



**International Institute of Information Technology, Bangalore**

**Consent Management System for Distributed Electronic Health  
Records  
(Under the Guidance of Professor T.K Srikanth and Swapnil  
Shrivastava)**

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## **Objective**

Our main objective is to build a Consent Management System for Distributed Electronic Health Records.

Electronic Health Records are an electronic version of a patient's medical history that is maintained by the provider over time, and may include all of the key administrative clinical data relevant to that person's care under a particular provider, including demographics, progress notes, problems, medications. Ease of access, improved clarity and reduction of redundancy are some of the advantages of EHRs. Health Data is extremely sensitive personal data thus we must ensure that they are used appropriately i.e., only by authorized parties and for the intended purpose.

A consent management system is an attempt to manage this sharing of E- Health Records (EHRs) by giving patients (data principal acc. to Indian PDP Draft) more control in choosing who is using their records, for what purpose and for how long. It also helps eliminate the power asymmetry existing in current data sharing scenarios by giving patients ample choice from rejecting consent to access EHRs to abstracting information that they are unwilling to reveal (Scoping).

Our project intends to be a demonstration of consent-driven data sharing in Healthcare keeping in mind the aforementioned points.

## **Requirements and Use cases**

### **Hospital App**

S no.	Use Case	Description	Participants	Status
1	Adding hospital	Hospitals will be added manually.	Done manually	Done
2	Add doctor	Doctor has to be added by hospital admin first before his registration for security purposes	Hospital Admin	Done
3	Register the doctor	Doctor registers himself. OTP verification is done	Doctor	Done
4	Doctor's login	Doctor needs to login before he can access every hospital.	Doctor	Done
5	Doctor requests consent to access patient EHR	Doctor requests the patient for EHR access according to his requirements and consent request will be sent as a notification	Doctor	Done
6	Doctor adds EHR record	Doctor can add EHR after getting patient's consent	Doctor	Done
7	Doctor Create Login	Doctor can create his/her login credentials in the hospital app after first time registration. If the doctor is already registered, the doctor can create login credentials directly. OTP verification is done.	Doctor	Done
8	Displaying consented EHR	The patient EHR (only data that has been provided approved by patient) and consent details - date & time of consent, validity etc	Doctor	Done
9	Consent delegation	When the doctor gets access to any EHR, he is allowed to transfer or forward the consent to other doctors if the patient has given access to the doctor to delegate the consent. But the delegated doctor cannot delegate the consent further.	Doctor	Done

10	Approve/Reject Create Login request	Admin can approve/reject the create login request submitted by doctor. If approved, the doctor can log in to the system	Admin	Done
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### Patient App

S no.	Use Case	Description	Participants	Status
1	Registration	Patient fills a registration form. OTP verification is done.	Patient	Done
2	Adding Nominee	Patients can add nominee's according to their will.	Patient	Done
3	Patient Login	Patients can login using his/her credentials.	Patient	Done
4	Display all EHR records	Display all of the patient's records	Patient	Done
5	Create consent	Patients will be provided options to create and revoke consent.	Patient	Done
6	Display EHR access logs	Patients can view the access logs for his/her EHR accessed by various doctors across different hospitals.	Patient	Done
7	Consent request notification	View consent requests received.	Patient	Done
8	Display Patient Consent History	Will display all the history of consent given by the patient. Here the patient has options to revoke consent, view consent details.	Patient	Done

### Consent Repository

S no.	Use Case	Description	Status
1	Consent Creation	Consent creation shown in the patient app. When a patient grants consent a unique consent id is generated and the consent artifact is stored in the consent repository.	Done
2	Granted Consents	Retrieve all the valid consents associated with a doctor id from the consent repository.	Done
3	Consent Validation	Consent validation request received from doctor app. The request is validated against consent stored in the consent repository.	Done
4	Consent Retrieval	Retrieve all the consents associated with a patient id from consent repository	Done
5	Consent Revocation	Consent is revoked by the patient. The consent is marked as invalid in the consent repository.	Done

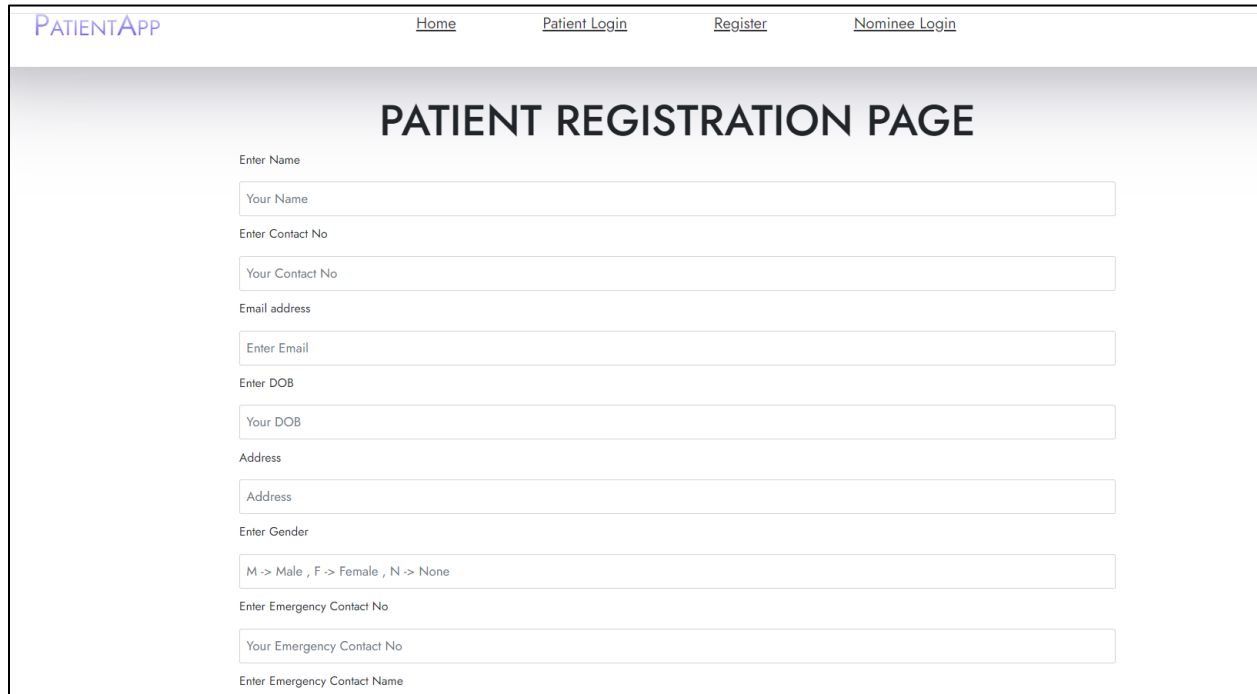
### Non Functional Requirements

S no.	Requirement Description	Applicable Use Cases	Status
NFR - 1	Password Encryption	UC – 1,3	Done
NFR - 2	Performance		Done
NFR - 3	Compatibility		Done
NFR - 4	Usability	UC - 2,4,5,8 (patient app)	Done

## UI structure/flow

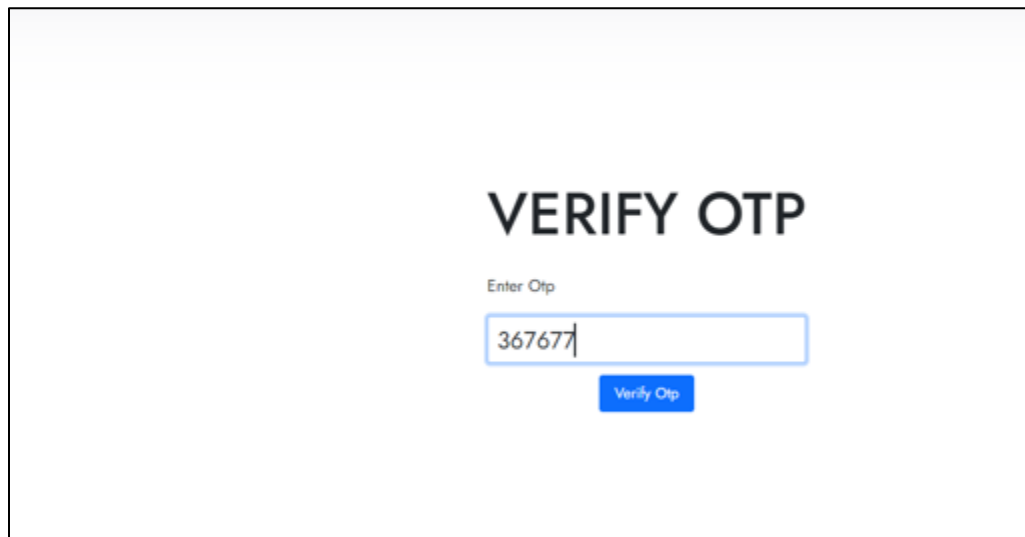
### PATIENT APP

#### PATIENT REGISTRATION



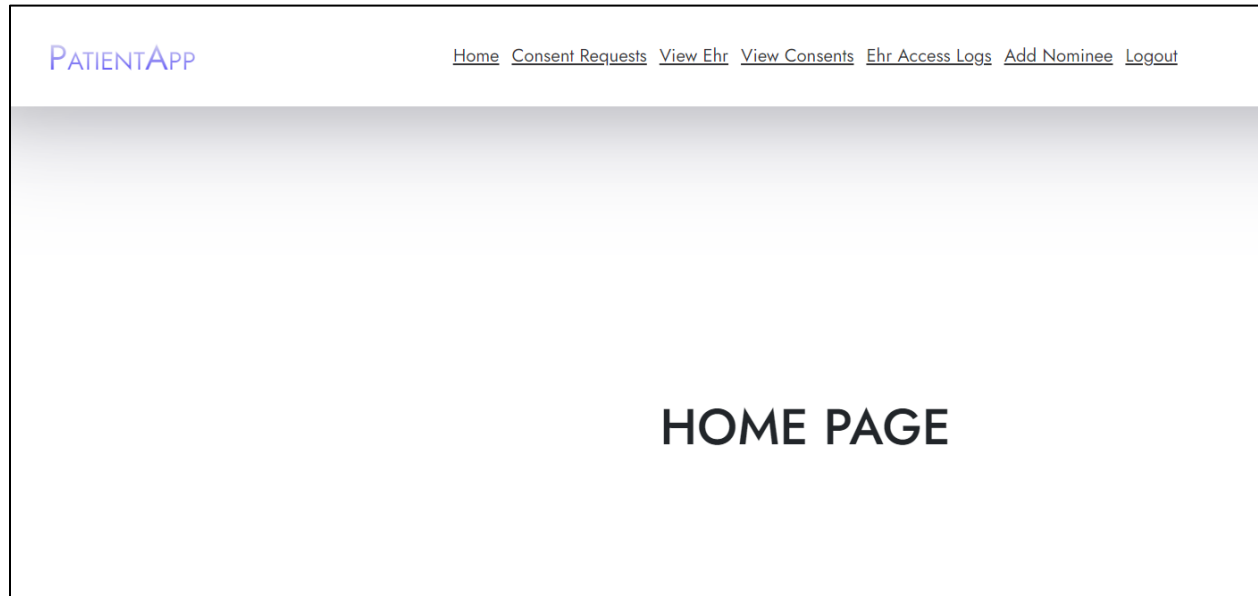
The Patient Registration Page features a header with the 'PATIENTAPP' logo and navigation links for Home, Patient Login, Register, and Nominee Login. The main content area is titled 'PATIENT REGISTRATION PAGE' and contains a series of input fields for user registration. The fields are labeled as follows: 'Enter Name' (with a placeholder 'Your Name'), 'Enter Contact No' (with a placeholder 'Your Contact No'), 'Email address' (with a placeholder 'Enter Email'), 'Enter DOB' (with a placeholder 'Your DOB'), 'Address' (with a placeholder 'Address'), 'Enter Gender' (with a placeholder 'M -> Male , F -> Female , N -> None'), 'Enter Emergency Contact No' (with a placeholder 'Your Emergency Contact No'), and 'Enter Emergency Contact Name'.

#### PATIENT OTP VERIFICATION



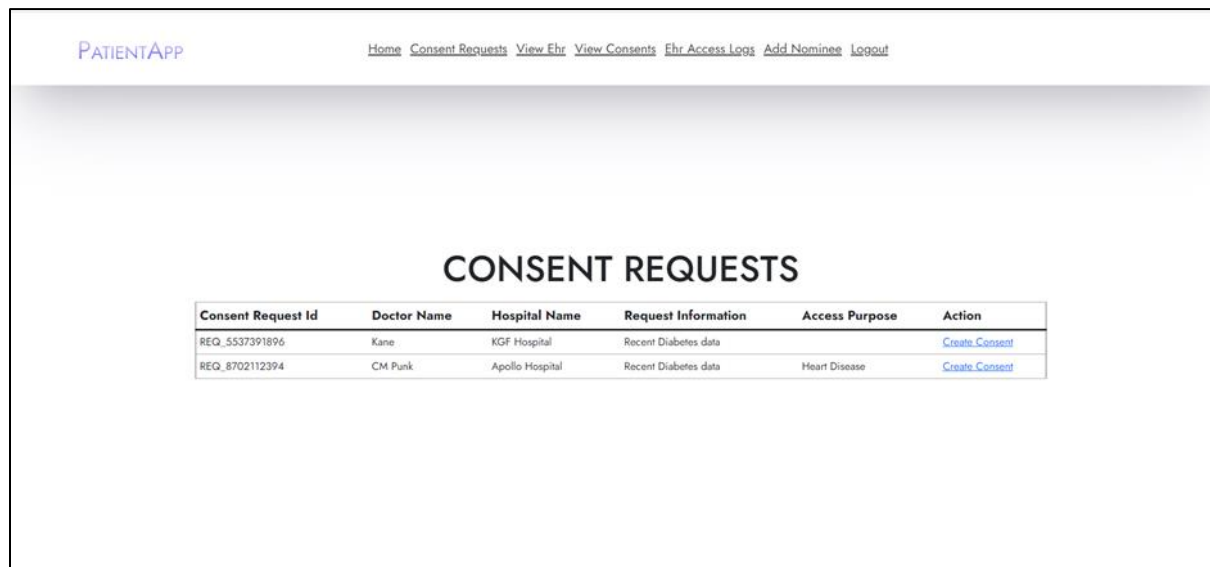
The Patient OTP Verification Page features a large heading 'VERIFY OTP'. Below the heading is a label 'Enter Otp' followed by a text input field containing the number '367677'. A blue button labeled 'Verify Otp' is positioned below the input field.

## HOME PAGE(after login)



## CONSENT REQUESTS

After logging in the patient can see the consent requests made by the doctor.





## CREATE CONSENT

The patient can create consent and give access to his/her records to the doctor who requested.

PATIENTAPP

[Home](#) [Consent Requests](#) [View Ehr](#) [View Consents](#) [Ehr Access Logs](#) [Add Nominee](#) [Logout](#)

### CREATE CONSENT

Apollo Hospital

Episodes:  
Episode Id : EPI\_54544  
Episode Name : General  
Encounters :  
☒  
Doctor Name : CM Punk  
Encounter Id : ENC\_54213  
OpRecords:  
Diagnosis : Diarrhea  
Op Record Id : OP\_89789  
Details : { "complaints": "stomach ache,vomiting", "prescription": "tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date": "01/04/2022", }  
Timestamp : 24-04-2022 09:57:36  
Encounters :  
☒  
Doctor Name : CM Punk  
Encounter Id : ENC\_65756  
OpRecords:

PATIENTAPP

[Home](#) [Consent Requests](#) [View Ehr](#) [View Consents](#) [Ehr Access Logs](#) [Add Nominee](#) [Logout](#)

Details : { "complaints": "stomach ache,vomiting", "prescription": "tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date": "01/04/2022", }  
Timestamp : 24-04-2022 10:28:03  
Encounters :  
☒  
Doctor Name : Kane  
Encounter Id : ENC\_4545  
OpRecords:  
Diagnosis : Diarrhea  
Op Record Id : OP\_76868  
Details : { "complaints": "stomach ache,vomiting", "prescription": "tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date": "01/04/2022", }  
Timestamp : 24-04-2022 10:28:29

Yes

Heart Disease

signature

Create consent

localhost:3000 says  
Created Consent successfully with Id : Cons\_7789669078

**PATIENTAPP** Home Cons [Add Nominee](#) [Logout](#)

Details : { "complaints": "stomach ache, vomiting", "prescription": "tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date": "01/04/2022", }  
Timestamp : 24-04-2022 10:28:03

Encounters :

☒ Doctor Name : Kane  
Encounter Id : ENC\_4545  
OpRecords:  
Diagnosis : Diarrhea  
Op Record Id : OP\_76868  
Details : { "complaints": "stomach ache, vomiting", "prescription": "tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date": "01/04/2022", }  
Timestamp : 24-04-2022 10:28:29

Yes

Heart Disease

signature

Create consent

## VIEW CONSENTS

The patient can view the consents given by him/her to the doctor and can also revoke them.

**PATIENTAPP** Home [Consent Requests](#) [View Ehr](#) [View Consents](#) [Ehr Access Logs](#) [Add Nominee](#) [Logout](#)

### VIEW CONSENSTS

Consent Id	Doctor Name	Access Purpose	Delegate Access	Creation Date	Validity	Revoke Consent	View Consent
Cons_6647022190	CM Punk	Surgery	Yes	2022-04-24 10:34:21	2022-07-23 10:34:21	<a href="#">Revoke</a>	<a href="#">View</a>
Cons_7789669078	CM Punk	Heart Disease	Yes	2022-04-26 11:07:50	2022-07-25 11:07:49	<a href="#">Revoke</a>	<a href="#">View</a>

## VIEW CONSENT DETAILS

The patient can see the details of the respective consented record

PATIENTAPP

[Home](#) [Consent Requests](#) [View Ehr](#) [View Consents](#) [Ehr Access Logs](#) [Add Nominee](#) [Logout](#)

CONSENT DETAILS

Apollo Hospital

-

Episodes:

Episode Id : EPI\_54544

Encounters :

Encounter Id : ENC\_54213

Encounters :

Encounter Id : ENC\_65756

Episodes:

Episode Id : EPI\_5898888072

Encounters :

Encounter Id : ENC\_5778603789

## VIEW EHR

The patient can see all his/her health records

PATIENTAPP

[Home](#) [Consent Requests](#) [View Ehr](#) [View Consents](#) [Ehr Access Logs](#) [Add Nominee](#) [Logout](#)

VIEW EHR

Apollo Hospital

-

Episodes:

Episode Id : EPI\_54544

Episode Name : General

Encounters :

Doctor Name : CM Punk

Encounter Id : ENC\_54213

OpRecords:

Diagnosis : Diarrhea

Op Record Id : OP\_89789

Details : { "complaints": "stomach ache, vomiting", "prescription": "tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date": "01/04/2022", }

Timestamp : 24-04-2022 09:57:36

Encounters :

Doctor Name : CM Punk

Encounter Id : ENC\_65756

OpRecords:

Diagnosis : Diarrhea

Op Record Id : OP\_67868

## ACCESS LOGS

The patient can view the access logs, that is which record is accessed by which doctor at what time.

PATIENTAPP

[Home](#) [Consent Requests](#) [View Ehr](#) [View Consents](#) [Ehr Access Logs](#) [Add Nominee](#) [Logout](#)

ACCESS LOGS

Log Id	Doctor Name	Hospital Name	Consent Id	Access Purpose	Timestamp
Acc_1235990685	Kane	Apollo Hospital	Cons_4998785648	Surgery	2022-04-24 11:49:16
Acc_1520918317	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:13:32
Acc_1830022510	Kane	Apollo Hospital	Cons_4998785648	Surgery	2022-04-24 12:23:14
Acc_1943877697	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:52:15
Acc_2146317557	Kane	Apollo Hospital	Cons_4998785648	Surgery	2022-04-24 11:57:02
Acc_2615552949	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:16:21
Acc_3031433897	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 10:58:04
Acc_3458559780	Kane	Apollo Hospital	Cons_4998785648	Surgery	2022-04-24 11:48:35
Acc_3505112924	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:21:25
Acc_3921273924	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:07:34
Acc_3935382467	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:07:37
Acc_4634342720	CM Punk	Apollo Hospital	Cons_7789669078	Heart Disease	2022-04-26 11:10:28
Acc_5236180762	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:06:49
Acc_5400863300	Kane	Apollo Hospital	Cons_4998785648	Surgery	2022-04-24 11:56:03
Acc_6324853299	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:12:14
Acc_6857010476	CM Punk	Apollo Hospital	Cons_6647022190	Surgery	2022-04-24 11:14:19

## ADD NOMINEE

The patient can add a nominee, who can make the important decisions on his/her behalf other than adding another nominee.

PATIENTAPP		<a href="#">Home</a> <a href="#">Consent Requests</a> <a href="#">View Ehr</a> <a href="#">View Consents</a> <a href="#">Ehr Access Logs</a> <a href="#">Add Nominee</a> <a href="#">Logout</a>							
ADD NOMINEE PAGE									
Name									
<input type="text" value="Nominee"/>									
Email									
<input type="text" value="nominee@gmail.com"/>									
Contact									
<input type="text" value="23424"/>									
<input type="button" value="Add"/>									

localhost:3000 says  
Nominee Added Successfully!! Your password for login is : 3684793813

PATIENTAPP

[Home](#) [Cons](#) [Nominee](#) [Logout](#)

## ADD NOMINEE PAGE

Name

Nominee

Email

nominee@gmail.com

Contact

23424

Add

## LOGIN NOMINEE

PATIENTAPP

[Home](#) [Patient Login](#) [Register](#) [Nominee Login](#)

## LOGIN NOMINEE PAGE

Email

nominee@gmail.com

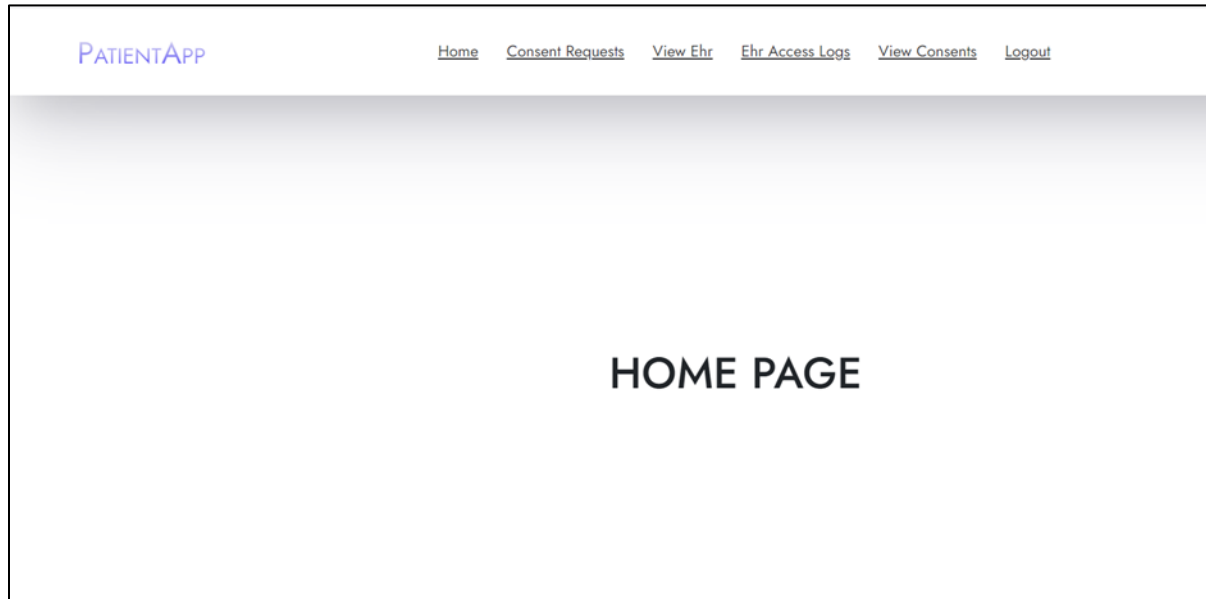
Password

.....

Login

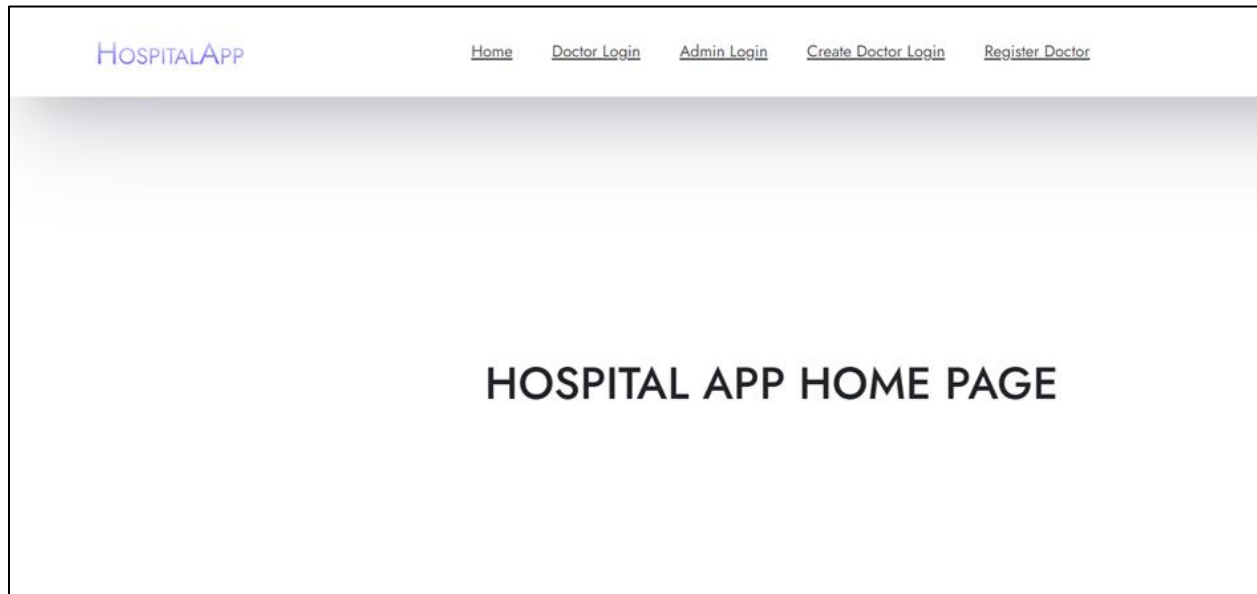
## HOME PAGE AFTER NOMINEE LOGIN

After logging in as a nominee, all the other functionality remains the same but the add nominee functionality is not available anymore since only the patient can add the nominee.



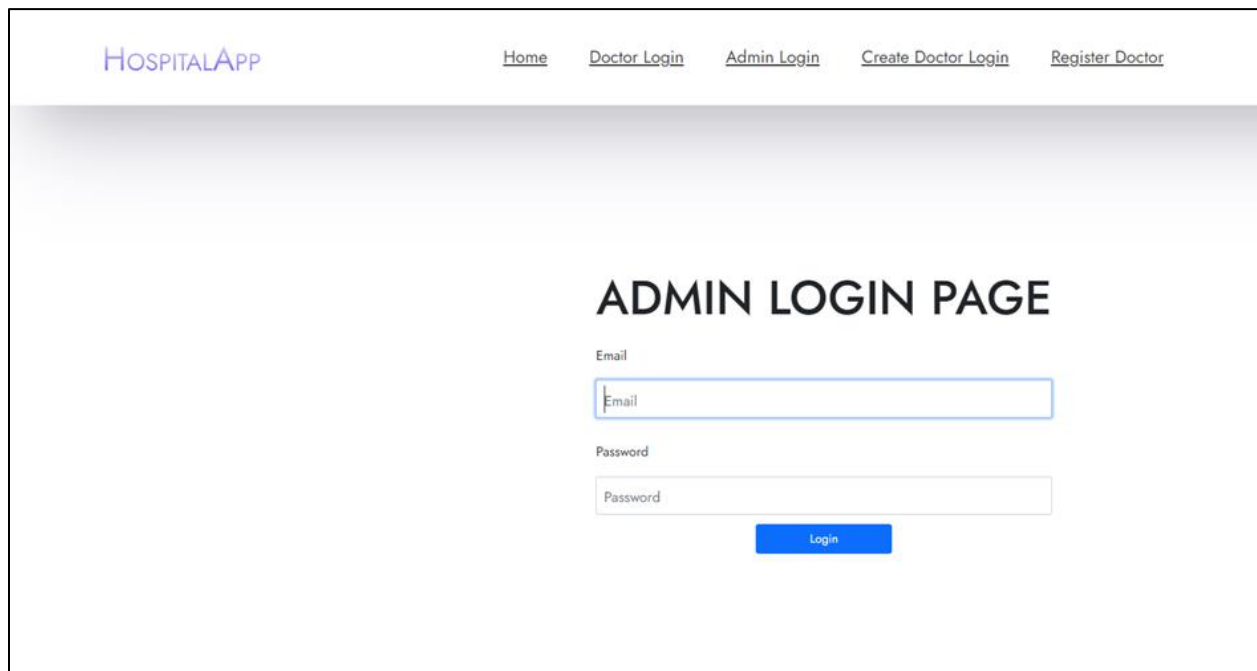
# HOSPITAL APP

## HOSPITAL HOME PAGE



The screenshot shows the home page of the Hospital App. At the top, there is a navigation bar with the logo "HOSPITALAPP" on the left and five links: "Home", "Doctor Login", "Admin Login", "Create Doctor Login", and "Register Doctor". The main content area has a light blue gradient header. Below this, the text "HOSPITAL APP HOME PAGE" is centered in a large, bold, black font.

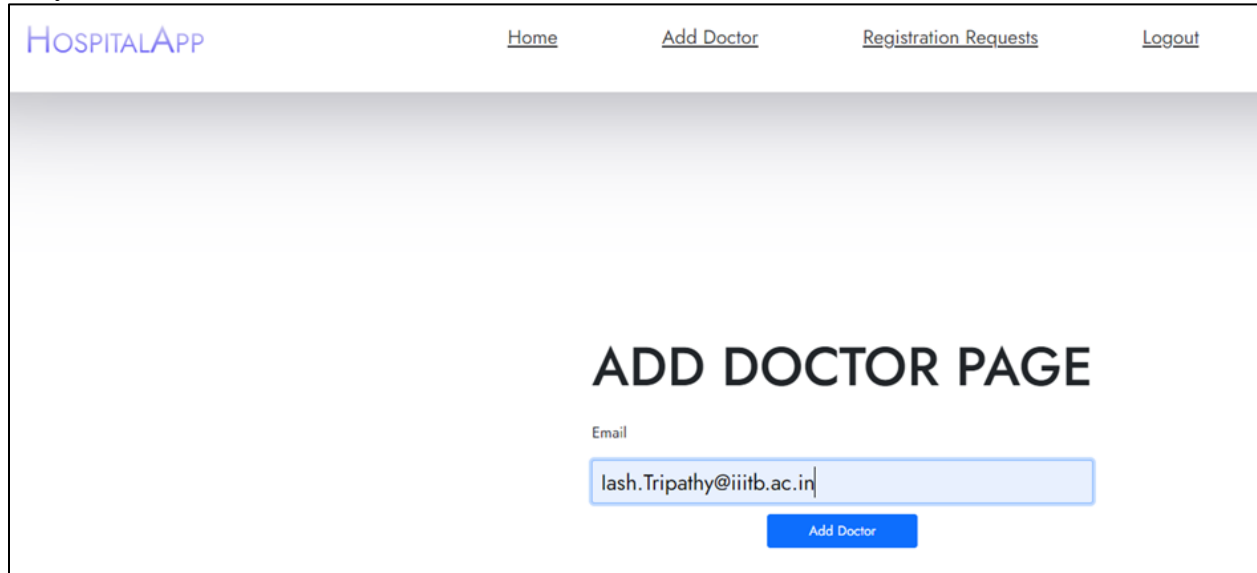
## ADMIN LOGIN PAGE



The screenshot shows the admin login page of the Hospital App. It features the same navigation bar as the home page. The main content area has a light blue gradient header. Below this, the text "ADMIN LOGIN PAGE" is centered in a large, bold, black font. Underneath, there are two input fields: "Email" and "Password". The "Email" field has a blue border and a small blue icon on the left. The "Password" field has a grey border. Below these fields is a blue "Login" button.

## ADD DOCTOR

Only admin can add a doctor.



HOSPITALAPP

[Home](#) [Add Doctor](#) [Registration Requests](#) [Logout](#)

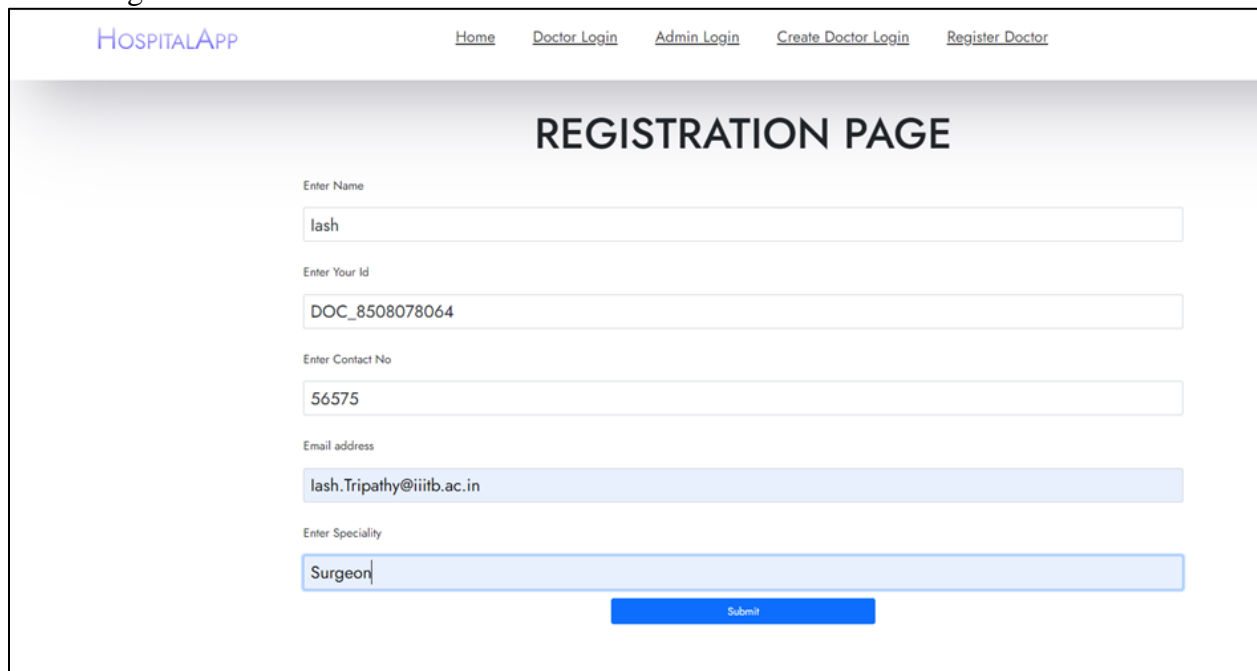
## ADD DOCTOR PAGE

Email

Add Doctor

## DOCTOR REGISTRATION

Doctor registers himself.



HOSPITALAPP

[Home](#) [Doctor Login](#) [Admin Login](#) [Create Doctor Login](#) [Register Doctor](#)

## REGISTRATION PAGE

Enter Name

Enter Your Id

Enter Contact No

Email address

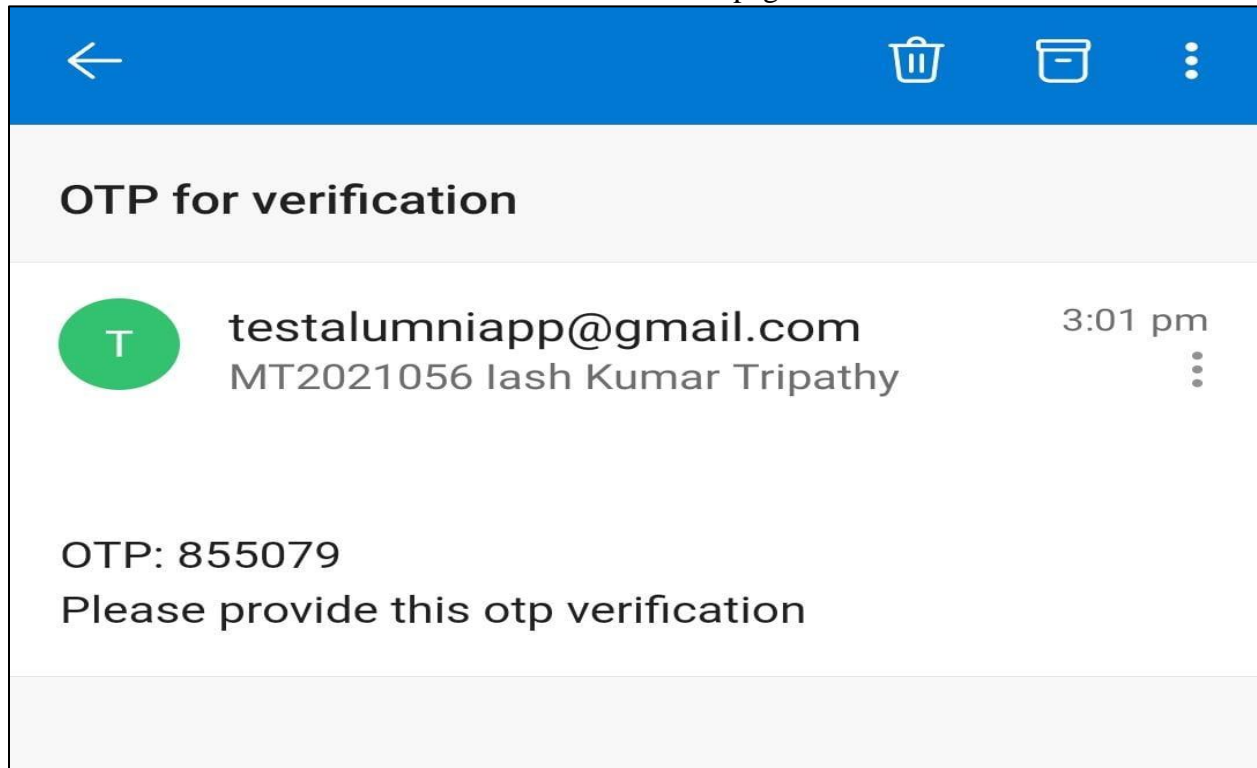
Enter Speciality

Submit

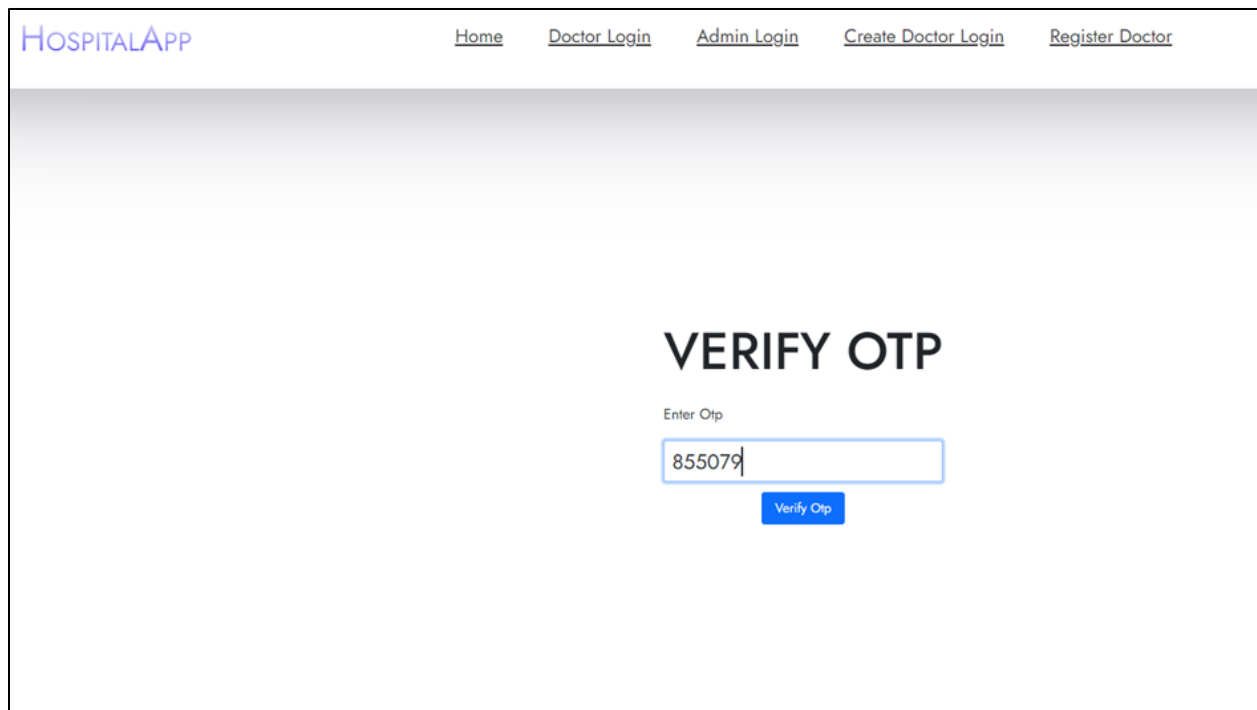


## OTP VERIFICATION

In the registration page after clicking the submit button an OTP Will be sent to the doctor's email id and the Doctor will be redirected to OTP verification page.



## VERIFY OTP



## CREATE DOCTOR LOGIN

The doctor creates his login credentials before logging in which is specific to the hospital.

HOSPITALAPP

[Home](#) [Doctor Login](#) [Admin Login](#) [Create Doctor Login](#) [Register Doctor](#)

### CREATE DOCTOR LOGIN

Enter Doctor Id

DOC\_8508078064

Email

lash.Tripathy@iiitb.ac.in

Password

.....

Submit

## CREATE LOGIN REQUESTS

The Admin can either accept or reject the received create login requests from the doctors.

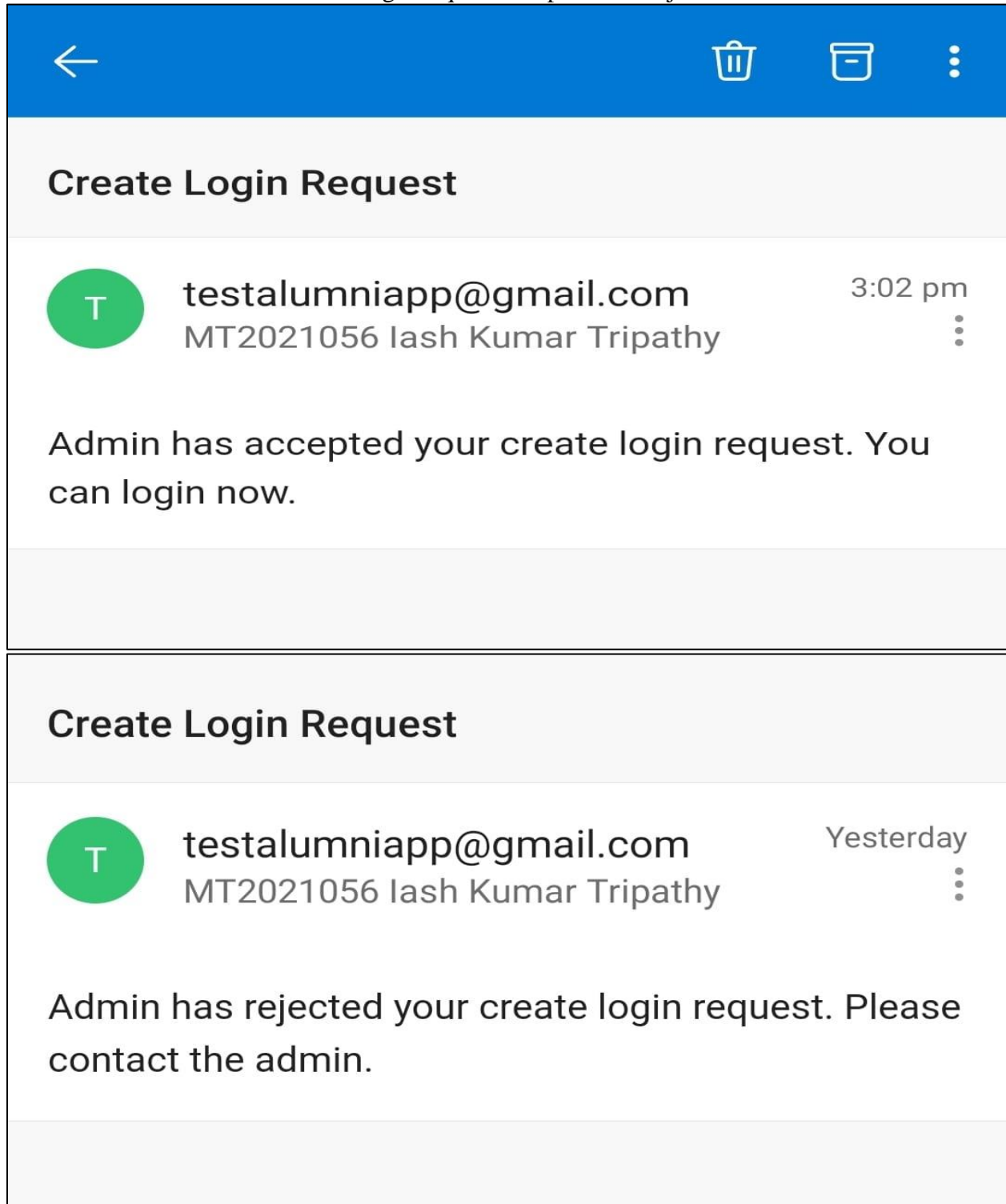
HOSPITALAPP

[Home](#) [Add Doctor](#) [Registration Requests](#) [Logout](#)

### CREATE LOGIN REQUESTS

Doctor ID	Doctor Email	Doctor Name		
DOC_8508078064	lash.Tripathy@iiitb.ac.in	lash	Accept	Reject

The doctor either receives a create login request acceptance or rejection mail.



## DOCTOR LOGS IN

The screenshot shows the 'DOCTOR LOGIN PAGE' of the 'HOSPITALAPP'. The header includes the app name and navigation links: Home, Doctor Login, Admin Login, Create Doctor Login, and Register Doctor. The main content area features a large heading 'DOCTOR LOGIN PAGE' and a login form with fields for 'Email' and 'Password', and a 'Login' button.

HOSPITALAPP

[Home](#) [Doctor Login](#) [Admin Login](#) [Create Doctor Login](#) [Register Doctor](#)

## DOCTOR LOGIN PAGE

Email

Password

Login

## REQUEST CONSENT

After logging in the doctor can request consent from the patient.

The screenshot shows the 'REQUEST CONSENT' page of the 'HOSPITALAPP'. The header includes the app name and navigation links: Home, Granted Consents, Request Consent, Add Record, and Logout. The main content area features a large heading 'REQUEST CONSENT' and a form with fields for 'Enter Patient Id', 'Enter Request Info', and 'Select Access Purpose', and a 'Submit' button.

HOSPITALAPP

[Home](#) [Granted Consents](#) [Request Consent](#) [Add Record](#) [Logout](#)

## REQUEST CONSENT

Enter Patient Id

Enter Request Info

Select Access Purpose

Submit

## GRANTED CONSENT

The doctor can view all the consents granted to him/her. The delegate consent button will appear only if the patient has given access to the doctor to delegate the consent.

HOSPITALAPP						
<a href="#">Home</a> <a href="#">Granted Consents</a> <a href="#">Request Consent</a> <a href="#">Add Record</a> <a href="#">Logout</a>						
Patient ID	Patient Name	Consent Id	Delegate Access	Validity	View Consent	Delegate Consent
PAT_3305630037	Triple H	Cons_6647022190	Yes	2022-07-23 10:34:21	<a href="#">View Record</a>	<a href="#">Delegate</a>
PAT_3305630037	Triple H	Cons_7789669078	Yes	2022-07-25 11:07:49	<a href="#">View Record</a>	<a href="#">Delegate</a>

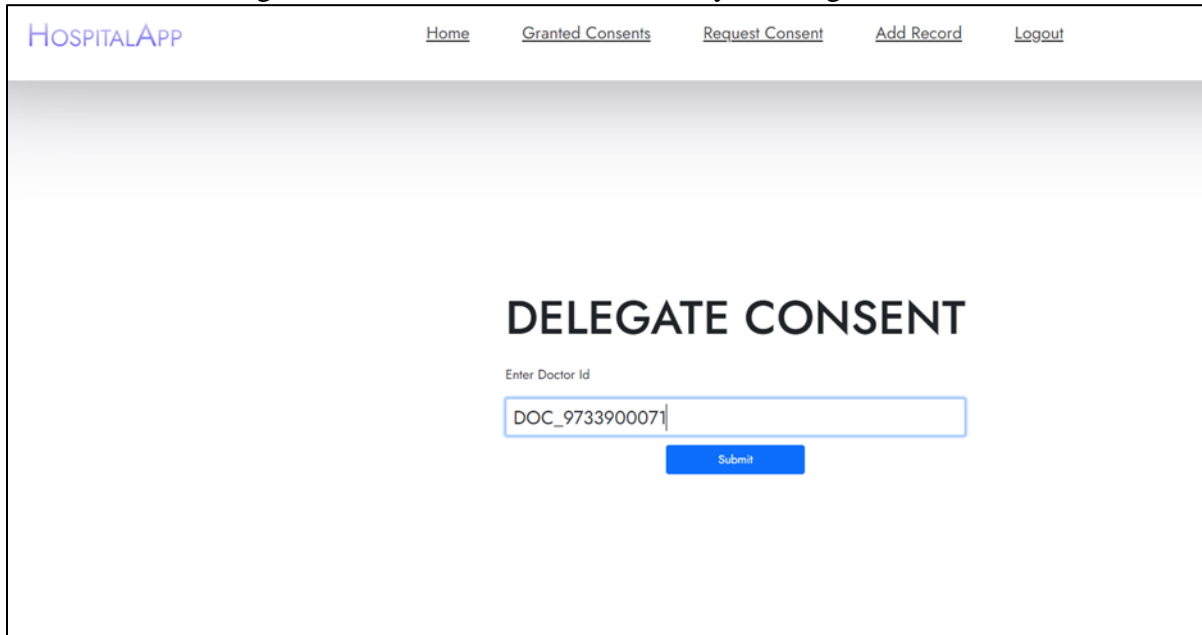
## VIEW CONSENT

The doctor can view the EHRs of the granted consents.

← → ↺ localhost:3001/view-ehr/PAT_3305630037/Cons_7789669078						
<a href="#">Gmail</a> <a href="#">YouTube</a> <a href="#">Maps</a>						
HOSPITALAPP						
<a href="#">Home</a> <a href="#">Granted Consents</a> <a href="#">Request Consent</a> <a href="#">Add Record</a> <a href="#">Logout</a>						
Episodes:						
Episode Id : EPI_54544						
Episode Name : General						
Encounters :						
Doctor Name : CM Punk						
Encounter Id : ENC_54213						
OpRecords:						
Diagnosis : Diarrhea						
Op Record Id : OP_89789						
Details : { "complaints":"stomach ache,vomiting", "prescription":"tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date":"01/04/2022", }						
Timestamp : 24-04-2022 09:57:36						
Encounters :						
Episodes:						
Episode Id : EPI_657657						
Episode Name : General						
Encounters :						
Doctor Name : Kane						
Encounter Id : ENC_4545						
OpRecords:						
Diagnosis : Diarrhea						
Op Record Id : OP_76868						
Details : { "complaints":"stomach ache,vomiting", "prescription":"tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date":"01/04/2022", }						
Timestamp : 24-04-2022 10:28:29						

## DELEGATE CONSENT

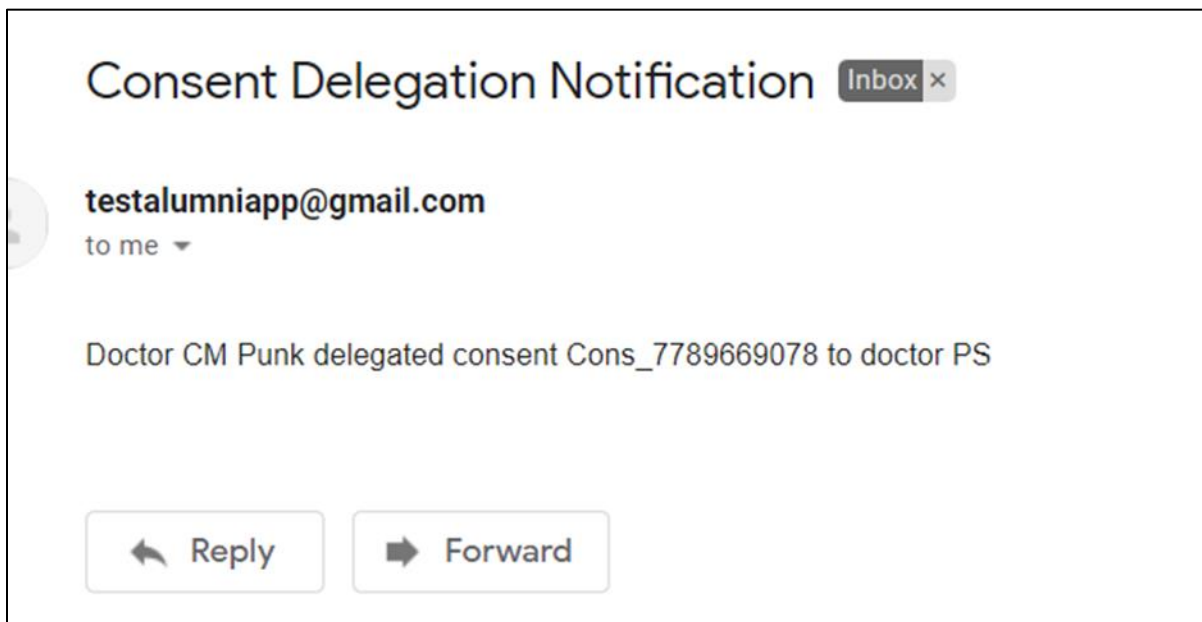
The doctor can delegate the consent to another doctor by entering his doctor id.



The screenshot shows a web application interface for 'HOSPITALAPP'. The top navigation bar includes links for 'Home', 'Granted Consents', 'Request Consent', 'Add Record', and 'Logout'. The main content area is titled 'DELEGATE CONSENT' and features a form to 'Enter Doctor Id'. The input field contains the text 'DOC\_9733900071', and a blue 'Submit' button is positioned below it.

## CONSENT DELEGATION NOTIFICATION

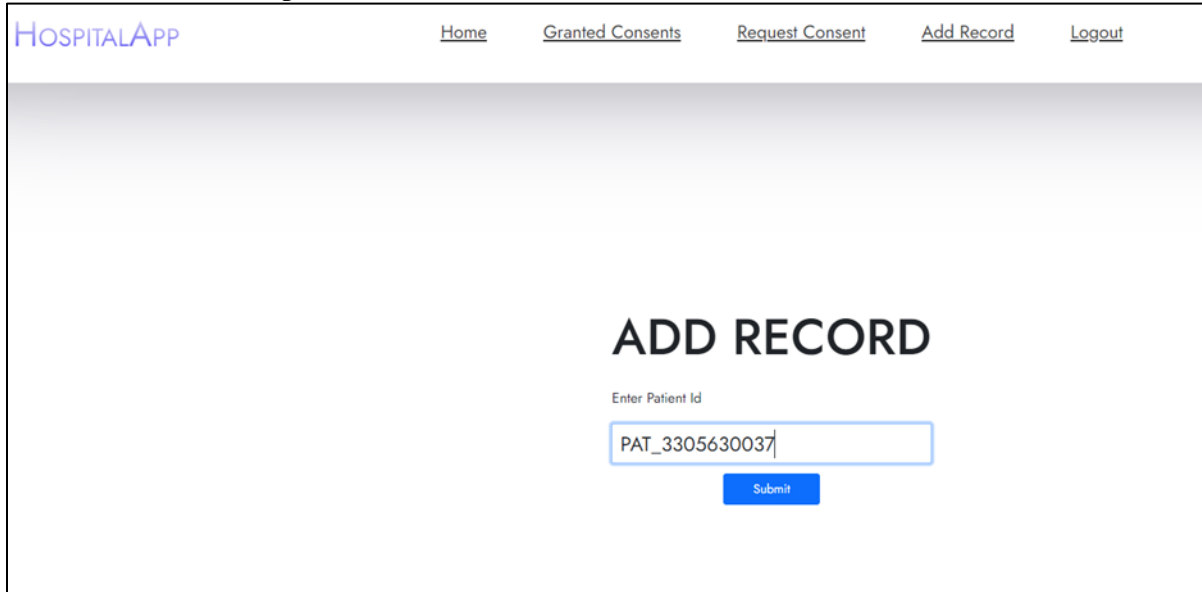
The patient will receive a notification (email) after the consent delegation.



The screenshot displays an email notification titled 'Consent Delegation Notification' with an 'Inbox' label and a close icon. The email is from 'testalumniapp@gmail.com' and is addressed 'to me'. The body of the email states: 'Doctor CM Punk delegated consent Cons\_7789669078 to doctor PS'. At the bottom, there are two buttons: 'Reply' with a left-pointing arrow and 'Forward' with a right-pointing arrow.

## ADD RECORD

The doctor enters the patient id for whom he/she wants to add a new record.



HOSPITALAPP

[Home](#) [Granted Consents](#) [Request Consent](#) [Add Record](#) [Logout](#)

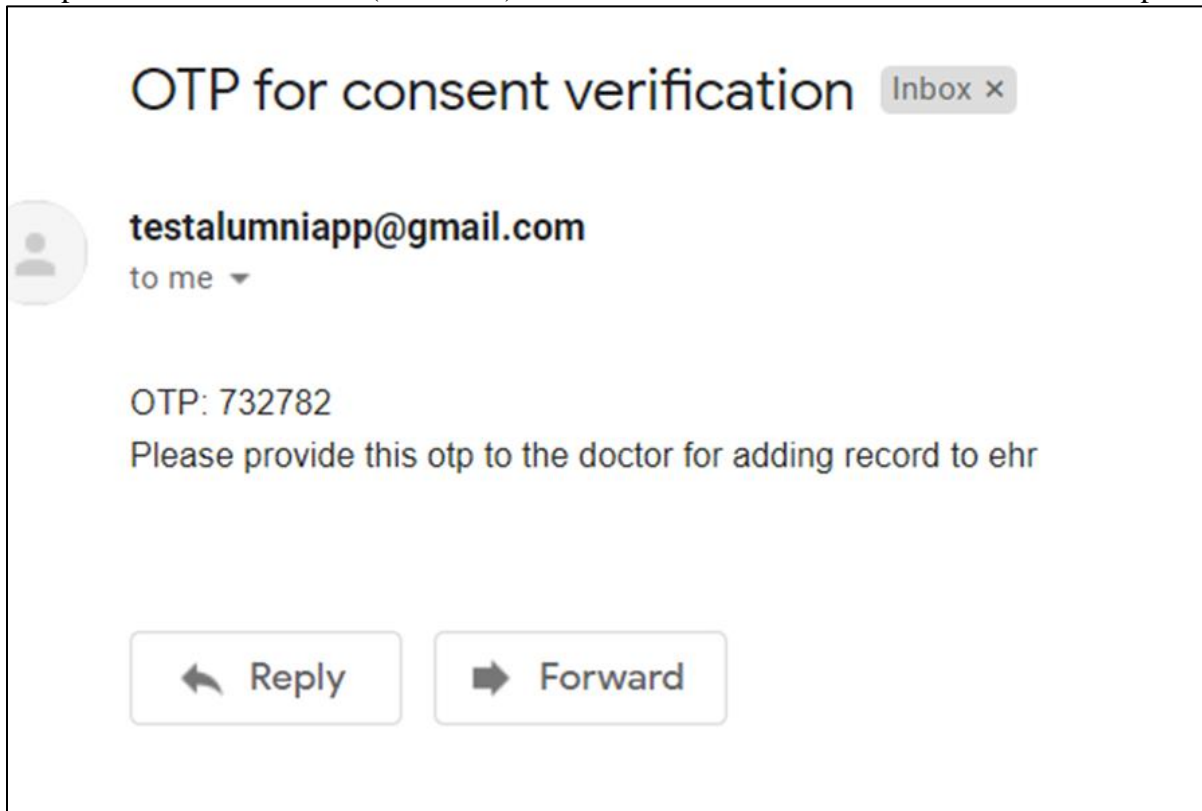
## ADD RECORD

Enter Patient Id

Submit


## RECORD ADDING NOTIFICATION

The patient receives an OTP( via email) that a doctor wants to add new record to his/her profile.





## OTP for consent verification

Inbox x

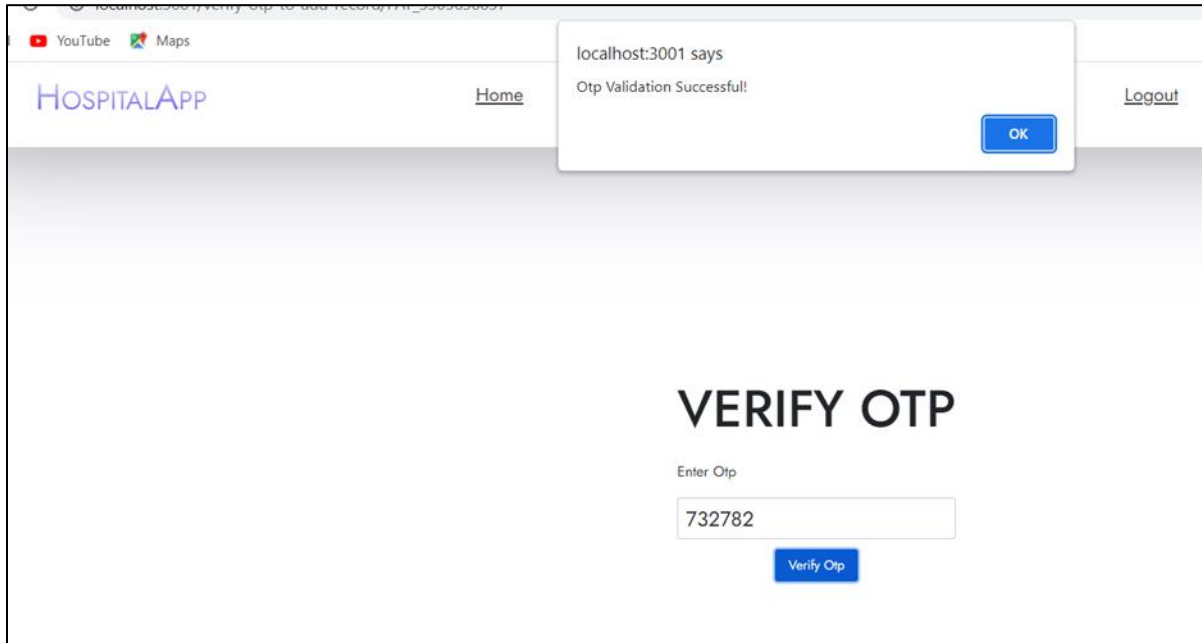
 **testalumniapp@gmail.com**  
to me ▾

OTP: 732782  
Please provide this otp to the doctor for adding record to ehr

 Reply  Forward

## OTP VERIFICATION FOR ADD RECORD

The patient shares the OTP with the doctor and the doctor verifies the OTP.



The screenshot displays a web browser window with the address bar showing 'localhost:3001/verify-otp-to-add-record?pin=732782'. The browser's top bar includes links for YouTube and Maps. The page header for 'HOSPITALAPP' features a 'Home' link on the left and a 'Logout' link on the right. A white notification box in the upper right corner contains the text 'localhost:3001 says' and 'Otp Validation Successful!' with an 'OK' button. The main content area is titled 'VERIFY OTP' and includes a label 'Enter Otp' above a text input field containing the number '732782'. Below the input field is a blue 'Verify Otp' button.



## ADD RECORD

The doctor can now add the record after OTP verification.

# ADD RECORD PAGE

Episode ID

HYP

Episode Name

Hypertension

Diagnosis

High BP

Complaint

headache

Treatment

medicines

Prescription

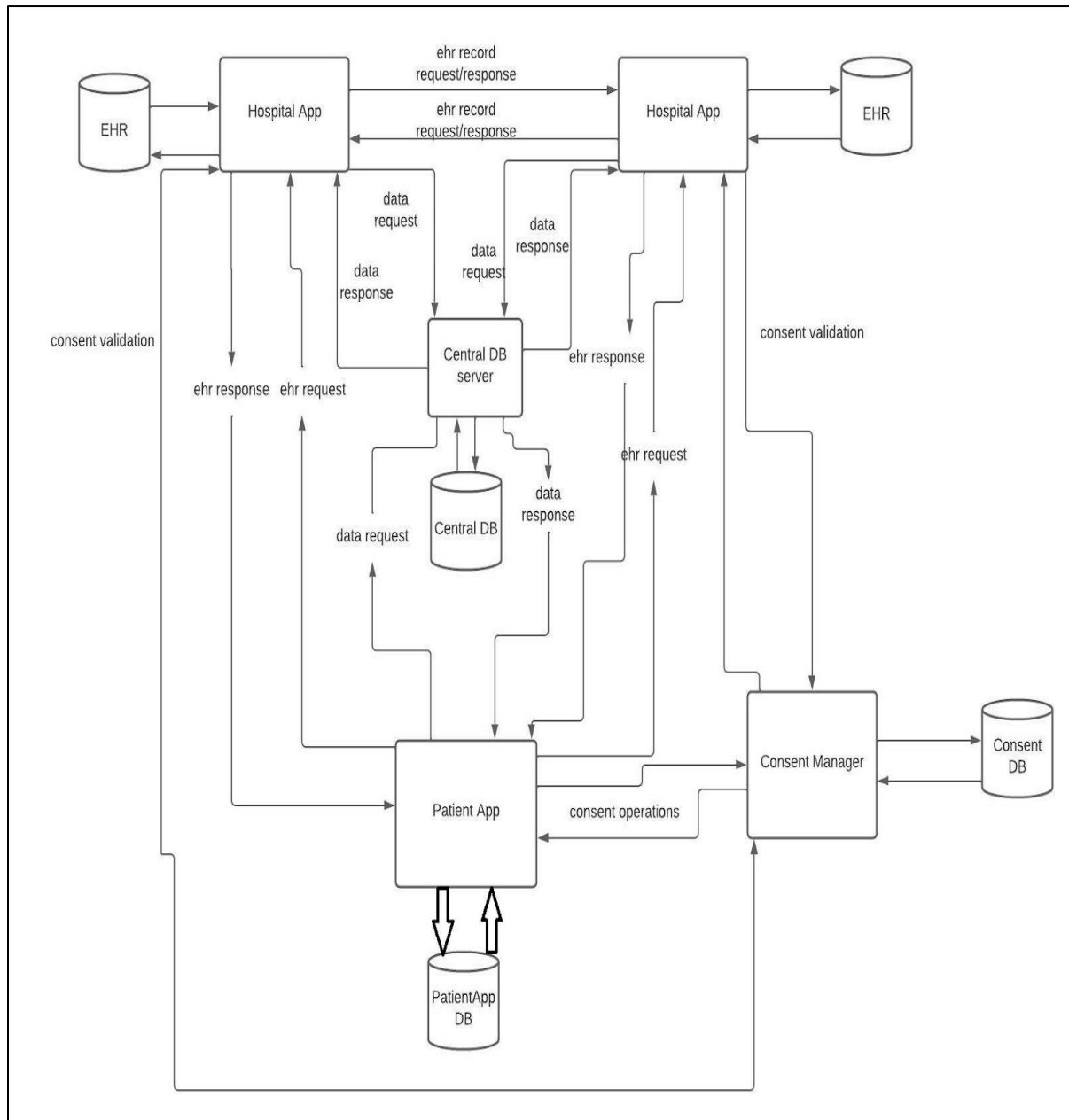
tablet BP 2 per day, tablet AB 3 per

Follow up plan

Next visit 28/04/2022

Add record

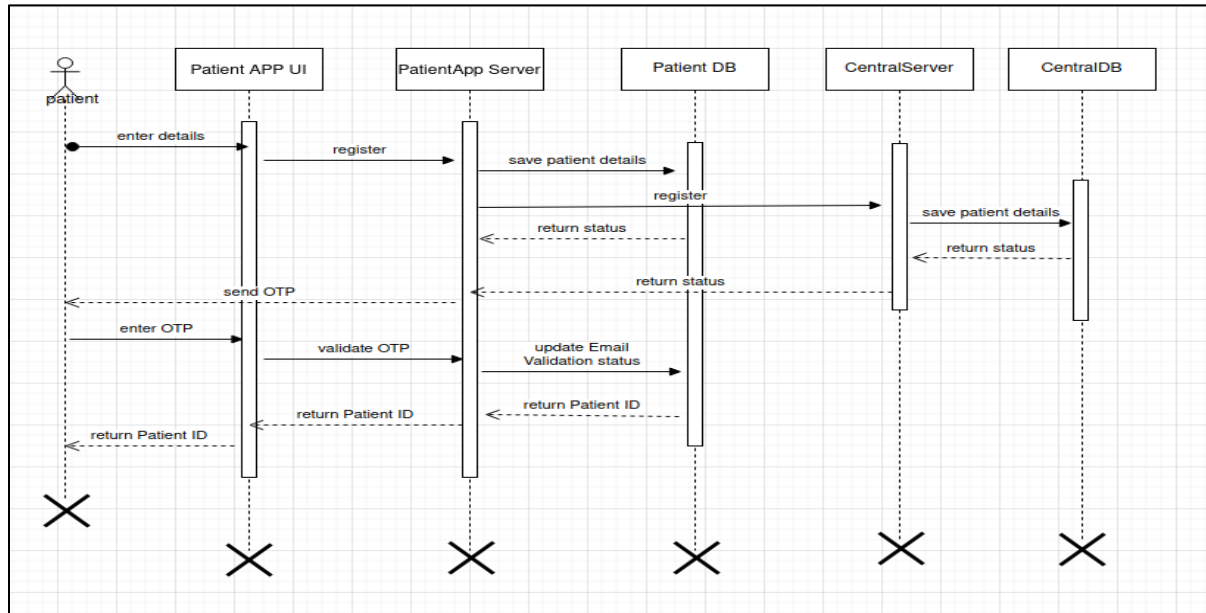
## Architecture and key modules



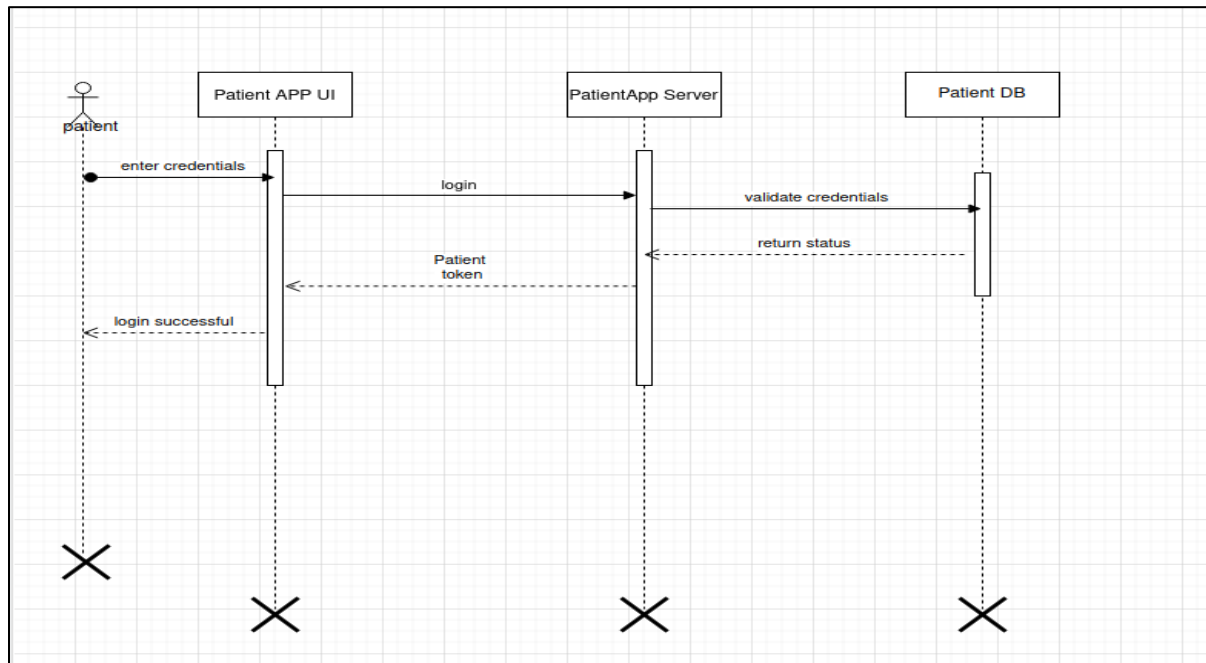
## Sequence diagrams for representative flows

### PATIENT APP

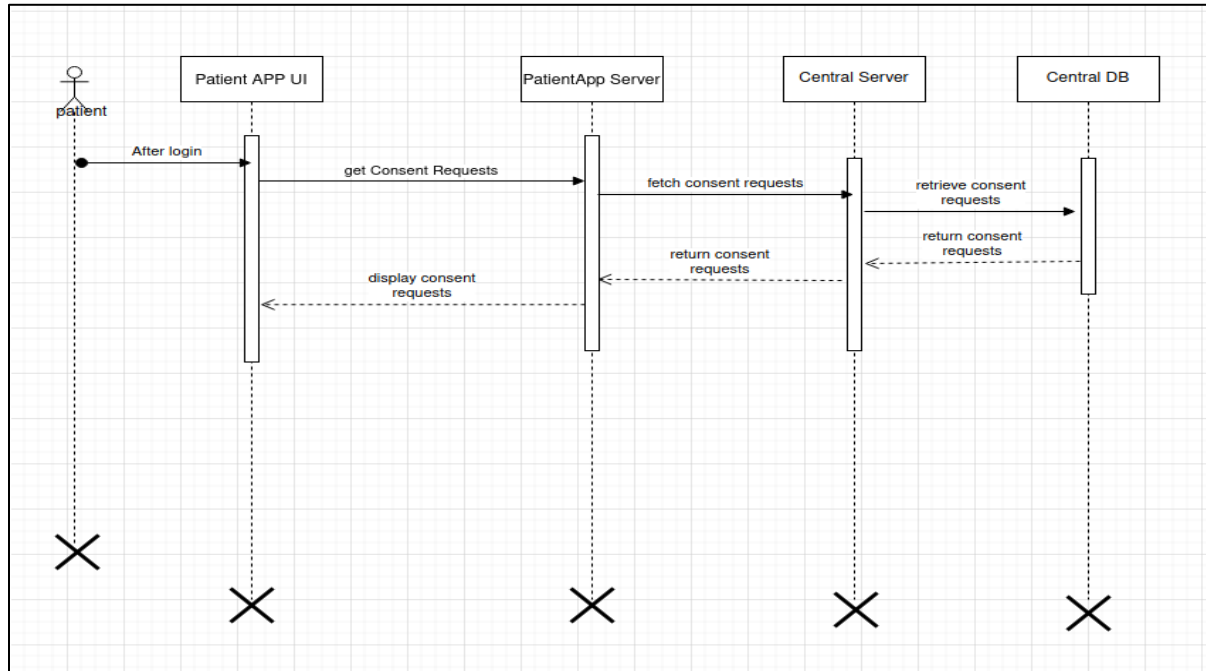
#### REGISTER



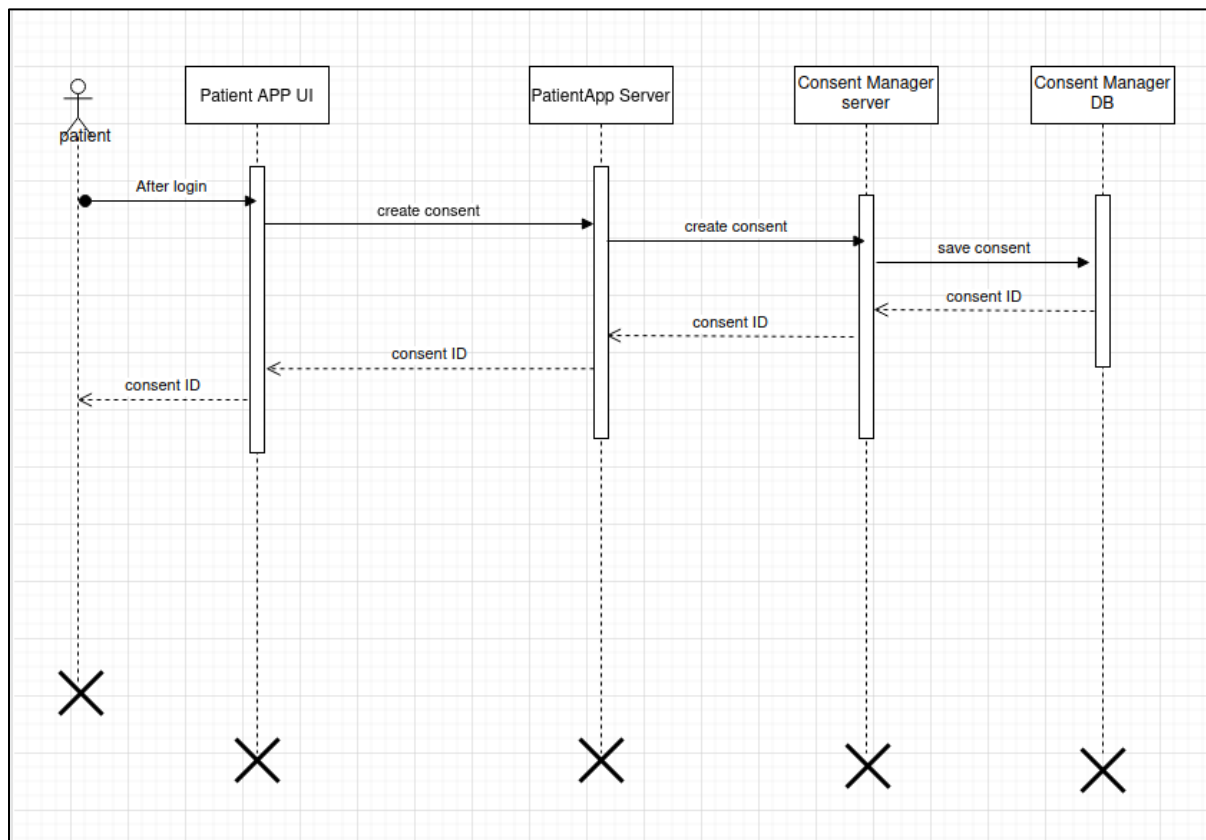
#### LOGIN



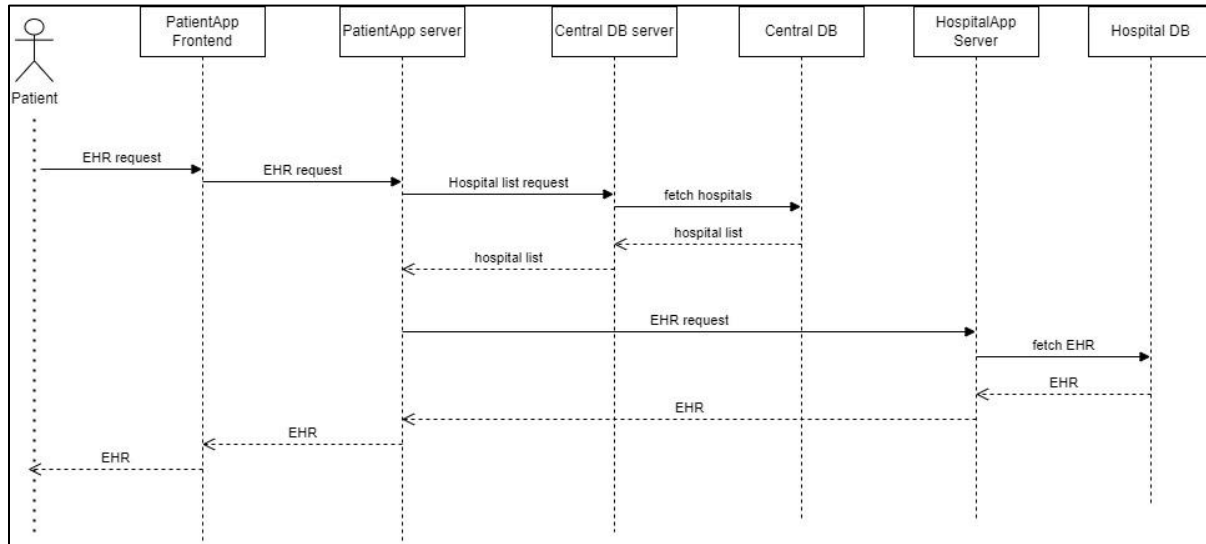
## CONSENT REQUESTS



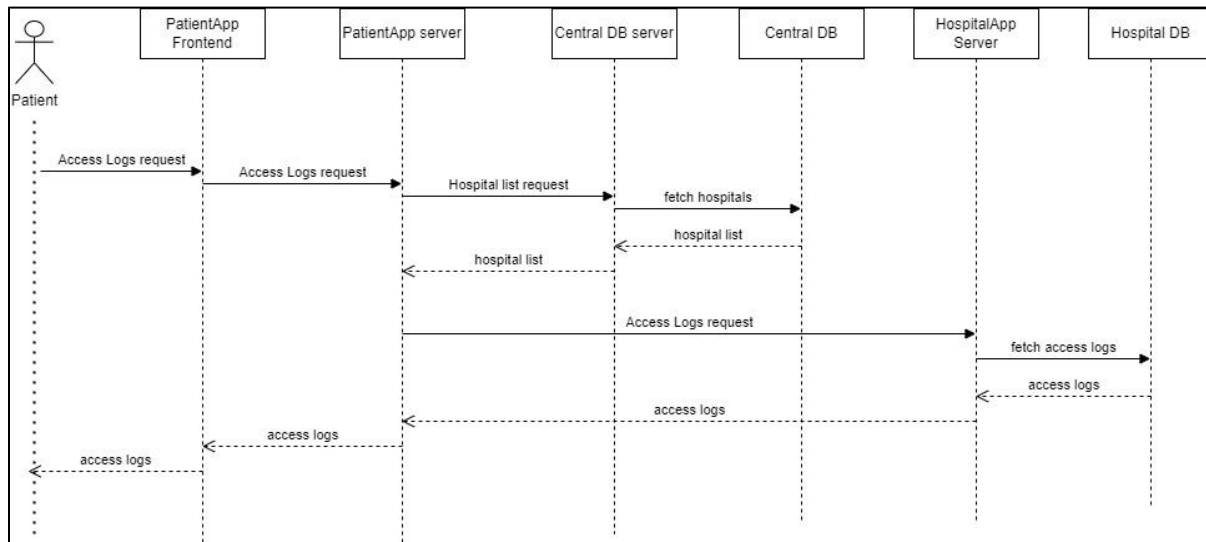
## CREATE CONSENTS



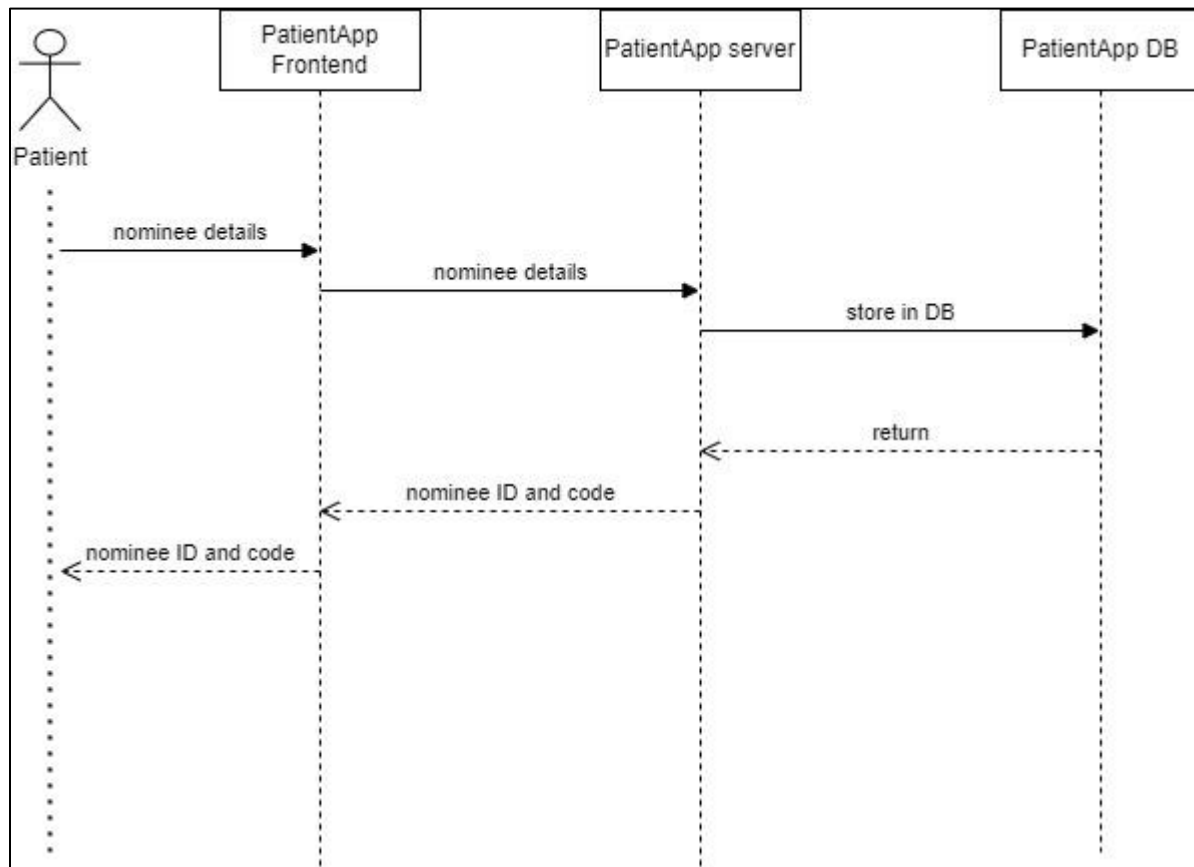
## GET PATIENTS EHRs



## ACCESS LOGS

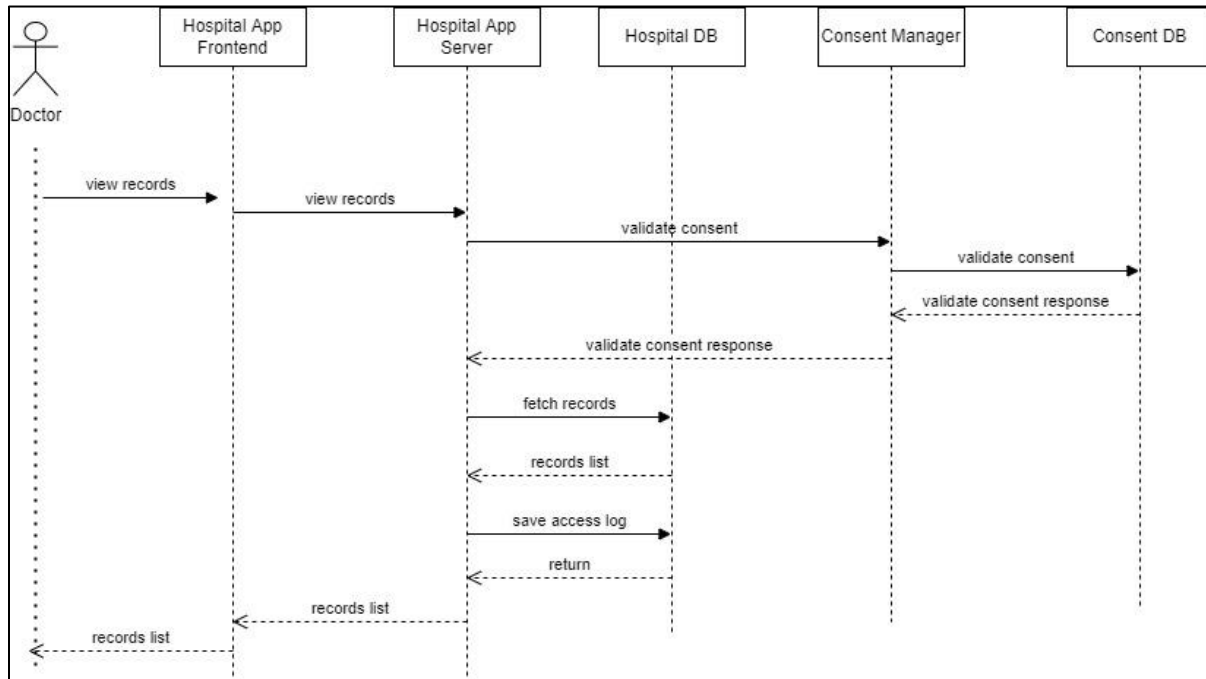


## ADD NOMINEE

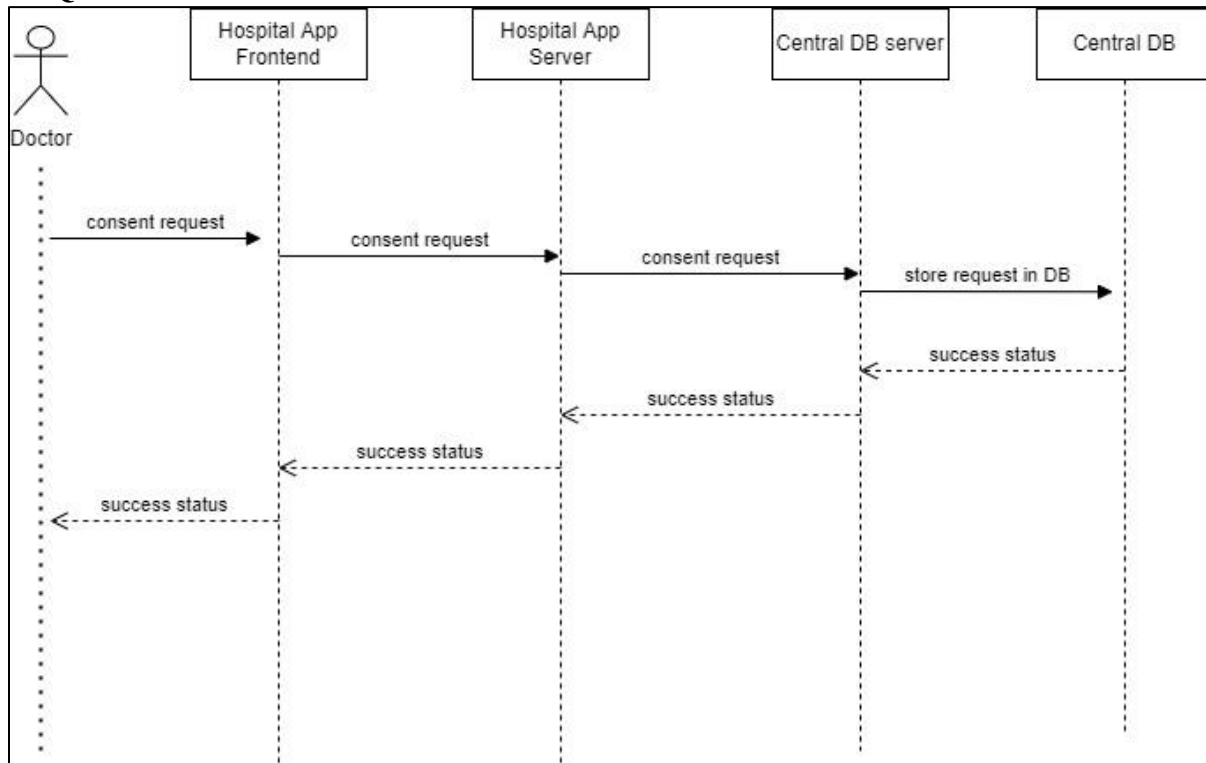


# HOSPITAL APP

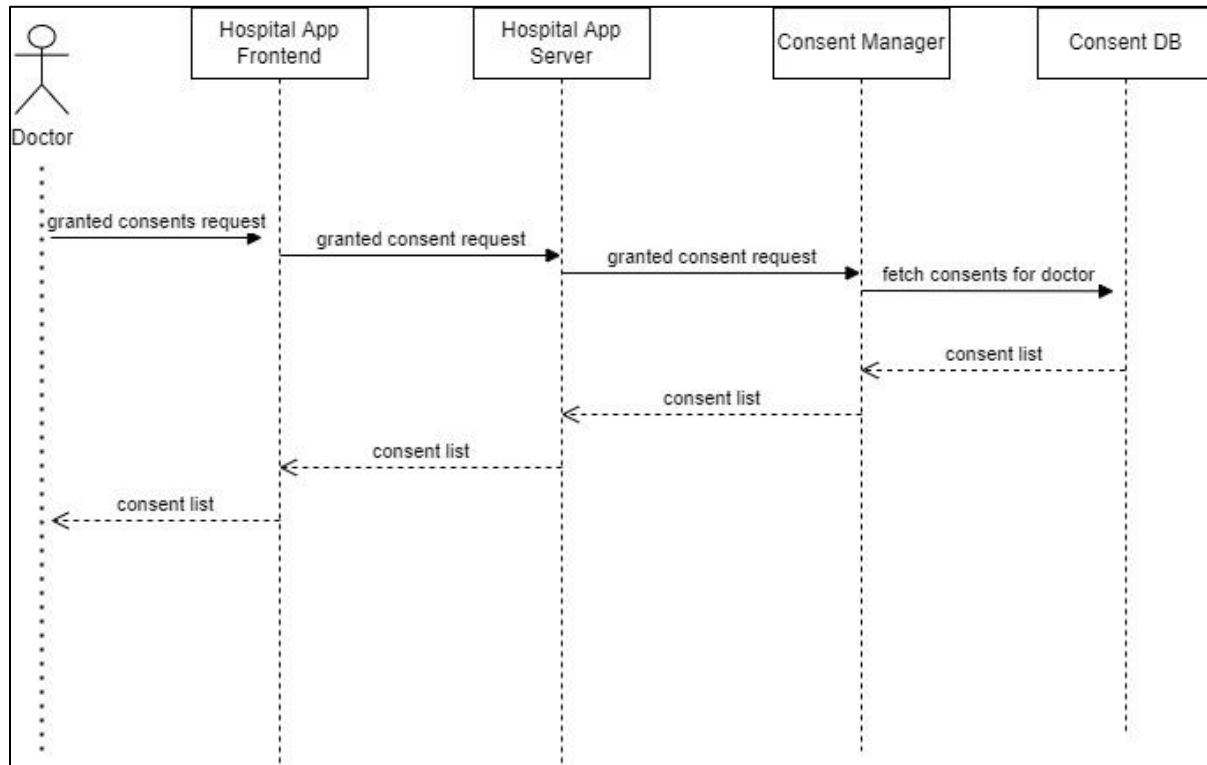
## VIEW RECORDS



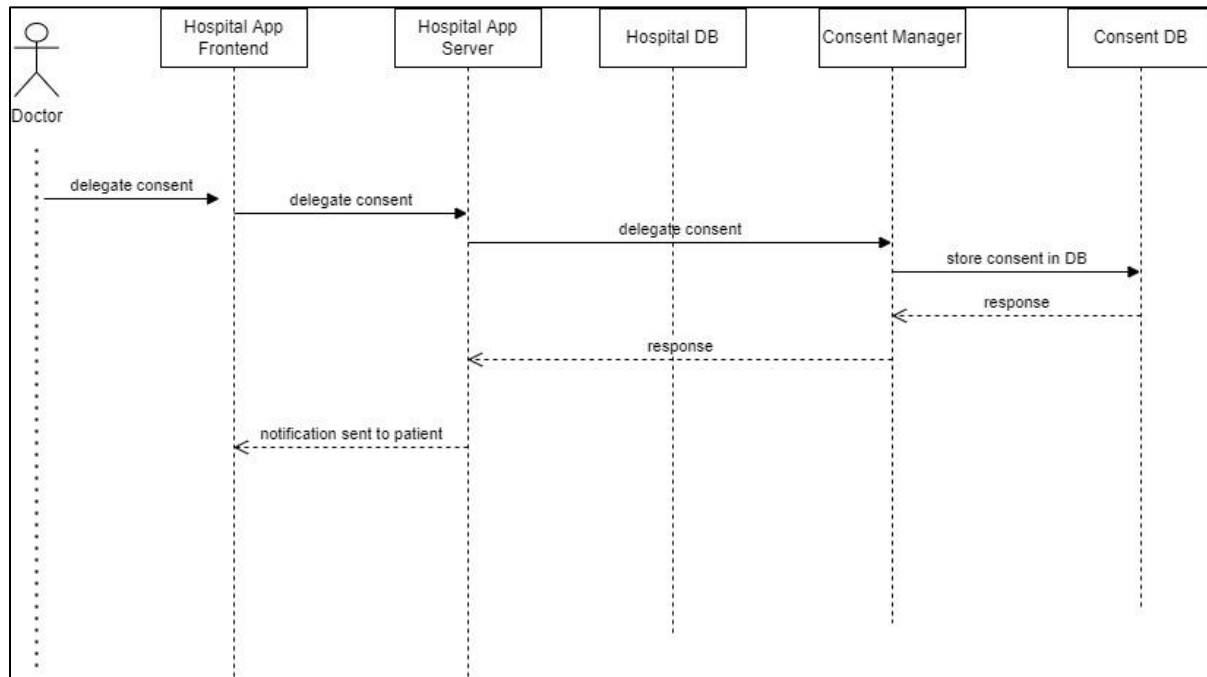
## REQUEST CONSENTS



## GRANTED CONSENTS

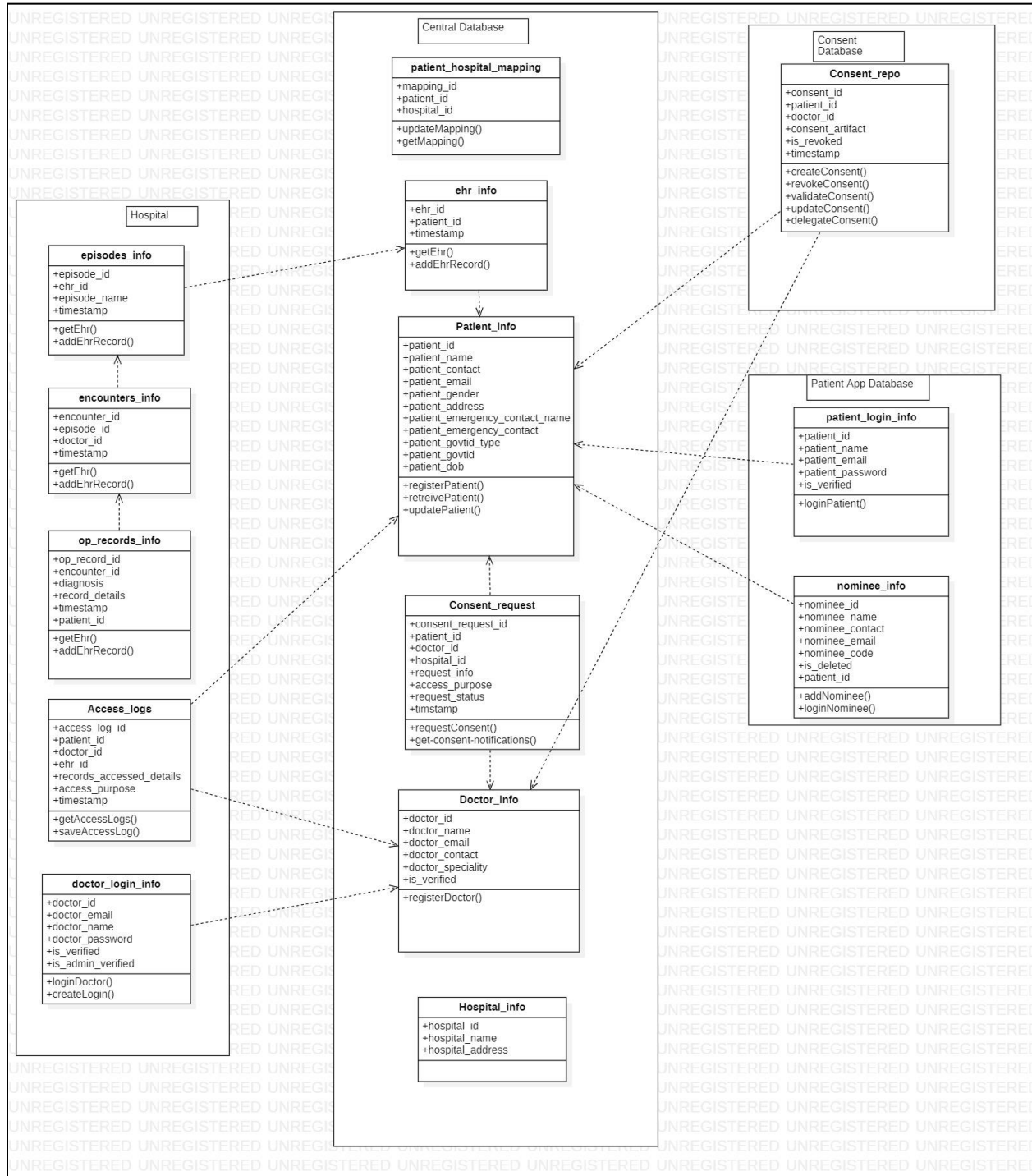


## DELEGATE CONSENT





## DB design



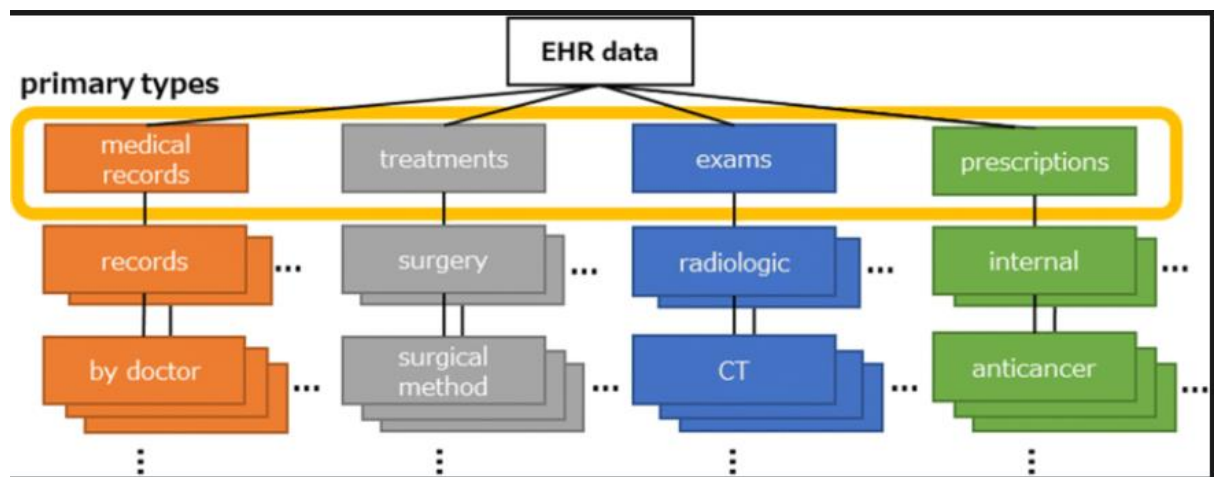
## Frameworks libraries used

### Tech Stack

Front End Framework	React JS
Backend Framework	Java with Spring Boot
Databases	MySQL

### Key technical challenges

1. Designing and displaying the EHR Tree



Source: The Improvement of the Electronic Health Record User Experience by Screen Design Principles - Scientific Figure on ResearchGate. Available from: [https://www.researchgate.net/figure/The-example-tree-structure-of-EHR-data-types-and-primary-types\\_fig1\\_337879439](https://www.researchgate.net/figure/The-example-tree-structure-of-EHR-data-types-and-primary-types_fig1_337879439) [accessed 27 Apr, 2022]

An EHR Tree provides a division of how the EHR data is represented. For our project we have merged the location (hospital where the record originated) and the data present in the EHR i.e.,

Hospital

Episode 1

Record 1

Episode 2

Record 2

Designing the EHR tree structure and displaying it posed a challenge for us. Initial designs include - Cascading List i.e, Hospital > Episodes > Records in the form of drop downs. This proved to be hurtful for the UI .

After many iterations we decided on creating an according design for the EHR with a multi select operation as shown below.

The screenshot shows the PATIENTAPP interface. At the top, there is a navigation bar with links: Home, Consent Requests, View Ehr, View Consents, Ehr Access Logs, Add Nominee, and Logout. The main content area displays details for an encounter. It includes a checkbox for 'Encounters' which is checked. Below this, it shows 'Doctor Name : Kane', 'Encounter Id : ENC\_4545', and 'OpRecords:'. The 'OpRecords' section contains 'Diagnosis : Diarrhea', 'Op Record Id : OP\_76868', and 'Details : { "complaints": "stomach ache,vomiting", "prescription": "tabletA 2 per day, tabletB 3 per day. Take for 3 days. "Next visit date": "01/04/2022", }'. The timestamp is '24-04-2022 10:28:03'. Below the details, there is a 'Yes' button, a text input field containing 'Heart Disease', and a text input field containing 'signature'. At the bottom right, there is a blue button labeled 'Create consent'.

## 2. Implementing and Storing Consent according to MeitY Specifications

We followed a report issued by MeitY on creating and storing Consent Artifact. Our main technical hurdle was storing the artifact. Initially we chose to store across columns field wise. But for our final implementation the consent is stored as a JSON string.

Below is a sample consent artifact stored in the consent repository

```

{
  "patientId": "PAT_3305630037",
  "beneficiaryId": "DOC_9858151117",
  "ehrDetails": {
    "ehrId": "EHR_78768",
    "dataCustodians": [
      {
        "dataCustodianId": "HOSP_123",
        "episodes": [
          {
            "episodeId": "EPI_54544",
            "time_limit_records": "",
            "encounterDetails": [
              {
                "encounterId": "ENC_54213"
              },
              {
                "encounterId": "ENC_65756"
              }
            ]
          }
        ],
        {
          "episodeId": "EPI_5898888072",
          "time_limit_records": "",
          "encounterDetails": [
            {
              "encounterId": "ENC_5778603789"
            }
          ]
        }
      ]
    }
  },
  "purpose": "Surgery",
  "delegateAccess": "Yes",
  "creationDate": "2022-04-28 10:46:48",
  "validityDate": "2022-07-27 10:46:48",
  "signature": "signature",
  "systemId": "consent_manager"
}

```

## **Open/incomplete issues**

1. Nurse registration
  - a. Other roles which help to demonstrate administrative hierarchy have not been included such as nurse, resident doctor etc. these have been avoided because of the increased complexity it would present when granting consent and sharing EHRs.
2. Update consent - time, records
  - a. We have not implemented update consent due to its increased level of complexity.
3. Change password/forgot password
4. View patient profile, Update patient profile.
5. During consent creation, instead of selecting records one by one under an episode, the patient can give a time period. All the records that fall in this time period will be part of the consent.
6. View nominees
7. Consent logs : the patient or the nominee can view the list of consent granted by him/her to every doctor.

## **Key learnings**

### Non - Technical Learnings

- From classroom lectures we have learnt about various initiatives of IIIT-Bangalore EHRC in helping digitize Healthcare. The regulatory perspective of designing healthcare applications and the massive amount of user experience issues that come along with it. In our project we could experience the same difficulties while implementing the EHR Tree structure.
- The considerable gap between techies and doctors and their process (eg. Handwritten prescriptions are easier for doctors instead of typing or selecting from various dropdowns)
- Role of Consent in Healthcare and how complex it is to abstract data according to patient privacy choices.

### Technical Learnings

- Spring Boot and Micro services
- APIs
- React

### Experience

- Designing an application has taught us the brainstorming of ideas, team spirit and most of all the importance of a well formed design. Initially our struggles revolved around understanding the requirements of healthcare applications and the concept of 'Consent'.
- Through multiple brainstorming sessions we were able to come up with a foundational design that we would carry on throughout our project.

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1. The Improvement of the Electronic Health Record User Experience by Screen Design Principles - Scientific Figure on ResearchGate. Available from:  
[https://www.researchgate.net/figure/The-example-tree-structure-of-EHR-data-types-and-primary-types\\_fig1\\_337879439](https://www.researchgate.net/figure/The-example-tree-structure-of-EHR-data-types-and-primary-types_fig1_337879439) [accessed 27 Apr, 2022]
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4. Rantos, K., Drosatos, G., Demertzis, K., Ilioudis, C., Papanikolaou, A., Kritsas, A. (2019). ADvoCATE: A Consent Management Platform for Personal Data Processing in the IoT Using Blockchain Technology. In: Lanet, JL., Toma, C. (eds) Innovative Security Solutions for Information Technology and Communications. SECITC 2018. Lecture Notes in Computer Science(), vol 11359. Springer, Cham. [https://doi.org/10.1007/978-3-030-12942-2\\_23](https://doi.org/10.1007/978-3-030-12942-2_23)
5. <https://www.youtube.com/channel/UC29ju8bIPH5as8OGnQzwJyA>
6. <https://www.figma.com/>
7. MeitY Consent Framework