CSE230 Examination Handout

1 Introduction to HCA

Health care is at the forefront at a national level as its future is debated and discussed. A critical component for such a Heath-Care Application (HCA) would be a national database for patient records and claim form processing. HCA was initially motivated and developed on the basis of a call by former Health and Human Services Secretary Louis Sullivan in 1992 for a national database for patient records and claim form processing. In the past few years, there has been an increased emphasis on electronic medical records and the usage of computing in support of health care. Thus, HCA is again popular as an emerging, complex application. For HCA, some individuals indicate that the level of complexity of such a system has not been seen in previous applications. The potential involved entities: hospitals, insurance companies, MD offices, government agencies, patients, universities and research institutes, medical supply and pharmaceutical companies, local drugstores and pharmacies, etc.; are numerous, and are all driven by unique, and at times, conflicting, needs and requirements. The information for such an application is staggering, both in volume (10s of thousands of gigabytes or more?) and in complexity (textual, record-based, x-rays, images, etc.). Even if we could support the information needs, there are many ethical questions regarding protection and accessibility of patient information. In addition, the technical issues related to standards for patient data and claim forms, and the integration of existing hardware, software, and communications systems must all be addressed.

2 An Overview of HCA

A system for supporting all aspects of health care delivery is required as one of the critical steps towards a national health care policy. The goals of such a system are:

1. Integration of all delivery units of HCA: e.g., hospitals, private laboratories, physician offices, insurance companies, patient data, etc.
2. Information consistency (usage, persistence, relevance, and integrity/security) is foremost in HCA.
3. Integration provides a seamless environment that standardizes and automates claims processing and billing.
4. Longitudinal data on different aspects of health care delivery can be used to evaluate performance and predict trends, e.g., a patient’s records can be analyzed to predict the most likely future problems and employ preventive medicine to anticipate their occurrence and reduce their impact.
5. Summary data on different illnesses, available across the country, can be utilized as the basis of treatment and research studies. For example, the Orphan Drug Act provides monetary incentive for pharmaceutical companies to develop drugs and treatment plans for illnesses that affect only a small subset of the population. Despite this Act, there are still difficulties in identifying patients who have a specific illness. A comprehensive repository, such as the one needed for HCA, could serve such a purpose.

One of the most important aspects of HCA involves the potential of misuse of information, i.e., confidentiality is critical! For example, a patient’s history might be used to deny insurance or to disclose an illness that could impact significantly on his/her lifestyle. Other issues related to HCA are:
• Wide variety of users both across delivery and within a subset, e.g., hospitals have nurses, MDs, technicians, administrators, housekeeping, etc., who all require some degree of access to HCA.

• Interoperability is critical due to myriad of existing hardware/software, e.g., hospitals have separate systems for laboratory analyses/results, scheduling, patient classification, budgeting, etc.

This initial characterization of HCA serves as only the basis for detailing and elaborating on the overall system requirements and capabilities.

3 Operating Environment for HCA

The operating environment for HCA will need to tackle many issues related to interoperability and usage, including:

• Within each specific delivery unit (e.g., hospital, MD office, etc.), all of their current systems must be integrated with the common system that supports HCA. For example, in a hospital, the system that processes certain laboratory tests contains typical computing hardware and software, and also includes specialized hardware for storing and analyzing fluids to determine test results. These results would need to be integrated with a local hospital patient care database to allow the transmission of time-critical laboratory tests. With interoperability, there is the requirement that a wide variety of existing and new hardware/software systems must be integrated to support the exchange of information in a seamless fashion.

• Within each specific delivery unit, varied and specialized interfaces are required. For example, in a hospital, relevant interfaces are:
  * display and modify patient data,
  * manage prescriptions and the formulary database,
  * occupancy for housekeeping and maintenance, and
  * management level for aggregated data.

Note that in some cases each interface represents a collection of two or more interfaces that are tailored to user needs.

• Some user interfaces must be located in a sterile environment (e.g., operating rooms, emergency rooms, etc.). Their designs must be customized to suit these environments. Other user interfaces need access to either off-site data or remote access to data. For example, in a truly ‘futuristic’ HCA, rescue squad personnel would be able to access patient data from an MD office or hospital at the accident scene.

• The number of delivery units nation-wide is extremely large (1 million or more?), since it must include all physicians, hospitals, insurance companies, medical product firms, etc. It is unclear whether such a system also extends into other accepted forms of medicine including chiropractic care and optometry. The amount of patient data is voluminous, especially if we mandate that all US citizens must have patient records.

• Distributed computing and the information highway - Hardware, software, and databases are distributed within one delivery unit and between multiple delivery units (both locally and nationally). An ‘Information’ highway via networking provides the means for delivery units to interact. Links via phones, local networks, high-speed networks, etc., are all required.
4 Information for HCA

There are many different databases that are required to engineer the information for HCA. For the various departments (e.g., pediatrics, nursery, surgical care, operating room, etc.) in a delivery unit (say, a hospital), the following databases must be available:

- **Formulary**: The collection of all drugs on the market that are used for treatment, their interactions with other medications, prescribing information, and possible side-effects.
- **Prescriptions**: The database of all prescriptions that have been filled by the Pharmacy per MD orders.
- **Patient Records**: Tracking all information on the patient’s current visit and all past visits.
- **Budgeting**: Necessary database for the operational side of a hospital. Important to patient care, since costs related to equipment and personnel all factor in to the equation that determines treatment costs.
- **Laboratory Tests/Results**: A database that maintains information on all tests that have been ordered, their status, and their results.

These databases are local, since they exist within the delivery unit. However, there are mandatory links between these repositories and a collection of non-local databases, namely:

- **MD Office**: Contains patient records of visits at each MD’s office.
- **Medical Databank**: A databank that might contain information on new and up-to-date treatments for various diseases.
- **Drug Warnings/Updates**: This database is necessary to report problems or recalls for various drugs.
- **Insurance Companies**: Databases that track the claims that have been processed for patients.

Clearly, the key issues regarding all of these databases involve currency and downloading (in both directions) for maintaining consistency and insuring confidentiality.

5 User Interfaces for HCA

The interfaces for HCA span a wide-spectrum of need and capabilities. To manage, control, access, and modify patient data, there are a number of interfaces required, with the variants determined by activities or responsibilities within a hospital:

- **Nursing**: This interface has moderate read and limited write capabilities on patient data. Writing is necessary to enter vital signs and other information as the treatment of the patient is implemented. This interface is further complicated since one would only want a specific nurse to be able to see data related to the patients that s/he is responsible for, and not all patients in a hospital.
- **Physicians**: This interface extends the one for Nursing, since MDs must be able to enter treatment orders/prescriptions.
- **Administration**: Nursing managers, department directors, and other administrators need a dedicated interface that provides aggregate and statistical results on the information in an HCA system.
- **Pharmacy**: This interface allows pharmacists to fill prescriptions per an MD’s orders and also to check interactions of all drugs being given to a patient.
- **Laboratory**: This interface, as described in part in the previous section, would integrate the perform tests actions with the ability to automatically forward results when the test has been completed.
Interfaces for patients and their immediate family members may also be appropriate. In addition, there are interfaces required for the insurance companies that will process claims associated with patient treatment. Finally, interfaces related to occupancy and scheduling are necessary, to: admit patients for treatment, request housekeeping to preparing rooms upon a discharge, and file a maintenance request for repairs.

6 Security for HCA

In HCA, one goal of the security policy is to support the confidentiality of patient records. This is in direct conflict to the goal that requires reasonable and shared access to this same information. At a national-level, access to the patient records must be controlled. Within each delivery unit, access must be further restricted based on responsibilities. For example, the Nursing interface for HCA allows read access/limited writes on patients. However, this must be further refined to restrict access to those patients for whom a given Nurse (or other Health Care Professional) is directly responsible for. There are many units in a hospital, and in fact, VIPs, whose privacy must be protected. Clearly, confidentiality issues are pervasive throughout the health care delivery system. On the other hand, accessibility of patient records with identifying characteristics removed is also important. Such access allows statistical and medical trends to be queried and analyzed. For a certain rare disease, while a local overview is not possible (e.g., not enough patients), a national review of all patients with a given disease may allow researchers to identify trends and individual practitioners to predict health problems and establish preventive treatments.

At a finer-level of granularity, there are many different user roles and associated descriptions of responsibilities that are definable:

- **Nurse:** Direct involvement with patient care on a daily basis.
- **Staff-RN:** Administer direct care to patients and implement the physician treatment plan.
- **Education:** Educate both the nursing staff and patients regarding new treatments and self care.
- **Manager:** Responsible for the day-to-day operation of a nursing unit.
- **Vitals:** The actions taken to obtain the vital signs (pulse, BP, respiration) of patients.

Once again, the responsibility level of the different user roles varies, ranging from the general (Nurse) to the specific (Vitals).

The security requirements for user roles are utilized to delineate the information access. Sample requirements for the three kinds of nurses given above are listed below:

- **Staff_RN:** Clinical information on their own patients. Can write/modify a substantial portion of clinical information to record the results/patient progress. Cannot change a Physician’s orders on a patient.
- **Education:** More restrictive access to clinical information than Staff_RN. Needs access to a patient’s history to teach after-discharge care. Can write notes which document a patient’s progress. Cannot change a Physician’s orders on a patient.
- **Manager:** Clinical information on all patients in their unit. Additional information required to transfer patients between units, information on the nurses that work in their unit (including shifts, staffing, and skill levels), and budgetary data. Can write privileges of Staff_RN plus extra privileges to read information on other units (censuses) Can write summary and employee data on their own units. Cannot change a Physician’s orders on a patient.

Given these security requirements, it is possible to establish a ranking regarding the capabilities of each user role. From the above descriptions, Manager has more capabilities than Staff_RN which in turn has more capabilities than Education. This ranking is important, since if specified, it can be used to insure that a user role (say Education) is not given a privilege that is not present in a user role that is ranked above it (in this case, Staff_RN or Manager). Thus, privileges for different user roles can be analyzed and controlled.