Implementation of a Database on Drugs into a University Hospital Intranet

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Abstract
Several databases on drugs have been developed worldwide for drug information functions whose sources are now electronically available. Our objective was to implement one of them in our University hospitals information system. Thériaque is a database which contains information on all the drugs available in France. Before its implementation we modeled its content (chemical classes, active components, excipients, indications, contra-indications, side effects, and so on) following an object-oriented method. From this model we designed dynamic HTML pages according to the Microsoft's Internet Database Connector (IDC) technics. This allowed a fast implementation and does not implies to port a client application on the thousands of workstations over the network of the University hospitals. This interface provides end-users with an easy-to-use and natural way to access information related to drugs in an Intranet environment.

Keywords:
Database Management Systems; Drug Information Services; Hospital Information Systems; User-Computer Interface; Internet.

Introduction
The integration of various computerized services in medical information systems favors the development of applications that can help health professionals in their daily practice. Several databases on drugs have been developed worldwide for drug information functions: ABDA in Germany, Thériaque in France, Martindale in the United Kingdom, First Data Bank in the United States of America, for instance. These databases are now available on electronic supports. They have in common the particularity to be poorly structured and to use much free text. So, authors propose models sufficiently general to avoid the use of free text, specially for computerized drug prescription [1-3]. More generally, users need in a Hospital Information System a fast, easy, and efficient access to information on drugs. So, the development of user-computer interfaces that favor the communication and the dissemination of information on drugs is a topical question [4,5].

This paper presents the implementation of the database Thériaque in the University hospital at Marseille. Thériaque is a database which contains information on all the drugs available in France, including drugs delivered in hospitals only [6]. It has been created and it is maintained by a group of pharmacists and physicians. The database contains in a large set of relational tables the complete information related to drugs: pharmaco-therapeutic group, active component, excipient, commercial presentation, indications, contra-indications, and so on. The method used to implement it is object-oriented. We implemented the user interface with the currently emerging Internet technology.

Objectives
The "Assistance Publique - Hôpitaux de Marseille" groups the five public hospitals of the city. They are located in various areas in the city. A unique high-speed network links all the hospitals, and the workstations inside the hospitals. Thousands of PCs are connected to the network. The network is based on Windows NT servers. The PCs are Windows for workgroups and Windows NT workstations, and some Macintoshes. The communication protocol is TCP/IP. In this frame, our objective is to provide health professionals with an access to the Thériaque database on drugs from any workstation.

For implementing this database on drugs in our hospital network, we had the choice either to develop a client application that queries a database management server, or to benefit from the current Internet technology that provides with a universal client: the Internet browser already present on each workstation. The first solution imposes to develop the client application for each platform and to implement it on each workstation over the network. We have chosen the second solution. We developed neither a specific object-oriented system for drugs, nor an
object-oriented database to store and retrieve information. We did a conceptual model of information related to drugs by means of an object-oriented method [7]. Then, we transposed the content of the attributes of the classes of objects isolated and the relationships between them to the screens (HTML pages). This design allows access to information in an easy-to-use and natural way.

**Method**

A drug can be described by its pharmacological class, its active component, its commercial name or manufactured preparation, and its presentation. The excipient or vehicle has to be added if we want to have a complete view of the concepts linked to drug. Active component and excipient are grouped into a chemical class. With this description, we have identified the core classes of objects involved in a model of drug.

**Classes of objects involved in the concept of drug**

We will now describe more precisely these core objects and the relationships that hold between them.

- **Chemical class.** The active component and vehicle belong to a chemical class. A chemical class can have interactions with other chemical classes and side effects. This two properties are inherited by active component and vehicle.

- **Pharmaco-therapeutic class.** Commercial presentations which share therapeutic properties are grouped in a pharmaco-therapeutic class. The Thériaque database uses various nomenclatures such as ATC (Anatomical Therapeutic Chemical), and EPhMRA (developed by the European Pharmaceutical Marketing Research Association). Each item of the class is identified by its name and a code. The pharmaco-therapeutic class has relationships with the classes interactions and side effects.

- **Active component and excipient.** An active component is a molecule which has therapeutics action. It is defined by its name so that it can be identified by the physicians. An excipient does not have therapeutic action. Active components and excipients must have information on incompatibility with associated vectors, interactions and dosage.

- **Manufactured preparation.** It is the name of the commercial product manufactured by a pharmaceutical company. A manufactured preparation is defined by its name, the formulation in active components, excipients, and pharmaceutical form. A manufactured preparation includes information on indications, contra-indication, dosage, side effects, overdose, interaction, incompatibility, and so on.

- **Presentation.** A manufactured preparation can have many presentations which differ by the number of units, the materials used for packaging.

Some other classes of objects have been identified, such as indications, contra-indications, and side effects. Obviously they have relations with some of the above classes. But, because they have no direct relationship with the concept of drug, that is the core concept of our representation, they are not formalised here.

**An object-oriented model of drug**

From this analysis we were able to model the classes of objects involved in the definition of a drug. A part of the complex object-oriented model presented by the diagram of Figure 1. In particular are not represented the classes indications, contra-indications, and side effects with which some classes, such as chemical class, have relationships.

An object-oriented model provides with a lot of advantages. The inheritance mechanism allows to define at some levels properties of objects that will be automatically inherited by objects issued from children classes. The properties which are characteristic of pharmaco-therapeutic class or chemical class can be obtained by the manufactured preparation through the association link between these last two classes, or through intermediate classes (active component or excipient) in the case of the latter ones. For instance, the relationships that hold between the chemical class and the classes indications, contra-indications, and side effects are thus obtained automatically by the objects of the class manufactured preparation, through the intermediary classes active component and excipient.
We have identified areas on pages which have the same meaning, from screen to screen, allowing a coherent navigation according to the different levels of classes in the model. Moreover, the content of these areas are instantiated with respect to the inheritance mechanism due to the hierarchy of classes. Two areas identify a current object and display information related to it. Two other areas are: a menu bar which proposes complementary information that has not be spontaneously displayed, and a navigation bar gives access to other related pages. This will be illustrated below.

**Results**

To create dynamic web pages with information contained in the Thériaque relational database we used the Internet Database Connector (IDC) mechanism [8]. This solution is developed by Microsoft and allows a web browser to query a relational database and display the result of the query in a HTML page. In this section we will first detail the mechanism of the IDC. After what we will show how we applied it in our framework.

**How the IDC works**

Figure 2 shows the components used to access databases from a web browser. A web browser submits requests to the web server by means of the HTTP protocol (1). The web server responds to the query with a document formatted in HTML language (8). The IDC uses two types of files to control how the database is accessed and how the output HTML page is built. These files are Internet Database Connector (.idc extension) files and HTML extension (htx extension) files. A query is sent by the web server to a component with the name of ".idc" file (2). This file contains the identification of the appropriate database and related SQL queries. These SQL queries are updated by the data keyed on the initial page (3). The SQL queries are sent, via the Open Database Connector (4), to the target relational database management system where they are processed. Results are sent, via the ODBC, to the IDC (5). The HTML extension file is the template for the actual HTML document that will be displayed (6). The final HTML page is sent to the web server (7), and then to the web browser (8).

**The graphical user interface**

The screen of our user-computer interface is designed in four areas:

- The first area is used to identify the object displayed on the screen (a manufactured preparation, an active component, ...);
- The second area shows the information related to the current object that the user has chosen using the following navigation bar;
- The third area is a menu bar that allows the user to display complementary information about the current displayed drug (the commercial name of the preparation, its pharmaco-therapeutic class, its active component, its indications);
- The last area is a navigation bar with different buttons that give access to different pages according to the current type of object displayed.

![Figure 2 - The software architecture of the Microsoft's Internet Database Connector](image)

![Figure 3 - Relations between the class "Manufactured preparation" and other classes in the model](image)
ones. The diagram of Figure 3 shows its relations with three other classes of objects: indications, contra-
indications, and side-effects.

Let suppose that a health professional searches information about "CLAMOXYL 500 mg capsule". The
screen dump of Figure 4 shows a part of the information extracted from the database related to this drug. Each
button of the menu represents either a relation or an attribute of this object. Here are the buttons contra-
indications, indications and side-effects ("effet indésirable" in French) which are part of the manufactured
preparation's relations. Each button allows the user to display the information concerning the object linked by
the related relationship. The navigation bar represents the look-and-feel of the object because it is the reflect of the
object's relations. If the end-users want to have more information about the active component of the currently
displayed drug (for instance to know its interactions with other drugs), he/she has to change the current object
displayed on the screen by a click on the icon on the right side of the active component. As a result, he/she
obtains another page, with a new navigation bar which is now characteristic of the new active class, as shown by
Figure 5.

Conclusion

Our main objective was to disseminate the information on drugs contained in the database Thériaque over the
network of our University hospital in an Intranet environment. Nevertheless, if it does not exists today an
effective method for the implementation of Intranet services, we followed the principle which says that "what
lives on is that which is useful". Thus, after we analyzed the users needs in relation with drugs information, we
modeled the notion of drug in an conceptual (object-oriented) way so that the different screens displayed to the
users respond to their needs. When information related to a drug is displayed as an answer to a user's query, only the
basically useful information is present. But, complementary information is proposed by the means of
buttons and links. Buttons have always the same meaning: they give access to attribute values of objects that are
modeled by their respective classes. A specific look-and-feel being designed for objects of different classes must
help users to locate their browsing in the database.

Even if the implementation is strongly dependent of the database on drugs we chose to make available to health
professionals in our University hospital, we think that the method and the technics we used for that are general. First,
the choice of the Internet technology allows to have a universal client on the workstations over a large network.
This authorizes to not develop client applications that must be ported on each of these workstations. Secondly, the
techics we chose to adopt minimizes the necessary developments. Effectively, the Microsoft's IDC technology
allows to attach formal queries that are instanciated by data keyed by users, and answers templates that are
fulfilled by the results coming from the database management server. This is in favor of a low cost in
maintenance. Finally, the use of dynamic web pages guarantees the useful life of the implementation along the
successive updates of the database content.

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References


Address for correspondence
Composition de CLAMOXYL 500MG GELULE

## Composition

**Substance active**
- AMOXICILLINE TRIHYDRATE 574 MG

**Substances(s) auxiliaire(s)**
- EYTHROSINE COLORANT (ENV GELULE)
- FER OXYDE JAUNE (ENV GELULE)
- GELATINE (ENV GELULE)
- INDIGOTINE (ENV GELULE)
- MAGNESIUM STEARATE
- TITANE DIOXIDE (ENV GELULE)

## Teneur

AMOXICILLINE BASE 500MG

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Figure 4 - Screen dump of a commercial presentation: "Clamoxyl 500 mg capsule"

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Classe AMOXICILLINE TRIHYDRATE

**Classe chimique:**
- AMINOSPECIFICILLINE

**Classe pharmacothérapique(s):**
- ANTIBIOTIQUE ANTI-ET / BACTERIEN

**Classe ATC:**
- AMOXICILLINE J01CA04

Figure 5 - Screen dump of the active component of Clamoxyl displayed on Figure 4