**Case Study: Healthcare Patient Analytics & Prediction**

**1. Background**

MediCare Hospital, a multi-specialty healthcare provider, struggled with **high patient readmission rates** and **inefficient risk assessment** for critically ill patients. The major challenges included:

* **Delayed identification of high-risk patients**, leading to complications.
* **Lack of real-time analytics**, making it difficult for doctors to take preventive measures.
* **Manual data tracking**, slowing down decision-making and increasing hospital costs.

To address these challenges, **MediCare Hospital** decided to integrate its **Electronic Health Record (EHR) system** with a **cloud-based data warehouse (Google BigQuery)** and use **Power BI for predictive analytics**. The goal was to optimize:

1. **Patient admission & discharge processes**
2. **Early prediction of high-risk cases**
3. **Post-discharge monitoring & follow-up care**
4. **Overall hospital efficiency & patient satisfaction**

**2. Case Study Scope**

The project focused on developing a scalable analytics solution by integrating patient admissions, vitals, and treatment data from the **EHR system into Google BigQuery**, with key reporting features in **Power BI**.

**Key Components:**  
🔹 **Patient Admission & Discharge System** – Tracks hospital stays and discharge patterns.  
🔹 **Predictive Risk Analysis** – Identifies high-risk patients using AI-based models.  
🔹 **Post-Discharge Monitoring** – Automates follow-up scheduling and patient tracking.

The primary objective was to improve **patient care and hospital efficiency** through **data-driven insights**.

**3. Key Activities**

**1. Data Integration & ETL Process**

✔ **Extract** patient admissions, vitals, and lab results from **EHR systems (Epic, Cerner, Meditech)** via **FHIR APIs or HL7**.  
✔ **Transform & clean** data using **Python (Pandas, NumPy) and SQL scripts**.  
✔ **Store structured data** in **Google BigQuery** for fast querying and reporting.

**2. Data Model Design**

The solution included key tables for structured analytics:

| **Table Name** | **Description** |
| --- | --- |
| Patients | Stores patient demographics & medical history. |
| Admissions | Tracks hospital admissions & discharges. |
| Vitals | Stores real-time vitals (heart rate, BP, oxygen levels, etc.). |
| Treatments | Information on prescribed drugs & procedures. |
| Readmission\_Risk | Predictive model output for high-risk cases. |

**3. Predictive Analysis Using Python (Pandas & AI Models)**

* Load data into **Pandas** for preprocessing and exploratory analysis.
* Apply **Machine Learning (Logistic Regression, Random Forest, XGBoost)** to **predict readmission risk**.
* Identify key **risk factors** such as **age, chronic conditions, past hospital visits, and abnormal vitals**.

**4. Analytics & Reporting (Power BI Dashboards)**

* **Hospital Admission Trends** – Tracks daily admissions & discharges.
* **High-Risk Patient Prediction** – Identifies critical cases requiring extra care.
* **Vitals Monitoring Dashboard** – Displays abnormal trends in patient vitals.
* **Readmission Rate Analysis** – Evaluates effectiveness of treatments & follow-ups.
* **Post-Discharge Follow-Up Tracker** – Automates appointment scheduling & patient monitoring.

**4. Results & Business Impact**

✅ **30% reduction** in hospital readmission rates.  
✅ **Early identification of high-risk patients**, improving survival rates.  
✅ **Automated risk scoring**, reducing manual workload by **50%**.  
✅ **Improved patient satisfaction** with better post-discharge follow-ups.

**5. Conclusion**

By integrating **EHR with cloud-based analytics**, **MediCare Hospital** improved **patient monitoring, risk prediction, and healthcare decision-making**. AI-driven **predictive models** enabled **better resource management** and **preventive patient care**, leading to overall hospital efficiency and higher patient satisfaction.

**1. Table: Patients**

Stores basic patient demographic and medical history details.

| **Column Name** | **Data Type** | **Description** | **Constraints** |
| --- | --- | --- | --- |
| patient\_id | INT | Unique identifier for the patient | **PK** |
| first\_name | VARCHAR(50) | Patient's first name | NOT NULL |
| last\_name | VARCHAR(50) | Patient's last name | NOT NULL |
| dob | DATE | Date of birth | NOT NULL |
| gender | VARCHAR(10) | Gender (Male/Female/Other) | NOT NULL |
| contact\_no | VARCHAR(15) | Phone number | NOT NULL |
| address | VARCHAR(255) | Home address | NULLABLE |
| chronic\_conditions | VARCHAR(255) | List of chronic diseases | NULLABLE |

**Sample Data:**

| **patient\_id** | **first\_name** | **last\_name** | **dob** | **gender** | **contact\_no** | **address** | **chronic\_conditions** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 101 | John | Doe | 1985-06-12 | Male | 9876543210 | 123 Main St | Diabetes, Hypertension |
| 102 | Emily | Smith | 1992-08-25 | Female | 8765432109 | 456 Elm St | Asthma |
| 103 | Robert | Johnson | 1975-03-30 | Male | 7654321098 | 789 Oak St | None |

**2. Table: Admissions**

Tracks hospital admissions, discharges, and treatment details.

| **Column Name** | **Data Type** | **Description** | **Constraints** |
| --- | --- | --- | --- |
| admission\_id | INT | Unique identifier for each admission | **PK** |
| patient\_id | INT | Patient who was admitted | **FK → Patients(patient\_id)** |
| admission\_date | DATE | Date of hospital admission | NOT NULL |
| discharge\_date | DATE | Date of discharge | NULLABLE |
| diagnosis | VARCHAR(255) | Initial diagnosis | NOT NULL |
| doctor\_id | INT | Attending doctor | **FK → Doctors(doctor\_id)** |
| room\_no | VARCHAR(10) | Assigned hospital room | NULLABLE |

**Sample Data:**

| **admission\_id** | **patient\_id** | **admission\_date** | **discharge\_date** | **diagnosis** | **doctor\_id** | **room\_no** |
| --- | --- | --- | --- | --- | --- | --- |
| 2001 | 101 | 2025-02-10 | 2025-02-15 | Pneumonia | 301 | A102 |
| 2002 | 102 | 2025-02-18 | NULL | Severe Asthma Attack | 302 | B210 |
| 2003 | 103 | 2025-01-20 | 2025-01-25 | Hypertension | 303 | C305 |

**3. Table: Vitals**

Stores real-time vitals recorded during a hospital stay.

| **Column Name** | **Data Type** | **Description** | **Constraints** |
| --- | --- | --- | --- |
| vital\_id | INT | Unique identifier for each record | **PK** |
| admission\_id | INT | Link to admission | **FK → Admissions(admission\_id)** |
| recorded\_time | TIMESTAMP | Time of vital recording | NOT NULL |
| heart\_rate | INT | Heart rate (bpm) | NOT NULL |
| blood\_pressure | VARCHAR(10) | Blood pressure (systolic/diastolic) | NOT NULL |
| oxygen\_level | INT | Oxygen saturation (%) | NOT NULL |
| temperature | DECIMAL(5,2) | Body temperature (°F) | NOT NULL |

**Sample Data:**

| **vital\_id** | **admission\_id** | **recorded\_time** | **heart\_rate** | **blood\_pressure** | **oxygen\_level** | **temperature** |
| --- | --- | --- | --- | --- | --- | --- |
| 5001 | 2001 | 2025-02-10 08:30 | 80 | 120/80 | 98 | 98.6 |
| 5002 | 2001 | 2025-02-11 10:15 | 85 | 130/85 | 96 | 99.2 |
| 5003 | 2002 | 2025-02-18 09:00 | 95 | 140/90 | 92 | 100.1 |

**4. Table: Treatments**

Stores medical treatments, medications, and procedures during hospitalization.

| **Column Name** | **Data Type** | **Description** | **Constraints** |
| --- | --- | --- | --- |
| treatment\_id | INT | Unique identifier for treatment | **PK** |
| admission\_id | INT | Related admission record | **FK → Admissions(admission\_id)** |
| treatment\_date | DATE | Date of treatment | NOT NULL |
| procedure | VARCHAR(255) | Procedure name | NULLABLE |
| medication | VARCHAR(255) | Prescribed medication | NOT NULL |
| dosage | VARCHAR(50) | Dosage instructions | NULLABLE |

**Sample Data:**

| **treatment\_id** | **admission\_id** | **treatment\_date** | **procedure** | **medication** | **dosage** |
| --- | --- | --- | --- | --- | --- |
| 7001 | 2001 | 2025-02-11 | Oxygen Therapy | Amoxicillin | 500mg 2x daily |
| 7002 | 2002 | 2025-02-19 | Nebulization | Prednisone | 10mg 1x daily |
| 7003 | 2003 | 2025-01-22 | Blood Pressure Monitoring | Metoprolol | 50mg 1x daily |

**5. Table: Readmission\_Risk (Predictive Model Output)**

Stores AI-predicted risk scores for readmission.

| **Column Name** | **Data Type** | **Description** | **Constraints** |
| --- | --- | --- | --- |
| risk\_id | INT | Unique identifier for prediction | **PK** |
| admission\_id | INT | Related admission | **FK → Admissions(admission\_id)** |
| prediction\_date | DATE | Date of risk assessment | NOT NULL |
| risk\_score | DECIMAL(5,2) | Probability of readmission (0-1) | NOT NULL |
| risk\_level | VARCHAR(10) | Low, Medium, High | NOT NULL |

**Sample Data:**

| **risk\_id** | **admission\_id** | **prediction\_date** | **risk\_score** | **risk\_level** |
| --- | --- | --- | --- | --- |
| 9001 | 2001 | 2025-02-14 | 0.75 | High |
| 9002 | 2002 | 2025-02-19 | 0.85 | High |
| 9003 | 2003 | 2025-01-24 | 0.40 | Medium |

**6. Table: Doctors**

Stores doctor information.

| **Column Name** | **Data Type** | **Description** | **Constraints** |
| --- | --- | --- | --- |
| doctor\_id | INT | Unique identifier for doctor | **PK** |
| first\_name | VARCHAR(50) | First name | NOT NULL |
| last\_name | VARCHAR(50) | Last name | NOT NULL |
| specialization | VARCHAR(255) | Medical specialty | NOT NULL |
| contact\_no | VARCHAR(15) | Phone number | NOT NULL |

**Sample Data:**

| **doctor\_id** | **first\_name** | **last\_name** | **specialization** | **contact\_no** |
| --- | --- | --- | --- | --- |
| 301 | Alice | Carter | Pulmonologist | 555-1234 |
| 302 | Mark | Wilson | Cardiologist | 555-5678 |
| 303 | Emma | Davis | General Physician | 555-9012 |

**Key Constraints Summary**

* **Primary Keys (PK):**
  + patient\_id, admission\_id, vital\_id, treatment\_id, risk\_id, doctor\_id
* **Foreign Keys (FK):**
  + admissions.patient\_id → patients.patient\_id
  + admissions.doctor\_id → doctors.doctor\_id
  + vitals.admission\_id → admissions.admission\_id
  + treatments.admission\_id → admissions.admission\_id
  + readmission\_risk.admission\_id → admissions.admission\_id