Goal Attainment in Comprehensive Care, Community and Culture Program

Final Draft

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1 Abstract

Two large-scale multi-year Randomized Control Trials (RCT) currently run at the University of Chicago Hospital to evaluate the effect of the Comprehensive Care Program (CCP) and its subsidiary program Comprehensive Care, Community and Culture Program (C4P) on patient outcomes. The two RCTs aim to settle the long-term debate over the trade-off between physician specialization and continuity of care. This project aims to explore the role that goal attainment and patients' self-reported goal categories play in the C4P Program. Our results confirm the positive effect of C4P in reducing number of hospitalizations, and increasing mental health ($p < 0.001$) and provider ratings ($p > 0.05$). However, we find patients in the C4P group have lower goal attainment ratings ($p < 0.001$), although they share an increasing trend with the other two groups. Patients who report higher life goal attainment rates are associated with lower mental health ratings ($p < 0.001$), and patients who report higher health goal attainment rates are associated with higher number of hospitalization ($p < 0.001$). We hypothesize that this is because patients reporting higher goal attainment rates tend to have more unmet needs in the goal category, reflected bad adverse outcome results in the category. To categorize goals, I apply two unsupervised topic modeling models, LDA and CorEx to the corpus of patients' longitudinal goals. We find five predominant topics for health-related goals: losing weight, controlling blood pressure, mobility/physical therapy, surgery/pain control and being healthy. We also find five predominant topics for life-related goals: working/being independent, spending more time with families, staying active, being healthy, and going to church. However, I find no mediation effect of goal category "controlling blood pressure" and "spending more time with families" on the effect of C4P on outcomes.

2 Introduction

The sustained growth of health care costs in the US, occupying a staggering 18% of the total GDP in 2018, has incentivized many research studies to come up with interventions that curtail costs. One area of focus is the trade-off between increasing specialization in the delivery of care and enhancing the continuity of care. Both models have grounds for containing costs and improving care: the former by specialization in knowledge and the latter by reducing communication overheads. Despite the massive amount of literature detailing the benefits of both, there is no causal evidence proving the superiority of one over the other. The effect of continuity of care, in particular, has not been tested causally in a large scale experiment as the specialization of care has been in the implementation of the Hospitalist specialty.

Motivated by this, the Comprehensive Care Program (CCP), a new model of health care delivery that ensures the continuity of care in a non-disruptive way, is currently running at the University of Chicago Hospital. Its complementary program Comprehensive Care, Community and Culture Program (C4P), implements the same model of delivery but focuses additionally on the unmet needs of patients through social work interventions. Concurrently implemented are two randomized control trials (RCT) aiming to test the causal effect of CCP and C4P on patients' self-reported and measured health outcomes.The two RCTs tracks patients' self-reported metrics via followup surveys distributed every three months. The two programs are expected to better patient outcomes such as number of hospitalization times, self-reported physician rankings, self-reported mental health scores, etc.

This paper primarily focuses on goal attainment and patients' self-reported goals in C4P. Goal attainment is widely accepted as an outcome measure in many domains, including physical therapy (Hurn et al., 2006), postacute brain injury rehabilitation (Malec et al., 1991), mental health (Kiresuk and Sherman, 1968), etc. Based on the goal setting theory, which states that all conscious human behaviors are purpose-driven and goal-oriented, goal attainment is a good reflection of patients' well-being and unmet needs (Hurn et al., 2006). We thus include goal attainment as an outcome

measure in our study, in addition to patient-reported physician ratings, and patient-reported mental health ratings. Our previous results have shown that the CCP program, in general, has a positive effect on these measures. In this paper, we aim to answer the following questions:

- Does C4P positively affect patient outcomes, including goal attainment?
- How do patient outcomes correlate with goal attainment?
- What are the categories of patients' goals?
- Do goal categories have a mediation effect on C4P's effect on patient outcomes?

This project will use topic modeling to abstract the categories to which patients' goals, described in words in the followup surveys, belong. We do this through two unsupervised NLP methods: the CorEx Model (Gallagher et al., 2017) and the LDA Model (Blei et al., 2003). This project can provide and example of how NLP can be used in large scale RCT, where there have been few precedents.

The results from this research can have significant policy implications. First, the study provides causal evidence of how a program that allows for the continuity of care and social interventions can affect patient outcomes. Secondly, the goal attainment results can be a precursor to the larger-scale C4P study at the University of Chicago Hospital in investigating its effects on outcome measures of patient health and cost containment. Lastly, large-scale government subsidy programs like Medicare and Medicaid can include CCP or C4P as a component, which would magnify the positive effects of CCP and C4P.

3 Literature Review

3.1 Motivation for Continuity of Care

Should the delivery of health care be specialized or continuous? Is it better to have different physicians, each with her own area of expertise, consult at the different stages of treatment, or is it better

to have the same physician care for the patient throughout the treatment process? This debate has been a long-standing one in the field of medicine (Starfield and Simpson, 1993). In economics, the fact that specialization leads to increase in returns is a well established principle (Romer, 1987).

The division of labor (Becker and Murphy, 1992; Durkheim, 1933), in a response to the ever-increasing volume of knowledge, has been a trend for hundreds of years despite its implication of increasing coordination costs. The past few decades, the field of medicine has witnessed increasing division into specializations (Birenbaum, 1990). Nowadays, over two thirds of the US physicians are specialists, exceeding its demand (Pasko et al., 2000). Different specialties vary in their medical spendings, where some specialties, such as cardiology and endocrinology, take up a higher concentration of total hospital spendings (Kravitz and Greenfield, 1995). With the expansion of governmental subsidy programs like Medicare and Medicaid, and coverage of preventative care, the demand for primary care physicians have increased significantly, but it is not met by its supply due to lower compensation compared to the specialist physicians (Bodenheimer and Pham, 2010).

Hospital costs, especially concentrated on the high-risk patients (Orszag and Ellis, 2007), inhabit a large proportion of overall spending (Joynt et al., 2013). The Hospitalist specialty (Wachter, 1999), where a physician is specialized in caring for patients in the hospital, was created in response to the call for specialization within the hospital. It asks the primary care physicians to focus on ambulatory care and the hospitalists to exclusively attend to the hospitalized patients (Meltzer and Chung, 2010). Its rise in popularity was primarily motivated by two reasons. First, due to a surge in modern medicine's ability to treat acute diseases, patients who are hospitalized post-ER are more severely ill, making Primary Care Physicians (PCP) less comfortable with providing inpatient care (Meltzer and Ruhnke, 2014). Also, PCPs are motivated to see more patients in hopes of billing patients throughout the day, but there are not enough patients in the hospital to justify their inpatient services (Hamel et al., 2009). Despite the popularity of the Hospitalists specialty, there is mixed evidence towards its benefits. Since the specialty's birth in 1996, many studies have shown that patients do not have better outcomes under Hospitalist care compared to standard care, and it also has limited effects on cutting costs (Wachter and Goldman, 2002). For example, while Diamond

et al. (1998) found that Hospitalists significantly decrease patient's length of stay in the hospital, cost of care, and 14-day readmission rate, Lindenauer et al. (2007) found that patients attended by Hospitalists experience a shorter length of stay, but similar death ratio, 14-day readmission rate, and costs, as compared to patients attended by the general internists. On one hand the Hospitalist specialty provides opportunity for PCPs to see more patients in the out-clinic setting, and for specialized Hospitalists to focus on the inpatient process. On the other hand the continuity of care is disrupted by such specialization, potentially causing adverse affects. For patients with chronic illness or complex diseases, the continuity of care is of greater importance (Hamel et al., 2009). In addition, researches LIAW et al. (1992); Wang and Luo (2005); Fan et al. (2005) have also shown that socioeconomic status is also associated with patients' perception of continuity of care, and its importance in patients' satisfaction with their primary care. Patients of lower socioeconomic statuses are more susceptible to the fragmentation of care even with comprehensive insurance (Menec et al., 2005; Stange, 2009).

Given the mixed effects of Hospitalists, the importance of continuity of care, especially for the vulnerable population of higher risks of hospitalization, motivates a review of the mechanism through which it provides care. Haggerty et al. (2003) identifies two core elements in the continuity of care: patient and time. The first element emphasizes the individuality of care. Even though the units of measurements for continuity can be aggregated at an organizational level, fundamentally, continuity is how individuals experience integration of services and coordination. The second element is the longitudinal dimension of continuity. In chronological diseases like Type II diabetes or cancer, the benefits of continuity, compared to a single clinical encounter, is long-standing. The CCP Program reflects these two elements by its longitudinal and patient-centered study design to be introduced later in Section 4. Haggerty et al. (2003) also identifies three types of continuity: informational, management and relational continuity. Informational continuity ensures the clinical information to be preserved in different stages of treatment or hospitalization. A lack of informational continuity can lead to adversely affected patient care (Kripalani et al., 2007). Management continuity allows for different physicians to attend to the same patient, but within the same management system. Relational continuity stresses the ongoing relationship between the patient and

physicians, where physician trust plays an instrumental role (Starr, 1978). Ours studies, CCP and C4P, focus the relational continuity, by having the same physician care for the patient during both the inpatient and outpatient process, while preserving the informational continuity.

Continuity of care also applies differently to multiple disciplines, most obviously in primary care (Nutting et al., 2003), mental health (Ware et al., 1999), and disease management (Bachrach, 1981). Evidence has shown associations between increased continuity of care and elevated patient satisfaction (Saultz and Albedaiwi, 2004) and improved health outcomes (Cabana et al., 2004). However, the effect of continuity of care, on the other hand, has not been tested with an intervention program of equal scale the Hospitalist specialty as an intervention, due to its span across multiple domains in medicine (Haggerty et al., 2003). This calls for new and feasible care models that include the feature of the continuity of care to be implemented and tested, which motivates the Comprehensive Care Program (CCP) and the Comprehensive Care, Community and Culture Program (C4P).

3.2 CCP and C4P

The Comprehensive Care Program (CCP) and the Comprehensive Care, Community and Culture Program (C4P) are two innovative care models currently running at the University of Chicago Hospital (Meltzer and Ruhnke, 2014). The CCP program targets patients with high hospitalization risks, and asks the same physician to provide both inpatient and outpatient service within a hospitalization stay. The randomized control trial (RCT) running in parallel tests the causal effect of CCP on patients' self-reported and measured health outcomes. The RCT has 1000 patients per arm in the CCP treatment and standard care (SC) group. The team asks every enrolled and active patient in both the CCP and SC groups to complete a follow-up survey every three months, preserving both the individuality and the temporal consistence in the continuity of care mentioned in Haggerty et al. (2003).

The CCP RCT was initiated in 2012. During its implementation, the team found that around 30% of patients did not engage fully, with low response and high no-show rates. This suggest

that patients of high risk of hospitalization still face obstacles of care and unmet needs, despite the CCP intervention. Such unmet needs include unaccessible transportation, little access to food and housing, and etc. Thus, the team created the Comprehensive Care, Community and Culture Program (C4P), which systematically assesses the patients' unmet social needs, and help them fulfill those needs through programs like Community Health Worker (CHW) and Artful Living Program (ALP). With sufficient funding, another RCT was installed to assess the effects of C4P. 529 patients participate in the C4P program, 172 of which in the standard care arm, 180 in the CCP arm and 177 in the C4P arm.

3.3 Goal attainment

In my proposed research, I will focus on how continuity of care affects the role that patient goal attainment plays in patient outcomes among C4P patients. Goal Attainment Scaling (GAS), originally developed to evaluate mental health treatments and other interventions (Kiresuk et al., 2014), is widely used in physician-patient interactions settings (Ottenbacher and Cusick, 1990) to address physician accountability. Proposed by Kiresuk and Sherman (1968), the GAS is set up in such a way that the goal attainment is transformed to a standardized t-score to evaluate an intervention program. Kiresuk et al. (2014) proposed a generally applied GAS score calculation where patients are asked to rate their goal achievement level for each goal on a $(-2, 1, 0, 1, 2)$ basis, where $+1$ and $+2$ mean better outcomes and -1 and -2 mean worse outcomes. In our study, we did not adopt this scale because with finer scalings such as a 0-100 system, people tend to be more precise with their response (Luce et al., 1988).

Our goal attainment scaling system follows Schedule for Evaluation of Individual Quality of Life (SEIQoL), which allows for individualized measurement of quality of life. It consists of 4 parts (O'Boyle, 1994):

1. Introduction: Provides contextual information about the following questions
2. Cues: Asks patients to give a number of most prioritized items (e.g. Five most important aspects in life)

3. Determining Level: Set up examples of how ratings of each of the item mentioned in the cues should be done

4. Elicit Ratings of the Present Life: Asks patients to provide a rating for each of the item mentioned in the cues

This schedule has been tested as a valid instrument to measure quality of life (Wettergren et al., 2009), and widely applied in areas such as mental health (O'Boyle, 1994),gastroenterology (McGee et al., 1991), AIDS/HIV population (Hickey et al., 1996), etc. It possesses psychometric properties that show sufficient reliability and internal validity, without losing its ideographic approach, where the individuality of the participants are preserved. SEIQoL is particularly useful for continued psychometric evaluation in large populations with a longitudinal design (Wettergren et al., 2009).

In our study, the schedule is applied longitudinally, where the patients are asked a set of questions following SEIQoL at intake to provide three goals and their ratings on the goals (see Appendix 8.1 for the survey questions), and subsequently at each followup months to provide the followup ratings on the intake goals, as well as whether they have new goals, what the new goals are, and how would they rate the new goals. However, unlike SEIQoL, we ask our goal attainment level on a percentage scale, as opposed to the generally practiced (-2, 2) scale. This is because the (-2, 2) scale is primarily used by physicians to rate patients' progress. In our study, however, patients are asked to give self-reported ratings. This calls for a more fine-grained rating system such as the 0-100 percentage system.

Setting up goals helps achieve the goals through an intention-to-behavior process, where goal-directed behaviors transform into actions and outcomes in an anticipated situational context (Gollwitzer, 1993). It is extensively used in primary care (Bodenheimer and Handley, 2009), physical therapy (Hurn et al., 2006), postacute brain injury rehabilitation (Malec et al., 1991), mental health (Kiresuk and Sherman, 1968), chronic disease (Alexander et al., 2012) etc., by morphing their behavior towards more active participation, which in turn has been proven to have positive effects over other health outcomes. In our study, outcomes include number of hospitalizations in the past three

months, self-reported physician ranking, and self-reported mental health ranking. We hypothesize that continuity of care positively affect goal attainment level by fostering a good physician-patient relationship. Conversely, goal attainment level would positively correlate with the patient outcomes listed above by the intention-to-behavior process.

3.4 Initial Results from CCP

In this section I will review the preliminary results we have for CCP. Figure 1 shows the consort diagram for the first year evaluation of the CCP program. In the CCP study, 2000 patients were contacted for randomization, of which 10 dropped out. Out of the remaining 1990 patients, 994 were assigned standard care (SC) and 996 were assigned the treatment. During the first year, a total of 253 patients have died, 124 of which belong to the SC group and 129 belonging to the CCP group. The missing patterns are accounted for in the mix-effect pattern mixture model.

3.4.1 Physician Rating

Figure 2 shows that on average the CCP group performs better than SC at physician ratings, but only significantly up to 6 months post intake. Similarly, Figure 3 shows that for the raw mean of percentage of best rating (rating=10), CCP seems to perform significantly better than SC for the first year, with a around 10% increase in rating compared to the SC group. However, the effect's significance decreases (p-value increases) as more followup months are included in the analysis, starting from month 9. After applying the mixed-effect pattern mixture model, as shown in Figure 4, CCP still outperforms SC by around 10%, but the conclusion remains significant across all followup months up to two years.

3.4.2 General Health

For the outcome of patient reported general health, we see no significant treatdment effect of CCP when comparing the raw mean ratings (Figure 5). There was also no significant treatment effect of CCP in the percentage of patients who report the best two ratings of general health (excellent

and very good) (Figure 6). However, after we control for the missingness in response pattern using MEPM model, the CCP group seems to perform worse than SC group, albeit insignificantly. This is an interesting finding that merits more discussion. One explanation can be that since our scores are self-reported, patients expect more from the physicians, or hold a higher standard for them, after their relationships have been established.

Figure 1: Consort Diagram for 1 Year CCP

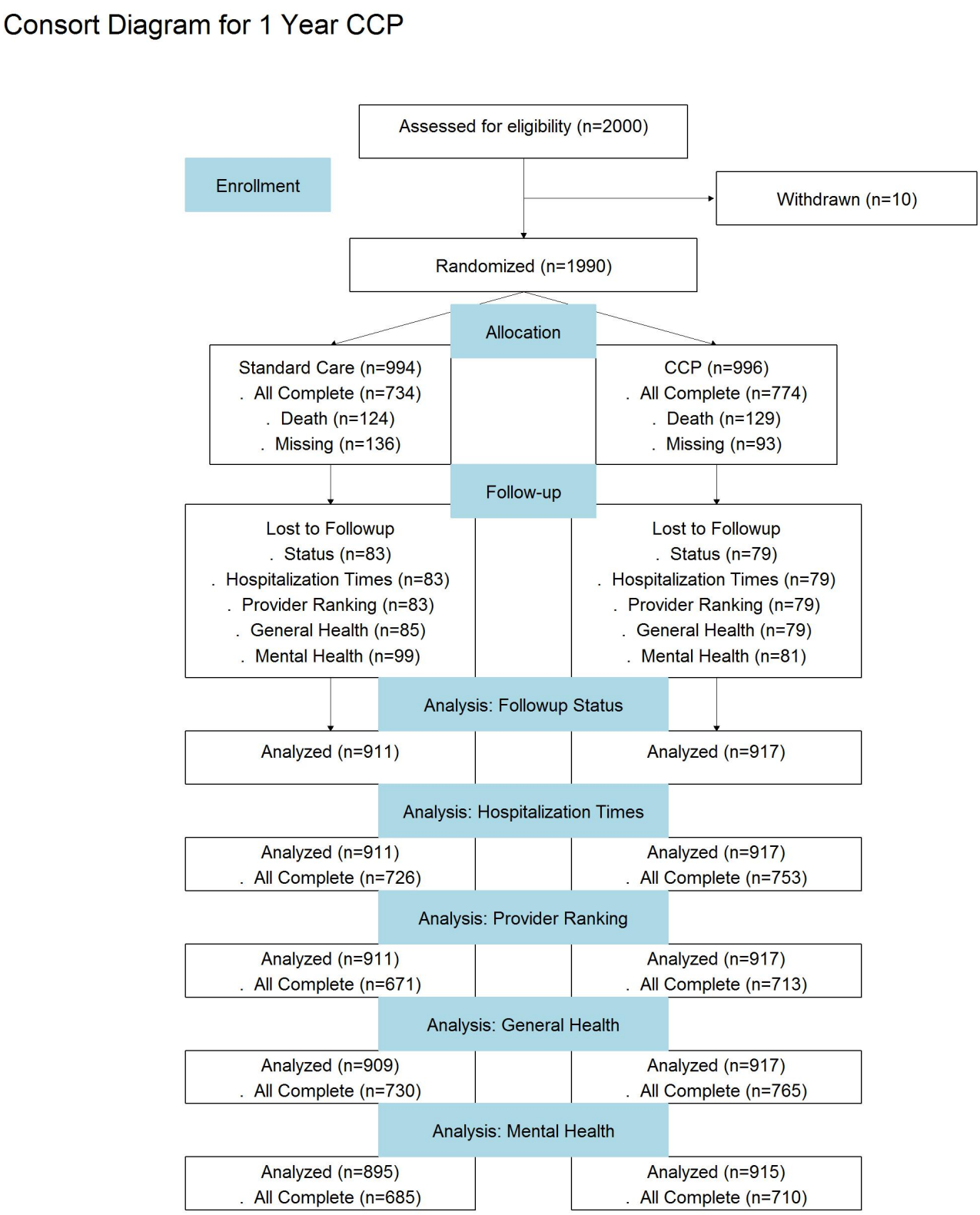


Figure 2: Mean of Physician Rating

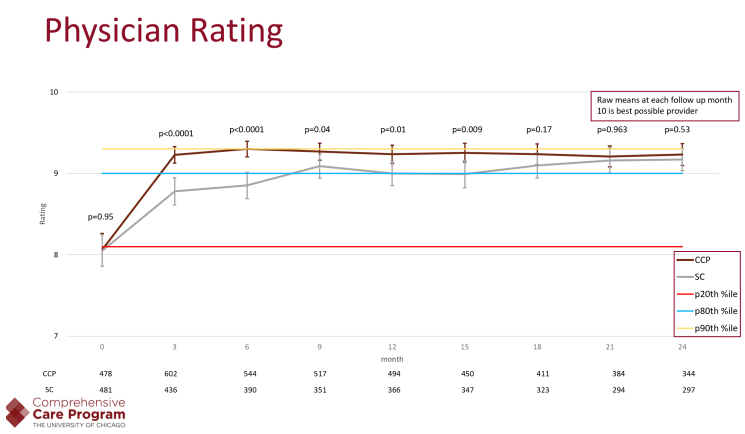


Figure 3: Percentage of Best Ratings (Raw) for Physician Ratings

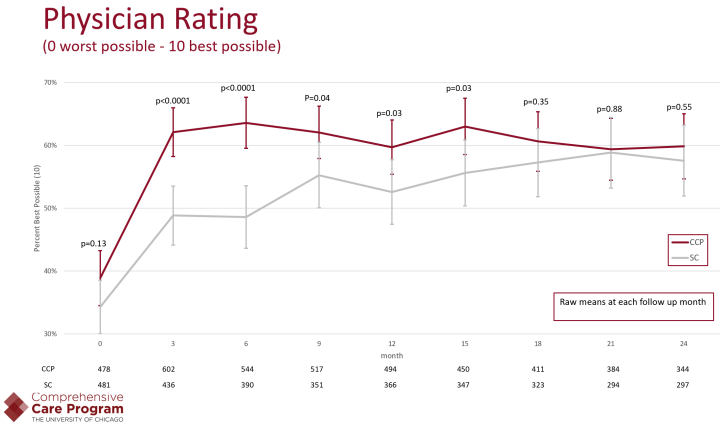


Figure 4: Percentage of Best Ratings (MEPM Model) for Physician Ratings

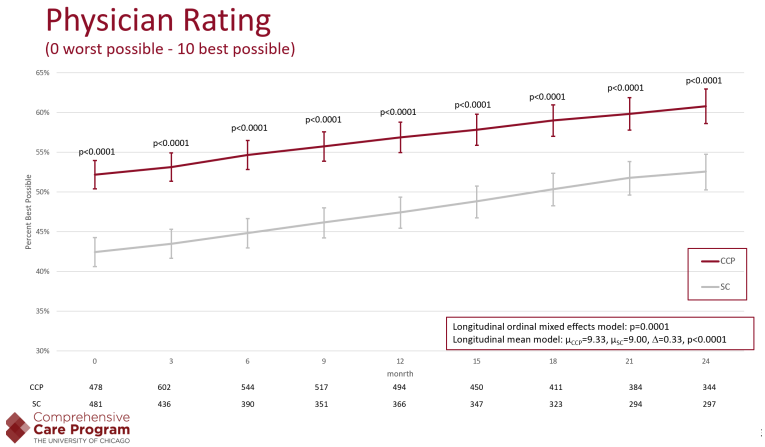


Figure 5: Mean of General Health Rating

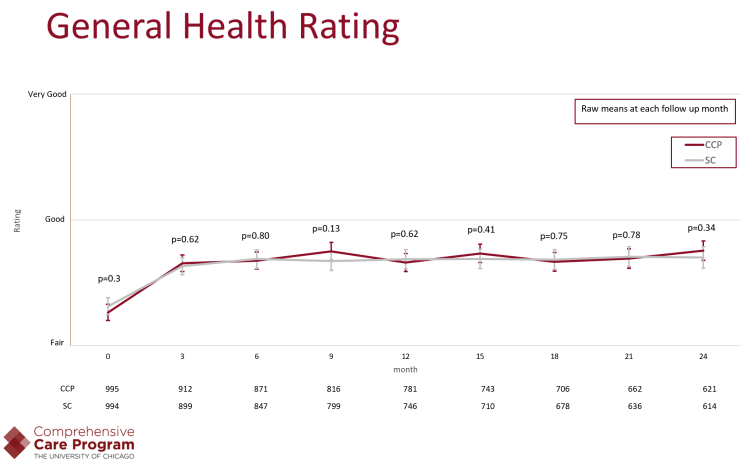


Figure 6: Percentage of Best Ratings (Raw) for General Health Ratings

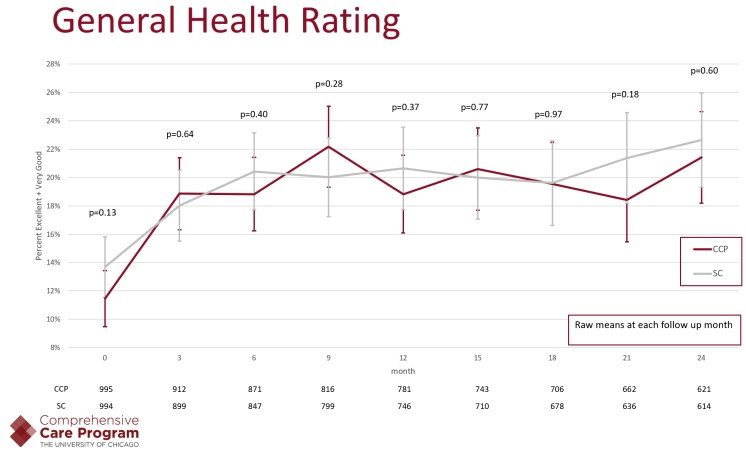
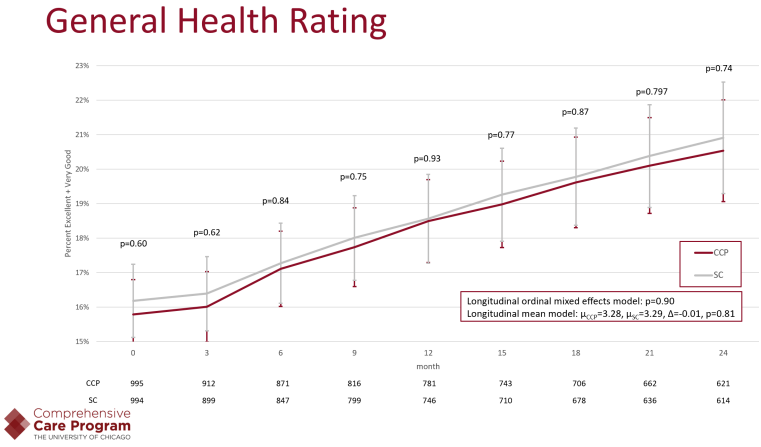


Figure 7: Percentage of Best Ratings (MEPM Model) for General Health Ratings



3.4.3 Mental Health

For the outcome of patient reported mental health, we see significant treatment effect of CCP across all followup months (Figure 8 and 9), both for mean ratings and mean percentage of top ratings (excellent and very good). CCP patients report 5-10% more "excellent" and "very good" for mental health ratings. The effect is even more salient after we control for missingness using MEPM Model (Figure 10).

Figure 8: Mean of Mental Health Rating

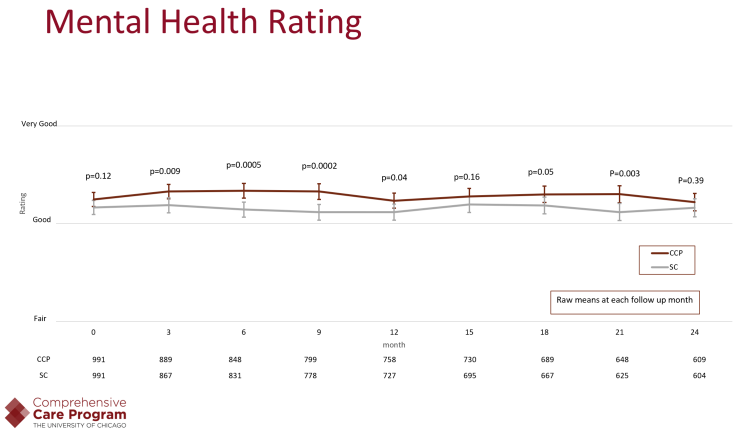


Figure 9: Percentage of Best Ratings (Raw) for Mental Health Ratings

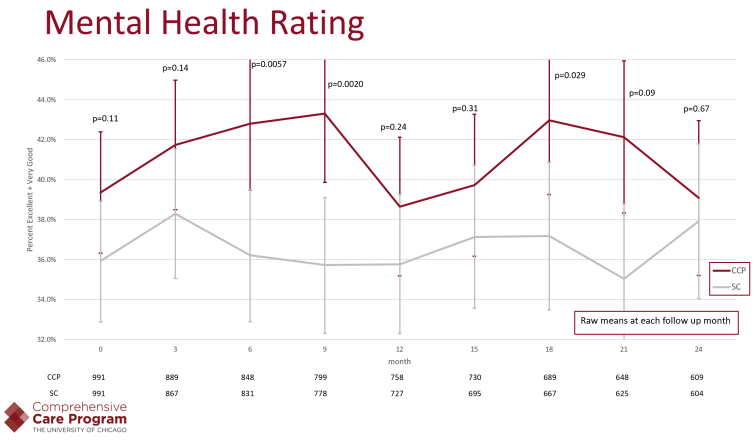
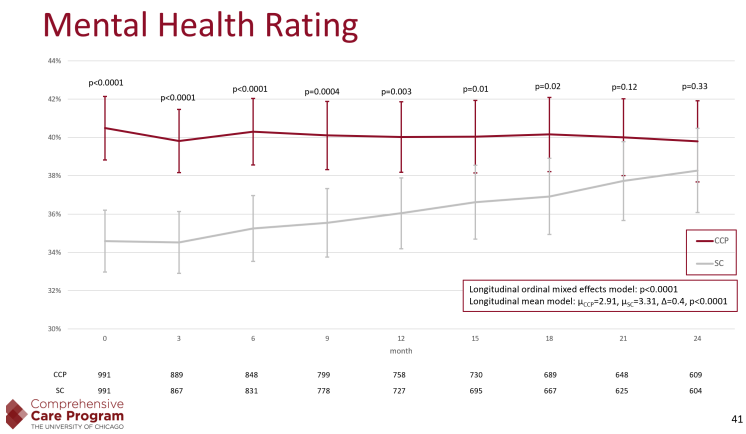


Figure 10: Percentage of Best Ratings (MEPM Model) for Mental Health Ratings



3.4.4 Followup Hospitalization Times

Figure 11 shows that the CCP Program does not improve the raw score of the number of hospitalization in followup months. However, the MEPM Model (Figure 12) shows that the CCP Program on average decreases the number of hospitalizations in followup months by 0.2. The results are also significant on a $p < 0.05$ scale. This can translate to decrease in health care spending, and better health for patients since they have fewer health problems meriting hospitalizations.

Figure 11: Number of Followup Hospitalizations (Raw Score)

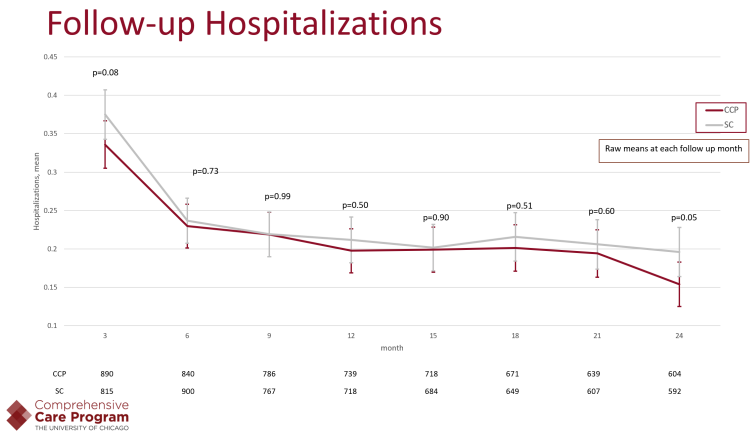
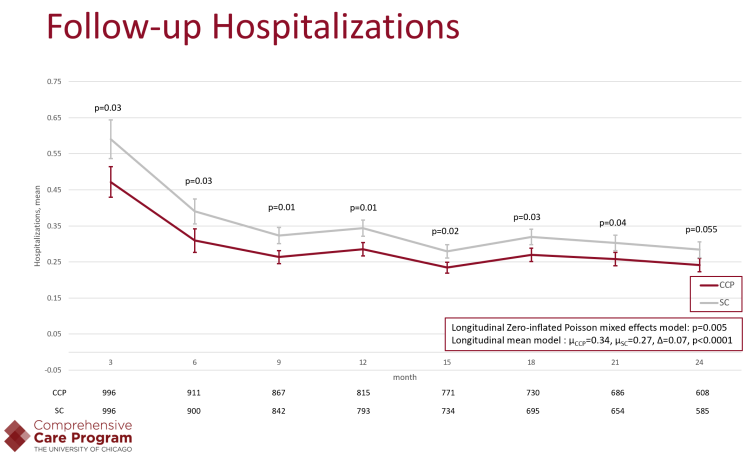


Figure 12: Number of Followup Hospitalizations (MEPM)

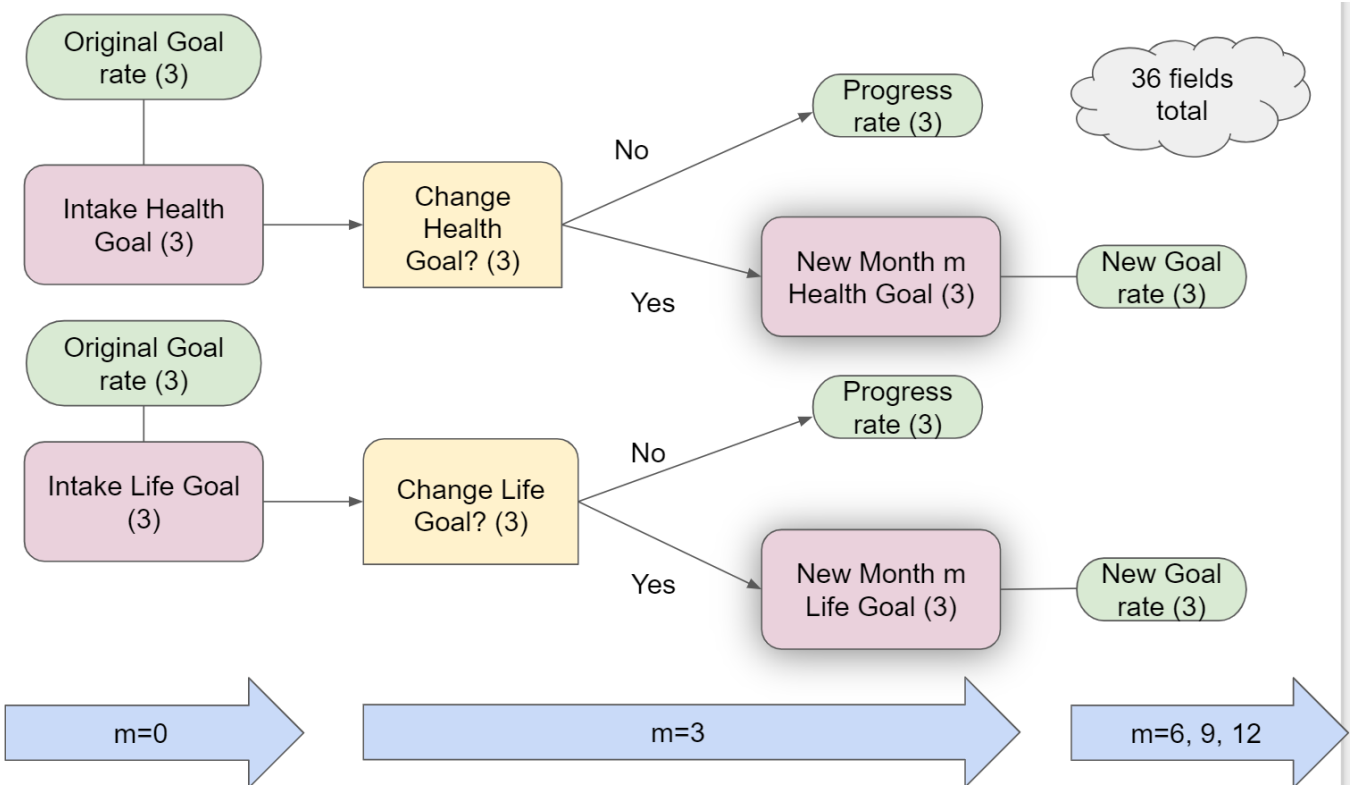


Given the success of CCP program on patient outcomes, I hypothesize that in general, C4P will also have a positive effect on patient outcomes. Namely, patients would report reduced number of hospitalization , give better physician ratings, give better mental health ratings, and most importantly, increased goal attainment level. Goal attainment levels should positively correlate with patient outcomes. This may be because as patients feel more positive about their treatments, the positive psychological signals would motivate them to adhere to physician's orders and thus result in better outcomes. Lastly, patients who report goals belonging to different categories should experience different effect of C4P on outcomes. For example, patients who want to lose weight, or control blood sugar might benefit more from the social interventions provided by C4P than patients who want to be able to walk again, because of the latter needs professional physical therapy that C4P fails to provide.

In what follows, I will first introduce the study design by describing the data and demographics involved in our study in Section 4. Then I will describe the methods applied in this paper in more details in Section 5. Section 6 gives the results of the study, which consist of raw scores of the goal-related outcomes, topic grouping results form the two models, the mixed effect results given by MEPM Model, and lastly, the mediation effects of the goal categories. Finally, Section 7 concludes with discussion for future directions.

4 Data

Figure 13: Workflow of Survey Questions



4.1 Survey Data

The dataset for C4P study consists of coded surveys administered every three month for 532 patients in total on RedCap since their date of randomization. Around equal number of patients should be in each research arm: C4P (n=177), CCP (n=180) and Standard Care (n=172). The portion of survey questions that I will focus this project on is about goal attainment, which have around 36 fields in total. As Figure 13 explains, at intake (m=0), we ask the patients for 3 health and 3 life goals, and ask them to rate the current attainment level of those goals. For health goals, we ask the question of *First, I would like for you to tell me 2-3 of the most important goals or values (you have/PATIENT HAS) about (your/PATIENT'S) health now.* And for goals, we ask *Second, I would like for you to tell me 2-3 of the most important goals or values (you have / PATIENT HAS) regarding (your/PATIENT'S) life and general well-being now.* In three months, we ask them about how well they are doing with achieving those goals. Then, we proffer them with an option to

switch health and life goals, and ask them to rate their current attainment levels for the new goals. This happens for every 3 month starting the patient's randomization date. For full list of survey questions of interest please see Appendix 8.1.

4.2 Descriptives

Table 1 describes statistics of our population in study. The C4P dataset consist of 532 patients in total. Since C4P is designed to target at patients of high risk of hospitalization with unmet needs, it is not surprising that the most patients are on the lower end of the income brackets. Out of the 317 patients who reported their incomes, 178 (56%) were below the Illinois poverty line of $25,000$ annual income. Also, since University of Chicago Hospital serves several adjacent predominantly African American neighborhood, the majority of the C4P study population consists of African Americans. Studies suggest that the most marginalized patients, such as those recruited in this study, may benefit the most from continuous care and social work, by reducing the fragmentation of health care (Fan et al., 2005).

Table 1: Summary Statistics of C4P Patients

Characteristics		Estimates
No. of patients		N=529
	Men	323
	Women	206
Mean age (at screening)		61.1 (45.9-76.3)
Race		
	Black	417
	White	47
	Hispanic	15
	Multiple	15
	American Indian or Alaskan Native	11
	Asian	3
	Other Pacific Islander	2
	Other Asians	2
	Refused	17
Randomization Outcome		
	C4P	177
	CCP	180
	Standard Care	172
Income Bracket		
	$10,001$ to $15,000$	70
	$5,001$ to $10,000$	56
	$15,001$ to $25,000$	52
	$25,001$ to $35,000$	32
	$2,501$ or less	29
	$35,001$ to $50,000$	28
	$50,001$ to $10,000$	26
	$2,501$ to $5,000$	14
	$100,001$ to $200,000$	10
	Do Not Know	81
	Refused	131
Medicaid		247

5 Methods

This project aims to apply topic modeling within Natural Language Processing to group patient-reported goals into different topics in an unsupervised fashion. Each goal can have a pertinent score to all the topics. It will then be classified to a topic that has the highest pertinent score. I will incorporate the categorical topic of the text field and its associated pertinent score into the mixed-effect pattern-mixture model.

5.1 Latent Dirichlet Allocation Model

The latent Dirichlet Allocation Model (LDA) is an established model for topic modeling (Blei et al., 2003). LDA is a three-level hierarchical Bayesian model, allowing for each item (each entry in a field in this case) to have a finite mixture of an underlying set of topics. Conversely, each topic is modeled as an infinite mixture over an underlying set of topic probabilities. Via unsupervised learning, LDA will divide my data into different topics, and by judging from the most frequent words within each topic we can decide what the topic is about. At each wave (follow-up month), the patient's goals will be mapped to a category variable of which topic this goal belongs to.

The LDA model is widely applied for topic modeling purposes. It has been used for tagging online systems (Krestel et al., 2009), performing content analysis for political manuscripts (Grimmer and Stewart, 2013), discerning user-generated contents (Koltcov et al., 2014), and even in fields of computer vision, performing tasks like annotating satellite images (Lienou et al., 2010).

Currently there are two predominant statistical packages popular in performing LDA. One is Python's open source package named gensim (Rehuurek, Radim and Sojka, Petr, 2011), and the other one is Mallet (McCallum, 2002). In my analysis, I will use and compare both packages.

One thing to note is that to keep the topics consistent across waves, I will group all the text variables into one single variable, and apply the LDA, and CorEx (discussed later) Models on them, after which I will revert them back to their original form, and create a column of topic category for each field. This variable will then feed into the Mix-Effect Pattern Mixture Model for further analyses.

5.2 CorEx

The Correlation Explanation (CorEx) Model, proposed first by Ver Steeg and Galstyan (2014) is a much more recent topic modeling model, with an extra feature of anchoring (Gallagher et al., 2016) and including n-grams in our analysis Reing et al. (2016). Gallagher et al. (2016) reports that the novel methods consistently outperforms LDA in accuracy and also orders of magnitude in speed, when they are both trained on binary topic labeling data. The CorEx Model optimizes in an unsupervised fashion requiring minimal domain knowledge, by maximizing total correlation between a subset of total vocabulary X_G and its topic groups Y according to the following equation:

$$max_{G_j, p(y_j|x_{G_j})} \sum_{j=1}^{m} TC(X_{G_j}; Y_j)$$

. Here j denotes the index of topic group. In our study, I allow both unigrams, and n-grams with n ranging from 2-5 to be considered in topic modeling.

5.3 Mixed-Effects Pattern-Mixture Model

The current model being employed to investigate the effect of CCP on patient health outcomes is the mixed-effects pattern-mixture model (Hedeker and Gibbons, 1997). The model is particularly good for imputing missing data in longitudinal research studies. It also can be used to study treatment-related change across time, which suits the purpose of this study.

In this paper, I will 1) see if the positive effects of CCP is repeated in this study, 2) see how C4P affects patient clinical outcomes (number of hospitalization times in 3 months, mental health rating and physician ranking), 3) use goal attainment level, both for health and life goals, as an outcome measure, 4) explore the mediation effect of goal categories between C4P and clinical outcomes. To do these, the model is specified as follow:

$$Y_{i,j} = \beta_0 + \beta_1 Treatment_i + \beta_2 logwave_j + \beta_3(Treatment_i * logwave_j) + \beta_0^D Drop_i +$$
$$\beta_1^D(Drop_i Treatment_i) + \beta_2^D(Drop_i * logwave_j) + \beta_3^D(Drop_i * Treatment_i * logwave_j) +$$
$$v_{0i} + v_{1i} logwave_j + \epsilon_{ij}$$

Here, the mixed-effects pattern-mixture model accounts for missingness of data by incorporating a field named *Drop* and its interaction with the field *logwave*. The former is the response pattern of a patient i. Only patients who have completed all followup surveys within one year (4 followup rounds) will have 1 for $Drop_i$. All other patients will have 0 for the field. *logwave* is defined as the log value of number of follow-up month (1 4). Since the study is designed to be three-armed, $Treatment_i$ here can be either CCP or C4P. v_{0i} here are baseline characteristics, which include gender, age, whether have dual insurance coverage (Medicare & Medicaid), and baseline outcome variable (at intake). $\beta_0 \quad \beta_3$ are coefficients for completers, while $\beta_1^D \quad \beta_3^D$ are how dropouts differ from the completers. Of particular interest is the variable of interest is β_3^D, which is the effect of treatment on outcome controlling for the missingness.

5.4 Mediation Effect of Goal Categories

To study if the goal categories serve a mediator in C4P's effect on outcomes, I refer to the causal inference framework proposed by Robins and Greenland (1992) and Pearl (2001) detailed as follows. Let Y be the outcome, T as the treatment and M be the mediator (goal categories). Here, the natural director effect (NDE), which compares outcomes under treatment level $T = 1$ versus $T = 0$, fixing $M = 0$ (Method 1 in the regression) and $M = 1$ (Method 2 in the regression) is defined as

$$NDE_0 = E(Y(T(1), M(0))) - E(Y(T(0), M(0)))$$
$$NDE_1 = E(Y(T(1), M(1))) - E(Y(T(0), M(1)))$$

Natural Indirect Effect, which compares outcomes under $M = 1$ versus $M = 0$, fixing $T = 0$ (Method 1 in the regression) and $T = 1$ (Method 2 in the regression) is defined as

$$NIE_0 = E(Y(T(0), M(1))) - E(Y(T(0), M(0)))$$
$$NIE_1 = E(Y(T(1), M(1))) - E(Y(T(1), M(0)))$$

The total causal effect (TCE) can then be defined as the sum of the two components.

$$TCE = NDE_0 + NIE_1 = NDE_1 + NIE_0$$

. The proportion of mediation (PM), which is the variable of interest here, can be then defined as

$$PM = \frac{NIE}{NIE + NDE} = \frac{NIE}{TCE}$$

6 Results and Analysis

6.1 Descriptive Analyses

This analyses of this paper will focus on the C4P study, an RCT with three arms, for standard care, CCP and C4P respectively. The earliest recruitment of patients for the C4P study happened in July, 2016. The most recent recruitment of patient happened in March 2019. Below is a list of questions I aim to answer in this section:

- How many patients are answering each question?
- How many patients have 0,1,2,3 goals for life (well-being), health and total during intake and 3m? How many patients changed their goals?
- How are patients rating their goals at intake and 3 months? How are the rates changing?
- Are the changes significant? How do the above changes differ between randomization outcome (SC/CCP/C4P)?

6.1.1 How many patients are answering each question?

Each followup month, we have data for all 529 patients (barring withdrawn patients). Figure 14 shows that the progress of C4P Data Collection. The decline in number could be caused by non-eligibility, where patients are not eligible for later follow-up months since their randomization dates are later, or survey attrition, where patients are tired of being grilled about their current status of life, and refuse the followup interview. Figure 15 shows an example of such attrition. One the Left is the total number of non-empty response to the question of whether the patient wants to change her first health goal. On the right is the response rate, which is calculated as the response number over the retention number. We can see that even when the response number is normalized by the retention number, the rate is still dropping, due to the attrition. The attrition rates of other variables look similar, except for the new goals for each follow-up month, which turned out to be too sparse and will be left out of the discussion here.

Figure 14: Progress of C4P Data Collection

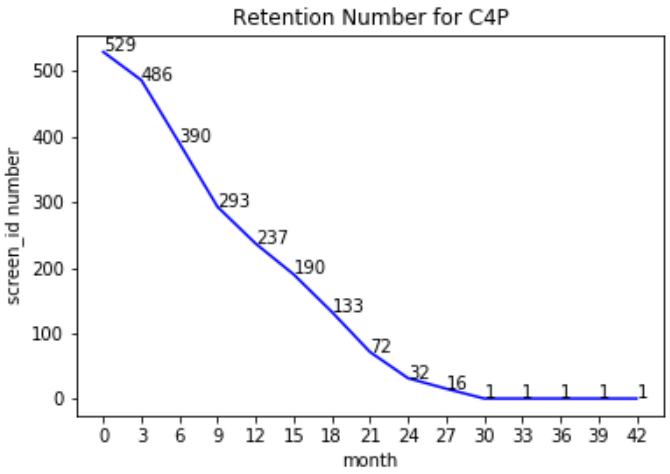
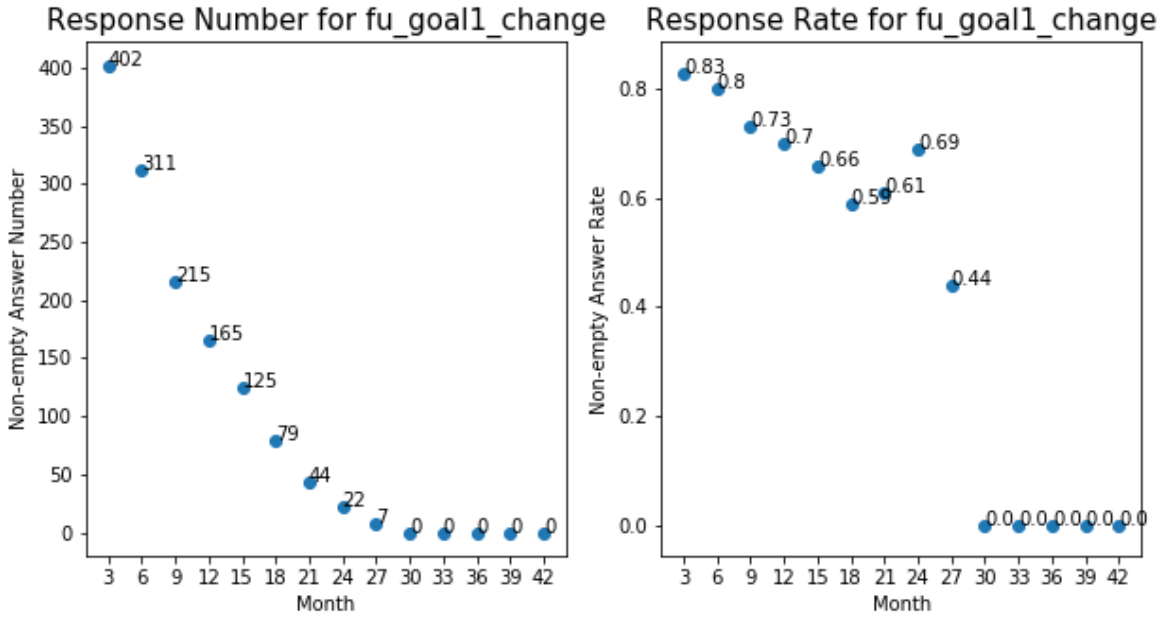


Figure 15: First Goal Change Attrition Over 42 Months



6.1.2 How many patients have 0,1,2,3 goals for life (well-being), health and total during intake and 3m? How many patients changed their goals?

At intake, patients on average have 2 goals for life, and 2 goals for health, a total 4 out of 6 (Figure 16). We can see that for health goals, patients are concentrated on answering 3 goals, and only 34 patients out of 529 gave 0 goals. The number of patients who gave 0 goals at intake is higher for life goals, totaling 100 out of the 529. They also answer 2 out of 3 for both health and life survey rate questions (Figure 17). At 3 months, on average patients report 3 progress rates out of 6 for their listed goals at intake (Figure 18). The response number for both life and health goals are bimodal, in that patients are concentrated on giving 0 and all 3 progress rates on their previous goals.

Figure 16: Frequency of Rate in Intake Interview

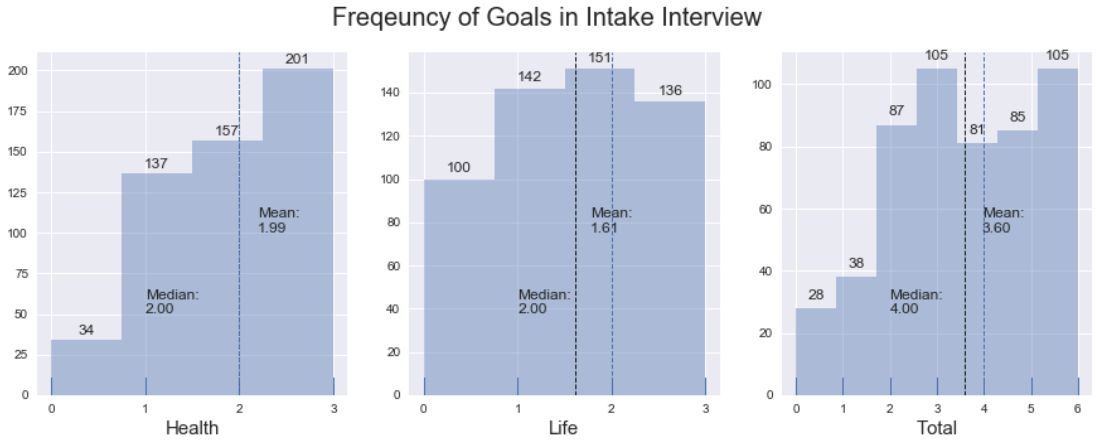


Figure 17: Frequency of Progress Rate in 3 Month Followup Interview

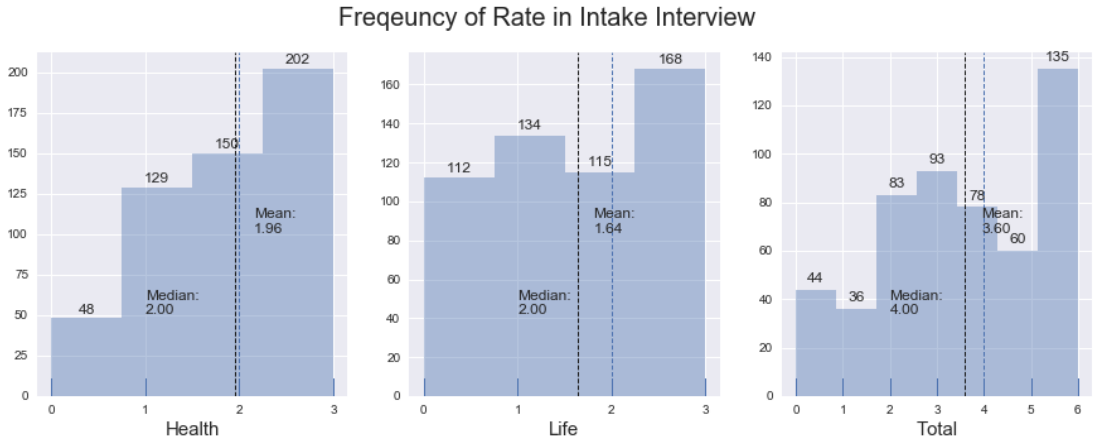


Figure 18: Frequency of Progress Rate in 3 Month Followup Interview

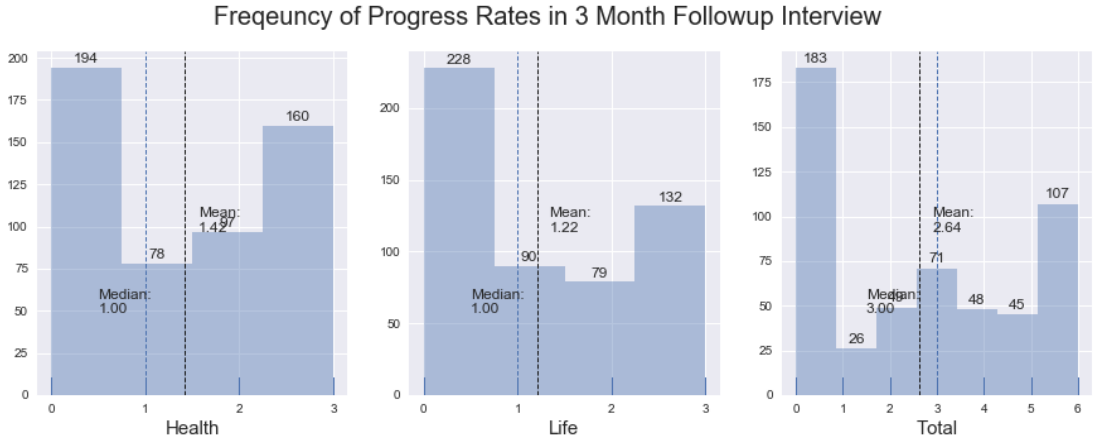


Figure 19: Frequency of Changed Goals in 3 Months Followup Interview

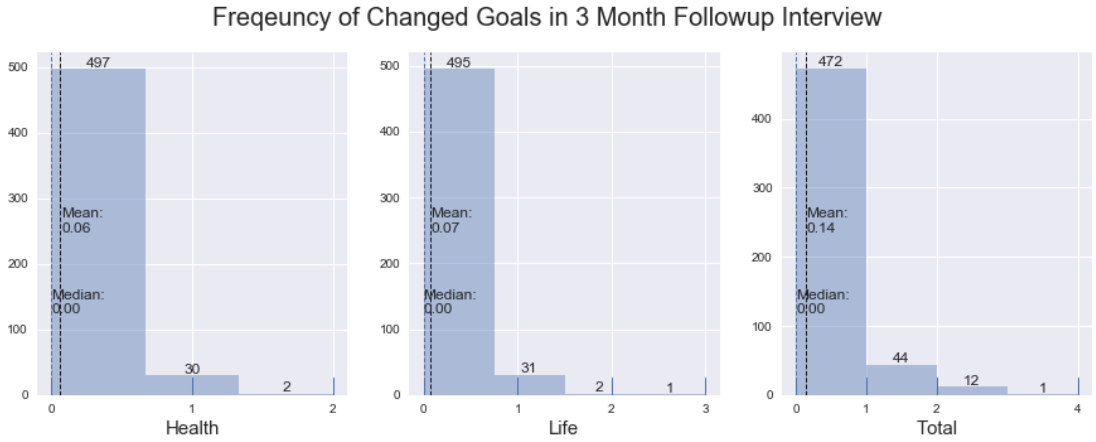


Figure 20: Frequency of New Goals in 3 Month Followup Interview

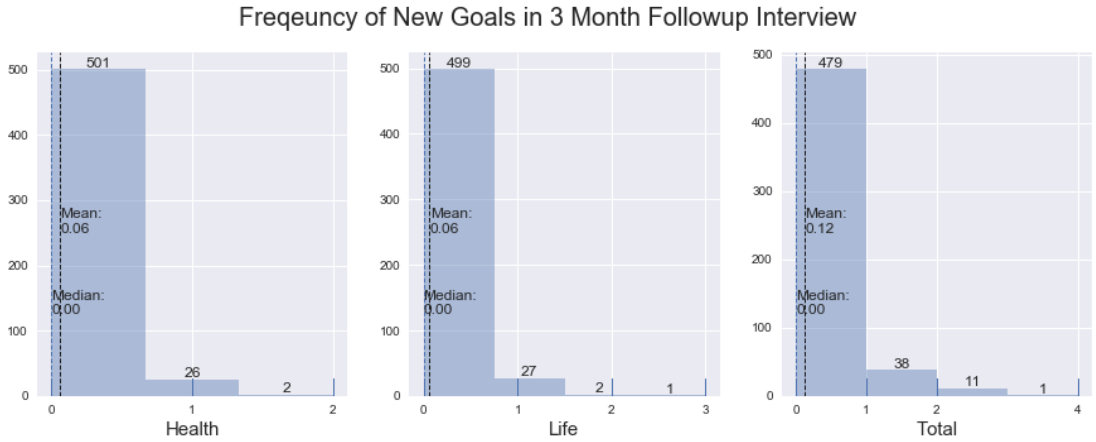


Figure 21: Frequency of New Goal Rates in 3 Month Followup Interview

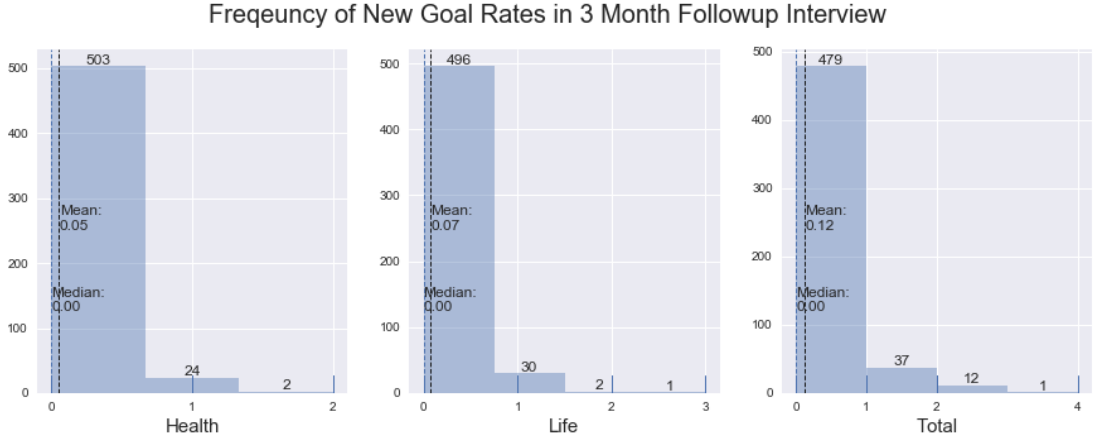


Table 2 details the number of answers patients give to the goal related questions at each followup month (3,6,9,12). In general, the response number decreases as time goes on. For example, the number of response for health goals drop from an average of 1.94 at intake to 0.61 at 12th month. Patients answer more health related questions than life related questions, which is likely associated with the fact that health-related questions precede the life-related ones in the survey. Similarly related to the order of survey questions, the frequency at which patients answer goal question trump the rate questions. This means that patients sometimes do not report rates for their previously listed goals at the ensuing followup months.

On average, 2.45% of patients change their health goals, and 2.25% change their life goals, bringing down the average number of responses for the change goal/new goal/ new goal rating questions to an average value of below 0.01, as shown in Table 2. Table 3 reports out of the people who change their goals, the number of answers they give at each followup month for the change goal/new goal/ new goal rating questions. On average, if patients choose to change their goals, they change around nearly 3 goals, and give around 1 new goal and 1 new goal rating at each followup month.

Table 2: Average Number of Answers by Patients within 1 Year

	Followup Month	Intake Health Goal	Intake Life Goals	Health Ratings	Life Ratings	FU Health Change	FU New Health Goal	FU New Health Rating	FU Life Change	FU New Life Goal	FU New Life Rating
SC (n=172)	Intake	1.983±0.96	1.616±1.08	1.942±1.02	1.628±1.17						
	3 Months			1.419±1.29	1.192±1.29	1.791±1.4	0.052±0.24	0.064±0.29	1.703±1.43	0.029±0.17	0.041±0.2
	6 Months			1.052±1.26	0.919±1.23	1.256±1.43	0.041±0.25	0.035±0.24	1.233±1.43	0.017±0.13	0.005±0.76
	9 Months			0.767±1.2	0.686±1.15	0.907±1.35	0.012±0.11	0.006±0.08	0.866±1.31	0.005±0.76	0.005±0.76
	12 Months			0.616±1.13	0.587±1.11	0.709±1.24	0.006±0.11	0.006±0.08	0.686±1.23	0.012±0.12	0.005±0.76
CCP (n=180)	Intake	1.911±0.94	1.611±1.05	1.878±1.31	1.606±1.14						
	3 Months			1.311±1.2	1.183±1.2	1.817±1.36	0.083±0.29	0.067±0.27	1.694±1.39	0.089±0.04	0.089±0.3
	6 Months			1.150±1.18	1.017±1.2	1.461±1.38	0.044±0.01	0.028±0.2	1.367±1.4	0.044±0.2	0.039±0.2
	9 Months			0.711±1.12	0.644±1.08	0.872±1.3	0.011±0.11	0.017±0.17	0.856±1.31	0.028±0.2	0.028±0.2
	12 Months			0.589±1.04	0.550±1.03	0.817±1.3	0.011±0.15	0.006±0.075	0.789±1.3	0.017±0.13	0.011±0.11
C4P (n=177)	Intake	2.096±0.93	1.610±1.07	2.068±0.96	1.690±1.1						
	3 Months			1.638±1.25	1.344±1.22	2±1.3	0.04±0.2	0.04±0.2	1.887±1.3	0.08±0.34	0.084±0.35
	6 Months			1.368±1.28	1.414±1.25	1.661±1.4	0.045±0.23	0.04±0.22	1.48±1.43	0.03±0.17	0.023±0.15
	9 Months			1.028±1.29	0.864±1.21	1.18±1.4	0.017±0.13	0.006±0.08	1.1±1.38	0.017±0.13	0.017±0.13
	12 Months			0.757±1.21	0.616±1.12	0.893±1.3	0.017±0.13	0.017±0.13	0.842±1.33	0.0056±0.08	0.006±0.08

Table 3: Number of Goals Changed for Patients who Changed Their Goals

Followup Month	FU Health Change	FU New Health Goal	FU New Health Rating	FU Life Change	FU New Life Goal	FU New Life Rating
3 Months	2.69±0.68	0.94±0.42	0.91±0.52	2.71±0.57	1±0.54	1.09±0.45
6 Months	2.78±0.42	1.21±0.54	0.94±0.71	2.89±0.45	0.84±0.37	0.63±0.5
9 Months	2.87±0.35	0.87±0.35	0.63±0.74	2.78±0.67	1±0.5	1±0.5
12 Months	2±1	1.2±0.35	1	3	0.86±0.38	0.57±0.53

6.1.3 How are patients rating their goals at intake and 3 months? How are the rates changing?

As reported in Table 4 and visualized in Figure 22 to 24, on average, patients rate their life goals more than their health goals. Figure 22 to 24 show that for both health and life goals, the distribution of ratings are bimodal, concentrated both on the 0 end and on the higher 80-100% ends, meaning that patients have a tendency to either give very high or very low goal attainment ratings. For health goals, patients have a strictly increasing trend in SC and C4P arm. C4P patients have a slightly higher ratings of 59.18% than the SC patients, who have a 58.4%, but for the ensuing months, SC patients report a higher health rating than C4P patients, with a approximate 6% margin. The patients in CCP arm, however, experience a rise in ratings peaking at 6 months at 61.6%, which then decrease to 58.27%. C4P patients experience the highest boost in health goal ratings, a 13% increase overshadowing CCP and SC's around 8%. Likewise, for life goals, all patients of SC, CCP and C4P experience an increase in ratings as time goes on, but most saliently for CCP, which reports a 12% increase in the 12 month period, seconded by C4P and SC's around 9%. Overall, SC patients report the highest ratings for both health and life goals. As shown in Table 6, ANOVA tests show that the differences across arms are highly significant for both health and life goals across months, with F scores ranging from 61 to -25315. The significance is much less pronounced in life goals than health goals.

Figure 22 to 24 also show that the difference between health and life goals defined as $\Delta\text{rate}_m = \text{rate}_m - \text{rate}_{m-1}, \forall m \in 3, 6, 9$, are centered around 0, with decreasing means across arms. For health goals, the C4P group experience a around 5% decrease in Δrate across time as opposed to CCP's 9% and SC's 6%. Similarly, for life goals, the C4P group experience a around 2% decrease in Δrate across time as opposed to CCP's 5% and SC's 5%. This means that as time goes on from intake to 12 months, the ratings increase for C4P patients and plateaus. A rank-sum test shows us that the difference between rate_m and rate_{m-1}, or Δrate_m is only significant for the SC Group between intake and 3 months. This might be because 3 months is not a sufficiently large enough window to see significant difference, since the trend of reported ratings is strictly increasing.

Figure 22: Distribution of Goal Rates between Intake and 3 Months

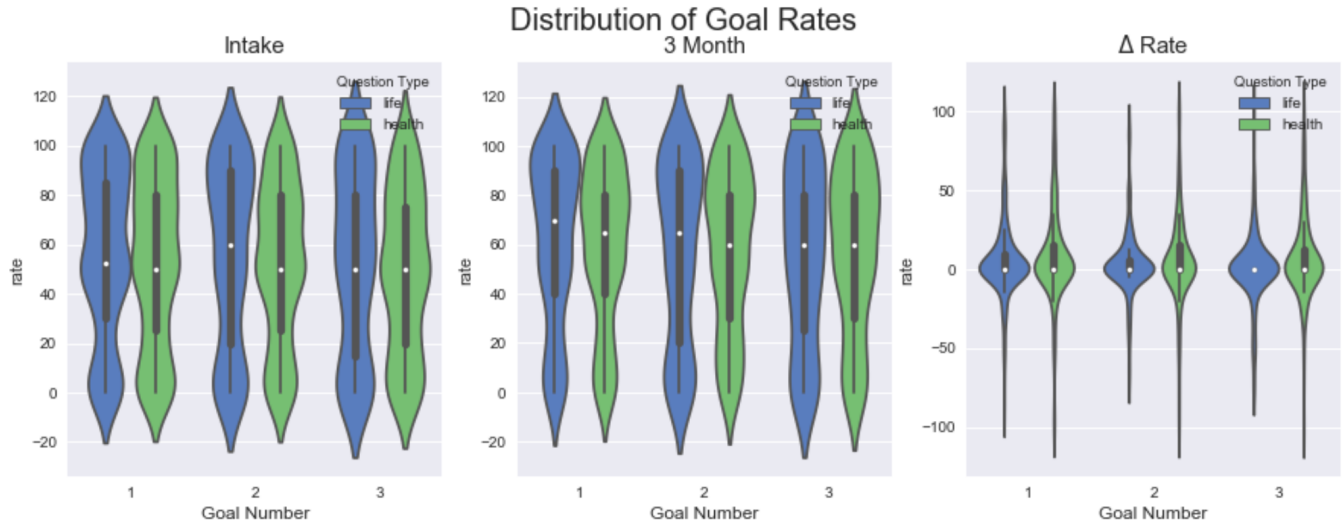


Figure 23: Distribution of Goal Rates between 3 Months and 6 Months

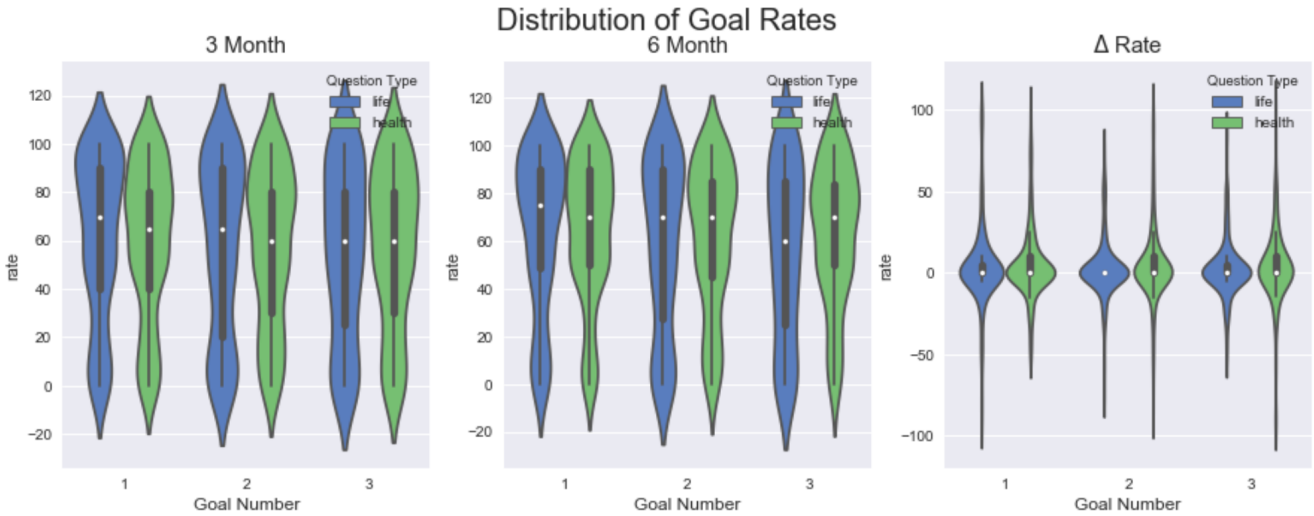


Figure 24: Distribution of Goal Rates between 6 Months and 9 Months

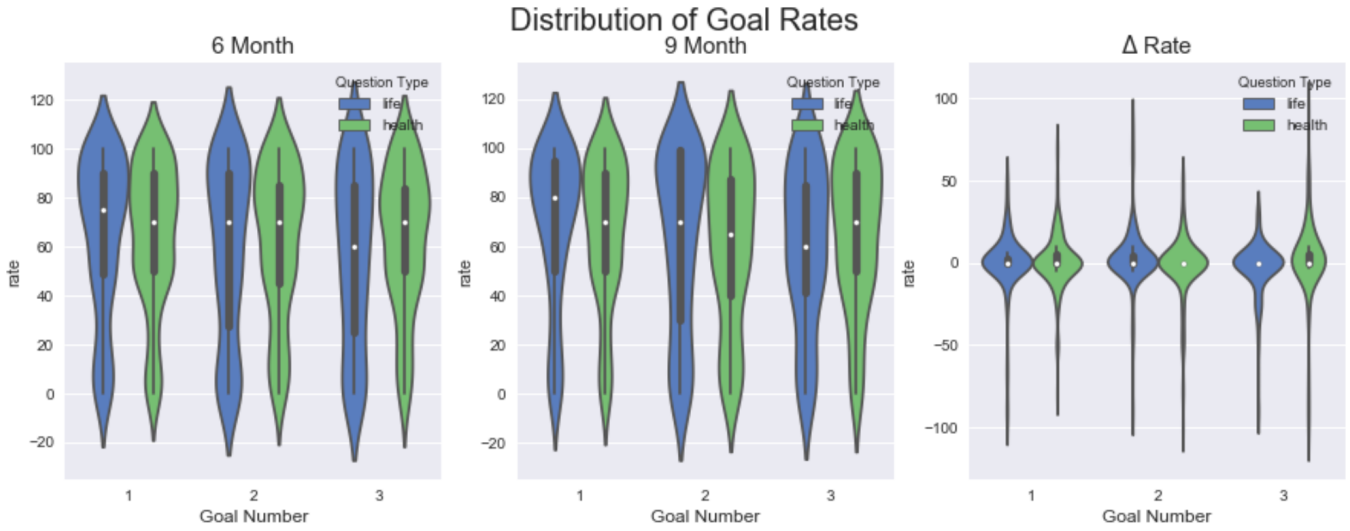


Figure 25: Distribution of Goal Rates between 9 Months and 12 Months

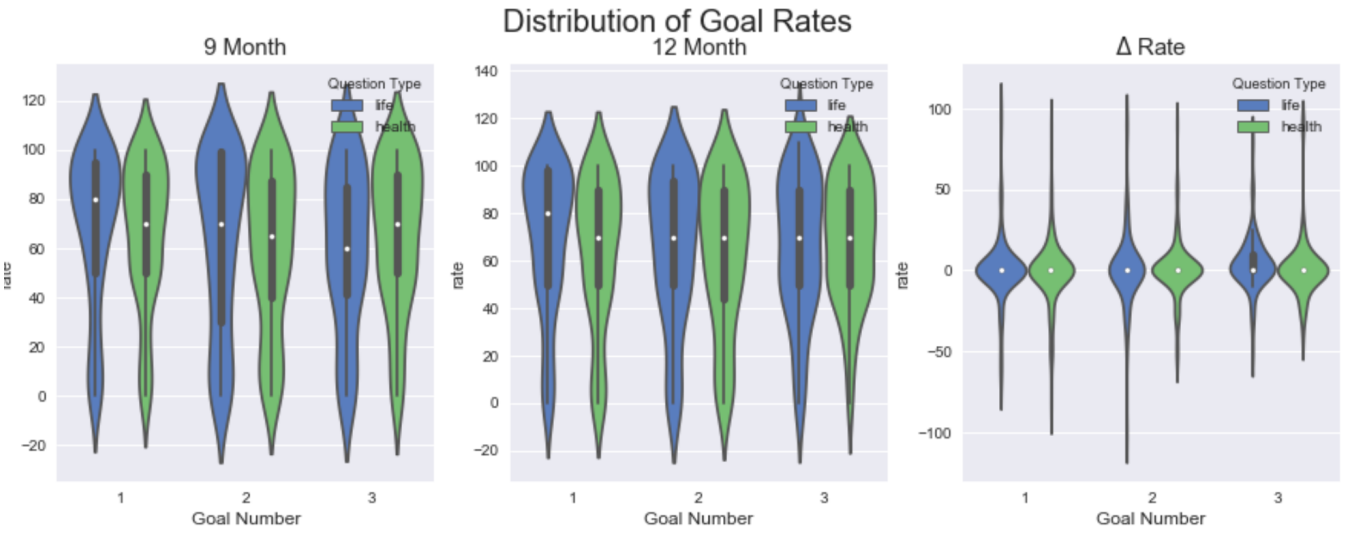


Table 4: Average Rates and Change in Rates in First Year

		Month				
		Intake	3	6	9	12
Health	SC	52.99±33.16	58.4±33.68	66.67±28.68	67.85±28.35	70.44±28.96
	CCP	51.14±33.45	56.98±30.55	61.6±31.03	60.89±33.27	58.27±30.88
	C4P	51.66±32.39	59.18±31.36	60.95±2915	62.04±29.5	64.36±28.46
Life	SC	57.43±34.47	63.38±33.89	64.03±33.1	69.33±30.37	68.63±30.68
	CCP	54.07±36.66	58.15±45.63	61.24±33.88	64.68±32.56	66.81±30.79
	C4P	53.65±34.59	54.04±35.31	56.12±35.56	59.66±35.51	64.50±30.45
Delta Health	SC		7.35±28.2	3.9±23.23	0.13±13.05	1.2±16.9
	CCP		6.93±26.87	6.3±23.39	1.27±18.76	`-2.67±20.29
	C4P		6.35±30.45	3.57±21.38	`-0.37±24.38	1.41±19.51
Delta Life	SC		5.4±22.2	0.74±21.52	2.46±17.68	0.43±16.33
	CCP		4.02±25.06	4.86±23.65	0.57±13.21	`-1.8±24
	C4P		2.29±22.29	2.7±20	`-1.98±22.26	4.19±20.6

Table 5: Rank Sum Test of Rates

	Current Month VS Baseline Month			
t-Value	3 - Intake	6 ~ 3	9 ~ 6	12 ~ 9
Overall (n=529)	3.25**	1.14	-0.05	0.33
SC (n=172)	2.58**	-0.33	0.18	0.07
CCP(n=180)	1.43	1.9	-0.02	-0.7
C4P(n=177)	1.93	0.08	-0.2	1.09
p<0.05 *, p<0.01 **, p<0.001***				

Table 6: ANOVA Test for Δ rate based on Randomization

	F-Value	Current Month VS Baseline Month				
		Intake	3	6	9	12
Overall	Rate	203***	359***	442***	408***	586***
	Delta		2.41	5.82**	0.5	3.68**
Health	Rate	230***	712***	2837***	`-25315***	`-3025***
	Delta		2.57	4.34*	1.69	0.76
Life	Rate	41***	61***	63***	56***	73***
	Delta		0.89	2.79	2.74	3.5*
p<0.05 *, p<0.01 **, p<0.001***						

6.2 Mixed Effect Pattern Mixture Model Results

Figure 26 shows the consort diagram for the population analyzed here. This is different from the whole population as only patients who have completed all followup surveys in the one-year window

are included in the model. As we can see, out of the 534 patients randomized, 4 in the C4P arm withdrew from the study. Out of the remaining 530, only 304 are analyzed for the outcome of hospitalization times, 263 are analyzed for provider ranking, and 303 are analyzed for mental health ranking. The latter two outcome variables are binary, where only patients who report an 'excellent' are marked as 1, and the rest are marked as 0.

The outcome variables are in their binary forms, converted from the categorical survey responses, except for the number of hospitalization times. The self-reported mental health rating *Mental* we consider patients who answer "excellent" or "very good" in their survey to be 1, and the rest to be 0. Likewise for provider ranking, we consider patients who answer "best provider possible" to be 1, and the rest to be 0. For health and life goal attainment level, from Figure 22 to 25 we can see that the distribution of goal rates are bimodal. We define average goal ratings as an average of all reported followup ratings, for health and life goals respectively, including the ones reported for new goals. Within the first year window, the means of average ratings for health and life goals are 57.9 ± 26.7, and 60.1 ± 29.9, with upper quartile 80 and 85. Here we consider patients who report ratings > 80 to have 1 for binary variables *Health Level* and *Life Level*.

Figure 26: Consort Diagram for C4P

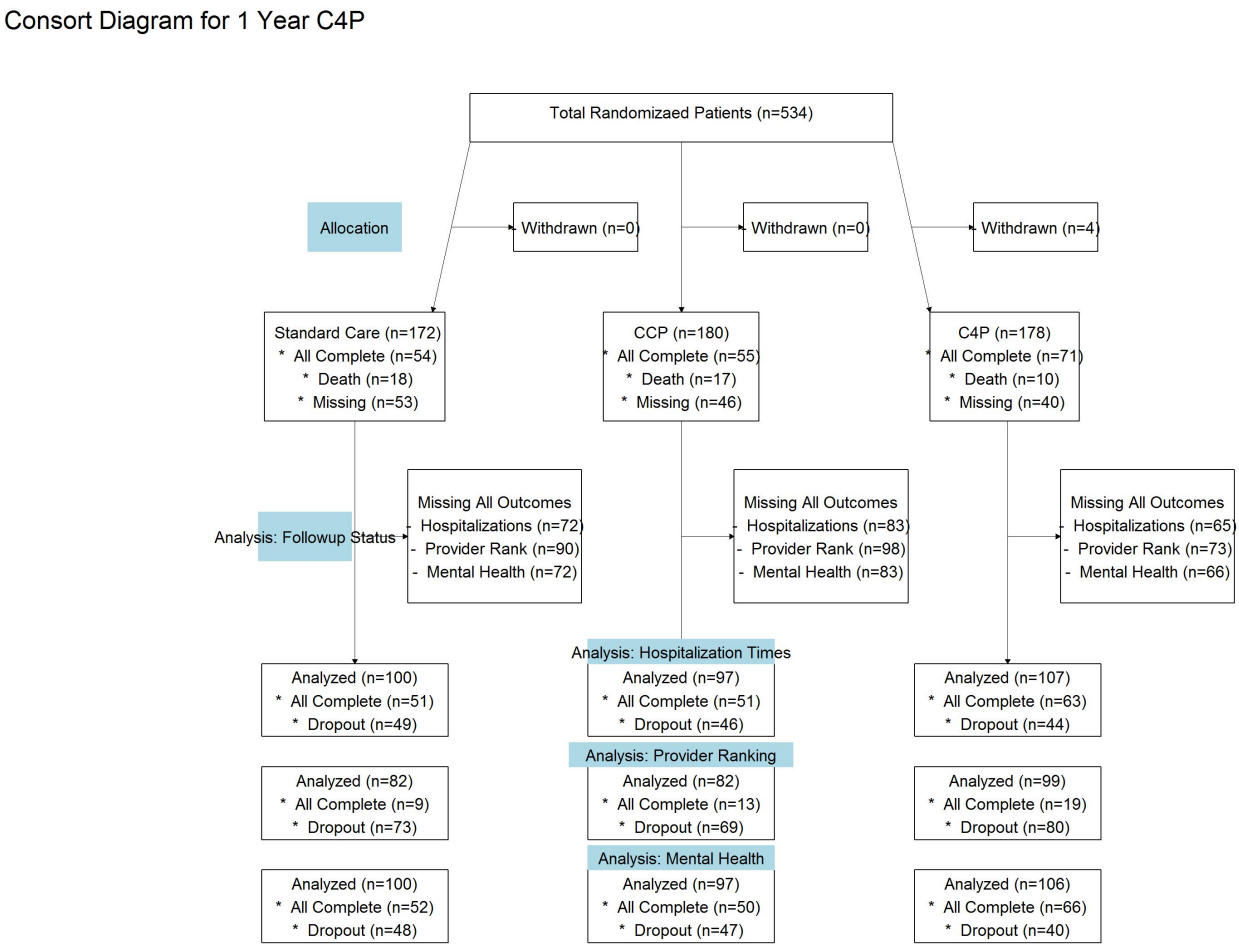


Table 7 reports that controlling for the bias created by drop-out patients, on average for both drop-out and non-drop-out patients, C4P reduces hospitalization numbers within a one year time window by 0.07 ($p < 0.001$). C4P also increases the log-odds to report 'excellent' for mental health rating by 0.2 ($p < 0.001$), which translates to an increase in likelihood of 22.1%. C4P increases the log-odds to report 'Best Provider Possible for provider rating by 0.21, which translates to a likelihood of 23.3% ($p > 0.05$). However, consistent with what we found in Table 4, C4P patients report lower health and life goal ratings. In the MEPM Model, C4P patients are 40.5%($p < 0.001$) and 75.1%($p < 0.001$) less likely to report the goal attainment ratings in the highest quartile. This can be due to the fact that patients hold higher standards for life and health goals, given the information they are provided in the Community Health Worker (CHW) and Artful Living Program (ALP).

Table 8 reports that patients in the higher quartile of average health ratings on average have 0.04 more hospitalizations than patients who are not. The former also are 122.6% ($p < 0.001$) and 390.4% ($p > 0.05$) more likely (with increased log-odds of 0.8) to report the highest mental health and provider ratings. Patients in the higher quartile of average life ratings, on the other hand, are associated with a 0.04 ($p < 0.001$) decrease in number of hospitalizations, and 100.4% ($p > 0.05$) increase in likelihood in reporting the best provider ranking (Table 9). However, they are associated with a 22.4% ($p < 0.001$) decrease in likelihood to report the highest mental health ratings. This might be due to the fact that patients who report most progress with their life goals have much room for improvement with their life goals, resulting in issues that could lead to the decrease in likelihood of reporting the best mental health ratings.

Overall, we can see that C4P has the expected effect of reducing number of hospitalization and increasing mental health ratings significantly. It also increases provider ranking insignificantly. However, C4P patients are associated with lower ratings of health and life goal attainment levels. Better ratings for both health and life goal attainment levels are associated with higher likelihood of reporting higher provider rankings, although the associations are insignificant. High health goal ratings significantly associate with increase in hospitalizations, and life goal ratings with decrease in mental health ratings. This might be because patients who report higher goal attainment ratings

for their health and life goals have more problems with their health and life respectively, resulting in the negative effect in number of hospitalizations and mental health respectively.

Table 7: C4P Effect on Outcomes by MEPM Model

	(1) Hospitalizations	(2) Mental	(3) Provider	(4) Health Level	(5) Life Level
main					
c4plwdrop	-0.379	-1.210	1.040	-0.478	-1.928
	(-1.55)	(-1.08)	(0.55)	(-0.26)	(-1.19)
c4pdrop	-0.324	-0.092	-0.261	-2.726	1.799
	(-1.52)	(-0.09)	(-0.17)	(-1.61)	(1.25)
lwdrop	0.352*	0.850	-0.299	1.352	1.161
	(2.57)	(1.41)	(-0.33)	(1.62)	(1.23)
c4p	-0.047	-0.320	0.733	0.814	-1.246
	(-0.38)	(-0.59)	(0.85)	(1.08)	(-1.62)
logwave	-0.262***	-0.798**	0.361	0.452	0.384
	(-4.01)	(-2.89)	(0.76)	(1.22)	(1.10)
c4plogwave	0.125	0.813	-0.314	-0.097	0.417
	(1.20)	(1.91)	(-0.44)	(-0.17)	(0.70)
ageless50	0.134	0.285	-3.423*	-1.064	-2.389
	(0.68)	(0.31)	(-2.06)	(-0.56)	(-1.52)
age50_64	0.153	0.099	-3.353*	-1.164	-2.601
	(0.80)	(0.11)	(-2.15)	(-0.62)	(-1.68)
age65_74	0.090	0.349	-3.730*	0.275	-1.243
	(0.48)	(0.40)	(-2.34)	(0.15)	(-0.82)
age75_84	0.092	-0.083	-3.460*	0.028	-1.504
	(0.46)	(-0.09)	(-2.11)	(0.02)	(-0.96)
female	0.021	-0.550	-0.273	-0.915	-0.301
	(0.27)	(-1.54)	(-0.49)	(-1.78)	(-0.60)
numhosp	0.116***				
	(6.04)				
dual	0.022	-1.234**	0.130	1.146*	-0.606
	(0.27)	(-3.15)	(0.22)	(1.99)	(-1.12)
drop	0.219	-0.485	0.600	-0.054	-1.516
	(1.78)	(-0.88)	(0.69)	(-0.07)	(-1.75)
rate_mental_best_bas		-3.231***			
		(-6.50)			
provider_best_bas			0.899		
			(1.54)		
avgh_bas				5.355***	
				(6.31)	
avgl_bas					5.848***
					(7.35)
Constant	0.200	1.188	2.823	-3.262	-0.356
	(1.02)	(1.31)	(1.82)	(-1.71)	(-0.23)
Linear Combination	-0.07***	0.20***	0.21	-0.34***	-0.56***
S.E.	(0.12)	(0.56)	(0.95)	(0.92)	(0.81)
R-squared					
N. of cases	908	934	322	790	731

Table 8: Health Goal Attainment Level's Effect on Outcomes by MEPM Model

	(1) Hospitalizations	(2) Mental	(3) Provider
main			
ahrlwdrop	-0.075	1.623	1.815
	(-0.25)	(1.21)	(0.84)
ahrdrop	0.419	-0.328	-0.448
	(1.76)	(-0.30)	(-0.25)
lwdrop	0.108	0.134	-0.936
	(0.71)	(0.20)	(-0.82)
avgh	-0.060	0.524	-0.124
	(-0.50)	(1.03)	(-0.13)
logwave	-0.255***	-0.509	-0.038
	(-4.14)	(-1.92)	(-0.09)
ahrlogwave	0.073	-0.018	0.676
	(0.63)	(-0.04)	(0.68)
ageless50	0.291	-0.128	-2.150
	(1.39)	(-0.13)	(-1.35)
age50_64	0.284	-0.270	-2.577
	(1.39)	(-0.28)	(-1.69)
age65_74	0.200	-0.105	-3.193*
	(1.00)	(-0.11)	(-2.04)
age75_84	0.161	-0.564	-3.039
	(0.76)	(-0.56)	(-1.87)
female	0.025	-0.292	0.247
	(0.34)	(-0.83)	(0.43)
numhosp	0.097***		
	(5.28)		
dual	-0.043	-1.519***	-0.596
	(-0.53)	(-3.85)	(-0.96)
drop	0.007	-0.358	0.574
	(0.06)	(-0.67)	(0.67)
rate_mental_best_bas		-2.842***	
		(-5.76)	
provider_best_bas			0.749
			(1.24)
Constant	0.165	1.249	2.475
	(0.80)	(1.28)	(1.62)
Linear Combination	0.04***	0.80***	1.59
S.E.	(0.15)	(0.68)	(1.09)
R-squared			
N. of cases	797	827	277

Table 9: Life Goal Attainment Level's Effect on Outcomes by MEPM Model

	(1) Hospitalizations	(2) Mental	(3) Provider
main			
alrlwdrop	-0.423	1.140	1.656
	(-1.45)	(0.87)	(0.87)
alrdrop	0.335	0.677	-0.571
	(1.41)	(0.61)	(-0.38)
lwdrop	0.313	0.124	-0.990
	(1.92)	(0.17)	(-0.84)
avgl	-0.259*	1.087*	0.415
	(-2.15)	(2.12)	(0.49)
logwave	-0.272***	-0.210	0.195
	(-4.11)	(-0.73)	(0.43)
alrlogwave	0.173	-0.780	-0.138
	(1.52)	(-1.63)	(-0.18)
ageless50	0.200	0.332	-2.571
	(0.95)	(0.34)	(-1.68)
age50_64	0.184	-0.141	-2.672
	(0.90)	(-0.15)	(-1.87)
age65_74	0.167	0.378	-3.022*
	(0.83)	(0.40)	(-2.05)
age75_84	0.092	-0.524	-3.229*
	(0.43)	(-0.53)	(-2.10)
female	0.001	-0.603	-0.211
	(0.01)	(-1.64)	(-0.37)
numhosp	0.099***		
	(5.36)		
dual	-0.015	-1.485***	-0.196
	(-0.19)	(-3.64)	(-0.33)
drop	-0.061	-0.340	0.925
	(-0.50)	(-0.59)	(1.02)
rate_mental_best_bas		-2.673***	
		(-5.26)	
provider_best_bas			0.492
			(0.85)
Constant	0.284	0.833	2.556
	(1.38)	(0.87)	(1.76)
Linear Combination	-0.04***	-0.20***	0.70
S.E.	(0.15)	(0.66)	(0.93)
R-squared			
N. of cases	738	760	271

6.3 Topic Modeling

For topic modeling, I applied both CorEx and LDA to health and life goals reported by patients in the first follow up months (1 year). For consistency, the three goal related questions were concatenated into one corpus for analysis, respectively for health and life goals.

CorEx has an extra features that allows for n-grams to be processed as individual tokens during the unsupervised training. For example, instead of analyzing "get" or "lose" on its own, I would

analyze "get healthy" or "lose weight" as a 2-gram. Here, I included word combinations of length from 2 to 5 to be included in the CorEx model. CorEx and LDA report two different metrics in selecting the best number of topics. CorEx optimizes on total coherence and LDA on total correlation. Both metrics measure how similar two variables are. The difference is that coherence measures similarity in frequency space, while correlation measures similarity in time space. For both models, the optimal number of topics is selected based on the rule that if the $n + 1$th topic can add very little to the total coherence/correlation, then n is the optimal number of topics.

Figure 29 shows that the optimal number of topics for both health and life goals is 8. The 9th topic would contribute little to the total correlation of the whole corpus. Using CorEx Model, as shown in Figure 30, 16 is the ideal number of topics for both life and health goals. The health goals have a total coherence score of 12.3, while the life goals have a total coherence score of 15.24.

From Figure 31 we can see that CorEx Model has a tendency to concentrate goals to belong to the same category. For health, the most concentrated goal category is the 15th, which is related to seizure and pain control, where 399 out of 808 entries of health goals reside. The most common n-gram words associated with the goal category suggest that the category has something to do seizure and chronics pain. Similarly for life goals, the most common goal category is the 14th , where 346 out of the 808 reside. Judging from the most frequent word phrases, the category is correlated with doing the right thing, and dialysis.

The most common words in a category can reflect the topics most closely associated together. For example, the second CorEx topic for health (Appendix 8.2) has both "blood pressure" and "medication" as the most common words, which is consistent with the fact that patients with high blood pressure take BP controlling medicines frequently. Similarly, the first category of life goals suggest that "neighbors" and "music" is closely correlated. Table 10 summarizes such similarities.

Table 10: Frequent Word Summary for CorEx and LDA

	Index	Health	Life
CorEx	1	want, lose weight, cancer treament, better quality life	neighbors, music
	2	blood pressure, medication	god, outdoor concert, new car warranty
	3	Climbing stairs, physical activity	quality of life, spiritual
	4	physical therapy, patient wants	physicially fit, commit crime
	5	new glasses, physical activities	family, work
	6	patient leg, healing wound	spend time, kids
	7	kidney transplant, use left	overcome disability, good interactions
	8	make sure, get rid of arthritis sinuses	new goal, nurturing talk
	9	new kidney, healthy eating	poetry, sleepy, grand kids
	10	medication, lose weight, patient better	healthy eating, jehovah witness, lousy girlfriend
	11	new goal, lose 20 lbs	care for children, live till 92
	12	fruits and vegetables, lose 15 lbs	play parakeets, scooter, activities
	13	orders doctor, operation success	ride bike, buy new home
	14	change goal, 30lbs	do the right thing, dialysis
	15	seizure, chronic pain	return to church, care for people, new sofa
	16	exercising, stay healthy	go outside, go to church
LDA (Mallet)	1	stay at hospital, control sugar, dental	marry, job
	2	healthy, care, gain back	travel, home
	3	healthy, run, fruits	care for kid, activity
	4	work, eat, physical	life, goal
	5	exercise, heart	family, time
	6	pain, walk, kidney, get rid of smoking	stay healthy, church
	7	lose weight, active, doctor	work, grandkidsd
	8	diabetes, medication, surgery	friend, travel

Some common overarching topics identified by both models for health goals include losing weight, controlling blood pressure, mobility/physical therapy, surgery/pain control and being healthy. Some topics for life goals include working/being independent, spending more time with families, staying active, being healthy, and going to church. Table 27 and Table 28 shows the frequency of goals belonging to each overarching category. Using CorEx, not surprisingly, the new Surgery/Controlling Pain/Seizure category that includes the original 15th category for health occupy the most percentage, and the new Staying Active/ Participate category that include the original 14th category dominate for life goals.

Contrary to CorEx's concentrated behavior, LDA gives a more even distribution of the five topics. Based on LDA (mallet), the most common topic for health is wanting to get better or more healthy (28.6%), seconded by controlling blood pressure (26.2%), and those related to patients' mobility (22.4%), like physical therapy, or movements like walking, running and climbing. Note that the Gensim's (Rehuurek, Radim and Sojka, Petr, 2011) LDA model gives slightly different predictions from Mallet (McCallum, 2002). Gensim's LDA model categorized goals are mostly

Table 11: Primer Words for Anchored CorEx Model

	Goal Description	Primer
Health	Controlling Blood Pressure	'blood pressure'
	Lose weight/ Eating Healthy	'lose weight','20 pounds','pounds 194','15 pounds','l
	Mobility/ Physical Therapy	'climbing stairs','able walk','physical therapy','phys
	Surgery/Controlling Pain/Seizure	'kidney transplant','seizures slow','control pain','rid
	Want to be better/ healthy	'stay healthy','better quality','new goal'
Life	Working/ Independence	'work gives independence','pt like work','work incon
	Care for/ Spend Time with children/ Family	'spend time grandchildren','watch grand kids','time
	Staying Active/ Participate	'physically fit','program stay healthy','physically he
	Be Healthy	'play parakeets','play basketball','active involved','p
	God/ Church/ Community	'going church','ones god','minister church'

concentrated on mobility (31.7%), seconded by losing weight (25.2%) and getting healthy (24.2%). For life goals, both Gensim and Mallet give similar categorizations. Topics related to caring for or spending time with children, grandchildren and families take dominance, with a 35% by Gensim and 34.9% by Mallet. Topics related to working and independence come in second, occupying a 26.4% by Gensim and 27.9% by Mallet. The third place goes to topics related to staying active and participating in events, occupying a 15.3% by Gensim and 13.4% by Mallet.

With the five overarching topic categories, I anchored the CorEx with primer words that appeared in the raw goals and correspond to the five categories. Table 11 details the primer words I used to create the anchored CorEx Model. Figure 27 and 28 show that the anchored CorEx model, like the unanchored one, gives a concentrated distribution. The frequent words associated with the different goal categories (Appendix 8.2) given by the anchored model are more similar within topic than the unanchored one. For health goals, the anchored CorEx Model predict controlling blood pressure (57.9%)to be the dominant topic, seconded by wanting to be better and healthier (17.7%). The prediction for life goals are more consistent with the unanchored CorEx Model, where staying active and participating in events take dominance (57.9%), seconded by working and independence (17.9%).

Overall, the five categories for health goals (losing weight, controlling blood pressure, mobility/-physical therapy, surgery/pain control and being healthy) take turn in dominance in the population predicted by different models. In contrast, among the five overarching categories for life goals

(working/being independent, spending more time with families, staying active, being healthy, and going to church), the different models converge on caring for children/families, and staying active/ participating in events to be the dominant topics.

Figure 27: Grouping of Health Topics by CorEx and LDA

Health Topic Groups (n=818)								
New index	Topic	Indices CoreEx	Indices LDA	Indices LDA (Mallet)	Unanchored CoreEx Pct	Anchored CoreEx Pct (%)	LDA Pct	LDA Mallet Pct
1	Controlling Blood Pressure	2, 11, 12, 14, 16	7	1, 8	19.7	57.9	12.5	26.2
2	Lose weight/ Eating Healthy	1, 10	3, 5	7	7.6	8.6	25.2	10.3
3	Mobility/ Physical Therapy	3, 5	6, 8	6, 4	6.1	8.9	31.7	22.4
4	Surgery/Controlling Pain/Seizure	6, 7, 9, 13, 15	4	5	61.7	6.8	6.5	12.6
5	Want to be better/ healthy	4, 8	1, 2	2, 3	4.9	17.7	24.2	28.6

Figure 28: Grouping of Life Topics by CorEx and LDA

Life Topic Groups (n=700)								
New index	Topic	Indices CoreEx	Indices LDA	Indices LDA (Mallet)	Unanchored CoreEx Pct	Anchored CoreEx Pct	LDA Pct	LDA Mallet Pct
1	Working/ Independence	5,10	1, 3	1,7	6	17.9	26.4	27.9
2	Care for/ Spend Time with children/ Family	6, 9, 11	4, 6, 7	2, 3, 8	8	7.3	35	34.9
3	Staying Active/ Participate	3, 7, 12, 13,14	2	6	62.1	57.9	15.3	13.4
4	Be Healthy	4	5	5	3	9.9	13.9	12.1
5	God/ Church/ Community	1, 2, 8, 15, 16	8	4	20.9	7.1	9.4	11.7

Figure 29: Total Correlation and Number of Topics using LDA

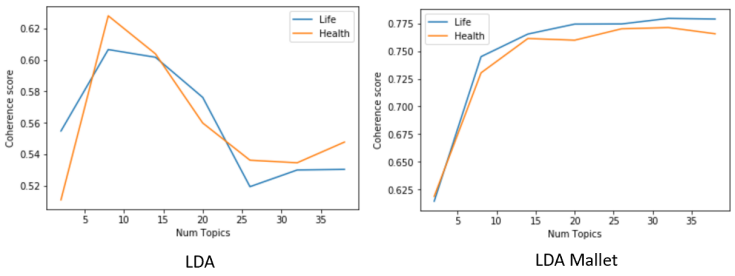
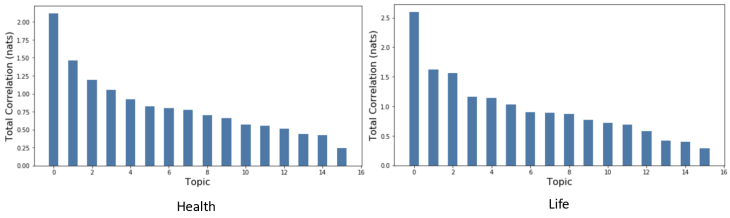


Figure 30: Total Correlation and Number of Topics using CorEx



Despite the regrouping of the topics determined by the unsupervised LDA Model makes intuitive sense, the classification of topics given by the models were decided arbitrarily. There are certain topics that can classify as multiple overarching goal categories. Thus, to keep the exclusiveness of topics, for the mediation effect analysis in the ensuing section, I will use the original topics predicted by the Mallet LDA model and the unanchored CorEx Model as the covariate to be analyzed in the following section.

6.4 Mediation Effect

To consider the mediation effect of goal categories, I take the most typical topic for health and life goals respectively according to Figure 27 and 28: controlling blood pressure, and spending time with children/families. The controlling blood pressure health topic corresponds to topic 1 and 8 determined by LDA Mallet method, and topic 2, 11, 12, 14 and 15 determined by CorEx method. The spending time with children/families life topic correspond to topic 2, 3, 8 determined by LDA Mallet method, and topic 8 determined by CorEx method.

Overall we do not see big contribution of these two topics to the effect of C4P on outcomes, and

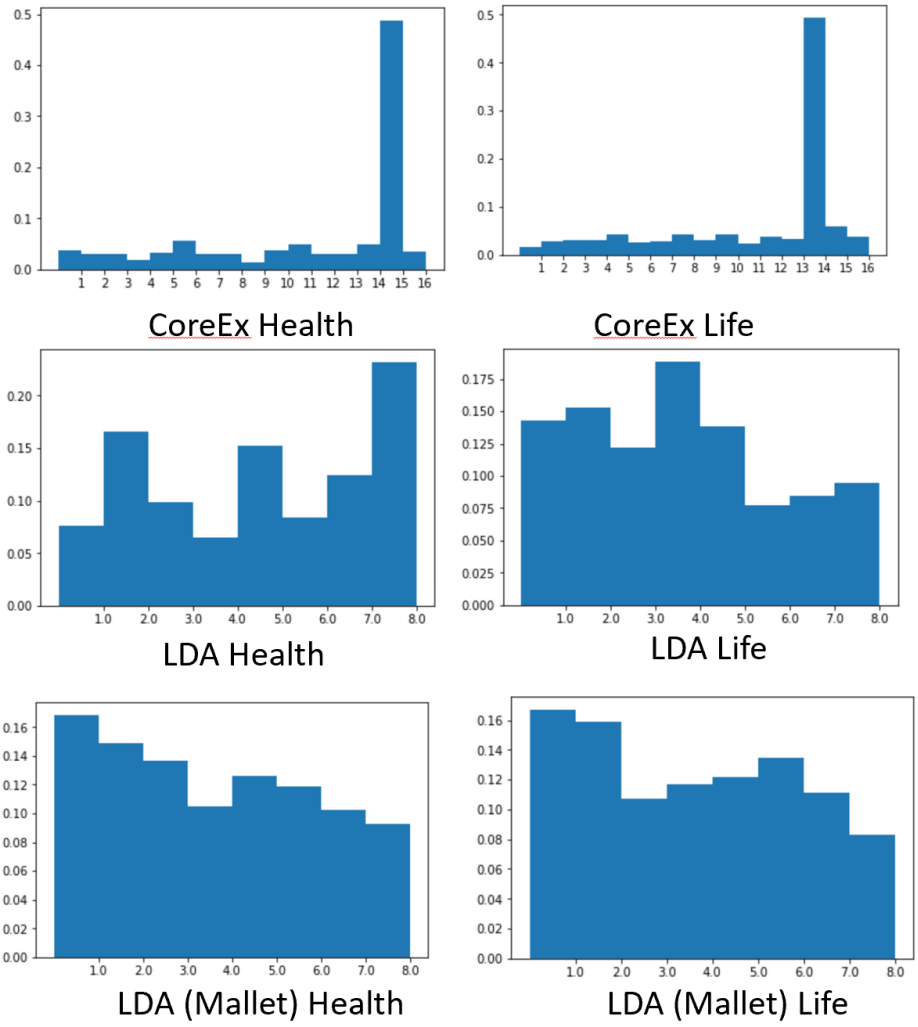


Figure 31: Frequencies of topics in CorEx and LDA Topic Modeling

none of the effect is significant. This is especially true for the contribution of the health goal "controlling for blood pressure" defined by CorEx. As shown in Table 15 the topic contributes around 1e-12 Ĩe-9 % to C4P's effect on outcomes. I hypothesize that this is due to the hybrid nature of the subtopics in this overarching topic. As shown in Table 27, 5 subtopics defined by the unsupervised CorEx Model can classify as "controlling blood pressure". It could be that some subtopics include key words of less but still significant correlation with other overarching topics, which can undercut the mediation effect of the "controlling blood pressure" overarching topic.

Table 12 reports that the "spending time with families" topic defined by the LDA model account for almost no proportion of C4P's effect on hospitalizations, -2.71% of C4P's effect on mental health, and -0.31% of its effect on provider's ranking. The negative signs indicates that the patients reporting spending morel time with children and families experience slightly negative effect of C4P on mental health ratings and provider ratings. One tenuous hypothesis is that the programs that C4P provides take up time that they could have spent with their families. However, such negative effect is contradicted by the "spending with families" goal categorized by the CorEx Model (Table 13), which predicts that the goal category contributes 6.1% to C4P's effect on mental health ratings and 4.4% to provider ratings.

Table 14 predicts that the topic of "controlling blood pressure" contributes 12.3% of C4P's effect on decreasing the number of hospitalizations, which is the highest contribution amongst all estimates. This can be due to the fact C4P's community workers give the patients information about controlling blood pressure, which in turn allow C4P patients to reduce their number of hospitalizations. However, patients who report controlling blood pressure to be a goal experience adverse effect of C4P on increasing mental health ratings. One hypothesis is that patients who have blood pressure problems in the C4P group are more pressured to keep track of their health statuses, resulting in lowered mental health scores.

Table 12: Mediation Effect of Life Goal Categories defined by LDA Model on C4P's Effect on Outcomes

	(1) Hospitalizations	(2) Mental	(3) Provider
total	0.726	0.319	4.292
	(0.04)	(0.25)	(0.21)
indirect1	0.00000277	-0.00861	-0.0138
	(0.00)	(-0.11)	(-0.05)
direct1	0.726	0.328	4.305
	(0.04)	(0.26)	(0.21)
indirect2	0.00000277	-0.00870	-0.0124
	(0.00)	(-0.10)	(-0.04)
direct2	0.726	0.328	4.304
	(0.04)	(0.26)	(0.21)
method1	0.00000382	-0.0270	-0.00322
	(0.00)	(-0.01)	(-0.05)
method2	0.00000382	-0.0273	-0.00289
	(0.00)	(-0.01)	(-0.04)
average	0.00000382	-0.0271	-0.00305
	(0.00)	(-0.01)	(-0.04)
Observations	54	91	51

t statistics in parentheses

Table 13: Mediation Effect of Life Goal Categories defined by CorEx Model on C4P's Effect on Outcomes

	(1) Hospitalizations	(2) Mental	(3) Provider
total	0.726	0.300	3.405
	(0.08)	(0.32)	(0.19)
indirect1	0.000163	0.0176	0.263
	(0.00)	(0.18)	(0.03)
direct1	0.725	0.282	3.142
	(0.09)	(0.30)	(0.17)
indirect2	0.000162	0.0187	0.0348
	(0.00)	(0.15)	(0.04)
direct2	0.725	0.281	3.370
	(0.09)	(0.29)	(0.19)
method1	0.000224	0.0587	0.0773
	(0.00)	(0.03)	(0.01)
method2	0.000224	0.0625	0.0102
	(0.00)	(0.03)	(0.01)
average	0.000224	0.0606	0.0438
	(0.00)	(0.03)	(0.01)
Observations	54	91	51

t statistics in parentheses

Table 14: Mediation Effect of Health Goal Categories defined by LDA Model on C4P's Effect on Outcomes

	(1) Hospitalizations	(2) Mental	(3) Provider
total	-0.208	1.073	1.532
	(-0.01)	(1.42)	(0.47)
indirect1	-0.0256	-0.0327	0.0534
	(-0.14)	(-0.30)	(0.34)
direct1	-0.182	1.106	1.479
	(-0.01)	(1.45)	(0.45)
indirect2	-0.0254	-0.0334	0.0580
	(-0.14)	(-0.27)	(0.30)
direct2	-0.182	1.106	1.474
	(-0.01)	(1.44)	(0.45)
method1	0.123	-0.0305	0.0349
	(0.03)	(-0.01)	(0.11)
method2	0.122	-0.0311	0.0379
	(0.03)	(-0.01)	(0.11)
average	0.123	-0.0308	0.0364
	(0.03)	(-0.01)	(0.11)
Observations	57	99	56

t statistics in parentheses

Table 15: Mediation Effect of Health Goal Categories defined by CorEx Model on C4P's Effect on Outcomes

	(1) Hospitalizations	(2) Mental	(3) Provider
total	-0.180	-0.00793	0.155
	(-1.08)	(-0.06)	(0.98)
indirect1	9.77e-15	1.51e-14	1.33e-15
	(1.32)	(1.12)	(0.11)
direct1	-0.180	-0.00793	0.155
	(-1.08)	(-0.06)	(0.98)
indirect2	-1.23e-14	1.58e-14	4.66e-15
	(-1.60)	(1.13)	(0.42)
direct2	-0.180	-0.00793	0.155
	(-1.08)	(-0.06)	(0.98)
method1	-5.42e-14	-1.90e-12	8.59e-15
	(-0.11)	(-0.19)	(0.00)
method2	6.84e-14	-1.99e-12	3.01e-14
	(0.11)	(-0.08)	(0.01)
average	7.09e-15	-1.95e-12	1.93e-14
	(0.02)	(-0.25)	(0.00)
Observations	910	1298	790

t statistics in parentheses

7 Discussion

7.1 Summary of Findings

This paper examines the role that goal attainment plays in the C4P study within a one year time window. We discover that patients report higher life goal attainment ratings than its health counterpart, a 3-5% difference. We see a significant increasing trend for both health and life goals within one year (Table 4). The biggest increase happens between intake and 3 months, significant for the standard care group. We find no significance for the increases in other months. The C4P group report lower scores than the SC and CCP groups, especially for health goals. Mixed-Effect Pattern Mixture Models confirms that C4P patients are 40.5%($p < 0.001$) and 75.1%($p < 0.001$) less likely

to report the goal attainment ratings in the highest quartile. However, we hypothesize that this is due to the fact that patients in the C4P group, with more exposure to information and life opportunities, hold higher bars for health and life goals.

Our analyses with Mixed-Effect Pattern Mixture Model find that C4P has the positive effect of significantly decreasing hospitalization times by 0.07 (Table 7), increasing the likelihood of reporting the best mental health and provider ratings by 22% and 23%. We also report significant positive association between high health goal attainment level and mental health ratings (Table 8). However, such association is significantly negative for life goal attainment levels (Table 9). Conversely, high health attainment levels are significantly associated with increase in number of hospitalization times, while high life goals are associated with a decrease in number of hospitalization times. We hypothesize that this is because higher goal attainment level is associated with more room in improvement for that goal category. Thus, a higher goal attainment level in health goals can relate with problems with health, reflected by an elevated number of hospitalization times. Likewise, a higher life goals attainment level relate with life issues, which can result in decreased mental health scores.

After applying CorEx and LDA for unsupervised topic modeling, we discover five overarching topic groups (Table 28 and 27. For health goals, the five topic groups are:

1. Losing weight
2. Controlling blood pressure
3. Mobility/physical therapy
4. Surgery/pain control
5. Being healthy

For life goals, the five topic groups are:

1. Working/being independent

2. Spending more time with families

3. Staying active

4. Being healthy, and going to church

Figure 27 and 28 show the frequencies of topics given by each model. I find that the CorEx Model gives more concentrated topic groups than the LDA model.
Two typical topics: controlling blood pressure (health) and spending time with families (life) were considered for mediation effect analysis. However, I did not find significant mediation proportion of the two topics to C4P's effect on patient outcomes.

7.2 Significance and Future Direction

The results from this study confirm the positive effects of C4P on patient outcomes: number of hospitalization times, self-reported mental health and physician ratings, and life and health goal attainment levels. However, the size of the study is still limited, with $\tilde{3}00$ people who have completed all surveys for the one year time window, which can contribute to insignificant results such as the effect of C4P and goal attainment levels on physician ratings, since the patient physician relationship might take more than one year to establish. The positive results set the stage for the Phase II of the C4P study, which plans to enroll around one thousand patients per arm, on equal scale with the CCP study. The results also provide policy motivation to include C4P program in programs such as Medicaid and Medicare.

With enlarged scale of the RCT studies, it will become near impossible to label text fields with human labor. Two topic modeling techniques were employed in this study to classify patients' self-reported goals in an unsupervised fashion. This provides inspirations for how NLP techniques can marry with traditional large-scale outcome research.

For future directions, we hope to test the effect of C4P on a larger scale in Phase II. One

modification to make is to change the scale 0-100% scale with 1% increments to the same percentage scale but with 10% increments. This will make it easier for patients to classify their progress rates.

8 Appendix

8.1 Survey Questions

1. Intake Goal

    1.1. *First, I would like for you to tell me 2-3 of the most important goals or values (you have/PATIENT HAS) about (your/PATIENT'S) health/life now.*

2. Intake Goal Attainment Level

    2.1. *Now, for each of these ratings, I want to know how well (you/PATIENT) feel (you/PATIENT) are doing at achieving these goals or values. Use the scale 0 to 100, with 0 being "doing the worst possible" and 100 being "doing the best possible."*

3. Followup Old Goal Progress Rate

    3.1. *Last time, you said $\cdots$ was a goal or value about your health. In terms of achieving that goal, you reported a rating of $\cdots$, on scale of 0-100 with 0 being doing the worst possible and 100 being doing the best possible , On that same scale of 0-100, how would you rate things now in terms of achieving that goal?*

4. Followup Goal Change

    4.1. *Now, we want to go through each of the goals and values about your health and see if you would like to change or keep that goal: (Yes, change the goal, No, keep the goal)*

5. Followup New Goals

    5.1. *If yes, new goal or value:*

6. Followup New Goal Attainment Level

6.1. *On the scale 0 to 100, with 0 being "doing the worst possible" and 100 being "doing the best possible." How would you rate that goal or value right now: ⋯ (0-100)*

8.2 Most Frequent Words in Goal Categories

8.2.1 CorEx Health

1: need eat , pt summary , pt summary want , want lose , physically mentally , weight want
2: blood pressure , lower blood pressure , lower blood , high blood , high blood pressur
3: doing things , climbing stairs , doing better , want able , ninth floor , ninth floor f
4: pt want , improve quality , able breath , trying stay , physical therapy , pt want heal
5: pt new , new glasses , able run , goal able , physical activities , physical activities
6: healing wounds , control pain , feel better , pt leg fixed right , pt leg fixed , pt le
7: transplant list , 20 pounds , use left , able use left , able use , kidney transplant
8: want make , want make sure , make sure , 20 lbs lost , pt just rid arthritis sinuses , p
9: new kidney , getting new , getting new kidney , staying healthy eating , able walk , h
10: medications prescribed , taking medications prescribed , lose little weight , lose
11: new goal just , goal just , new goal , 20 lbs , want feel , new goal just working anyr
12: fruits vegetables , goal new , lose 15 , lose 15 pounds , doesn know , goal new goal , r
13: able eat , operation successful january 5th , order time , orders gast , orders gast
14: 30 pounds , lose 30 pounds , lose 30 , like walk , better health , 100 healthy , patient
15: seizures want , 190 lbs , seizures slow tired seizures want , seizures slow tired
16: stay healthy , eat better , better exercising , sure meds , increase protein better ,

8.2.2 CorEx Life

1: getting involved , 200 month , neighbors married hard , neighbors married , neighbors
2: live life , able things want , ones god life faced wouldn , ones god life faced , one
3: quality life , day day , stay active , best quality life , best quality , want stay , wa
4: physically fit , 70 having , people crimes commit , people crimes commit stupidity ,
5: good family , good family member , family member , work gives independence , gives in

6: spend time,doing things,spend time grandchildren,time grandchildren,time kids

7: active involved,enjoy life,45 years,overcome diability says wants support,pe

8: new goal,better relationship,new goal given,nursing home,nurturing talking,n

9: grands kids,10 additions,pain medications make sleepy,performing poetry,progr

10: healthy eating,jehovah witness,50 weeding,pretty lousy girlfriend,pretty lou

11: taking care,good health,care husband,grandson graduate,taking care children,

12: want continue,activities great,place wanted bedrooms,place wanted bedrooms b

13: stuff want,purchasing new,purchasing new home,relationship husband,riding bi

14: pt want,doing right thing,right thing,doing right,pt dialysis center,pt dial

15: return church,reached goal,pt caring people,pt caring,possibly teaching,play

16: pt able,able care,outside home,px going,going church,pt able drive car,pt al

8.2.3 CorEx Anchor Health

1: lose weight,eat better,15 pounds,lose 30 pounds,lose 30,20 pounds,better exe

2: blood pressure,high blood,high blood pressure,lower blood pressure,lower bloo

3: able walk,climbing stairs,physical therapy,taken care,pt like,able walk bette

4: medications prescribed,healing wounds,control pain,seizures slow,taking medi

5: stay healthy,new goal,better quality,goal just,new goal just,quality life,wa

8.2.4 CorEx Anchor Life

1: work gives independence,pt like work,work income,grands kids,work gives,gives

2: good family member,time grandkids,spend time grandchildren,care children,good

3: physically fit,healthy eating,physically healthy,scooter chair,make sure,pea

4: active involved,physically fit staying active,play basketball,things day,heal

5: going church,minister church,ones god,nurturing supporting,nurturing supporti

8.2.5 LDA Gensim Health

[(0,

'0.062*"doctor" + 0.050*"keep" + 0.038*"could" + 0.037*"see" + 0.035*"much" '

```
'+ 0.034*"wish" + 0.031*"make" + 0.028*"find" + 0.024*"work" + 0.021*"sure"'),
(1,
'0.123*"get" + 0.071*"exercise" + 0.070*"back" + 0.056*"better" + '
'0.054*"health" + 0.039*"time" + 0.034*"home" + 0.028*"arthritis" + '
'0.026*"shape" + 0.026*"fit"'),
(2,
'0.188*"eat" + 0.166*"healthy" + 0.055*"strength" + 0.055*"right" + '
'0.027*"diet" + 0.023*"food" + 0.019*"diabetes" + 0.013*"smoking" + '
'0.012*"receive" + 0.011*"sleep"'),
(3,
'0.070*"pain" + 0.046*"physical" + 0.045*"free" + 0.045*"year" + '
'0.042*"last" + 0.030*"would" + 0.029*"heart" + 0.026*"surgery" + '
'0.016*"mobile" + 0.016*"figure"'),
(4,
'0.150*"walk" + 0.134*"able" + 0.051*"thing" + 0.040*"pt" + 0.032*"walker" + '
'0.030*"go" + 0.027*"dependent" + 0.026*"want" + 0.021*"pound" + '
'0.015*"dialysis"'),
(5,
'0.209*"weight" + 0.179*"lose" + 0.047*"leave" + 0.043*"new" + 0.032*"goal" '
'+ 0.030*"need" + 0.027*"foot" + 0.021*"use" + 0.015*"regular" + '
'0.012*"learn"'),
(6,
'0.119*"stay" + 0.095*"hospital" + 0.074*"take" + 0.054*"gain" + '
'0.052*"blood_pressure" + 0.047*"medication" + 0.043*"healthy" + '
'0.040*"care" + 0.033*"pill" + 0.032*"maintain"'),
(7,
'0.288*"get" + 0.171*"good" + 0.057*"want" + 0.037*"kidney" + 0.028*"stop" + '
'0.025*"control" + 0.022*"put" + 0.022*"try" + 0.020*"do" + 0.018*"memory"')]
```

8.2.6 LDA Gensim Life

```
[(0,
'0.067*"good" + 0.064*"life" + 0.061*"family" + 0.045*"take" + 0.037*"move" '
'+ 0.032*"care" + 0.024*"vacation" + 0.021*"social" + 0.021*"relationship" + '
'0.020*"apartment"'),
(1,
'0.214*"get" + 0.040*"active" + 0.039*"happy" + 0.033*"finish" + '
'0.031*"well" + 0.029*"job" + 0.029*"back" + 0.025*"try" + 0.023*"involve" + '
'0.022*"son"'),
(2,
'0.168*"go" + 0.088*"work" + 0.077*"back" + 0.047*"want" + 0.026*"become" + '
'0.025*"exercise" + 0.024*"health" + 0.013*"shopping" + 0.011*"spiritual" + '
'0.009*"independent"'),
(3,
'0.079*"healthy" + 0.076*"stay" + 0.054*"kid" + 0.051*"want" + 0.048*"see" + '
'0.039*"time" + 0.037*"grandkid" + 0.030*"keep" + 0.021*"spend" + '
'0.021*"family"'),
(4,
'0.102*"travel" + 0.101*"able" + 0.035*"thing" + 0.033*"want" + '
'0.031*"right" + 0.026*"new" + 0.024*"place" + 0.019*"around" + 0.018*"eat" '
'+ 0.017*"goal"'),
(5,
'0.066*"get" + 0.027*"year" + 0.024*"marry" + 0.024*"better" + '
'0.022*"important" + 0.020*"wife" + 0.013*"great" + 0.013*"car" + '
'0.013*"coverage" + 0.013*"want"'),
(6,
'0.089*"live" + 0.049*"love" + 0.040*"home" + 0.040*"would" + 0.034*"like" + '
'0.034*"long" + 0.026*"continue" + 0.026*"pt" + 0.025*"house" + '
```

```
'0.022*"learn"'),
(7,
'0.058*"school" + 0.049*"go" + 0.047*"people" + 0.044*"church" + '
'0.042*"enjoy" + 0.030*"friend" + 0.029*"make" + 0.025*"child" + '
'0.022*"stuff" + 0.022*"maintain"')]
```

8.2.7 LDA Mallet Health

```
[(0,
'0.224*"stay" + 0.148*"hospital" + 0.095*"control" + 0.038*"foot" + '
'0.038*"live" + 0.023*"sugar" + 0.019*"activity" + 0.019*"list" + '
'0.019*"problem" + 0.015*"dental"'),
(1,
'0.291*"healthy" + 0.103*"back" + 0.065*"care" + 0.054*"find" + 0.038*"gain" '
'+ 0.023*"regular" + 0.019*"mentally" + 0.015*"bed" + 0.015*"learn" + '
'0.015*"wound"'),
(2,
'0.326*"good" + 0.149*"health" + 0.054*"make" + 0.019*"run" + 0.019*"stable" '
'+ 0.019*"mobile" + 0.019*"sleep" + 0.015*"fruit" + 0.015*"general" + '
'0.015*"focus"'),
(3,
'0.250*"eat" + 0.053*"work" + 0.043*"strong" + 0.040*"time" + '
'0.033*"improve" + 0.033*"physically" + 0.030*"food" + 0.027*"day" + '
'0.027*"life" + 0.023*"care"'),
(4,
'0.162*"exercise" + 0.059*"pt" + 0.052*"heart" + 0.052*"thing" + '
'0.041*"kidney" + 0.041*"pound" + 0.038*"med" + 0.038*"diet" + '
'0.034*"continue" + 0.031*"home"'),
(5,
'0.230*"walk" + 0.099*"pain" + 0.099*"goal" + 0.066*"kidney" + '
```

```
'0.033*"smoking" + 0.025*"quit" + 0.025*"rid" + 0.025*"free" + 0.021*"move" '
'+ 0.021*"lifestyle"'),
(6,
'0.208*"weight" + 0.178*"lose" + 0.074*"doctor" + 0.037*"active" + '
'0.033*"transplant" + 0.033*"strength" + 0.030*"physical" + 0.022*"start" + '
'0.022*"body" + 0.015*"healthy"'),
(7,
'0.102*"medication" + 0.082*"stop" + 0.057*"maintain" + 0.041*"surgery" + '
'0.037*"diabete" + 0.037*"smoke" + 0.033*"diabetes" + 0.033*"fix" + '
'0.029*"leave" + 0.029*"problem"')]
```

8.2.8 LDA Mallet Life

```
[(0,
'0.060*"house" + 0.060*"long" + 0.060*"move" + 0.043*"job" + 0.043*"place" + '
'0.034*"maintain" + 0.030*"marry" + 0.026*"independent" + 0.026*"mother" + '
'0.026*"member"'),
(1,
'0.168*"travel" + 0.071*"home" + 0.067*"happy" + 0.050*"pt" + 0.046*"finish" '
'+ 0.034*"daughter" + 0.025*"wife" + 0.021*"visit" + 0.017*"graduate" + '
'0.013*"quality"'),
(2,
'0.098*"kid" + 0.076*"make" + 0.071*"care" + 0.049*"activity" + '
'0.040*"grand" + 0.040*"exercise" + 0.036*"apartment" + 0.036*"relationship" '
'+ 0.031*"support" + 0.018*"senior"'),
(3,
'0.101*"life" + 0.077*"thing" + 0.065*"goal" + 0.057*"health" + '
'0.049*"community" + 0.045*"involve" + 0.036*"year" + 0.024*"business" + '
'0.024*"event" + 0.020*"read"'),
(4,
```

```
'0.172*"family" + 0.109*"time" + 0.084*"school" + 0.059*"love" + '
'0.059*"enjoy" + 0.046*"spend" + 0.033*"social" + 0.029*"money" + '
'0.025*"learn" + 0.017*"general"'),
(5,
'0.127*"stay" + 0.127*"healthy" + 0.112*"live" + 0.093*"church" + '
'0.058*"active" + 0.031*"continue" + 0.027*"son" + 0.023*"eat" + '
'0.019*"physically" + 0.019*"housing"'),
(6,
'0.171*"back" + 0.155*"work" + 0.044*"grandkid" + 0.032*"walk" + '
'0.032*"give" + 0.024*"grandchild" + 0.024*"bike" + 0.020*"stop" + '
'0.020*"great" + 0.020*"return"'),
(7,
'0.162*"good" + 0.075*"people" + 0.053*"friend" + 0.048*"child" + '
'0.039*"day" + 0.039*"important" + 0.031*"successful" + 0.022*"trip" + '
'0.022*"vacation" + 0.018*"meet"')]
```

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