Group 12 - Project 1
COMP 421 Database Systems Winter 2015
Medical and Financial Information Analysis Database

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(1) Requirement Analysis

Objective: This database is designed to be a tool for a hospital to keep track of its finances and services as a medical, operational, and financial organising system. In particular, we hope that this database can help hospital management staff to organise treatment of a maximal number of patients whilst operating with a budget. Furthermore, we provide the means to allocate resources, with regards to staff and equipment, in an optimal manner, so as to minimise cost and to maximise lives saved.
For an exploration of some of what this functionality entails please see Section 1.2.

Scope: This database is intended for use by the typical hospital with a wide ranging number of departments. For example, it should be able handle a hospital on the order of complexity as the Montreal Jewish General Hospital (http://www.jgh.ca/en/home), which has a large number of departments. However, due to its flexibility with modeling a hospital's finance and logistics, it is also not very specialised at handling other aspects. For example, it has a limited capacity to help allocating wards and rooms to patients with regards to gender privacy, psychological assessments, and so forth.

Inspirations:
Insta Health Solutions:
- ➢ Website: http://www.instahealthsolutions.com/
- ➢ Demo: https://www.youtube.com/watch?v=SUSd6erdVfk

GNU Health (see accounting section):
- ➢ http://en.wikibooks.org/wiki/GNU_Health

1.1 Data Requirements

1.1.1 Entities

- **Patients:** Patients have first name (type: CHAR), last name (type: CHAR), date of birth (type: DATE), care cost (type: FLOAT), and patient ID (type: INT) attributes. Specifically, the care cost of a patient is the amount it takes to keep the patient in a ward and other maintenance costs (not including operation/treatment costs -- see **suffering from** in 1.1.3) This is not part of the **suffering from** relationship because the cost of feeding, dressing, and housing a patient is typically independent of what disease they have. A patient may have multiple illnesses (many-to-many) or none (under observation), is treated by certain staff members (many-to-many), and may be in the care of a particular hospital department since a particular time (total participation, and many patients to one department).
- **Staff:** Staff members have first name (type: CHAR), last name (type: CHAR), contact (type: CHAR), shift from (type: TIME), shift to (type: TIME) and staff ID (type: INT) attributes. The contact entry may be the address of an office, or a phone number, or any information required to find the staff member. Shift from and shift to describe the time the member is expected to be at the hospital. Staff maybe doctors, nurses, or admins. They may work for particular departments (total participation, and many members to many departments), and may be treating a particular patient since a particular time (many-to-many, and admins may be responsible for certain patients as well).
- **Doctors:** Doctors are staff members. They also have a particular board certification (type: CHAR) and rank (type: CHAR). A doctor's rank may be a head of a specific division or unit. Doctors may specialise in a particular illness (many-to-many).
- **Nurses:** Nurses are staff members. They also have particular certified skills (type: CHAR), which may include psychological/trauma counselling, etc.
- **Administrators:** Admins are staff members. They may have certain administrative responsibilities, such as maintaining hospital records, sanitisation, facility scheduling, etc.
- **Departments:** Departments have address (type: CHAR), budget (type: FLOAT), other costs (type: FLOAT), and a name (type: CHAR). The budget may come from government funding, donations, etc (not including patient insurance, which is case-by-case; see description for **suffering from** in 1.1.3). Other costs may, for example, include renovation, hydroelectric, transportation costs. A department may be in charge of many patients, employ multiple staff members, and have multiple pieces of equipment (many-to-many).
- **Equipment:** Equipment may have a cost (type: FLOAT), name (type: CHAR), and a consumability tag (type: BOOLEAN). For example, antibiotics are consumable, whereas MRI scanners are typically not consumable. Equipment may belong to particular departments (many-to-many), and may be required to treat specific diseases (many-to-many).
- **Illness:** Illnesses have a name (type: CHAR), average treatment cost (type: FLOAT), and a contagious level (type: INT). The average treatment cost attribute is used in cases where the exact cost of treatment (see description for **suffering from** below) is not known. The contagiousness may be important information for a hospital.

1.1.2 Notes on Attributes

- The primary keys for staff members and patients are integers, whereas the primary keys for other entities are their names. This is because human names are often non-unique, whereas names of illnesses, equipment, and departments are unique.
- Costs, values, budgets are floats because they have non-integer values.

1.1.3 Relationships

- **Works For:** A staff member works for a department, with contract from (type: DATE), contract until (type: DATE), salary (type: FLOAT), wages (type: FLOAT), and over-time hours (type: FLOAT) attributes. The wages are used to calculate the cost of the over-time hours that a staff member puts in, and salary is used to calculate the cost of employment over the contract. Staff totally participate, and many members may work for many departments.
- **Treats (Patient):** A patient is treated by multiple staff members, with a since (type: DATE) attribute. Patients totally participate, as a staff member is at all times responsible for a patient even if the patient is to be discharged (an admin member could 'treat' the patient by handling transportation).
- **In Charge Of (Patient):** A patient is cared for by a department of the hospital again with a since (type: DATE) attribute. Patients totally participate and must have a supervising department, and a department may be in charge of many patients.
- **Suffering From (Illness):** A patient may be suffering from multiple diseases or none (under observation, or about to be discharged). This has the attributes ill since (type: DATE), ill until (type: DATE), insurance coverage (type: FLOAT), urgency (type: CHAR), treatment cost (type: FLOAT). The insurance coverage and treatment cost here are considered on a case-by-case basis for each patient, as cost/coverage are dependent on the circumstance of the patience. In lieu of a specific cost, an average cost can be found in the attributes of a specific illness entity.
- **Has (Equipment):** Each department has one or more types of equipment for treating illnesses (total participation - a department is not empty), and each type of equipment must belong to at least one department (total participation - no floating equipment). It has two attributes that indicate the amount of equipment needed (type: INT) and the amount currently in stock (type: INT).
- **Specialises In (Illness):** Each doctor specializes in a particular general set of illnesses. This is a simple relation without attributes, and can be used in conjunction with **suffering from** to compute patient allocation.

1.2 Functional Requirements

1.2.1 Staff Allocation

We would like our database to allow for the analysis of staffing logistics. Specifically, we want to know if there are enough doctors specialising in the illnesses of patients, and if the

departments are adequately staffed. For instance, if there is a need for staffing in the emergency room (ER), a particular department in our hospital, then proper allocation of staff can be made efficiently to accommodate the fluctuating visitation in the ER. Of course, we would therefore also want to know if there is a surplus of staff with overlapping skills (nurse skills, doctor specialisation, admin responsibilities), of if a department has more on its payroll than its budget allows.

1.2.2 Staff Payments

Following from 1.2.1, we would like to keep track of staff payments depending on contract and salary. We also would like to keep track of overtime and wages due for overtime work.

1.2.3 Treatment Scheduling

We would also like to use the database to aid the scheduling of patient treatment. The cost factor of this would depend on cost of non-treatment (i.e. care cost), cost of treatment, and insurance coverage of each patient. Other logistics would depend on how urgently treatment is needed for a patient, whether a doctor specialises in his/her illness, and if the doctor is already treating many other patients. For example, patients that arrive in the hospital with life-threatening injuries should be prioritized for treatment.

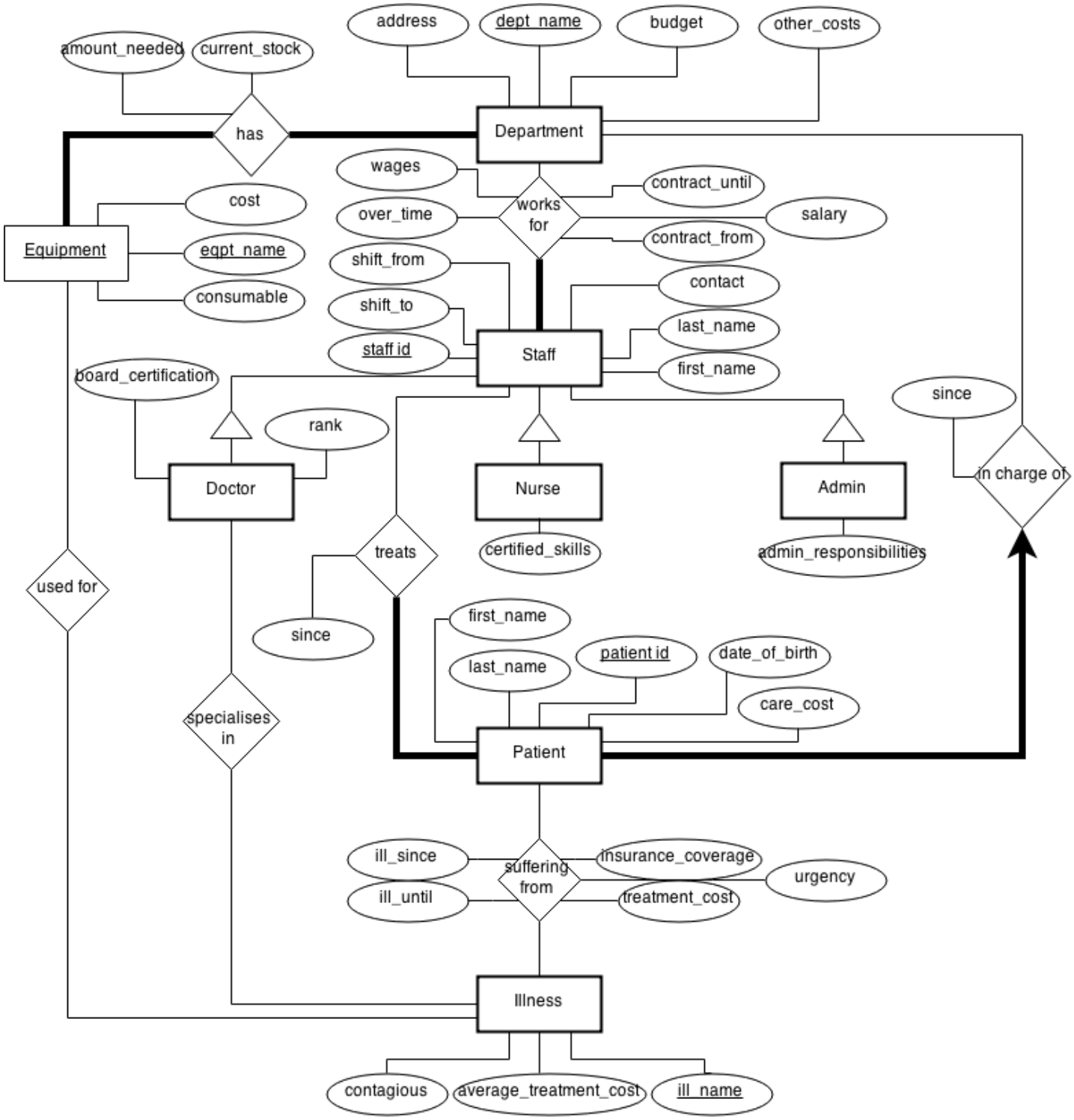
1.2.4 Resource Book-Keeping

Equipment belonging to a department and required for treatment can be tracked. Such a record system would also notify hospital staff when certain pieces of equipment are out of stock and need replenishment, hence preventing a deficit in inventory quantity. This depends on the patients the department is in charge of, what illnesses they have, how much equipment the department has, how much it would cost to buy more, and what budget the department has.

1.2.5 Finance Tracking

Depends on all of the above in addition to the budget and additional costs, this allows for the proper general allocation of financial resources to different needs across the hospital departments and staff.

(2) E/R Diagram


address
dept_name
budget
other_costs
amount_needed
current_stock
has
Department
wages
contract_until
works for
salary
over_time
contract_from
cost
Equipment
eqpt_name
consumable
shift_from
contact
shift_to
last_name
staff id
Staff
first_name
board_certification
since
rank
in charge of
Doctor
Nurse
Admin
certified_skills
admin_responsibilities
treats
used for
since
first_name
patient id
date_of_birth
last_name
care_cost
specialises in
Patient
ill_since
insurance_coverage
suffering from
urgency
ill_until
treatment_cost
Illness
contagious
average_treatment_cost
ill_name

(3) Conversion of ER Model to Relational Model

Entities:

- Illness(ill_name, contagious, average_treatment_cost)
- Equipment(eqpt_name, cost, consumable)
- Department(dept_name, address, budget, other_costs)
- Staff(staff_id, shift_to, shift_from, contact, first_name, last_name)
- Doctor(staff_id, rank, board_certification)
- Nurse(staff_id, certified_skills)
- Admin(staff_id, admin_responsibilities)

Relations:

- Has(dept_name, eqpt_name, amount_needed, current_stock)
- InChargeOf(patient_id, dept_name, since)
- SpecializesIn(staff_id, ill_name)
- SufferingFrom(patient_id, ill_name, ill_since, ill_until, insurance_coverage, treatment_cost, urgency)
- Treats(staff_id, patient_id, since)
- WorksFor(staff_id, dept_name, wages, over_time, contract_until, salary, contract_from)

We believe that there is no good way to combine the entities and relations that we have. For example, Nurse and Doctor could not be combined because Nurse has certified_skills which Doctor does not have, and Doctor has rank and board_certification which Nurse does not have. Keeping Doctor and Nurse separate allows them to have their own separate properties while still being able to enter into the Treats relation, for example.

One possible way to simplify Doctor and Nurse would be to create a new entity called Certification. This new entity could allow us to remove board_certification from Doctor and certified_skills from Nurse. Thus, we could introduce a HasCertification weak entity to handle the relations between Doctors, Nurses, and Certifications.

We ultimately decided against this approach because separating certifications into their own tables would not make sense in the context of the hospital database. This is because, firstly, medical and nursing staff are typically trained in general areas to qualify as staff. So, each member's certificate attribute should only take note of the most significant certification. Also, the board certification for a Doctor is categorically different from a Nurse's certification, in general. For instance, a doctor may have a certification in neurosurgery, but such a certificate is not applicable to nurses as their roles do not cover such tasks. Rather, they may be trained in family counselling.