographical means to purchase or access them. In particular, medication adherence can be negatively affected by drug prices, especially in countries where patient out of pocket costs (e.g. copays, coinsurances or full costs) are prohibitive for certain populations. Similarly, people who live in remote areas sometimes struggle to access pharmacies<sup>11</sup>. While this mental model of non-adherence relates to a structural issue, as opposed to patient-behavior concerns, it is very prevalent and has been targeted by a myriad of mitigation strategies such as insurance design initiatives (i.e. changes in copay and coinsurance levels), savings programs from pharmaceutical companies, and mail delivery pharmacies. It should also be noted that a holistic approach to care, including patients' financial and geographical status, also indirectly tackles this model.

180 Firstly, insurers structure their plans to increase preventative care use while also limiting healthcare services overuse. This is done by providing patients with low out of pocket costs for preventative services and higher copays or coinsurance for other services. While these efforts are costly in the short-term, as they increase preventative care use, they are expected to lead to important increases in adherence as well as to significant decreases in healthcare costs in the long run, mainly by decreasing the amount of therapeutic care use, especially hospital care.

Secondly, various pharmaceutical companies, including Merck and Allergan, have started covering patients' copays and coinsurances through savings programs and coupon giveaways. Craig Dashofsky<sup>12</sup>, in charge of the adherence group at Allergan, has noted that their savings program, which provides coupons to cover patients' out-of-pocket costs, has had a significant positive impact on adherence. In fact, these efforts benefit both the patients, as they are given access to treatments virtually free of charge, and the pharmaceutical company as it increases its revenue. However, it is important to note that these coupons actually end up costing insurance companies: patients choose brand name drugs over generics, leaving insurance companies with hefty bills to pay<sup>13</sup>. Thus, this initiative creates competing forces: patients' adherence to medication decreases associated healthcare costs while induced brand name preference increases those same costs.

This mental model was further echoed by Mike Evans<sup>14</sup>, the vice president of clinical innovation and a clinical pharmacist at Geisinger. Evans argued that Geisinger patients faced four main barriers to medication adherence: affordability, strong side effects, lack of visible desirable effects and religious beliefs. Geisinger's position as an integrated delivery network allows them to use a holistic approach to care and focus on each patient's specific needs and barriers, including financial and geographical ones. For example, instead of following best practices guidelines for all patients, Geisinger seeks to first uncover patient characteristics, such as potential financial or geographical hurdles, and adapt their practices and prescriptions

200 accordingly. This patient-centric approach extends to Geisinger pharmacies, where pharmacists' roles are emphasized: because of their frequent interactions with them, pharmacists are ideally positioned to deal with financial, geographical or other hurdles that patients might face. Pharmacists are able to build relationships with patients, have one-on-one interactions with them, and eventually address, report, and solve issues vis-à-vis adherence to medication.

Finally, geographical hurdles are also addressed by integrated delivery systems. For instance, Geisinger provides patients with 90-day instead of 30-day refills to reduce the number of trips they take to the pharmacy. Similarly, mail delivery systems, which will be further discussed under the complexity of medication regimen model, overcome geographical hurdles by mailing medications to patients in daily packs. Both of these initiatives are expected to improve adherence for the concerned populations, as they effectively address patients' lack of geographical access, but their effectiveness has yet to be formally established.

220 While this model is definitely valid, it should be noted that it has been shown to be incomplete. A study from the *New England Journal of Medicine* (Choudhry et. al, 2011)<sup>15</sup> showed that even when medicines were free of charge and accessible at a local hospital, medication adherence rates only increased marginally. In particular, while there was a reported increase in medication adherence for the group of patients with free and accessible medication when compared with the control group, this increase was not enough to account for all of the non-adherence observed in patients. In other words, the patients with free access to medication had slightly higher levels of adherence (4 to 6 percentage points), but a significant number of them were still non-compliant.

### ***Lack of treatment coordination and continuity***

Healthcare is undeniably fragmented. Between 2000 and 2002, the average Medicare beneficiary saw a median of two primary care physicians and five specialists in addition to pharmacists and other healthcare workers<sup>16</sup>, thus demonstrating a lack of care continuity. This clear inefficiency leads to limited coordination between different clinicians, potentially contradicting advice as well as excessive choice, which reduce overall medication adherence. In order to address this mental model, efforts should be undertaken to coordinate and streamline care between all of the clinicians involved with each patient.

These efforts are actually undertaken by various stakeholders: *integrated* healthcare systems are, by definition, able to standardize patient interactions with the system as a whole. In other words, when insurers, primary care physicians, pharmacists, nurses, specialist physicians and so on, all belong to the same organization, it is much easier for patients to directly access the care they need and get all of their questions answered at once<sup>1\*</sup>.

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<sup>1\*</sup>It is also important to note here that the fact that insurers are part of integrated health systems aligns their financial incentives with patients' health outcomes, thus emphasizing the importance of medication adherence for these organizations.



Similarly, concierge physicians build personal relationships with their patients and become their point of entry to the healthcare system, which allows for continuous and coordinated care. Concierge physicians – who are different from healthcare concierges in that they are physicians who provide care at the patients’ request and not assistants there to help patients navigate the healthcare system – are thus able to tackle issues of continuity and coordination of care by being the patient’s healthcare point-person.

240 Finally, the creation of health navigators or healthcare concierges has been particularly interesting and fruitful in coordinating care for patients. This initiative’s most prominent example is Accolade, a healthcare concierge company that connects patients with health assistants and leverages technology to drive meaningful, personalized engagement. Over the course of their interactions, Accolade Health Assistants® are often able to learn about patients’ backgrounds, socio-economic and health statuses, and identify specific barriers to adherence and potential mental models of non-adherence. Emily Balmert<sup>17</sup>, a senior manager at Accolade, argued that Accolade’s role as a healthcare concierge not only helps patients navigate the intricacies of the healthcare system, but also navigate the contextual factors that impact patients seeking care, for example, finding a provider located along a local bus route to enable patients without cars to visit an in-network physician.

Tom Spann’s assumptions when founding Accolade were that patients were disengaged because of a fragmented healthcare system, with too many options, poor service, and lack of personalization<sup>18</sup>. Thus, his company allows patients to bypass the complexities of the healthcare system and keep their respective data in easy to access and understand formats. Accolade data shows a 9% increase in prescription refills for their patients<sup>19</sup>, which suggests higher medication adherence for longer periods of time and validates the lack of treatment coordination and continuity mental model of medication non-adherence. However, this slight increase only accounts for some of the medication non-persistence in the US and around the world, which suggests that other mental models are at play for these patients.

260 Moreover, it is important to note that Accolade’s initiatives are different from managed care networks’ efforts in that they connect each patient with a single health assistant, who then keeps track of their medical records and develops a personal relationship with them. On the other hand, managed care networks tend to have case managers, usually nurses\*<sup>2</sup>, available to answer patients’ questions and help them navigate the healthcare system, but without case assignments. Thus, whenever a patient calls the insurance customer service line, they are matched up with a different case manager, which leads to care discontinuity. While these case managers do help patients access and navigate care, they do not tackle the lack of treatment coordination and continuity mental model of non-adherence. On the other hand, assigned health assistants per Accolade’s model, do so by assigning each patient a single health assistant. Both of these initiatives are expected to lead to increased patient adherence; however, according to this mental

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\*<sup>2</sup> For example, UnitedHealth is in fact the largest employer of nurses in the United States.

model, assigned health assistants should lead to a more drastic positive change in adherence than case managers.

### ***Lack of health literacy***

280 The lack of health literacy mental model touches more than one third of U.S. adults<sup>20</sup> and corresponds to patients' limited capacity to obtain, process and understand basic health information<sup>21</sup>. Health literacy is essential for patients to use preventative measures, learn about risk facts, make informed healthcare decisions, and follow relevant health recommendations (e.g. medication label directions)<sup>22,23</sup>. In particular, health literate patients tend to access and use healthcare services appropriately<sup>24</sup> and adopt health-promoting behaviors such as medication adherence. On the other hand, low health literacy is correlated with infrequent health screenings, increased hospitalizations and mortality rates and poor adherence to medication<sup>25</sup>. Moreover, while education is sometimes used as a proxy for health literacy, the two are not directly correlated; and it is in fact health literacy that mediates improved outcomes for patients<sup>26</sup>.

Patients of all ages, ethnicities, incomes and educational levels suffer from low literacy. It should be noted however that some population groups, including the elderly, people with less than a high school education, people living in poverty, racial and ethnic minorities and people with limited English proficiency, are more likely to be vulnerable to low health literacy than others. Currently, different initiatives were undertaken to address this mental model: Noora Health aims at educating patients indirectly through their families, Merck is using marketing campaigns to target and educate patient groups with low health literacy, and PatientsLikeMe uses online peer-to-peer interactions to empower patients to educate each other.

300 Firstly, Noora Health educates patients and their family members during hospital downtime. In particular, nurses use hospital hallways and waiting rooms to provide personalized care-taking lessons to patients' family members, adapted to their level of health literacy and education. These trainings aim to educate patients' families on the importance of adherence, and teach them practical skills and health facts around medications' mechanisms of action. Noora Health's services improve health literacy and focus on the importance of patients' drugs and on regular medication-taking behavior. They use a "train-the-trainer" approach, i.e. they train nurses, who train family members, who train the patients, and so on. This preparation allows family members to become an in-house resource for patients, offering advice and information about their disease or treatment and highlighting the importance of medication, thus leading to improvements in adherence.

Moreover, most people inevitably interact with the healthcare system eventually, so Noora Health's initiative in fact educates future patients such that they are health literate by the time they seek care for themselves. While this program results in drastic improvements in the form of reductions in post-surgical complications and 30-day readmissions<sup>27</sup>, its impact on medication adherence has not yet been measured. However, in light of the research done on the

positive effects of health literacy on medication adherence<sup>28,29</sup>, we believe that Noora Health's approach is likely to increase adherence amongst current and future patients.

Another initiative tackling this mental model is Merck's marketing campaign, aimed at out of reach, low-literacy patients. This campaign consists of easy to read materials (flyers, pamphlets and such) that apply health literacy principles like bigger font size, spacing and simpler language, and recruits patients in out of reach areas such as senior centers. Merck's health literacy team, led by Laurie Myers<sup>30</sup>, has developed best practices guidelines around direct-to-consumer material design to better communicate with low literacy patients and facilitate their engagement. These practices include labeling, packaging, and outreach efforts and have empowered patients and improved their adherence to and understanding of medication. While their effectiveness has not yet been determined, these practices are expected to lead to improved adherence and health outcomes<sup>31</sup>, as they would increase health literacy amongst the some of the most vulnerable populations.

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Moreover, Merck has also implemented physician-centric initiatives to tackle this mental model: the Teach-Back<sup>32</sup> method for example consists of teaching physicians to ask patients to repeat their instructions before leaving the exam room. This is in contrast to asking whether the patient has any questions, as is conventionally done<sup>33</sup>. This method puts the burden of communication on the physicians, and thus increases the likelihood of uncovering misunderstandings and obtaining necessary clarifications. In fact, because of their lack of health literacy, many patients often do not recall their physician's instructions; and amongst those who do recall, nearly half don't remember the information correctly<sup>35</sup>. Merck's Teach-Back technique serves to facilitate communication between healthcare providers and patients without burdening the patients. This is expected to lead to higher health literacy, and in turn, to higher adherence amongst patients.

Finally, PatientsLikeMe is another innovative initiative that tackles this mental model of non-adherence, amongst others. It connects patients to one another and offers them a safe space to discuss their respective symptoms and experiences and build a community. PatientsLikeMe's efforts will further be discussed under the lack of social support mental model, as that is the main mental model they touch on. However, it is important to note that PatientsLikeMe also significantly contributes to educating patients; creating trust and relationships between them and fostering shared decision-making. This online community provides patients with a resource to help answer the question: "Given my status or condition, what is the best outcome I can hope to achieve, and how do I get there?" Reported benefits of the community created on PatientsLikeMe include patients feeling that they knew more about their health and about the care they were administered, and asking their physician questions they would not have asked otherwise<sup>33</sup>. In fact, online communities like PatientsLikeMe not only provide information and opportunities to increase patients' health literacy, but they also empower patients to feel more confident about their knowledge. These three initiatives are expected to increase patients' health

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literacy and adherence. However, it should be noted that there has yet to be a study comparing their relative effectiveness.

### ***Lack of trust in healthcare providers***

Trust in physicians is positively correlated with medication adherence rates amongst patients<sup>34</sup> as well as with time spent with and number of questions asked by the physician during a consult<sup>35</sup>. These correlations are most likely due to physicians' ability to engage patients in discussions around the importance of medication adherence and to recommend strategies to achieve positive health outcomes. However, clinicians spend an increasingly shorter time with their patients, thus making relationship building more challenging. This is especially the case in developed countries and urban areas where patients see more than 18 physicians on average over the course of their lifetime<sup>36</sup>; and where physicians are only able to allocate an average of 15 minutes per patient visit<sup>37</sup>. In fact, in rural areas, where primary care providers are integral members of the community they treat, trust is not an issue.

360 Various initiatives have been undertaken to foster trust between patients and providers: technology-based enterprises like Augmedix, improve physician-patient interactions, while integrated delivery networks such as Geisinger emphasize pharmacists' roles as providers to increase contact with patients, and virtual forums, e.g. PatientsLikeMe, empower patients to reach out to their providers.

Firstly, Augmedix re-purposes Google Glass technology to improve patient-physician quality of time by delegating record keeping. In particular, patient-physician relationships are recorded and sent to remote scribes in real time, which frees up to 15 hours of physicians' schedules weekly<sup>38</sup>, allowing them to spend more time with each patient. This is expected to improve relationships and increase patient trust, in turn leading to higher rates of medication adherence. On the other hand, this increase in patient-physician time might also result in higher health literacy levels for patients, as they would have access to more time with their physician, which could reinforce trust and adherence. However, it should be noted that while Augmedix' impact on patient satisfaction and adherence is expected to be significant, as the literature shows a direct link between quality of patient-physician time and positive outcomes<sup>39</sup>, it has yet to be measured.

380 Secondly, integrated delivery networks such as Geisinger have pioneered a pharmacist-centered initiative by training their pharmacists to identify "patient failures" and "medication failures" in adherence. "Patient failures" relate to barriers such as beliefs, costs and so on that are not related to the medication itself but rather to the patient, while "medication failures" correspond to the presence of strong side effects or lack of visible desirable effects of the medication. By making pharmacists central to care, these delivery systems give patients a go-to person to answer all of their questions and educate them, which, in turn is expected to foster trust

and eventually adherence. Multiple pharmacists have reported positive trends in trust and adherence, and the extent of these interventions' effects is currently studied through randomized clinical trials<sup>40</sup>.

Finally, online resources such as PatientsLikeMe indirectly foster patients' trust in their providers. By having access to an online community to discuss their symptoms, treatments and provider recommendations, patients gain enough confidence and knowledge to ask questions during their interactions with physicians, pharmacists and other healthcare providers. This type of online resource affects other mental models (such as lack of health literacy, lack of social support, lack of visible effects of medication) that, in turn, have indirect repercussions on patients' trust in their healthcare team, on adherence and on health outcomes in general. It should also be noted that while the literature suggests that these three initiatives could be effective in tackling this mental model and improving adherence, there is not enough information to compare their impact.

### ***Lack of involvement in medical decision-making***

400 Another mental model of medication non-adherence is patients' lack of involvement in their medical decision-making. In particular, patients are sometimes excluded from the decision-making process because of their lack of confidence, education, understanding, and health literacy or because of their physician's perception and bias. Instead of deciding on a course of action with the help of their physicians, they sometimes end up having the decision prescribed to them. In fact, medical paternalism, i.e. the extent to which physicians assume a paternalistic attitude and disregard patient autonomy by not involving them in the decision-making process, is at odds with patient-centered care and often leads to lower rates of medication adherence<sup>41</sup>.

This mental model is especially prevalent in low-health-literacy areas, which are usually developing countries and rural regions, and leads patients to perceive their physicians as omniscient. This might in turn make them more likely to accept physicians' recommendations as unequivocal truths, but not necessarily more likely to follow them. Conversely, patients from areas with higher rates of health literacy and education are more likely to research their symptoms online or use decision-making aids before attending a consultation with a physician<sup>42</sup>. This, in turn, leads patients to ask more questions during their time with physicians, and have a better understanding of the course of treatment they will eventually follow, thus increasing their likelihood of adherence. In fact, patients' lack of involvement is most often due to a combination of lack of background information, formality of their relationship with their physician<sup>43</sup>, and belief that they are not qualified to be part of the process. The more empowered patients feels, the more likely they are to participate in the decision making process and adhere to their medication.

420 This mental model drove pharmaceutical companies, insurance companies and health professionals to create decision aids or quick-to-read informational documents to tackle medication non-adherence. Decision-making aids range from flyers and pamphlets to educational

videos and organized events, and aim to educate patients prior to their consultations with physicians, prompt them to ask more questions, and engage them in the decision-making process. However, while these tools were found to increase patient engagement and shared decision-making between clinicians and patients, they were not always accessible. In fact, while many health decision aids around serious illnesses are available for clinicians, the reliable resources available to patients are scarce. Increasing their quantity and accessibility, and targeting them to the patients that need it most would lead to increased engagement and eventually to improved adherence.

Moreover, it is important to note that some of the initiatives mentioned previously, such as Geisinger's holistic approach to care, Accolade's healthcare assistants, Noora Health's educating services and PatientsLikeMe's peer-to-peer education all indirectly impact patients' involvement in medical decision making by empowering them through direct effects on other mental models (Figure 2). For example, Noora Health's initiatives primarily tackle the lack of education and health literacy mental model; and when patients are educated, they feel more confident and qualified to participate in their medical decision-making. Similarly, Accolade's healthcare assistants help patients navigate the healthcare system and provide them with tips and tools to learn more about their conditions, thus empowering them to participate in their medical decision-making process. Thus, because these initiatives are expected to increase adherence by directly or indirectly impacting various mental models, their relative effectiveness would be hard to establish.

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### ***Forgetfulness***

Up to 60% of patients claim forgetfulness as their primary mental model of medication non-adherence<sup>44</sup>, thus making it one of the most commonly reported models. However, patients often identify this mental model as primordial in their non-adherence when they are in fact unaware of the real drivers of their lack of adherence. These drivers can be uncovered by studying medication-taking patterns amongst patients: forgetfulness implies patients not taking their medication in a random fashion; however, most patients (98%) actually show consistent patterns<sup>45</sup>, thus suggesting other underlying models.

Various initiatives and resources such as reminder devices and personalized calls exist to tackle this mental model. Reminder devices range from standard daily pill boxes to pill bottle caps with timers displaying the time elapsed since the last medication was taken (TimerCap) and pill bottles with affixed strips with toggles that can be slid after each dose has been taken (Take-n-Slide). While both TimerCap and Take-n-Slide claim to be proven ways of increasing medication adherence amongst patients, a research study<sup>46</sup> has in fact shown the opposite: the odds of adherence are not substantially different between the patients using these devices, those using standard pill bottles, and those in the control group. Moreover, patients from different demographics responded differently to these tools. For example, men responded to Take-n-Slide better than women did, while patients who had higher rates of adherence before testing these

460 devices were more responsive to TimerCap but not to Take-n-Slide. This suggests that these reminder devices could be targeted to appropriate patient populations if an effective screening process is developed.

On the other hand, there are various pieces of anecdotal evidence – both in the literature and mentioned by interviewees<sup>47</sup> – claiming that reminder calls from health assistants or pharmacists are in fact effective. For example, Geisinger’s pharmacies, as well as other retail and integrated health system pharmacies, track patients’ refill patterns and issue reminder calls when refills are overdue. This has allowed providers to inquire on the reasons behind patients’ non-adherence and work out potential medication issues with patients. Similarly, healthcare assistant services, such as Accolade mentioned earlier, play an important part in addressing this mental model of medication non-adherence. While reminder calls are not issued per se, health assistants will keep track of patients’ self-reported adherence by asking them about it regardless of the reason of their call. The impact of these initiatives cannot directly be compared to that of reminder devices, as the nature of their evidence is different (randomized control trial and anecdotal evidence, respectively). However, given that reminder devices do not seem to be effective, we believe that reminder calls and health assistants are better suited to tackle this mental model of non-adherence.

### ***Complexity of medication regimen***

480 According to the complexity of medication regimen mental model, the more complex a patient’s medication regimen, the less likely they are to adhere to it. Even though only one interviewee identified this mental model as a barrier to adherence, the literature shows that this is a particularly prevalent model. In the US alone, 59% of the population is taking at least one prescription drug, and 15% of the population is taking five or more<sup>48</sup>. Complex medication regimens can be difficult to manage, understand and keep track of because there are many variables at play: with more than one drug, patients need to remember each medication’s schedule, as well as the mechanism of action and interactions between the different drugs. Moreover, patients sometimes have to refill each of their medications separately, which represents another barrier to adherence. Various initiatives are undertaken to alleviate this burden: pharmacies attempt to coordinate prescription refills for patients, mail delivery services provide patients with alternatives to conventional pharmacies, and educating services indirectly help patients make sense of each of their treatments.

Firstly, Pillpack tackles this mental model of non-adherence by simplifying the day-to-day hardships of adhering to more than one treatment and delivering patients’ prescriptions to their door in daily packs. In particular, Pillpack groups different regimens by time of day, as opposed to by treatment, thus leaving patients with one pack for “before breakfast”, one for “after lunch” and so on. This helps them overcome the hurdle of remembering and sorting through the different schedules of their medications. In fact, there is strong anecdotal evidence<sup>49</sup> that the convenience of this service increases medication adherence by eliminating activities that

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patients do not enjoy doing (e.g. sorting medications and going to the pharmacy) and by breaking down medication adherence into daily goals, thus offering patients small wins every day. This positively reinforces adherence and encourages patients to continue following their complex regimens.

Furthermore, educating services such as decision aids and trainings (as is offered by Noora Health and Merck's literacy initiative, both mentioned above) also play a significant role in management of and adherence to complex medication regimens. By addressing the health literacy mental model, these initiatives indirectly impact patients' understanding of their medication regimen as well as their ability and propensity to adhere to medication.

Finally, insurers and pharmacies are attempting to streamline patients' medication refills, i.e. allowing for 90-days refills instead of 30-day refills at a time and coordinating all refills. This would decrease the necessary patient trips to pharmacies, and would facilitate patient access to all of their required therapies, which, in turn, is expected to improve adherence. While all three of the initiatives mentioned here should be fruitful and lead to improved adherence, there is not enough data in the literature to compare their effectiveness.

### ***Lack of social support***

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There is a strong positive correlation between social support and patient adherence to medication<sup>50</sup>. The literature reports that patients with weak structural or functional support systems, including low family cohesiveness and low emotional and practical support, are less likely to adhere to their medication regimens, especially in regions where familial life is emphasized<sup>51</sup>. Similarly, comfort and social support have been shown to increase medication adherence<sup>52</sup>. Moreover, it should be noted that while social support is usually accompanied by access to help in managing medication regimens, the emotional support itself is also instrumental in increasing patients' medication adherence<sup>53</sup>.

Two main initiatives tackle this mental model of non-adherence: online forums where patients suffering from similar conditions or symptoms are provided with a space to share information (such as PatientsLikeMe), and healthcare assistants (Accolade), both mentioned earlier. It should be noted that these two initiatives provide patients with significant support systems but also touch on more than this one mental model, and could thus have ripple effects.

First, PatientsLikeMe offers virtual emotional and social support for patients by connecting them to "just-in-time, someone-like-me" peers<sup>54</sup>, i.e. others who might be suffering from similar symptoms or conditions, that can be relied upon to compare options and aid in decision making. These new connections alleviate patients' fears and allow them to teach one another about drug's mechanisms of action, potential ways to manage side effects or adherence techniques. This empowers patients to assume more responsibility for their care and thus decreases the burden on healthcare providers<sup>55</sup>. Participation in online communities has actually



been shown to heighten levels of emotional well being, perceived control over disease, and level of medical knowledge<sup>56,57</sup>. This, in turn, should lead to increased medication adherence.

Moreover, this online tool allows patients to share their own data on medication effectiveness, dosage and side effects, as well data on their adherence to specific treatments<sup>58</sup>. For example, a patient is able to see how adherent others were, what kind of side effects they suffered from, how efficacious the drug was for them, and what they switched to after stopping that treatment. The availability and accessibility of this data is expected to drive adherence through peer approval, as echoed by various interviewees. In other words, this data could serve as a positive social pressure to drive patients to adhere to their medication<sup>59</sup>. On the other hand, if most patients did not adhere to a specific treatment, PatientsLikeMe data could also serve as a warning sign for pharmaceutical companies, healthcare providers and other patients. This tool not only empowers patients to learn from each other and develop a virtual social support group, but it also provides them with data from patient groups that could help them be more engaged in their diagnosis and treatment choice, and thus increase medication adherence according to the shared decision making mental model.

Finally, healthcare assistants, such as those provided by Accolade, also tackle the social support mental model of medication non-adherence. While they do not form a community per se, they do provide patients with access to someone who knows about different aspects of their lives and is able to discuss not only medical issues, but also other social barriers or troubles that might be preventing patients from accessing care. Accolade has proven effective in improving medication adherence, but there is no data around whether this improvement is in fact due to a mitigation of the lack of social support mental model.

### ***No visible effects of medication***

Presence of visible effects of medication is another mental model of non-adherence: when side effects are very strong, and/or desirable effects are not noticeable, patients are more likely to discontinue their treatment regimen without consulting their healthcare providers<sup>60</sup>. When patients do not experience relief after taking their medication, or those with no symptoms to alleviate are less likely to take their medication diligently<sup>61</sup>. Similarly, the most common adherence-related patient complaints reported at Geisinger were lack of visible desirable effects of medication, and side effects of upset stomach and impotence.

In fact, as mentioned previously, Geisinger's Mike Evans<sup>17</sup> noted that medication failure, defined as lack of desirable effects or presence of strong side effects, often leads to medication non-adherence<sup>62</sup> and can be mitigated by emphasizing the role of the pharmacist as a medication point-person for patients. These pharmacist-patient interactions are necessary to provide patient-centric care and consider patient related factors (e.g. effects of specific treatments on each patient) instead of always following best practices, as is currently done. In addition, pharmacists are the first healthcare providers to know when a patient is not adhering to medication, as they have access to patients' last refill date and number of missed refills. This unique position empowers

pharmacists to start the conversation around adherence, find out whether the medication is a good pharmacological fit for the patient, and offer potential alternatives if necessary, which is expected to drive patient adherence.

Moreover, virtual patient forums such as PatientsLikeMe, also mentioned previously, offer patients more information vis-à-vis dealing with strong side effects, and point them towards potentially better alternatives to their current treatment. By educating them on their options, these online resources empower patients to know whether and how side effects could be mitigated, as well as to find out about potential alternatives, hence fostering conversations with providers and indirectly driving medication adherence. It should however be noted that this initiative touches on many facets of adherence, and its effectiveness in tackling this mental model would be difficult to determine.

### ***Lack of motivation***

Finally, medication non-adherence can be due to a lack of motivation. Patients do not seem to be motivated by the possibility of future disease and thus tend to forgo taking their medication, especially in the case of preventative therapies. In fact, physicians have noted that patients tend to be more adherent to therapeutic treatments with immediate gratification in the form of health regain than to preventative treatments with delayed gratification in the form of a lack of potential future severe health episode. In other words, patients' perceptions of treatments are dependent upon delay discounting effects, so preventative treatments appear less desirable because they only offer future rewards. For example, statins (cholesterol drugs), which prevent potential future heart-related episodes, are easily forgone, while therapeutic treatments such as antibiotics, which offer immediate relief, are more likely to be adhered to<sup>63</sup>. This is in fact confirmed by the neuroscience literature, which suggests that individuals tend to act in suboptimal manners when faced with longer time-delays<sup>64</sup>.

Therefore, this mental model of medication non-adherence implies that offering financial or social incentives to patients would lead to increased adherence, especially for long-term preventative treatments. This theory has in fact been verified by various clinical trials<sup>65</sup> where patients who are presented with social or financial (or both) incentives see consistent improvement in adherence versus control groups. In particular, these trials gave patients incentives for adherence that varied from lottery based monetary gains to peer mentorship or games played with the patients' social entourage<sup>66</sup>, and found that the most effective incentives were small and regular monetary gains<sup>67</sup>. Moreover, these incentives have been proven effective not only in nudging patients towards adhering to their medication or to regular exercise, but also in nudging them towards healthier behaviors such as smoking cessation.

Health systems such as Geisinger stand to gain the most from offering financial or social incentives. Because they are not only responsible for insuring patients but also for treating them, health systems stand to collect the long-term savings that these incentives lead to by preventing patient hospital readmissions and other health episodes, thus rendering them cost-effective<sup>67</sup>.

However, to our knowledge, these incentives have not yet been used alone, but have instead been part of broader efforts to increase adherence within health systems and insurance networks and their effectiveness is therefore difficult to estimate. For instance, in addition to financial incentives, Geisinger has implemented lower copays and coinsurances, surveys to gather information on patients' treatment preferences, and periodic check-ins with patients to monitor adherence. All of these efforts combined have led to increased medication adherence amongst Geisinger's patient population.

620 In summary, financial and social incentives couple short-term social and monetary rewards with long-term medication-taking behavior in order to nudge patients into taking their medications as prescribed. While preventative treatments are meant to avoid severe health episodes, their long-term nature is such that this reward is often discounted in patients' minds, hence the effectiveness of financial and social immediate incentives demonstrated in clinical trials. This should be effective for most patients, as future gain – including health gain – discounting is very common amongst individuals.

### **Limitations**

Our study has several limitations. Firstly, our interviewees are inherently biased: these stakeholders are involved with different initiatives, and are thus more likely to believe in their respective initiatives' effectiveness. We selected these stakeholders mainly based on convenience, by first identifying their organizations and reaching out to various key members within that organization. Moreover, we only interviewed a small number of stakeholders (14). While they confirmed all mental models identified in the literature search, the number of interviewees who reported each model was different and most likely depended on these stakeholders' respective positions and organizations. Some interviewees were able to identify multiple mental models and their associated mitigation strategies while others only identified one model, and sometimes did not have access to the appropriate information to confirm or deny certain models. Future research should focus on further investigating these trends and verifying the claims made by our interviewees.

640 Secondly, while we do expect combinations of approaches to be most effective in reducing non-adherence, the data currently available only allows us to identify the need for more rigorous effectiveness data around these initiatives. Indeed, each of the mitigation strategies mentioned was either tested against a placebo control, or implemented on its own or with other initiatives. Thus, while the evidence presented suggests that these strategies are working to improve adherence, there is not enough data to compare their effectiveness.

Thirdly, our data points to a significant need for the development of a diagnostic tool that would identify patients' mental models of adherence. Future research should focus on developing a screening tool to delimitate the audiences that would be most responsive to each

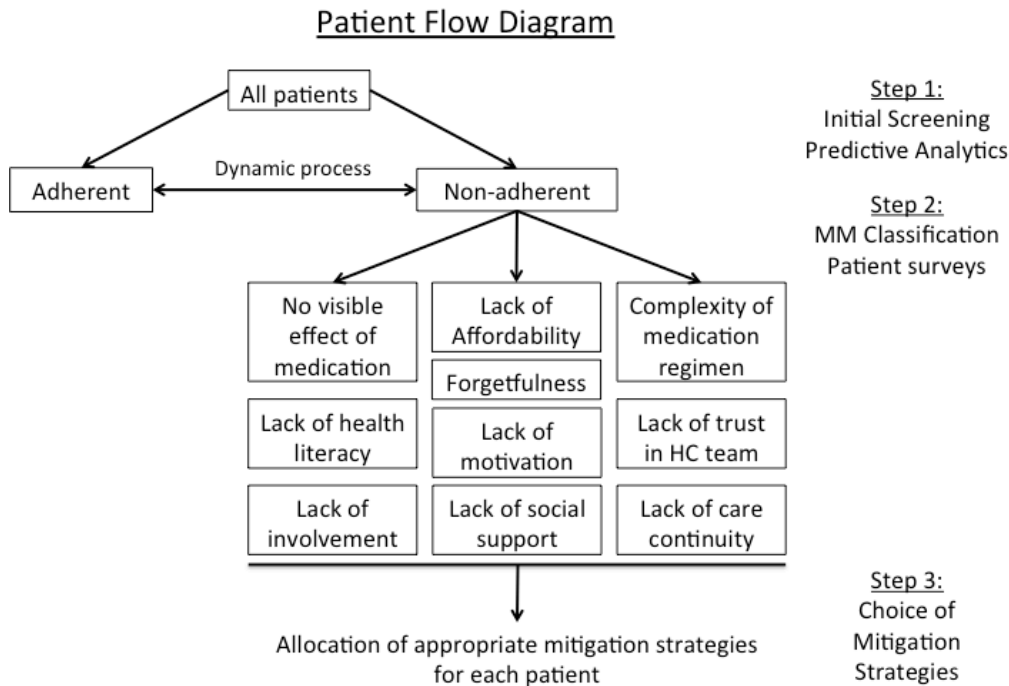
mitigation strategy, as that would allow for personalized and targeted approaches to improve adherence. This tool could be used as described in Figure 3 to identify each patient's mental model and match him or her with a personalized strategy to improve adherence.

### **Conclusions and Next Steps**

Medication non-adherence is a significant issue that stems from various mental models, often leading to unnecessary adverse events and additional costs for patients. The most prevalent mental models of medication adherence reported by patients and physicians are lack of affordability, lack of treatment coordination and continuity, lack of health literacy, lack of trust in healthcare providers, lack of involvement in medical decision making, forgetfulness, complexity of medication regimen, lack of social support, lack of visible effects of medication, and lack of motivation. These models were discussed above, and the corresponding efforts to mitigate each of them were presented. So, how should these efforts be combined to obtain maximal effects on medication adherence?

660 In order to construct the most appropriate combinations of initiatives for each patient, we must first identify non-adherent patients (Step 1, Figure 3). Managed care companies such as UnitedHealth have been using predictive analytics tools to foresee patients' levels of adherence. These tools are proprietary algorithms that use retrospective patient data to predict their future behavior. For example, they allow managed care companies to identify the patients who are most at risk of non-adhering to their medication and send them targeted reminder texts or calls. Moreover, as stated by UnitedHealth, when used within one customer pool where most patients exhibit similar behavior (e.g. large employer groups), these algorithms are even able to predict patients' behavior based on other individuals' adherence patterns. However, this initiative is only able to detect whether a patient is non-adherent, and could not identify the corresponding underlying mental model. It therefore needs to be supplemented with a further screening process, as shown in Figure 3.

680 In particular, we recommend that healthcare providers use predictive analytics tools in order to identify at risk patients, followed by surveys to match patients with their mental models and the mitigation strategies that are best fitted for them (Figure 3). Effective interventions will be those that identify and target a patient's mental models through various complementary initiatives. Moreover, it should be noted that the more mental models a specific initiative impacts, the higher its expected effect would be on the concerned patients. For example, a patient who is non-adherent because of lack of health literacy and complexity of medication regimen will benefit most from connecting into virtual support groups, as this initiative targets both mental models (Figure 2).



*Figure 3: Recommended Patient Flow Diagram*

If this patient screening process cannot be used for practical or feasibility reasons, then we would recommend that the most diversified mitigation strategies – those that touch on the highest number of mental models, such as holistic approach to care or health assistants, be implemented. Patients are more likely to benefit most from these strategies because they touch on multiple mental models, thus increasing the probability of tackling at least one mental model of adherence of any specific patient. While this solution is not ideal, as it is not personalized to each patient and it provides services that some patients may not need, it could in fact be an immediate way to tackle medication non-adherence amongst patients. Thus, implementing these broad mitigation strategies could be a short-term solution while more long-term personalized initiatives are designed.

It is also important to note that using too many initiatives that tackle the same mental models might lead to diminishing marginal returns. For example, using a health assistant and a concierge physician would doubly tackle lack of treatment continuity and coordination, lack of education and health literacy, and lack of trust in the healthcare team mental models. Thus, using these mitigation strategies together would not in fact result in a much higher adherence than only using one of them. We would therefore recommend diversifying the mitigation strategies targeted at each patient such that they encompass various mental models and avoid overlap.

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In short, implementing a screening process such as the one described above would be ideal in the long term: patients could be first split into two groups depending on their levels of adherence, and then onto ten (or more, if more mental models are uncovered) depending on their

models of non-adherence (with some patients being in more than one group), and each patient would be given a specific combination of mitigation strategies that would be best for them. It is important to note here that adherence is a dynamic process, i.e. patients constantly fall in and out of adherence. This screening process would therefore have to be administered regularly by healthcare providers (Figure 3), in order to ensure that the mitigation strategies implemented are adequate for the patient at a specific point in time. This approach would allow for individualized solutions instead of widespread initiatives that only work on certain populations, and should thus lead to better results as well as lower overall healthcare costs.

### **Competing Interests Statement**

Conflicts of interest: none.

## Appendix 1 – Semi-Structured Interview Questionnaire (15 min +)

### Questionnaire Overview: (Data collection to be done over phone)

Explanation of background – 2 min

Questions – 12 min

Optional Questions (if interview lasts more than 15min)

Thank you & Conclusion – 1 min

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### Explanation of background:

I am writing a thesis at Wharton around medication adherence. In particular, I would like to find out the different efforts undertaken to solve medication adherence and the understandings of non-adherence they imply. For example, if you were to use a reminder device to solve your medication adherence that would mean that you believe you are not adherent because of forgetfulness. So, I seek to find out the different ways in which people understand and define adherence in order to come up with recommendations as to how to best tackle this issue and I would like to ask you some questions around the efforts and metrics around those efforts, that you or your organization are undertaking to tackle medication non-adherence.

### Questions

1. Do you think medication non-adherence is an issue for your organization?
  - a. If no, do you think medication adherence is an issue at all?
    - i. If so, who do you think is concerned?
  - b. If yes, why do you think that is?
    - i. *If needed, give examples of reasons (list of mental models)*
2. Do you think your organization is affecting patient medication adherence? If so, how?
3. What efforts are you undertaking to mitigate non-adherence amongst patients?
4. What efforts do you think have been working?
5. Do you think these efforts have overall saved money to your organization?
6. Is there anything you think I should know given the background of my project that I haven't asked about?

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## Optional Questions

1. Mainly for insurers/Health systems: How random does it seem that your patients forget their medicine? For example, do they not taking every Friday, or is the pattern truly random?
2. Do patients only complain of forgetfulness, or is it accompanied by other worries?
  - i. If so, what else do patients usually claim alongside forgetfulness?
3. Are you tracking the evolution of adherence amongst your patients and how?
  - i. Have you been able to quantify your efforts' effects on adherence?
  - ii. Why were these measures in particular chosen?
4. Who do you think is the most crucial health provider in increasing medication adherence?
  - i. Why? What aspect of their interactions with patients is most important?
5. For integrated health systems: What do you think is the role of physicians in mitigating medication adherence?
6. Mainly for insurers/Health systems/Physicians: How do patients on platinum/gold plans adhere vs patients on catastrophic plans?

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## Thank you & Conclusion



Appendix 2: List of interviewees

Type	Organization	Point Person	Role	Status
Insurers	UnitedHealth	Lambert van der Walde	Executive Director	Completed
TeleHealth	Clarion Telehealth	David Kimball	Founder	Completed
	Geisinger	Janet Rushing	Head of Telehealth	Completed
Health Systems	Kaiser	Anne-Maree Cantwell	Senior Physician/Partner	Completed
	Geisinger	Michael Evans	Pharmacist and Head of Research	Completed
		David Feinberg	CEO	Put me in touch w/ Mike Evans
Centers	The institute for strategic threat analysis and response	Harvey Rubin	Physician	Completed
	Penn Diagnostic Center - Concierge Doc	Lawrence Spitz	Physician	Completed x2
Healthcare Concierge	Accolade	Emily Balmert	Senior Manager	Completed
		Peter Muller	Previous Director of HC Products	Put me in touch w/ Emily Balmert
Education	PatientsLikeMe	Paul Wicks	Head of Research	Completed
		Gayle Squires	Business development	Put me in touch w/ Paul Wicks
	Harvard	Niteesh Choudhry	Professor	Completed
Pharma/ Biotech	Merck	Jamie Rosati	Head of Adherence	Completed
		Laurie Myers	Head of Literacy team	Completed
		Adam Schechter	CEO	Put me in touch w/ Jamie Rosati
	Allergan	Craig Dashefsky	Head of Adherence	Completed
		Vijay Raghavan	On Adherence Team	
		Brent Saunders	CEO	Put me in touch w/ Craig Dashefsky

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