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Guidelines for GUI Analysis: Assessments and Recommendations for GUIs of AHLTA and VistA CPRS

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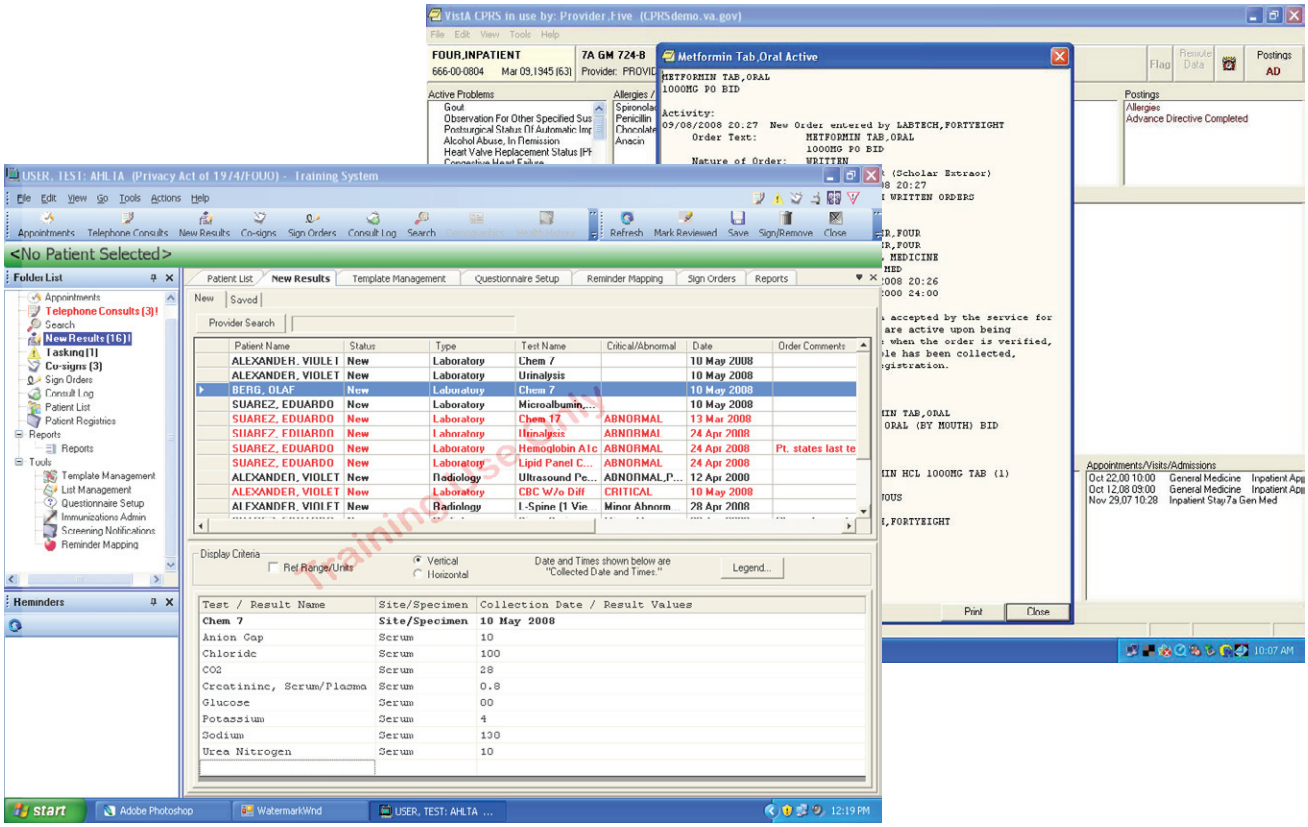

INTRODUCTION

The Parsons Institute for Information Mapping (PIIM) performed a Graphic User Interface (GUI) focused assessment of two Electronic Medical Record (EMR) systems: Armed Forces Health Longitudinal Technology Application (AHLTA), developed by the U.S. Department of Defense; and Computerized Patient Record System (CPRS), developed by the U.S. Department of Veterans Affairs. PIIM conducted this thorough analysis leveraging its expertise in Knowledge Visualization, Graphic User Interface (GUI) design, Information Architecture (IA), and User Experience Design (UXD).

This paper discusses the investigation into the AHLTA and CPRS systems, documents current GUI problems and limitations of each system, suggests GUI modifications to each system, and presents potential usability enhancements resulting from suggested GUI modifications.

Through this intensive review PIIM has identified several, key issues which adversely affect the use of these EMR systems. These issues were identified and documented with the following categorizations:

- Information Architecture and Hierarchy
- Content Realignment
- Ease of Navigation
- Iconography
- Color
- Type Treatment

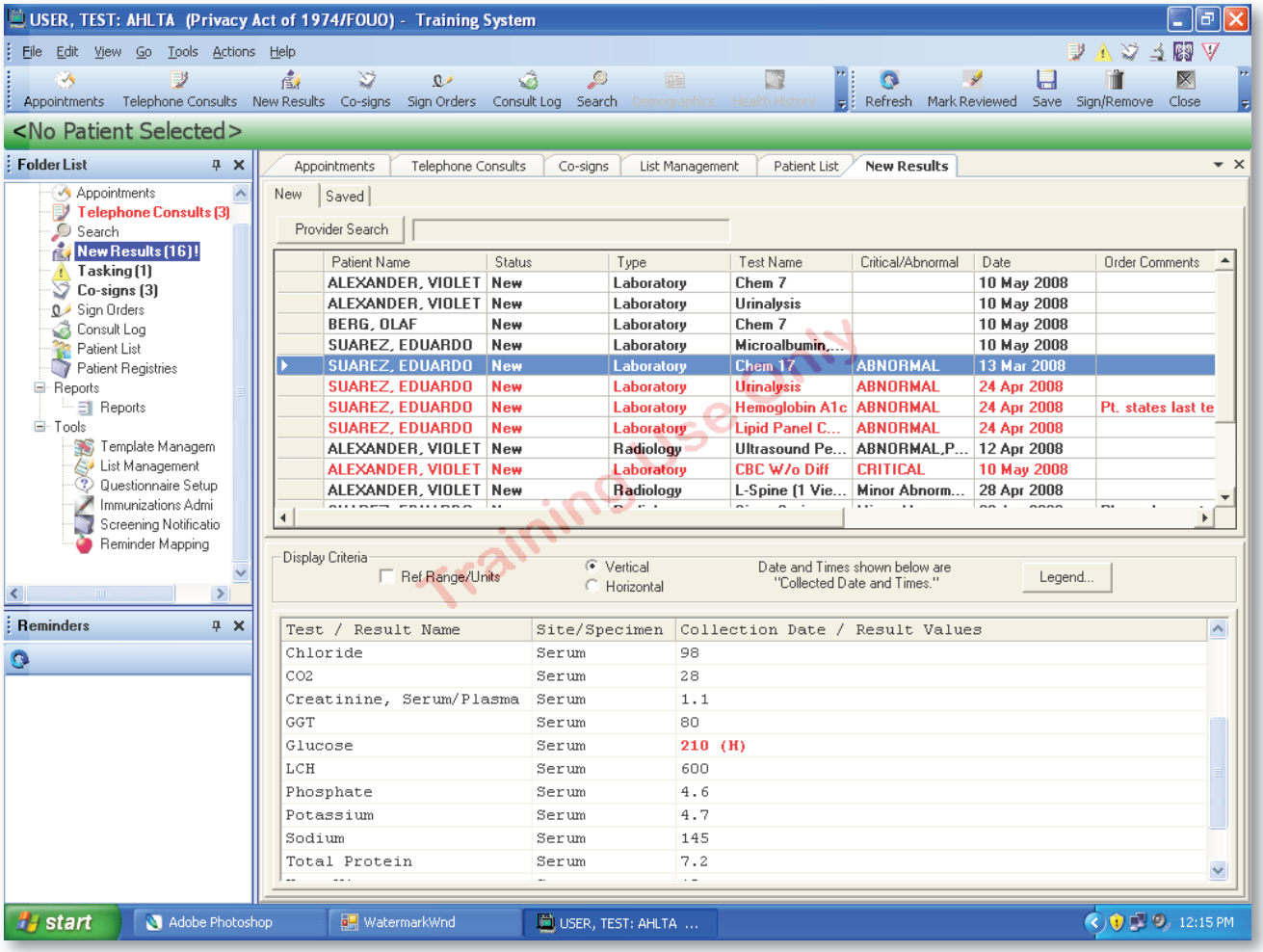

FIGURE 1: *AHLTA, Version 3.3*

1. DESIGN ASSESSMENT OF THE CURRENT AHLTA GUI

The design and development team at PIIM has assessed the training software of AHLTA, Version 3.3 (FIGURE 1).

1.1 INFORMATION ARCHITECTURE AND HIERARCHY

Addresses current screen layout problems creating inefficient knowledge transfer due to inappropriate assessment of information value or importance. Consistent conceptual structure and coherent logical organization is stressed.

The following information hierarchy issues affect the overall functionality and user experience of AHLTA. These overarching problems invariably affect how one accesses, discerns and uses information at every level of interaction:

Essentially, the current AHLTA system lacks any discernible information hierarchy or logical architecture. All modules seem to have been created independently of each other and behave accordingly. The AHLTA GUI suffers from structural and logical predicament common in many enterprise systems: The development emphasis was placed on aggregating and expanding feature sets rather than creating and branching off from a coherent and focused system-wide framework.[1] Consequently, the AHLTA system has grown laterally and out of control, as no apparent central organization strategy has been established from the onset. The result is a poorly planned and poorly communicating system that is heavy on visual and functional complexity that only confounds the user.

> *Organization begins with classification, which involves grouping related elements and establishing a hierarchy of importance for elements and groups. When this hierarchy is clear, the display itself can be structured to reflect the relationships between the elements while maintaining a pleasing balance in the resulting composition.*[2]

First and foremost, the AHLTA GUI lacks this type of initial classification: There is no separation and distinction between basic interface features, task-specific features and data types. Within AHLTA, general interface or task-related features, such as the "Search" feature, are considered the same "type" of object/category as clinical administration data such as the "Patient List". In most interfaces, features are what push the data. Features and data types simply are not the same thing.

Secondly, all features and data types within AHLTA maintain the same "weight," i.e. carry the same level of significance. For example, most information-driven interfaces consider the search capability a significant feature, if not one of the most significant features. Yet, the current AHLTA system buries the search capability at the same categorical level as data types. Thus, all features and data—regardless of its purpose or place within the workflow—are, more or less, lumped into the main tool bar without any consideration as to why and how it functions and affects the user.

Lack of initial classification leads to lack of apparent informational hierarchy. Lack of clear hierarchy means there is no clear relationship between elements being presented. When this relationship is unclear, the user is unable to recognize and evaluate the relevance of the data for oneself.[3]

If one were to get a view of all the features and subcategories available through the "Folder List" in AHLTA, one would simply be overwhelmed by the lack of organization and consistency in the tool's primary classification system.

Within the AHLTA schema, there are only two major categories: what is deemed as the "Desktop" category, a generic Windows-based OS nomenclature for high-level files/applications, and the "Patient" category, which contains subcategories that help the user access patient data.

The "Desktop" category encompasses all major administrative features as well as "Reports" and "Tools" subcategories. The "Patient" category encompasses too many subcategories. There are eight subcategories in total [e.g. "Demographics", "Health History", "Lab", "Radiology", "Clinical Notes", "Previous Encounters", "Flow sheets", and "Current Encounter"] and just as many features nested within these subcategories.

Lack of clear categorical definition at the primary level inevitably causes inaccurate or misleading categorization at subsequent levels. Within the "Desktop" category, there is no subcategory name for the administrative features to fall under.When the "Patient" category is accessed, the category name changes to a specific patient's name, for example "Suarez, Eduardo A". This makes the navigation not only inconsistent and a cause for disorientation but makes all task features and data types subsets of the patient—when in fact the patient data should be the result or the subset of these features and data types.

Additionally, many of the subcategories are redundant and can be reclassified under combined subcategories. For example, "Previous Encounters" and "Current Encounters" can be classified under a single subcategory "Encounters" and instances separated at a lower level. "Lab", "Radiology" and "Clinical Notes" can be classified under "Health History." If we were to discount the previous suggestion and keep the current subcategories, "Previous Encounters" can also be classified under "Health History."

Overabundance of unorganized options results in A) inability to access necessary data; B) devaluation of the interface's subcategories and features; and C) frustration and inundation on the part of the user. Inaccessible data is useless data. The job of an interface is to turn data into comprehensible information.[4] When the user cannot access, perceive or process the data, let alone understand it intuitively, then the interface as a whole has failed to meet its objective and obligation.

1.2 CONTENT REALIGNMENT

Addressing issues of improper or incongruous content alignment between various modules within AHLTA.

As stated in the previous section, AHLTA's fundamental usability issue stems from the overarching fact that the interface does not have a meaningful, higher-level functional and informational organization. This certainly is the case with its overall content alignment, as the discord in its content and graphical layout of its content is essentially a "trickle down" effect of this insufficiency.

Instead of providing an environment that does not require strenuous conscious effort on the part the user, the AHLTA GUI relies on the user to carry on the burden of creating an organizational and semantic logic of his or her own. One clear example is when the user is left to figure out why there are four ways to access the same set of primary features (see Section 1.3 for more details). By creating confusing and unclear instances like this, the interface undermines the core tenets of simple and thus usable design: Approachability, Recognizability, and Immediacy.[5]

Firstly, the AHLTA interface fails to be approachable because there are too many features offered without any clear organization or visual distinction between them. The lack of visual hierarchy is, in essence, an extension of the lack of thoughtful information hierarchy. Moreover, the

lack of visual hierarchy in AHLTA can be attributed to the fact that there was no conceptual differentiation instituted in the first place, i.e. thus, it did not warrant any secondary differentiation—a visual one.

Secondly, the AHLTA GUI is not recognizable because all of its content and features are obscured by the generic, Windows-based application design scheme: The drab, monotonous gray background/white text field design scheme further homogenizes the value of the presented data and makes them indiscernible from one another.

One of the many instances that this kind of data obfuscation occurs is in the "Lab Results" feature. Here, a patient's extensive lab data is inconsiderately thrown into a small white text box in a simple text format. There are no categorical distinctions between any of the data. Furthermore, the small and restrictive box makes visually scanning this lengthy data output nearly impossible.

Mullet considers one of the foremost considerations in human-computer interaction to be visual unity.[6] To its credit, there is visual unity within AHLTA (albeit an ineffectual one). Ironically, this visual unity is the very element that works against AHLTA in that it perpetuates and accentuates its most critical flaws.

Thirdly, the AHLTA interface does not generate any sense of immediacy, because its features and datasets are not to immediately recognizable and understandable. It requires memory and maximum conscious effort on the part of the user, because there is no clear and universal visual identity to welcome back the user. Consequently, the user must rescan, reorient and retrain oneself of all the available features each time he or she accesses the tool.

By establishing a well-considered information hierarchy, then continuing this logic to realigning its content visually and spatially, the AHLTA's GUI will be able to successfully lift the burden from the user and gain their trust to further explore to the tool.

1.3 EASE OF NAVIGATION

Addressing issues of navigation affecting data flow and user orientation

Ease of navigation is yet another area affected by AHLTA's lack of structural framework. The very first instance where the user faces complication in navigation is with the Primary Navigation scheme. Within the current AHLTA system, there is no single, universal point of departure from which the user can access its various features and datasets. In fact, AHLTA provides four places from which a user can access the same features:

- The blue tool bar at the very top of the interface,
- Gray tabs at the primary display area,
- The "Go" and "Tools" options of the application menu
- The Windows OS-specific "Folder List" option located at the left side of the interface [if the user chooses to view this option]

The principle role of a Primary Navigation scheme is to provide the user with a sense of place and a recognizable point to which one can return. However, the current AHLTA system's redundancy in functionality and presentation not only congests the real estate but creates severe disorientation within the user as well. As such, the interface cannot be rapidly apprehended and understood well enough on the part of the user to support immediate use or induce further exploration. The complexity and disorganization of the design presents too much visual information to the user, and thus, they are unable to easily ingest, understand or remember the core features of the interface.

Another instance that affects recognizability and a sense of place within AHLTA is when a particular patient's name is selected. Upon selecting a patient name, the primary point of spatial reference transforms itself, as the patient's name becomes the header for all features of the AHLTA interface. Thus, even features and data that have no bearing on the patient become part of this particular patient's information, e.g. the administrative task features and data types for all patients, higher level features such as "Tools" or "Reports", ways to access other patients' information, etc.

Thirdly, each of AHLTA's Primary Navigation tabs has different behaviors, which further complicates access and orientation for the user. For example, when one accesses AHLTA features through the "Folder List" menu, the data

and feature categories shown on the gray tabs change sequence or new tabs with features that belong to another subcategory suddenly appear, i.e. When one clicks the "Sign Orders" subcategory, features under the "Tools" category like "List Management", "Reminder Mapping", and "Questionnaire Setup" appear before the "Sign Orders" tab. This type of sudden change and appearance of new categories creates an odd "jumping" effect that is very jarring to the user.

Also, the fact that these "new and misplaced" categories appear in random order, i.e. the sequence in which these categories appear on the left panel being different from the sequence in which they appear on the tabs, create further confusion and disorientation.

These kind of subtle differences between interface features not only increase learning times but also can lead to irksome and dangerous errors—which is particularly risky in the medical profession.[7]

1.4 ICONOGRAPHY

Addressing current icon use in AHLTA to suggest more representative iconography per available user functions

Areas to consider regarding the AHLTA interface include color, type, layout, navigation, iconography, etc. Of these, iconography may be one of the weakest aspects. The AHLTA GUI uses many icons to facilitate visual communication with its users. The researchers and designers at PIIM/TNS thoroughly assessed the icons that the AHLTA interface employs. Many problems were apparent; most of these would be considered a hindrance to usability. Currently AHLTA's icons are: too numerous, too complex, misleading, and carrying redundant meanings.

There are numerous benefits for using icons in a GUI. Icons save space and easily integrate within components such as tool bars. Icons also support improved cognition of users once they are successfully established.[8] The objective of using icons is to communicate with users through effective visual representations which take increasingly effortless and involuntary attention.[9] Since icons applied to represent objects and functions, they strengthen usability when users can easily recognize each icon and what it represents.[10] Icons are often integrated with a text label. These text-supported icons can benefit both new and advanced users. New users unfamiliar with the system often rely on the label complimenting the icon, while icons make the product much easier to use for the advanced users who are familiar with the system.[11] Because AHLTA must serve highly advanced and sophisticated users on a daily basis, AHLTA must take advantage of the space and rapid assessment benefits of icons. The icons used in AHLTA were beneficial in saving real estate in the GUI, however due to inconsistencies, benefits were not universally employed nor were their meanings universally conveyed across the platform.

PIIM/TNS found that the most serious icon-related issue with the current AHLTA GUI is that icon count is too numerous. Icons must clarify what they represent. They must be distinctive, and they must establish whether they relate to an object or a function. This is why good usability requires each icon to become distinctive from every other icon.[12] In addition, distinction is a factor relative to specific icons as well as their collective arrangement. If they cluster together poorly, then objects such as tool bars will become visually overwhelming and illegible. It requires extensive effort to become familiarized with a plethora of icons when their meanings are not regimented and distinctive, further the design effort to establish such nuanced classifications is generally wasted. Effort must first be applied to iconographic logic. In this manner, the fewest and most productive series of icons can be planned first and an effective iconography system can be designed afterwards.

The current AHLTA interface contains many misleading icons which do not represent the objects or functions in a familiar and recognizable manner. The icon for "Wellness" under "Health History," for instance, has been visually represented by a red apple. The "Wellness" menu displays routine checkups such as screening blood pressure, mammogram, and cholesterol. Although an apple can be a symbol for health, its meaning is too expansive and incoherent when used in a toolset that is entirely related to health. Therefore, this icon may not logically lead users to the screen for scheduling and follow-up with routine screenings. In another example, both "Notifications" and "Tasking" use an exclamation mark, which is perceived universally, but now becomes confusing because it is used for two different menus. Overuse weakens distinction. Icon design requires deep consideration in the physical, conceptual, and cultural context.[13] It is not possible to communicate with users through icons if they are unrecognizable. In fact, they can easily become counter-intuitive and therefore contribute to a less productive environment. Katja Rimmi, who designed interfaces for Adobe in the 1990s stated the obvious, "The challenge of icon design is to come up with something that will be widely recognized by a great diversity of people."[14] However the practice of achieving this goal is not always straightforward.

The AHLTA GUI contains icons used redundantly. For example, an image of a red apple is used for "Wellness" as well as "Immunization." Another benefit for using icons on a GUI is that well-designed icons can help users memorize items more than text because users remember visually encoded concepts better than those encoded verbally.[15] Each and every icon used on a GUI must be identified independently for better recall. Use of redundant, or multi-meaning icons makes the AHLTA GUI obscure and difficult to operate.

1.5 COLOR

Addressing current color scheme of text and graphic elements within the user interface and properly align to user workflows and information hierarchies to ease navigation, create emphasis, and warn users through the application

Color fulfills an important role when designing complex interfaces such as AHLTA. Competently applied color can help users with orientation, information structure, identification, and improved clarification while operating the GUI. The researchers and designers at PIIM/TNS thoroughly investigated color as it is used in the AHLTA GUI. In general, the AHLTA interface does not misuse color at the level where it may negatively affect users' perception and cognizance; the color in AHLTA interface serves to distinguish functional relationships and plays a moderate role in layout as well as warnings. However, color is not effectively leveraged to greater purpose in AHLTA. Color has tremendous potential to communicate and help users navigate through information. Color can enhance the display of information, as it is used to label, measure, represent or imitate reality, and to enliven or decorate.[16] PIIM has assessed the color display of AHLTA from these four aspects.

Color helps identify and organize content once it is applied as a labeling function. Color-coding is a very common technique popularly implemented by GUI developers. Consistent color codes enable users to easily identify, relate objects, and separate the differences. Color codes are not found on the AHLTA interface. The current AHLTA interface does not consistently support users with identifying, relating, or differentiating features, functions, and objects through color. The background colors filled inside of frames and boxes do not carry any meanings. This is a lost opportunity. Blue frames for navigation tools and menus, and grey boxes for the main display seem randomly selected without logical and constructive design considerations. Color should have been used to organize content in AHLTA. Color can facilitate subtle discriminations in complex displays and emphasis the logical organization of information.[17] For example, one color could be used to fill areas for tool menus and navigation, another color could be applied for schedule, appointment and task management, and third color can be utilized for patient's health record. Different types of information clarified with three different colors would allow users to navigate these areas more quickly.

Color can be utilized to organize and clarify production flow. AHLTA is a bidirectional interface; users can access archived records as well as enter new records. The current interface uses the same color for the fields where users view records and for the fields where they enter records. The two fields serves very different purposes and could be color-coded for users to perceive the difference immediately. A simple workflow improvement would be to apply a unique color to fill in the field: where users can only view the record without modification; where users are required to enter records; and, where users have an option to enter records.

Content can also be organized according to a hierarchy with color. In AHLTA, the "Desktop" folder located under the "Folder List" module is at the top level menu containing submenu items such as "Reports" and "Tools." There are the tertiary menu items expanded under "Tools." The primary, secondary, and tertiary menus have been treated

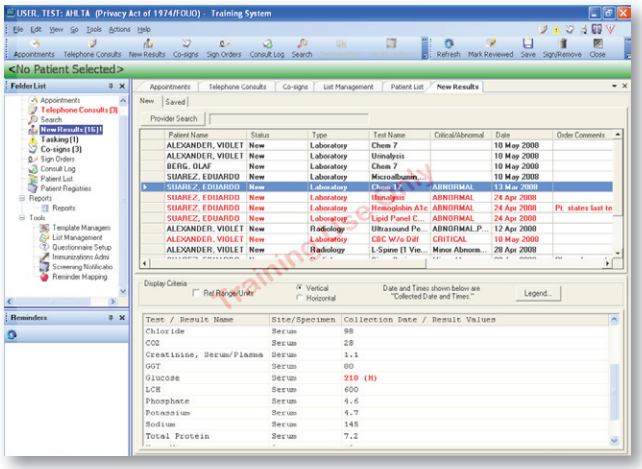

FIGURE 2

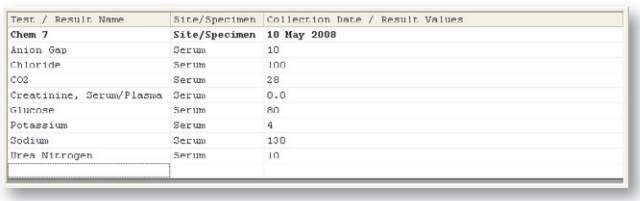

FIGURE 3

with visual equality. This does not help the user perceive the hierarchy effortlessly. In order to improve the AHLTA interface, visual treatments such as color, typography, and layout must be better utilized.

Applying color to create emphasis is also highly beneficial for a clinical informatics GUI like AHLTA. AHLTA has, in fact, started to use color to emphasize areas to draw attention. The text on the AHLTA interface is mostly black, but some menu items where users need to pay attention under every circumstance are displayed in red (FIGURE 2). AHLTA also indicates quantitative information in the color red to alert users. Applying red to draw attention for alerts is a good beginning to take advantage of color. However, its utilization needs to be further expanded. Also, designers must be careful of losing color dimensionality by overusing warning colors such as red—or user may begin to ignore the emphasis.[18]

In some cases, AHLTA supports color displays for quantitative information that AHLTA handles bidirectionally. The health condition of each patient is often represented by quantitative data such as blood pressure, cholesterol, glucose, calcium, hemoglobin, etc. The current AHLTA interface displays most of quantitative patient records in black text, but it needs to be improved. Color can indicate the condition levels according to the measure as found on many charts and schematic maps (FIGURE 3). It will also enable AHLTA to send alerts to users where abnormalities occur.

Applying color to better communicate with users is strongly associated with cultural and symbolic significances. In cartography, as an example, color is often used to imitate reality.[19] We can easily find cartographers applying blue to represent water, applying green for forest, and applying brown for deserts. A GUI can take advantage of representing colors that have such implied meanings. By mixing these commonly understood colors with custom color sets, many advancements can be gained toward better and faster communication. For the AHLTA system no specific connection needs to be established between reality and the color scheme applied to the interface skin, because the interface does not necessarily represent any aspects of reality. However, the principle of applying representative color can improve the content display extensively. Additional integrations will reveal color advantages beyond likeness and warning schemas.

Color serves beyond improving functional task performance, communication, and usability. Color enlivens the interface when employed properly and artistically. Color can evoke strong emotional reactions of joy, excitement, fear, or anger.[20] It is obvious that a good interface should have a color scheme positively influencing users, by artistically improving their workflow displays. It is difficult to evidence that the visualization of the current AHLTA interface is entertaining or positively influencing users. AHLTA needs an elegant and engaging color treatment to permit improved comfort with the system.

1.6 TYPE TREATMENT

Addressing current use of specific font families, sizes, and treatments and the need to redevelop master and more cohesive style sheets for use in all modules of AHLTA, in addition, this section addresses current issues of legibility, readability and navigation related to type treatment.

The AHLTA system digests and displays enormous information through text. Schedules, tasks, patients' health records, and decision support are all communicated with text-based displays. Proficient type treatment is essential for accurately and effortlessly communicating these classes of data. As with color treatment, type treatment can be applied beneficially for organizing content, emphasizing hierarchy, and drawing attention to alerts sensitivity. At first sight, the AHLTA interface is typographically dense and inconsistent. This makes it difficult to know where to start because the hierarchy within the text has not been clearly defined visually. In order to resolve this problem, the content needs to be reorganized, and the text treated with appropriate standards of typographic excellence concerning legibility and readability.[21] This will establish base levels of comfort and usability when using the toolset. Type treatment includes such areas as choice of fonts, typefaces, upper and lower case usage, highlighting, and underlining techniques. The benefits of such application include increased clarification and readability for titles, menu items, quantified records, and body text. Type treatment goes beyond letterform choice; typographic considerations include arrangement of text; space between lines, words, and characters, as well as the spaces between blocks of text and windows.

The current AHLTA interface does not distinguish type used in main menu, submenu, titles, instruction, and text. It does not evidence any logical organization of text-based content established through type treatment. For example, the type treatment for the top menu item, "Tools," its submenu item, "Reminder Mapping," and the displayed content for "Reminder Mapping" all take the same font, size, weight, and color. Unstructured type treatment for a text-heavy interface like AHLTA creates confusion and delay. It also diminishes readability. AHLTA needs a logical and

constructive type matrix which supports content organization. This will greatly enhance readability of consequential information and ultimately improve overall workflow.

2. HYPOTHESIZED NEW AHLTA GUI

Through the assessment of the current AHLTA GUI, designers and engineers at PIIM have addressed solutions for each design area identified above. We hypothesize how our approaches for each area will affect the redesigned AHLTA GUI.

2.1 INFORMATION ARCHITECTURE AND HIERARCHY

Through a detailed data profiling process, PIIM will review all existing features, data and metadata within the AHLTA interface to determine its quality, necessity and potentiality for other use.

The information architecture and hierarchy assessment efforts will focus on value determination, level designation, classification or reclassification of all AHLTA components. Repetitive and gratuitous elements will be discarded and efficiency and necessity stressed. Taking various clinical workers' workflow into consideration, PIIM will provide a modular yet consistent and systematic solution that will improve the overall utility and experience of the AHLTA tool.

The modular interface will allow the system administrator to easily control the user authorization while accessing the data. The new and adaptive AHLTA interface will support clinicians, nurses, physicians and pharmacists to communicate and collaborate intuitively. It will also support a set of rudimentary activities and access to data for users with limited authority (e.g. Receptionist can use the system to enter appointments, telephone consults, alerts, etc. However, they are not allowed to access further restricted data set by the system administrators.). It will become possible by having multiple modules such as "Appointment," "Drug Prescription," "Examination Orders Allergies," "Family Medical History," "Clinician's Note," etc. and controlling the access to each module according to user authentication. For instance, when a pharmacist logs on to the system, the widgets of "Drug Prescription," "Allergies," "Clinician's Note" are accessible, but irrelevant widgets for the pharmacist such as "Appointment," "Family Medical History" are grayed out (not permitted).

2.2 CONTENT REALIGNMENT

PIIM will research and develop redesigns of AHLTA user interface components to properly align content modules with tasks. This includes reorganizing and restructuring the entire content framework by function and category according to user workflows.

The information architecture and hierarchy overhaul mentioned in Section 1.2 will drastically and directly affect the content realignment issues. Grids and real estate of the interface will be not only redefined but defined for the first time in many cases. Better and more efficient use of space will also provide a solid basis for easier navigation, legibility, and cognizance.

2.3 EASE OF NAVIGATION

PIIM will review the ways in which users are navigating the current AHLTA to access information.

All menus, submenus and active links will be fully reviewed and reconstructed according to their necessity and reassessed value.

Eliminating the redundant primary navigation scheme will be central to this initiative. Having a single, consistent point of reference and source of action will empower users to be more engaged and involved with all features of AHLTA. Previously neglected interface items will be seen in a different light, or perhaps discovered for the first time, and will become natural and daily part of their workflow.

Also, creating a solid and rational secondary and tertiary navigation scheme to buttress the primary navigation scheme will be essential to this process. The primary navigation scheme alone cannot carry the entire weight of the interface. Having a supportive but not overpowering ancillary navigation system will make the data access and decision-making process for the user straightforward and effortless.

2.4 ICONOGRAPHY

PIIM will first find out areas within the interface where applied iconography can benefit the usability the most, then develop more representative iconography per available user functions. This also includes limiting the icon count by removing unnecessary icons.

Icons will be completely redesigned to clearly and effectively represent objects and functions. PIIM will also be attentive to symbolic significance of colors and iconography to different cultures and ethnic groups. Removal of misleading or redundantly used icons help users memorize the tools associated with icons. This will ultimately enhance the workflow.

2.5 COLOR

PIIM will develop the color scheme of text and graphic elements within the user interface and properly align to user workflows and information hierarchies to ease navigation through the application. The structured color schemes will create emphasis (e.g. alerts) and relations (color-coded

contents) for users to rapidly obtain knowledge with ease. For example, the tabs on the bottom of the VistA CPRS interface will have clarified visual distinction between the selected/active tab and unselected/inactive tabs.

The current VistA CPRS interface is made up with various neutral colors that create quite a clean look and feel. However, color has not been utilized to establish the uniqueness for this tool. PIIM will develop a color scheme to establish the style and identity for the VistA CPRS GUI

PIIM will fully take advantage of color for information display while using it to label, measure, represent or imitate reality, and to enliven or decorate. Color will be utilized to organize AHLTA's complex and confidential content, alert users, better display quantitative data, and improve comfort with an elegant and engaging treatment.

2.6 TYPOGRAPHY

PIIM will employ a proficient type treatment for accurate and effortless communication of enormous text-based information that the AHLTA system digests. The type treatment will be applied beneficially for organizing content, emphasizing hierarchy, drawing attention to alerts sensitivity. PIIM will carefully utilize type through choice of fonts, typefaces, upper and lower case usage, highlighting, and underlining techniques with typographic considerations of text arrangement; space between lines, words, and characters, as well as the spaces between blocks of text and windows.

PIIM's type treatment for the new AHLTA GUI will greatly support clear and effortless communication as well as enhance readability of complex information.

3. DESIGN ASSESSMENT OF THE CURRENT VISTA CPRS GUI

Designers and engineers at PIIM will assess the demo software of VistA Computerized Patient Record System (CPRS) (FIGURE 4). The following top-level design elements of VistA CPRS will be reviewed constructively:

- Information Architecture and Hierarchy
- Content Alignment
- Ease of Navigation
- Iconography
- Color
- Type Treatment

3.1 INFORMATION ARCHITECTURE AND HIERARCHY

The information hierarchy within the CPRS interface is well-organized. The interface assists both cognitive response and performance efficiency within standard navigational processes.

The design and development team at Parsons Institute for Information Mapping (PIIM) has thoroughly investigated the structure and hierarchy concerning the usability and workflow for VistA CPRS. Overall, the VistA CPRS interface follows standard-practice information architecture and hierarchy; this allows users to navigate the tool effectively. There are three levels of navigation in the VistA CPRS interface. The highest level is the menu-set for selecting patients, inquiries, providers, primary care physicians, etc. The next level permits each patient's medical record to be viewed through the bottom tab set. A tertiary level of control is sometimes available within several of these bottom tabs. It is not difficult to understand the content structure and hierarchy within the VistA CPRS GUI because accessibility of content is sensibly classified and well-aligned, both conceptually and visually. Such logically classified and properly aligned content makes it easy and clear to learn the content structure as well as permitting ease of control selection speed.[22] In addition, it permits rapid access to information in every level of interaction. In essence, moving from one screen to other, drilling down from high to low levels, and returning to the previous or higher level screens are all relatively straightforward and simply executed operations while using the VistA CPRS tool.

3.2 CONTENT ALIGNMENT

Addressing current issues of alignment between modules affecting user workflows

Aligning content properly is a significant issue for a complex GUI like VistA CPRS. VistA CPRS is a bi-directional interface; users can access archived records as well as enter new records. Overall, the VistA CPRS interface displays aligned menu items and contents appropriately.

The VistA CPRS interface has clearly divided its classified content. The main menu set on the top, and the secondary on the bottom, and the tertiary within some tabs are clearly divided, and uniformly positioned. The clear division of the menus sets help users avoid overlapping objects and actions in multiple levels. For example, the main menu items, such as selecting patients, providers, or primary care physicians are comprehensibly isolated from the secondary menu set of the detailed individual clini-

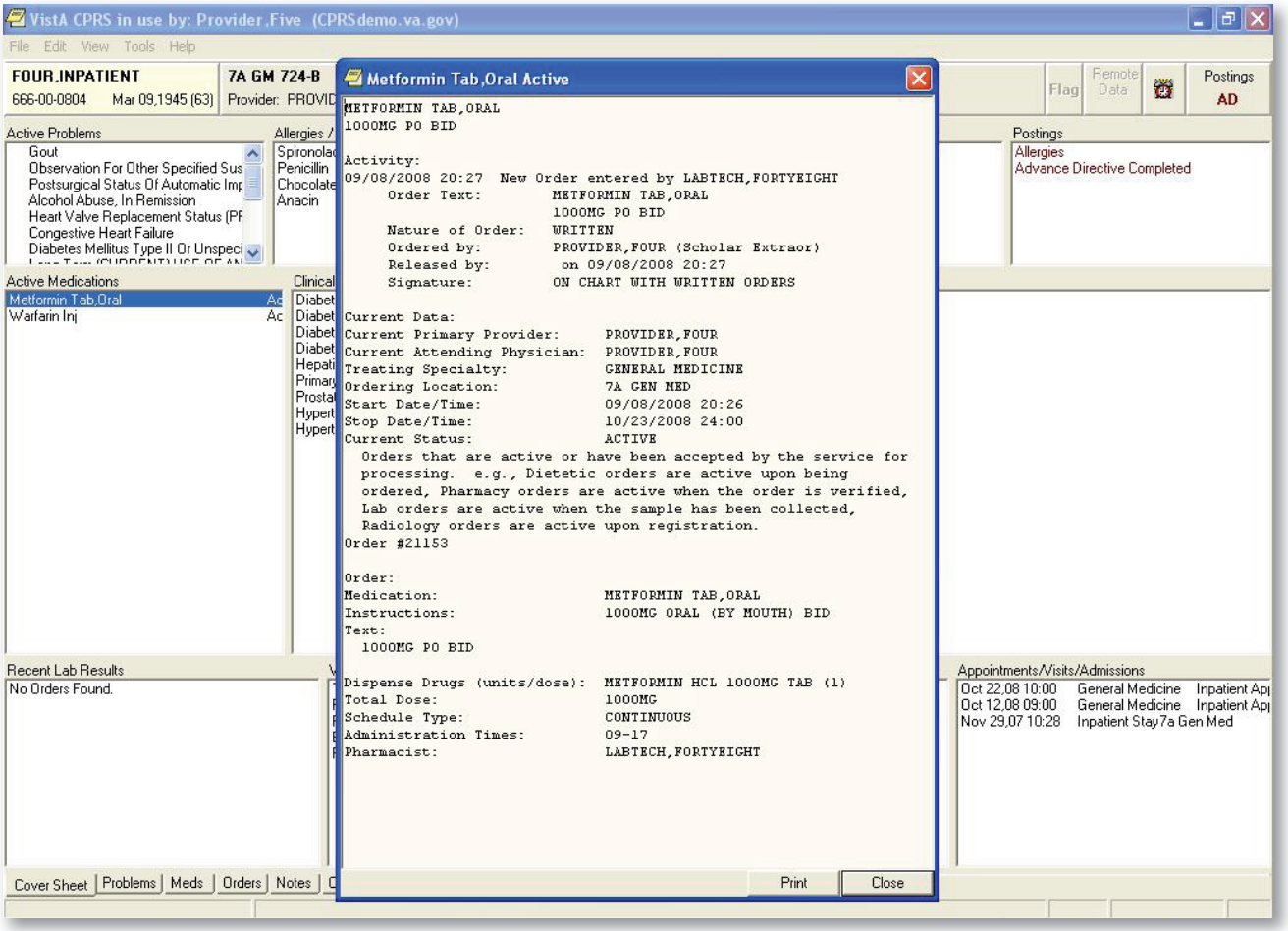

FIGURE 4

cal records accessible from the tabs on the bottom. The detailed clinical records accessed through the menu items are placed on multiple tables. They are logically organized in multiple tables. The readability and accessibility for the complex medical data benefit from the module-based content organization.[23]

The tertiary menu items belonging to some of the bottom tabs always appear on the left column. Those are also clearly isolated from other higher level menus; their consistent position makes the menus easier to access. However, these menus are displayed within table cells that also display other non-menu items. Selectable items and non-selectable items should be treated differently for easier navigation. In addition, the alignment and size assigned to the tertiary menu cells are not uniform. Establishing a single arrangement and graphic treatment for the tertiary menus will improve the workflow.

3.3 EASE OF NAVIGATION

Addresses current issues of navigation that affect data flow and user orientation

Overall, navigating the VistA CPRS tool is relatively simple considering the amount of data that the tool carries. One of the most factors supporting the simple navigation is that VistA CPRS is a single-page interface which does not require Back and Forward buttons. It displays multiple-column two-dimensional menus with tabs. They provide a good overview of selections, simplified actions, and faster choices.[24] Users can easily move to discrete sections of a patient's medical record and have these entirely displayed through the use of these tabs without a concern for how many levels they have drilled down from the main screen.

Some moderate restrictions, such as requiring users complete necessary steps before moving forward can help users stay better oriented within the workflow. For

FIGURE 5

example, as the tool launches, users must select one patient. After fulfilling this required step, users are able to access the clinical data, or the primary menus located at the top such as selecting patients, inquiries, providers, and primary care.

Accessing the clinical data is made straightforward by the bottom tabs. Once a patient is selected, it starts with the default cover sheet, which is a summary of the selected patient's health records. The rest can be effortlessly accessed one by one through other tabs. However, these tabs need to be improved. First, the titles for tabs should be rethought through out. Even though these tabs have "task-based" titles, they serve more as informative separations rather than actual action-based objects. Also, having the title such as "Meds" is not effective considering the entire tool is about medication. Another example would be the "D/C Summ" tab, which displays the selected patient's discharge summary. A more descriptive and comprehensible label, such as "Discharge Summary" will communicate much more clearly.[25] Second, there must be obvious visual distinction when one of the tabs are activated (selected). The single tone of grey and corresponding type treatment applied to both active and inactive tabs do not provide such a necessary visual cue (FIGURE 5).

Selecting patients is the significant workflow process of the VistA CPRS tool. Patients are selected through the "Patient List" feature which provides patients' names, types, etc. The ability to scroll through the lengthy patient list is useful because scanning the names of patients can help users recall the precise spelling of a desired patient's name. However, the box was too small for the amount of information it provides. This misuse of space is heightened by the fact that there is so much empty space to the right of this list. What one finds in that empty space is the "Save patient list setting" button, which really doesn't belong on the "Home" screen in the first place. Providing the option to "search" for patients is obviously a necessary one. However, placing the "Sorting" options as a primary functionality is not suitable. The list sorting option should not be the primary option; this option should be placed appropriately, below the search field to reflect the proper sequence of interaction.

3.4 ICONOGRAPHY

Addressing current icon use in VistA CPRS to suggest more representative iconography per available user functions

Unlike the AHLTA GUI that has a significant usability flaw through the overuse of icons, the VistA CPRS GUI does not contain many icons. Limiting the number of icons benefits the communication if they are not distinctively designed since redundancy is harmful to good communication.[26] With these guidelines in mind we recommend that icons are utilized to represent particular objects and functions within the VistA CPRS GUI. For example, the VistA CPRS system does not provide any universal, permanent features, such as a function/task-based tool bars, that a user can recognize and use consistently throughout the interface. It should be provided at a very clear and prominent place where it can be accessed readily and easily. Instead, the "Flag" button, "Remote Data", "Reminders, and "No Postings" buttons, which are *not* critical features, are placed at the very top, next to the patient name header, i.e. the primary real estate. These features can be better represented through well-designed icons clustered in a new tool bar.

Generally, the icons existing within the VistA CPRS GUI are not effective; they do not clearly represent their functions or objects. The icon for "Reminder" placed on the top menu bar, as an example, is not compelling because of poor conceptualization and execution. The icon represented by a clock image can be perceived as many different meanings other than a reminder. A clock image can represent: time in general, the current time, schedule/appointment, time-sensitiveness (urgency), etc. Using an image which can potentially mislead users should be been avoided during the stage of conceptualization. In addition, the substandard graphic quality makes the icon difficult to recognize. Exiting icons are complex and distracting by having too many unnecessary colors, shapes, and details. It requires articulated visual treatment for better communication (FIGURE 6).

FIGURE 6

There is another issue with the "Reminder" button. The "Reminder" button in the top menu bar is placed in-between other text-based icons. Indeed, this is the only graphic button on the top menu bar. This menu looks disconnected from other buttons on the same menu bar because of the inconsistent visual treatment. An icon group should be juxtaposed with the harmoniousness as a family of icons for compelling display.[27]

Some icons within the VistA CPRS GUI carry same or similar images while representing different functions or objects. This creates a problems because those indistinguishable icons require effortful and delayed recognition.[28] For example, the image of a white piece of paper, also known as a document icon, is used to represent both "Standalone Note," and "Interdisciplinary Entry." Obviously, these two icons look acutely similar. In addition, the clock image appearing on icons for "Reminder Due," "Reminder is Not Due," and "Reminder is Not Applicable" is another instance where icons are extremely difficult for users to distinguish them. Finally, the folder image has also been used redundantly (FIGURE 7).

3.5 COLOR

Addressing the current color scheme related to text and graphic elements within the user interface and the proper alignment to user workflows and information hierarchies to ease navigation, create emphasis, and warn users through the application

Overall, the color scheme for the VistA CPRS interface is clean and neutral. It also uses a limited number of colors. The limited number of colors and the calm and neutral color scheme make the content easy to read. This is beneficial because the application of contrasting and vibrant colors to a GUI can cause poor readability and confusion, and also overwhelm and mislead users.[29] However, there are areas within the VistA CPRS GUI that can potentially benefit from the improved color treatment. For better information display, and faster and more precise communication, color must be fully utilized; color can be applied to label, to measure, to represent or imitate reality, and to enliven or decorate.[30]

We observed that the VistA CPRS GUI does not exploit color to effectively draw attention to warning situations. Color is a useful element to emphasize certain information that users need to pay immediate attention. For instance, the tool should display any abnormalities within patients' medical records: such as blood pressure, cholesterol, glucose, calcium, hemoglobin, etc. An appropriately chosen contrasting color can be a great utility in this situation. The default text color (black) for the VistA CPRS GUI easily permits such distinction to be designed. In short, colored labels can easily emphasize objects to warn users who must make precise decisions in the limited patient-caring time.

The display of medical records should benefit from color-codes. Many medical records such as blood pressure, cholesterol, glucose, calcium, hemoglobin, et cetera, are quantitative data. Color can be applied to represent ranges of values as found in cartograms. Or, it can even be simplified to three colors to represent: Below Normal, Normal, and Above Normal. Competently utilized color codes can increase productivity in many tasks.[31]

Another example for applying color codes during the startup session when users are selecting a patient from the Patient List pop-up window (FIGURE 8). Users can scroll down this long list to search for patients' names, types,

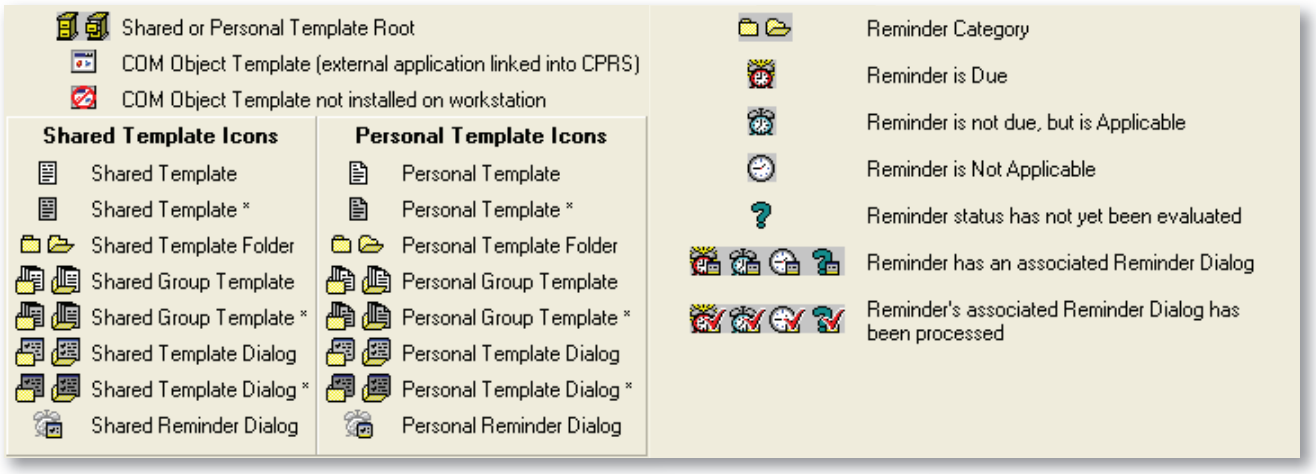

FIGURE 7

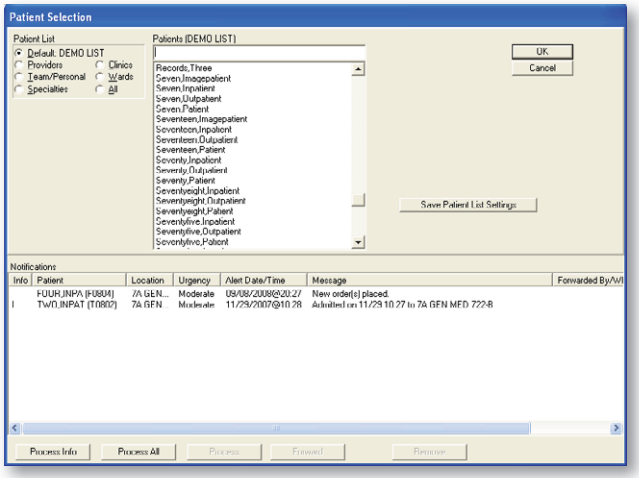

FIGURE 8

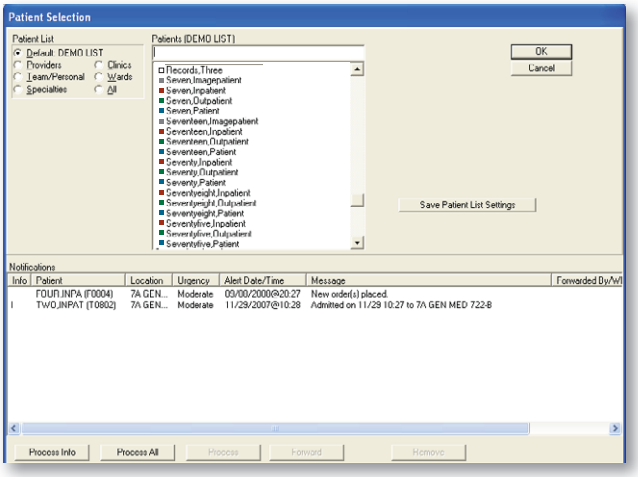

FIGURE 9

etc. Apparently, there are four categories of patient types: Patient, Inpatient, Outpatient, and Image patient. All four patient types are displayed in the default black text. Applying subtle color codes to distinguish categories will speed up the process in the case of selecting a patient by type. Even putting small color dot indicators (such as color coded square bullets) next to the names in the list will offer more rapid navigation (FIGURE 9). Such a color coding technique is particularly beneficial when users search for the desired patient from the lengthy patient list.

Color can be used to provide visual clues for menu status. One problem with the menu tabs on the bottom of the VistA CPRS interface is that there is a minor visual distinction between the active and inactive tabs. The tabs are presented in a single tone of grey and do not provide an adequate visual distinction. There is a very minor extrusion, but no clear header or other distinguishing visual cues to let users know which section they are in. The status of menus can become more obvious through a proper color treatment.

3.6 TYPE TREATMENT

Addressing current use of specific font families, sizes, and treatments and the need to redevelop master and more cohesive style sheets for use in all modules of VistA CPRS, in addition, this section addresses current issues of legibility, readability and navigation related to type treatment.

Overall, the CPRS interface is text-based. Type treatment is essential to effectively organize and display text-based contents. However, the VistA CPRS interface does not distinguish those text-based contents through typography. Letters appearing on the top main menus, tabs, titles for object, and text for various health record are handled with the same type treatment. Users can benefit from accessing visually distinguishable text-based content especially when great amount of text is displayed simultaneously. Typeface, size, weight, or italicization can be applied to create visual distinctions for classified contents.[32]

The interface does not take advantage of typography in a way that best utilizes emphasis for critical warnings and alerts. When the system displays a patient's medical records, the system should emphasize certain keywords, terms, or other areas where users should pay attention such as diagnosis, abnormalities, allergies, etc. The ability to create emphasis within a large body of running text will enhance the communication enormously. The standard form of typographical emphasis within a body of text is italicization. Other typographical techniques such as boldface, small caps, change in color, underline, combining different font, and/or manipulating the space around letters, words, and lines can also be employed to create such emphasis within running text.[33]

Effectively displaying large amount of text-based medical records to the VistA CPRS users is a significant challenge. In fact, we found several instances that the screen becomes visually overwhelmed while being filled with quantities of text. In this case, readability is the key to establish better communication.

"Good, readable type depends upon many factors: the type size, the distance from baseline to baseline, the length of the line, the organization of the text into paragraphs and sections, the arrangement of typographic elements, the treatment of color and images, etc. All characteristics and elements must be carefully chosen."[34]

For example, the text displayed within tables creates the overwhelming impression because they fill up the table cells without enough breathing space. The margin can be expanded to provide a more user-friendly orientation to the text, this increases user efficiency. This can easily be accomplished through increasing the padding by 1 or 2 pixels inside of each table cell. This will be one of the several enhancements to increase the readability.

4. HYPOTHESIZED NEW VISTA CPRS GUI

Through the assessment of the current VistA CPRS GUI, designers and engineers at PIIM have addressed solutions for each design area identified above. We believe our approaches for enhancement under each area below will improve the VistA CPRS GUI:

- Information Architecture and Hierarchy
- Content Realignment
- Ease of Navigation
- Iconography
- Color
- Type Treatment

4.1 INFORMATION ARCHITECTURE AND HIERARCHY

Through a detailed, data-profiling process, PIIM will review all existing features, data and metadata within the VistA CPRS interface to determine its quality, necessity, and potentiality for other use. PIIM will reclassify menus, submenus, and all other components to generate logical organization that will improve the overall usability of the CPRS GUI. The content structure and hierarchy will be supported by modules that will also allow the system administrator to easily control the user authorization while accessing data.

4.2 CONTENT REALIGNMENT

PIIM will research and develop redesigns of the VistA CPRS interface components to properly align content modules with tasks. This includes reorganizing entire content by function and category according to user workflows.

PIIM will establish a programmatic screen structure providing users predictable patterns for functions and objects.[35] Assigning consistent and designated places for menu sets and reclassified health records will provide users a solid basis for easier navigation, legibility, efficiency, and cognizance.

4.3 EASE OF NAVIGATION

PIIM will review the ways in which users are navigating the current CPRS to access information. All menus, submenus and active links will be fully reviewed and reconstructed according to their necessity and reassessed value.

PIIM will preserve the single-page interface of the current VistA CPRS GUI which allows users to easily access all features of the VistA CPRS tool. PIIM will also solidify the point of reference and source of action in all levels for easier and faster navigation.[36]

4.4 ICONOGRAPHY

PIIM will investigate options and seek methods by which the interface can benefit through the use of icons. In addition, PIIM will redesign icons not communicating clearly align the icons to their functionality, and ensure all icons are distinctive from each other for better use and recall.[37] Icons will be designed as a set; the background, foreground, and juxtaposition of icons will also be carefully considered. For example, the top menu set where an icon is mixed with text-based buttons will be rigorously reassessed, then revised.

Removal of misleading or redundantly used icons, and replacement of ineffective icons with sensibly designed new icons will enhance the workflow for the VistA CPRS GUI.

4.5 COLOR

PIIM will develop the color scheme of text and graphic elements within the user interface and properly align to user workflows and information hierarchies to ease navigation through the application. The structured color schemes will create emphasis (e.g. alerts) and relations (color-coded contents) for users to rapidly obtain knowledge from the data provided. Color schemes also help establish style and identity of the system.

PIIM will fully take advantage of color for information display while using it to label, measure, represent or imitate reality, and to enliven or decorate.[38] Color will be utilized to organize AHLTA's complex and confidential content, alert users, better display quantitative data, and improve comfort with an elegant and engaging treatment.

4.6 TYPE TREATMENT

Although VistA CPRS is a graphical user interface, it takes a large portion of text. Most of the patient health records are communicated through text; and functions are often represented through text. Therefore, a proper type treatment greatly contributes to the effective display of the various functions and objects. PIIM will employ a proficient type treatment for accurate and effortless communi-

cation of enormous text-based information. For example, the current VistA CPRS GUI displays buttons and text with the same or similar font, weight, and size. PIIM will reclassify text-based functions and objects entirely, then development ways to apply visual distinction systematically. PIIM will carefully utilize type through choice of fonts, typefaces, upper and lower case usage, highlighting, and underlining techniques with typographic considerations of text arrangement; space between lines, words, and characters, as well as the spaces between blocks of text and windows. The improved type treatment will benefit the VistA CPRS GUI with better readability, ultimately leading to higher productivity and efficiency.

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