Spreadsheet Documentation for the

Health Company Pandemic Modeling Tool

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1. INTRODUCTION

The accompanying spreadsheet is a tool for individual companies to model their potential risk exposure from an influenza pandemic. It is based on a model developed for an SOA study examining the potential implications of a pandemic on the U.S. health insurance industry. The spreadsheet is saved with many of the same assumptions used in this research and reproduces the results of the exhibits contained in the June 2010 report, "Potential Impact of Pandemic Influenza on the U.S. Health Insurance Industry."

The SOA does not endorse the use of this work to predict the impact of a pandemic on a particular company or group. Parties interested in applying this research to individual companies should engage actuaries experienced in modeling blocks of business to ensure the reasonableness of the results. Actuaries employing the spreadsheet tool as a part of their analysis should closely examine the characteristics of their unique situation and use professional judgment in developing and applying assumptions regarding pandemic scenarios, provider assumptions and company specific assumptions.

This documentation supports the appropriate use of the company tool and provides background on the assumptions used in the model. The spreadsheet calculations are documented through footnotes. This documentation is supplementary to the report, which contains full documentation of the development of the assumptions used. In order to properly utilize the company tool, any user must carefully read the accompanying report.

Your feedback on the company tool is solicited. Questions, concerns, suggestions or corrections should be directed to the author at Jim.Toole@MBAActuaries.com.

2. GENERAL INFORMATION

The first tab is a comment page. It is a blank sheet to keep track of questions, comments and documentation as you move through the sheet. Think of it as a handy piece of scratch paper.

Items in BLUE are inputs. There are three sets of assumptions: Scenario, Provider and Company Specific. Most input variables for scenario, provider and company specific assumptions have been centralized in sheets with rose-colored tabs visible in Office 2007 versions. Variables associated with specific calculations (e.g., value of deferred care) can be found in other sheets. Cells containing input variables not contained on the main Scenario, Provider and Company Specific assumption pages have been highlighted in rose to make them stand out.

The spreadsheet has been saved with the same scenario and provider assumptions used in preparing the report. Sample data required to define an individual company insurance portfolio has been provided.

It is a simple matter to change the scenario assumptions provided to reflect a company's view on matters such as mortality, morbidity, distribution of cases by provider type and charges. Provider assumptions are more intricately woven. It is not recommended that users make adjustments to provider assumptions without investing time to understand the logic behind the current assumption set and the downstream implications of any changes. That said, due to the flexibility inherent in spreadsheet design, it would be a straightforward matter to include additional parameters of a company's own devising.

3. SCENARIO SPECIFIC ASSUMPTIONS

Company and scenario specific assumptions are selected and/or input in tab Scenario.

3.1 Scenario Selection

The Scenario tab in the spreadsheet contains drop-down menus for selecting the scenario severity and distribution curve by age. For flexibility, the user can choose one of three scenarios and independently choose from a distribution curve set. By clicking next to Selected Scenario, a drop-down list of severity choices (seasonal, moderate and severe) is presented. Default values reflect seasonal, moderate and severe scenarios as published by the U.S. Department of Health and Human Services (HHS).

Similarly, clicking next to Distribution Curve reveals the menu of supported age distribution curves. The dropdown menus pull from the Scenario and Distribution Curve Menus should the user wish to change the labeling convention. ***Any changes to the menus will impact downstream calculations which are expecting these particular input variables.***

Selecting the scenario drives the assumption set pulled for the calculations but does not change them. Users can input their own assumptions by scenario for population deaths, morbidity and distributions by age in the Mortality and Morbidity Distribution Tabs (discussed later).

3.2 Company Specific Assumptions

The company specific assumptions include an input area for various items for which the company may have its own view. The first item brings forward claim costs in the model (which are based on data from 2003) to 2010. If the user has more current claims information and inputs it in sheet Provider Charges, this could be set to zero to override the impact of inflation.

The next item is tax rate. The user should input the estimated tax benefit due to loss carryforwards.

The next two items are the names of the lines of business that are being modeled for formatting purposes.

The next two items are the approximate number of covered members by line of business. If only modeling one population, the second number should be zeroed out.

The next three items (Insured Population, Total Private Insurance and Pop Zero to 69) are used by the model to distribute aggregate system calculations in the ratio of the company specific exposure. Note that the default age distribution for private insurers in the model is based on the U.S. population for ages 0 to 69. Companies that target specific populations should review this assumption for reasonableness. The distribution by age for each line of business can be found in Column 7 of the respective LOB Dist tabs.

4. PANDEMIC SCENARIO ASSUMPTIONS

The pandemic scenarios are generated in the tabs following the blank Scenario Assumptions tab. The process of developing the assumptions that drive the pandemic scenarios is described in this section. The core of the scenario assumptions are population deaths attributable to influenza and their distribution by age (“mortality curve”), the morbidity rate and distribution by age (“morbidity curve”) and distribution of cases by provider type. These, along with the identification of at-risk groups and an assumption about the duration of the pandemic, form the basis of the specific pandemic scenarios.

Two scenarios were developed to support this research: a moderate scenario and a severe scenario. A scenario calculating the annual impact of seasonal influenza was also prepared for model validation purposes.

This research has made the assumption that the duration of the pandemic wave will be completed in a time frame that will not allow for the development and large scale distribution of antivirals or vaccines that might materially impact the course of the pandemic. The impact of mitigation strategies on general population health costs could be modeled by adjusting the base mortality and morbidity assumptions. The effect of interventions targeted specifically towards insured populations could be captured in the risk and utilization assumptions.

4.1 Mortality Distribution

The Mortality Distribution Tab contains all the information needed to produce various distributions of mortality by age. Input items are described in more detail below.

4.1.1 Population Deaths per Thousand

Users should input their assumptions for total estimated population deaths for selected scenarios. Default values represent seasonal, moderate and severe scenario deaths as published by the U.S. Department of Health and Human Services. Selections can be modified to reflect a view of the overall expected deaths in the general population.

4.1.2 Distribution by Age

The mortality curve for the current scenario is selected on the Scenario tab. The model currently supports four different mortality curves (distributions of deaths by age): a seasonal "U" curve, a hypothetical moderate "U" curve reflecting increased deaths at low and high ages (similar to a combined seasonal and mild pandemic), a hypothetical "VV" curve with excess deaths at the older ages as well as increases at ages 20–40 and a "V\" curve derived from 1918 with deaths at the younger ages and increases at ages 20–40, tapering off at the older ages. The curves (in blue) can be modified by the user to reflect their view of the distribution of deaths by age.

4.1.3 Ratio of Insured versus General Population Mortality

This variable reflects the company view of the relative impact of a pandemic on insured population mortality versus general population mortality. This variable captures the cumulative impact of differences between insured and uninsured populations in overall health, access to care, mitigation and interventions. The default assumptions in the spreadsheet are based on the "SOA Pandemic Delphi Mortality Study" from 2007, which reflect assumed differentials between individual and group life populations versus the general population.

4.2 Morbidity Distribution

The Morbidity Distribution Tab contains all the information needed to produce distributions of cases by age. Input items are described in more detail below.

There are two components of morbidity: attack rate and severity, both of which vary by age. The population exposed to morbidity is net of exposed deaths (number of deaths grossed up for the attack rate). The attack rate drives the total number of cases, while the severity drives the number of deaths and the distribution of total cases by provider (hospitalizations, alternate care facility (ACF), outpatient and self-care). Cases are further separated into low and high risk groups, which drive costs.

4.2.1 Morbidity

Accurate morbidity rates are more difficult to estimate than mortality rates. While public records are maintained by cause of death, no comprehensive national surveillance system is in place to capture incidence of influenza cases during a seasonal flu season, much less during the stress of a pandemic. It is now believed that seasonal influenza may present in anywhere from 5 percent to as much as 20 percent of the population during a given season, but because of the difficulties in positively identifying the disease, actual numbers are not known. Morbidity estimates during a pandemic range from 30 percent to 50 percent. The number of people who become sick in the model (cases) is calculated by multiplying the attack rate by the census figures net of exposed individuals who died.

4.2.2 Distribution by Age

The distribution of morbidity by age for this research is based on a report on seasonal influenza by Dr. Noelle-Angelique Molinari.[1] These results were adjusted by scenario to reflect relative changes in death rates by age. Actual factors used were smoothed by judgment to conserve the total expected incidence rate for the scenario.

4.2.3 Risk Adjustment Factor

The risk adjustment factor adjusts the proportion of high risk individuals in the insured population versus the general population, similar to the mortality adjustment. The effect is not assumed to be as pronounced as with mortality.

The relative proportion of high risk individuals in the insured population is assumed to be 15 percent less than that of the general population. Adjusting for 175 million insured individuals, this results in an assumption of the privately insured high risk population at 92.5 percent of the general population and the publicly insured and uninsured high risk ratio of approximately 109 percent of the general population.

4.2.4 Utilization Adjustment Factor

The utilization adjustment modifies the insured population demand to reflect the relative utilization of health care services between the insured versus the general population. This is a composite factor based on judgment that incorporates various adjustments, including relative utilization of health care resources, overall population health status, access to vaccine, prophylaxis and/or mitigation strategies. On a seasonal basis, the insured population is assumed to utilize resources at a rate 20 percent higher than the general population, 5 percent more during a moderate scenario, and 5 percent less during a severe scenario. The reduction reflects the assumption that the insured population will have better access to vaccines and prophylaxis, as well as more resources and information for managing both exposures and response.

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[1] Molinari, Noelle-Angelique, et al. The Annual Impact of Seasonal Influenza in the U.S., Measuring Disease Burden and Costs, *Vaccine* 25 (2007) 5086–5096.

4.2.5 Peak Wave Duration

The modeling time frame is assumed to be the period of a peak wave, conceivably following a sentinel wave. Later waves have not been modeled under the assumption that the system would have an opportunity to "reset" and various mitigating factors would come online that were not assumed to be a factor in the modeling of the initial peak wave (vaccines, re-pricing, etc.).

One objective of this research is to test for solvency as a potential consequence of a pandemic. Counterintuitively, conservatism suggests a longer duration of the wave. The longer duration allows for more capacity in the provider system with more individuals receiving high intensity treatment, increasing overall costs. The research has assumed a peak wave duration of 12 weeks for all scenarios.

4.3 Case Distribution by Provider

In addition to the death rate, the virulence of the pandemic is captured by defining what types of services each case requires. The Case Distribution by Provider Tab contains all the assumptions needed to distribute the total number of cases by provider. Five levels of care have been defined in the model, in order of intensity of care:

- Deaths—may occur in or out of the hospital.
- Hospitalization—impairment such that hospitalization is sought.
- ACF—hospital overflow capacity.
- Outpatient—seeks outpatient care only.
- Self-care—assumed not to seek treatment.

Estimates for hospitalizations under the moderate scenario were based on the HHS figure of 865,000. In order to develop the severe scenario, the ratio of the increase in deaths from moderate to severe was applied to the moderate scenario hospitalizations, yielding severe scenario hospitalizations of approximately 7.9 million.

Cases are initially assigned to hospitalization, outpatient or self-care. Outpatient assumes outpatient services only, while hospitalization and deaths may include outpatient visits as well as time in the hospital. Based on the number of cases and wave duration, if there is more demand than capacity to provide services within the traditional care setting, this research assumes ACFs are available to provide services at a rate appropriate for the services provided.

4.4 Case Distribution by Risk Class

Illness severity and mortality are greatest in high risk populations. Not surprisingly, so are health care costs. Rather than modeling specific high risk groups, all high risk groups are modeled together. After the total number of influenza cases is determined and split by provider type, cases are further split between low risk cases and high risk cases. The split by age in this report is based on hospitalization and outpatient estimates provided in the Molinari report and smoothed using judgment.

5. PROVIDER ASSUMPTIONS

The purpose of this section is to consider the impact of a pandemic on provider capacity and provide estimates of service charges by age, provider type and risk class.

Bed capacity will be affected both by elasticity in hospital beds and consumer decisions to defer elective care. Reduction in staffing due to a pandemic has not been assumed to impact hospital capacity. This reflects the assumption that caregivers will respond to a public health emergency by staffing the highest level of care needed to support the system. This is a conservative assumption from the standpoint of costs to payers.

The cost of influenza care provided in ACFs and the financial impact of the deferral of elective care during a pandemic have also been estimated. The tabs behind the blank Provider Assumptions tab detail the various assumptions required for calculating hospital, ACF and outpatient capacity, charges and utilization by scenario.

5.1 Hospital Scenario Assumptions

Capacity and staffing assumptions are summarized on the Provider Scenario tab; line numbers refer to this page. Seasonal assumptions are based on current capacity. Moderate and severe scenarios are derived as multiples of seasonal assumptions. Current capacity data has been derived from 2008 American Hospital Association (AHA) hospital statistics and includes general, special, rehabilitation/chronic and psychiatric beds. Although the nursing shortage is a major contributor to capacity problems both now and for the foreseeable future, staffing challenges have not been assumed to affect capacity or the amount of care delivered in different scenarios. From a cost standpoint this is a conservative assumption.

5.1.1 Hospital Capacity and Utilization Assumptions

Available hospital beds are calculated as total hospital beds (1) minus projected utilization by non-influenza patients (5). The result is the available bed capacity (9) for influenza patients (or any other surge in demand). This simple formula has been refined to reflect intensive care bed capacity versus non-intensive care beds. Although not used in calculating results, the total number of ventilators and ventilator demand from non-influenza patients has also been estimated.

In order to determine available hospital capacity under different pandemic scenarios, the base staffed beds were modified. Under normal conditions, the available bed capacity is staffed hospital beds minus average daily inpatient utilization. However, total capacity is assumed to be somewhat elastic, as there is some flexibility both on behalf of hospital staff and regulatory officials to increase bed capacity. Based on discussions with hospital administrators and judgment, this research assumes that hospitals are able to increase their total bed capacity by 10 percent under a moderate scenario and by 25 percent under a severe scenario. ICU bed capacity is assumed to increase 5 percent and 10 percent under a moderate and severe scenario respectively. This is conservative from a total cost standpoint.

5.1.2 Hospital Staffing Considerations

The hospital staffing needs for a scenario are determined a priori. Current AHA information shows that 225,000 physicians (13) and 1,370,000 nurses (15) are employed by hospitals. Per bed staff ratios have been adjusted based on expectations of staffing needs and response under different pandemic scenarios. Staff is decremented for illness at the same rate as the population, so as demand goes up, staff availability goes down. A “family care factor” based on judgment is applied to the illness decrement rate to account for the fact some individuals will stay home to provide care to their family or community (30).

In a moderate scenario, the expectation is that staffing needs would increase commensurate with the increase in beds (e.g., staffing ratio is maintained). The rationale behind this is that individuals going to the hospital would expect the same level of attention and services in a moderate scenario that they would receive during seasonal flu conditions. At some point, there would be a change in expectations as the stress on the system would be too great as a result of staff absences and increasing numbers of patients. This point is assumed not to have been reached in the moderate scenario.

Recall that hospital capacity is assumed to increase by 25 percent under the severe scenario. However, the per bed staff ratios decrease by 25 percent, so the net number of physicians and nurses stays the same, implying that fewer people are doing more in a crisis.

Since the hospital setting is the highest intensity service provider, it has been assumed that physicians and nurses would be drawn from the overall pool of health professionals to adequately staff the needs of the hospitals. This assumes less critical health care resource needs (outpatient and ACFs) would be met by reducing staffing levels and increasing use of volunteers rather than permit inadequate hospital staffing. This approach is conservative because it maximizes the services provided, charges and costs to insurers.

5.1.3 Outpatient Capacity Assumptions

It has been implicitly assumed that the demand for outpatient services will be met.

The starting point for the outpatient capacity assumptions is the health care staffing pool. The total number of physicians (28) and nurses (29) was taken from association data and adjusted for absences due to illness and a family care factor to account for individuals staying home to take care of family members. The hospital staffing needs are subtracted from the remaining healthy staff and further decremented by the number of staff needed to run ACFs. The number of outpatient providers is total, less hospital, less ACF, less illness and family care.

Patient demand is projected employing the same model used to estimate hospital cases but using a different utilization curve. A Weibull distribution is used to reflect utilization by the worried well early in the course of the pandemic (Case Distribution tab). Tab Provider Utilization projects utilization and weekly physician caseloads. Note that this approach assumes all physicians see influenza patients, so caseloads for primary providers are significantly understated.

5.2 Provider Charges

Provider charges by scenario, provider and risk group are summarized on tab Provider Charges. Costs per case of influenza by provider used in the model are based on the work of Dr. Molinari, which measured the annual impact of seasonal influenza in the United States. This report estimated the cost per case of influenza using the Medstat Marketscan database from a sample of 40 self-insured employers from the years 2001 through 2003.

Costs were broken out by outpatient, hospital and deaths and further refined by low risk and high risk individuals. Dr. Molinari presents the costs in five age ranges, which were expanded into quinquennial groups for use in this model. Costs by provider and risk group for the seasonal scenario were tied to the Molinari work in aggregate and for the original age ranges used.

Charges for patients that die are higher than for hospitalized patients that survive. All deaths in the seasonal scenario receive full charges. Based on judgment, it has been assumed that 95 percent of deaths are hospitalized in the moderate scenario and 85 percent of deaths in the severe scenario receive charges (tab Provider Scenario, line 23). The most conservative assumption would be to assume that all deaths were hospitalized.

Because the costs were derived from the self-insured population, they may not be representative of the uninsured or publicly insured population. Because private reimbursement rates tend to be higher than public reimbursement rates, this might lead to overestimation of the cost per case of the publicly insured population (Medicare and Medicaid). Incidence and utilization may offset these factors.

It is difficult to predict whether these relationships by age, provider and risk class from this data would be consistent or vary under the stresses of a moderate or severe scenario. For this research it has been assumed that the relationships that were demonstrated in the seasonal case would continue to hold true in the moderate and severe scenarios.

5.3 Provider Utilization

The assumptions driving provider utilization are input on the Provider Scenario tab; line numbers refer to this page. Scenario totals and weekly provider utilization calculations for the wave are presented in tabs Provider Utilization and Case Distribution.

The total number of hospitalizations is determined from the scenario assumptions as hospital-only cases plus the number of deaths which occur in the hospital. In order to estimate hospital bed demand in any given week, a weekly case distribution projection model was developed based on the FluSurge package developed by Dr. Martin

Meltzer.[2] In order to determine the weekly demand for hospital beds, both the number of patients and their length of stay are needed. The length of stay has been broken out for ICU (17) and non-ICU patients (18). Base ICU length of stay is assumed to be 10 days, twice the length of stay for non-ICU beds. Ventilator usage is assumed to be the same duration as the ICU length of stay (19). The percentage of cases needing ICU care and ventilators is based in Dr. Meltzer's work and input on lines (21) and (22) respectively.

High risk patients are assumed to be allocated to available ICU beds. Excess ICU demand steps down to normal hospital beds. High risk patients who step down to normal beds are assumed to receive lower intensity care and low risk patient charges. If there are inadequate hospital beds to meet total demand, the excess low risk patients are assumed to step down to ACFs (see below).

Under the severe scenario the length of stay is reduced by 20 percent. This reflects the assumption that the hospitals will discharge patients more quickly to allow sicker individuals access to a higher intensity care. Discharged individuals step down to ACFs or home care. To reflect the reduced hospital stay, charges are assumed to be reduced by one-half of the proportionate decrease in length of stay,[3] with no additional charges accruing from ACFs or home care settings. The hospital charge adjustment is found on line (17).

5.4 Alternate Care Facilities

ACFs are often considered in public sector pandemic preparedness plans as a means of addressing possible shortages of traditional medical facilities during a pandemic. The severe scenario demonstrates the mechanics involved in incorporating ACFs in the modeling. The calculation of the estimated cost of ACF services is detailed in tab ACF Costs. The projected weekly utilization of ACF overflow sites is detailed in the Provider Utilization tab.

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[2] http://www.cdc.gov/flu/flusurge.htm

[3] .5 x (1 - (4 days / 5 days)) = 10% charge reduction

The hospice care model may well approximate level of care delivered at an ACF during a pandemic. As of 2007, there were 3,257 Medicare certified hospices, of which 562 were hospital-based (thus already included in the hospital capacity figures provided by the AHA). The National Hospice & Palliative Care Organization estimates 1.3 million patients received services from hospice in 2006, of which approximately 75 percent were Medicare patients.

Hospice reimbursement rates vary depending on the level of care received. Medicare rates effective Oct. 1, 2007 range from $135.11 for routine home care days, to $601.02 for general inpatient care days, to $788.55 for continuous home care days (which include an element of skilled nursing). This research has assumed a five-day stay with a charge of $500 per day (tab Provider Scenario, lines 26 and 27), a reasonable assumption given the level of care provided. Under the conditions of a pandemic, it is likely that a significant number of ACF claims would never be filed. It is also possible that the uninsured would make disproportionate use of the ACF setting versus hospital care.

5.5 Deferred Elective Care

The utilization of non-influenza patients has been adjusted to reflect the fact that some patients will choose to defer or cancel elective care rather than go to the hospital during a pandemic. Studies have shown that this deferral of care during a crisis is often not recaptured but is instead a net savings to the system. This effect has been quantified by assuming a 5 percent reduction in individuals seeking elective services in a moderate scenario and a 20 percent reduction in a severe scenario (tab Provider Scenario, lines 5 and 6). ICU bed use and ventilator use have been adjusted to a lesser extent, reflecting the fact that a greater proportion of ICU use is non-elective.

As a rule, elective procedures are more expensive to insurers than illnesses. An estimate of the value of deferred elective care has been calculated using service costs from the AHRQ Healthcare Cost and Utilization Project (HCUP) and the elective deferral rates described above. The derivation of the estimated value of this deferred care is detailed on Tab Deferred Care. Note also there is likely to be an upsurge in uncompensated care from uninsured and undocumented individuals utilizing hospital services. This will have an impact on hospital cash flow and finances, which varies by institution, but presumably will have only a secondary impact on insurers.

6. COMPANY SPECIFIC RESULTS

The tool has been built to support the analysis of two lines of business. The calculations for each line of business are contained in three tabs: Distribution, Costs and Summary. They are primarily driven by assumptions that have been input in previous tabs. Adding additional products or lines of business is relatively straightforward. The three line-of-business sheets can be grouped and copied and all calculations remain internally consistent. The formulas in the two Total sheets would need to be updated to reflect the new line. This would be appropriate for companies that have concentrations in lines of business with significantly different distributions or out-of-pocket costs. Intermediate sheets could be added to support the needs of particular product types.

The LOB Sum sheet consolidates results from the associated Costs and Distribution sheets. The line-of-business estimated gross costs are calculated by provider, and the cost allocation of ACFs and a credit for deferred elective care are shown, if appropriate. The gross payer costs as of 2003 are then adjusted for inflation to arrive at estimated 2010 gross costs.

Lines 10, 11 and 12 adjust the total costs by assumed employee out-of-pocket costs for each line of business. The out-of-pocket costs are broad estimates and should be replaced by assumptions that reflect appropriate average co-pay and co-insurance dollar amounts for the user's book. Finally, the pre-tax cost is estimated and an after-tax cost accounting for net operating losses.

The results of deterministic testing are often shown in a range. When specific combinations of scenarios and curves are run, the results can be documented by copying Column E and pasting as values to the right. This sheet currently assumes three such scenarios will be presented.

As an additional reasonableness check, the average cost by provider has been presented in a table that does not appear in the report. Users should confirm that average outpatient, hospital and costs for deaths reconcile with influenza costs for their book of business.

The Total sheets are consolidated from the line-of-business results. The Total Summary sheet includes population statistics based on the U.S population and the company. Depending on the types of company risk and utilization adjustments assumed in the distribution sheets, a different distribution of general population versus insured will result.