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PATIENT PORTAL SYSTEM: A COMPREHENSIVE APPROACH TO MANAGING ELECTRONIC HEALTH RECORDS

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Abstract

Background: The integration of patient portals with electronic health records (EHRs) has been promoted globally to improve patient engagement, communication, and continuity of care. These platforms allow patients to access health information, schedule appointments, renew prescriptions, and communicate with providers. Challenges remain regarding usability, disparities in adoption, interoperability, and workflow integration. **Objective:** This study aimed to design and evaluate a patient portal system that functions as a comprehensive hub for patient-related data, addressing limitations identified in the literature regarding accessibility, interoperability, and patient engagement. **Methods:** We conducted a review of current evidence from international studies and systematic reviews focusing on EHR-integrated patient portals. The literature informed the portal's design, with emphasis on interoperability, usability, equity of access, and integration into healthcare workflows. Key themes, patient experience, barriers to adoption, and provider perspectives were incorporated to guide system development. **Results:** Findings from the literature indicate that 90% of healthcare providers now offer portal access, only 15–30% of patients consistently use them without additional support. Usability testing demonstrates that positive experiences strongly correlate with higher engagement, while negative interactions reduce perceived value. Disparities in portal activation and use persist across age, socioeconomic status, and disease populations, with vulnerable groups less likely to benefit. Interoperability challenges, such as fragmented data formats, inconsistent access controls, and limited cross-institutional sharing, remain barriers to realizing the full potential of portals. Nonetheless, systematic reviews confirm that portals can improve health literacy, patient satisfaction, adherence, and some clinical outcomes, particularly in chronic disease management. **Conclusion:** Patient portals have the potential to transform patient engagement and healthcare delivery when designed with interoperability, usability, and equity in mind. Evidence highlights the importance of addressing disparities, integrating clinician workflows, and implementing robust governance frameworks for secure data exchange. The proposed system leverages these insights to create a comprehensive patient portal designed to enhance engagement, improve outcomes, and support continuity of care.

Keywords: Patient Portal; Electronic Health Record; Interoperability; Usability; Patient Engagement; Healthcare Disparities.

1. INTRODUCTION

Digital transformation has reshaped how health information is captured, shared, and acted upon, positioning the electronic health record (EHR) and its patient-facing companion, the patient portal, as core infrastructure for safer, more coordinated, and patient-centred care [8–10]. Patient portals provide secure, 24/7 access to selected EHR data (visit summaries, laboratory results, medication lists) and services (prescription renewals, scheduling, secure messaging), with growing policy momentum worldwide encouraging routine patient access to their records [2,8–10]. Despite this promise, real-world effectiveness depends on how well portals interoperate with clinical systems, fit clinician workflows, and meet the needs and skills of diverse patient populations [1–3,7–10].

Interoperability remains a central challenge. A recent scoping review spanning multiple countries found that only a minority of portals support comprehensive, cross-site access to the full longitudinal record and identified eight recurring requirements: incentives for data sharing; heterogeneity of organizations and systems; data storage/management; scope of available information and functions; data formats/standards; reliable patient identification; granular access/consent; and robust security/privacy [1]. These factors underscore that success is as much organizational and governance-related as it is technical.

Evidence for patient-level benefits is generally favourable when portals are embedded in coordinated care pathways. Systematic reviews report improved health knowledge, medication adherence, patient–clinician communication, and, in specific cohorts, measurable gains in clinical control (blood pressure and glycaemia) [8–10]. However, effects on health-service utilization and efficiency are mixed, reflecting differences in portal design, populations, and maturity of implementation [8]. Consequently, portal programmes should prioritize outcomes most likely to yield benefit in their context (chronic-disease follow-up, test-result transparency) while monitoring for unintended consequences [8–10].

Adoption and sustained engagement remain uneven. In the United States, approximately 90% of providers now offer patients portal access, yet only 15%–30% of patients use

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even a single feature without targeted support [2]. Best-supported strategies to increase meaningful use include one-to-one patient training, iterative usability testing, and aligning portal tasks with clinician workflows so staff can confidently recommend and reinforce portal use during routine care [2]. At scale, user experience matters: a national survey of Finland's mature My Kanta portal reported good usability (mean System Usability Scale =74), with very positive and very negative experiences strongly shaping perceived usability; patients valued fast, reliable information access and prescription renewals and requested more interactive features [3].

Equity is a persistent concern. Disparities in portal activation and use have been documented across age, race/ethnicity, socioeconomic status, language, and digital literacy, trends that risk widening care gaps as more services move online [4–6,8]. Within oncology, for example, underserved groups with hematologic malignancies were less likely to activate or use portals despite high care-coordination needs [4]. Outside high-income settings, usage patterns may be driven more by health needs (chronic conditions, frequency of visits) than by app "quality" per se, highlighting the importance of context-aware design and outreach [6]. Equity-minded approaches, multilingual interfaces, low-bandwidth options, caregiver proxies, clinician endorsement scripts, and community training, are therefore essential [5].

Finally, operational realities have shifted. With broader data availability and the 21st Century Cures Act's emphasis on timely electronic access, secure messaging volumes have grown, blurring lines between quick questions and billable clinical encounters; some health systems now formalize triage and, in limited cases, bill for certain message types to protect clinician time while maintaining responsiveness [7]. Effective portal programmes must therefore include governance for message routing, turnaround expectations, documentation, and staff roles, alongside data-quality management, privacy, and auditability [1,7].

Against this backdrop, our project presents a comprehensive, role-aware patient portal tightly integrated with an enterprise EHR. The design aims to (i) implement standards-ready interoperability, (ii) prioritize usability and continuous measurement, (iii) embed equity-by-design choices, (iv) integrate seamlessly with clinical workflows (appointments, results, prescribing, education), and (v) enforce privacy, consent, and security controls aligned with contemporary guidance [1–3,7–10]. In doing so, it translates a robust evidence base into a practical architecture intended to improve patient engagement and support safer, faster, and more coordinated care.

2. LITERATURE REVIEW

Definition and scope. Patient portals are secure, web-based gateways that provide patients 24/7 access to their EHR data and selected services (test results, notes, immunizations, secure messaging, scheduling, renewals). They are now widespread in integrated health systems and increasingly prescribed by regulation and national strategies [1.2.8].

Interoperability is pivotal. A 2024 scoping review identified eight recurring interoperability requirements for connecting portals with EHRs across countries: (1) data-sharing incentives/supports, (2) organizational heterogeneity, (3) storage/management, (4) available information & functionalities, (5) data formats & standards, (6) patient identification, (7) user access/consent, and (8) security/privacy. The review emphasizes that success depends as much on governance and stakeholder alignment as on technical standards [1].

Engagement and best practice. Although approximately 90% of U.S. providers offer portal access, only 15–30% of patients use even a single feature without additional support. Interventions with 1:1 patient training, formal usability testing, and explicit clinician-workflow integration show the most promise for increasing uptake and sustained engagement [2]. These findings underscore that portal deployment should include change management for staff and targeted support for patients with limited digital or health literacy.

Usability and patient experience. National surveys of mature portals (Finland's My Kanta) report good usability (mean SUS=74) and demonstrate that very positive and very negative experiences significantly shape perceived usability. Patients prize quick access to accurate information and prescription renewal; they also request more interactive features (richer communication, clearer explanations of results) [3].

Equity and "techquity." As portals become central to accessing services (telehealth, secure messaging, pre-visit forms), long-standing disparities in activation and use, by age, race/ethnicity, language, digital literacy, and socioeconomic status, risk widening care gaps. Editorials and empirical studies call for equity-minded strategies: multilingual UX, low-bandwidth options, community outreach, and clinician endorsement practices that normalize portal use across diverse populations [4.5]. Specialty-specific data (hematologic cancers) reveal similar patterns of under-activation in underserved groups, even when portal access could substantially improve care coordination and patient knowledge [4]. Evidence from Lebanon's MyChart deployment shows that usage frequency correlates more with patient characteristics (chronic conditions, visit frequency) than with app quality per se, an important signal that context and need drive engagement and must shape design and outreach [6].

Operations and workforce implications. Beyond "enrollment," health information (HI) professionals now manage data quality, access policy, and secure messaging at scale. Increased messaging volume has blurred lines between quick questions and billable clinical encounters, prompting some systems to formalize triage and adopt billing policies for certain message types. Governance and staffing models should anticipate this shift to avoid clinician overload and ensure timely, equitable responses [7].

EHR access and outcomes. Systematic reviews converge on favorable patient-level effects, greater health knowledge, improved medication adherence, better patient-doctor communication, and, in some cohorts, improvements in clinical outcomes (blood pressure and glycemic control), when portals are embedded in shared care processes. Effects on

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system utilization (ED visits, admissions) are mixed, reflecting differences in design, population, and implementation maturity [8.10]. A 2024 review focused specifically on patient access to EHRs shows a positive association with engagement and self-management, while also documenting persistent barriers (usability, privacy, literacy, language) that can limit the benefits if unaddressed [9].

Implications for our build. These findings guide several design imperatives for our portal: (i) standards-based interoperability and a roadmap for data sharing; (ii) usability-first UX with measurement and iterative improvement; (iii) equity by design (language, accessibility, outreach, training); (iv) clinician-workflow integration (clear routing, triage, expectations for response); and (v) governance for messaging, release rules, privacy, and security. These directions are sustained by high-quality reviews and multi-country experience.

3. METHODOLOGY

3.1 Architectural Overview

Our portal is a role-aware web application layered on a relational EHR database. It exposes patient-facing views (results, medications, vaccinations, vitals, radiology, laboratory PDFs, multimedia education, appointments) and staff-facing worklists (registrations, vitals capture, prescriptions, imaging upload/annotation, laboratory file ingestion, scheduling, billing visibility). An event-notification layer triggers email confirmation (verification, appointment approvals/denials). The overall logic is summarized in the System Flowchart (Figure 1), which traces authentication, authorization, routing, CRUD operations, and audit logging.

3.2 User Roles and Access Control

We enforce role-based access controls (RBAC) with the following user classes:

Super Admin: Grants/denies staff access; manages policies and workload dashboards.

Physician: Views/edits vitals, diagnoses, prescriptions, vaccinations/medications; reviews labs (PDF) and radiology; manages appointments and educational materials.

Nurse: Captures vitals, reviews relevant prescription flags for inpatient safety.

Radiologist: Uploads imaging descriptors and links (with controlled patient access).

Laboratory Technician: Uploads verified lab results as PDFs; maintains normal ranges.

Receptionist: Reconciles patient appointment requests with physician availability; sends confirmations/denials.

Patient: Registers and verifies identity; views results, diagnoses, meds, vaccinations, vitals, imaging descriptors, lab PDFs; books appointments; accesses multimedia; submits complaints.

The authorization matrix constrains read/write privileges to clinical necessity, and all high-risk actions (results release, diagnosis changes) are audited.

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3.3 System Flowchart (Figure 1)

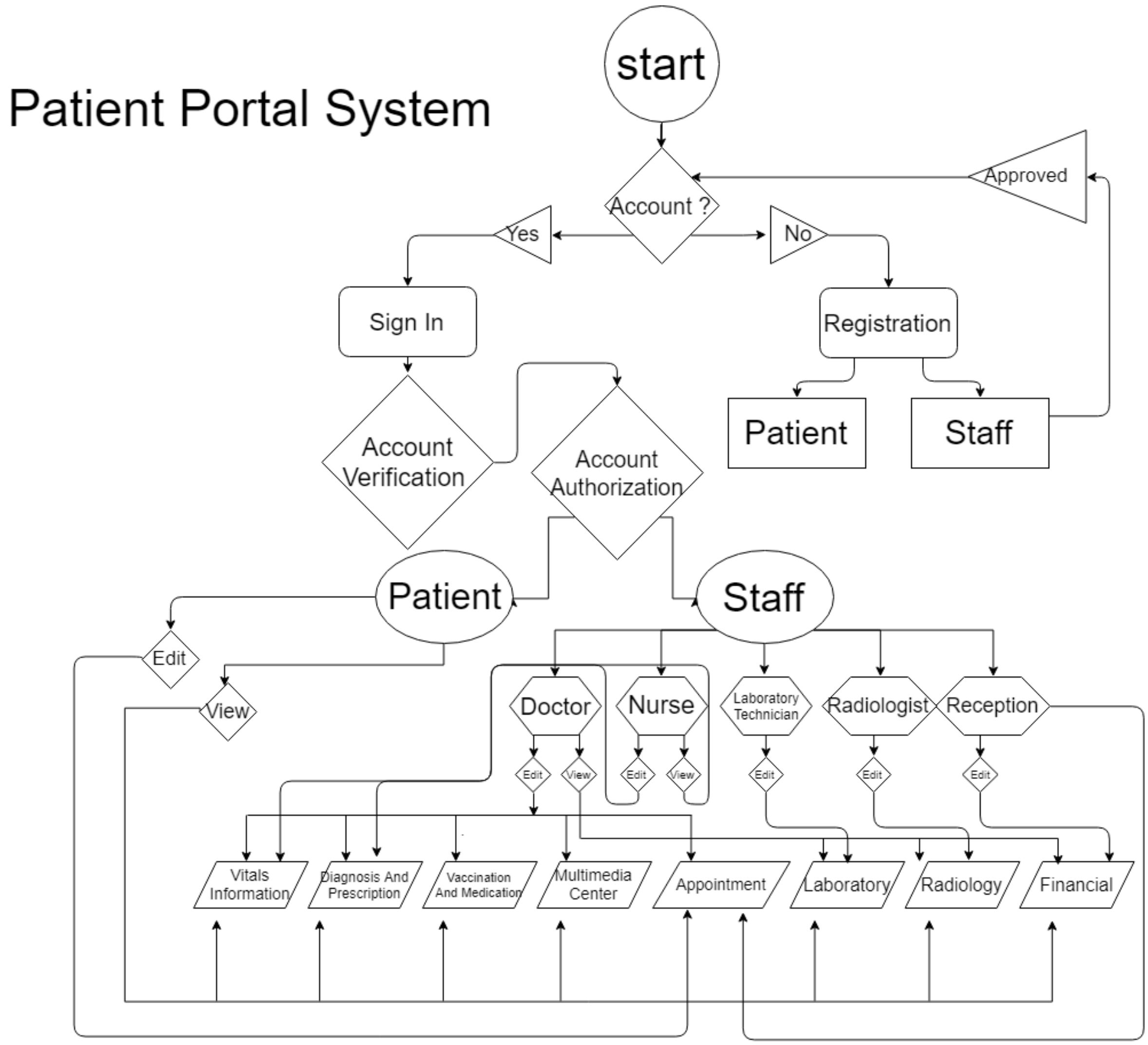

Figure 1: System flowchart (overall workflow)

Figure 1 depicts the operational path: (i) user login → role selection → MFA/email verification as needed; (ii) router dispatches to role-specific home pages; (iii) controllers execute CRUD with server-side validation; (iv) DB transactions enforce referential integrity; (v) notifications for events (appointment approvals, cancellations); (vi) audit capture.

3.4 Design and Implementation

3.4.1 Database Design (Relational)

A MySQL schema underpins the system. Referential integrity is enforced via primary keys (PK) and foreign keys (FK). Sensitive entities (patients, medications, labs) include created_by, updated_by, and timestamp fields to support auditing and lineage tracking.

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3.4.1.1 Relationships and Integrity

Patient is the parent for encounter-level entities (vitals, labs, imaging descriptors, prescriptions, appointments).

Staff (with specialty) links to authored content (prescriptions, notes, uploads).

Appointment references Patient and Physician (or Lab/Radiology task type), with status transitions (requested → accepted/denied). Where appropriate, CASCADE is used for child rows when a parent record is removed, only after policy review to ensure compliance with retention rules.

3.4.1.2 Data Types (Rationale)

int: identifiers and counters (auto-increment).

char / nchar: fixed-length codes; nchar supports internationalization (Arabic).

varchar / nvarchar: variable text; nvarchar for Unicode.

text: long-form clinical narratives and education content.

date / datetime: standardized temporal fields (ISO8601 compatibility).

varbinary (MAX): binary payloads (signed PDFs).

image/link fields: store URI to imaging objects or controlled BLOBs, depending on PACS integration.

3.4.1.3 Core Tables and Example Payloads

We provide schema exemplars in Figures 2–12:

ASUS-PC.PPS - dbo.Patients | ASUS-PC.PPS - dbo....t_Vital_Information

Column Name	Data Type	Allow Nulls
PID	int	☐
Username	varchar(50)	☐
Password	varchar(50)	☐
Name	text	☐
PhoneNumber	int	☐
Email	nchar(60)	☐
Age	int	☐
Gender	nchar(1)	☐
Image	image	☑
SID	int	☐
		☐

ASUS-PC.PPS - dbo.Patients

PID	Name	Phone Number	Email	Age	Gender	Image	SID
1234567	John watson	453627212	eng@gmail.co...	28	M	NULL	7654321
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 2: Patient tables (registration, demographics, contact, physician of record)

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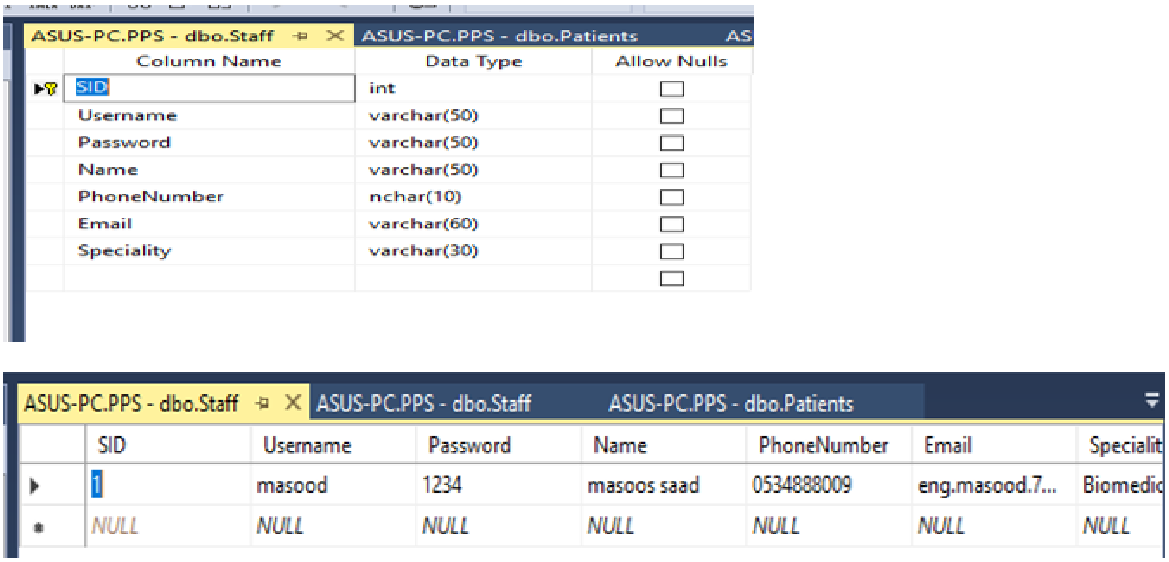
Patient table: is the databank for patient information. It stores the essential information for patient data inserted from the registration page that we will explain it later on. In this tables, we used SID which is a foreign key for the staff table. which means in registration process of patient, it must select its physician from the beginning. also, PID is a primary key for another tables.



ASUS-PC.PPS - dbo.Staff | ASUS-PC.PPS - dbo.Patients

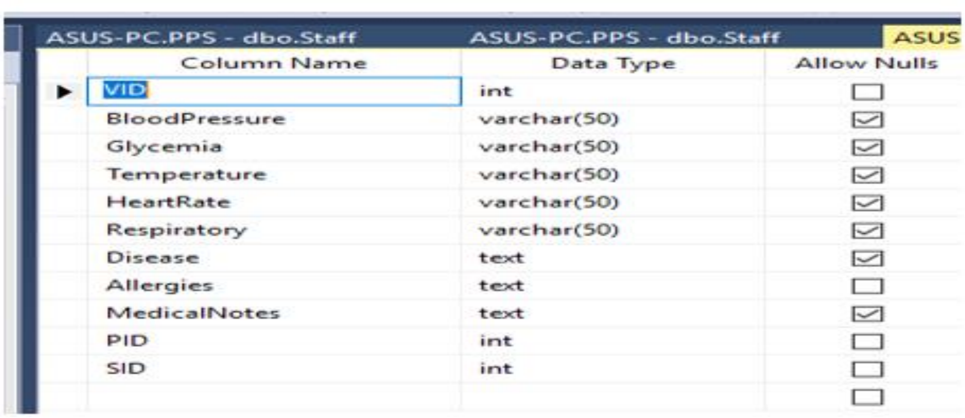
Column Name	Data Type	Allow Nulls
SID	int	☐
Username	varchar(50)	☐
Password	varchar(50)	☐
Name	varchar(50)	☐
PhoneNumber	nchar(10)	☐
Email	varchar(60)	☐
Speciality	varchar(30)	☐
		☐

ASUS-PC.PPS - dbo.Staff | ASUS-PC.PPS - dbo.Staff | ASUS-PC.PPS - dbo.Patients

SID	Username	Password	Name	PhoneNumber	Email	Specialit
1	masood	1234	masoos saad	0534888009	eng.masood.7...	Biomedic
NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 3: Staff tables (account, role, specialty, status)

Staff table: is the databank for Staff information. It stores the essential information for staff inserted from the registration page. Staff table is a master table in our project and is connected to almost every table in PPS.



ASUS-PC.PPS - dbo.Staff | ASUS-PC.PPS - dbo.Staff | ASUS

Column Name	Data Type	Allow Nulls
VID	int	☐
BloodPressure	varchar(50)	☑
Glycemia	varchar(50)	☑
Temperature	varchar(50)	☑
HeartRate	varchar(50)	☑
Respiratory	varchar(50)	☑
Disease	text	☑
Allergies	text	☐
MedicalNotes	text	☑
PID	int	☐
SID	int	☐
		☐

Figure 4: Vitals (BP, HR, Temp, RR, SpO_2, glucose; with provenance)

Vitals Information Table: is the databank for vital information that is inserted for a specified Patient. It stores the essential information for Vitals and it can be repeated for the same patient. (PID, SID). it's a foreign key that select information of anther table.

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ASUS-PC.PPS - dbo....osis_Prescreptions | ASUS-PC.PPS - dbo.Staff

Column Name	Data Type	Allow Nulls
DID	int	☐
Diagnosis	text	☑
prescreption	text	☑
PID	int	☐
FID	int	☐
SID	int	☐
		☐

ASUS-PC.PPS - dbo....osis_Prescreptions | ASUS-PC.PPS - dbo....t_Vital_Information | ASUS-PC.PPS - dbo.Staff

DID	Diagnosis	prescreption	PID	FID	SID
4	Headache	Panadol	1	1	1
NULL	NULL	NULL	NULL	NULL	NULL

Figure 5: Diagnosis & Prescription (problem lists, orders, allergies, notes)

Diagnosis and Prescription Table: is the databank for Prescription that uses the Diagnosis and Prescription information related to identified PID Storage by SID.

ASUS-PC.PPS - dbo.vac_med | ASUS-PC.PPS - dbo....osis_Prescrept

Column Name	Data Type	Allow Nulls
VMID	int	☐
Vaccination_type	varchar(50)	☑
date	date	☑
medication_1	varchar(50)	☑
medication_2	varchar(50)	☑
medication_3	varchar(50)	☑
PID	int	☐
SID	int	☐

ASUS-PC.PPS - dbo.vac_med | ASUS-PC.PPS - dbo....osis_Prescreptions | ASUS-PC.PPS - dbo....t_Vital_Information

	Vaccination_ty...	date	medication_1	medication_2	medication_3	PID	SID
	Pertussis	2018-04-01	NULL	NULL	NULL	1	1
	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 6: Vaccination & Medication (CVX-like codes where applicable; start/stop)

Vaccination and Medication Table: is the databank for Vaccination and Medication that uses the information related to identified PID Storage by SID.

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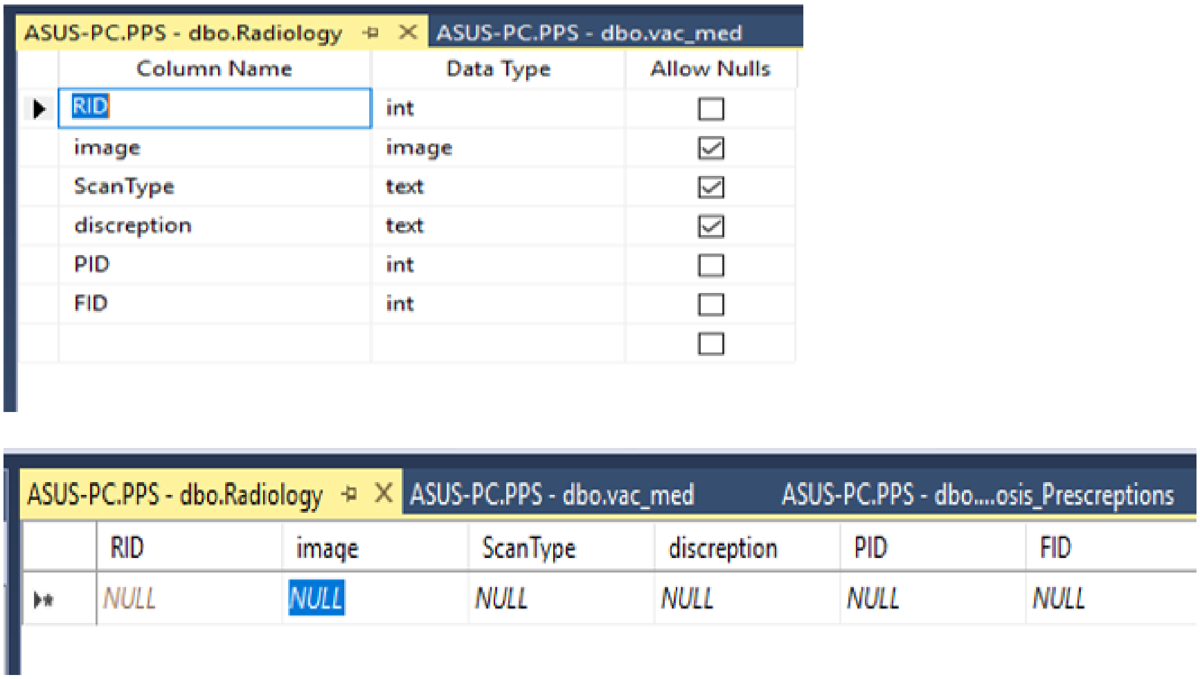
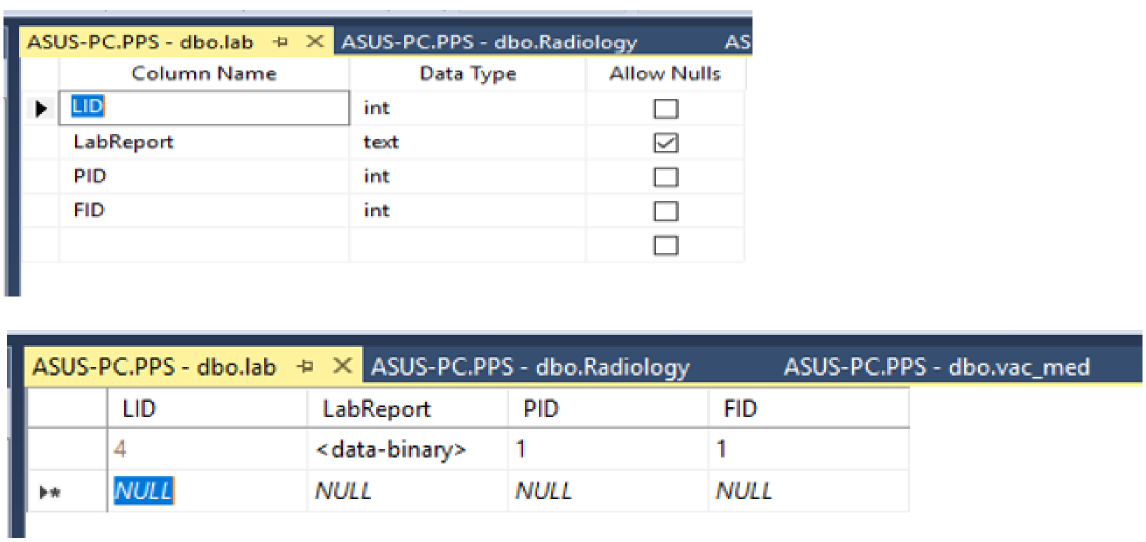


Column Name	Data Type	Allow Nulls
RID	int	☐
image	image	☑
ScanType	text	☑
discreption	text	☑
PID	int	☐
FID	int	☐
		☐

RID	image	ScanType	discreption	PID	FID
NULL	NULL	NULL	NULL	NULL	NULL

Figure 7: Radiology (study type, description, date, image links)

Radiology Table: is the databank for images that uses the information related to identified PID. Different kinds of image like CT, X-Ray ... etc. that can be saved with extensions: JPEG, PNG ... Storage by SID (Radiologist).



Column Name	Data Type	Allow Nulls
LID	int	☐
LabReport	text	☑
PID	int	☐
FID	int	☐
		☐

LID	LabReport	PID	FID
4	<data-binary>	1	1
NULL	NULL	NULL	NULL

Figure 8: Laboratory (test name, panel, result; uploaded as PDF; normal ranges)

Lab Table: is the databank for Laboratory report that uses the information related to identified PID. In our project, we chose the report information use PDF extensions storage by SID (Lab Technician).

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ASUS-PC.PPS - dbo.Multimedia | ASUS-PC.PPS - dbo.lab

Column Name	Data Type	Allow Nulls
MID	int	☐
Image	image	☑
Video	text	☑
Voice	varbinary(MAX)	☑
Text	text	☑
PID	int	☐
SID	int	☐
		☐

ASUS-PC.PPS - dbo.Multimedia | ASUS-PC.PPS - dbo.lab | ASUS-PC.PPS - dbo.Radiology | ASUS-PC.PPS - dbo.vac_m

MID	Image	Video	Voice	Text	PID	SID
1	NULL	link	NULL	Dear Mr. Nasser...	1	1
NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 9: Multimedia (education assets and clinician uploads)

Multimedia Table: is the databank for multimedia interactive system that uses Image, Videos link, Up load Voice and Text to identified PID, sent out by SID (Doctor).

ASUS-PC.PPS - dbo.Complain | ASUS-PC.PPS - dbo.Multimedia

Column Name	Data Type	Allow Nulls
CID	int	☐
complian	text	☑
image	image	☑
RequestForRefill	text	☑
PID	int	☐
SID	int	☐
		☐

ASUS-PC.PPS - dbo.Complain | ASUS-PC.PPS - dbo.Multimedia | ASUS-PC.PPS - dbo.lab

CID	complian	image	RequestForRefill	PID	SID
1	Emergency	NULL	Clovage	1	1
NULL	NULL	NULL	NULL	NULL	NULL

Figure 10: Complaint (patient-initiated tickets with routing and SLA timestamps)

Complain Table: is interactive table between patient and staff where patient can complain about services, upload emergency image cases or ask for refill medication.

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ASUS-PC.PPS - dbo.Appointment | ASUS-PC.PPS - dbo.Complain

Column Name	Data Type	Allow Nulls
APID	int	☐
Clinic	varchar(100)	☐
DateAndTime	datetime	☐
PID	int	☐
SID	int	☐
FID	int	☐
		☐

ASUS-PC.PPS - dbo.Appointment | SQLQuery2.sql - AS...(asus-PC\asus (53)) | ASUS-PC.PPS - dbo.financial

APID	Clinic	DateAndTime	PID	SID	FID
1	Radiology	2018-04-03 00:0...	1	1	1
NULL	NULL	NULL	NULL	NULL	NULL

Figure 11: Appointment (request queue, approvals, confirmations)

Appointment Table: is interactive table between patient and receptionist where patient can schedule a hospital appointment that can be seen by the receptionist waiting for the approval.

ASUS-PC.PPS - dbo.financial | ASUS-PC.PPS - dbo.Appointment

Column Name	Data Type	Allow Nulls
FID	int	☐
Clinic	varchar(50)	☑
Cost	money	☑
PID	int	☑
		☐

ASUS-PC.PPS - dbo.financial | ASUS-PC.PPS - dbo.Complain | ASUS-PC.PPS - dbo.Multimedia

FID	Clinic	Cost	PID
1	Diagnosis	50.0000	NULL
2	Radiology	150.0000	NULL
3	Laboratory	350.0000	NULL

Figure 12: Financial (billing visibility for reception; read-only ledger references)

Financial Table: is interactive table between patient and receptionist where patient can view his history bills and payments as well as current bills. It is managed by the receptionist for charging the patient.

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3.4.1.4 Database Diagram (Figure 13)

Figure 13 illustrates the ER model, highlighting PK/FK relations, many-to-one/one-to-many cardinalities, and on-delete actions. The diagram documents query paths used by the application (patient-centric joins that fetch the latest vitals, active meds, and recent labs efficiently) and marks indexes on high-cardinality fields (patient_id, encounter_date).

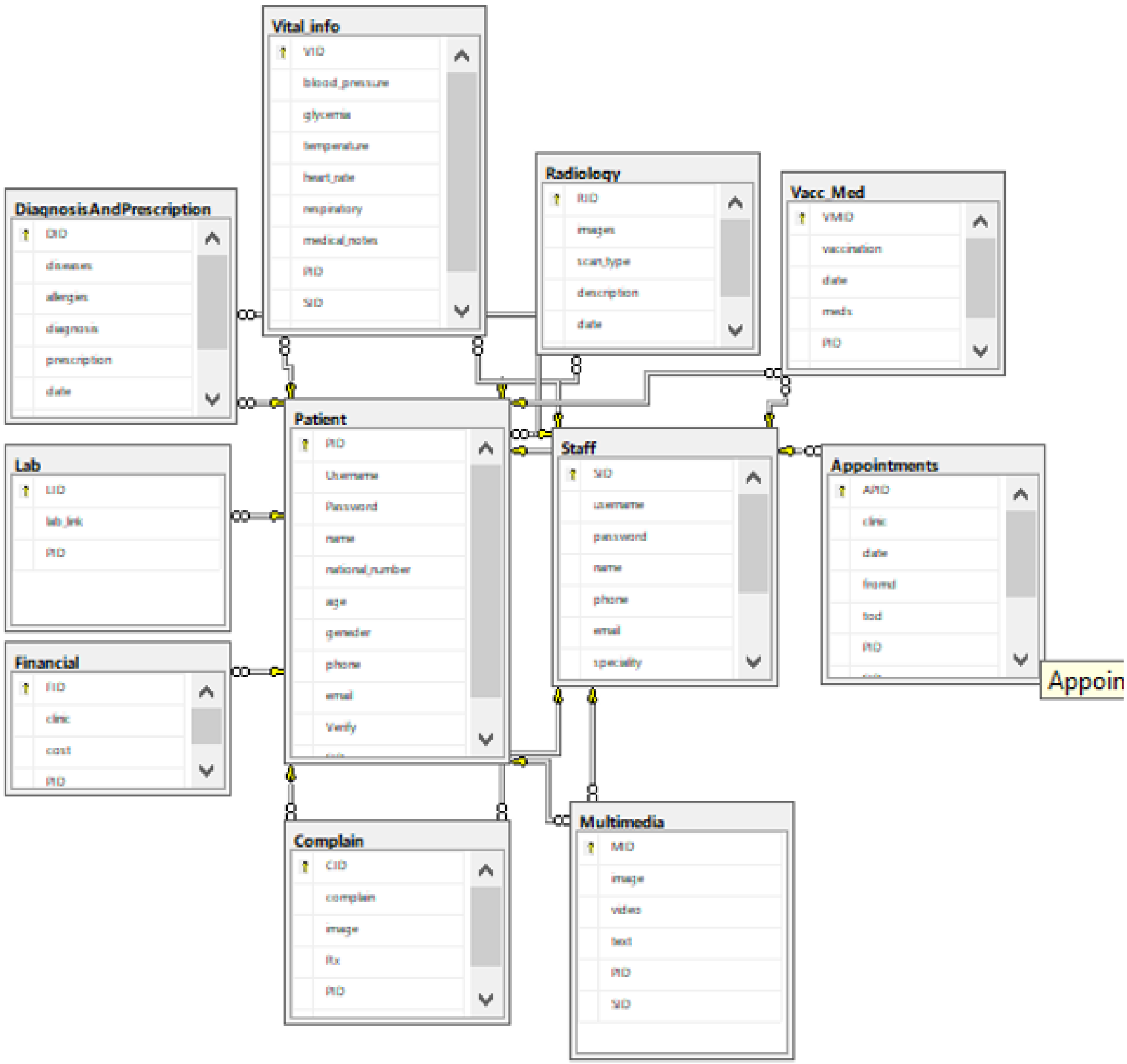

Figure 13: Database Diagram

Database diagram is important to connect the information between tables so that it can be selected, deleted, updated or applied any other operation. In the designing phase of database diagram, developer should be very careful about the connection of the related information between tables and what kind of related action that will be applied on the information in tables.

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3.5 User Interface and Application Layer

3.5.1 Development Stack

The application is built in C# using Visual Studio 2015.

Designer view accelerates UI composition via drag-and-drop components.

Source view provides fine-grained control over markup and behavior.

Server-side C# controllers handle validation, RBAC checks, and DB I/O.

Email services send verification links and event notifications.

Charts (vitals trends) render time-series data with tooltips and labels (Figure 4).

4. RESULTS: SYSTEM FEATURES AND WORKFLOWS

4.1 Authentication and Session

The Login page supports patient or staff sign-in. Role selection and credentials determine routing: patient → Patient Home; staff → role-specific home (Physician, Nurse, Radiologist, Laboratory, Receptionist, Super Admin). New users register from Sign Up.

4.2 Registration

4.2.1 Staff

Staff supply username/password and specialty, then await Super Admin approval. Attempting to log in pre-approval triggers an inline status message ("Your Account Is Not Approved Yet").

4.2.2 Patient

Patients create credentials, select their physician of record from a grid, and must verify email via a link; otherwise, login returns "Your Account Is Not Verified Yet." Successful verification unlocks access to the Patient Home.

4.3 Patient Home (Multi-View)

4.3.1 Vitals.

Latest Vitals Recorded: displays most recent measurements captured by nurse or physician.

Vitals History: plots selected metrics (BP, glucose, temperature) over time for trend recognition (Figure 4).

4.3.2 Diagnosis & Prescriptions

Patients view diagnoses, allergies, active prescriptions, notes, and dates (Figure 5).

4.3.3 Vaccination & Medication

Displays immunization history (including legacy records) and active medications with start/stop dates (Figure 6).

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4.3.4 Radiology

Shows imaging studies, modality, date, and descriptions; images are linked via secure references or thumbnails consistent with policy (Figure 7).

4.3.5 Laboratory

Lab reports are uploaded as signed PDFs by the laboratory technician and are downloadable; commonly referenced normal ranges are displayed (Figure 8).

4.3.6 Appointment

Patient's book appointments with their physician or for ancillary services (lab, radiology) by selecting available date/time slots. A Receptionist validates and confirms or denies. Confirmation or denial triggers an email to the patient (Figure 11).

4.3.7 Multimedia Center

A library of clinician-approved education assets (text, images, links, videos) is accessible; select patient uploads can be permitted with moderation (Figure 9). *(Logout ends the session.)*

4.4 Physician Home

Patient Selection: sets context for downstream views.

Vitals (Staff): enter or review vital signs.

Prescription (Staff): add diagnoses, allergies, and prescriptions.

Vaccination & Medication: update immunizations and medications.

Radiology (Staff/Doctor): review images and record interpretations.

Laboratory (Staff/Doctor): view and download lab PDFs.

Multimedia Center (Staff): upload tailored education for the patient.

Appointments: see approved patient requests; cancel with automated email suggesting rescheduling.

4.5 Nurse Home

Vitals (Staff/Nurse): capture vitals at registration, during nurse-led checks, or in high-volume clinics. Prescription View (Inpatient Safety): verify flags (isolation precautions) to guide safe nursing care.

4.6 Radiologist Home

Radiology Upload: add imaging descriptors (type, date, description) and secure links (Figure 7).

4.7 Laboratory Technician Home

Laboratory Upload: post verified reports in standardized PDF format; maintain visible normal ranges (Figure 8).

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4.8 Receptionist Home

Three synchronized grids: Patient Info, Pending Requests, Confirmed Appointments. Approval moves items from Pending to Confirmed and sends a confirmation email; denials trigger a structured explanation with alternative suggestions (Figure 11).

4.9 Super Admin

4.9.1 Approval/Revocation

Approve or reject Staff registrations by Staff ID; deactivate/reactivate accounts; enforce MFA or password resets.

4.9.2 Workload Dashboard and Overtime Calculator

A decision aid estimates overtime costs to manage appointment surges:

1 appointment = 1 hour; 1 hour = 120 SAR; monthly limit = 200 hours.

Let a = hours over limit; distribute across =20 workdays/month → b hours/day.

Overtime cost estimate: b × 120 SAR × 20. Comparison with day-rate staffing informs whether to authorize overtime or add discrete staffing blocks.

5. DISCUSSION

Our portal translates the evidence base into a practical architecture that centers on interoperability, usability, equity, and workflow fit. Interoperability roadmap. The scoping literature indicates that technical standards alone are insufficient; data-sharing incentives, identity management, and consent models are equally decisive [1]. Our design prioritizes standards-ready data (structured labs, coded vaccinations/meds) and modular interfaces to external systems (LIS, PACS), while reserving governance choices (release rules, consent granularity) for policy bodies [1].

Usability measurement and iteration. Sustained adoption requires continuous usability testing with target groups and feature-specific training where needed. Positive/negative experience loops can sharply alter perceived usability; quick wins include prescription renewal clarity, explanations of results, and predictable appointment confirmations [2.3]. Our design exposes quick actions prominently and uses natural language summaries for results pages, with drill-down to structured values and ranges.

Equity by design. To avoid widening the techquity gap, we propose multilingual UX, large-type and low-bandwidth modes, SMS/email verification alternatives, and opt-in caregiver proxies. We also recommend clinician scripts that normalize portal use for all patients, especially in high-need specialties where coordination demands are high [4.5]. Dashboarding should monitor activation and use by demographic segments to guide targeted outreach.

Workflow integration and messaging governance. Evidence shows that clinician endorsement and clear workflows amplify engagement [2.7]. Our staff views minimize context switches (vitals-to-orders) and include audit trails. Should secure messaging be

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enabled, we recommend triage rules, service-level targets, and explicit definitions of billable e-visits to protect clinician time while maintaining responsiveness [7].

Outcomes and utilization. Reviews show generally favorable patient-level outcomes when portals are integrated into care pathways (hypertension, diabetes), with mixed effects on utilization [8.10]. [8.10] Our vitals trends, medication/vaccination histories, and PDF lab access are deliberately integrated with scheduling to encourage closed-loop care (result → guidance → appointment → follow-up), which is where portals often yield the most benefit.

Limitations and future work. As currently configured, the portal prioritizes documented results release (PDF labs) and image links rather than native imaging viewers. Future steps include standards-based exchange (FHIR APIs), decision support (alerting for abnormal time-series trends), remote monitoring for chronic conditions, and selective voice calling integration, all with appropriate consent and audit controls. These directions align with the literature's trajectory toward more interactive, patient-centered portal ecosystems [1.2.3.8.9].

6. FUTURE DIRECTIONS

Secure Inbox Messaging (staff↔patient, staff↔staff) with triage, templates, and turnaround-time SLAs.

Standards-based Integrations: LIS and PACS connections (HL7 v2, FHIR, DICOM-web) and national registries.

Decision Support: rules for lab thresholds, medication conflicts, vaccination reminders.

Voice Calling: click-to-call with documented consent and recording policies where permitted.

Remote Monitoring: telemetry capture (BP/glucose) with thresholds and nudge messaging.

Government Systems: eligibility checks, immunization registries, and e-referral linkages.

7. CONCLUSION

We implemented a patient portal tightly coupled to an EHR that consolidates patient data and staff workflows into a single, role-aware interface. The design directly reflects contemporary evidence: prioritize interoperability, usability, equity, and workflow fit to drive adoption and outcomes.

Literature based on multi-country and specialty-specific experiences indicates that portals can enhance knowledge, self-management, and, when used in structured care pathways, clinical outcomes, while effects on utilization vary by context. With a roadmap for standards-based exchange, decision support, remote monitoring, and robust messaging governance, this portal positions the organization to deliver safer, faster, and more coordinated care.

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