A Program of The Actuarial Foundation

Modeling the Future Challenge

MTFC Scenario Quest

MTFC 2024-25 Scenario Phase

Instructions & Prompts

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Welcome to the 2024-25 Modeling the Future Challenge Scenario Quest!

This document contains the materials and prompts teams need in order to complete the Phase 1: Scenario Quest submission of the 2024-25 Modeling the Future Challenge (MTFC). The Scenario Quest is structured with the 5 steps of Actuarial Process and is designed to prepare and equip teams with resources and skills that will allow them to not only successfully qualify for Phase 2: Projects, but to also successfully complete their MTFC risk-modeling project. The Scenario Quest is self-contained and requires NO outside research to complete.

Scenario Quest Scoring

Each problem #1-25 is scored on a 2-point scale based on thorough completeness.

Scenario Quest: 50 Points				
Step 1 (#1-3) 3 questions	Step 2 (#4-9) 6 questions	Step 3 (#10-16) 7 questions	Step 4 (#17-21) 5 questions	Step 5 (#22-25) 4 questions
6 points	12 points	14 points	10 points	8 points

All Scenario Phase Submissions

There are **THREE** total submission items for Phase 1: Scenarios in the MTFC that are used to determine advancement to Phase 2: Project Phase of the MTFC. See the ICS Dashboard for submission spots and templates.

- **Scenario Quest Response** (1 Scenario Quest completed for the entire team; *Topic: Diabetes*)
- **Project Proposal** (1 Project Proposal completed for the entire team; *Topic: Team Choice*)
- **Participation Waiver** (1 waiver completed for **each** team member & their coach)

Scenario Quest Submission Instructions

- The responses to the Scenario Quest prompts should be clearly numbered, organized in order, and compiled into a single file to be submitted on the ICS Dashboard.
- A template document for submissions can be found on the ICS Dashboard. Its use is not required but is an additional resource for teams who choose to use it.

All Scenario Phase Submissions Deadline:

Sunday, December 8, 2024 11:59PM Pacific

Support for MTFC Teams

- The Challenge staff are readily available via email: challenge@mtfchallenge.org
- The Actuarial Process Guide (APG) contains general background information on the Actuarial Process and should be consulted as a resource during the Scenario Phase. Additional resources can be found on the MTFC Resource Library: mtfchallenge.org/resources
- Join us for the Live Virtual Scenario Workshop by registering here: mtfchallenge.org/all-events

Scenario Quest Background: Diabetes

Diabetes was the 8th leading cause of death in the United States in 2021 with accompanying high risk of developing other diseases.

The hormone insulin (created in the pancreas) is essential for regulating blood sugar levels by facilitating the uptake of glucose into cells. However, for someone with diabetes, their body either doesn't make enough insulin or it can't use insulin properly, causing high levels of sugar in their blood, which can lead to health problems.

There are three types of diabetes:

- A Type 1 diabetes diagnosis occurs when a person's body doesn't produce insulin itself, requiring them to take insulin externally everyday. Type 1 diabetes is usually diagnosed in children, teens, and young adults. Type 1 diabetes accounts for approximately 5-10% of all diabetes cases.
- A Type 2 diabetes diagnosis occurs when a person's body either doesn't produce enough insulin, or does not utilize the produced insulin well. Historically, type 2 diabetes was more commonly diagnosed in adults but is increasingly seen in younger people, too. Type 2 diabetes can often be managed with healthy eating, regular exercise, and sometimes medication or insulin. Type 2 diabetes accounts for approximately 90-95% of all diabetes cases.
- Gestational diabetes occurs in pregnant women during pregnancy and usually goes away after the baby is born. However, it increases the risk of developing type 2 diabetes later in life. *Note: the data in this scenario and datasets do NOT include gestational diabetes as it is considered temporary.*

Diagnosis of diabetes requires blood tests, including an A1C test (measuring average blood sugar levels over the last 2-3 months; an A1C of 6.5% or higher indicates diabetes), a fasting blood sugar test (measuring blood sugar after not eating for at least 8 hours; a level of 126 mg/dL or higher indicates diabetes), or an oral glucose tolerance test (measuring blood sugar before and after drinking a sugary drink; a level of 200 mg/dL or higher after 2 hours indicates diabetes).

If diabetes isn't well managed, high blood sugar levels can cause serious health problems over time. Resulting conditions could include heart disease and stroke from damaged blood vessels, nerve damage, kidney failure due to damaged kidney filtering functionality, vision problems or blindness due to damage in the eye's blood vessels, foot problems due to nerve damage and poor circulation which can sometimes result in amputation, and skin conditions.

Managing diabetes involves keeping blood sugar levels in a healthy range with a healthy diet (and avoiding excessive sugar intake), regular exercise that helps the body utilize insulin more effectively, regular monitoring of blood sugar to track and respond to (i.e., stabilize) blood sugar levels, and medication (e.g., insulin, Metformin, or other medication). Metformin is an oral medication primarily used to treat type 2 diabetes by increasing insulin sensitivity (by reducing glucose production in the liver and amount of sugar absorbed by the intestines) and has a low risk of causing low blood sugar (hypoglycemia). Insulin is a subcutaneously injectable (or in rare cases, inhalable) medication used to treat both type 1 and type 2 diabetes and works to directly lower blood sugar by helping glucose enter cells from the bloodstream. While it effectively lowers blood sugar levels (and is essential for type 1 diabetics who cannot produce their own insulin) and can be tailored to match the body's insulin needs, it can cause hypoglycemia if not managed properly.

Your Scenario Quest Mission

Diabetes incurred direct costs of $306.6 billion and indirect costs of $106.3 billion in 2022 in the United States alone.

You work for an independent research and analytics consulting firm. You were recently contracted by the U.S. Department of Health and Human Services to look into the current state of diabetes treatment in the United States. Trends have indicated that diabetes and prediabetes diagnoses are continuing to increase and an increasing number of younger people are diagnosed with diabetes than historical trends. There is a need to understand the current trajectory of the disease and recommend a risk mitigation strategy to relevant stakeholders and projecting short-term trends into 2030.

To begin, you are working with a relatively small health insurance company, Insuracare, who has provided you with a random (anonymized) data subset of 500 of their members who have been diagnosed with diabetes (Insuracare has more policyholders than these 500 who have been diagnosed with diabetes). Insuracare has a total of 500,000 policyholders, not all of whom have been diagnosed with diabetes. Respond to the following prompts as you are guided through the 5 steps of the Actuarial Process to understand and characterize the risks of diabetes, and ultimately make recommendations to Insuracare for how they can best mitigate their risk of loss so that they can remain solvent as an insurance company and continue to serve their policyholders well.

Attached Dataset:
The accompanying dataset contains all data needed to complete the MTFC Scenario Quest. See the "Data Description" tab for a complete outline of the data provided.

Data Description Summary:

Tab #1: Diabetic Insuracare Claims (2021)

- **Member ID** (Identifier for individual person)
- **Age** (Member age)
- **Gender** (Male or Female)
- **Annual Medical Costs** (Cost of medical claims for 2021 [does not include pharmacy costs])
- **Metformin Claims** (The number of pharmacy claims for Metformin)
- **Metformin Costs** (Cost of Metformin claims)
- **Insulin Claims** (The number of pharmacy claims for Insulin)
- **Insulin Costs** (Cost of Insulin claims)
- **Annual Pharmacy Cost** (Cost of all pharmacy claims for 2021 [does not include medical costs])

NOTE: While modeled off of actual data, all information in this Diabetic Insurance Claims (2021) data set is artificial.

Tab #2: US Diabetes Prevalence Trends (1999-2015)

- **Physician-diagnosed diabetes**
  - Percentage of US Population for 20 years and older (age adjusted)
- **Undiagnosed diabetes**
  - Percentage of US Population for 20 years and older (age adjusted)

NOTE: This table of actual data is simplified and adapted from the CDC's Table 14 expanded dataset. The MTFC Scenario Prompts can be answered using this version of the table as provided.

Note: This Scenario Quest is self-contained and no additional or outside data is needed to be able to respond to and complete the following prompts.

PART 1: PROJECT DEFINITION

#1: WHO IS AT RISK?

In 3-5 sentences, describe what groups (besides Insuracare Company itself) might be at risk of loss in regards to diabetes diagnosis and treatment? Identifying the scope and scale that the risks have is important for understanding what needs to be characterized. Identify at least two other groups who may have a loss related to diabetes diagnosis and treatment in the United States.

#2: DEFINING THE RISKS

To be able to conduct a valuable research project, we must be able to characterize the risk in quantifiable terms. In other words, we have to get down to the numbers.

In 3-5 sentences, consider the risk to Insuracare Co. themselves – what kind of quantified values can you identify that could be valuable numerical ways of characterizing the risks of diabetes treatment and management?

#3: IDENTIFY RISK MITIGATION STRATEGIES

The goal of a Modeling the Future Challenge project is to make recommendations on how to best mitigate or manage the risks your team has identified. In the Actuarial Process Guide, we define three types of risk mitigation strategies: (1) Behavior Change, (2) Modifying Outcomes, and (3) Insurance.

In 3-5 sentences (considering the Insuracare policy holders from Tab #1: Diabetic Insuracare Claims (2021)), describe how you think each of these three strategies might be able to help mitigate those losses for Insuracare (no calculations needed).

PART 2: DATA IDENTIFICATION & ASSESSMENT

#4: IDENTIFYING THE TYPE OF DATA

In the Actuarial Process Guide, three categories or types of data are identified that may be valuable in analyzing risks and making recommendations on mitigation strategies. The data provided on the diabetes prevalence and insurance claims for this scenario includes some valuable information and include everything needed to be able to address the prompts in this Scenario Quest. For your own topic, you will need to identify your own data and evaluate whether the data you have identified will enable a good data analysis.

Which of the three categories of data identified in the Actuarial Process Guide are provided in this scenario's dataset (Tab #1: Diabetic Insuracare Claims 2021 and Tab #2: US Diabetes Prevalence Trends 1999-2015)? Explain (at a high level) what information and insights these datasets can provide in 2-3 sentences.

DATA SUMMARIES: USE TAB #1: DIABETIC INSURACARE CLAIMS (2021) TO ANSWER #5-8:

#5: INSURACARE RESERVES

Insuracare needs to make sure that they have enough in their reserves to cover the claims made in any given year. What was the total loss due to medical and pharmacy claims that Insuracare needed to be able to cover in 2021 for just these 500 policyholders?

#6: DIABETIC POLICYHOLDER TOTAL CLAIM AVERAGE & STANDARD DEVIATION

What is the average and standard deviation for total claim amount per policyholder diagnosed with diabetes? What do these values mean for Insuracare?

#7: AVERAGE PHARMACY CLAIMS COSTS

What are the average annual pharmacy claims costs for those who take metformin only, insulin only, and both? What does this suggest as an area of focus for risk mitigation for Insuracare?

#8: FREQUENCY OF PHARMACY CLAIMS

What percentage of individuals had at least one pharmacy claim in 2021? What percentage of the individuals take Metformin only, insulin only, or both? What does knowing this information tell Insuracare?

#9: CREATION OF A DATA VISUALIZATION

Using Tab #1: Diabetic Insuracare Claims (2021), create a histogram of annual TOTAL medical costs (pharmacy and medical) and include the histogram in your response.

Critical thinking: What does the shape of this histogram mean for Insuracare considering planning and expectations for coverage of their policyholders' claims? Include numerical justification (frequencies, severities, etc.) that directly references the histogram created in your response (3-4 sentences).

PART 3: MATHEMATICAL MODELING

USE TAB #2: US DIABETES PREVALENCE TRENDS (1999-2015) IN THE DATASET FOR #10 & 11

#10: LINEAR REGRESSION

> Conduct a linear regression on the Physician-diagnosed diabetes data for all persons. Provide the plot, regression equation, and correlation coefficient in your response. Describe the trend and its implications for diabetes prevalence in the US in 2-3 sentences. What is the trend of the annual rate of diabetes diagnosis?

#11: COMPARE PROJECTIONS

> Using your regression analysis in #10, project the % of US population with physician diagnosed diabetes in 2030. Compare your projected % of the US population diagnosed with diabetes with the CDC's projection of 13.1% in 2030 and comment on what factors may play into any differences between your projection and the CDC's projection.

#12: EXPECTED VALUE

> Insuracare has provided a subset of their policyholders who have been diagnosed with diabetes to you, but they insure far more than the 500 members identified in the dataset; Insuracare has an overall portfolio of 500,000 policyholders (this includes policyholders who have not been diagnosed with diabetes, as well). According to the CDC, in 2024, 11.3% of the US population have been diagnosed with diabetes.
>
> If we assume that Insuracare's policyholders are representative of the US population (11.3% are diagnosed with diabetes), using the average total claims of a person diagnosed with diabetes as severity from the data, find the expected value of total claims due to diabetes for Insuracare's policyholders? *Refer to the APG for more information on Expected Value and use Tab #1: Diabetic Insuracare Claims (2021).*

ASSUMPTION EVALUATION

Critical Thinking: For your own MTFC Project Topic and Proposal, you will need to develop and evaluate assumptions that simplify the complexities of the real-world situation that will enable you to develop the conditions under which your mathematical model is valid. Refer to the APG for more information on assumption development.

For this Scenario Quest, evaluate and assess the reasonableness and rational basis for the following assumptions (1-2 sentences each) noting why the assumption is necessary or reasonable to simplify the topic in order to model or if the assumption goes beyond what is reasonable.

> **#13:** "Disregard inflation for the projections."
>
> **#14:** "The data on the 500 policyholders with diabetes are representative of all of the Insuracare policyholders with diabetes."
>
> **#15:** "Insuracare will continuously maintain 500,000 policyholders annually."
>
> **#16:** "Insuracare's policyholders' demographics follow the same trends and proportions of disease prevalence as the US population."

PART 4: RISK ANALYSIS

#17: CHARACTERIZING RISK

> In identifying what area to target for risk mitigation, Insuracare needs to understand and characterize the risk and the conditions to expect a loss.
>
> Is pharmacy claim, age, or A1C score the strongest predictor of risk of loss? Why? In 3-4 sentences, explain and justify with data visualization(s) and/or analysis from Tab #1: Diabetic Insuracare Claims (2021).

ASSESSING THE CURRENT TRAJECTORY: REFER BACK TO #12 WHEN ANSWERING #15 & 16

In order to characterize the current trajectory of the diabetes crisis for Insuracare, we have to identify and comunicate a projection of the future if no interventions are made (i.e., no new risk mitigation strategies are implemented). Once we have this characterization, we can then evaluate the impact and effectiveness of a risk mitigation strategy. For these calculations, we make the following assumptions to simplify the situation:

- disregard inflation for the projections.
- the data on the 500 policyholders with diabetes are representative of all of the Insuracare policyholders with diabetes.
- Insuracare will continuously maintain 500,000 policyholders annually.
- Insuracare's policyholders' demographics follow the same trends and proportions of disease prevalence as the US population.

#18: PROJECTING EXPECTED VALUE TO 2030

> What is the expected value of loss (pharmacy and medical) on claims for Insuracare due to diabetes in 2030, assuming 13.1% of the policyholders have been diagnosed with diabetes?

#19: CURRENT TRAJECTORY

> Based on this, what is the trajectory and projection of the risk for Insuracare if no interventions are made? Refer back to #12 to compare to the current expected value of loss.

CRITICAL THINKING: NO CALCULATIONS ARE NECESSARY) FOR #20 & 21

#20: CONSIDERING PHARMACY CLAIM REASONS

> Comparing policyholders who take metformin, insulin, or both with those who aren't taking either, what might be a reason that these policyholders aren't having pharmacy claims? Explain in 3-5 sentences.

#21: ASSESSING INCENTIVIZATION STRATEGY

> Since Metformin is generally significantly less expensive than insulin, one financial risk of loss mitigation strategy for Insuracare could be incentivizing Metformin instead of insulin for their policyholders. Is incentivizing the use of Metformin by offering a discount for a Metformin prescription rather than insulin a good strategy for the insurance company? Why or why not? Explain in 3-5 sentences.

PART 5: RECOMMENDATIONS

The goal of Insuracare is to reduce the risk that their policyholders are facing with incurred medical and pharmacy costs. Policyholders often have already paid a fee or co-pay by the time a claim is made to Insuracare, so both Insuracare and their policyholders benefit by undertaking preventive measures. Encouraging and incentivizing behavior changes for their policyholders that mitigate the risks prior to actually making a medical or pharmacy claim is one approach that Insuracare is interested in focusing on. They are interested in incentivizing behavior changes for their policyholders with diabetes self-management education and support services (DSMES). According to the CDC, DSMES is highly effective in improving health and diabetes management skills, but less than 7% of eligible patients participate within the first year of diagnosis.

Insuracare is considering implementing a DSMES 12-month program for policyholders diagnosed with diabetes with monthly 1-hour educational programs as evidence from other DSMES programs indicate that completing 10 or more hours of DSMES services yields a reduction of A1c scores by 0.6% with no side effects. Financially, other successful programs have shown results in a 5% reduction in annual average medical costs per policyholder diagnosed with diabetes. To incentivize diabetic policyholders to participate and complete the DSMES program, Insuracare is considering offering a $20 voucher for each 1-hour DSMES session completed of the 12-month program. These vouchers can be redeemed for fresh fruits and vegetables at any grocery store for each 1-hour DSMES session completed of the 12-month program. The curriculum, staffing, infrastructure of the DSMES program is already in place and is assumed to not be an additional cost. Inflation is disregarded for all projections.

Insuracare is interested in understanding the impact that this risk mitigation strategy could have for their 2030 projections for their policyholders diagnosed with diabetes.

USE THE INFORMATION ABOVE TO ANSWER #22 - 25

#22: COST OF THE MITIGATION STRATEGY

> Assume that Insuracare maintains 500,000 members (regardless of the year) and 13.1% of their policyholders have been diagnosed with diabetes in 2030. How much does implementation of this DSMES incentivization program cost Insuracare for 1 year if 10% of their diabetic policyholders participate and complete all 12 sessions and redeem all 12 vouchers they receive?

#23: EXPECTED VALUE OF LOSS WITH THE MITIGATION STRATEGY

> What is the expected value of loss due to diabetes claims if 13.1% (the CDC's projected % of the US population diagnosed with diabetes in 2030) of Insuarcare's policyholders are diagnosed with diabetes but the overall average total claim amount is reduced by 5% as a result of the mitigation program?

#24: DIFFERENCE BETWEEN MITIGATION & CURRENT TRAJECTORY

> What is the difference between the expected value of loss of total claims WITH mitigation (the DSMES implementation) and the "baseline" expected value of loss WITHOUT implementing the risk mitigation strategy computed in #18 above? What does this mean to Insuracare? Explain in 2-3 sentences.

#25: EVALUATING IF THE STRATEGY SHOULD BE RECOMMENDED

> When comparing the difference between the baseline and mitigation scenario's expected value of loss, is the cost of implementing the risk mitigation program with vouchers justified? Explain and justify your reasoning in 2-3 sentences.