A Clinical Approach to Population Stratification Analytics:

Dispelling the Myths of Traditional Risk Segmentation Models used in Population Health Management Programs
Abstract

The concept of population health management has become synonymous with care management, which still exists in three discrete forms:

1. Case management for individuals who have had a major health event or diagnosis that requires the extensive use of healthcare resources
2. Disease management for moderate to high high-risk populations with expensive chronic conditions
3. Wellness programs for those groups who are healthy and considered low risk

Many of the analytical methods used to stratify populations into these three categories require that every individual meet a specific entry point threshold, such as the diagnosis of a clinical condition, a hospital admission, or a specific number of emergency room visits. Typically, the stratification analysis is based on events and costs that have already been incurred. Furthermore, programs that use this traditional stratification methodology are often designed as a “one-size fits all” intervention approach and assume that all individuals in these three subgroups have similar health needs and future risk trajectories.

Our goal in this white paper is to discuss the myths that perpetuate this paradigm and to demonstrate value in stratifying populations into more targeted and clinically-based subgroups that account for the unique factors of every individual’s healthcare needs. The paper will introduce a new method for population stratification—called the Care Pathways framework—which segments individuals into nine clinically relevant population subgroups. Additionally, we will demonstrate the benefits of using the Care Pathways approach to develop today’s population health management programs. We will also compare this framework to the traditional high-moderate-low predicted medical cost segmentation approach and discuss how Care Pathways points to potentially missed clinical and financial opportunities*. Future white papers will focus on the evaluation of clinical and financial outcomes from applying management to these opportunities.

* Our paper only looks at financial opportunity as measured by medical expense. There are concomitant and substantial gains to be had in employee satisfaction with their health plan and in employee presenteeism which we do not report on in this study.
Introduction

Industry background

The concept of population health management came into existence as an evolution and convergence of two relatively distinct approaches: disease management (which includes case management) and wellness. The legacy business models used by these two approaches have a significant influence on how population health management vendors currently configure and offer solutions to the healthcare market. The result of these legacy models is a continued focus on the two extreme ends of the disease burden spectrum: the relatively well population with little or no disease burden and the relatively complex population with significant disease burden. Traditional stratification analytics support this paradigm—assigning populations into high-level risk buckets, categorized as low, moderate, or high (figure 1 demonstrates this approach).

Prior to the Affordable Care Act, the high-moderate-low approach efficiently satisfied the need of risk bearing entities (i.e., health plans and self-funded employers) to drive short-term cost savings and return on investment. At the time, there was little desire from purchasers to spend money on programs with a longer horizon for recapping expenses due to the turnover rates in employers and commercial insurers. Therefore, disease management programs that focused primarily on high-risk individuals proliferated in the mid-90s and were seen as a panacea for curbing high costs in the chronic population.\(^1\),\(^2\),\(^3\) Cost-savings and quality outcomes were varied, with some reports of savings achievement and some reports of no significant effect.\(^4\),\(^5\),\(^6\),\(^7\),\(^8\)

Due to the difficulty in measuring the effect of “what did not happen,” the typical standard that disease management programs are held to, there was a backlash against these programs beginning in the early 2000s.\(^9\),\(^10\) Purchasers began to shift their interest in other outcomes. For example, whether members/employees felt that they were receiving superior services or whether a program might help them feel more healthy and productive at work.

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The following white paper argues that the traditional high-risk disease management framework is no longer effective in driving successful population health management. As more and more providers begin to share in the risk of a population and as the industry continues to scrutinize healthcare inefficiencies and escalating costs, the need for a long-term cost saving strategy with application for a broad spectrum of the population has become an important priority.

The shift from short-term to long-term population health management

Assuming that one of the ultimate goals of a population health management program is to avoid unnecessary complications or exacerbations of chronic disease, we believe that the best approach is one that is focused on understanding when these events might occur, identifying the precursors to these events, and searching for the occurrence of these events at any point within an individual’s tenure with their healthcare coverage. We call this the Care Pathways framework.

Unlike the high-moderate-low approach to risk segmentation, Care Pathways focuses on a longer-term view of an individual’s healthcare journey by segmenting populations into nine stages of a chronic condition. This framework analyzes the progression of a disease and predicts how individuals will progress along this trajectory.

The Care Pathways approach drives several key benefits. Improved patient experience is a given, due to more proactive health engagement and care planning for every individual in a population (subsequent white papers will focus on these topics). Additionally, this approach enables purchasers to plan and identify more opportunities for long-term cost savings that are demonstrable at the same level as a short-term return on investment approach.
White paper objectives

The primary objectives of this paper include:

1. To demonstrate the need for health plans, employers, and other purchasers to develop a long term approach to population health management that focuses clinical efforts on a two to five year disease trajectory—instead of the traditional 12-month approach. We will analyze the migration of individuals from low/moderate risk to high risk within a time frame where risk-bearing entities will still be responsible for the healthcare spend of these individuals.

2. To demonstrate the limitations of using high predicted medical costs as a means to develop outreach thresholds for effective population health management programs. We will analyze the clinical and financial improvement opportunities that can be missed by this approach—especially the opportunities found within the low and moderate risk groups. As an example, we will show the future five year migration of an identified low risk group and demonstrate that a high predicted medical cost approach would only identify these opportunities when this group has already migrated to later stages and incurred costs.

3. To demonstrate the limitation of using high financial risk as a means to predict the likelihood of costly sentinel events for individuals with chronic conditions. We will analyze sentinel event distribution across the high-moderate-low risk groups and point to potential cost-saving opportunities that can be achieved by analyzing the moderate and low risk groups.

To demonstrate the above, we will present three “myths” that we believe currently drive the structure of most population health management programs. While the focus of this paper is not to calculate return on investment (ROI) using Care Pathways, we will point out the financial opportunities that exist by taking a more longitudinal view of population health.

Resources used for managing the costliest and neediest patients are at a premium. As stated above, the identification of high predicted medical cost individuals for population health management has been important for helping risk-bearing entities to allocate costly resources to the neediest individuals. We believe that by using a Care Pathways approach, these same groups will be able to configure a wellness/health coaching solution that produces superior results when needing to go beyond the top tier of highest predicted medical cost.
Framework

Unlike the traditional segmentation approach of low, moderate, and high financial risk used in traditional population health management programs, the Care Pathways framework stratifies populations into nine clinically-relevant stages of a condition. Each stage represents a key point on the progression path of that condition. Figure 2 depicts all nine stages.

Figure 2: The Care Pathways Framework stratifies populations into nine clinically-relevant stages of a condition.

The Care Pathways approach was developed to:

1. Support true population health management by identifying and stratifying 100 percent of a population for clinical intervention opportunities

2. Address the need for a more personalized experience for individuals at the “well” and “sick” ends of this spectrum as well as all stages in between. By segmenting a population by stage of illness, instead of financial risk, it becomes easier to direct best practice, evidence based targeted health-related messages based on a specific disease stage and state, rather than have a clinical professional hastily determine what message should be delivered and what specific coaching would most benefit that individual in that moment.

The Care Pathways logic was built first using a clinical framework—the natural disease progression for 11 pathways was examined and sorted by increasing severity over time. Next, administrative claims data was used to match disease progression to events that could be marked through the claims adjudication process. Finally, each stage was examined for financial consistency—each stage of a pathway should have increasing cost associated with it (with the exception of the recovery stage) and there should be distinct financial cut points between stages.
The 11 pathways developed in this framework include:

1. Cardiovascular Disease
2. Diabetes
3. CKD
4. Asthma
5. COPD
6. Musculoskeletal: Low Back
7. Musculoskeletal: Hip
8. Musculoskeletal: Knee
9. Musculoskeletal: Shoulder
10. Cancer
11. Mental Health

The stages of the Care Pathways framework

All of the 11 pathways have the same first three stages:

1. **Well**
   This is the well population. Members in this category have no significant lifestyle risks or chronic conditions. However, they may have an occasional short-term illness or health-related issue that does not interfere with quality of life or impact their risk for developing significant disease.

2. **At-Risk**
   This population has one or two identified lifestyle issues that elevate their risk for developing a significant health condition or that interfere with their quality of life—such as high stress, over-weight, physical inactivity, and poor nutrition. Members in this category may also have episodic conditions that are not significantly progressive such as chronic sinusitis, dermatitis, and irritable bowel syndrome (IBS).

3. **Pre-Diagnostic**
   This population has a combination of lifestyle factors or a pre-diagnosis that can be shown to represent a very high risk for a short-term transition (<5 years) to a significant long-term health condition such as obesity, tobacco use, pre-hypertension, and pre-diabetes. These individuals may have one or more diagnoses of other lifestyle related conditions, including acid-related disorders, stress, anxiety, or anemia and gout. Members in this population may also have had prior musculoskeletal conditions but are not currently experiencing an acute episode.
From here, the pathways differ by condition, but all rely on the same framework of progressing disease. An example of the diabetes pathway is below:

4. Diabetes - Condition Onset
   This population is newly diagnosed with diabetes or someone previously diagnosed with diabetes and being treated with oral anti-diabetic agents. This population has no evidence of micro or macro vascular complications.

5. Diabetes - Early Progressive
   This population has a diagnosis of diabetes and evidence of insulin therapy or microvascular complications (e.g., eye, kidney, or nerve damage). In this stage, long-term high sugars may be starting to impact blood pressure and other cardiovascular systems.

6. Diabetes – Late Progressive
   This population has a diagnosis of diabetes and evidence of macrovascular complications, including blood vessel or heart disease or chronic kidney disease (e.g., stage-III or higher). Anyone with a diagnosis of diabetes and late progressive cardiovascular disease or late progressive chronic kidney disease is considered to be in the diabetes late progressive stage.

7. Diabetes - Critical
   Anyone with a diagnosis of diabetes and in a critical stage of cardiovascular or chronic kidney disease is considered to be in the diabetes critical stage.

8. Diabetes – Sentinel Event
   Anyone with a diagnosis of diabetes and in the sentinel stage of either cardiovascular disease or chronic kidney disease is considered to be in the diabetes sentinel stage. This population also includes anyone with a diagnosis of diabetes-related blindness or diabetes-related amputation of a limb.

9. Diabetes - Recovery
   Anyone with a diagnosis of diabetes and in the recovery stage of the cardiovascular pathway is considered diabetes recovery. This population also includes anyone with a discharge for diabetes-related blindness or diabetes-related amputation of limb.
Analysis

Myth 1: Short-term savings are not achievable, except with the critically ill, due to high plan and employee turnover rates

A common fallacy and reason why population health management programs do not focus intensive resources on moderate and low risk individuals is the belief that those individuals are on a disease trajectory such that any money spent managing their conditions will not be recouped before the member/employee/patient moves out of their risk pool. Thus, traditional programs focus almost entirely on what can be achieved in a 12-month time frame and rely on very low touch programs for those not considered a part of the high-risk group. To test our assumption that these individuals warrant intensive intervention as they are likely to incur significant costs in a short period of time, we compared a mid-size employer group’s continuously enrolled members from 2010 (figure 3) and 2015 (figure 4).

Figure 3: An employer group “All Pathway” Stages as of January 1, 2010.

Figure 4: An employer group “All Pathway” Stage as of January 1, 2015.
Figure 5: Costs associated with moving between stages along All Pathways. For those in the “Well”, “At-Risk” and “Pre-Diagnostic” states, the summary statistic “Progression %” includes those who transitioned to other disease states. For these groups, the summary statistic “Progression %” is greater than the sum of the individual state-specific progression statistics (i.e. % progressing to other disease states is not reported).

The analysis showed that within a five-year period, significant disease migration was observed for the entire population with clear trends in:

- The well and at-risk groups moving to the pre-diagnostic group
- The onset and early progressive groups moving to the late progressive group

As part of the analysis, we also examined cost increases associated with each level of disease progression (figure 5). As an example, the average annual cost per individual in the at-risk group was $461. Of these individuals, 81% were found to have moved to a later stage of disease progression between 2010 and 2015, each with a proportionately higher cost. Of the 81%, who were found to be in a later stage of disease progression:

- 28% migrated to the pre-diagnostic stage (average annual cost $1,167)
- 13% migrated to the onset stage (average annual cost $2,356)
- 8% migrated to the early progressive stage (average annual cost $3,965)
- 24% migrated to the late progressive stage (average annual cost $5,293)
• 3% migrated to the sentinel stage (average annual cost $33,965)

(Note: members may have moved to these stages prior to 2015—this analysis only shows where they were in 2010 compared to their status in 2015).

The Care Pathway concept of disease progression applied as an analytic tool demonstrates the fluid nature of health and wellness and associated cost over a relatively short five-year time frame. While we used a five-year time frame to demonstrate the concept, significant disease migration also occurs within shorter time intervals throughout the observed measurement period.

The relevance of this cost and opportunity demonstration needs to be considered within the context of time frame experienced by health plans, employers, and providers. As an example, we need to counter the overriding belief that typical health plan enrollment and churn is experienced within a two to three year period of time. This belief stems from the commonly observed statistic of a 20% annual churn in health plan membership. While this statistic is true in a sense, it is a misconception to equate or extrapolate this as a 100% churn over a five year period. In fact, using our book of business, we see that on average nearly 50% of health plan members are enrolled for at least five years in the same health insurance plan and for large self-insured employers, 60-70% of employees have tenures of five or more years.

Thus, population health management programs do not need to be considered solely within a 12-month period and the majority of plan membership can benefit from interventions with horizons in the two to five year period.

Given these findings, we recommend that risk-bearing entities:

• Understand the churn rate of their populations, but also examine the particular disease rate progression for tenured employees/members/patients

• Consider altering their disease management/wellness strategy to address those that may fall outside of the high-risk bands for predicted 12-month cost
Myth 2: High predicted medical cost is the most effective way to maximize identification of financial saving opportunities for population health management

Another common misconception for those trying to manage costs within a population is that the potential for savings from clinical interventions is best identified by using 12-month predicted medical cost metrics. This perspective directs intervention resources to only the top tier of predicted risk and does so without regard to specific clinical objectives. However, in many cases, the individuals in this group have already incurred high medical costs. Therefore, clinical interventions are focused mostly on preventing readmissions and other expensive sentinel events. In addition, this misconception creates the assumption that clinical objectives and cost savings cannot be achieved with long-term intensive care provided to the moderate and low financial risk groups.

The Care Pathways approach segments individuals by clinical stage, not by predicted medical cost. This allows for a more appropriate view of who would most benefit from an intervention—specifically those who have not yet incurred high costs or a sentinel event.

To demonstrate the limitations of the predicted medical cost perspective, we overlay the concept of high-moderate-low financial risk (as defined in figure 1), with the Care Pathway disease stages (see figure 6). In the overlay, as expected, we see a concentration in the later pathway stages in the high-risk group. Unexpectedly, we also see large numbers of later stage progression for moderate financial risk individuals and to a lesser extent in the low financial risk group (i.e., calling into question the precision of financial risk as a surrogate for clinical risk).
Figure 6: Cohorts identified by a predicted financial risk model as high, moderate, and low risk overlaid with the pathways disease stages.
Translating these findings into opportunities for savings, we conclude that within non-high financial risk groups, a significant number of individuals are clinically within late stages of disease progression and therefore, strong candidates for population health management services. These findings imply that these services could be offered to these individuals as means to delay or prevent further disease progression and/or prevent patterns of service utilization that would otherwise result in the individual being classified as high financial risk.

As further evidence of the potential value in managing non-high financial risk individuals, we take a closer look at the population considered to be low-risk (according to the financial risk model) as of January 1, 2010 (figure 7) and follow their disease progression within a five-year time period (figure 8). We can see (figure 9) that a significant portion of low financial risk individuals migrate to later, more costly stages of disease in the five-year time frame.

![Five Year Cohort Follow-Up: Distribution of Disease Stage and Average Cost Within Cohort of Low Financial Risk Members (January 2010)](image)

Figure 7: All Pathways disease state for low risk members. Note: the scale is logarithmic in this chart so looks slightly different than the same data presented in figure 6.
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Figure 8: All Pathways disease state for low risk members in five years.

Figure 9: Costs associated with low risk members at the end of five years. For those in the “Well”, “At-Risk” and “Pre-Diagnostic” states, the summary statistic “Progression %” includes those who transitioned to other disease states. For these groups, the summary statistic “Progression %” is greater than the sum of the individual state-specific progression statistics (i.e. % progressing to other disease states is not reported).
Figure 9 demonstrates potentially missed opportunities for delaying progression and avoiding medical cost throughout the low financial risk cohort:

1. Those who were identified as low financial risk, but were found to be in the early and late progressive stages in the Care Pathway framework: we see a significant portion progressing to the late progressive and sentinel stages within five years.

2. Those who were identified as low risk by the predictive model and well by the Care Pathways framework: we still see a relatively quick migration for a significant portion of the population, with over 20% migrating to late progressive and sentinel events in five years.

In both examples, ignoring this cohort as one not needing intervention would be a wasted opportunity. In these cases and those cited earlier, we are not positioning the disease progression framework as a replacement to a financial risk model. Rather, we are pointing out the limitations of financial risk for supporting the overall objectives of a population management program. Specifically, we demonstrate that the financial risk model (applied as designed within the bounds of a 12-month time horizon) has a limited ability to identify opportunities for population health management interventions.

Given these findings, we recommend that risk-bearing entities apply these strategies for non-high financial risk populations:

- Use clinically-based criteria, such disease progression for identifying individuals with potentially high intervention need

- In combination with clinical bases for identifying intervention opportunities, overlay financial risk for moderate and low risk individuals as a surrogate for those most likely to progress and/or become high financial risk in the future

- Explore alternative predictive models to focus on those most at risk for disease progression

- As opposed to predicting risk, monitor for emerging risk factors and address those risk factors in a specific and immediate fashion
Myth #3: High financial risk is equivalent to risk for a sentinel event and the basis for targeted interventions

A common approach for targeting resources and interventions is to identify individuals with specific disease conditions and who have high financial risk. The assumption here is that the program achieves impact through direct intervention with individuals who are most at risk for a high cost event as a means to preventing the event. The underlying premise is that high financial risk individuals are in a disease trajectory where an acute event is imminent.

To examine this theory, we used Care Pathway metrics to assess evidence for likelihood of sentinel events for a cohort of individuals considered to be within the late progressive stage of cardiovascular disease.

In figure 10 below, we look at both predicted 12-month risk of cardiovascular disease (CVD) sentinel events (i.e., heart attack, stroke and cardiac revascularization) and actual 12-month sentinel for high, moderate, and low financial risk individuals with cardiovascular disease. While some degree of risk is associated with financial risk, all levels of financial risk have relatively similar levels of actual events. These findings suggest that the primary predictive value of the financial risk model is not wholly related to disease associated outcomes.

Figure 10: Within a cohort of Late Progressive cardiovascular disease (CVD) members, financial risk demonstrates only a marginal ability to discriminate both predicted risk of a CVD sentinel event and actual one year sentinel event outcomes. As a means for discriminating who or who should not be included in interventions to protect against CVD sentinel events, the financial risk model demonstrates poor predictive power.
As a follow-up analysis to support the observation that financial risk is a poor predictor of future risk for specific chronic disease outcomes (e.g., heart attack and stroke), we looked for differences in the utilization of clinical events that are triggers for, or indicators of, migration into the late progressive stage of cardiovascular disease.

In figure 11, we look at the distribution of events that were defined as triggers for these individuals entering the late progressive stage of cardiovascular disease. In this analysis, we compare rates of these trigger events for high, moderate, and low financial risk individuals. As demonstrated in figure 10, we see that there is no clear differentiation between high, moderate, and low risk groups. While some differentiation for specific trigger events can be observed between high, moderate, and low financial risk groups (e.g., brain MRI, coronary angiography, and abnormal cardiology exams), the high, moderate, and low financial risk classification does not result in any clear differentiation in the clinical profile of these individuals. Additionally, it does not discriminate high financial risk individuals as any more or less likely to be at a higher level of clinical severity. This finding points to a significant opportunity for clinical intervention beyond the limiting and artificial constraints of a high financial risk classification.

Figure 11: The events listed in the X-Axis all triggered placement within the Late Progressive part of the pathway. However, if a program was focusing on only high-risk members, we would miss many opportunities for intervention and for delaying/preventing the critical stage of a cardiovascular pathway.
Given these findings, we recommend that risk-bearing entities:

- Avoid using predicted financial risk models as indicators that specific clinical events may occur
- Design intervention strategies based on clinical needs, rather than using a “one-size-fits-all” approach
- Examine low and moderate risk cohorts for potentially important outreach needs in order to potentially prevent high cost sentinel events in the near future

**Conclusion**

Using a Care Pathways approach to total population health management is not a panacea or a single solution. Risk models still have a strong role to play—both in prioritizing individuals and in helping to understand overall disease burden. However, risk models cannot fully stratify a population into meaningful interventions and are still likely to miss key cost saving opportunities.

The Care Pathways framework is a way of stratifying a population to uncover value at all levels of financial risk. Through this white paper, our goal was to demonstrate that the Care Pathways frameworks create value in the short term (within 12 months) and the longer term (within five years). Further, we hoped to demonstrate that low and moderate risk groups contain specific opportunities for intervention and that sentinel events are likely to occur in these risk groups over time as well.

Subsequent white papers will drill down into:

- Targeted outreach efforts that deliver personalized messaging based on the pathway stage and state of an individual
- In-depth examinations of each of the 11 pathways and specific clinical and financial outcomes
- Demonstration of financial ROI and avoided events from population health management programs using a Care Pathways approach
- An exploration of appropriate outreach modalities depending on stage and state to broaden program participation and optimize ROI