

**UMEC/Utah AHEC Primary Care Workforce Optimization -**

**Data Inputs & Calculations**



Contents

[Workforce Optimization Model – Data Inputs & Calculations 2](#_Toc532575367)

[Purpose 2](#_Toc532575368)

[Background 2](#_Toc532575369)

[Overview 4](#_Toc532575370)

[Data Inputs 4](#_Toc532575371)

[Types and Sources 4](#_Toc532575372)

[Input Tools 4](#_Toc532575373)

[Calculations 5](#_Toc532575374)

[Appendix A: Data Input Details 6](#_Toc532575375)

[Population Needs 6](#_Toc532575376)

[About the Population 6](#_Toc532575377)

[Defining the Care Required 9](#_Toc532575378)

[Provider Supply 10](#_Toc532575379)

[Appendix B: Use and Maintenance of Excel-based Data Input Tool 12](#_Toc532575380)

[Supported requirements 12](#_Toc532575381)

[Use of the Tool 12](#_Toc532575382)

[Overview of Sheets 12](#_Toc532575383)

[Scenarios for Expanding Data Needs 13](#_Toc532575384)

# Workforce Optimization Model – Data Inputs & Calculations

## Purpose

This document describes the data inputs and calculations performed by the tool developed jointly by UMEC, Utah AHEC and IBM to model the future of primary care in Utah. The document forms part of the knowledge transfer performed by the IBM Health Corps at the close of their three-week engagement. The document provides a detailed description of the data inputs and the calculations performed using those inputs which are then sent to the optimization modeling step.

## Background

As described in the “Tool Technical Overview” document, the solution uses a combination of technologies to provide a maintainable model with an easy to use set of interfaces. The key technologies used are described in the following table. This specific document describes the **Input Data** required by the model, as highlighted below. Note that once the Input Data can be edited using the User Interface, this document can be used to define the various elements of data for that purpose as well.

|  |  |  |  |
| --- | --- | --- | --- |
| **Architecture Component** | **Primary Technology** | **Description** | **Github Link** |
| Input Data | Microsoft Excel | This spreadsheet represents the base data that is used to initialize the Analytical Model. The governance and maintenance of this component is outside the scope of this document. Please refer to *Data Standards and Governance* document |  |
| User Interface | JavaScript, React, HTML | The user interface is rendered in standard web-browsers using HTML. Most of the HTML is generated from a series of user-interface components written in React. React is a JavaScript framework. This enables a very responsive user interface, similar to those offered by mobile device apps. The style of UI is known as a SPA (or single page app). |  |
| Model Controller | node.js, Express, JavaScript | The Model Controller controls the conversation between the User Interface and the Analytical Model. This layer enables the Analytical Model to remain ignorant of the end user (thus keeping things simpler). It also stores user state between interactions, providing the basis for building complex query contexts or retrieving data without interacting with the Analytical Model. It is built on node, which provides basic web server capabilities. Because we also wish to offer web service APIs from the Model Controller we are using Express.js to extend the basic capabilities of node. |  |
| Analytical Model | Python (pandas, numpy) | The Analytical Model offers a number of optimization solutions for different problems. The Model itself is written in Python using standard data science libraries such as pandas (enables the manipulation of data in rows and columns similar to a spreadsheet) and numpy (adds multi-dimensional arrays and linear algebra). |  |

### 

## Overview

The Workforce Optimization Model requires input data describing the current population and their primary care needs, the current supply of primary care providers, and the geographic distribution and anticipated trends of both population and supply. Together, this information is used by the tool to calculate the anticipated primary care needs of the population, along with the current and future gaps in primary care provider supply.

## Data Inputs

### Types and Sources

To most accurately calculate a population’s need for primary care, one must first understand the composition of the population in terms of their demographics and clinical profile. One must then estimate the amount of primary care needed for each population segment based on these variables. To translate this need into workforce requirements, the time and resource types required for each type of care must be defined. Finally, the actual available resources are required to calculate the current and anticipated gaps in workforce supply.

To support these needs, the data inputs have been organized into four main categories which correspond to the following questions:

1. Population Needs
   1. Who: Which segment of the population needs what type of primary care, and how is this expected to change over time?
   2. What: What is included in the various types of primary care?
   3. How: How might the care be delivered (time and resource types)?
2. Provider Supply
   1. What is the current and anticipated supply of primary care providers?

To achieve the most accurate results from the optimization model, each piece of information requires a reliable, consistent data source. Because no data source is perfect, it is important to understand the limitations of each, and the potential impact of those limitations on the final answer provided by the solution.

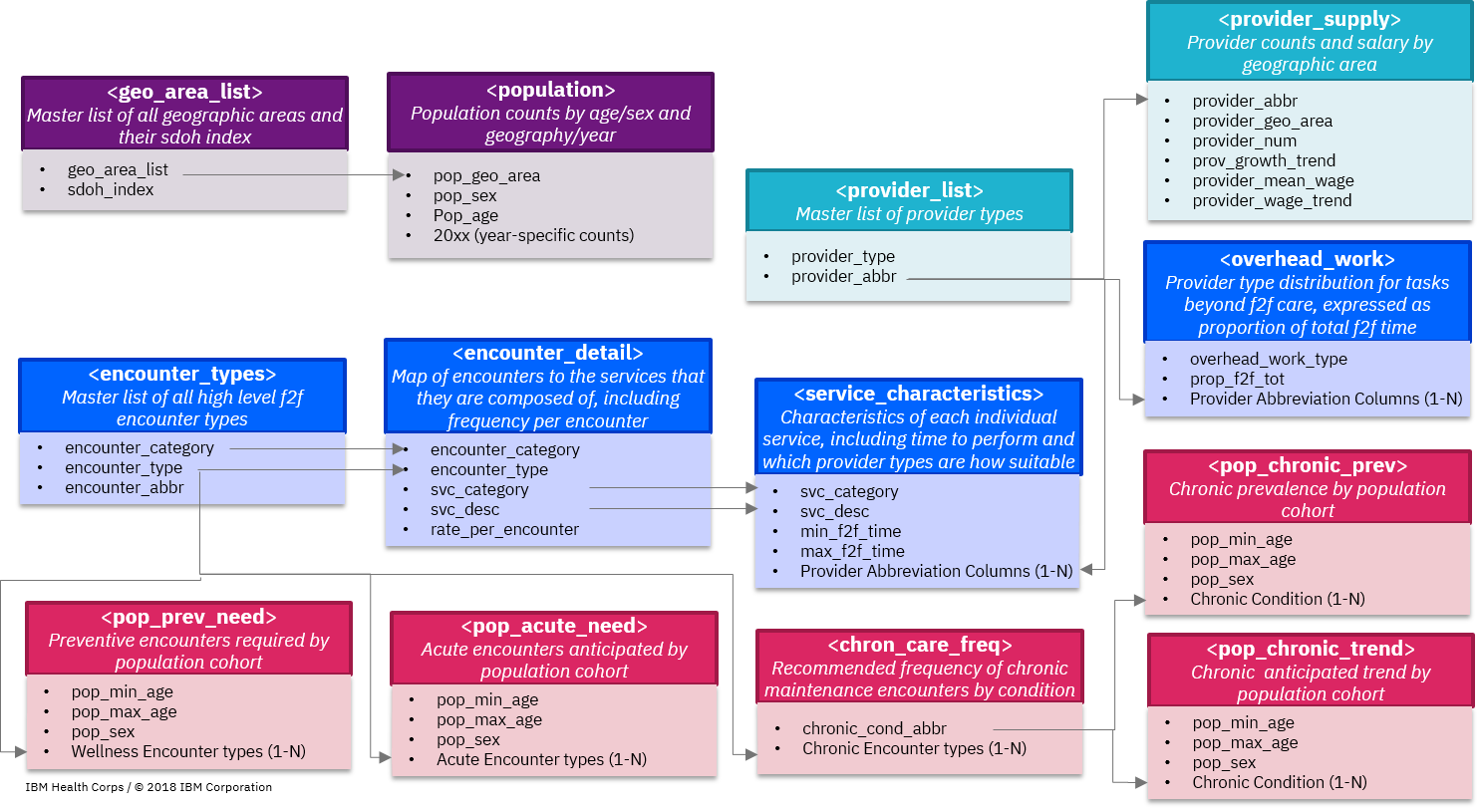
**Appendix A** describes the various data types included in the input.

### Input Tools

There are two main methods to updating the input data.

* The first is via the Excel-based data entry tool, in which all data elements may be modified. The Excel-based tool is expected to serve as the “master dataset”, representing the best available data values for the state and geographic regions supported by the tool. The intended user of the Excel-based data entry tool is the Administrator, who will be responsible for updating and maintaining the data values. Changes made to the master spreadsheet will be reflected in all results across all end-users of the tool. While the Excel-based tool was designed with the intention of being intuitive to use, additional documentation is required to ensure its accuracy. That documentation is provided in **Appendix B**.
* The second is through the user interface, which allows an end-user to edit a limited set of input data to perform “what-if” analysis using the optimization model. This type of modification and analysis does not change the underlying “master dataset”, nor does it affect the data seen by other end-users of the system. The purpose of this functionality is to accommodate user-specific local variability and/or data with greater accuracy for a specific location/situation.

Regardless of the mechanism used, the data inputs are automatically converted into comma-separated value (CSV) files, which are then fed into the next steps of the solution. The diagram below illustrates the CSV file structure and how various columns in each file relate to one another.



## Calculations

The data inputs are utilized by the solution to calculate the overall primary care demand of a given population via several steps:

1. Identify the current number of individuals in the population by age, gender, and geographic area; multiply by any relevant trending factors
2. Identify the portion of each cohort requiring a specific encounter type (acute, chronic, or well) using the prevalence rates, accounting for any relevant chronic trending factors
3. Determine the number of each encounter type required for each cohort per year
4. Calculate the effort required to support the population in minutes by service using the service level time estimates, service-to-encounter mapping, and the SDoH index for the population
5. Compute the cost of each resource type that is eligible to perform the various services, using salary estimates by role; convert F2F work-effort in minutes to FTE by dividing by 60 minutes/hour and 2080 hours/year
6. At this point, the optimization model is run to determine the optimal allocation of F2F FTE by provider type, given the parameters of the model, the cost of each resource type, and the total time required by service for the population
7. Add any additional budget required for overhead services performed as a percentage of total F2F time; use the percentage of F2F time, the distribution by provider type, the conversion from minutes to FTE as shown above, and the salary estimates as assigned in the input data

# Appendix A: **Data Input Details**

## Population Needs

The data supporting the calculation of the population primary care needs must answer questions relating to who requires what care, and how it might be delivered in terms of resources. It also needs to define anticipated trends in need.

### About the Population

#### Demographics

The age, gender, and social determinants of health (SDoH) of a given population help drive the types of care needed.

* Currently the age/gender mix of the population (both current and anticipated future) are supplied from US Census data.
* The SDoH factors are currently derived from the Community Needs Index (CNI), which is a publicly available index created and maintained by Dignity Health and Truven Health Analytics (now part of IBM Watson Health). This index is available at the state, county, and zip code level and indicates the potential for barriers to healthcare based on education, housing, insurance, income, and cultural factors. The index is a numeric value from 1-5, with 5 representing the most intense barriers.

#### Chronic Condition Profile

A significant portion of chronic care can be provided by primary care providers, particularly routine maintenance care. To assess a population’s need for chronic care, the prevalence of chronic diseases must be estimated. For the initial version of the model, 5 chronic diseases or ongoing conditions were included: Anxiety Disorders, Osteoarthritis, Asthma, Coronary Artery Disease (CAD), Chronic Obstructive Pulmonary Disease (COPD), Depression, Diabetes Mellitus, Hyperlipidemia, Hypertension, Osteoporosis, Smoking, and Obesity.

At this time, only prevalence was estimated. In the future, an average severity of disease might be appropriate to add since that impacts the volume of care required by a chronic patient. This is not yet included in the model.

Trends in prevalence by age and gender were “hard coded” at an annual increase of .01 (1%) per year. This is only a placeholder and not based on any evidence of trend.

##### Source:

The prevalence of chronic conditions was estimated using the 2015 Behavioral Risk Factor Surveillance Survey (BRFSS) results for the State of Utah when possible. For Osteoporosis and Anxiety disorders, other sources were utilized. *Since BRFSS does not report prevalence rates for children, estimates for those under 18 were obtained from national organizations for those diseases that are likely to occur in children (Depression, Asthma, Anxiety, and Obesity)*

Calculation:

* Anxiety: Not available in BRFSS data. Used a conservative estimate based on the prevalence of depression since the National Institute of Mental Health indicates higher prevalence of Anxiety disorders compared to Depressive disorders
* Arthritis: BRFSS variable “Respondents diagnosed with arthritis” (\_DRDXAR1) = 1 (Diagnosed with some form of arthritis)
* Asthma: BRFSS variable “Current Asthma Calculated Variable” (\_CASTHM1) = 2 (Have been told they currently have asthma)
* CAD: BRFSS variable “Ever had CHD or MI” (\_MICHD) = 1 (Reported having MI or CHD)
* COPD: BRFSS variable “Ever told you have COPD…” (CHCCOPD1) = 1 (Ever told you have COPD, emphysema, or chronic bronchitis)
* Depression: BRFSS variable “Ever told you had a depressive disorder” (ADDEPEV2) =1 (Been told you have a depressive disorder)
* Diabetes: BRFSS variable “Ever told you have diabetes” (DIABETE3) = 1 (Ever told you have diabetes, not just during pregnancy)
* Hyperlipidemia: BRFSS variable “High Cholesterol Calculated Variable” (\_RFCHOL) = 2 (Have had cholesterol checked and have been told it was high)
* Hypertension: BRFSS variable “High Blood Pressure Calculated Variable” (\_RFHYPE5) = 2 (Been told they have high blood pressure)
* Osteoporosis: Not available in BRFSS data. Estimated based on International Osteoporosis Foundation website data
* Obesity: BRFSS variable “Computed body mass index categories” (BMI5CAT) = 4 (Obese, BMI>30)
* Smoking: BRFSS variable “Current Smoking Calculated Variable” (\_RFSMOK3) = 2 (Current smoker –smokes every day or some days)

#### Acute Condition Needs

Acute conditions often require primary care. Historical utilization is the best approximation of need for this type of care. To accurately reflect the varying levels of care that might be required for acute conditions, 5 levels of acute care visit were included in the data model. For each level, the annual visit rate per 1000 population was calculated by age group using historical claims data.

##### Source:

Utilization for acute conditions was calculated using the IBM MarketScan Commercial Claims and Eligibility database for 2016 for the US. However, it is anticipated that the Utah All-Payer Claims Database (APCD) will be a more reliable source of information for the Utah population as it includes multiple payers and reflects the more localized Utah population.

##### Calculation:

For the initial estimates, the Current Procedural Terminology (CPT) code levels for evaluation and management (E&M) visits were utilized in combination with provider types. A visit was defined as:

* a unique patient/date/provider combination,
* with a procedure code between 99201 and 99215,
* performed by a Family Practitioner, Internal Medicine, or Pediatric physician,
* with a principal diagnosis indicating an acute condition (not chronic, not well care)
* reported on a professional claim form.

The counts were accumulated by age groups and gender:

* Ages 0-17
* Ages 18-34
* Ages 35-44
* Ages 45-54
* Ages 55-64
* Ages 65-74
* Ages 75-84
* Ages 85+

*Note: Because MarketScan represents a commercial population, no one over age 65 was reported. Therefore, the estimates for Ages 55-64 were simply repeated for the older segments of the population.*

The visits were also segmented into five levels of severity based on the CPT codes used.

* Level 1: CPT 99201 or 99211
* Level 2: CPT 99202 or 99212
* Level 3: CPT 99203 or 99213
* Level 4: CPT 99204 or 99214
* Level 5: CPT 99205 or 99215

Finally, the counts were divided by the appropriate population count based on the enrollees of the specific age/gender cohort who were eligible for these types of claims in the associated eligibility file. The result was multiplied by 1000 to achieve a per 1000 rate.

#### Patient Complexity

The model does not currently account for patient complexity and its effects on the demand for primary care. Currently each chronic disease is treated as an individual condition, additive in nature. In the future, a measure of patient complexity could be derived, but how it would interact with the various demands/types of care is to be determined.

### Defining the Care Required

#### Encounter Types and Services

The types of tasks included in various encounters (preventive, acute, and chronic) were originally estimated by clinical staff within the Utah stakeholder team. Both Preventive and Chronic Condition maintenance service frequencies were determined using nationally endorsed guidelines from various professional societies.

#### Work Estimates

The model allows for quantification of the work effort required to supply the various care types defined above, as well as the type of providers who can perform the work. For the initial version of the model, information provided by the Utah stakeholder team was converted into the new data structure. Specifically:

* Time estimates by task originally created by the Utah stakeholder team were converted into ranges by the IBM team based on the values provided by Utah (often the minimum and maximum of a range are identical). This requires review and confirmation.
* To identify the provider types who perform various tasks, the original mappings were provided by the Utah stakeholder team. The suitability scores were estimated by the IBM team and require review and confirmation.

#### Overhead Work

The time required for overhead tasks as well as the proportion by specialty were estimated by the Utah Stakeholder team based on anecdotal evidence.

### Provider Supply

#### Type and Distribution

The specific primary care roles and supply values were provided by the UMEC survey data for physicians, nurse practitioners, physician assistants, pharmacists, and mental health professionals.

* **Physicians** (2015 survey): Physicians who indicated specialties of Family Medicine, Internal Medicine, Internal Medicine & Pediatrics, or Pediatrics, who *also* indicated a primary site of practice as Correctional Facility, Community Health Clinic, Office/Clinic, University Health Center, or Volunteer Clinic were all included as primary care physicians.
* **Nurse Practitioners** (2017 survey): Nurse Practitioners indicating a specialty of Family Practice, Internal Medicine, Pediatrics, or unspecified, who *also* indicated a primary site of practice as Rural Health Clinic, Correctional Facility, Community Health Clinic, VA Hospital, Non-hospital OP Clinic, or a Physician Practice (solo, multi-specialty, or single specialty) were included as primary care Nurse Practitioners.
* **Registered Nurses** (2017 Survey):RNs indicating a specialty of Primary Care, Chronic Care, or General Medical Surgical, who *also* indicated a primary site of practice as *anything OTHER than* Academic, Hospital, Insurance/Benefits, Policy/Planning were counted as primary care RNs.
* **Physician Assistants** (2015 survey): PAs indicating a specialty of Family Medicine, Family Medicine with Urgent Care, IM: General, or Ped: General, who *also* indicated a primary site of practice as Rural Health Center, Community Health Center, Federally Qualified Health Center, Correctional Facility, HMO Facility, Multi-specialty Physician Group Practice, Single-specialty Physician group practice, School-based Health Facility, Solo Practice Physician Office, or University Student Health Facility were included as primary care PAs.
* **Pharmacists and Mental Health Providers** (2016 survey): Pharmacists (Pharm D), Social workers, Psychologists, and Family Therapists were given very conservative size estimates since few of them are directly involved in providing primary care in conjunction with a physician team. The estimates were proportionate to the total number of each specialty that practices in each county, but only a very small portion of each specialty was included.

Other types of professionals did not have collected survey data. Specifically, the number of Clinical **Educators** and **Medical Assistants** were therefore estimated by the UMEC team.

The trend in provider types was “hard coded” at 1% per year. This was only a placeholder to test the model and should be revisited.

#### Provider Salaries

The annual salaries by provider type were calculated using information from GlassDoor and other public web sites and are set to the same values by county. Better estimates could likely be obtained for future use. Trends in salaries were set at a flat 2% for testing purposes.

# **Appendix B:** **Use and Maintenance of Excel-based Data Input Tool**

## Supported requirements

The following requirements were supported by the creation of the Excel-based data input tool:

1. Ensure referential integrity: As much as possible within the limitations of Excel, reduce the potential for referential integrity errors in the data elements that are shared across worksheets (e.g., ensure consistency in names and labels)
2. Ease of maintainability/update: Organize the data in a way that minimizes the effort and redundancy required to modify/update values
3. Maintenance capabilities: Organize the data in a generic way that allows for easy modification as more reliable data sources become available (e.g., don’t rely upon a specific source format or naming convention)
4. Expansion capabilities: Allow for expansion over time to reflect additionally defined population needs and primary care definitions and delivery options.

## Use of the Tool

### Overview of Sheets

The Excel-based data entry tool consists of multiple individual sheets, each of which contains important data elements used by the overall solution. Each sheet is briefly described below:

|  |  |  |
| --- | --- | --- |
| **Sheet Name** | **Data Category** | **Description** |
| frontsheet | General info | Title and logo information for input file |
| metadata | General info | Information about utilizing the data input spreadsheet in Excel format |
| index | General info | Index to various components of data contained in each csv view |
| geo\_area\_list | Demographics | List of geographic areas supported in the analysis, and their Social Determinants of Health index |
| population | Demographics | Population counts by age, gender and county across years |
| provider\_list | Provider Supply | List of primary care provider types supported in the analysis |
| provider\_supply | Provider Supply | Counts of the various provider types by geographic area |
| encounter\_types | Care Types | Types of face to face encounters provided in primary care |
| encounter\_detail | Care Types | For each encounter type, what services are included in the encounter |
| service\_characteristics | Care Types | For each type of face to face service, who can perform the service and what is the estimated time in minutes |
| overhead\_work | Care Types | Types of overhead tasks that are performed as part of primary care as a proportion of face to face time |
| pop\_prev\_need | Population Need | Preventive care encounters and frequency required for a given age range and sex supported by evidence-based guidelines |
| pop\_acute\_need | Population Need | Acute care encounters and frequency anticipated for a given age range and sex supported by historic data |
| pop\_chronic\_prev | Population Need | Estimated prevalence of the included chronic care conditions by age range and sex |
| pop\_chronic\_trend | Population Need | Anticipated annual trend in chronic prevalence by age range and sex |
| chron\_care\_freq | Population Need | Frequency at which various chronic encounter types should be delivered, supported by evidence-based guidelines |

### Scenarios for Expanding Data Needs

As the solution expands to account for additional types of primary care (or beyond primary care), more geographic granularity, or a broader set of provider types and delivery mechanisms, the Excel-based input tool can expand as well. This section covers how to modify the spreadsheet to account for some of the likely data expansion scenarios.

The scenarios below describe additions to the data model, however they can be used to understand how a user would remove specific values or types of data as well.

\*\* *Note that for any scenario that requires additional rows to be added to tabs, they must be inserted above the current last row, which is designated with the text “<<end>>”. This ensures that all data rows are read by the CSV conversion process. Also note that any scenario that requires that additional columns be added may require changes to other areas of the solution to ensure the data flows through consistently*. \*\*

#### Increased Geographic Specificity

Currently the input data structure supports analysis for the state of Utah, the individual counties, and the 7 multi-county districts (MCDs). It is anticipated that in the future, more granularity may be desired, such as analysis by the 99 Utah Small Health Statistics Areas (developed by the Utah Department of Health) or even by individual zip code. To add a level of geography to the data model, the following information must be available or estimated:

* Population by age/gender for each area, including future year trends
* Provider supply and salary information by provider type for each area, including trend estimates
* Social Determinants of Health (SDoH) index for each area

The spreadsheet can then be edited as follows:

1. Insert a row for each new area on the <*geo\_area\_list*> tab. For each row, in the appropriate column, include the name of the geographic area (must be unique from all other geographic area names) and the SDoH index.
2. Insert 202 rows for each geographic area in the <*Population*> tab and enter the number of individuals by age and gender for each year for each area (Ages 0-100 for both Male and Female are required for each area).
3. Insert one row per area per provider type (currently there are 11 provider types) in the <*provider\_supply*> tab. This is where the provider type counts and salary information for each geographic area are to be entered.

#### New Source for Social Determinants of Health (SDoH) Index

The current SDoH index values were derived from the Dignity/Truven Health Community Needs Index (CNI), a publicly available SDoH index by county. If, in the future, a different source of SDoH information is to be utilized, there is no need to modify the spreadsheet other than to replace the current index values on the <*geo\_area\_list>* tab. However, it is critical that any values used range on a scale from 1 to 5, where 5 indicates the highest level of SDoH needs. Using any other scale will require coding changes within the solution itself.

#### Add Provider Role (s)

Additional Provider roles can be added to the data model as long as information exists that describes:

* The number and salary of such resources available by geographic area
* The services that the provider role is licensed to perform and their suitability to perform each service
* The proportion of any overhead tasks that the provider type might perform

The spreadsheet can then be edited as follows:

1. Insert a row in the <*provider\_list*> tab and enter a unique provider type name and abbreviation.
2. Insert a column in the <*service\_characteristics*> tab to indicate a provider type’s suitability to perform various services. Ensure that the column header in the new column matches the Provider Abbreviation entered in the <*provider\_list*> tab.
3. Insert a column in the <*overhead\_work*> tab to indicate the provider type’s participation in any specific overhead tasks. Ensure that the column header in the new column matches the Provider Abbreviation entered in the <*provider\_list*> tab. Remember to reallocate the proportion of work delegated to other provider roles so that the total allocation remains at 100% per work type.

#### Add Chronic Condition(s)

New chronic conditions may be added to the data input. This requires the following information:

* Prevalence and anticipated annual growth trends of condition by age/gender cohort
* Required annual primary care maintenance service schedule for patients with the condition (optional, may choose to use a generic set of services for multiple chronic conditions)
* FUTURE: Anticipated unplanned care to address flare-ups of condition.
* FUTURE: Estimated patient distribution by severity of condition

The spreadsheet can then be edited as follows:

1. Determine whether a new encounter type is required for this condition. The spreadsheet currently includes a generic encounter type called “Chronic Maintenance Visit: Other” which includes many of the basic services required to manage a chronic condition.
   1. If this is specific enough for this condition, there is no need to add a new encounter type. Move on to step 2.
   2. If this is not specific enough, then follow the instructions in “*Add or Remove Chronic Encounter Type(s)*” to add a new Encounter Type for this condition prior to proceeding.
2. Insert a row in the <*chron\_care\_freq*> tab and enter a full name and an abbreviated name of the new chronic condition in the first two columns. In the appropriate column, indicate the number of annual maintenance encounters required for patients with this condition.
3. Insert a new column in the <*pop\_chronic\_prev*> tab, using the same condition abbreviation you created in Step 1 as the column header. Enter the prevalence per 1000 individuals for each age/gender group in the spreadsheet for the new condition in this column.
4. Insert a new column in the <*pop\_chronic\_trend*> tab, using the same condition abbreviation you created in Step 1 as the column header. Enter the anticipated growth trend for the condition for each age/gender group in the spreadsheet in this column.

#### Add Acute Encounter Types

Note that the current 5 levels of Acute Care Encounter reflect the total acute care visit demand for primary care. If additional types are required or a different categorization is required, new acute encounter types may be added to the data input. This requires an estimated visit rate for the type of encounter by age and gender cohort.

Acute encounter types currently refer to acute visits care delivered by primary care providers for a given acute condition (e.g., flu, ear infection, skin condition). Note that the current 5 levels of Acute Care Encounter reflect the total acute care visit demand for primary care. If additional types are required or a different categorization is required, new acute encounter types may be added to the data input. This requires an estimated visit rate for the type of encounter by age and gender cohort. In this situation, you can add a new chronic maintenance encounter type as follows:

1. Insert a new row in the <*encounter\_types*> tab using “Acute” as the encounter\_category and a new name for the encounter\_type.
2. Go to the <*encounter\_detail*> tab to define the services required for this new encounter type. Insert a row for every service required for maintenance care for the condition. On each row, set the first column to “Acute” and the second to the new encounter\_type name you defined in step 1. In the 3rd and 4th columns, for each new row select one service category/service that is to be part of this encounter (if you need to create a new service, see the section “Add/Delete Services” and complete that first).
3. Insert a new column on the <*pop\_acute\_need*> tab and title it using a reference to the cell with the encounter type name created in step 1.
4. Enter the appropriate per 1000 rates by age/gender cohort on the <*pop\_acute\_need*> tab.

#### Add Chronic Encounter Types

Chronic encounter types currently refer to maintenance care delivered by primary care providers for a given condition (e.g., Asthma, Diabetes) or ongoing health status (e.g., Obesity, Smoking). If a new chronic condition is added to the data model, it may be necessary to add a new chronic maintenance encounter type. This occurs if there are regularly scheduled services to be delivered to patients with this chronic condition that *differ* from those included in the “Chronic Maintenance Visit: Other” encounter type already provided. In this situation, you can add a new chronic maintenance encounter type as follows:

1. Insert a new row in the <*encounter\_types*> tab using “Chronic” as the encounter\_category and a new name for the encounter\_type.
2. Go to the <*encounter\_detail*> tab to define the services required for this new encounter type. Insert a row for every service required for maintenance care for the condition. On each row, set the first column to “Chronic” and the second to the new encounter\_type name you defined in step 1. In the 3rd and 4th columns, for each new row select one service category/service that is to be part of this encounter (if you need to create a new service, see the section “Add/Delete Services” and complete that first).
3. Insert a new column on the <c*hron\_care\_freq*> tab and title it with a reference to the cell with the encounter type name created in step 1.

#### Add F2F Services

Individual services that require face-to-face patient time are defined on the <*service\_characteristics*> tab. Adding a new service (task) requires inserting a new row in this tab and completing the columns that indicate the minimum and maximum time in minutes, and the suitability scores for each provider type who can perform the service. Once a service is added to the spreadsheet, it can be selected as a component of an encounter on the <*encounter\_detail*> tab.

#### Add Overhead Services related to F2F Time

Services that do not require direct face-to-face patient contact, yet are proportionate to face to face visit time, are captured in the <*overhead\_work*> tab. To add a new type of overhead service of this type, enter a row on this tab and complete the information indicating the portion of face-to-face time it requires, as well as the distribution of provider types who will complete the task. The percentages across provider types must add up to 100% for each work type.

#### Implementation of Patient Complexity

Patient complexity is not yet included in the data model. Patient complexity is a measurement of the clinical (and perhaps social) characteristics of a given person that can increase his or her needs for care. There are various ways this could be added to the data model in the future.

* The simplest approach is to calculate an average patient complexity by geographic area and utilize the current SDoH column in the <*geo\_area\_list*> tab to reflect both SDoH and an average complexity factor. This would have the effect of increasing the amount of anticipated service time spent per patient in a particular geographic area that has more complex patients, and would require no changes to the optimization model code. However, this would not account for individual differences within a geographic region nor the age and gender distribution of the patients within a given region and how complexity likely varies with that dimension.
* A more challenging yet more accurate approach might be to introduce a set number of patient complexity categories to the data model, similar to the current age/gender cohorts. This approach would require modifications to the code that reads and processes the input data as well as to the python optimization model. This new dimension would be added as a new column in the <*population*>, <*pop\_chronic\_prev*>, <*pop\_acute\_need*>, and <*pop\_chronic\_trend*> tabs. This would require increasing the number of rows in these tabs by a factor representing the number of complexity categories defined (e.g., 5 complexity categories equates to 5 times the number of current rows in each tab). In the Population tab, this would create a fairly granular population distribution. It might be reasonable to collapse the population tab into ranges if this additional patient complexity granularity is desired.

#### Implementation of Chronic Condition Flare-up Management

Currently the model assumes that the only primary care provided for a chronic condition is routine maintenance care. In reality, chronic conditions can result in occasional flare-ups which might be treated by a primary care provider. The most efficient way to add this type of care to the data model would be to create new chronic encounter types for flare up treatment and define their estimated frequency using the instructions provided earlier in this document (Add Chronic Encounter Type).

#### Implementation of Chronic Condition Combinations

Currently the model assumes each chronic condition is independent of the other. A patient with multiple chronic conditions is expected to receive all maintenance treatment for each condition independently. This ignores the more realistic approach of delivering maintenance care for a patient’s various chronic conditions within a single encounter. This can be addressed in a number of ways, but the simplest would be to create common combinations of chronic conditions as a new “chronic condition”. For example, a new chronic condition could be created labeled “Diabetes and CAD”. The prevalence of this combination would need to be estimated, and the prevalence for Diabetes and CAD alone would also need to be adjusted to exclude people with this combination. This new condition would be added to the data model, and a new type of encounter that reflects care for both diseases would be created.

#### Implementation of Chronic Condition Care Proportions

Currently the model assumes that all maintenance care for the chronic diseases identified is provided by a primary care physician. In reality, some portion of that care for some individuals is likely to be delivered by a specialist. A new tab/parameter could be introduced to the model that indicates the proportion of care delivered by primary rather than specialty providers for each condition. This would require software and optimization model changes.

#### Implementation of Chronic Condition Severity

Currently the model assumes that if a patient has a chronic condition, they require the same type of primary care regardless of the severity of the condition. In reality, the more complex patients may require a more significant amount of care, although most of that would likely qualify as “flare up” management rather than routine maintenance. In addition, the more severe patients might seek care from a specialist more often than a primary care provider. Both situations could be addressed by adding a measure of condition severity to each chronic disease identified in the model.

* The most straight-forward approach is to split each chronic condition into two or more conditions that include an indicator of severity. For example, “Asthma” would become “Asthma Severe” and “Asthma Mild”. This allows the basic data structure to remain intact and should not require coding changes to the underlying software or optimization model. For each condition where this split is defined, the prevalence <*pop\_chronic\_prev*>, trend <*pop\_chronic\_trend*>, and care needs <*chronic\_care\_freq*> would need to reflect this change.
* A more complex approach would be to add a new dimension to each chronic condition indicating “severity”. This would require new columns be added to the prevalence <*pop\_chronic\_prev*>, trend <*pop\_chronic\_trend*>, and care needs <*chronic\_care\_freq*> tabs, and that the rows for these tabs be expanded proportionately to the severity levels. This would also require coding changes to the underlying software and optimization model.

#### Implementation of Population Care Management

Addressing the overall care management needs of a population is not currently included in the model. A simplistic but reasonable way to implement this would be to assume that Care Management is proportionate to f2f time and enter Care Management as another overhead work type using the current structure reflected in the <*overhead\_work*> tab. To instead create an add-on type of resource need that is not proportionate to f2f time requires a new data entry type as well as software and optimization model changes.