Hospital Management System

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1. Application Background

Hospitals can be tremendous organizations with many moving parts. On a daily basis the systems at large hospitals such as University Hospitals are expected to register thousands of new patients each day, assign varying staff to these patients, and contact insurance companies to verify payment for procedures. With the recent influx in patients and increased stress added to staff life by the coronavirus (COVID-19) pandemic, sorting these patients has become paramount even though faster patient turnover is more important than ever.

The large number of patients means that it is unrealistic to expect these accounts to be processed by hand and separately. Updating these charts separately causes many issues when data from different sources are conflicting. Sometimes even providers for a patient in different departments have conflicting information which makes diagnoses so much more difficult and possibly inaccurate. It would be much easier for hospital management if all of the information could be accessed and updated all in one place. To this purpose, we have created a database that allows for automated creation and sorting of both patients and staff within a hospital in order to relieve stress and increase efficiency throughout the organization. The system also tracks which staff have been assigned to a patient, along with that doctor's department in the hospital. This would allow faster patient turnover as less time would be spent on frivolous concerns such as ensuring everything was up to date and accurate.

Our software, Hospital Management Database System, will be used to make all patient care and hospital management personnel's lives so much easier by consolidating all of the necessary information. The hospital management system can be used for administrative duties such as billing insurance and contacting patients' emergency contacts when need be. Our system can also be used to figure out which departments have more patients and would need more funding and resources in the future. Doctors and nurses, on the other hand, can use this system to ensure better patient care and diagnoses. While our system is named Hospital Management Database System, it can actually be used in any setting with patient care such as hospitals, clinics, and dispensaries.

2. Data Description

Our database has six entities and five relations. Patients holds all the personal information for the various patients in the hospital, including attributes such as their date of birth, sex, and their diagnosis. When a patient is entered into the system, they also must be assigned a doctor and nurse from their respective tables. The patient may also select their emergency contact and insurance from those entities. Each emergency contact belongs to a patient. And nurses and doctors can have multiple patients, with every doctor belonging to a department. Doctors are assigned to different departments, each of which have a head doctor listed.

There are several constraints set on the entities in this database. The first is that each entity must have a primary key which is Unique and Not Null. All other attributes in entities also have the Not Null attribute assigned to them, regardless of data type. This is to ensure that no patient, staff, insurance plan, emergency contact, or department is missing information that could be critical to the patient. Each table also has Not Null foreign key constraints to other tables in order to preserve relationships within the diagram. The data populating these tables has been falsely generated using Python's Faker and Panda libraries in order to preserve privacy when displaying and confirming data, as opposed to using information regarding real medical patients.

3. E/R Diagram
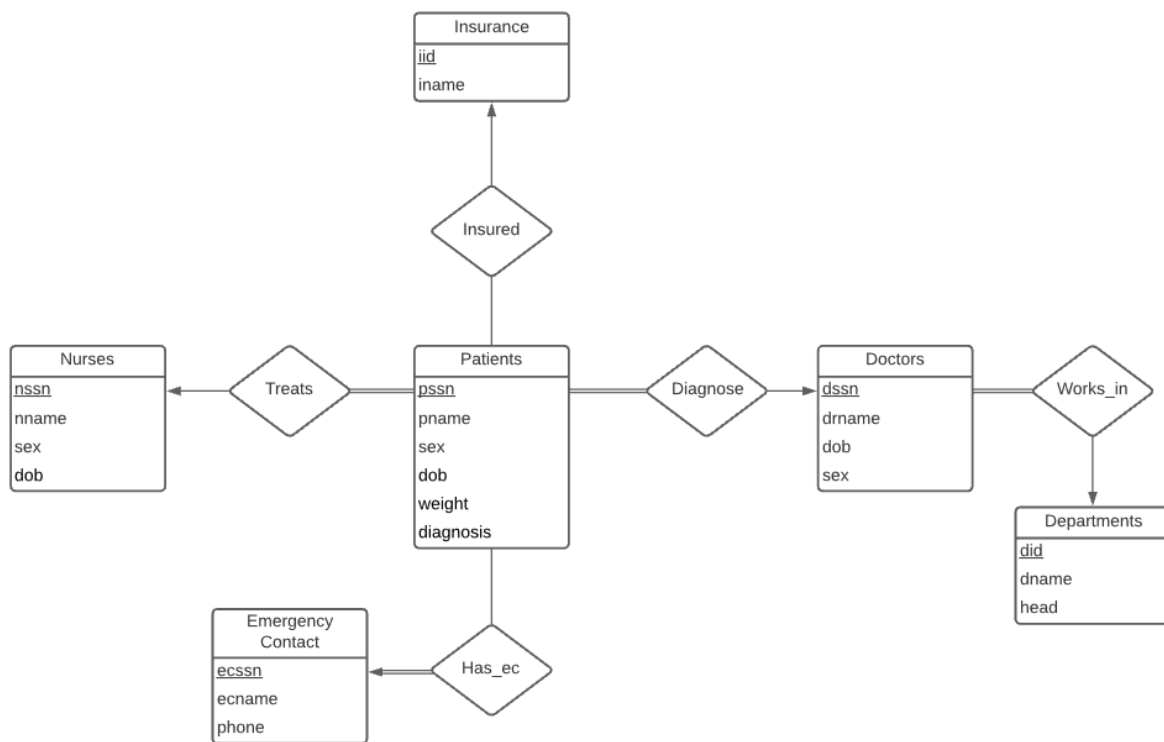
4. Functional Dependencies

Entities

Patients

The patients attributes are personal information about the patient including their diagnosis, they are independent of each other so the only functional dependency (FD) is the pssn implying all other attributes:

pssn→{pssn, pname, sex, dob, weight, diagnosis}

BCNF: The pssn is a superkey of Patients.

Nurses
Nurse's attributes are a list of personal information about the nurse, given independence the only FD here is the primary key nssn implying all other attributes:
nssn→{nssn, nname, sex, dob}
BCNF: The nssn is a superkey of Nurses.

Doctors
Doctor's attributes are a list of personal information about the doctor, the only FD here is the primary key dssn implying all the other attributes:
dssn→{dssn, drname, dob, sex}
BCNF: The dssn is a superkey of Doctors.

Emergency Contact
Emergency Contact has multiple attributes like their ssn, name, and phone number. Since a phone number is unique to each person, it could theoretically be used to identify the emergency contact. This is due to phone having the attribute ecssn which contains the rest of the emergency contact's information.
ecssn→{ecssn, ecname, phone}
phone→{ecssn}
      phone→{ecssn, ecname, phone}
BCNF: The ecssn is a superkey of Emergency_contact, and phone is superkey because it's attribute closure is {ecssn, ecname, phone} using the transitivity axiom.

Insurance
Insurance contains the insurance ID and the name of the insurance company, the only FD is the primary key iid implying the other attributes:
iid→{iid, iname}
BCNF: The superkey is iid and it is the only superkey.

Departments
Departments contains the department ID, the name of the department and the head of the department. The functional dependencies are as follows and because they are superkeys of Departments it implies BCNF:
did→{did, dname, head}
dname→{did}
      dname→{did, dname, head}
head→{did}

head→{did, dname, head}

BCNF: The did, dname, and head are superkeys of Departments. This is because every department has a unique did and a unique department name. Also a department can only have one unique department head.

Relationships

treats, insured, diagnose, has_ec

"diagnose" describes the relationship between the doctor and the patient, "treats" describes the relationship between the nurse and the patient, "insured" describes the relationship between the insurance company and the patient, and "has_ec" describes the relationship between the emergency contact and the patient.

pssn→{all attributes}

BCNF: The pssn is a superkey for treats, insured, diagnose, and has_ec. This is because all of these relationships are one to many with patients on the many side.

works_in

"works_in" describes the relationship between a doctor and a department.

dssn→{dssn, drname, dob, sex, did, dname, head}

head→{dssn}

head⊆dssn

pssn→{dssn, drname, dob, sex}

pssn→{dssn, drname, dob, sex, did, dname, head}

BCNF: The pssn again is a superkey of works_in because a unique doctor treats a patient, and many doctors are in one department. Head is a subset of dssn so the functional dependency is trivial. Also, dssn is a superkey of works_in.

5. Relation Schemas

Entities Schemas

```sql
CREATE TABLE `patients` (
    `pssn` int(9) NOT NULL,
    `pname` varchar(45) NOT NULL,
    `sex` char(1) NOT NULL,
    `dob` date NOT NULL,
    `weight` int(3) NOT NULL,
    `diagnosis` varchar(45) NOT NULL,
    PRIMARY KEY (`pssn`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4

CREATE TABLE `doctors` (
    `dssn` int(9) NOT NULL,
    `drname` varchar(45) NOT NULL,
    `dob` date NOT NULL,
    `sex` char(1) NOT NULL,
    PRIMARY KEY (`dssn`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4

CREATE TABLE `nurses` (
    `nssn` int(9) NOT NULL,
    `nname` varchar(45) NOT NULL,
    `sex` char(1) NOT NULL,
    `dob` date NOT NULL,
    PRIMARY KEY (`nssn`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4

CREATE TABLE `departments` (
    `did` int(9) NOT NULL,
    `dname` varchar(45) NOT NULL,
    `head` int(9) NOT NULL,
    PRIMARY KEY (`did`),
    KEY `head_fk_idx` (`head`),
    CONSTRAINT `head_fk` FOREIGN KEY (`head`) REFERENCES `doctors` (`dssn`) ON DELETE NO ACTION ON UPDATE NO ACTION
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
```

```sql
CREATE TABLE `emergency_contact` (
  `essn` int(9) NOT NULL,
  `ecname` varchar(45) NOT NULL,
  `phone` bigint(10) NOT NULL,
  PRIMARY KEY (`essn`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
CREATE TABLE `insurance` (
  `iid` int(11) NOT NULL,
  `iname` varchar(45) NOT NULL,
  PRIMARY KEY (`iid`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
```

Relationship Schemas

```sql
CREATE TABLE `diagnose` (
  `dssn_diagnose` int(9) NOT NULL,
  `pssn_diagnose` int(9) NOT NULL,
  PRIMARY KEY (`dssn_diagnose`,`pssn_diagnose`),
  KEY `pssn_fk_idx` (`pssn_diagnose`),
  CONSTRAINT `dssn_diagnose_fk` FOREIGN KEY (`dssn_diagnose`) REFERENCES `doctors` (`dssn`) ON DELETE CASCADE ON UPDATE CASCADE,
  CONSTRAINT `pssn_diagnose_fk` FOREIGN KEY (`pssn_diagnose`) REFERENCES `patients` (`pssn`) ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
CREATE TABLE `has_ec` (
  `essn_has_ec` int(9) NOT NULL,
  `pssn_has_ec` int(9) NOT NULL,
  PRIMARY KEY (`essn_has_ec`,`pssn_has_ec`),
  KEY `pssn_fk_idx` (`pssn_has_ec`),
  CONSTRAINT `essn_has_ec_fk` FOREIGN KEY (`essn_has_ec`) REFERENCES `emergency_contact` (`essn`) ON DELETE CASCADE ON UPDATE CASCADE,
  CONSTRAINT `pssn_has_ec_fk` FOREIGN KEY (`pssn_has_ec`) REFERENCES `patients` (`pssn`) ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
CREATE TABLE `insured` (
  `iid_insured` int(11) NOT NULL,
  `pssn_insured` int(9) NOT NULL,
  PRIMARY KEY (`iid_insured`,`pssn_insured`),
  KEY `ppsn_fk_idx` (`pssn_insured`),
  CONSTRAINT `iid_insured_fk` FOREIGN KEY (`iid_insured`) REFERENCES `insurance` (`iid`) ON DELETE CASCADE ON UPDATE CASCADE,
  CONSTRAINT `ppsn_insured_fk` FOREIGN KEY (`pssn_insured`) REFERENCES `patients` (`pssn`) ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
CREATE TABLE `treats` (
  `nssn_treats` int(9) NOT NULL,
  `pssn_treats` int(9) NOT NULL,
  PRIMARY KEY (`nssn_treats`,`pssn_treats`),
  KEY `pssn_fk_idx` (`pssn_treats`),
  CONSTRAINT `nssn_treats_fk` FOREIGN KEY (`nssn_treats`) REFERENCES `nurses` (`nssn`) ON DELETE CASCADE ON UPDATE CASCADE,
  CONSTRAINT `pssn_treats_fk` FOREIGN KEY (`pssn_treats`) REFERENCES `patients` (`pssn`) ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
CREATE TABLE `works_in` (
  `dssn_works_in` int(9) NOT NULL,
  `did_works_in` int(11) NOT NULL,
  PRIMARY KEY (`dssn_works_in`,`did_works_in`),
  KEY `did_works_in_fk_idx` (`did_works_in`),
  CONSTRAINT `did_works_in_fk` FOREIGN KEY (`did_works_in`) REFERENCES `departments` (`did`) ON DELETE CASCADE ON UPDATE CASCADE,
  CONSTRAINT `dssn_works_in_fk` FOREIGN KEY (`dssn_works_in`) REFERENCES `doctors` (`dssn`) ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4
```

6. Example Queries

Query finds department id and the number of patients under 100lbs per that department.
SELECT de.did, COUNT(p.pssn) FROM Patients p, Departments de, Diagnose di, Doctors dr, Works_In w WHERE p.weight < 100 AND p.pssn = di.pssn_diagnose AND di.dssn_diagnose = dr.dssn AND dr.dssn = w.dssn_works_in AND w.did_works_in = de.did GROUP BY de.did

	did	COUNT(p.pssn)
▶	2168	1
	5484	1
	5691	2

The head of the "Traditional Chinese Medicine" department has been arrested for running a drug smuggling operation for the notorious gang leader Ian Pallares, and all the doctors in their department, are suspected of malpractice. List all the patients and their respective doctors in that department.

SELECT p.pname, dr.drname FROM Patients p, Doctors dr, Diagnose di, Works_In w, Departments d WHERE p.pssn = di.pssn_diagnose AND di.dssn_diagnose = dr.dssn AND dr.dssn = w.dssn_works_in AND w.did_works_in = d.did AND d.dname = "Traditional Chinese Medicine"

	pname	drname
▶	Andrea Stewart	Nathan Allen
	Tim Williamson	Nathan Allen
	Bryan Johnson	Nathan Allen
	Tanya Hicks	Nathan Allen
	Natasha Whitehead	Mary Fitzgerald
	Ashley Delacruz	Mary Fitzgerald

7. Technology Used

This project was created using MySQL as the primary Database Management System. We utilized the free MySQL Workbench program to create schemas and entities, test queries, and verify data entry. Using several python scripts with faker we were able to generate large amounts of data which were then imported as CSV files into MySQL Workbench. Using PHP plugins for Eclipse we created the front end of the website, and used local XAMPP Apache and MySQL servers to communicate across the platforms. Git was used for version control.

8. Code Repository

The GitHub repository for this project can be found at:
https://github.com/avuppalapati/HospitalManagement.
Screenshots of the web application will be included in section 10.

9. Member Roles

Justin Lee
- Worked on html and css
- Provided additional features for forms
- Created ER diagram with relational schema and functional dependencies
- Worked on php scripts and MySQL

Ian Pallares
- Created php scripts
- Worked on front end design

Olive Snider
- Functional dependencies/3NF satisfaction
- Python data generation
- Assisted ER diagram updates

Akhila Vuppalapati
- Wrote the application background
- Created the example queries
- Assisted Python data generation

10. Web Application Screenshots

1. Home Page

2. New Patient Form

Hospital Management System

Name	Sex	Weight	Diagnosis	Doctor Name	Emergency Contact	Phone
Kelly Nelson	F	206	Allergic rhinitis	Sharon Hanna	Timothy Martinez	9981262666
Ricardo Robertson	M	291	Diabetes	Dominique Villarreal	David Knox	2268986804
Martin Lozano	M	206	Diabetes	Dominique Villarreal	Hannah Martinez	6978429144
Jessica Joyce	F	292	Fibromyalgia	Frank Davis	Bob Hubbard	5914822820
Curtis Fitzgerald	M	168	Anxiety	Victoria Garcia	Pamela Flowers	2100223426
Darlene House	F	129	Hypothyroidism	Derek Fletcher	Monica Mcdaniel	9159649036
Christina Lam	F	275	Hypertension	Derek Fletcher	Sarah Smith	6518427138
David Higgins	M	89	Diabetes	Daniel Davila	Travis Sandoval	9397363440
Andrea Stewart	F	84	Covid-19	Nathan Allen	Anthony Mendez	6287979989
Tim Williamson	M	208	Allergic rhinitis	Nathan Allen	Barbara Schneider	4467562645
Bryan Johnson	M	184	Nail fungus	Nathan Allen	Cynthia Russo	4816551979
Tanya Hicks	F	170	Dry skin	Nathan Allen	Anne Jackson	5906941364
James Reyes	M	121	Urinary tract infection	Stephanie Barton	Sara Nunez	7233355969
Brandon Phillips	M	86	Allergic rhinitis	Stephanie Barton	Jacqueline Jennings	6092510740
Lisa Mckinney	F	220	Diabetes	Keith Garcia	Randy Washington PhD	3521992931
Dylan Miller	M	270	Hyperlipidemia	Keith Garcia	Vincent Wilson	7583012050
Thomas Parsons	M	236	Diabetes	Dr. Kimberly Harmon	Megan Duran	3400196908
Jordan Chung	F	217	Dry skin	Dr. Kimberly Harmon	Frederick Reid	3354151986
Alyssa Rivera	F	200	Reflux esophagitis	Dana Beltran	Jason Smith	7141913616
Ryan Rogers	M	124	Reflux esophagitis	Rodney Griffin	Austin Andrews	5097200616
Lynn Carter	F	165	Dry skin	Victoria Bass	Jose Taylor	1756807623
Bradley Klein	M	296	Acute bronchitisAsthma	Dennis James	Jon Daniels	2171281907
Ian Pallares	M	145	broken bones	Jessica Knight	Olive Synder	37493948345
John Benitez	M	181	Hypothyroidism	Jessica Knight	Rhonda Scott	8443482051
Jill Garcia	F	257	Hypertension	Jessica Knight	Elizabeth Powers	4453053304
Elizabeth Washington	F	279	Acute bronchitisAsthma	Jessica Knight	Joseph Obrien	9059229234
Kristin Johnson	F	103	Hypothyroidism	Ashley Vega	Maria Rice	3117973355
Molly Dixon	F	175	Fibromyalgia	Melissa Waller	Aaron Smith	2360419949
Cynthia Ibarra	F	117	Urinary tract infection	Melissa Waller	Francisco Douglas	2247567486
April Gonzalez	F	91	Hypertension	Amy Hall	Brooke Fleming	1864303660
Karen Gray	F	245	Acute laryngopharyngitis	Amy Hall	Rachel Baldwin	6188217964
Natasha Whitehead	F	231	Reflux esophagitis	Mary Fitzgerald	Beth Williams	8534498169
Ashley Delacruz	F	281	Anxiety	Mary Fitzgerald	Laura White	9683263978
Robert Fitzgerald	M	146	Hypertension	Sarah Henderson	Deborah Salazar	1644386889
Jonathan Mclaughlin	M	142	Fibromyalgia	Sarah Henderson	Robert Phillips	1605886511
Kyle Mills	M	112	Urinary tract infection	Michael Ruiz	Virginia Marshall	8468358897
Heather Sandoval	F	226	Anxiety	Michael Ruiz	Colin Hall	6669557775
Derek Davis Jr.	M	275	Dead	Tim Wise	Joshua Griffith	8356758418
Peter Fowler	M	119	Reflux esophagitis	Tim Wise	Mark Mckenzie	9373641523
James Mahoney	M	191	ADHD	Devin Edwards	Robert Miles	9488681823
Alexander Vasquez	M	149	Acute laryngopharyngitis	Devin Edwards	Joseph Hensley	8936742904

3. View Patient Results

Hospital Management System

Employee Lookup

Filter by Staff Type:
- ◉ All
- ○ Doctor
- ○ Nurse

Date of Birth: mm / dd / yyyy

Sex:
- ◉ All
- ○ Male
- ○ Female
- ○ Other

Department:
Select Department ▾

Submit Query

4. View Employee Form

Hospital Management System

Name	Sex	Date of Birth	Department
Sharon Hanna	F	1966-05-16	Gynecology
Derek Fletcher	M	1982-02-27	Gynecology
Thomas Cruz	M	1961-09-10	Gynecology
Christina Brown	F	1973-07-15	Emergency Services
Dominique Villarreal	F	1946-03-31	Emergency Services
Daniel Davila	M	1973-07-21	Emergency Services
Deborah Davis	F	1986-11-23	Emergency Services
Tim Wise	M	1950-06-28	Emergency Services
Frank Davis	M	1970-11-02	Urology
Rodney Griffin	M	1955-01-27	Urology
Ashley Vega	F	1987-10-27	Urology
Sarah Henderson	F	1976-05-29	Urology
Victoria Garcia	F	1970-11-02	Gastroenterology
Dana Beltran	F	1974-01-18	Gastroenterology
Dennis James	M	1972-11-04	Gastroenterology
Keith Garcia	M	1982-04-26	General Surgery
Jessica Knight	F	1957-10-03	General Surgery
Nathan Jones	M	1978-04-09	General Surgery
Victoria Bass	F	1978-03-02	Dermatology
Martin Brown	M	1959-02-17	Dermatology
Devin Edwards	M	1954-08-18	Dermatology
Nathan Allen	M	1987-05-19	Traditional Chinese Medicine
Maria Castro	F	1972-09-27	Traditional Chinese Medicine
Mary Fitzgerald	F	1965-10-28	Traditional Chinese Medicine
Stephanie Barton	F	1983-06-08	ICU
Amy Hall	F	1976-12-09	ICU
Dr. Kimberly Harmon	F	1961-03-05	Psychology
Melissa Waller	F	1974-11-20	Psychology
Michael Ruiz	M	1965-06-05	Psychology
Kristen Hernandez	F	1964-03-03	Psychology
Michael Fitzpatrick	M	1987-12-28	Nurse
Diane Poole	F	1977-09-19	Nurse
Anthony Nguyen	M	1993-03-21	Nurse
Ryan Atkinson	M	1959-01-17	Nurse
Peggy Lee	F	1995-02-18	Nurse
Patrick Ruiz	M	1985-07-06	Nurse
Erin Cook	F	1993-03-03	Nurse
Megan Phillips MD	F	1973-12-18	Nurse
Margaret Jacobs	F	1985-05-19	Nurse
Christina Rodriguez	F	1987-04-30	Nurse
Ashley Villanueva	F	1988-07-15	Nurse
Kathleen Jones	F	1980-12-14	Nurse
Herbert Johnson	M	1950-11-29	Nurse
Harold Guzman	M	1977-05-28	Nurse
Robert Francis	M	1972-12-22	Nurse

5. View Employee Results