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Design of an original interface that facilitates the use of clinical practice guidelines of infection by physicians in primary care

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Abstract. Increasing physician adherence to the clinical practice guidelines (CPG) for infections should improve antibiotic prescription practices. The aim of this study was to present the decision elements of these CPG in an original interface to be implemented in the website "Antibiocarte". We manually analyzed all CPG available for ambulatory treatment of infections. We extracted all terms related to the antibiotic therapy decisions and grouped them into decision or action variables. We then modeled the antibiotic therapy decision process and designed an interface according to ergonomic principles. The interface consists of five fixed parts: a decision table, two information zones, a zone with the reasons for hospitalization, and a zone with situations not concerned by the CPG. All CPG could be implemented according to this model. The usability of the new interface was evaluated by ten general practitioners using the System Usability Scale (SUS) and found to be satisfactory and appropriate for clinical use.

Keywords. empiric antibiotic therapy; infectious diseases; user interface design; information visualization; primary care

Introduction

In primary care, infectious diseases are frequently the reason patients seek consultation. Antibiotics are often prescribed in these cases yet. Overconsumption of antibiotics or inappropriate antibiotic prescriptions can increase bacterial resistances. To limit this risk, health authorities provide clinical practice guidelines (CPG) [1, 2] to help physicians select the correct antibiotic to prescribe. The texts of these CPG are long, ambiguous, complex and not easy to use in clinical practice [3]. CPG have been structured in various ways (from semi-structured texts [2] to highly structured trees [4]) to facilitate their access, navigation and integration into clinical decision support systems (CDSS). In the domain of empiric treatment of infections in primary care, Linder et al. [5] developed a CDSS devoted to respiratory infections. However, in evaluations, physicians were reluctant to use the system. This poor performance may have been due to the long times required to conduct a consultation with this system.

In our laboratory, we developed the Antibiocarte website [6], which recommends antibiotics for particular clinical situations. The site also contextualizes the etiology of

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the infection and the prevalence of resistance. Thus, it enables physicians to understand the particularities of the recommended antibiotics relative to all of the antibiotics available for treating the infection in question. The major problem found in the first version of this website was that too many clicks were needed to navigate through each clinical situation. This hierarchy was complex, took too long to explore and was not intuitive.

The aim of this study was to improve the presentation of clinical situations on the website in order to minimize interaction time and facilitate the use of Antibiocarte by physicians.

1. Methods

To create this new interface, we needed to understand the details of the antibiotic therapy decision process. First, we analyzed all available CPG concerning the infectious diseases treated in primary care. We manually extracted all the terms related to this decision making, and grouped the terms into categories of variables (e.g., fever was included in the "symptom" category). We distinguished decision and action variables. Decision variables were then clearly specified and made unambiguous (e.g., "simple cystitis" means cystitis without uropathies and comorbidities). At the end of this step, we modeled the decision process used to determine infectious disease treatments. For each category of decision variables, we then determined its rank of occurrence in each CPG. This allowed the level and importance of the decision variables in each segment of the navigation in the CPG to be identified.

In a second step, we used the modeled decision process and the rank of the decision variables to create an interface. We designed the interface according to ergonomic criteria [7] which included: homogeneity, simplicity, intuition, minimizing human-computer interactions and maximizing information, by applying information visualization methods and iconic languages [8].

In a third step, we evaluated the usability of the new interface by using the System Usability Scale (SUS) and a cross-over survey of blinded evaluators consisting of general practitioners who did not know which interface was new. First, we randomly selected 20 clinical cases from a list of 169 cases. Clinical cases were stratified according to the disease and the type of treatment (antibiotic; no antibiotic; monitoring or laboratory testing; or hospitalization). Then, ten general practitioners responded to questions about these 20 clinical cases using either the old or the new Antibiocarte interface (e.g., "The patient presents symptoms of cystitis. What do you prescribe?"). Afterward, physicians evaluated the interfaces using the SUS.

2. Results

2.1. Extraction of decision and action variables

Eight CPG were analyzed. They concerned 14 diseases: pharyngitis, otitis, sinusitis, pneumonia, infections in chronic obstructive pulmonary disease (COPD), bronchitis, bronchiolitis, cystitis, pyelonephritis, prostatitis, skin infections, Helicobacter pylori infection, urethritis and cervicitis.

Five types of action variables were defined: hospitalization, antibiotic prescription, laboratory testing, monitoring, and no treatment.

Decision variables included two major disjoint types: (i) hospitalization criteria, and (ii) etiologic and therapeutic orientation criteria. For each disease, one or more of these criteria were organized in a hierarchy leading to one action. The rank of these criteria in the hierarchy varied according to the disease (Table 1). Age, gender and pregnancy were always in the first rank whereas other criteria (e.g., risk factors, scoring, infection sub-localization, signs and symptoms, stage, evolution, test and vaccination) could be in the second, third or fourth rank. Decision variable ambiguity was removed using elements present in the CPG. Physicians were reminded of the definitions (e.g., how to distinguish maxillary sinusitis from frontal sinusitis) and the variables contained in the scores or risk factors (e.g., age, symptoms in Mac Isaac's score in pharyngitis).

Table 1. Frequency (in %) of the rank of occurrence of the decision variable among all diseases (n=14).

Etiological and therapeutic decision variables	***Position***				***Example***
	1	2	3	4	
Age	71	0	0	0	Less than three years
Gender	21	0	0	0	Male
Pregnancy	21	0	0	0	Pregnant
Risk factors	0	29	7	14	Trip in Africa
Scoring	0	7	0	0	Mac Isaac's score
Sub-localization	0	14	0	0	Maxillary sinus
Signs, symptoms	0	43	21	0	Fever
Test	0	7	14	0	Test for streptococcal pharyngitis
Stage	0	7	0	0	Stage 1 in CPOD
Evolution	0	29	14	0	Persistent pain
Vaccination	0	14	0	0	Vaccination

2.2. Description of the decision process in determining infectious disease treatment using CPG.

For each disease, the variables of age, gender and pregnancy are the first-level variables considered in the therapeutic decision. Afterwards, if hospitalization criteria or grave criteria are present, then the action is "hospitalization". Otherwise, a viral or bacterial etiology is concluded according to the value provided by one or more decision variables. If a viral etiology is concluded, the action is "no treatment". If a bacterial etiology is concluded, then the action is "antibiotic prescription". If no conclusion can be drawn, then the actions are "laboratory testing" or "monitoring". If the action is "antibiotic prescription", the organ where the antibiotic must be concentrated is deduced from "disease" and antibiotic contraindications are deduced from "age" and "pregnancy". The type of bacteria likely to be involved, as well as its susceptibility and resistance threshold, are deduced from the values of a succession of decision variables. All of this deduced information ultimately leads to recommended antibiotic.

2.3. Design of the interface

Two to three screens are needed to navigate from the initial situation to the recommended antibiotic. All pages are designed in the same fashion, regardless of the disease. In the first page, the user chooses the infectious disease (e.g. sinusitis) and the patient profile, (i.e., age, gender, and pregnancy status).

The second page contains five areas (Figure 1). The first area (A) contains the decision algorithm and is the first to be read due to its upper left position. It contains the hierarchy of etiologic and therapeutic orientation criteria. To control the page occupa-

tion of this hierarchy, a treemap representation was chosen instead of a simple tree. The last column in (A) contains the action decision according to intuitive colors (red: no prescription; green: antibiotic prescription; orange: monitoring or laboratory testing; black: hospitalization). Green boxes lead to a third page. This area contains a hyperlink to the original CPG. The other areas in the second page are facultative. Below the table in (A), one area (B) contains definitions and another area (C) contains score or risk factors. These areas highlight the content of the table in (A) by explaining decision variables. On the right side of the screen, two areas are represented. One area (D) presents the criteria of hospitalization with a graphical summary (Mister VCM [9]) (e.g., a highlighted eye means that if patient has eye trouble, then he should be hospitalized). The area in (E) shows situations not concerned by the CPG.

The third page (Figure 2) presents the appropriate antibiotics that result from earlier selected elements. For example, if the user chooses "sinusitis" and "child" in the first page, and selects the action "antibiotic prescription" in the second page, then the third page shows only antibiotics that are concentrated in the sinus, that are not contraindicated for children and that are active against the etiological bacteria. Among these, the recommended antibiotics are flagged. Antibiotic spectra and resistance thresholds are displayed by using intuitive color codes, which allow differences in susceptibility (red = resistant, green = susceptible, orange = moderately susceptible, black = no described susceptibility) to be easily identified [10].

Data about all diseases addressed by the CPG have been included in the Antibiocarte website (http://www.antibiocarte.org/v7/html/Liste_sitclinique_Page1.html).

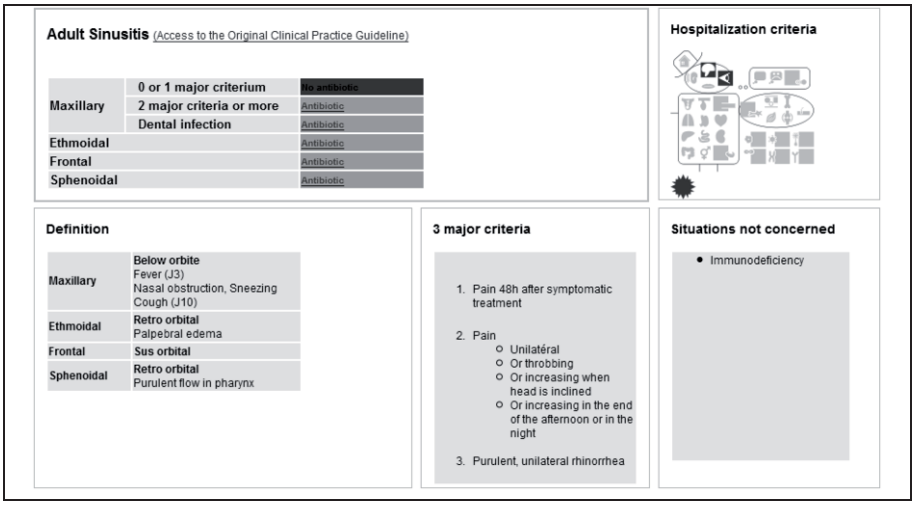

Figure 1. The second page of the adult sinusitis CPG. (Area A: decision treemap, Area B: definitions, Area C: score, Area D: hospitalization criteria, Area E: situations not concerned by the CPG).

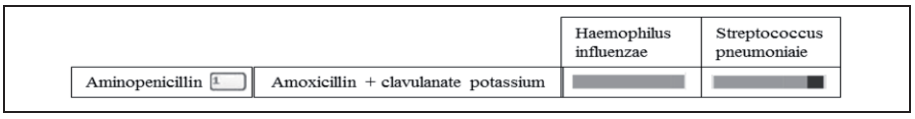

Figure 2. The third page displays antibiotic spectra.

Ten general practitioners evaluated the interface. For each clinical case, they were instructed to choose the type of treatment. The mean SUS score value was 54 with the old interface versus 72 with the new interface (SUS range: 0-100).

3. Discussion and Conclusion

From the analysis of the various CPG that concern the treatment of infectious disease, we were able to derive a general model of the reasoning process used to determine treatment. Using this model, we identified a set of information to display to users. The developed interface always presents information in the same manner, so users know where to find the information they need. This organization allowed the time of interaction with the interface to be between 30 seconds and two minutes (our estimate) depending on the clinical situation. Short interaction times are important success criteria in information searching [11]. Using this interface, physicians are able to understand why an antibiotic is recommended or not, as all elements involved in the therapeutic decision are presented. This aspect is important for increasing physician adherence to the recommendation results [12].

This method of analysis could be applied to other categories of diseases (such as cancer) for which multiple CPG are available and similar therapeutic decision processes are employed. The new version of Antibiocarte was well-appreciated by the users and therefore appears to be appropriate for clinical practice. A larger evaluation is being conducted to confirm these findings.

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