# ActiveGuidelines: Integrating Web-Based Guidelines with Computer-Based Patient Records

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*Use of the World Wide Web provides an efficient means to disseminate guidelines, but integrating them into the workflow at the point of care remains elusive. We developed a method, ActiveGuidelines (AGL), of integrating web-based guidelines with computer-based patient record (CPR) systems. An ActiveGuideline is an HTML document containing special tags that are interpreted by a CPR as actions (e.g., medication order, test order, referral, patient instructions). In our usage scenario, the CPR automatically displays ActiveGuidelines relevant to the current patient context. After reviewing the guideline, the user selects recommended orders directly from the ActiveGuideline. The selected orders are automatically transmitted to the CPR and executed as regular orders. An ActiveGuideline editor facilitates easy conversion of existing HTML-formatted guidelines into ActiveGuidelines. We believe that integrating patient-specific ActiveGuidelines within a CPR system will improve utilization of clinical guidelines in routine patient care.*

## INTRODUCTION

Although the use of clinical guidelines was widely predicted to change the practice of medicine, the impact of guidelines on routine care is yet to be felt on a broad scale. Integrating guidelines into the routine workflow of patient care has been a critical obstacle to their effective use.[1,2] The process of creating guidelines, disseminating them, making sure clinicians are aware of them, ensuring their use, and measuring their impact has been difficult to accomplish.[2-5]

Despite the existence of well designed evidence-based guidelines that physicians endorse, documented compliance with these intentions fall substantially short of expectations. For example, administering influenza vaccinations to elderly people has been shown to reduce mortality, morbidity, and health-care costs.[6] Even though most physicians are aware of the recommendations and agree with them, approximately half of the eligible population goes unvaccinated each year,[6] leading to excess influenza-related deaths numbering in the tens of thousands.[7] Although there are several other reasons why a patient may not receive the vaccination (e.g., patient allergies, patient preference, ability to pay), implementing simple guidelines in computer-based patient record (CPR) systems has been shown to increase physicians' compliance with them, and the impact on patient care has been significant.[8-13] Most of the clinical reminders generated by current operational systems invoke simple rules (e.g., health maintenance reminders, drug interaction checking, drug-lab checking). Simple in form, these rules can be applied to a large proportion of clinical encounters, improving the quality of care and reducing its costs.

Guidelines that are more complicated or involve more professional interpretation are often difficult to implement in computer programs, which require precise definitions and complete data.[14] Computer-based guideline authoring tools would help guideline developers write executable guidelines.[15] Until executable guidelines tailored to specific patients become available on a routine basis, however, healthcare professionals will need to access, read, and interpret textual guidelines. Since textual guidelines constitute the preponderance of guidelines currently available, finding an effective way to implement these guidelines would leverage a substantial body of clinical practice knowledge that is currently underused. The work described in this paper focuses on integrating these types of guidelines into CPRs. The first step is to facilitate access to available guidelines.

## GUIDELINE RESOURCES ON THE INTERNET

To address the problem of guideline dissemination and to increase their availability to clinicians at the point of care, many developers have posted their guidelines on World Wide Web servers. The Agency for Healthcare Research and Quality, the American Association of Health Plans, and the American Medical Association created a National Guideline

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Clearinghouse for clinical guidelines (http://www.guideline.gov/index.asp) to facilitate guideline dissemination. Through the clearinghouse, interested parties can find a sizable repository of guidelines developed by professional associations, often with links to abstracts or full text of the supporting literature. Similarly, health systems and individual healthcare organizations have taken steps to make their guidelines and best practices available on their own organizational Intranets. This is a significant step forward, but past experience has shown that to influence physicians' ordering behavior effectively, reminders, alerts, and guideline recommendations must be presented at the time decisions are made – typically at the time physicians enter their orders.[1,16-18] Consequently, the ready availability of guidelines on the Web is a necessary, but not sufficient step toward integrating guidelines into clinical practice. The next step is to seamlessly integrate textual guidelines into CPR systems.

## INTEGRATING TEXTUAL GUIDELINES WITH CPRS

Integrating computer-based reminders and recommendations seamlessly within the workflow of a patient encounter requires the following: 1) the CPR should provide patient-specific guidelines at appropriate points in the workflow of the encounter, 2) guidelines should provide an easy method to select appropriate actions directly off the guideline, and 3) CPR systems should automatically incorporate and execute actions selected from guideline recommendations.

We have implemented a method, ActiveGuidelines (AGL), of integrating web-based guidelines available over the Internet or Intranet into a CPR that satisfies the above requirements.

### Workflow Using ActiveGuidelines

Asking the user to search for guidelines that apply to a specific patient during an encounter or asking the provider to reenter guideline-recommended actions into the CPR impedes use of guidelines in practice. We designed ActiveGuidelines to be integrated into the normal workflow. Guidelines relevant to a specific patient context (e.g., based on the patient's problems, medications, allergies, lab test results, or health maintenance topics) are invoked in real-time at the point of care. Rules specifying eligibility criteria for guidelines are written to map various aspects of patient context to available guidelines. The system automatically presents relevant guidelines for the current patient. If the provider wishes to view a guideline, he or she selects the desired guideline and a Web browser within the CPR is invoked to view the guideline in HTML format (see Figure 1).

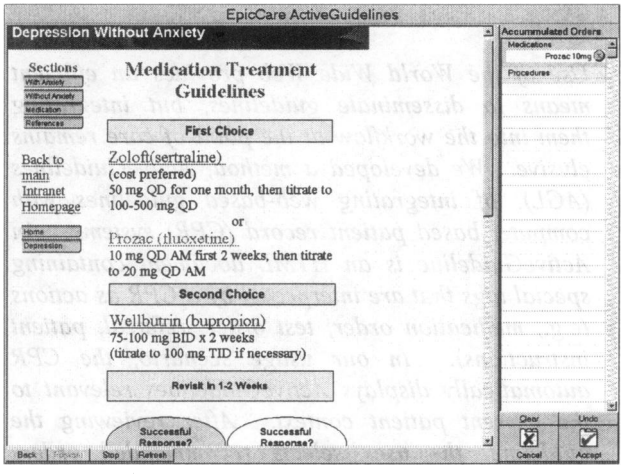


**Figure 1: Depression ActiveGuideline.**

When the user elects to view an ActiveGuideline, the HTML page containing the guideline is presented through a Web browser within the CPR. In this example, the user has selected fluoxetine off the guideline, and the order has been placed in the Orders Accumulator on the right-hand side of the browser. The depression guideline excerpt shown in the figure is copyrighted by Dr. Bruce Bienenstock at the Palo Alto Medical Foundation and is used with his permission.

Typically, the textual guidelines contain recommendations in the form of orders (e.g., medication order, test order, referral request). In an ActiveGuideline (where the recommended orders have been "activated"), the provider "clicks" on the orders he or she wants to include in the CPR and the selected orders are accumulated in a list at the right-hand side of the browser (analogous to a "shopping cart"). When the user is finished selecting actions from the guideline, clicking "Accept" (at the bottom right of the window) will transmit the selected orders to the CPR, where they will be acted upon in the normal fashion as if they were entered in the CPR by the user directly.

### ActiveGuideline Architecture

The ActiveGuideline architecture specifies the linkage between a CPR system and a guideline server that stores ActiveGuidelines. The architecture for AGL is depicted in Figure 2.

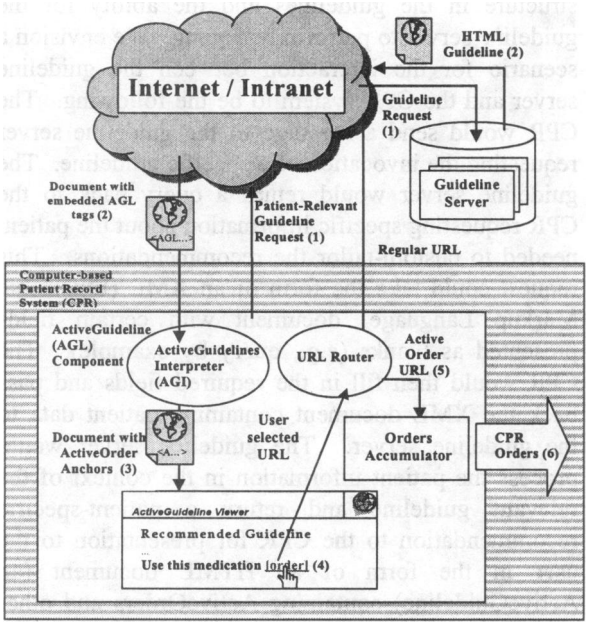


**Figure 2: Architecture of ActiveGuidelines Integrated within a CPR.**

The CPR issues a patient-relevant guideline request to the guideline server (1). The guideline server returns an ActiveGuideline with embedded AGL tags (2). The ActiveGuideline interpreter converts the AGL tags into ActiveOrder anchors (3). When the user clicks on the ActiveOrder hyperlink (4), the URL router sends the ActiveOrder to the orders accumulator (5) which, upon acceptance, is transmitted to the CPR (6) as a regular order.

The information process flow corresponding to the workflow described in the previous section would occur as follows. When the patient context triggers the retrieval of a relevant guideline, a guideline request is sent to the guideline server. The guideline server returns an HTML document with embedded AGL tags (the tag contains information used by a CPR to process an order), which is described further in the next section. The AGL component in the CPR contains an ActiveGuideline interpreter which translates the hidden AGL tags into ActiveOrder-anchors for viewing by a standard Web browser control. ActiveOrders (an order expressed in HTML syntax) are viewed as hyperlinks. When the user clicks on the ActiveOrder hyperlink, a URL Router sends ActiveOrders to the Orders Accumulator. If the user clicks on a normal hyperlink, the URL Router will process the URL address as a normal selection of an HTML page. After the user is finished selecting all the relevant orders from the guideline document for the current patient, the user "accepts" the current transaction which sends the selected orders to the CPR for normal order processing.

### ActiveGuideline Message Syntax

Syntax and terminology standards need to be developed to specify an actionable order within the ActiveGuideline. Below, we provide simple examples of AGL tags that specify orders to be carried out in a CPR system. The examples below illustrate a simple syntax for ActiveOrders that uses commonly available standard codes (e.g., NDC, CPT). The first example of an AGL tag contains an order for the medication fluoxetine:

```
<AGL type="MED" Name="Fluoxetine HCL
Cap 10 MG" NDC="0777-3104-01" Sig="T
ake 1 cap daily in the morning for 2
weeks,then take 2 caps daily in the
morning" DoseStrength="10mg" Dispens
e="42" Refill="0">Prozac(fluoxetine)
</AGL>
```

The second example shows an AGL tag for a complete blood count diagnostic test:

```
<AGL TYPE="PROC" Name="COMPLETE BLOO
D COUNT" CPT="85001" Priority="Routi
ne"> Complete Blood Count (CBC)</AGL
>
```

The ActiveGuideline Interpreter converts an AGL tag into an ActiveOrder hyperlink, visible within a web browser. For example, the above medication AGL tag for fluoxetine is converted into an ActiveOrder hyperlink, represented below:

```
<A HREF=CPR:/agl/Order.asp?Type=MED&
Name=Fluoxetine+HCL+Cap+10+MG&NDC=07
77-3104-01&DoseStrength=10mg&Sig=Tak
e+1+cap+daily+in+the+morning+for+2+w
eeks,+then+take+2+caps+daily+in+the+
morning&Dispense=42&Refill=0>Prozac
(fluoxetine)</A>
```

In the browser (see Figure 1), this link is displayed as: Prozac (fluoxetine). When the user clicks on the fluoxetine hyperlink, a medication order is sent to the Orders Accumulator.

### ActiveGuideline Editor

To facilitate converting an existing HTML guideline document into an ActiveGuideline, we have developed an ActiveGuideline Editor as an Add-in to Microsoft's FrontPage 2000™ HTML document editor. Using the editor, an author can easily "activate" the guideline by associating the recommended orders contained within the guideline with standard CPR orders.

The editing tool provides access to the database of medication and procedure orders in the CPR and

inserts a properly formatted tag into the HTML guideline document automatically.

We have implemented ActiveGuidelines in EpicCare,™ a CPR system developed by Epic Systems (Madison, WI). EpicCare is the electronic medical record in use at the Palo Alto Medical Foundation, a multi-specialty group practice of 400 physicians affiliated with Sutter Health.

## DISCUSSION

Many organizations, both national and local, have invested significant time and resources to develop clinical guidelines that are based on best available evidence in the literature and have been vetted through a consensus process nationally and/or locally. Some organizations have already converted their textual documents into HTML documents and made them available on the Internet or Intranet. To ensure stability of the document content, most organizations will choose to host ActiveGuidelines on their controlled Intranet. By "activating" existing textual guidelines and making them available to the clinician at the point of care through a CPR system, organizations can take advantage of the time and resources they have already expended to develop locally accepted best practices. Because ActiveGuidelines use hidden tags within the HTML guideline document that do not display in a normal browser, the same guideline documents stored on a web server can be used both for routine public browsing as well as for responding to queries from AGL-enabled CPRs.

Geissbühler described a method of embedding an order in an HTML document that can be returned to Wizorder, a physician order entry system at Vanderbilt.[19] Their wizorder command is invoked as an HREF hyperlink to an out-of-process action executed on a web server. Our method differs in that the browser process is contained within the CPR application, which would allow us to take advantage of CPR decision-support functions such as drug interaction checking, and interactive order checking. Also, the hidden nature of the tags we use (vs. the visible HREF) makes it possible for a single guideline document to serve public read-access needs as well as serve as an ActiveGuideline for CPRs, which simplifies guideline maintenance.

We envision that the next step in guideline integration would be for the guideline server to provide patient-tailored recommendations to the CPR without requiring users to read through the guideline themselves. This would require more sophisticated structure in the guidelines and the ability for the guideline server to perform reasoning. We envision a scenario for the interaction between the guideline server and the CPR system to be the following. The CPR would send a message to the guideline server requesting the invocation of a specific guideline. The guideline server would return a query back to the CPR requesting specific information about the patient needed to custom-tailor the recommendations. This request could take the form of an XML (Extensible Markup Language) document with certain fields presented as blanks (e.g., query by example). The CPR would then fill in the required fields and pass back the XML document containing patient data to the guideline server. The guideline server would process the patient information in the context of the relevant guideline and return a patient-specific recommendation to the CPR for presentation to the user in the form of an HTML document (an ActiveGuideline) containing ActiveOrders and other links to rationale for the recommendations. The ActiveGuideline would then be processed by the AGL-enabled CPR in the same manner as described in this paper. This scenario is similar to that proposed by Dubey,[20] but enhanced through the use of ActiveGuidelines. Other researchers and developers have described various notions of a guideline server.[21-24]

Chueh, et al. described an example format for exchanging patient data between systems using XML.[25] Use of XML for exchanging patient data is actively being developed in HL-7 and ASTM work groups. To implement the concept of guideline servers on a broad scale, standards must be adopted to codify data content, guideline knowledge representation, and guideline exchange syntax. Several research groups are working together to develop a guideline interchange format (GLIF) to define standards for encoding and sharing guideline knowledge in executable formats.[26]

We propose that standards be developed to facilitate the use of ActiveGuidelines with any CPR system. Only when interoperability standards are adopted will the Achilles heel of guideline utilization – integration into routine practice – be overcome.

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