A Model and Prototype for Using Intelligent Software Agents to Monitor Adherence to a Medication Regimen

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Background: Reported percentages of patient non-adherence to prescribed medication regimens vary between 35% and 90%. When compliance is improved by early intervention, better outcomes result. Electronic medical records that contain the treatment plan and systems that allow Internet communication between patient and provider can be coupled to capture regular input about adherence to prescribed treatments and to monitor and evaluate compliance continuously. Such systems can even inform the provider when the prescribed regimen is not being followed or when indicators of a poor outcome appear and allow the provider to intervene. This level of sophistication requires intelligent software agents that can ”reason” about the data and respond appropriately. Such agents can be configured to perform many tasks in the interface where the patient and clinician interact.. We previously developed a software infrastructure that uses the Internet to provide a lifelong, individual health record and allows secure electronic messaging among caregivers, patients, and physicians. This is currently implemented as HealthCompass, which is in field tests at Celebration Health in Orlando, Florida. To enhance this system, we analyzed the tasks intelligent software agents might perform on behalf of the physician, the patient, and the caregiver.
Methods: As a model for analysis we selected type 2 Diabetes Mellitus because it is a common, difficult-to-manage illness for which detailed clinical practice guidelines are available from the American Diabetes Association. We analyzed the different monitoring scenarios in the guidelines with object-oriented techniques. The result guided the architectural design for a system of intelligent agents, which perform continuous individualized monitoring of medication compliance. We created an additional set of agents that act on data input into a patient’s health record and send e-mail notifications to the physician and patient caregiver. Using the HealthCompass software to supply the database, record storage, and Internet communications, a prototype system was built that uses a treatment plan contained the database to control the activities of the agents. We then subjected the prototype to a functional evaluation by creating exemplar patients to determine whether the agents performed according to the model.
Results: Our initial analysis identified 5 categories of agents useful in monitoring patient compliance with a medication regimen. We then developed detailed analytical models for two medication compliance scenarios: (1) Was the prescription filled? (2) Was the dosage taken appropriately? The resulting prototype system monitors 3 different compliance activities: prescription compliance, dosage compliance, and change of medication. Additional agents monitor each patient's progress according to the treatment guidelines. If the patient deviates from the guideline, the agents follow specified criteria and send email messages either to the caregiver or the physician.
Conclusions: We have modeled one aspect of the interactions required to manage a chronic illness and built a prototype software program that uses intelligent agents to monitor patient adherence to a medication regimen and notify the primary caregiver and attending clinician of problems. Using agents we can intervene to improve adherence to prescribed treatment. Our model analysis and prototype demonstrate that 1. Agents can be configured to perform monitoring activities specified in clinical guidelines, 2. Agents can perform the tasks defined in our analysis, and 3.A lifelong health record could be used as a repository to support personalized continuous compliance monitoring with agents. The next steps are to extend the agents capabilities and to model other disease settings. Ultimately, the impact of clinical monitoring by agents on patient outcomes will need to be measured.