Provision and assessment of pharmacology and pharmacotherapy education across an integrated medical school curriculum

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CHAPTER 2

Development of visual pharmacology education across an integrated medical school curriculum

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J Vis Commun Med 2007; 30(4):156-61

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ABSTRACT

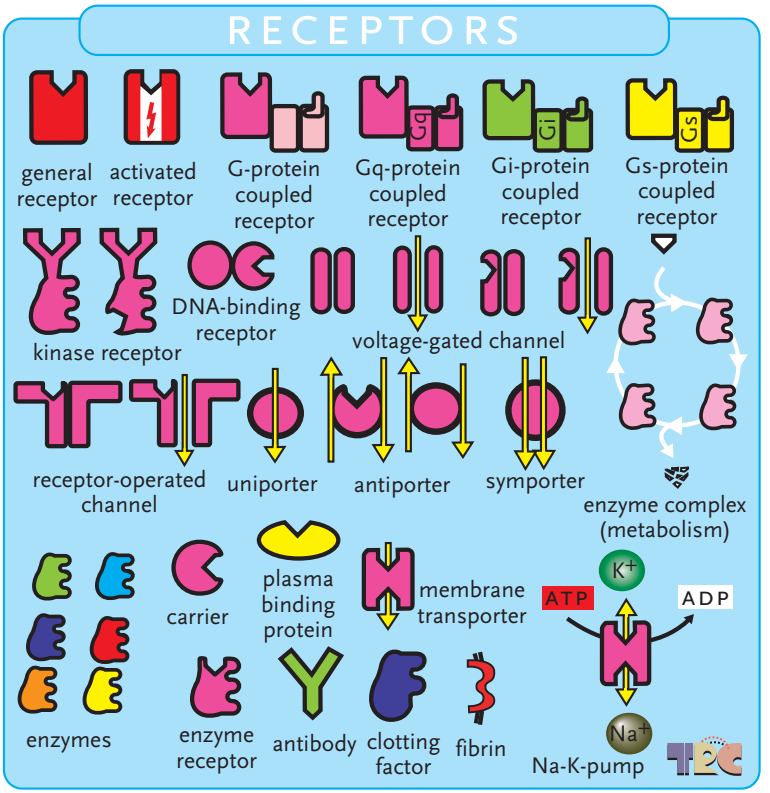
Background: Due to curricular integration in many medical schools, clinical pharmacology is no longer a dedicated course taught by clinical pharmacologists. This calls for new approaches to clinical pharmacology teaching, with aims to be 1) complete; 2) integrated with other subjects; and 3) presented consistently across the curriculum.
Methods: Using a previously developed graphical icon language, a self-study computer database program was developed. The database was formatted so that pharmacological mechanisms were shown interacting with pathophysiological processes. The program contains the visual graphics as well as animations, formative feedback questions, and sample cases and is developed together with basic science and clinical teachers. The students access the program throughout the curriculum via self-learning assignments. Learning efficiency is assessed by 1. the number of courses adopting the database; 2. the number of students using the program and 3. the percentage of students per course.
Results: The use of the database was monitored for a five-year period and at times throughout the curriculum. Students increasingly use the programs as they progress through the curriculum and are successfully challenged by these self-study methods. Initial hesitation by teachers made place for widespread use of and contributions to the graphical materials.
Conclusions: The data indicate that both teachers and students increasingly rely on the self-study computer program which incorporates visual graphics into an e-learning program.

INTRODUCTION

Medical students are expected to learn a significant amount of information in their studies. In no area is this more true than in the understanding of pharmacology and pharmacotherapeutics where there are nearly 20,000 currently utilized therapeutic agents (source: Netherlands Medicine Evaluation Board). Traditionally, pharmacology was taught in stand-alone courses by a single professor where the students were introduced to pharmacology and were presented the mechanisms for drug classes (1,2). This method required many hours of lecture by the teacher and even a longer time for the student to memorize (3). Due to the large volume of information to be absorbed in a short time, students no longer know the mechanistic meaning behind the classes of different agents such as beta-blockers. To them this has become like a breed distinction in that they know what it looks like, but can no longer describe what it does or how it works. This problem was exacerbated by the fact that the courses were given early in the curriculum and the knowledge obtained could not be applied when it was clinically necessary.

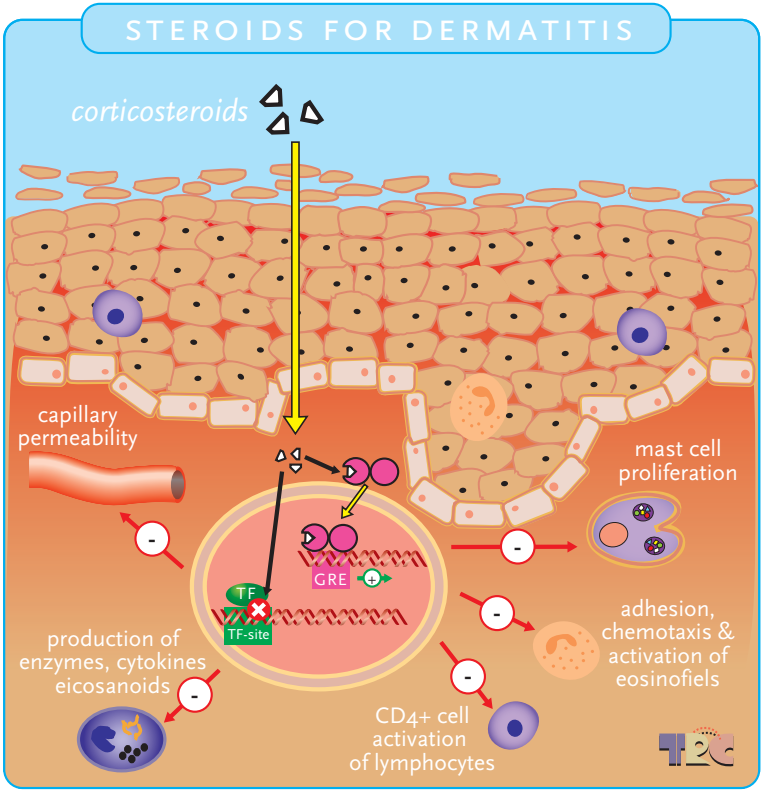
In the new curriculum at Leiden University Medical School (LUMC), students examine disease states in an integrated manner. This curriculum is based on the Calgary system of clinical presentations (4). The students evaluate the signs and symptoms, in a forward thinking model in order to determine the diagnosis. They then use pharmacology to come up with the appropriate therapeutics. In practice, this results in more emphasis on diagnostics and only a limited time for pharmacology and therapeutics. Unfortunately, pharmacology can be presented in a multitude of ways, and the images from textbooks and articles often contain unnecessary and distracting information. This often causes confusion among medical students. Our group, the Teaching Resource Centre (TRC), reviewed the various presentations of the mechanism of benzodiazepines and found that students were presented with 18 different representations of the chloride channel throughout the medical curriculum (5).

Figure 1 *Teaching Resource Cenre (TRC) icon language*



It is not our intention to demonstrate that visual aids are distracting in the curriculum; on the contrary, we believe them to be an outstanding method for teaching. Other groups have discussed the utilization of visual symbols to enhance learning and even life-long learning (6-8). Research has found that using visual symbols to teach pharmacology to non-English speaking groups enhanced learning and believe this is due to stimulation of all three areas of memory: attention, storage, and retrieval (9). Based on this type of research, the TRC created an unique icon language to present our own graphical descriptions of pharmacological mechanisms at the LUMC (figure 1). The graphics are created in Adobe Illustrator® by non-graphic artists, by instructors trained in physiology and pharmacology. The result is a graphic that is simple and cartoon-like, yet still contains basic information about essential pharmacological characteristics that are standardized and easily discernable for the student to learn (figure 2).

Figure 2 *Example of a TRC illustration explaining a pharmacological mechanism*



However, a problem remained. How do we integrate these graphics throughout the curriculum? In considering the new curricular format, the pharmacological teaching should meet the following programmatic needs: 1) exposure should be 'complete'; 2) pharmacology should be integrated with other scientific disciplines 3) presentation should be consistent across the curriculum including (repetition, implicit information, cross-referencing/generalization); 4) educational methods should foster self-learning, and 5) program should provide feedback to both students and teachers. However, there were a few challenges that complicated our efforts: 1) a new course was not possible; 2) there was no time for additional lectures in already established courses, and 3) no time or opportunity for summative assessments. Based on these circumstances, it was decided to provide the pharmacology graphic materials primarily by computer-based methods, and this program would consist of reusable computer education for student self learning.

AIM

To develop a computer-based teaching solution for student self-study that will visually review pharmacology.

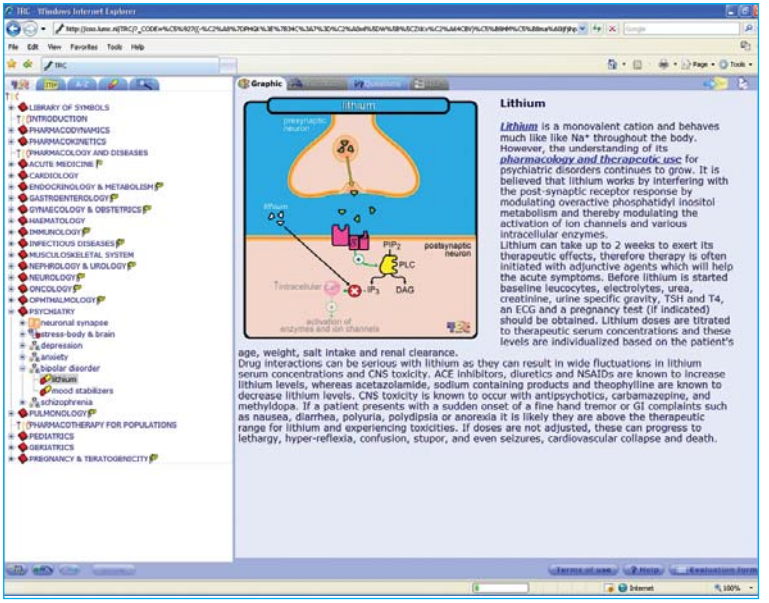
METHODS

Using the newly developed TRC graphical language for uniformity, a self-study computer database program was created (coo.lumc.nl/TRC). The database contains information about physiology, pathophysiology, pharmacodynamics, pharmacokinetics, drug mechanisms of action, and pharmacotherapeutic principles. We started with a Microsoft Access® treeview database, in which the program displays a tree structure on the left-hand side of the screen (figure 3),where topics can be viewed by either searching for specific materials or learning by proceeding through a tutorial part of the tree. Each branch of the tree consists of topics that are presented in the form of an introduction, physiology, pathophysiology at the organ and cell level, and finally the mechanism of action for the drugs indicated for the particular disease. Thus, each tutorial can 'teach' a student how a drug's mechanism of action interacts with either physiologic or pathophysiologic processes if they follow a concept along a branch of the tree. Lastly, it is easy to make cross-references between various sections; offering the students the chance to see beta-blockers in use for arrhythmias as well as for anxiety disorders.

The right side of the screen contains several tabs for each topic. The first contains graphical material (in the icon language), that is either discernible on its own or accompanied by simple text for ease of self-

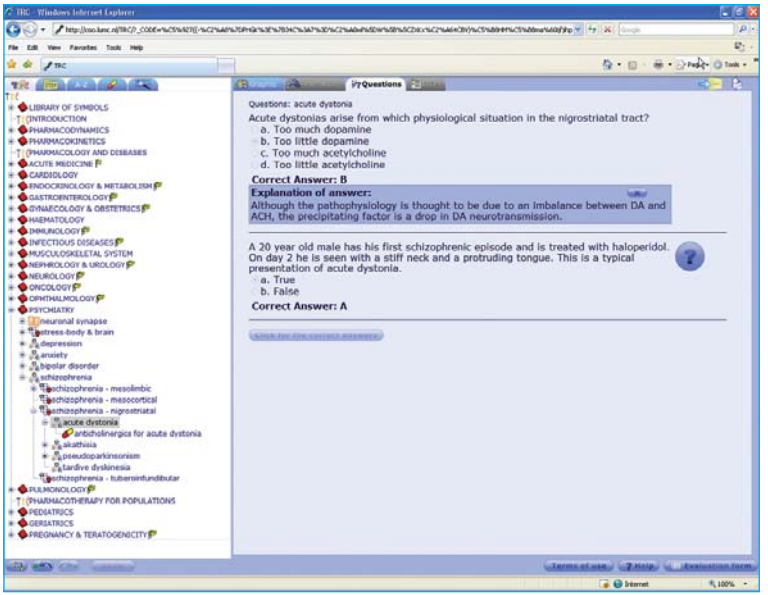
study. In addition, supportive text and charts with links to the relevant literature provides insights into the therapeutic utilization of the drug or drug class. On the second page, accessible by a tab, a few multiple-choice practice questions with explanations of the answers assess the students understanding of the information presented (figure 4).Finally, there is a tab that leads the students to a sample patient case in which the student can practice developing a therapeutic plan using the information learned and the links provided. These last two tabs provide the students with formative assessment opportunities (provide feedback without effecting grades) and mimic their final examination assessments, thus preparing the students for their summative assessments.

Figure 3 *The TRC Pharmacology database as it appears online*



The scope of materials covered in the TRC database have been determined by cross-referencing the Core Curriculum for Dutch Medical Schools and the Dutch Heath Insurance National Formulary and combining this with the focused topics of the clinician in charge of delivering the various courses. In addition, the system entails converting existing visual teaching materials of the individual teachers into standardized illustrations, and the teachers use the TRC graphics for other purposes in their courses (e.g. PowerPoint presentations, course handouts, other computer based teaching activities). With this design, the database is a dynamic source of up-to-date information, which can easily be supplemented or replaced.

Figure 4 *The question tab of the TRC database*



Student access to the TRC database is achieved through the virtual learning environment (Blackboard). The student log-in data are transferred to the TRC database. Any (other) user can access the TRC database via Internet (http://coo.lumc.nl/TRC). Entry into the program via web access requires provision of the student identification number or an email address. The back-end of the database contains a reporting program that allows the TRC group to monitor the students' use of the pharmacology teaching program throughout their curricular experience. The back-end is primarily used as an assessment of the database as a tool for teaching clinical pharmacology.

Lastly, since the database is freely available over the internet, we decided to survey the outside users for their reasons for using the program. We sent an online questionnaire developed from a package from www.FreeOnlineSurveys.com® to all TRC database users who logged into the website with an email address.

INCORPORATION AND UTILIZATION

During the implementation process, the progress of incorporating the TRC Pharmacology database into the curriculum was catalogued. In the first year, 10% of the courses at least partially utilized the TRC database. Initially, the program was used primarily to explain pharmacological mechanisms

of action and physiological/ pathophysiological mechanisms of disease. In the subsequent years the TRC was adopted by more faculty members to be used in their courses (see table 1) and content began to include pharmacotherapy. Theoretically, the pharmacological elements are constantly kept current, but we have found that once the faculty has developed their sections, they rarely initiate a revision. We can only assume that the reason for this is a lack of time. Now, a population that includes nearly all the students in the medical curriculum and some from the biomedical curriculum views more than 130,000 topics each year. A closer look at the medical students' utilization patterns indicates that they prefer to review the materials shortly before exams (see figure 5), and that (in general) more students access the program as the year and curriculum proceeds. Student log-in data from individual courses (table 2) indicate that increased utilization of the database is associated with the professor using the TRC Pharmacology illustrations in lectures and with clear statements that the materials contained therein will be assessed on the exam. In the year of the Internet survey, we had more than 14,000 hits from 588 people outside of the university, including 114 students referred to the database from another medical school. The reasons reported for using the website by the other 105 outsider users responding to the survey were: studying (33%), drug information (27%), copy materials (14%), teach (12%), or just looking (12%).

Table 1 *Utilization of the TRC by students and courses*

Curricular year	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006
# courses/year using TRC	9	13	15	17	20
# students/year using TRC	290	445	899	1113	1488

CONCLUSIONS

The goal of this project was to provide a complete overview of clinical pharmacology in a uniform and visual manner across the curriculum which is easily accessed and utilized by medical students. The preparation of the visual materials and their placement in the e-learning program are offered as a 'service' to coordinators during the preparation of each course. For an e-learning program to be efficient for learning it needs to be used by students. The use of the database was monitored for a five-year period and at times throughout the curriculum in order to identify and address needs that were not met. In situations in which the results were less than expected, we updated the content, invested in technology and usability, increased assessment of the students regarding the content, and further embedded

the TRC Pharmacology database into the course environment. We are encouraged that the medical students have increased their utilization over the years. In addition, they increasingly rely on TRC database as each year progresses and as they get nearer to actually seeing patients. Surprisingly large number of outsiders accessed the site for studying, drug information, and teaching due to referrals and links to website without any outside advertising for the system. Our initial concerns about sabotage and loss of proprietary information have not been realized and open access has allowed for more collaboration. For example, the TRC graphics now provide the majority of illustrations for the two Dutch language pharmacology textbooks (10,11), as well as the chapter of psychopathology in the Dutch language psychiatry textbook (12). This is despite the fact that the illustrations are 'low fidelity', a term used for computer based education that is not technologically sophisticated.

Our visual method of presenting clinical pharmacology information has been widely accepted and integrated in the medical curriculum. At the same time, the teachers' individual teaching methods are fully maintained, while the pharmacological elements are constantly kept current. The data indicate that both teachers and students increasingly rely on our e-learning strategies. As such, since using the TRC database has proven to be successful and has effectively incorporated our pharmacology outcomes throughout the curriculum, courses are now required to use it to meet the objectives. Ongoing assessments will help determine what influences successful courses and student learning of the material.

Figure 5 *Timing of student utilization as compared to the various courses*

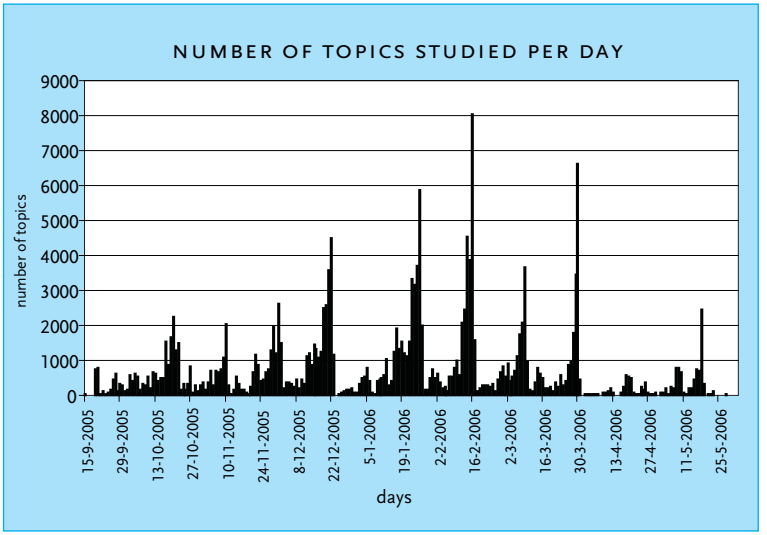


Table 2 *Log-in data per course (where data is available for both years)*

Course	2003 ratio students using TRC/taking exam	2006 ratio students using TRC/taking exam
1st year		
Control & regulation	0.49	0.41
2nd year		
Infectious diseases	0.45	0.45
3rd year		
Gastroenterology	0.80	0.53
Chest	0.63	0.67
Renal disorders	0.28	0.58
Endocrinology	0.72	0.75
Oncology	0.51	0.72
Psychiatric diseases	0.52	0.81
Rheumatology	0.53	0.67
4th year		
Reproduction	0.27	0.67
Paediatrics	0.44	0.59
Geriatrics	0.79	0.84
Average per class	0.53	0.64

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