Review Article

Expert –System: A Web-Based System for Patient Specific Drug Interaction Testing

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Abstract: The information system presented in this article makes drug selection easier and indicates possible interactions with existing medication. In the event of an interaction with multiple medication, the consumer is specifically warned. In addition, special algorithms determine alternative drugs with the same effect in order to avoid the undesired interaction.

Keywords: Drug selection, interaction, medication, algorithm, diseases, therapy.

1 INTRODUCTION

In today's world, doctors are confronted with the risks and dangers of drug interactions on a daily basis when treating diseases. In Germany alone, more than 50000 people die each year from adverse drug interactions [1, 2].

The annually increasing number of known diseases (approx. 30,000 [3]), available commercial products (approx. 60,000 [4]) and the increasing complexity of drug therapy undoubtedly ensure that doctors may only provide a fraction of the necessary information when the prescription is consider. Because of this, drug interaction pose not only a significant health risk, but also a financial problem for patients.

In addition to extending the length of stay in hospital, additional cost-intensive, diagnostic and drug therapies are required [5, 6]. In elderly patients, adverse drug interactions are the reason for hospitalization in 5-23% of cases, in 1.75% the reason for an outpatient visit to the doctor and in one in 1000 patients the cause of death [7, 8]. In 19-36% of the admission cases this can be traced back to medical prescription errors [8]. Expressed in terms of costs, this means a multiple expenditure of an estimated 500 to 600 million euros per year [2]. Older and multimorbid patients are particularly affected by this complex problem, as polypragmatic disease is becoming increasingly common [9].

2 METHODS

2.1 Task and goals

An information system that depicts the amount and complexity of the continuously growing medical and pharmaceutical knowledge in a usable way and functions as a "warning system" in the event of possible drug interactions can then sustainably support the quality of the drug prescription and thus ensure improved drug safety. This is why the web-based system described here - for patient-specific drug interaction testing - is being developed that meets the following requirements:

- Integration of the drug database "RED LIST [10]" and the book "MSD manual of Diagnostics and Therapy [11]" into the expert system
- Resolution of the inconsistencies in the "RED LIST" database.
- Examination of any number of drug interactions / side effects
- Determination of alternative drugs with the same effect in the event of an interaction

- Linking the diseases with the associated drugs
- Detailed information about drugs and diseases should be searched efficiently and presented clearly
- Implementation of the system using the following tools: Apache, PHP and MySQL
- User-, location- and web browser independent access to the Information
- Design of a German and English user interface for better orientation and navigation
- Guarantee of data independence

The Expert-System can serve as a guide for nurses, pharmacists, patients and especially for doctors, provided that the licensing provisions of the "RED LIST" and it can also be a great reference work that contains detailed information on medicines and diseases. This medical system is intended to provide assistance with the incomplete infrastructure of the pharmaceutical industry. In this way it is intended to contribute to the efforts to reduce risk in drug therapy to support effectively, which ultimately results in better tolerability and tolerance-based drugs for the patient.

2.2 Implementation
The Expert-System is characterized by a comprehensive and innovative drug and therapy database. A web-based graphical user interface enables fast and targeted access from all common browsers, such as MS Internet Explorer or Mozilla Firefox, to all Information in the database. The chosen development strategy not only allows a high number of users, but also good scalability and maintenance. Especially the functions that should be emphasized are the facilitate the choice of medication and point out possible interactions with existing medication. In addition, alternative drugs that have the same effect and do not interact are identified. In order to identify the interactions and the alternative drugs, self-developed and modern database algorithms are used. Through this web-based system, the user is specifically warned of interactions and can accordingly detect and deal with serious, moderate, or minor interactions. In addition, drugs that are causing an existing side effect can be identified.

2.2.1 System architecture and database structure
The technological requirements of the Expert-System require an extended client-server architecture. The client (browser) communicates over the internet with a central web server that manages all the data and executes the application logic. On the server side, an Apache HTTP web server and PHP scripts are used to dynamically generate static HTML pages that present database information to the user.

The use of the client-server architecture ensures an advantageous separation and decoupling of the aspects of the user interface (GUI) from the actual application logic and the data management aspects, which ensured data independence. The Development strategy of the Expert system can thus be divided into these functional reas:
1. Presentation layer, the client
2. Application layer, the web server
3. Data storage layer, the database

The following figure is intended to illustrate the interaction of the basic architecture components.
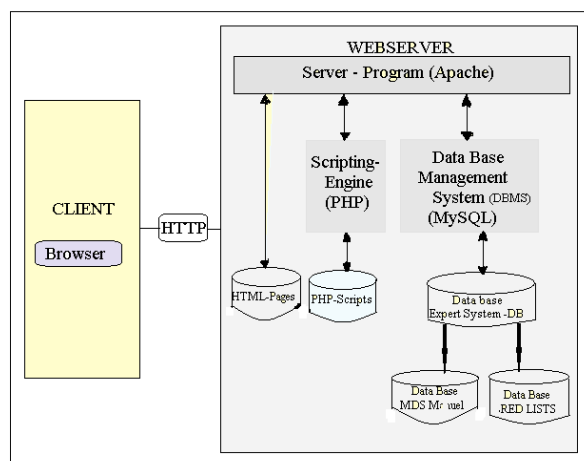

Figure 1: Architecture of the Expert system

The database (Expert-System-DB) is based on a relational MySQL database management system, which enables the efficient management of large and persistent data amounts through user-friendly query processing and internal data optimization. The Expert-System-DB describes the integration of the drug directory RED LIST [10] and the book MSD

Manual of Diagnostics and Therapy [12]. For this, the database schema was normalized accordingly and indexed with progressive algorithms so that 9 Codd's rules are also met. The database schema is geared towards the general structure of the interaction and information search, in which the integrated schemas from the existing data sources forming the starting point.

Pharmaceutical information as well as diagnostic and therapeutic explanations provide detailed information on the drugs and diseases. A special section of the database schema has information on how to effectively test and bypass potential drug interactions.

2.2.2 User interface
The most important criterion for the design of the graphical user interface (GUI) was usability, which is made up of effectiveness, efficiency and satisfaction. A contribution to the usability comes through simple search forms and menus that always follow the same logic. The user can use the forms to select and display the data from the database using the database management system. The control mechanisms used only allow correct entries. Menus serve as lists with categories, such as drugs, interactions or diseases. For reasons of ergonomics, the main menu is wide rather than deep. Furthermore, a constructive, clearly marked response or error message is issued after each action by the user. An action that has taken place can always be done by pressing the "Back" button. Furthermore, the Expert-System has fundamental advantages in terms of use and training:

- For the search, complicated names of drugs, active ingredients, etc. can be entered truncated.
- Despite recognizable incorrect entries, the intended result can be achieved with little or no correction effort on the part of the user.
- Uniform presentation of the information from the database
- Uniform and easily understandable functional processes
- All information is linked in the system in such a way that different paths lead to them
- Help documentation makes it easier for users to learn the application

3. SUMMARY
In the age of multiple medication, the major challenge for medical staff and patients is to minimize medical interactions, as these lead to undesirable, (sometimes) life-threatening consequences. The Expert system, implemented at a high level of web technology, is a web-based system that not only checks and avoids the interactions and side effects of drugs, but also links diseases and drugs.

The usable, multilingual user interface provides, in addition to many disease and drug facts in the form of an encyclopedia, an efficient and effective search for professional information. Access to the system is possible regardless of user, location and web browser.

Such a system could help reduce the number of deaths from drug interactions, sustainably support the quality of drug prescriptions and thus improve drug safety.

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