Overview of Team Project

The purpose of the team project this semester is to design and prototype a framework and infrastructure that centers around a collaborative web portal for allowing patients, providers, and pharmacists, to interact with one another in tracking: 1. medications and their interactions with nutritional supplements; and 2. observations of daily living that actively and passively track the progress and status of patients with chronic diseases or conditions. The framework and the interactions are represented in Figure 1.

![Figure 1: Architecture Diagram of the TMR and ODL and their Interactions.](image)

In the figure, there are three primary groups of users all with different aims and objectives:

- **Health Care Providers:** This group of users encompasses a wide range of professions, including: primary care physicians, physician assistants, nurse practitioners, education and discharge planning nurses, and so on. This group has one overriding objective, to improve medical treatment for their patients, particularly for those patients with diseases that require constant and vigilant monitoring (e.g., diabetes, asthma, congestive heart failure, high blood pressure, etc.). To support this activity, there are two paths of interactions for providers in Figure 1:

  - For patients with chronic conditions (e.g., asthma, diabetes, CHF, high blood pressure, etc.), providers are interested in establishing a medium for a secure electronic dialog with them to track what is referred to as *observations of daily living (ODLs)*, that would include patient-supplied data (e.g., glucose level, BP, peak flow rate, etc.), with the goal of heading off adverse events and hospitalizations; this could be accomplished, for example, by having the infrastructure include a ODL Analyzer component that can alert the provider when a patient’s trend data (e.g., glucose level for diabetes) exceeds some threshold for that patient for some time interval (set by the patient or the software). This essentially provides a means to track patient supplied disease management data, and may result in a number of actions, including
contacting the patient to talk or to schedule a face-to-face meeting (patient appointment). This second path also requires easy to use provider user interfaces of multiple types (mobile devices and computer based) to allow notification when the providers are not in their offices; clearly adverse events will not always happen during regular business hours. In addition, this second path will require the permission from an individual patient to open a portion of their personal health record to certain providers. This is a complicated situation; in the event that it is a night or weekend, the covering provider may have neither access nor permission to patient data.

- For certain patients that haphazardly visit different providers (e.g., physicians, community health centers, emergency rooms, etc.) at different times, resulting in different prescriptions obtained in different settings, a traveling medication record (TMR) will be created and maintained again, like ODLs, on various platforms, to allow the medications to be localized in a single repository (PHR – Google Health) that are accessible to both providers and pharmacists. The key issue in this case is to identify medication conflicts (e.g., interactions, same drug given multiple time, etc.). In addition, we are also seeking to track nutritional supplements and home remedies that may be taken by the patient, which have the potential to generate medication-supplement interactions.

In summary, any patient interactions via the collaborative portal as given in Figure 1 should integrate with the provider’s local electronic medical record (EMR) system and its associated database. This allows the data collected from the portal to be available in one setting (EMR) when the patient is in for an office visit. If available, clinical trials organized by discipline and type, would also be useful for providers in their daily interactions with patients.

- **Patients:** This group of users are seeking a collaborative portal that provides a wide-range of functional components tailored to their needs and integrated with their providers. These include:

  1. **Personal Health Record (PHR):** This is the key focal point of the patient aspect of the portal, to allow patients to manage their own personal health data, particularly for those patients who require chronic disease management. Patients will be able to access and manipulate their PHR; as shown in Figure 1; this means that a patient would have a PHR on their own local computer (purchased or open source product), or subscribe to a service that provides the PHR to the patient. This will include the capability to open portions of their PHR to providers that are selected from a list. For each selected provider, the patient can supply specific access (read or read/write) to individual portions of the PHR. There may also need to be a “download” process that allows a subset of patient data from a provider’s EMR to be loaded to initialize portions of the PHR. This component is targeting the PHR data, its initialization, and its management in terms of permissions (authorization to providers).

  2. **Prescription Management:** As indicated above, patients that visit multiple providers, obtain prescriptions at multiple locations, and couple their use with nutritional supplements, are key candidates for misdiagnosis and adverse events. As a result, the objective is to provide smart phone applications via traveling medication record (TMR) that would track prescriptions, over-the-counter (OTC) medications, supplements, and allergies, as a means to provide a central location that tracks all of this potential interactions and problems.

  3. **Disease Management:** This component has many different capabilities that are structured around the premise that patients are seeking to manage their chronic disease (e.g., asthma, diabetes, CHF, high blood pressure, etc.) in order to avoid adverse events, referred to as ODLs. Such a component could include: a. the patient entry of medical diagnostic data (e.g., glucose
level, peak flow rate, etc.) for management of chronic diseases, coupled with upload/download functionality; b. the tracking of said medical data over time via various multi-modal graphical formats; c. secure on-line interactions (mobile device or computer-based) with their provider(s) for disease management (accomplished via the portal or a combination of the portal and another server — e.g., relayhealth.org); and, electronic notification (simultaneous hand-held and computer-based) when a trend has been identified by the provider that warrants immediate interaction with the patient (initiated by the provider).

4. Tailored Education Materials: This component should have education materials that have been selected to be tailored to each patient with respect to their need(s) and/or condition(s). This may also include a patient-focused education version of the treatment plan as generated from the clinical researcher provider materials. That is, for the on-line provider materials (Cardiovascular Gram) there may be corresponding patient versions that follow along with the plan being utilized by the provider. The division of Cardiovascular Gram into materials suitable to the patient (or to the provider), will require interaction with social and public health scientists to properly organize and present the material (and to obtain feedback) in many different formats (e.g., audio, video, etc.). From the perspective of our project this semester, the intent is to provide the infrastructure to support the publishing of such materials for patients and providers, when we are given the materials in the appropriate format.

As with providers, the user interfaces and interactions for patients will be critical, to facilitate adoption of the technology and continued usage. These are just the initial capabilities for patients; others are possible as the project evolves over the semester.

- **Pharmacists**: This group of users are seeking access to the traveling medication record (TMR) to track a patient’s medication and allergy history, and in particular, on potential medication/medication, medication/supplement, and supplement/supplement interactions. If a patient visits multiple providers for medical care and fills the resultant prescriptions at different pharmacies, this may result in a scattered and incomplete medication record that poses numerous problems impacting patient care, including:

1. **Overmedication.** In the absence of a complete list of current medications, a provider may prescribe the same medication (or medication within the same class) to the patient again or prescribe a drug that interacts with an existing medication being taken by the patient. If there is an automatic drug interaction checker of the new prescription against a collated list of medications/supplements, then perhaps a potential interaction can be avoided.

2. **Adverse Interactions.** Many patients use dietary supplements or home remedies, which may lead to pharmacokinetic or pharmacodynamic drug interactions. *Pharmacodynamic interactions* occur when drugs attenuate or potentiate the effects of a drug without changing either drug’s serum concentration. *Pharmacokinetic interactions* occur when a drug increases or decreases the serum concentration of another drug by altering one or more of the following processes – absorption, distribution, metabolism and elimination. Dietary supplements may also induce adverse events, including allergic reactions which cannot be linked to the product if the consumption is not conveyed to the provider or pharmacist. For example, ephedra-containing products raise blood pressure and can induce tachycardia, arrhythmias, strokes, and myocardial infarctions. Knowing that a patient was taking such a product would help identify the cause of a sudden increase in blood pressure. Another example is Echinacea, which is sometimes used to reduce the severity and duration of viral upper respiratory infection symptoms. This herbal supplement belongs to the Asteraceae family which includes ragweed.
and may be the cause of an unexplained allergic reaction in a patient with seasonal allergies to ragweed and other pollens.

3. Adverse Reactions. Patients may fail to report all allergies to all health providers, or may report non-allergic side effects, such as stomach upset, as allergies. Some hospital electronic health records add to this problem, because they do not contain a field for reporting side effects or adverse reactions other than allergies. When the patient is discharged the patient may erroneously be labeled allergic to those medications that caused a nuisance side-effect. The ability to capture information on side-effects and allergies in the context of a comprehensive medication list will improve communication and medication management.

While health information technology such as e-prescribing, electronic health records, or personal health records (PHRs) have the potential to improve medication management, the process of leveraging these innovations to capture, track and improve the use of medication lists across a variety of stakeholders in a community setting is complicated by issues surrounding patient use of non-prescription drugs and dietary supplements, patient-provider communication, system use, and limitations of available technologies.

Project Goals and Objectives:

The objective of this semester project is to develop a family of smart phone applications in support of:

1. Traveling medication record (TMR) to be able to track basic demographics (name, height, weight, etc.), medications, nutritional supplements, and allergies, with the intent of providing an automated means for various types of interaction and adverse event checking.

2. Observations of daily living (ODL) to be able to track specific information on chronic diseases that can be maintained in a database, with the ability to provide ODL-specific analyses that are able to inform both the patient and provider in order to head off potential problems.

Collectively, as given in Figure 1, these capabilities will be placed into a larger system context to be able to store medications (in a PHR like Google Health) and ODLs (in a database), with a long-term goal for automated interaction with an electronic medical record (EMR).

The idea is to develop smart phone application components that include:

- For each patient, the ability to enter and track medications and/or nutritional supplements.
- For each patient, the ability to enter and track allergies and adverse reactions.
- For each patient, a collection of selectable ODLs that are able to track information on multiple chronic diseases.
- For each provider, a smart phone application (and perhaps web-based computer application) to be able to analyze medication/supplement interactions and ODLs for each patient.
- For each pharmacist, a smart phone application (and perhaps web-based computer application) to be able to track and analyze medication/supplement interactions for conflicts and adverse events.

The smart phone applications can leverage both iphone and ipad platforms are target environments.

Reconfiguring Project to Support Smart Platform

As given in Figure 2, to complement the aforementioned project, we are seeking to utilize the SMArt Platform as a middle layer to replace our usage of Hibernate and to provide access to the TMR and ODL databases and the PHR Google Health. In the SMArt context, any platform that contains data such as the TMR/ODL DBs and Google Health, has the potential to serve as a SMArt container by exposing the
SMArt API and providing means to use SMARt Apps. One interesting aspect of such an approach would be to provide an interfacing layer that turns Google Health (in this case possibly on top of our existing interfacing code in hibernate) and the TMR and ODL databases into such a container. This layer would have to achieve two goals: a) exposing the SMARt API and hosting SMARt Apps towards the remaining architecture and b) translating the SMARt API calls and RDF Data model for storage/retrieval towards Google Health.

Writing Apps for the Smart API should be a task of reasonable effort and if we want to produce any of those we are not limited by the fact that we don't have a in-house container yet since the SMARt project is providing a test environment online and the code is available so that we can go as far as even reproducing and modifying it locally if needed.

Given this description, we can then essentially recast the project in the following separate parallel tasks which we can approach independently:

- Building a Google Health based SMARt Container
- Developing the TMR and ODL applications as SMARt Apps that are executable on the smartphone platforms that we are targeting, focusing on the Android platform.
- Building our smartphone applications independently of SMARt but include the capability of using the SMARt API where needed (i.e., we could build a browser application that uses our existing storage mechanism to Google Health but also foresees the option of connecting to an arbitrary SMARt Container) and/or explore the possibilities of SMARt Apps that only serve as interfaces to a container (however, this might be problematic at the current development state of the API).
The objective of this parallel design and development scheme is to investigate this emergent technology (SMArt Platform) and truly understand its scope and capability to support smartphone applications such as TMR and ODLs. A significant part of the early stages of this effort will be to design the appropriate architecture that integrates with the existing components.

Background on ODLs:

Introduction and Overview:
The objective of the project this semester is to provide exposure to a wide range of emerging technologies related to biomedical informatics, focusing on:

- Personal Health Records (PHR) such as Google Health (https://www.google.com/health) and Microsoft HealthVault (http://www.healthvault.com/).
- Electronic Medical Records (EMRs) specifically the General Electric Centricity EMR (www.gehealthcare.com/usen/img_info_systems/centricity_clin_info/products/phyooffice.html)
- Smartphone applications for multiple platforms (e.g., Android, Blackberry, iPhone, and Microsoft) with an emphasis on having these applications interact with PHRs and EMRs to store and retrieve patient health information.

The objective this semester is to bring all these technologies together into an integrated environment, with the Smartphones integrated via an emulation/simulation model (which is available in each of the different products’ development platform). In doing so, you will be working with existing software that interacts with Google Health, and working at times with graduate students who are focusing on projects related to health information exchange (HIE).

The Robert Wood Johnson Foundation has sponsored Project Health Design which is targeting the use of PHRs to improve patient care (http://www.projecthealthdesign.org/). Specifically: “Project HealthDesign stimulates innovation in the development of personal health record (PHR) systems by transforming the concept of PHRs as data collection tools to PHRs as a foundation for action and improved health decision-making.” The Round 2 proposal (http://www.rwjf.org/applications/solicited/cfp.jsp?ID=20762) focused on whether and how information about patterns of everyday living can be collected and interpreted such that patients can take action and clinicians can integrate new insights into clinical care processes. Such patterns are called Observations of Daily Living (ODL) and focus on information that patients can provide on a daily basis that could assist in their care and treatment of chronic diseases (e.g., congestive heart failure, diabetes, obesity, asthma, osteo-arthritis, etc.) by having this information available for use in individual and summary forms to physicians. The key issue will be to determine the appropriate technologies and platforms to utilize to collect ODLs on chronic diseases, which for our purposes this semester will be: Google Health, GE Centricity, and multiple Smartphone Platforms (Android, Blackberry, iPhone, and Microsoft). The applications that are to be developed for ODLs are in general very limited in terms of functionality. However, we want to explore the bound and limits of the technologies, so ODLs such as accelerometers (general movement) or pedometers (walking) which may be possible for some smartphone platforms are also of interest.

Observations of Daily Living (ODLs)

There are two types of ODLs: passive and active. Passive ODLs, like an accelerometer or pedometer, once enabled, collect data for a pre-determined (or user defined) time period; at the end of the period, the data collected from the passive ODL must be uploaded in an appropriate form to a PHR and/or EMR. Passive ODLs are initiated by a participant, but after activation, there is limited involvement. There are many examples. First, using a pill bottled that sends a time-stamped message to a Smartphone that the bottle has been opened, and recording all instances of opening the bottle. Second, installing a
accelerometer application on a SmartPhone that can passively send information on movement for each participant, which can be set up to occur at a specific time. Active ODLs require specific input from patients, related to a particular chronic disease (or diseases), collecting relevant information on a periodic basis (e.g., daily, twice daily, hourly, weekly, etc.); this information is actively entered by a patient and also uploaded to a PHR and/or EMR. This longitudinal information on a patient’s condition can be instrumental as health providers seek to assess their patients over time, seeking to refine treatments, notice potential problems before they require hospitalization, and so on.

Active and passive ODLs will be employed to gather information from participants on a scheduled basis (e.g., daily, weekly, etc.). Sample active ODLs include: We anticipate that these measures will include such items as fatigue, pain, functional status and adherence to the management plan for individuals with osteo-arthritis, chronic fatigue, or some other diseases; pulse, blood pressure, and weight, for individuals with heart or blood pressure problems; glucose levels and insulin injected (for each time the glucose is checked), and weight (on a different schedule) for individuals with diabetes; and so on. Note that some of these ODLs may be regularly schedule (e.g., the smartphone beeps a reminder), triggered as the result of a contact to the patient (e.g., an automated call or email to the smartphone), or initiated by the user. The numerical values are tracked for each individual to capture all of the values entered. In addition, there may be more advanced ODLs that involve the collection of information on medications that are being taken to cope with pain. There are a few possibilities in this regard: using a scanner on a SmartPhone to “record” the medication when it is being taken by scanning the label; or, using a camera cell phone to take a “picture” of the medication that can be then uploaded to the web or sent as a text message. Alternatively, a user may be provided with an application that is a series of screens to allow prescription information to be entered, and that information is then synchronized with the PHR and/or EMR.

Technical Approach, Feasibility, and Viability

Our technology approach will be three-fold: user-centered design and requirements definition for to obtain vital input from patients in regards to ODLs as realized in SmartPhone applications; providing a platform and associated technologies that results in a seamless integration of access by patients and their health care providers to all facets of the system. The PHR will serve as the remote storage repository for active and passive ODLs that are collected from each patient, that is maintained by a third party (Google), which dramatically reduces the functionality requirements for our solution, and places the onus on the vendor to support privacy, secure communication, storage, and other requirements.

Platforms and Technologies: The platforms and technologies chosen to support the collection and storage of ODLs, are summarized from a software architecture perspective in Figure 1. In tracking ODLs, we must ensure that all of the ODLs are stored to allow historical tracking of this information and facilitate generation of reports or displays to collate information over time. From a technical perspective, Google Health’s application programmer interface (APIs) and web services which are primarily Java-based, and use the continuity of care record standard, CCR implemented in XML Schema (http://www.astm.org/Standards/E2369.htm, http://www.centerforhit.org/online/chit/home/project-ctr/asm.html).

At the patient side, access to the active ODLs (scripted solicitation on ODLs to-be-determined by patients) will be through a SmartPhone. As shown in Table 1, assembled from http://www.gartner.com/it/page.jsp?id=910112, http://360degreesolution.spaces.live.com/default.aspx?sa=818879934, and http://blog.technos.com/blog/research-in-a-mobile-world-6), there are five different platforms of SmartPhones. In the US, BlackBerry, iPhone, and Windows Mobile phones dominate the market. From a development perspective, we have the potential to collect data on multiple ODLs simultaneous (e.g., a patient has a pedometer application running while accessing a lifeline).
Applications for ODLs:

While the intent is to begin using the ODLs as developed from the Spring 2010 undergraduate course, it is relevant to provide a list of potential ODLs just for everyone to understand the scope of the possibilities:

A. Multi-Media Support Repository: It has been found in a number of settings, that people with chronic diseases may be able to cope with their pain, fatigue, etc., through the use of audio clips, video clips, or pictures that mean something too them. For example, for one person it may be pictures and clips of family and loved ones, for another person it may be popular music, for yet another inspirational speeches, and so on. The intent is to develop a Smartphone application that is capable of tracking a repository of audio, video, and pictures, categorized by Topic, Title, and/or Keywords. Each participant can use this repository to cope with their daily living. The system will track a complete historical record for each participant, noting the selections that are being utilized along with their date-time stamp and frequency. There will be the ability to have a favorites list of most frequently used selections, as well as for each participant to upload their own audio/videos for her own use. The intent is to also have a version of this application that could cache selections with the memory of the Smartphone to reduce download times, particularly for those selections chosen most frequently.

B. Pedometer or Accelerometer: For either of these applications, you will need to have an actual Smartphone that has motion sensors. The idea would be that these applications would be initiated by a patient to collect information associated with walking (pedometer) or movement (accelerometer) for a fixed period of time.

C. Discrete Measurement of Symptom/Condition: Historically, pain scales have been used extensively in medical settings (just to a Google Search on “pain scale” images). This type of scale can be generalized to collect information related to pain, fatigue, mobility, adherence to medication, and so on. Note that some of these ODLs may be regularly schedule (e.g., the smartphone beeps a reminder), triggered as the result of a contact to the patient (e.g., an automated call or email to the smartphone), or initiated by the user. The numerical values are tracked for each individual to capture all of the values entered. This would be a simplistic ODL based on a scale (1 to 10, Good to Bad, etc.) rather than any actual collection of medical/personal data.

D. Tracking of Chronic Diseases: This ODL focuses on tracking chronic diseases that require a patient to enter information periodically (daily, multiple-times-daily, weekly, etc.). There are many diseases that fit this category: pulse, blood pressure, and weight, for individuals with heart or blood pressure problems; glucose levels and insulin injected (for each time the glucose is checked), and weight (on a different schedule) for individuals with diabetes; peak flow and weight for asthma; calorie intake and eating patterns for individuals that have had gastric bypass; tracking symptoms related to migraine headaches to identify patterns of onset; and so on. You can limit yourself to one of these diseases, or
research other conditions that may have information that can be collected via a Smartphone. Note that some of these ODLs may be regularly scheduled (e.g., smartphone beeps a reminder), triggered as the result of a contact to the patient (e.g., automated call or email to the smartphone), or user initiated.

E. Synching Information with PHR/EMR: For this application, you need to consider the information that is stored in a PHR and/or EMR, and develop Smartphone applications that provide a means for patients to enter the information which can then be synchronized with the PHR/EMR. For example, Google Health lets a user maintain his/her prescriptions, but it is not set up to handle nutritional supplements and other home remedies. A smartphone application could be developed to support the data entry of this information, which would then be synchronized into Google Health, and if the user is also a patient with data in the EMR Centricity, a second step would synchronize to this repository using its secure web services. A different application could also be considered to handle side effects and reactions to medications, food, allergens, etc. This application would be textual/web based.

F. Scanning/Recognition: For this application, it may be possible to leverage the digital camera in a cell phone to take a “picture” of a medication and/or nutritional supplement label that can be then uploaded to the web into the PHR or EMR. The idea would be for the patient to be able to create a pictorial representation of medications/supplements, that would also be supplemented with their complete dosing information (size, frequency, etc.). This would involve being able to capture perhaps multiple images from the same medication/supplement and meld them together.

Project Deliverables and Time Table – THIS IS TO BE REVISED

In terms of project deliverables, consider the following initial (subject to change) list:

PD1. Identification of responsibilities for team.
PD2. Using above pages as a basis to develop a more detailed specification.
PD3. Explore and select appropriate technologies for supporting PD2. Essentially provide a more detailed specification by selecting technologies from available candidates.
PD4. Identification of a subset of the specification (from PD2) with the chosen technologies (PD3) for development and prototyping.
PD5. Prototyping of these selected portions (PD4) of the infrastructure.

Over the course of the coming weeks, we will discuss these deliverables as part of every class.

In terms of a time table, consider the following:

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD1</td>
<td>Establish and Finalize Team Responsibilities by February 6, 2008.</td>
</tr>
<tr>
<td>PD5</td>
<td>Prototype in Multiple Deliverables – after semester break. Schedule TBD.</td>
</tr>
</tbody>
</table>
The project as described to this point is focused on the end-user capabilities, for clinical researchers, providers, and patients. The major objective of this project for the semester is to emphasize the design and construction of an underlying infrastructure and architectural solution that can be utilized to support the functionality as described. As such, our focus will be specifying, designing, and prototyping these building blocks, using a wide variety of technologies:

- **Ontologies**: In computing, the term *ontology* refers to a model to represent both concepts and relationships among concepts for a given domain. Ontologies will have a vital role to play in this project; there are many emerging in medicine such as medical ontology research from the US Natl. Library of Medicine\(^1\), in efforts such as Open Clinical\(^2\), in medical ontology research as tracked by NIH\(^3\), and in XML\(^4\).

- **Service-oriented architectures (SOA)**: Web-based solutions that rely on client-server interactions (e.g., PHP, scripting, SOAP, etc.).

- **Open Source Server Side Solution**: A wide range of possibilities including Java, Javascript, Perl, PhP, Phython, Ruby, etc.).

- **Standards and Messaging**: Standards for patient/medical data modeling (e.g., XML, CDA, etc.) and exchange (e.g., HL7). This will also include interoperability to open source EMR and other external provider/clinical researcher technologies.

- **Open source database platforms**: Ranging from standard relational solutions (e.g., MySQL) to emerging XML database alternatives (e.g., Apache Xindice, Sedna, etc.).

- **Data Encryption**: Ranging from secure web pages (https and XML signature and encryption) to programmatic server-side security (e.g., Java or .NET encryption) to database security (e.g., MySQL encryption).

- **Open Source EMR**: Identifying an open source EMR for use in the project. One of the most widely known product is VISTA from the Department of Veterans Administration (federal level).

- **Open Source PHR**: Technologies such as HealthVault can provide a means for a patient to monitor and track his/her patient data over time.

- **Open Source GUI Web Technologies**: Possibilities on the client side include the Struts framework (http://struts.apache.org/) for simplistic user interfaces or open source Clean AJAX (http://clean-ajax.sourceforge.net/) for more sophisticated interactions.

- **Open Source Hand Held Technologies**: Web-enabled cell phones and PDAs will require a simple, easy to use solution for patients (to upload medical diagnostic data and receive alerts) and providers (to download patient data and issue alert). For example, there are Diabetes and Peak Flow monitor technologies being made to interact with HealthVault.

- **Open Source Collaboration Technologies**: For providing the infrastructure, it may be relevant to leverage wiki (e.g., mediawiki) or collaboration (e.g., phpBB) solutions.

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\(^2\) [http://www.openclinical.org/ontologies.html](http://www.openclinical.org/ontologies.html)


\(^4\) [http://healthcare.xml.org/resources/MMOEBRR.pdf](http://healthcare.xml.org/resources/MMOEBRR.pdf)
For design and development, it is anticipated that we leverage standard software and database techniques and methodologies, including: design patterns, UML, ER diagrams and database modeling, etc. Again, the key issue is to put together the entire, extensible, framework.

**Appendix A: Cardiovascular Gram at UCHC**

The Pat and Jim Calhoun Cardiology Center at UCHC (http://heart.uchc.edu/) has a twice yearly publication *Cardiovascular Gram* to disseminate cardiology information to providers and the community (http://heart.uchc.edu/education/cardiogram/index.html). The links of the particular issues since 2005 are:

http://heart.uchc.edu/education/cardiogram/pdfs/cardiogram_summfall05.pdf
http://heart.uchc.edu/education/cardiogram/pdfs/cardiogram_summfall06.pdf
http://heart.uchc.edu/education/cardiogram/pdfs/cardiogram_winspr06.pdf
http://heart.uchc.edu/education/cardiogram/pdfs/cardiogram_summfall07.pdf
http://heart.uchc.edu/education/cardiogram/pdfs/cardiogram_winspr07.pdf