Agent Support for Patients and Community Pharmacists

J-P Calabretto\textsuperscript{1,2}, Damon Couper\textsuperscript{1}, Barrie Mulley\textsuperscript{1}, Mark Nissen\textsuperscript{3}, Saree Siow\textsuperscript{1}, Jonathon Tuck\textsuperscript{1}, Jim Warren\textsuperscript{1}\textsuperscript{*}

\textsuperscript{1} Advanced Computing Research Centre, University of South Australia
\textsuperscript{2} Adelaide Women’s and Children’s Hospital
\textsuperscript{3} US Naval Postgraduate School
\textsuperscript{*} warren@cs.unisa.edu.au

Abstract

This research explores agent technology to support the information needs of patients and community pharmacists toward a beneficial outcome for the patient. As patients make more use of over the counter (OTC) medications to manage their own conditions, they must achieve effective communication in dealings with community pharmacists to avoid drug interactions and for guidance to seek consultation with physicians when appropriate. We describe an agent architecture that utilizes implicit and explicit sources of information for patient profiling. Collected profiles are used to provide a range of agent-based functions – including question formulation aides, Internet search utilities, and to support navigation of treatment guidelines – for both patients and pharmacists. The agent services are implemented in the context of the “Winston” Internet Medicine Cabinet, an online personal medication history service. We illustrate the value of the agent architecture and profiling in terms of an Internet search function.

1 Introduction

The effectiveness of the patient/physician relationship has been addressed by numerous studies, resulting in the identification of several areas of the interaction that are of concern. Contemporary health encounters are limited by factors such as physician time, which may preclude attention for the complete set of a patient’s questions and concerns [1-2]. Thorough elicitation and utilization of preferences for all patients under a physician’s care may not reasonably be addressed within these limits [3]. In a recent study of general practice consultations, Barry et al. [2] found that only four of 35 patients voiced their full agendas during consultation with their physician. The most common unvoiced agenda items were: worries about possible diagnosis and what the future holds; patients’ ideas about what is wrong; side effects; not wanting a prescription; and information relating to social context. Moreover, it was found that these unvoiced agendas often led to problem outcomes (e.g., non-adherence to treatment) and that in all 14 consultations with problem outcomes, at least one of the problems was associated with an unvoiced agenda item.

Typically, physicians are perceived as possessing greater power to structure the nature of the patient/physician interaction – consequently leaving patients with a sense of being overridden [4]. There is strong evidence to support that patients instead desire to be treated as partners in their health care [5-6], particularly in the area of decision making [7]. Ball et al. suggest that patient attitudes are shifting towards a consumerist view, seeking convenience, control and choice in the health care field [5]. Holistically, the patient centred approach that is desired consists of (at least) three elements: communication, partnership, and health promotion [6]. The extent to which a patient centred approach is desired ultimately depends upon the patient - those who are vulnerable either socioeconomically or because they are feeling particularly unwell or worried may have a greater tendency towards these three components [6-7].

Self medication with over the counter medicines has long been a feature of the lay health system, and is an increasing trend across Britain, Europe, the United States, Australia and New Zealand [8]. In 1999, more people in the US visited alternative care providers than visited their physician [9]. This increase in home based, self-medicating care is driven by rising care costs, consumerism and the increase in telecommunication technology fuelling the move away from an institution based care model [10]. A significant increase in interest in telemedicine as a means
of healthcare delivery has also been observed [11-12], perhaps driven by an ageing population, rising admissions with falling lengths of stay, cost and difficulty of transportation [12]. These trends increase the importance of supporting self-management behaviours (referring to the activities performed by sufferers and their families to lessen the impact of an illness) [13].

The community pharmacist has an important support role to play, supplementing the physician in this patient-self-management and OTC-rich environment. Considering this role, it is important for community pharmacists to correctly recommend OTC treatments/medications [8]. However, OTC verbal recommendations often cause low rates of patient recall - good written information is an important way to reinforce verbal advice [8]. This leads us to wonder about the role that Internet-based technologies may play in supporting this vital patient-pharmacist interaction.

Patients are already actively seeking more involvement in their therapies [6, 14], which the expansion of the Internet has helped to facilitate. The Internet is seen to have an increasing influence on health care as an alternate information source [1, 5, 10, 14-16], and along with information technology in general it has been identified as a contributor in changing health care relationships [16]. In 1999, 74% of US Internet users searched for online health and medical information, and that percentage is increasing at a 43% annual growth rate (compared to a 22% growth in the Internet as a whole) [17]. Providing patients with online information can actually save time for health care providers, effectively reducing the overall cost of therapy [5, 12]. Simultaneously, the discovered information often encourages a patient to form further (informed) questions and explore their therapies and condition [5, 14-15]. The Internet also makes possible inter-patient collaboration that can provide valuable support and resources [14].

These positive aspects of Internet utilization for patients are offset by concerns regarding the accuracy and validity of online information [5, 15]. Search queries from users are often ineffective for finding the desired information [1], and it must be kept in mind that on-line resource may be intended for commercial rather than health care purposes [15] or be otherwise inappropriate (e.g., unsubstantiated). A similar issue exists with advice and resources that result from inter-patient collaborations [14]. Efforts must be made to guide patients toward content that is appropriate and useful [5, 15].

Further developed on-line technologies can increase the partnership felt by patients [5, 18], strengthening communication, increasing efficiency and improving decision making [5,11]. Web-enabled disease management holds great potential for cost savings and reduced mortality rates, especially for the treatment of chronic disease [5, 12]. To do so, health care must be approached more actively by online systems [5] to take advantage of the variety of viable applications in preventative healthcare and education for self-management, health maintenance, and health support [12].

A system for the collection and maintenance of electronic medical records (EMRs) is one such application that may benefit from web accessibility [12]. EMR systems can increase the effectiveness of physicians by reliably storing and retrieving patient data for use in decision support systems (DSSs) and related tools [1]. The seamless integration of these two technologies (DSSs and EMRs) is of great value to evidence based health care applications [1]. Providing medical guideline support as the DSS element linked to an EMR system can improve decision support by using patient data to tailor interventions on a patient by patient basis, using rules triggered by the stored data [10, 19]. For instance, McDonald et al. noted that translating existing knowledge bases into computerized guidelines would be helpful in diabetes treatments [20].

A system of this nature could be further augmented by, among other things, patient therapy preferences to assist in selecting the most appropriate treatment options [3]. The value of using patient preferences in health care is well recognized [21]. Secondly, query formulation and refinement capabilities may be useful. Clinical (clinician oriented) query support has been addressed by previous research and systems [1], but it may also be of use to consider patient query support. Lastly, entertainment enhanced education systems have previously been shown to increase patient knowledge and efficacy. Shegog et al [13] demonstrated this with their system to address self-management of chronic child asthma sufferers, with users of their WDTA (Watch, Discover, Think, Act) trial system demonstrating improved awareness and self-management behaviours as compared to a group that did not use the service.

The information needs of the patients and pharmacists must be supported as the trend toward OTC based therapies grows more popular. Providing secure on-line access to the technologies discussed above would allow patients to participate in maintaining their own EMRs, and offer an opportunity for real-time, patient/pharmacist oriented decision support and education. We believe that Internet based software agents may be used effectively to perform this support of community pharmacists and patients in OTC encounters, specifically by presenting guideline-based therapy guidance / pharmacist decision support and assisting in a patient’s understanding of their own condition and condition management.

In this paper we derive an architecture of Internet based agents to support the patient-pharmacist relationship in a community environment. In the next section we briefly review relevant models of patient behaviour and current agent technology. In section 3, we provide a mapping of support needs to an agent architecture. Section 4 describes our “Partnership” system implementation and patient profiling, and illustrates the system’s search aid function.
We conclude with a discussion of the benefits of such an architecture and with our research plans in this area.

2 Background

2.1 The Stages of Change Patient Model

Revere and Dunbar discuss theoretic models of patient behaviour in their review of outpatient health behaviour interventions [22]. The review suggests that an appropriately chosen theoretic model of a patient’s health behaviour can be used to target their needs more effectively, enhancing a patient’s motivation to adhere to the intervention. One of the models review, the stages of change model (or trans-theoretic model) of patient behaviour [23] is based in cognitive-behavioural theory. It is concerned with a patient’s readiness to change, and motivations to do so. Table 1 describes the concepts of each stage of the model, defining the stage’s role and application.

Warren and Nissen [24] provide a more specific adaptation of this model as applied to health encounters. The adapted model is intended for patient/physician encounters and behaviour, but the motivational elements seem equally applicable to the patient/pharmacist relationship. The model describes six contexts, as described in Table 2.

For the purposes of our present architecture development, a hybrid model derived from the models described above is used. The hybrid model considers the following contexts of a health encounter:

- Contemplation
- Digestion
- Maintenance

2.2 Internet Agent Technology

Despite frequent mentions of the term, ‘software agent’ is often left undefined and vague in the context of system designs and architecture discussions [25-26].

Table 1 – Stages-of-change model (as described in [22])

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-contemplation</td>
<td>Unaware of problem, hasn’t thought about changes</td>
<td>Increase awareness of need for change, personalize information on risks and benefits</td>
</tr>
<tr>
<td>Contemplation</td>
<td>Thinking about change, in the near future</td>
<td>Motivate, encourage to make specific plans</td>
</tr>
<tr>
<td>Preparation</td>
<td>Making a plan to change</td>
<td>Assist in developing concrete action plans, setting gradual goals</td>
</tr>
<tr>
<td>Action</td>
<td>Implementation of specific action plans</td>
<td>Assist with feedback, problem solving, social support, reinforcement</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Continuation of desirable actions, or repeating periodic recommended step(s)</td>
<td>Assist in coping, reminders, finding alternatives, avoiding slips/relapses</td>
</tr>
</tbody>
</table>

Table 2 – Patient/pharmacist encounter Model [24]

<table>
<thead>
<tr>
<th>Context</th>
<th>Definition</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contemplation</td>
<td>Stage of contemplation prior to advancement to action in modification of health behaviour.</td>
<td>Patient assesses what they would desire from an encounter.</td>
</tr>
<tr>
<td>Consultation</td>
<td>Stage of familiarization with purposes, terminology and therapies.</td>
<td>Conditions the patient to be more assertive/effective in consultation.</td>
</tr>
<tr>
<td>Preparation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-consultation</td>
<td>Captures the details of the encounter.</td>
<td>Aids patient recall of encounter.</td>
</tr>
<tr>
<td>Digestion</td>
<td>Clarification of discussed concepts and issues.</td>
<td>Discovery of appropriate and accurate information to supplement the encounter.</td>
</tr>
<tr>
<td>Patient Exchange</td>
<td>Sharing of experiences with similar patients.</td>
<td>Assistance and support in discovering and understanding the consequences of the encounter.</td>
</tr>
<tr>
<td>Rematch</td>
<td>Maintenance stage to continue therapies.</td>
<td>Expert clarification of issues.</td>
</tr>
</tbody>
</table>
Wooldridge et al. [27] and Parunak et al. [25] agree that ‘agents’ are an abstraction tool or bounded process that interact through defined interfaces in a shared environment. Additionally, an agent exhibits some set of intelligent behaviours with properties that are autonomous, reactive, proactive, or social [27-28].

Discussion concerning the application of the agent paradigm is extremely active, both supportive [25, 29] and cautionary [26-27]. Maes [29] describes a cooperative view of agent/user interaction in which both initiate communication, monitor events, and perform tasks. The concept is demonstrated by example e-mail and news agents that observe and learn the habits/preferences of the user in order to better service their requirements. Parunak [25] gives a lengthy coverage of several industrial systems based around agent technology as demonstration of agent applicability to use in production systems.

Agent criticisms generally stem from a lack of definition concerning agent nature, and the perception that agents are a ‘silver bullet’ solution [26]. Shneiderman [26] mentions that an anthropomorphic presentation, adaptive behaviour and vague goal specification sound initially appealing but have proven to be counterproductive. He does not contest the usefulness of agents, but rather advises that clear definitions and repeatable, user controllable behaviour is important to a successful agent system. Wooldridge et al. [27] are also supportive of agents in general, but stress the importance of recognizing that good software engineering practices are needed to counter pitfalls and avoid repetition of common mistakes.

A major focus of interest in agent development is multi-agent systems, such as the one Nissen [30] presents as a proof of concept prototype. The example, an “Intelligent Mall”, demonstrates the idea of agent communication and interaction. The agents (seller agents and shop agents) in the “Mall” negotiate with each other to provide the best solution for the end users. The shopper agents visit shops attempted to acquire the items specified by the user, hopefully at the best price and with minimal delay. Agents can interact autonomously, for instance negotiating the best price for a given item.

Drawing from Nissen’s paper [30], it is useful to classify such agents based upon their role in a given architecture. The following four categories are suggested by Nissen:

1. Information Filtering Agents – e.g., screening and categorising;
2. Information Retrieval Agents – e.g., assisted browsing;
3. Advisory Agents – e.g., decision support tools;
4. Performative Agents – e.g., performance of knowledge work and conducting of business transactions

The use of an agent based architecture to support community pharmacists and patients grounded in a desire to explore the usefulness of emerging technologies in the healthcare environment. Agents systems are inherently compatible with distributed systems offering a promising solution for telemedicine applications [28], while also exhibiting modular, decentralized, and changeable architectures [25] that support and encourage good software engineering practices. Previous systems have demonstrated the usefulness of computer based interventions and support [31-32], and we aim to continue efforts to develop useful tools [33] taking advantage of the benefits that an agent-based paradigm can present.

Our agent architecture is very much inspired by work on migraine patient profiling and customised interactive explanation as investigated by Buchanan et al. [32],

![Figure 1 – Mapping the patient context to agents](image-url)
however, we seek to update the methods to better exploit Web technology. Moreover, where Buchanan et al. aimed to supplant doctor-patient communication, we are more focused on encouraging doctor-patient and pharmacist-patient communication.

3 Deriving an Agent Architecture

The patient context model to be used has been discussed in section 2.1. We identify the agent requirements of each context as shown in Table 3 (with some reliance on [24]).

These requirements can be used as the basis for identifying a set of agents that satisfy them. Figure 1 illustrates the mapping of the patient context model to a set of agents that supports them. The agents identified in the mapping are described in Table 4, classified as per the four categories of agent outlined in Section 2.2. Figure 2 illustrates mapping of the identified agents to information sources, including the patient profile (and considering the EMR as part of the patient profile).

Figure 2 also includes agents to support the needs of community pharmacists within the system. The chief distinct requirement for community pharmacists within the system. The chief distinct requirement for community pharmacists is perceived to be tailored decision support on guideline adherence for patients.

4 The “Partnership” System

4.1 Architecture

In the previous section of the paper a set of agents was identified to support the patient/pharmacist relationship in a community environment and meet the needs of a patient centred approach. We now describe the “Partnership” architecture that implements the required agents, patient pro-

Table 3 – Agent requirements of patient contexts

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Requirements</th>
</tr>
</thead>
</table>
| Contemplation | Reflect Patient Preferences  
Interact With Patients |
| Digestion   | Search/retrieve information  
Reflect patient preferences  
Assess information reliability |
| Maintenance | Monitor and support ongoing therapy |
“Partnership” is grounded in a three-tiered architecture that consists of a presentation logic layer, an application logic layer, and a data layer. The highest level manages the look and feel of presented system behaviours for a user, the middle layer contains the processing logic that is the foundation of the system, and the lowest level manages the storage of (local) data and knowledge bases. The identified agent set comprises the middle, processing layer of the system.

“Partnership” is implemented as an extension of “Winston, the Internet Medicine Cabinet” [34]. Winston has been developed to satisfy a communication enhancement role for community pharmacists and patients. It allows the storage of current medication details and supports threaded discussion of problems and issues related to the medications, both intended to encourage substantive and relevant patient-pharmacist conversation. However, while Winston manages patient data and discussion, it does not provide “knowledge” support – i.e., to help the patient to learn. This is where “Partnership” comes in as an extension of Winston.

The presentation layer for the agent architecture is an extension of the existing Winston presentation system. To be compatible with Winston, “Partnership” is implemented primarily in ActiveX classes that are invoked by a server-side (Active Server Page) program that formulates the series of HTML and Javascript Web pages that the user views via a conventional Web browser.

Table 4 – Agent descriptions and classifications

<table>
<thead>
<tr>
<th>Agent</th>
<th>Classification(s)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Modeller</td>
<td>Performative</td>
<td>Constructs a model of a patient user based on observation of their behaviour (implicit profiling) and specifically gathered information (explicit profiling). The agent continually updates the model of the user to keep it relevant. The agent’s implicit-style work is to observe the user’s actions silently (visited sites, search keywords etc, time spent reading documents, links followed). The complementary explicit-style work requires specifically interacting with the user to gather further information concerning preferences (usefulness of a provided resource, preferred sources etc).</td>
</tr>
<tr>
<td>Query Assister</td>
<td>Performative</td>
<td>Accepts and evolves information queries directly from the user. This may include helping refine the user’s query, expanding it, suggesting alternatives or simply accepting keywords. Information gathered is given to the patient’s researcher, so that it may attempt to find the desired information.</td>
</tr>
<tr>
<td>Researcher</td>
<td>Information Retrieval and Filtering</td>
<td>An agent that assists a patient user in discovering information. This may be in the form of accepting specific queries (through the Query Assister), or by automatically gathering information that it believes may be useful to the patient user, based on their user model or complete profile.</td>
</tr>
<tr>
<td>Guideline Adherence Agent</td>
<td>Advisory</td>
<td>An agent that compares an encoded medical record for a patient with a set of therapy guidelines stored by the system. The agent examines the therapy history, looking for inconsistencies or deviations from the guideline (and other derivable data). If insufficient information is available for the comparison the agent must initiate a process of gathering the information required directly from the user, to be used and recorded for future behaviour.</td>
</tr>
<tr>
<td>News Broker</td>
<td>Information Filtering</td>
<td>An agent responsible for collating, analyzing and organizing all of the data that is intended for presentation to a user. This information is forwarded by the agent (as appropriate) to the User Interface. The agent behaviour would be instantiated based upon the user class that is using the system – patient or pharmacist.</td>
</tr>
<tr>
<td>Reporting Agent</td>
<td>Information Filtering</td>
<td>An agent that manages the presentation of information to a user.</td>
</tr>
<tr>
<td>EMR Encoder</td>
<td>Performative</td>
<td>Takes the information from a set of patient records and encodes it to a format understandable by guideline adherence agents.</td>
</tr>
</tbody>
</table>
The data layer of the agent architecture also extends Winston. The agent set takes advantage of the existing EMR provided by Winston, but adds further data sources to satisfy agent requirements. The extension consists of a pharmaceutical guideline knowledge base (only sparsely populated at present) and the framework for storing patient user profiles. We define the patient profile as including both the Winston EMR and a user model derived from the behaviour and statements of patients while interacting with the system.

The core application logic of “Partnership” is encapsulated in the agents, implemented as a set of Java classes. Communication with the JVM is achieved with a set of ActiveX objects made available to the presentation logic layer, and acting on knowledge derived from the data layer. The DLL contains a mixture of Visual Basic and Java classes that implement the system agents. Java objects have proved particularly useful due to the well-developed support for network / Internet applications that the language offers (e.g., to implement Internet search/filter functions).

Agent interactions must be managed and controlled in a multi-agent system, allowing the agent components to communicate, synchronize, and cooperate [35]. A vital element of this is the definition of an appropriate agent communication syntax and protocol. A KQML/KIF combination (Knowledge Query Manipulation Language and Knowledge Interchange Format, respectively) is a common example of such a definition – KQML being used to structure the agent messages, and KIF as a content language. We have chosen a similar approach, implementing a KQML/XML combination with XML used both to encapsulate the KQML, and as a content language. This allows the representation of KQML messages in an extensible, interchangeable format that also has the advantage of compatibility with a web-based information system environment.

4.2 Patient Profiling

The locus of “Partnership” system activities is a patient user model constructed based on patient user behaviour. The model is composed of attributes that describe the user’s preferences and reactions to presented content. The attributes of the model are gathered by the user modelling agent. The agent may be interacted with directly to record explicit attributes (such as ratings of search results, and answers to quiz questions), or it may gather implicit attributes (such as search keyword, elements of an electronic medical record, and links followed) by observing users as they navigate the system.

Various system activities are driven by the collected user model. Activities include the augmentation of search queries, and re-ranking of search results once acquired (researcher agent). It can also be used to target therapy guidelines to a specific patient (compliance agent). At the most basic level, the profile can be used to alter the physical appearance of the system. An example of this would be changing the size of text upwards for aged patients, or for patients suffering from some form of eye condition (for instance, diabetes related retinopathy).

The patient’s EMR would play a key role in the system’s ability to adapt its behaviour. Firstly, ‘issues’, ‘medications’ and ‘symptoms’ from the EMR can be used intelligently in the search augmentation and re-ranking task. Secondly, the EMR can be used by the user modelling agent to decide whether or not a patient may be suffering from certain conditions such as retinopathy.

Another part of the collected profile is used to construct a map of a patient’s knowledge regarding diabetes. The map defines how effective a patient’s knowledge is in a given area of diabetes. For instance, a knowledge map for a diabetic might show that their knowledge of footcare is well developed, but their understanding of long term complications is lacking.

The construction of such a knowledge map is based primarily on quiz results, and can be used to highlight deficits in a patient’s knowledge that may need attention. EMR elements also contribute – medication history may give an impression of a user’s breadth of knowledge regarding therapies, for instance. Additionally, searches conducted by a patient are valuable - a search for ‘glycemic index of foods’ indicates awareness of the importance of diet and diabetes to some degree. Furthermore, a male patient may find less use for information topics regarding diabetes and pregnancy.

Once constructed, this allows the system to respond to a given patient’s specific level of knowledge. The query assister agent can use identified deficits/strengths to sensibly suggest items (to the patient user) that may be included on a patient-pharmacist encounter agenda. Such an agenda would be presented to a pharmacist by the patient, and include items and issues intended for (brief) discussion during the encounter. Deficits in knowledge may also help to further target quizzes to a specific user, to better explore their knowledge.

4.3 Illustrated Function – Profile-based search re-ranking

Traditional search engines are excellent at retrieving relevant documents but few of the top ranking results are typically in the correct context [36]. This can occur for many reasons – too few query terms used, poor choice of terms, word meanings being different when used in certain ways are just a few. Unlike a traditional search engine, in “Partnership”, the context of the search can be derived from the user’s location in the system (i.e., the task that they are performing at that point in time).
When an explicit search query is given to the system it will first expand this query based on the perceived context of the query. Expanding the query into something more substantial has been show to improve the results that can be expected and many systems have been created that demonstrate this [36-42]. The context of the search can be derived from the user’s location in the system as the search will typically be resulting from the user seeking clarification of relevance to their current task. This context is also used for the re-ranking process.

Once a query has been reformulated the system will then use either a publicly available search engine or a local search engine (which only has trusted sources indexed) to retrieve the results for this query. If no search engine is selected an appropriate decision will be made on the user’s behalf based upon previous user actions. The system has been designed in such a way that the exact search engine that is used can be easily changed depending on the type of information that is being searched for and the context of the search. The results are retrieved they are re-ranked according to the context of the search and the user’s profile. Returned results that have proven to be of interest to users are promoted and results that have been shown to be undesirable are demoted. In particular the amount of time that a user and similar users have spent on a page is given a particularly strong weighting when re-ranking results as this has been proven to be an accurate measure of the relevance a web page to a user [43].

Some function of time would be used to determine how useful a page is – possibly a curve of relevance vs time that is initially steep, following by an asymptotic approach toward some maximum value of relevance.

This would mean that, initially, the more time spent on a page the more relevant it is considered. At some point the rate of increase in relevance would drop so that, for instance, spending 50 minutes on a page may make it no more relevant than spending 15 minutes viewing it. This incorporates both a reasonable compression of the relevance scale, and also tolerates interruptions while viewing a page (telephone calls or other distractions) that might otherwise skew relevance results.

Figures 3 and 4 illustrate search results for the query “Alternative Therapies” with and without re-ranking for a user invoking search from a view of their Diabetes history. Figure 3 shows the potential for virtually-useless Internet search results for health related queries if one fails to establish a clinical context for the query.

To give the users some confidence in the system and provide them with a level of explanation of agent behaviour in the system, the users are able to view and edit their own profile. This feature enables information that they feel is inappropriate, for whatever reason, to be removed so that no agent in the system will take actions based on that information in the future. By the same token they can promote topics that they feel may be of interest in the future. It also provides a mechanism by which all agent activity can be switched off so that no actions will be taken unless explicitly asked for.

5 Discussion

We have reviewed patient information needs as motivated by the combination of problems with patient/provider communication (“provider” being physician
or pharmacist) and the trend for patients to self-manage with OTC medications. We have derived a set of agent-based functions to satisfy these information needs and provide support for improved patient-pharmacist interaction. The agent functions have been implemented as the “Partnership” system that acts as a knowledge support service on top of Winston, the Internet Medicine Cabinet. As an illustration of “Partnership” functionality, we demonstrated a context-based augmentation of Internet search.

The importance of a system such as “Partnership” is two-fold. Firstly, it demonstrates the use of EMR technology in a patient-centred fashion. That is to say, EMRs and associated health information systems, decision support systems and expert systems are generally thought of as aids for the physician as user. Winston, and “Partnership” are about the patient as the key user, with the EMR and agent/knowledge aids serving to stimulate patient/provider conversation, understanding (and, well, partnership), leading to improved adherence to evidence-based treatment regimes. Secondly, the system demonstrates a view of the Internet and the “Web” that is distinct from that of browsing a hyperdocument. The Winston/Partnership interface is about focused interaction with definable, important, health-related goals. The system uses the Internet for ubiquitous connectivity, and browser software as a ubiquitous client interface shell, but the task model is far more detailed than browsing. With a model of patient contexts and activities, and a profile that includes the EMR, we can provide specific local (i.e., on the Winston/Partnership server) and distributed (“on the Web”) information in service of patient needs with an interface metaphor similar to a conventional information system.

A series of focus groups sessions are currently being conducted to further refine the system, with participation from diabetes patients and their associated community pharmacists. The sessions are divided into two streams – community pharmacist sessions and patient sessions. Initially, they will be concerned with further validating system requirements established from the literature. After a few initial sessions, the focus group agenda will move to user interface review. Because we use a multi-tiered architecture, we can adjust look-and-feel at the presentation layer for the users across a wide spectrum while preserving most of the development effort on the core agent objects and data layer. Eventually the focus groups will culminate in formal usability testing, assessing the system on elements of defined usability specifications. If results from these sessions are positive we will seek to pursue a field trial of the system, although this is some time in the future.

Acknowledgements

We extend special thanks to Prof Michael Shepherd for his insight and guidance on this work.

References
