OPTIMIZING ICU BED ALLOCATION FOR IMPROVED PATIENT OUTCOMES AND RESOURCE UTILIZATION

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HCIP 6396: Business Intelligence in Healthcare
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BACKGROUND & BUSINESS PROBLEM

Intensive Care Units face challenges in managing bed capacity, leading to extended lengths of stay and increased costs.

Business Problem: Optimize ICU bed allocation for better outcomes and resource utilization.

Research highlights approaches using optimization and simulation to enhance ICU operations.

BUSINESS INTELLIGENCE PROBLEM

IDENTIFY

patterns in patient flow and potential bottlenecks

ANALYZE

length of stay trends across different patient categories and disease groups

TRACK

and visualize resource utilization and associated costs

OFFER

actionable insights for healthcare clinicians to make informed decisions about bed allocation

AVAILABLE DATA DESCRIPTION

UC IRVINE MACHINE LEARNING REPOSITORY

This dataset includes 9,105 critically ill patients from five medical centers across the United States, with data collected during the periods 1989-1991 and 1992-1994.

Each row represents a hospitalized patient who met specific inclusion and exclusion criteria across nine disease categories: **acute respiratory failure, chronic obstructive pulmonary disease, congestive heart failure, liver disease, coma, colon cancer, lung cancer, multiple organ system failure with malignancy, and multiple organ system failure with sepsis.**

https://archive.ics.uci.edu/dataset/880/support2

AVAILABLE DATA DESCRIPTION

PATIENT DEMOGRAPHICS	CLINICAL INDICATORS	DISEASE AND SEVERITY METRICS
Age, Sex, Race	Mean Whole BP, WBC count, HR, Resp. Rate, Temp., PaO2/FiO2 ratio	Disease Group, Disease Class, No. of Comorbidities

RESOURCE UTILIZATION	PATIENT OUTCOMES
LOS, Hospital Charges, Total Cost, Total Medical Cost	Death Indicator, Days until Death, Hospital Death Indicator

https://archive.ics.uci.edu/dataset/880/support2

LIMITATIONS OF NON-VISUALIZATION SOLUTIONS

Traditional non-visualization approaches to ICU bed management face several limitations:

- Data Complexity: ICU data is multidimensional and dynamic. Non-visual methods often struggle to represent the interrelationships between various factors affecting bed utilization.
- Lack of Real-Time Insights: Static reports or basic dashboards fail to capture the rapidly changing nature of ICU environments, leading to delayed decision-making.
- Information Overload: Raw data or text-heavy reports can overwhelm busy healthcare professionals, making it difficult to quickly extract actionable insights.
- Limited Pattern Recognition: Non-visual methods make it challenging to identify trends, patterns, and anomalies in patient flow and resource utilization.

Proposed BI Solution

Bed occupancy tracking

Patient flow visualization

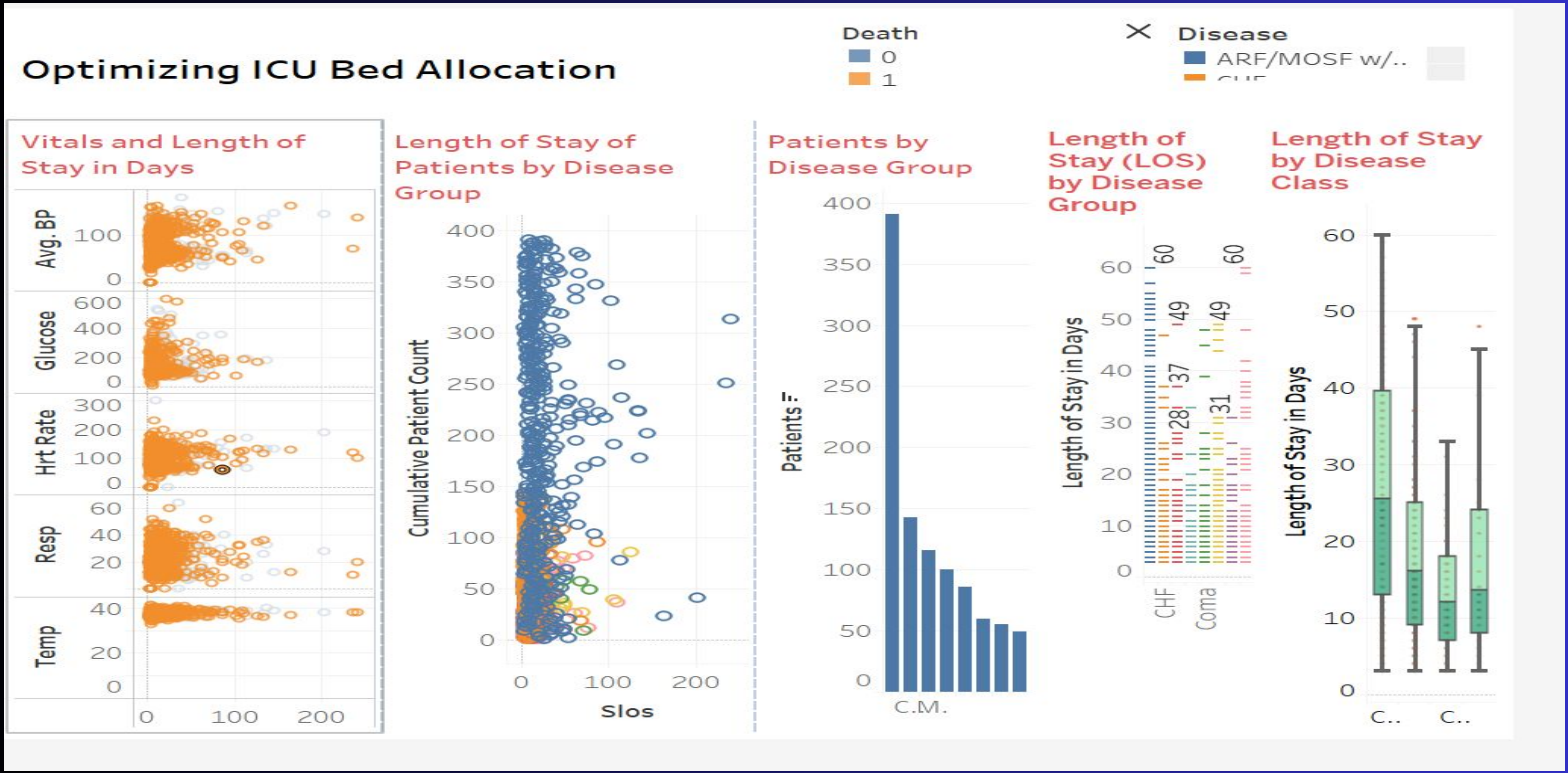
Resource utilization and cost metrics

Length of stay analysis

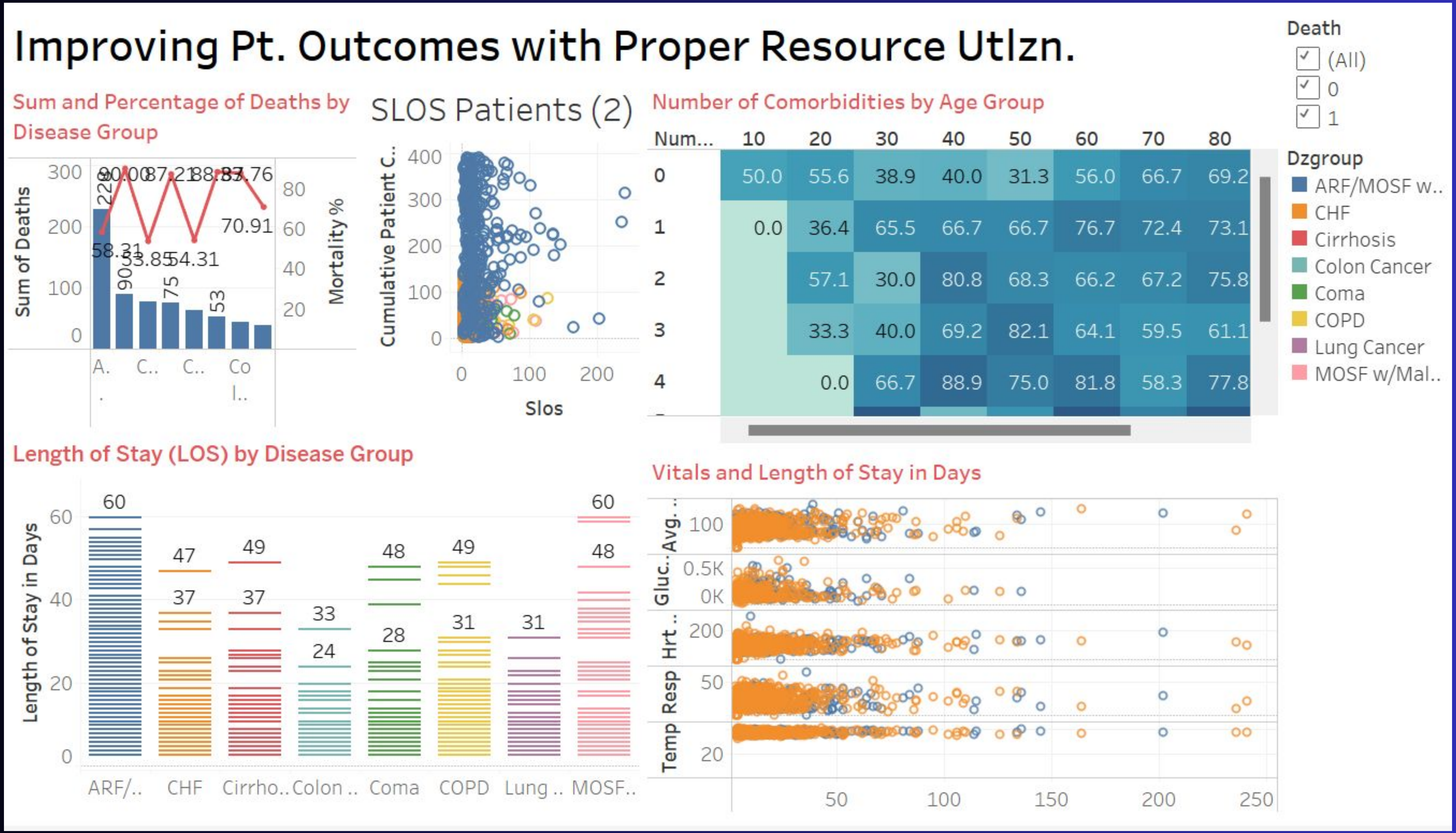
Benefits:
Tailored insights, dynamic planning, improved decision-making

Performance indicators

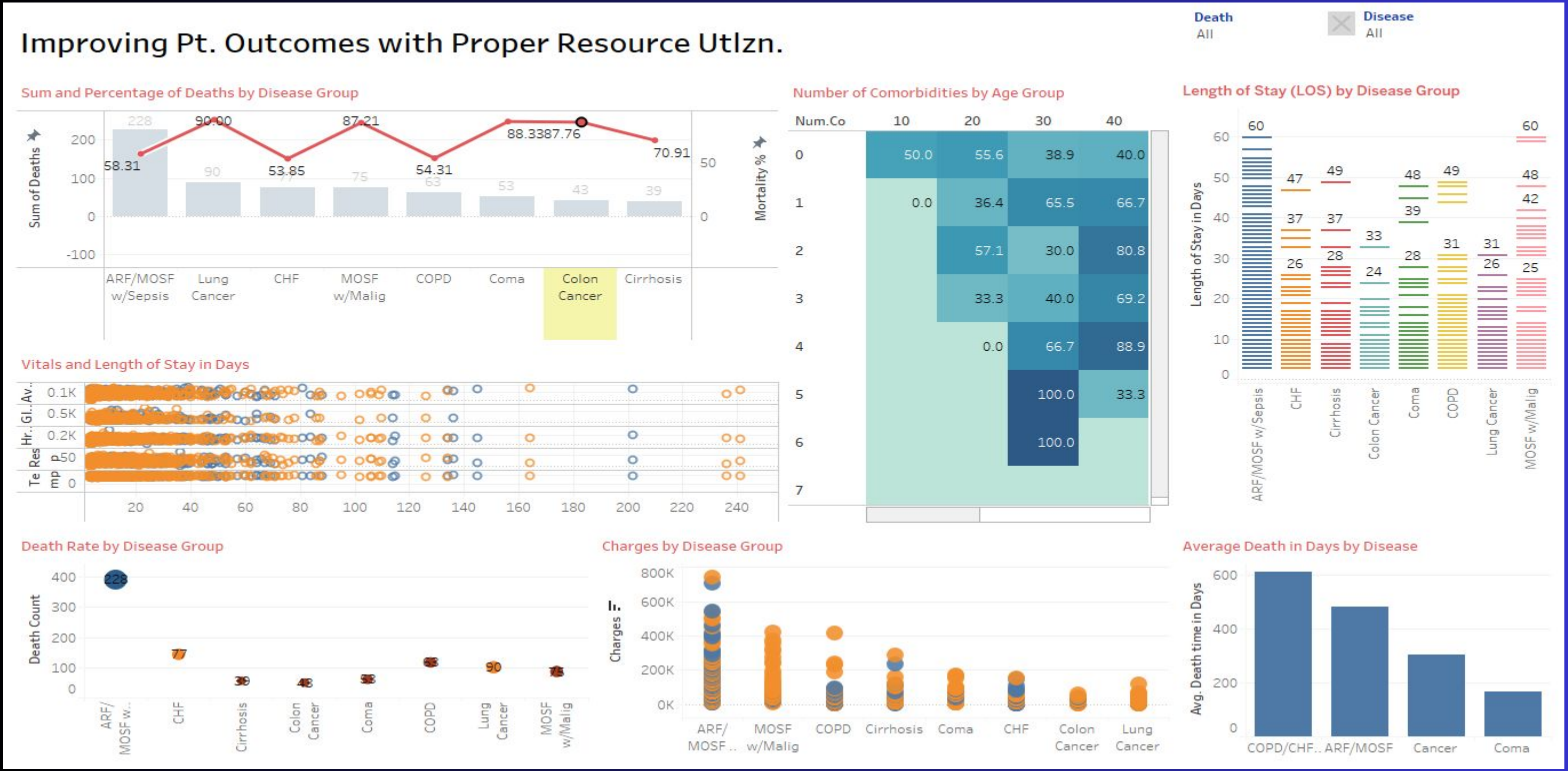
Dashboard Journey



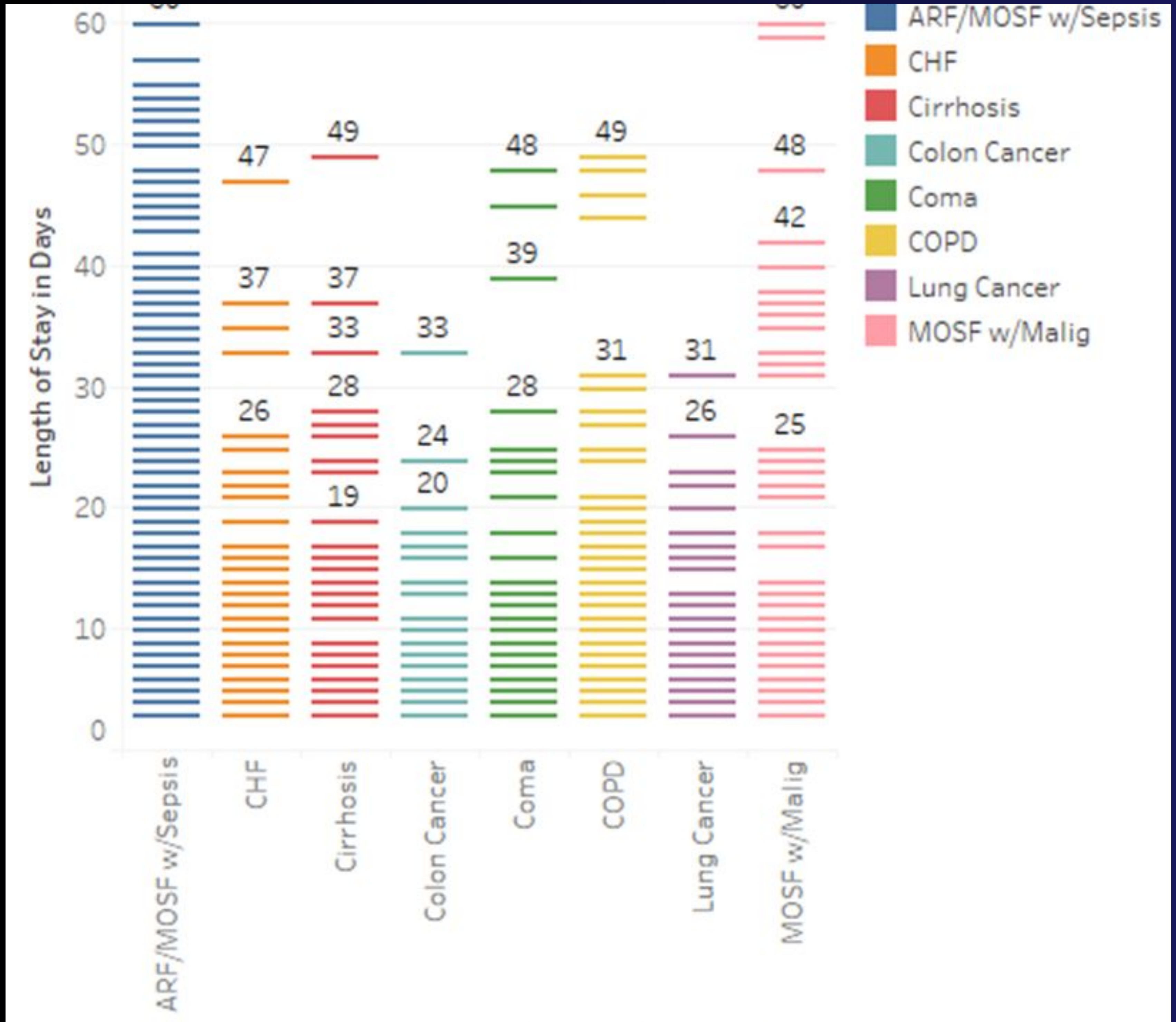
Dashboard Journey



Dashboard Journey



Objective of the Dashboard



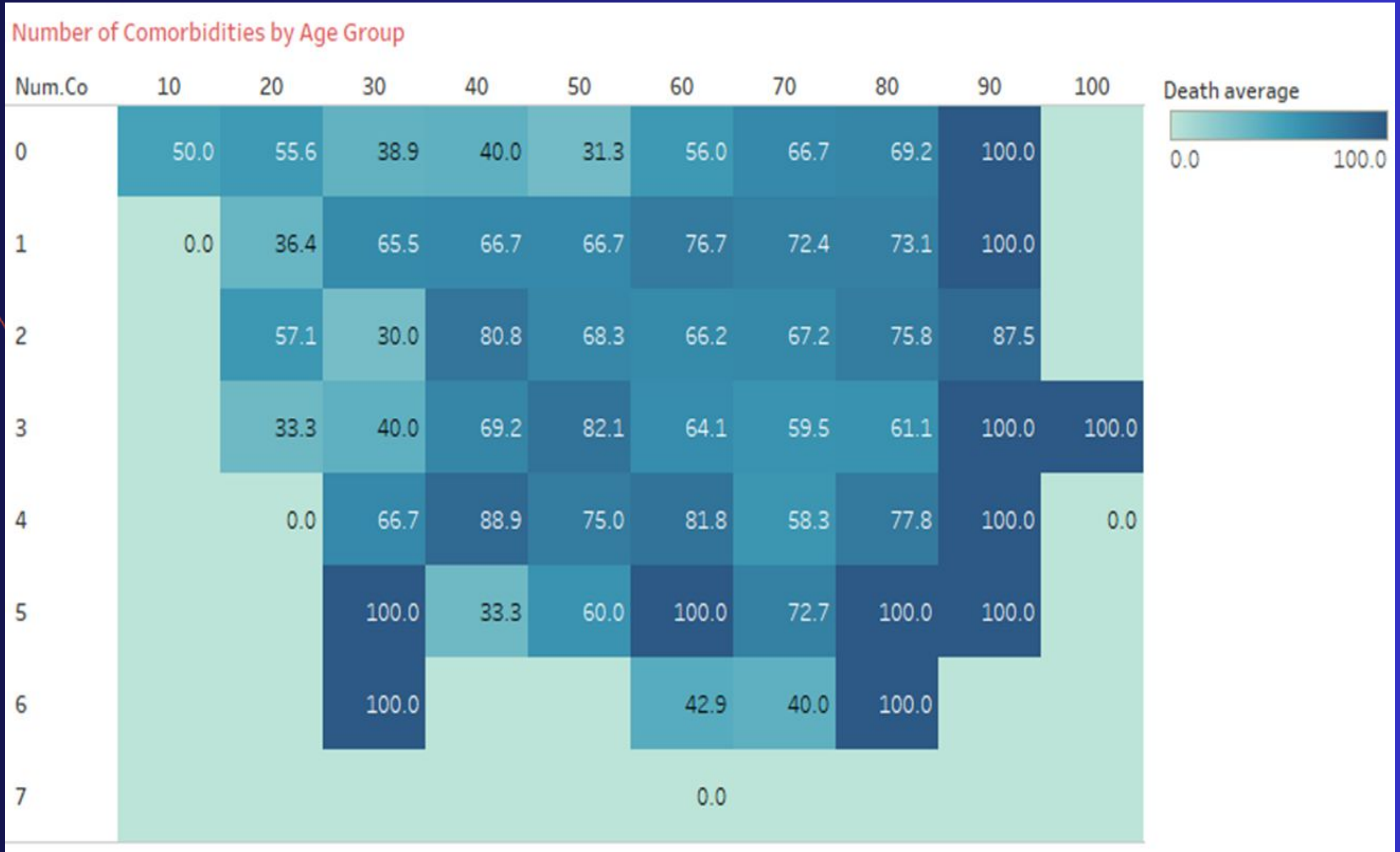
Slos for each Dzgroup. Color shows details about Dzgroup. The data is filtered on Death (Sheet1 (data_icu)), which keeps 0 and 1. The view is filtered on Slos and Dzgroup. The Slos filter ranges from 3 to 60. The Dzgroup filter keeps 8 of 8 members.

Optimizing ICU Bed Allocation for Improved Patient Outcomes and Resource Utilization

- **Goal:** Provide healthcare professionals with actionable insights to optimize ICU bed usage and enhance patient care.
- **Key Problems Addressed:**
  - Real-time tracking of ICU bed availability.
  - Identifying patterns in patient flow and potential bottlenecks.
  - Analyzing trends in length of stay across patient categories.
  - Monitoring and managing resource utilization and associated costs.

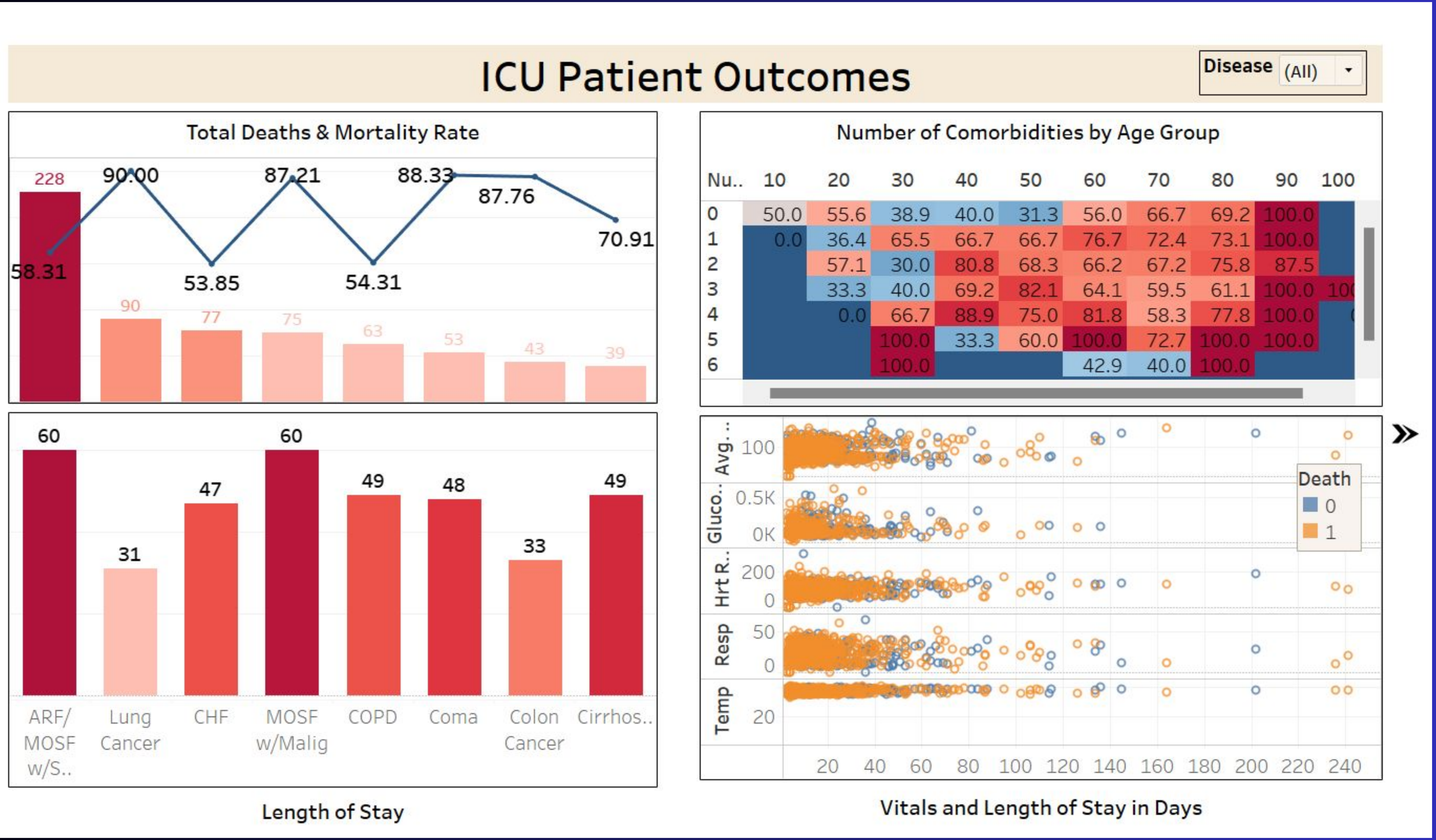
Leveraging Data for Actionable Insights

- **Data Insights:**
  - Patterns of patient flow through the ICU.
  - Disease-specific length of stay trends.
  - Peak demand periods and associated costs.
- **Processing Methods:**
  - Data cleansing to ensure accuracy.
  - Aggregation and visualization for clearer insights.

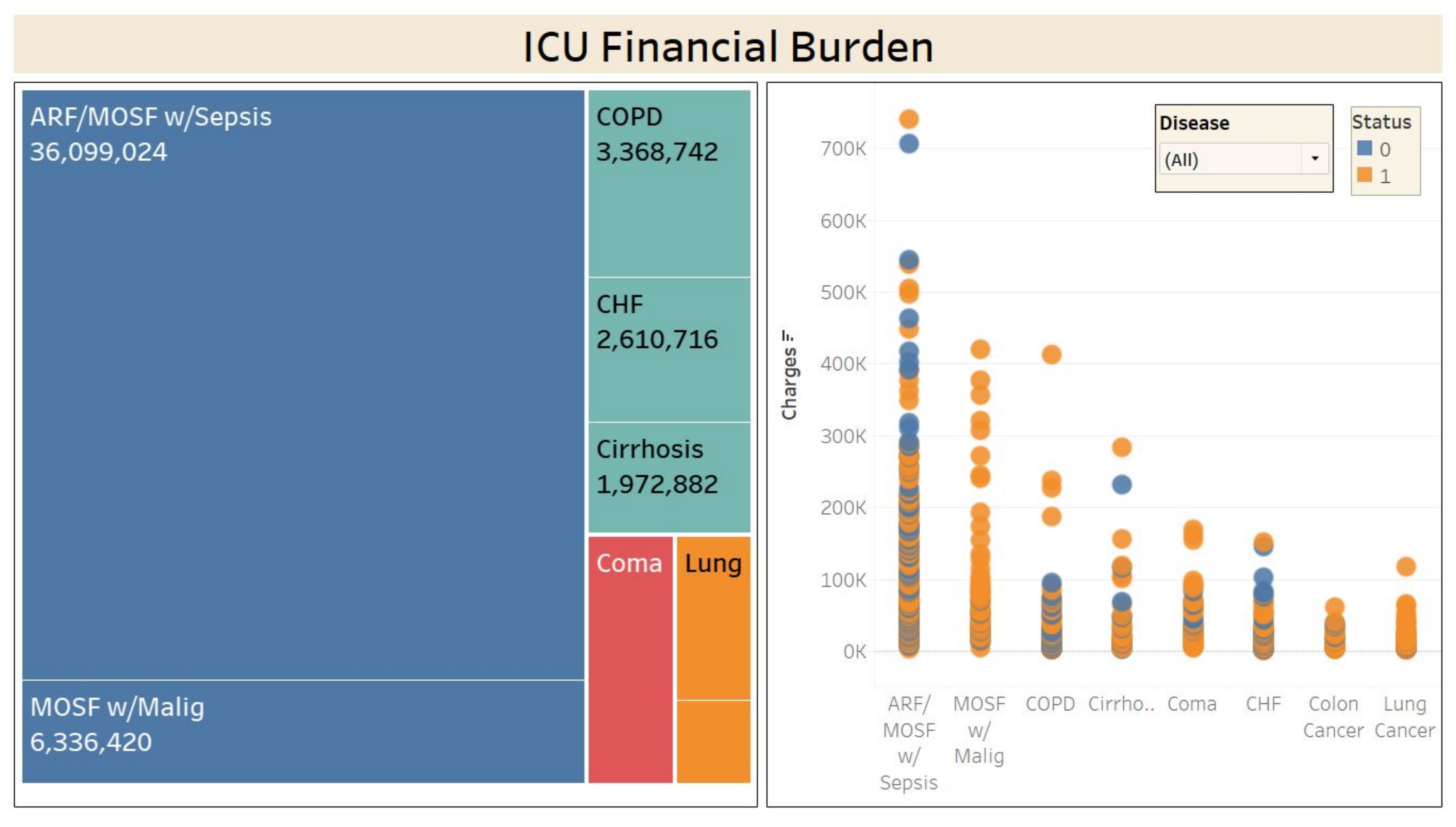


Death average broken down by age (bin) vs. Num.Co. Color shows Death average. The marks are labeled by Death average. The data is filtered on Death, Action (Dzgroup,Slos) and Dzgroup (Sheet1 (data_icu) (3)). The Death filter keeps 0 and 1. The Action (Dzgroup,Slos) filter keeps 257 members. The Dzgroup (Sheet1 (data_icu) (3)) filter keeps 8 of 8 members.

Final Dashboard



Final Dashboard



Final dashboard Key Insights

Purpose:
Optimize ICU operations by addressing mortality, length of stay, and resource allocation for better patient outcomes.

Sum and Percentage of Deaths by Disease Group

- Highest deaths: **ARF/MOSF w/Sepsis** (228 deaths, 58.31% mortality).
- **Colon Cancer** shows the lowest mortality.

Number of Comorbidities by Age Group

- Younger age groups have **0 comorbidities**, while older groups show higher numbers (2-6).

Length of Stay (LOS) by Disease Group

- Longest stays: **COPD, CHF** (~60 days).
- Shortest stays: **Colon Cancer, Coma** (~25 days).

Vitals vs. Length of Stay

- Scatterplot links vitals (e.g., heart rate, glucose) to LOS.

Death Rate by Disease Group

- Top cause: **ARF/MOSF w/Sepsis** (228 deaths).
- Low death counts in **Coma, Cirrhosis.**

Charges by Disease Group

- High charges for **ARF/MOSF w/Sepsis** and **MOSF w/Malignancy**

Average Death Time by Disease

- Longest: **Cancer, ARF/MOSF** (~500+ days).
- Shorter for **COPD and others..**

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