**Project Title:** The Impact of Psychiatric Comorbidities and Psychotropic Medication Management on ICU Readmission Risk (2008-2019, MIMIC-IV data)

**Objective 1: Identifying psychiatric disorders and psychotropic medications associated with increased ICU readmission.**

**Step 1.1: Identify ICU Patients**

* **Goal**: Create the base ICU patient population for analysis.
* **Inclusion Criteria**:
  + All adult patients (≥18 years) admitted to the ICU between 2008 and 2019.
  + ICU stay linked to a valid hospital admission (hadm\_id) and patient (subject\_id).
  + First ICU admission per hospitalization.
* **Exclusion Criteria**:
  + Patients with incomplete or missing ICU stay timestamps.
  + Neonatal or pediatric ICU patients (they should get removed when the age filter is applied).
* **Table**:
  + icustays (ICU stays)
  + admissions (hospitalization data)
  + patients (demographics)

**Step 1.2: Identify Patients with Psychiatric Comorbidities**

* **Goal**: Identify ICU patients with psychiatric diagnoses using ICD-10 codes.
* **Inclusion Criteria**:
  + ICU patients with ICD-10 diagnoses codes indicating psychiatric disorders:
    - Depression: F32, F33
    - PTSD: F43.10, F43.12
    - Anxiety: F40, F41, F42
    - Schizophrenia: F20
    - Bipolar Disorder: F30, F31
    - OCD: F42
    - Substance Use Disorders: F10–F19
* **Exclusion Criteria**:
  + ICU patients without any listed psychiatric diagnosis codes.
* **Table**:
  + diagnoses\_icd (diagnosis codes)
  + d\_icd\_diagnoses (ICD-10 descriptions)

**Step 1.3: Identify Psychotropic Medication Exposure During ICU Stay**

* **Goal**: Identify ICU patients exposed to psychotropic medications.
* **Inclusion Criteria**:
  + Patients prescribed any of the following medication classes during their ICU stay:
    - Antidepressants (e.g., SSRIs, SNRIs)
    - Antipsychotics (typical or atypical)
    - Anxiolytics (e.g., benzodiazepines)
    - Mood stabilizers (e.g., lithium, valproate)
* **Exclusion Criteria**:
  + Patients without any documented psychotropic prescriptions.
  + Medications prescribed only before or after the ICU stay.
* **Table**:
  + prescriptions (medication orders)
  + d\_items (for drug name classification)

**Step 1.4: Identify ICU Readmissions**

* **Goal**: Flag ICU readmissions within 30 days of discharge.
* **Inclusion Criteria**:
  + ICU patients with a second ICU stay within 30 days of the initial ICU discharge.
  + Readmissions either within the same hospital stay or a new one.
* **Exclusion Criteria**:
  + ICU patients with no readmission or with readmission after 30 days.
  + Death during index hospitalization.
* **Table**:
  + icustays (ICU admissions with timestamps
  + admissions (admission and discharge times for calculating 30-day windows)

**Objective 2: Evaluating if discontinuation or improper reconciliation of psychiatric medications at discharge contributes to higher readmission risks.**

**Step 2.1: Identify Patients Discharged on or Off Psychiatric Medications**

* **Goal**: Determine if psychotropic medications were continued, discontinued, or omitted at discharge.
* **Inclusion Criteria**:
  + ICU patients who received psychotropic medications during their stay.
  + Discharge medication status assessable via continued prescription or chart documentation.
* **Exclusion Criteria**:
  + Patients with unclear or missing discharge medication data.
  + Patients who died in hospital.
* **Table**:
  + prescriptions (compare ICU and post-ICU discharge meds)
  + admissions (discharge time)
  + icustays (to match ICU vs. hospital discharge)

**Step 2.2: Compare Readmission Rates by Discharge Medication Status**

* **Goal**: Assess whether medication discontinuation is linked to higher readmission.
* **Inclusion Criteria**:
  + Patients categorized into:
    - Continued psychotropic medication at discharge
    - Discontinued/not reconciled medication at discharge
* **Exclusion Criteria**:
  + Patients with ambiguous medication status or discharged to hospice/comfort care.
* **Table**:
  + prescriptions
  + admissions
  + icustays

**Objective 3: Develop predictive models to identify ICU patients at high risk of readmission due to psychiatric factors**

**Step 3.1: Define Analytical Cohorts for Model Training**

* **Goal**: Define four comparison cohorts for model input.
* **Inclusion Criteria**:
  + ICU patients categorized as:
    - **Cohort 1**: Psychiatric diagnosis + psychotropic medication
    - **Cohort 2**: Psychiatric diagnosis only
    - **Cohort 3**: Psychotropic medication only
    - **Cohort 4**: Neither diagnosis nor medication
* **Exclusion Criteria**:
  + Patients not fitting into any clear cohort group.
  + Overlapping or conflicting diagnostic and medication data.
* **Table**:
  + diagnoses\_icd
  + prescriptions
  + icustays

**Step 3.2: Select Variables for Prediction**

* **Goal**: Select clinical and demographic variables for model input. Create a summary statistics table based on the variables described below.
* **Inclusion Criteria**:
  + Psychiatric diagnosis indicators (binary or also known as one-hot encoded)
  + Psychotropic medication status (class/type)
  + Demographics (age, gender, ethnicity)
  + ICU/hospital features (length of stay, mechanical ventilation, SOFA score)
  + Comorbidities (Charlson index if computable)
* **Exclusion Criteria**:
  + Highly incomplete variables
  + Variables with low variance or no clinical interpretability
* **Table**:
  + patients, admissions, icustays, chartevents, labevents

**Step 3.3: Build and Evaluate Predictive Models**

* **Goal**: Develop predictive models to estimate ICU readmission risk, using psychiatric factors (diagnoses and psychotropic medication use) and other clinical variables.
* **2 approaches**:
  + **Global Model (Approach 1)**: Provides a unified model that evaluates the overall contribution of psychiatric diagnoses and medication use across all patients, with cohort membership (the four cohorts above) as a predictive feature.
    - **Benefits:**
      * Simple and interpretable model.
      * Easy to assess the influence of each cohort on ICU readmission risk.
      * Provides adjusted odds ratios for each cohort (vs. reference group).
  + **Stratified Models (Approach 2)**: Create models for each cohort, allowing for a understanding of the factors influencing ICU readmission risk within each group.
    - **Benefits**:
      * Customized models for each cohort allow deeper insights into the unique risk factors for readmission in different patient groups.
      * More flexible in capturing heterogeneity across cohorts.
      * Can provide cohort-specific clinical recommendations or risk scores.

***Approach 1: Single Global Model Using Cohort Membership as a Predictor***

1. **Outcome (Target Variable)**:
   * Binary outcome: ICU\_readmission\_within\_30\_days (1 = readmission, 0 = no readmission).
2. **Predictors (Features)**:
   * **Cohort Membership**: One-hot encode cohort variables (is\_cohort\_1, is\_cohort\_2, is\_cohort\_3, is\_cohort\_4), where Cohort 4 is the reference group.
   * **Psychiatric Diagnoses**: Binary indicators for each diagnosis (e.g., depression, PTSD). has\_depression, has\_PTSD, etc.
   * **Psychotropic Medication Use**: Binary flags for each medication type (e.g., antidepressants, antipsychotics). on\_antidepressants, on\_antipsychotics, etc.
   * **Demographics**: Age, gender, ethnicity.
   * **ICU Clinical Variables**: ICU length of stay, SOFA score, mechanical ventilation, vital signs.
   * **Comorbidities**: Charlson Comorbidity Index or individual comorbidity flags.
   * **Medication Discontinuation**: Binary indicator for medication continuation or discontinuation at discharge. psych\_med\_discontinued\_at\_discharge (binary)
3. **Model Type**:
   * Logistic Regression (for interpretability)
   * Random Forest or XGBoost (for higher accuracy and handling nonlinearities)
4. **Evaluation Metrics**:
   * AUC-ROC, Accuracy, Precision, Recall, F1 Score
   * Feature importance: Analyze the impact of each cohort on readmission risk.

***Approach 2: Stratified Models for Each Cohort***

1. **Outcome (Target Variable)**:
   * Binary outcome: ICU\_readmission\_within\_30\_days.
2. **Predictors (Features)**:
   * For each cohort, use features specific to that group:
     + **Model A (Cohort 1)**: Psychiatric diagnoses + psychotropic medications.
     + **Model B (Cohort 2)**: Psychiatric diagnoses only (no medications).
     + **Model C (Cohort 3)**: Psychotropic medications only (no diagnoses).
     + **Model D (Cohort 4)**: Standard ICU clinical and demographic variables (reference group).
3. **Model Type**:
   * Logistic Regression, Random Forest, or XGBoost, depending on the cohort.
4. **Evaluation Metrics**:
   * AUC-ROC, Accuracy, Precision, Recall, F1 Score for each cohort model.
   * Compare performance across cohorts to identify the most predictive factors for ICU readmission in each group.