

Database Term Project

Medico - Hospital Management System

Team Members

- Abdulsamet Ekinci 150220723:
Managing team – DB Analysis – Backend optimize, patients, encounters, insurers
- Uğur Erkan Bol 150210074:
UI/UX design – Frontend optimize, providers, diagnoses, specialty_heads
- Furkan İslamoğlu 150220065:
Frontend Lead, procedures, medications
- Mustafa Talha Hamsoğlu 150220066:
Backend Lead, calims_and_billing, denials
- Mustafa Yunus Diler 150210003:
Tester, lab_tests,

What is Medico?

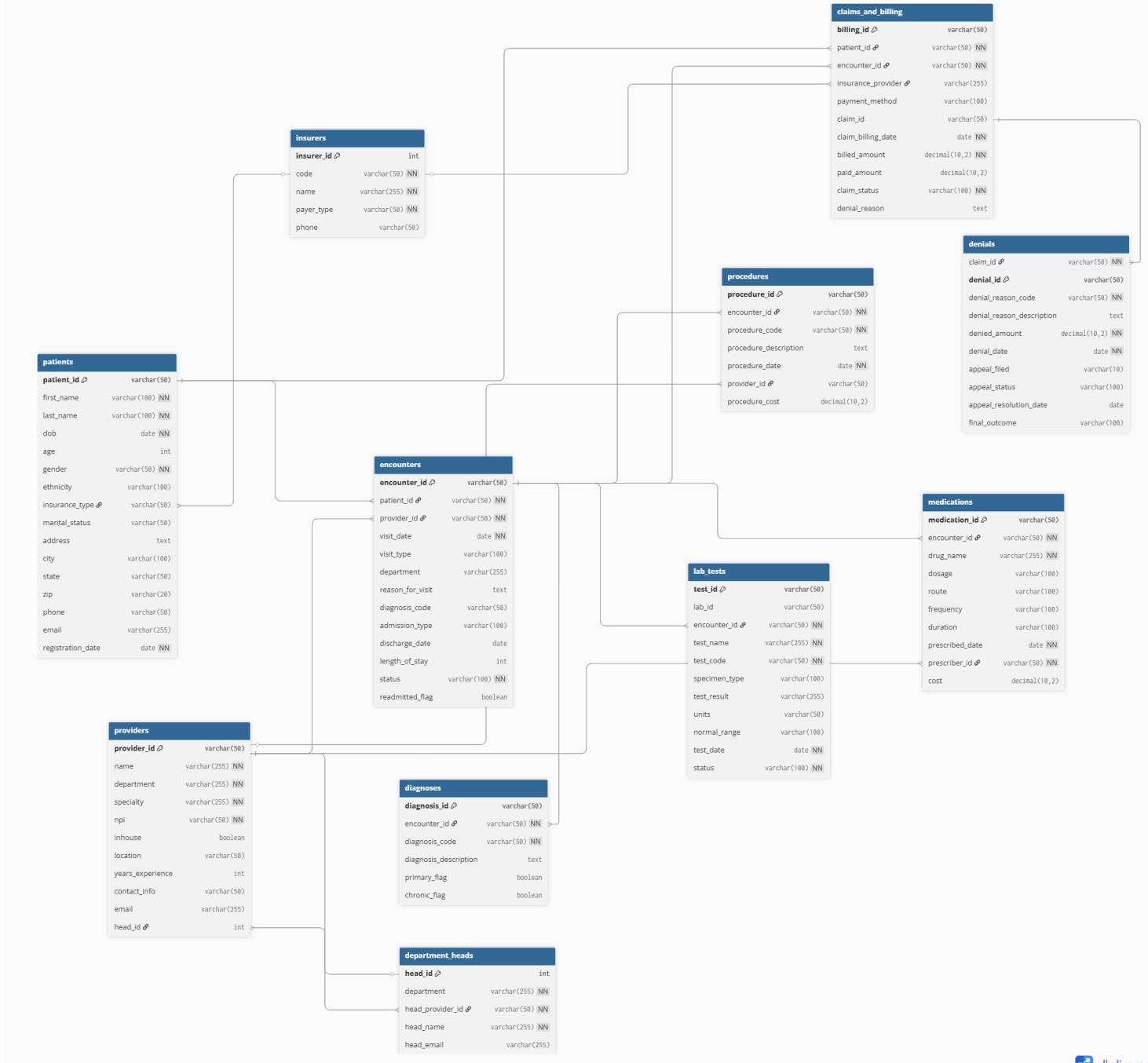
- **Content:**
- **Application:** Hospital Management System (HMS)
- **Purpose:** Manage patient records, encounters, procedures, billing, and hospital operations
- **Motivation:**
 - Centralize hospital data
 - Improve patient care tracking
 - Automate billing and claims
 - Support clinical decision making

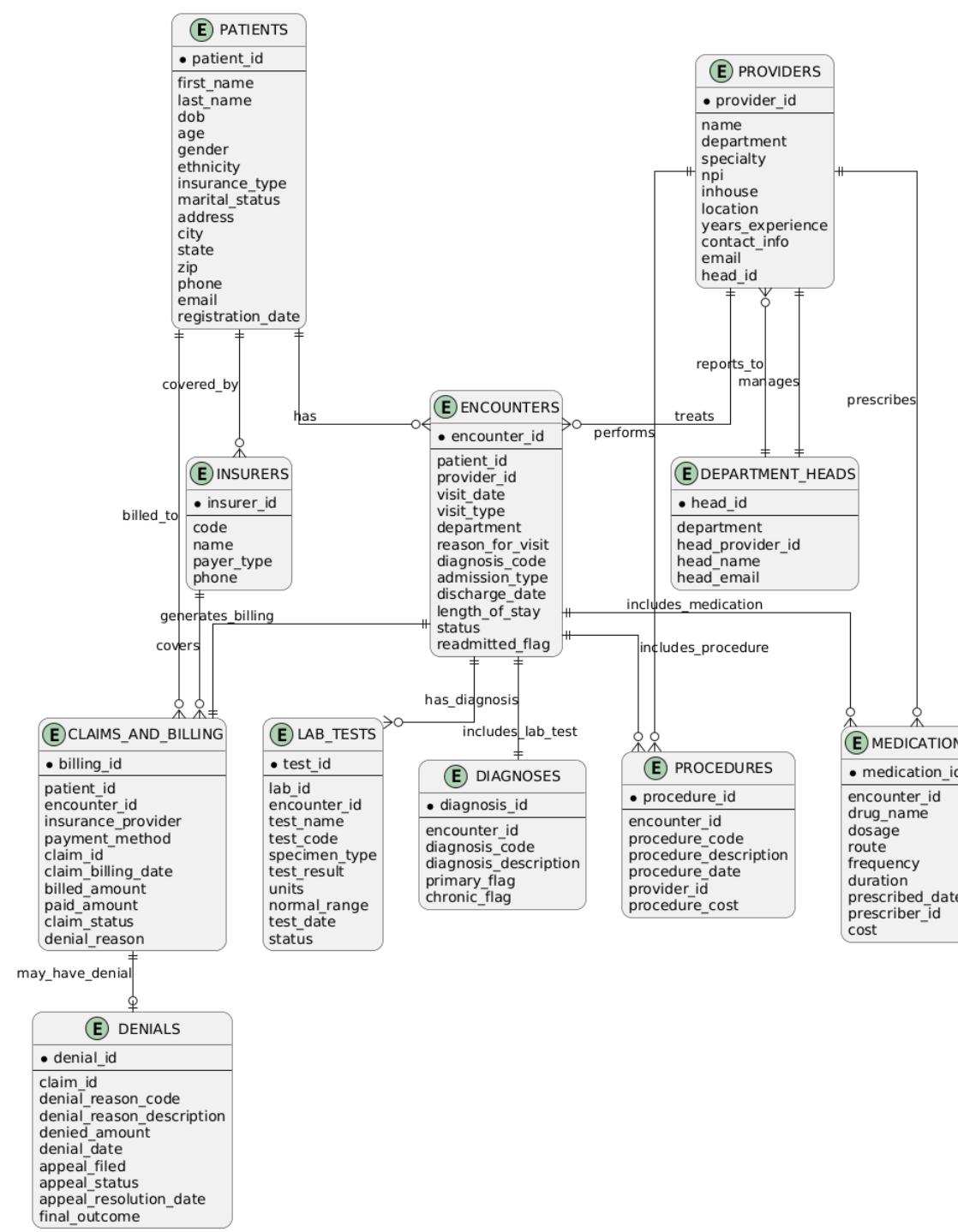
- **Goals:**

- Real-time patient information access
- Automated billing from procedures
- Comprehensive encounter tracking
- Financial management (claims, denials)

- **Technologies:**

- **Backend:** Flask (Python), MySQL
- **Frontend:** React.js, Vite
- **Database:** MySQL





1. INSURERS → PATIENTS

Notation: INSURERS ||--o{ PATIENTS : "covered_by"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One insurer can have many patients
 - One patient can have one insurer (or none for self-pay)

2. INSURERS → CLAIMS_AND_BILLING

Notation: INSURERS ||--o{ CLAIMS_AND_BILLING :
"covers"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One insurer can have many claims
 - One claim can have one insurer (or none for self-pay)

3. PATIENTS → ENCOUNTERS

Notation: PATIENTS ||--o{ ENCOUNTERS : "has"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One patient can have many encounters
 - One encounter belongs to exactly one patient

4. PATIENTS → CLAIMS_AND_BILLING

Notation: PATIENTS ||--o{ CLAIMS_AND_BILLING :
"generates"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One patient can have many billing records
 - One billing record belongs to exactly one patient

5. PROVIDERS → ENCOUNTERS

Notation: PROVIDERS ||--o{ ENCOUNTERS : "treats"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One provider can treat many encounters
 - One encounter is treated by exactly one provider

6. PROVIDERS → PROCEDURES

Notation: PROVIDERS }o--|| PROCEDURES : "performs"

- **Type:** Many-to-One (N:1)
- **Cardinality:**
 - One provider can perform many procedures
 - One procedure is performed by exactly one provider

7. PROVIDERS → MEDICATIONS

Notation: PROVIDERS ||--o{ MEDICATIONS : "prescribes"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One provider can prescribe many medications
 - One medication is prescribed by exactly one provider

8. PROVIDERS → DEPARTMENT_HEADS

Notation: PROVIDERS }o--|| DEPARTMENT_HEADS : "reports_to"

- **Type:** Many-to-One (N:1)
- **Cardinality:**
 - Many providers can report to one department head
 - One provider reports to exactly one department head (or none)

9. DEPARTMENT_HEADS → PROVIDERS

Notation: DEPARTMENT_HEADS ||--|| PROVIDERS :
"manages"

- **Type:** One-to-One (1:1)
- **Cardinality:**
 - One department head is exactly one provider
 - One provider can be exactly one department head

10. ENCOUNTERS → DIAGNOSES

Notation: ENCOUNTERS ||--|| DIAGNOSES :
"has_diagnosis"

- **Type:** One-to-One (1:1)
- **Cardinality:**
 - One encounter has exactly one diagnosis
 - One diagnosis belongs to exactly one encounter

11. ENCOUNTERS → PROCEDURES

Notation: ENCOUNTERS ||--o{ PROCEDURES :
"includes_procedure"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One encounter can have many procedures
 - One procedure belongs to exactly one encounter

12. ENCOUNTERS → LAB_TESTS

Notation: ENCOUNTERS ||--o{ LAB_TESTS :
"includes_lab_test"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One encounter can have many lab tests
 - One lab test belongs to exactly one encounter

12. ENCOUNTERS → LAB_TESTS

Notation: ENCOUNTERS ||--o{ LAB_TESTS :
"includes_lab_test"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One encounter can have many lab tests
 - One lab test belongs to exactly one encounter

13. ENCOUNTERS → MEDICATIONS

Notation: ENCOUNTERS ||--o{ MEDICATIONS :
"includes_medication"

- **Type:** One-to-Many (1:N)
- **Cardinality:**
 - One encounter can have many medications
 - One medication belongs to exactly one encounter

14. ENCOUNTERS → CLAIMS_AND_BILLING

Notation: ENCOUNTERS ||--|| CLAIMS_AND_BILLING :
"generates_billing"

- **Type:** One-to-One (1:1)
- **Cardinality:**
 - One encounter generates exactly one billing record
 - One billing record belongs to exactly one encounter

15. CLAIMS_AND_BILLING → DENIALS

Notation: CLAIMS_AND_BILLING ||--o| DENIALS :
"may_have_denial"

- **Type:** One-to-One (1:0..1)
- **Cardinality:**
 - One billing record can have at most one denial
 - One denial belongs to exactly one billing record

Before Normalization (Unnormalized)

Example: Patient-Encounter-Provider Combined Table

PATIENT_ENCOUNTERS (Unnormalized)

```
└── patient_id, first_name, last_name, dob, age, gender, insurance_type
└── encounter_id, visit_date, visit_type, department
└── provider_id, provider_name, provider_department, provider_specialty
└── diagnosis_code, diagnosis_description
└── procedure_code, procedure_description, procedure_cost
└── medication_name, dosage, cost
```

Problems:

- **Data Redundancy:** Patient information repeated for each encounter
- **Update Anomalies:** Changing patient name requires updating multiple rows
- **Insert Anomalies:** Cannot add a patient without an encounter
- **Delete Anomalies:** Deleting an encounter might delete patient data

◀ After Normalization (3NF/BCNF)

Step 1: First Normal Form (1NF)

Rule: Each column contains atomic values, no repeating groups

Result: Separated into distinct tables

- patients - Patient information
- encounters - Visit records
- providers - Provider information
- diagnoses - Diagnosis records
- procedures - Procedure records
- medications - Medication records

Step 2: Second Normal Form (2NF)

Rule: Remove partial dependencies (non-key attributes depend on full primary key)

Example Fix:

- **Before:** encounters table had provider_name, provider_department (depends only on provider_id, not encounter_id)
- **After:** Moved provider details to providers table, encounters only stores provider_id FK

Step 3: Third Normal Form (3NF)

Rule: Remove transitive dependencies (non-key attributes depend on other non-key attributes)

Example Fix:

- **Before:** patients table had insurance_name (depends on insurance_type, not patient_id)
- **After:** Created insurers table, patients only stores insurance_type FK

Step 4: Boyce-Codd Normal Form (BCNF)

Rule: Every determinant is a candidate key

Our Design:

- All tables have single-column primary keys
- Foreign keys reference primary keys only
- No overlapping candidate keys

Key Normalization Decisions

1. Separated Insurance Information

- **Why:** Insurance details (name, payer_type) don't depend on patient_id
- **Result:** insurers table with code as unique identifier
- **Benefit:** Update insurance name once, affects all patients

2. Separated Provider Information

- **Why:** Provider details (name, specialty, department) don't depend on encounter_id
- **Result:** providers table with provider_id as primary key
- **Benefit:** Provider information stored once, referenced by multiple encounters

3. Separated Department Heads

- **Why:** Department head information is independent of provider table
- **Result:** department_heads table with circular reference to providers
- **Benefit:** Prevents circular dependency issues

4. One-to-One Relationships

- **encounters ↔ diagnoses:** Each encounter has exactly one diagnosis
- **encounters ↔ claims_and_billing:** Each encounter generates one billing record
- **Why:** Maintains referential integrity and prevents orphaned records

Tables and Records

- **11 tables** covering all aspects of hospital operations
- **Synthetic dataset** with realistic healthcare data

Table Breakdown

1. **Insurers(7)** - Insurance provider information (codes, names, payer types)
2. **Patients(70k)** - Patient demographics, contact info, insurance coverage
3. **Providers(1.5k)** - Healthcare providers (doctors, specialists) with departments and specialties
4. **department_heads(21)** - Department leadership assignments
5. **Encounters(70k)** - Patient visits and hospital admissions
6. **Diagnoses(70k)** - Medical diagnoses linked to encounters
7. **Procedures(126k)** - Medical procedures performed with costs
8. **Medications(94.5k)** - Prescribed medications with dosages and costs
9. **lab_tests(54.5k)** - Laboratory test results and status
10. **claims_and_billing(70k)** - Insurance claims and billing records
11. **denials(6k)** - Claim denial records with appeal information

Why Synthetic Data? Data based on California Hospital

- **Privacy Compliance:** Real patient data is protected by HIPAA and cannot be used
- **Controlled Testing:** Allows testing of edge cases and data relationships
- **Realistic Structure:** Data follows real world healthcare patterns
- **Complete Coverage:** All relationships and constraints can be tested

Data Characteristics

- **Realistic Formats:** Patient IDs (PAT000001), Encounter IDs (ENC000001),
utils.py for auto increment
- **Valid Relationships:** All foreign keys reference existing records
- **Date Ranges:** Encounters span Q1 2025 (January - March)
- **Cost Data:** Procedure and medication costs for billing calculations
- **Code-Based Dropdowns:** Procedure codes, diagnosis codes etc. are implemented as
searchable dropdowns with automatic description matching,
ensuring data consistency and preventing invalid entries.

1. Dashboard Statistics Query

Active Patients with Non-Completed Encounters

Purpose: Count distinct patients with active (non-completed) encounters

(unfortunately always zero because all of them are completed)

```
SELECT COUNT(DISTINCT patient_id) AS count
FROM (
    SELECT DISTINCT e.patient_id
    FROM encounters e
    WHERE e.status != 'Completed'
    GROUP BY e.patient_id
    HAVING COUNT(e.encounter_id) > 0
) AS active_patients;
```

Complexity:

- **Subquery:** Inner query groups encounters by patient
- **HAVING:** Filters groups with at least one encounter
- **Aggregation:** COUNT(DISTINCT) for unique patients

2. Recent Activities Query

Procedures with Patient and Provider Info

Purpose: Fetch recent procedures with related patient and provider information

```
SELECT
    p.procedure_id,
    p.procedure_date,
    p.procedure_code,
    p.procedure_description,
    p.procedure_cost,
    e.encounter_id,
    e.visit_date,
    e.visit_type,
    pt.patient_id,
    pt.first_name AS patient_first_name,
    pt.last_name AS patient_last_name,
    pr.provider_id,
    pr.name AS provider_name,
    pr.specialty AS provider_specialty,
    'procedure' AS activity_type
FROM procedures p
INNER JOIN encounters e ON p.encounter_id = e.encounter_id
INNER JOIN patients pt ON e.patient_id = pt.patient_id
LEFT OUTER JOIN providers pr ON p.provider_id = pr.provider_id
WHERE p.procedure_date >= %s AND p.procedure_date <= %
ORDER BY p.procedure_date DESC, p.procedure_id DESC
LIMIT 10;
```

Complexity:

- **Multi-table JOIN:** 4 tables (procedures, encounters, patients, providers)
- **INNER JOIN:** Ensures procedure has encounter and patient
- **LEFT OUTER JOIN:** Includes procedures even if provider is missing
- **Date Range Filter:** Filter by date range
- **ORDER BY:** Multiple columns for consistent sorting
- **LIMIT:** Top 10 results

Pick a date for Dashboard:

03/03/2025



Dashboard Snapshot

Statistics for March 3, 2025

0

Active Patients

1458

Procedures Today

0

Open Encounters

1136

Medications Issued

Recent Activities

Latest procedures, medications, and encounters from the past 7 days

Type	Date	Description	Patient	Provider	Details
 Procedure	Mar 3, 2025	Collection of venous blood by venipuncture	Lawrence Bailey	Roy Williams	\$1423.67 View →
 Procedure	Mar 3, 2025	Electrocardiogram, complete	Lawrence Bailey	Roy Williams	\$896.74 View →
 Procedure	Mar 3, 2025	Pelvic ultrasound, non-obstetric	Phillip Mathews	Walter Torres PhD	\$1423.54 View →
 Procedure	Mar 3, 2025	Office visit for chronic condition management	Phillip Mathews	Walter Torres PhD	\$346.66 View →
 Procedure	Mar 3, 2025	Laparoscopy, surgical; with fulguration of lesions	Phillip Mathews	Walter Torres PhD	\$1227.49 View →
 Procedure	Mar 3, 2025	MRI pelvis, without contrast	Phillip Mathews	Walter Torres PhD	\$827.36 View →
 Procedure	Mar 3, 2025	Fecal occult blood test	Todd Flores	Mr. James Lang II	\$1337.35 View →
 Procedure	Mar 3, 2025	Office visit for chronic condition management	Todd Flores	Mr. James Lang II	\$1153.12 View →
 Procedure	Mar 3, 2025	GI tract imaging using capsule endoscopy	Todd Flores	Mr. James Lang II	\$1329.49 View →
 Procedure	Mar 3, 2025	Office visit, problem-focused	Vanessa Spears	Travis Thompson	\$1457.38 View →

3. Encounters List Query

Encounters with Patient and Provider Information

Purpose: Fetch encounters for the Encounters page with patient and provider details

```
SELECT e.*,
       p.first_name AS patient_first_name,
       p.last_name AS patient_last_name,
       pr.name AS provider_name,
       pr.department AS provider_department
  FROM encounters e
 LEFT JOIN patients p ON e.patient_id = p.patient_id
 LEFT JOIN providers pr ON e.provider_id = pr.provider_id
 WHERE 1 = 1
 AND (e.encounter_id LIKE %s OR e.patient_id LIKE %s OR e.provider_id LIKE %
      OR CONCAT(p.first_name, ' ', p.last_name) LIKE %
      OR pr.name LIKE %s OR e.department LIKE %s OR e.visit_type LIKE %s)
 ORDER BY e.visit_date DESC
 LIMIT %s OFFSET %s;
```

Complexity:

- **3-table JOIN:** encounters, patients, providers
- **LEFT JOINS:** Include encounters even if patient/provider missing
- **Multi-field Search:** Search across 7 different fields
- **CONCAT:** Combine first and last name for search
- **Pagination:** LIMIT and OFFSET for pagination

Encounters

Track visits, admission details, diagnoses and overall patient journey.

[+ New Encounter](#)[Filters](#)

Active Encounters

View all ongoing patient visits and admissions.

Encounter History

Search past visits, diagnoses and outcomes by date or provider.

Encounter List (70,000 total)

ID	DATE	PATIENT	PROVIDER	DEPARTMENT	TYPE	STATUS	ACTIONS
ENC068518	3/31/2025	Miguel Conner PAT046975	Andrew Wiley	Obstetrics & Gynecology	Outpatient	Completed	Edit Delete
ENC069125	3/31/2025	Mark Delacruz PAT033526	Robert Harris	Family Medicine	Outpatient	Completed	Edit Delete
ENC069434	3/31/2025	Melissa Edwards PAT046209	Jonathan Mcneil	ENT (Otolaryngology)	Outpatient	Completed	Edit Delete
ENC068929	3/31/2025	Mary Willis PAT045228	Donna Smith	Pathology / Lab Services	Outpatient	Completed	Edit Delete
ENC068294	3/31/2025	Matthew Davis PAT016328	Mary Porter	Nephrology	Telehealth	Completed	Edit Delete
ENC068932	3/31/2025	Lee Blake PAT053878	Jimmy Daugherty	Obstetrics & Gynecology	Inpatients	Completed	Edit Delete
ENC068183	3/31/2025	Rebecca Patterson PAT025359	Joe Garza	Psychiatry / Behavioral Health	Telehealth	Completed	Edit Delete

Features and Screenshots

- Doctor Abdulsamet started his new position at the hospital. He was working as a general practitioner in the Pathology / Laboratory Services department. He hadn't received the score he wanted on the USMLE.
- A patient, Mr. Uğur, arrived and completed his registration, and later made an appointment with Abdulsamet.
- Abdulsamet treated Uğur and made the necessary diagnosis and procedure.
- Later, when Mr. Uğur saw his bill, he was very surprised because his insurance had not covered the expenses, and a major financial collapse was waiting for him.
- To be continued...

Uğur Erkan Bol

Light Mode

Patient ID: PAT060001

[Edit Patient](#)[Delete](#)[Back to List](#)

MAIN

Dashboard

Patients

Encounters

Procedures

Medications

Diagnoses

Lab Tests

STAFF & INSURANCE

Providers

Insurers

Dept. Heads

ANALYTICS

Billing & Claims

Denials

Personal Information

Patient ID:	PAT060001
Name:	Uğur Erkan Bol
Date of Birth:	12/2/2002
Age:	23
Gender:	<input checked="" type="radio"/> Male
Ethnicity:	Turkish
Marital Status:	Widowed/Divorced/Separated

Contact & Insurance

Address:	ISTANBUL TECH
City:	ISTANBUL
State:	MARMARA
ZIP:	34000
Phone:	05555555555
Email:	ugurbey@example.com
Insurance:	Aetna
Registration Date:	12/21/2025

Encounters

ENCOUNTER ID	VISIT DATE	TYPE	DEPARTMENT	PROVIDER	STATUS
ENC070001	12/21/2025	Emergency	Pathology / Lab Services	Abdulsamet	Scheduled

Uğur Erkan Bol - 12/21/2025

[Edit Encounter](#)[Delete](#)[Back to List](#)

Encounter Information

Encounter ID: **ENC070001**

Patient: **Uğur Erkan Bol**
PAT060001

Provider: **Abdulsamet**

Visit Date: **12/21/2025**

Visit Type: **Emergency**

Department: **Pathology / Lab Services**

Status: **Scheduled**

Visit Details

Reason for Visit: **I prefer talk to my doctor special about this**

Diagnosis Code: **Z12.11**

Admission Type: **N/A**

Discharge Date: **N/A**

Length of Stay: **0 days**

Readmitted: **No**

Medications

No medications found for this encounter.

Medications

No medications found for this encounter.

ENCOUNTER DETAIL PAGE CONT.

Procedures

PROCEDURE CODE	DESCRIPTION	PROVIDER	DATE	COST
45378	Colonoscopy, diagnostic	Abdulsamet	12/21/2025	\$15000.00

Diagnoses

DIAGNOSIS CODE	DESCRIPTION	PRIMARY	CHRONIC
Z12.11	Encounter for screening for malignant neoplasm of colon	Yes	No

Lab Tests

No lab tests found for this encounter.

Claims & Billing

BILLING ID	CLAIM DATE	BILLED	PAID	STATUS
BILL070001	12/21/2025	\$15000.00	\$0.00	Denied

Claim: BILL070001

Uğur Erkan Bol - 12/21/2025

[Edit Claim](#)[Delete](#)[Back to List](#)

Claim Information

Billing ID:	BILL070001
Claim ID:	CLM059639
Patient:	Uğur Erkan Bol PAT060001
Encounter:	ENC070001
Billing Date:	12/21/2025
Status:	Denied

Billing Details

Insurance Provider:	Aetna
Payment Method:	Insurance
Billed Amount:	\$15000.00
Paid Amount:	\$0.00
Outstanding:	\$15000.00

Related Denial

Denial ID:	DEN069995	Reason Code:	PR109
Claim ID:	CLM059639	Appeal Filed:	N/A
Denial Date:	12/21/2025	Appeal Status:	Denied
Denied Amount:	\$15000.00	Description:	Claim not covered by this payer/contractor.

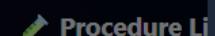
SAMPLE ADD FUNCTION, DROPODOWN AND SEARCHABLE



Procedures

View procedures linked to encounters and providers, including costs and codes.

Search procedure



Browse all recorded

Add New Procedure

Encounter ID

*

Search and select encounter

ENC070001

Uğur Erkan Bol - 12/21/2025

Procedure Code

*

Select or type procedure co

Procedure Date

*

12/21/2025

Recent Procedures

PROCEDURE ID

PROC126022

PROC123363

PROC124096

PROC124098

PROC124090

ENC068932

ENC068929

Lee Blake

86415

Jimmy Daugherty

3/31/2025

\$1217.75

Edit

Delete

5

\$764.80

Edit

Delete

5

\$1060.21

Edit

Delete

25

\$15000.00

Edit

Delete

Procedure Analytics

Analyze cost distribution, frequency and provider mapping.

PROCEDURE DATE	COST	ACTIONS
12/21/2025	\$15000.00	<button>Edit</button> <button>Delete</button>
3/31/2025	\$1060.21	<button>Edit</button> <button>Delete</button>
3/31/2025	\$764.80	<button>Edit</button> <button>Delete</button>
3/31/2025	\$1217.75	<button>Edit</button> <button>Delete</button>
3/31/2025	\$798.94	<button>Edit</button> <button>Delete</button>

Cancel

Create

Light Mode

😊 😊 Uğur's search history 😊 😊

Search history

By date By group

Today - Sunday, December 21, 2025

□ 11:06 PM  who is ceo of aetna insurance - Google'da Ara google.com ⋮

Thank you for listening