PROVISION AND ASSESSMENT OF PHARMACOLOGY AND PHARMACOTHERAPY EDUCATION ACROSS AN INTEGRATED MEDICAL SCHOOL CURRICULUM

To the memory of my mother whose most sage life advice was found in a driving lesson... 'Always speed up when changing lanes'.

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PROEFSCHRIFT ter verkrijging van de graad van Doctor aan de Universiteit Leiden, op gezag van de Rector Magnificus prof. mr. P.F. van der Heijden, volgens besluit van het College voor Promoties te verdedigen op dinsdag 3 juni 2008, klokke 16.15 uur

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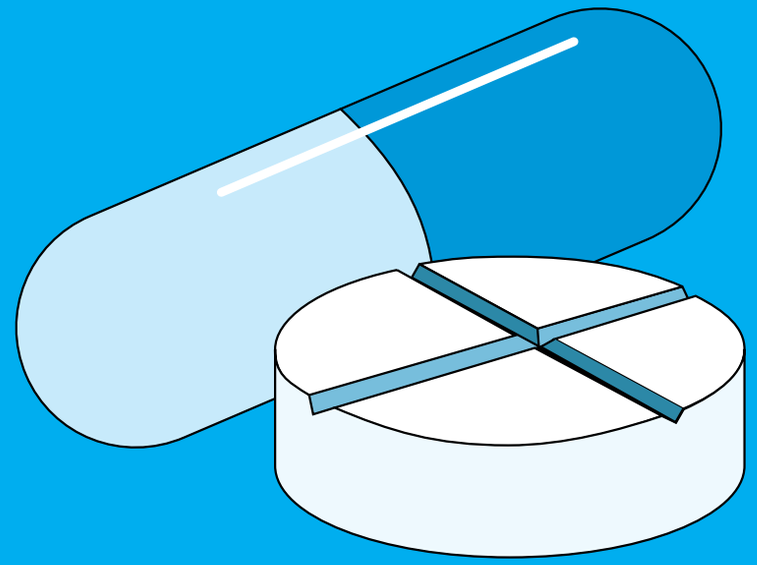
INTRODUCTION

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



INTRODUCTION

In the Netherlands pharmaceutical costs rise nearly 5% per year, and in 2006 reached 4.7 billion Euros per year (1). With the growth in Dutch population averaging less than 1% per year, the increased expenditures are attributed to both the rising costs of individual drugs (2) and an increased utilization by the population (3). The utilization of medications in the Netherlands has been consistently expanding over the years and has reached 5.9 prescriptions per capita per year (4). This increase is credited to the fact that many of the medications doctors prescribe are used to control diseases over the long term and reduce the risks of developing a disease. Thus, it is apparent that as our society becomes older there is an increasing reliance on medication to keep mortality at bay. No one has more audaciously represented this belief than the conceptual artist Damien Hirst. In 2005 he introduced an exhibition entitled 'New Religion', a controversial look at society's unquestioning belief in the healing power of medicine; examining 'the conviction that pills can cure you'. But are today's physicians prepared to live up to the expectation that they can ward off death by appropriately prescribing powerful drugs? No, not entirely, and not forever, of course. But, by improved pharmacological education and training for physicians, they will be able to maximize the potential of these medicines to improve and extend peoples' lives.

This introduction 1) provides the historical context of pharmacology and pharmacotherapy education at Leiden University Medical Center (LUMC); 2) presents a brief synopsis of the evolution of pharmacology education elsewhere; 3) reviews three of the educational concepts currently challenging medical curricula; 4) describes a new method for providing pharmacology education that meets these challenges and attempts to measure the impact of these methodologies.

PHARMACOLOGY EDUCATION AT LEIDEN UNIVERSITY MEDICAL CENTER

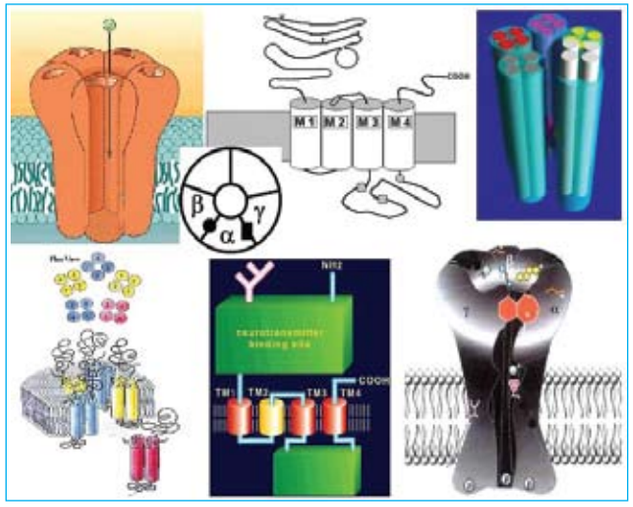
Early in the last century, E.C. van Leersum was the leading professor of pharmacology in Leiden (appointed 1904) (5). At that time, pharmacology was often seen as a part of clinical medicine, and as such, his teaching focussed on clinically-oriented pharmacotherapy to the medical students (6). Over the next few decades several scientific advances were made in the field (elucidation of the effects of digitalis, nicotine and opiates), and when his predecessor, W. Storm van Leeuwen, became a professor in 1920, he created a sophisticated textbook to introduce general pharmacology to medical students (7). The 1930's and 1940's saw the rise of dose-effect curves and endocrinology as important topics. S.E. de Jongh taught several generations of new physicians during his tenure from 1935-1963, and

Pharmacology courses became lecture and laboratory practicum intensive with demonstrations of drug actions in either tissue or entire animals (8).

After World War II, the focus turned to antibiotics and medical students were introduced the concept of pharmacokinetics in order to maximize the effects of this limited resource (6). Until this time, students were still assessed by oral examination. However, due to the shear number of medical students in the 1960's, the department of pharmacology (under the leadership of E.L. Noach) was the first to introduce multiple choice examinations at Leiden (9). Using an approach that many modern medical education researchers would envy, the department first compared the results of volunteers taking the same exam twice (oral and written) to determine comparability. This was followed by the introduction of the written examinations for all students and testing of various situational hypotheses (e.g. student performance on new questions versus core questions).

In the subsequent years, drug discovery led to an expanding number of topics to be covered, the faculty grew and there was increasing use of teaching collaborations between the departments of toxicology and Leiden school of pharmacy. In 1984, the LUMC made the decision to offer all the courses in the curriculum in the block format (individual courses taught uninterrupted over the period of a few weeks (10)). Concurrently, the clinicians were expressing their desire to teach pharmacotherapy, and this led to the pharmacologists teaching only basic pharmacological concepts in their new pharmacology block.

Figure 1 *Diverse representations of the chloride ion channel used at the Leiden University Medical Center prior to development of the Teaching Resource Centre for Pharmacology icon language*



In 1999 the LUMC introduced the latest reform to the medical curriculum. Using the new curriculum introduced in Calgary as a model, all the curricular blocks were integrated, and the stand-alone pharmacology block was lost. In this curriculum, the students start with the patient's clinical presentation and then move forward in their thinking process as they considered the anatomy, physiology, and pathophysiology (in order to determine the diagnosis) and pharmacology (to determine the therapeutic intervention) (11). Each disease state is presented by a teacher in the field, who uses diverse presentation materials (images from textbooks and/or articles) in their workgroups and lectures. Because each teacher was left to develop their own approach, pharmacology was presented in a variety of different ways, and it was found early in the provision of the new curriculum that this was indeed the situation (See figure 1) (12). Diverse study materials and examinations inconsistently covered the pharmacology material, leading to confusion as the students were unable to recognize a drug's mechanism of

Figure 2-a *The TRC icon symbols used for different receptor types*

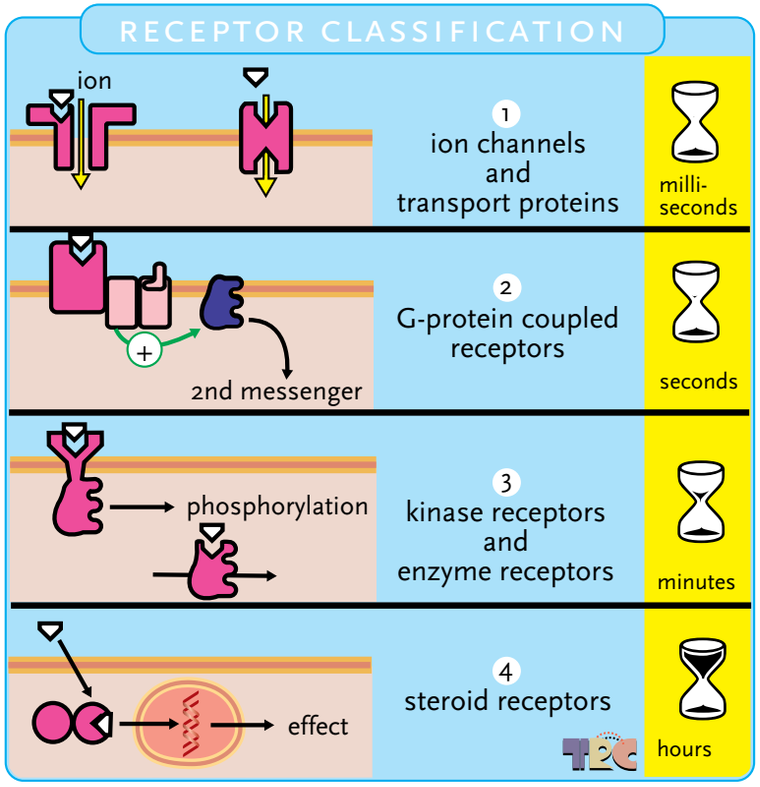
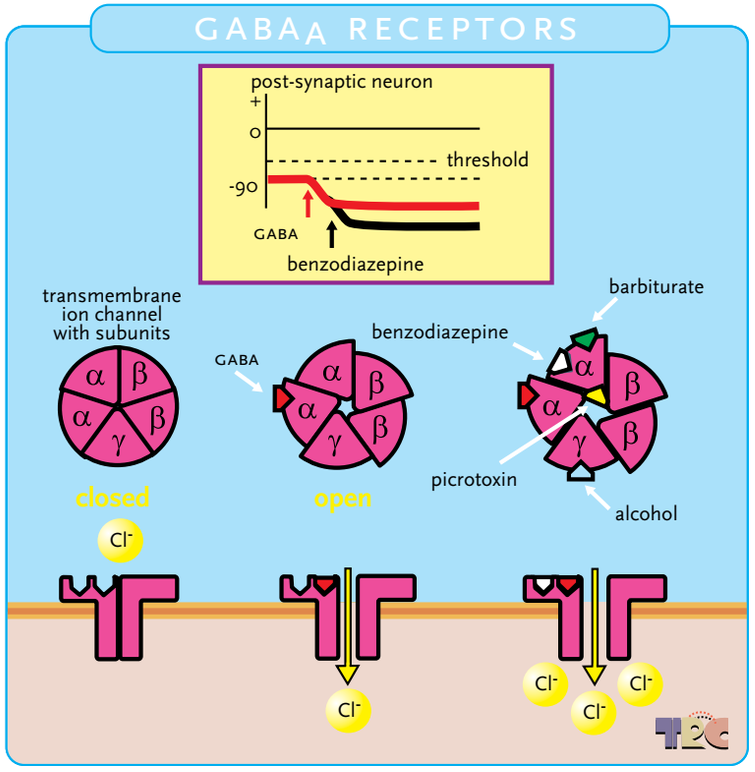


Figure 2-b *The TRC icon symbols used for different receptor types*



action as it is presented for two different disease states. It became clear that pharmacological principles needed to be presented consistently throughout the curriculum. In that same year, a group formed within the division of clinical pharmacology and created the Teaching Resource Centre (TRC) for pharmacology. The founding members: A.F. Cohen, J.M.A. van Gerven, and E. Benjamins, had the strategic intent to standardize pharmacology content in the curriculum. Development began on an icon language to describe pharmacological mechanisms (see figures 2A & B). Illustrations were created together with the course teachers for use in lectures and to be included into a pharmacology ring binder that the students would maintain throughout the curriculum. Although there was general appreciation for the illustrations created, their utilization in the curriculum was limited and often disconnected from the material which the students were expected to learn. In 2000 E. Benjamins left the group and in 2001 K.L. Franson took over the day to day management of the pharmacology program. E.A. Dubois joined later that year to assist in the expansion of the program. Later, during a

2002 visit by the Dutch accreditation committee, it was learned that students were not being provided with enough pharmacotherapy education, and the TRC group took on this additional task. Thus, the question became whether is it possible to systematically provide and assess pharmacology and pharmacotherapy education throughout an integrated medical curriculum.

EVOLUTION OF PHARMACOLOGY EDUCATION

The educational history of pharmacology at the LUMC has been similar to the evolution that occurred elsewhere. The Hopkins model of medical education (first acknowledged by the American General Education Board in 1914) (13) is commonly used the world over. In this model, an academically oriented medical centre with a strong focus on clinical and research activities drives the medical curriculum. Medical schools based on this model have classes in the basic sciences taught early in the curriculum and clinically-oriented classes taught later in the program. Thus, in the Hopkins model of medical education, pharmacology has traditionally been considered a basic science, a stand-alone course usually taught by a single teacher. In this manner, the teacher would spend many didactic hours presenting the basics of pharmacology as well as the mechanisms for various drug classes without providing a clinical context. This in turn required many hours of memorisation by the student. Over the years the amount of content that was required to be taught increased as pharmaceutical companies were more successful in bringing their drugs to market. To illustrate this point, since the 1970's, the Netherlands has seen the number of approved drugs increase from around 3000 to nearly 18,000 today (source: Foundation Pharmaceutical Indicators). Recognizing the increasing burden of factual knowledge to be true for other subjects as well, in 1991 the General Medical Council of the United Kingdom looked to reform medical school curricula in order to enhance learning rather than teaching, and knowing methods rather than facts (14). Yet three years later, in a review by Walley, Orme and Breckenridge, it was found that most medical schools in the United Kingdom still relied on lecture hours to teach pharmacology and therapeutics, and competencies were rarely assessed (15).

Thus, it appeared that for the time being, the task of teaching doctors how to prescribe was going to have to rely on the health care system itself. Reports by specific disciplines to improve the selection and assessment of drug therapy began to proliferate. Geriatricians (16-19), antibiotic use committees (20), and mental health departments (21,22) were busy attempting to develop guidelines and systems to increase the appropriateness of medication therapy for their patients. Only a few described the manner in which to improve the prescribing habits across the medical spectrum. Avorn and Soumerai described academic 'detailing' as the best approach to improve the knowledge which a physician needed to prescribe (23,24); whereas, the 'Guide to Good Prescribing' attempted to address the method required (25).

The academic world took notice and created core competencies that were to be developed in medical schools to address the needs of a prescribing physician. Although the number and depth of the competencies varied, all concentrated on the knowledge, skills and (occasionally) the attitudes required. Medical programs began to adopt educational innovations to try to cultivate the competencies in their students (26-29). However, in a 2005 report of curricular reform in South-East European Countries Medical Programs it was found that the majority of pharmacological teaching (between 120-165 hours) was still taking place in pre-clinical pharmacology courses, and only one program had integrated pharmacotherapy education as a part of the 6th year (30). The situation in the United States appears no different. Candler et al. reviewed the curricula of all US allopathic medical schools and found 67% offered a distinct pharmacology course, but the majority of time (93%) in these courses was still spent in lectures (31). In an effort to determine the current status of clinical pharmacology teaching in European medical schools, a recent joint meeting of the European Association of Clinical Pharmacology and Therapeutics and the British Pharmacological Society brought representatives from across the European Union to provide a glimpse of the teaching efforts that occurred in their countries (32). A representative from France reported that a recent review of clinical pharmacology teaching found that contact teaching time ranged from as little as 25 hours to nearly 150 hours in the various French medical schools (33). Some countries were teaching pharmacology in a traditional manner in stand-alone courses, others were integrated into organ-related courses, and some countries offered medical schools which did both or either (34-37). It is interesting to consider that despite the variability in competencies, time and educational format, each of these schools (and countries) graduates what is considered a competent physician prepared to prescribe.

AN EXAMINATION OF EDUCATIONAL STRATEGIES

Recently, the provision of education in medical schools has seen dramatic changes. During the 1980's the pedagogical changes being adopted by other levels of education (e.g. kindergarten through grade 12) were eventually noticed by medical training institutions. At the same time, there was increasing pressure from society that new medical graduates have the necessary skills to cope with the rapidly changing health care environment (such as the ability to prescribe). As a result, several reports were published making recommendations for changes in medical education (Physicians for the 21st-Century, Learning Objectives for Medical Student Education, Guidelines for Medical Schools, Training of Doctors in the Netherlands, Objectives

of Undergraduate Medical Education, Objectives for the Qualifying Examination, Tomorrow's doctors: recommendations on undergraduate medical education) (38-42). These publications have been the basis for curricular reform in many medical schools and academic medical centres. Three themes from these reports: competency development, curricular integration, and assessment have proven to be the most difficult challenges to the established methods of medical education. When teachers put these challenges together with the increasing amount of available medical information, the provision of a coherent curriculum becomes a difficult task. Few medical school programs have managed to incorporate these new educational strategies, and even fewer have been able to evaluate the impact of the curricular changes on the performance of the medical students.

Competency development: Medical school education has had to adjust to meet the expectations of society to produce competent physicians in the context of a practice setting (43,44). To address the needs of various constituents in society, the focus began to move away from obtaining knowledge and began to address deficiencies in communication skills, professional attitudes and ethics, and managing health systems (45,46). Students had to demonstrate their scientific knowledge in the context of providing clinical care. This would seem a fortuitous development for pharmacology as the act of prescribing would appear to require a sufficient amount of pharmacological expertise. However, with the ever increasing reliance on clinical treatment management guidelines, the medical students' (and the physicians that teach them) approach to the prescribing process is more like using a cookbook. In response, some groups have developed specific competencies* that address the prescribing process (26,48-52). These competencies are based on knowledge of basic pharmacology, clinical pharmacokinetics, factors that cause inter-individual variation, adverse drug reactions, drug interactions, and the skills necessary to prescribe and administer drugs, handle medication errors, monitor drug therapy, and attitudes that address the ethics of prescribing, assess the risk versus benefit analysis, and recognize the responsibilities of a prescriber.

Curricular integration: Medical school educational reform fuelled the growing trend of curricular integration (53-56). The goal was to prevent the presentation of classes as curricular silos. In many universities disease states were reviewed by examining patient symptomatology and integrating the relevant anatomy, physiology, pathophysiology and (sometimes) pharmacology and pharmacotherapy. Thus, specific disciplines such as pharmacology are no longer a dedicated course taught by clinical pharmacologists (34). Instead, disease state topics are presented by different clinicians, who tend to focus on the disciplines with which they feel most comfortable. Thus, core curricula were often employed to guide the teachers in the selection of topics to be taught (49-51,57,58).

Assessment: Having the educational learning moments spread throughout a medical school curriculum presents a logistical problem of how to assess the students' ability to perform the defined outcomes. Since education was moving away from information based retention of knowledge, the traditional examination procedures are no longer appropriate measures of success. To assess the performance of a student's ability requires observation, and unfortunately, observation is not deemed a rigorous, nor an objective measurement. In addition, this form of assessment is time-intensive and difficult to realize when assessing groups of medical students that are now numbering in hundreds. The reproducibility of results and the ability to discern between students has been shown to be the strongest for multiple choice questions and weaker for the more subjective measurements (59,60). The only manner in which the subjective measurements can reach parity with the multiple choice assessment is to test the students frequently. But as stated earlier, assessment of outcomes is more labour intensive. So educators began to introduce to the students formative assessments in which the student is asked to perform self-assessment on their performance of a task (61,62). These formative assessments do not contribute to the students' grades; however, have been shown to enhance the students' performance on the ultimate summative assessment that is associated with the students' grade.

THIS THESIS

The papers presented here detail the approach that was taken by the TRC to provide pharmacology and pharmacotherapy education at the LUMC. However, the methods utilized can be instructive for other institutions that are similarly trying to meet the educational reform challenges described above. In addition, this thesis tries to contribute to medical education research by evaluating the educational interventions by methods other than are typically utilized. A review of the abstracts presented at the 2006 Association of Medical Education in Europe annual meeting was performed using Kirkpatrick's well-recognized four level hierarchy of evaluations (63) (see table 1). According to this review, the most common method to

* The term competency often used interchangeably with the term outcome. However, these terms do differ. It is easiest to understand the different terms when they are used in context. Competencies are often defined by an accreditation committee to define the minimally acceptable threshold for a performance of a task. Outcomes are the achievements the learner is able demonstrate as a result of an educational program or course. The outcomes should also not be confused with the often cited goals and objectives of a course. Typically teachers set goals for the teaching that they will provide; whereas objectives are the steps that a student must accomplish to achieve the goal. Put another way: 'Goals are where you want to go, objectives are how you get there, and outcomes are proof that you have arrived'. (47)

evaluate educational interventions would be to assess students opinions (satisfaction or reaction to the intervention) using a Likert scale (64). Although these types of analyses have been performed to assess progress by the TRC at the LUMC (65), the reader will not find this data in this thesis. That is not to say that the opinions of students were not used in the development of this program, they are just not the sole method used to evaluate the usefulness of the intervention.

Table 1 *Abstracts at the 2006 Association of Medical Education in Europe meeting as assessed by using Kirkpatrick's four levels of evaluation*

Description of the method of evaluation indicated in the abstract according to Kirkpatrick's levels	**Total # abstracts = 545**
4) Evaluation of RESULTS (transfer or impact on society)	<1%
3) Evaluation of BEHAVIOUR (transfer of learning to workplace)	4%
2) Evaluation of LEARNING (knowledge or skills acquired)	8%
1) Evaluation of REACTION (satisfaction or happiness)	35%
No intervention performed (e.g. a survey of the current situation)	33%
No assessment performed (e.g. a new method is proposed, set-up, but not evaluated)	19%

The following are brief descriptions of the steps (and subsequent papers in this thesis) that were undertaken to integrate pharmacology and pharmacotherapy through the Leiden University Medical School curriculum:

1 The first step was to determine the educational method that was to be applied to the pharmacology portion of the curriculum. Chapter 1 details the decision to use the ability-based education model. It was decided that the outcomes chosen and the manner in which they were presented to both students and teachers were to be consistent throughout the curriculum.

2 Second, a better way in which to incorporate TRC icon language across the curriculum was needed. Chapter 2 describes the decision to move the material from a loose-leaf binder to a computer self-study program. The newly named TRC Pharmacology Database was created so that the pharmacology material was integrated with the pathophysiological mechanisms presented in the course. The students' acceptance of the new format is demonstrated in the students' utilization.

3 Chapter 3 describes our efforts to find the most objective measurement we could use to assess students' learning when using the TRC Pharmacology Database. The paper describes how we used the data obtained from the back-end of the database to correlate the students' time spent using the database and the grade they ultimately achieved in each course.

4 Chapter 4 describes a survey of the local and current environment for physicians to report a therapeutic plan to one another. The results determined which of the competencies the local physicians most needed to improve in order to communicate an appropriate therapeutic plan.

5 Based on the results of the study in chapter 4, a new learning strategy was developed for students to address the deficient competencies identified in the local physicians. Chapter 5 describes the efforts to create a culture of good prescribing by having the students repeatedly practice developing a therapeutic plan using the new learning strategy.

6 Finally, incorporating these initiatives across the curriculum was not easy. Integration required the same effort as a curriculum wide change. Change management skills were used to liaise with various colleagues, departments, and committees. Chapter 6 describes both the successful as well as unsuccessful techniques that were attempted in this effort.

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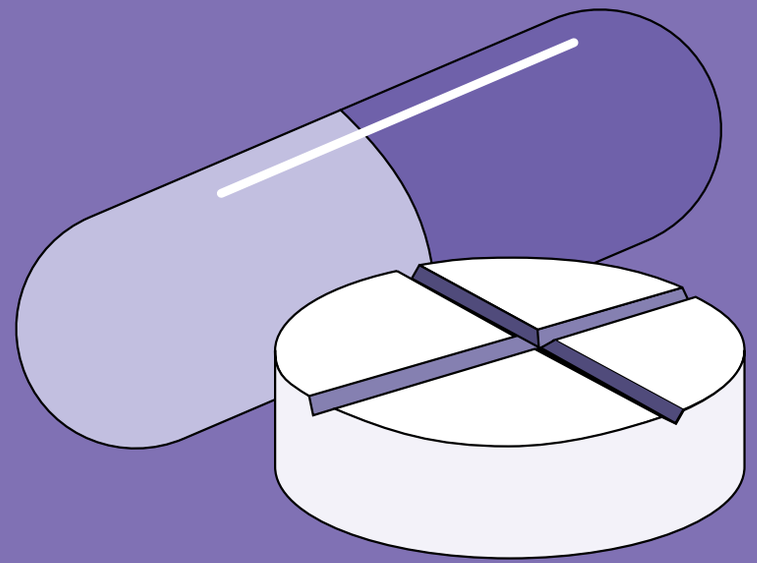
CHAPTER 1

Using ability-based educational methodologies to integrate pharmacology throughout a medical school curriculum

Kari L. Franson [1,2]; Eline A. Dubois[2]; Joop M.A. van Gerven [1,2]; Adam F. Cohen [1,2]



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ABSTRACT

Background It has long been recognized that medical schools have poorly integrated instruction on the mechanisms of drug action (pharmacology) with that of drug use in practice (combining pharmacotherapy with diagnostics). This is despite a significant increase in the number of errors in prescribing drugs. A change in medical school curriculum at Leiden University Medical Centre provided an opportunity for a renewal of pharmacology and pharmacotherapy education.
Methods The principles of ability-based education were utilized for the development of the pharmacology learning outcomes. It was determined that an appropriate level of pharmacological and pathophysiological knowledge was required to demonstrate the pharmacotherapeutic skills of identifying the indication of a drug, selecting appropriate (combinations of) therapy or monitoring the results of that decision. Two teaching methods; the Teaching Resource Centre (TRC) Pharmacology database, and the Individualized Therapy Evaluation and Plan (ITEP), were developed to provide knowledge, practice and assessment strategies, as well as possibilities for monitoring the educational process. Attention was also paid to the integration of these aspects with other subjects in the medical curriculum.
Results Implementation began in 2001. Currently, the pharmacology outcomes are integrated into nearly 90% of the curriculum. Students have shown that they are able to use and appreciate the computer programs with their increasing use during the introduction period. The teachers who have incorporated TRC Pharmacology education in their courses are enthusiastic.
Conclusion This new method of integrating a basic science in a medical school curriculum has provided initially encouraging results.

INTRODUCTION

As early as 1970, the World Health Organization was calling for medical school curricula to provide better training in clinical pharmacology (1). Their report suggested greater integration between pharmacology and clinical subjects was required to increase student insight into pharmacotherapy. A similar plea was made in 1993 to improve pharmacology and pharmacotherapy education in Europe (2). However, it is the increasing reporting of prescription error rates (3) which seem to have done the best job indicating that these curricular changes are necessary.

During the 1990s the University of Leiden and most other faculties of medicine in the Netherlands still had a central basic pharmacology course in the curriculum, followed by practical application of the course content in clinically-oriented courses during the undergraduate phase and a practical training in pharmacotherapy during the clerkship period.

In 1999 a new clinical presentation-oriented medical approach was introduced at the Leiden University Medical Centre (LUMC) based on the curriculum developed by the University of Calgary, Faculty of Medicine (4). The curriculum follows a thematic approach in which clinical presentations form the basis for the teaching, with integration between basic and clinical subjects (anatomy, physiology, pathology etc.) leading to the ability to solve medical problems. The central points of departure of this new curriculum are the promotion of active student participation in the learning process and to trigger the student's own thinking and learning abilities. Although these changes mimic the changes occurring elsewhere in medical education, the new curriculum has, however, meant the loss of the introductory pharmacology course. This development has forced those involved in clinical pharmacology to make radical changes to their teaching methods, while maintaining the aim of integrating (clinical) pharmacology and pharmacotherapy into the curriculum.

DEVELOPMENT OF THE EDUCATION SYSTEM

Outcome-based Education

Medical schools have been changing their curricula to become more outcome based (5). The initial stimulus for the adoption of outcomes seems to have arisen after it became apparent that many physicians were graduating from the best medical schools, and were unable to put their knowledge into practice and effectively communicate with their patients (and sometimes peers). Assessing a student's progression up Bloom's taxonomy pyramid of knowledge (6) was no longer sufficient, as it became apparent that the students lacked the appropriate skills and attitudes necessary to perform as medical professionals. Subsequent attempts to teach and assess attitudes or skills apart from knowledge led to the realization that these aspects are not independent of one or another (7). Medical schools now aim to demonstrate that students are able to perform the activities a competent physician is expected to do by defining learning outcomes (sometimes called competencies when used to describe the minimal threshold of acceptable performances) instead of learning goals and objectives. The outcomes relevant for pharmacology and pharmacotherapeutics include the ability to develop therapeutic plans and to appropriately communicate these plans.

Ability-based education is a type of outcome-based education that not only teaches, but also assesses the knowledge, skills and attitudes required to successfully perform a task (or ability) (8). It can be thought of as an outcome-based and assessment-guided curriculum. Central to this type of education are the following concepts: 1) ability outcomes must be clearly defined; 2) abilities must be practiced, not just taught; 3) abilities need to

be assessed (often) in order to enhance performance; 4) clear criteria need to be developed for students to understand what successful performance of the ability entails, and 5) formative feedback will strengthen student self-assessment skills, shift the learning from the teacher to the student and prepare the student for life-long learning (9). These principles of ability-based education were used for the development of the pharmacology learning outcomes and learning strategies that were to be implemented throughout the LUMC curriculum.

Establishing learning outcomes and levels of knowledge

The LUMC curriculum-wide pharmacology learning outcomes were established by determining what the students should be able to do when they complete the program.
Upon completion of the curriculum, students can:

1. explain pharmacological mechanisms of action;
2. explain physiological / pathophysiological mechanisms of disease;
3. critically analyze indications for drugs by comparing pharmacological and pathophysiological mechanisms;
4. select drug therapy based on pharmacotherapeutic principles, and
5. monitor drug therapy based on pharmacotherapeutic principles.

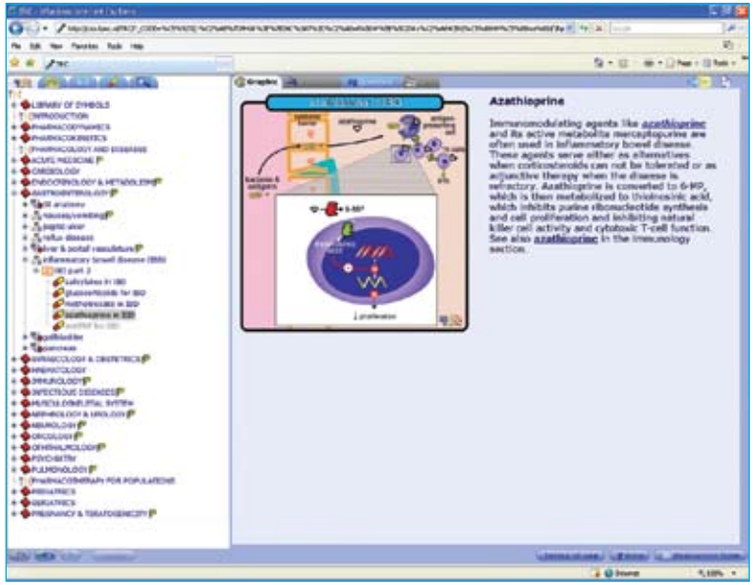
The pharmacology and pharmacotherapy learning outcomes are based on knowledge and the application of this knowledge. The level of this is built up throughout the curriculum, forming an integrated whole at the end. First, a complete overview of general pharmacological information must be acquired, including pharmacodynamics and pharmacokinetics and pharmacological mechanisms of action (outcome 1). Secondly, the student must also demonstrate knowledge of pathophysiology (outcome 2) in order to evaluate pharmacological mechanisms in relation to the disease processes (outcome 3). Then the acquired knowledge must be applied, since any acquired knowledge appears less practical to the aspiring doctor if it is not practised in the area in which it is intended to be used, such as in drawing up a treatment plan for the patient (outcome 4); and monitoring the results of the treatment plan (outcome 5). By drawing up an individual treatment plan for a variety of patients, certain medical skills and attitudes are also acquired. As it has been shown, for an optimal therapeutic process, it is important that pharmacology knowledge and application of the knowledge are not only integrated with one another, but are also firmly based in pathophysiology and diagnosis.

These general learning outcomes were used as a template and further specifications for the drugs and conditions addressed in individual courses were drawn up using the National Coordination Committee's core curriculum 'Training of Doctors: Blueprint 2001' (10), the Dutch pharmacotherapeutic formulary (Farmacotherapeutisch Kompas) and the recommendations from the pharmacotherapy education department (11). The exact outcomes and the details for integration of the pharmacology and pharmacotherapy education in each course were agreed upon in dialogue with clinical pharmacologists and the basic science and clinical lecturers of the subject area concerned.

Learning strategies

Since self-study is an important aspect of the new curriculum in Leiden, it was decided to provide the pharmacology training by primarily computer-based methods. The advantage of providing teaching material via the computer is that students can access it anywhere and at any time, and the material itself can be amended when necessary. The same materials can also be used at different stages of the curriculum. Thus, the Teaching Resource Centre (TRC) Pharmacology Database Program was created using a newly developed graphical language for uniformity (12). The database is found at http://coo.lumc.nl/TRC and contains figures (in the icon language), accompanying text, graphs, multiple-choice questions with explanations of the answers and references to relevant literature (13). The Pharmacology Database Program displays a tree structure on the left-hand side of the screen, where each subject can be viewed by expanding the different

Figure 1 *The TRC Pharmacology database*



branches of the tree. The program presents knowledge content that explains how a drug's mechanism of action interacts or interferes with either physiologic or pathophysiologic processes (thus addressing outcomes 1, 2, and 3). The program includes multiple-choice questions that challenge the student's ability to perform all outcomes (See figure 1). The program also contains a utility that reports the students' utilization of the program, providing the instructor with information regarding the student's exposure and performance on the outcomes.

Table 1 *The Individual Therapy Evaluation and Plan (ITEP) method for developing and communicating a therapy plan*

Evaluate the patient's disease states:
• Make a list of disease states and indicate the status of each
• Describe the aetiology / pathophysiological mechanism of each problem supported with the complaints, symptoms and results of the patient
Evaluate current therapy for each disease state:
• Determine if current therapy is effective and safe (without side effects)
• Support this by comparing the relationship between the pathophysiology of the medical problem with the mechanism of action of the therapy and evaluating the patient's complaints, signs and symptoms
Evaluation of patient-specific parameters that can influence therapy:
• Patient specific data (PK, allergies, side effects)
• Drug specific data (dose, cost, interactions)
• Disease specific data (drug-disease interactions)
• Patient compliance
Write a therapy plan based on your evaluation:
• Indicate your plan for current therapy (stop, continue, increase/decrease dose, etc
• Choose (if necessary) new therapy (non-drug, drug, surgical, etc.)
• Specify for each therapy the dose, route, frequency and duration
• Provide the rationale for your choice of therapy, dose, etc. Support this by describing the mechanism of action and impact of patient-specific data (as described above)
Monitor therapy plan:
• Describe the goals and monitoring parameters to determine efficacy (patient-specific pathophysiological symptoms) of the therapy
• Describe monitoring parameters to determine side effects and toxicity (pharmacological symptoms) of the therapy
• Establish appropriate time intervals and frequencies for these parameters

In order to provide the students with practice using their pharmacological knowledge for determining appropriate pharmacotherapy, the Individualized Therapy Evaluation and Plan (ITEP) (table 1) (14) was introduced into all clinically oriented courses as a standard method for drawing up a rationally-based treatment plan. Together with the course clinicians, clinical pharmacologists create cases in which students use the ITEP process to evaluate patient-specific data, relevant pathophysiological mechanisms, concomitant treatments, demographics and co-morbidities, and consequently select an appropriate drug to treat the disease. The format takes the student through the outcomes in a step-wise manner, and it obliges the student to demonstrate proficiency on each. During an individual course, students are provided opportunities to practice ITEP writing via a web-based program that guides them through the ITEP therapeutic decision making process in a self-study manner. Solving the cases leads the students to learn therapy which is consistent with either the Dutch National Formulary or General Practitioner Guidelines. Subsequent cases and follow-ups are either discussed in small workgroups or serve as summative assessments on examinations. The ITEP is highly suitable for use in the clinically-oriented curriculum blocks and during the clerkship period. The ITEP, in fact, provides the students with an expanded and systematic version of the thought processes that an experienced practicing doctor would rapidly run through less formally. An ITEP is also a good platform for communicating with fellow students or house officers, and later with fellow doctors and specialists.

IMPLEMENTATION AND EVALUATION

During the 2001-2002 academic year, implementation of the new pharmacology and pharmacotherapy education program using the TRC database got underway. The main priority upon start-up in a course was to make sure the pharmacology outcomes were clearly presented, and that the database provided the right material with opportunities for students to practice their understanding of the material, and assessment upon examination. In the first year, 60% of the courses in the curriculum included at least one of the pharmacology outcomes. The lowest level outcome (i.e., knowledge) of pharmacological understanding was adopted in 100% of these courses. Higher-level outcomes and assessments, which include the ability to select and monitor drug therapy based on pharmacological principles, were incorporated in 47% of the courses. Despite the fact that studying the pharmacology material was not compulsory, many students made use of the computer programs (26% of first year students, 32% of second year students and 56% of third year students). Student evaluations based on Likert Scales were used to make improvements over the introductory period and were generally positive regarding the learning strategies but indicated a preference for higher-level assessments and integration. Increasing numbers of courses and

students have participated in the pharmacology education program over the subsequent years. At present more than 90% of identified courses (table 2) and greater than 95% of the students in the curriculum use the TRC database (table 3).These numbers indicate increasing acceptance of the TRC database by both teachers and students.

Table 2 *Percent of courses with each of the pharmacology outcomes*

Outcome	2001-2002	2002-2003	2003-2004	2004-2005
1: explain pharmacology	41.9%	61.0%	76.2%	83.6%
2: explain (patho)physiology	43.5%	63.3%	79.1%	79.1%
3: critically analyze indications	12.9%	51.4%	90%	90%
4: select drug therapy	6.4%	45.0%	83.6%	90%
5: monitor drug therapy	0	51.4%	83.6%	90%

Table 3 *Number of students using the TRC learning strategies*

Total # of students averages 1100	2001-2002	2002-2003	2003-2004	2004-2005
TRCP	290	445	899	1113
ITEP		378	540	894

Adoption of the ITEP process for teaching pharmacotherapy was started later during the 2002-2003 academic year. As with the TRC database, practicing with the ITEP was not compulsory and as such, few students practiced solving the cases. After several years of low interest, the ITEP finally achieved wider adoption when students began to get feedback on an individual basis in workgroups (table 3). In addition, the students' knowledge of the outcomes is increasingly being tested using the ITEP format during examinations. Now the ITEP has been implemented on a large scale in both the preclinical and clinical phases. At the end of the internal medicine clerkship period, the students must submit a portfolio of ITEP case reports about their 'own' patients with a predefined list of clinical presentations.

QUALITY CONTROL AND MONITORING OF THE EDUCATIONAL PROGRAM

To avoid duplication or omissions, ongoing monitoring is performed to ensure that the student is presented with a complete and clear picture of pharmacology and pharmacotherapy over the entire curriculum. It is also essential that the integrated pharmacology education is uniformly presented throughout the curriculum. This is achieved by consistently applying the learning outcomes in each course, supported by the same learning strategies. The TRC Pharmacology database is used for the provision of knowledge and the ITEP as the standard system for practicing and evaluating the application of the knowledge.

Written and electronic surveys reveal that the students are satisfied with the current form of the Pharmacology and Pharmacotherapy education programs, with the positive feedback relating mainly to the clear identity of the program and uniform presentation of the information. No systematic research has been carried out to assess the opinions of the course lecturers who contributed to the content of the Pharmacology education program. However, the smooth introduction, successful collaboration and enthusiasm from 90% of the targeted courses seem to suggest that they are very satisfied with the ability based system of education.

CONCLUSIONS

The pharmacology education of our current generation of doctors is undergoing major changes. There has been a marked increase in both the complexity and amount of information, presenting the medical education system with new challenges. There is little doubt that doctors should continue to receive rigorous scientific training (15), yet the idea that more time or staff will be made available for this is an illusion. A new approach to medical education, which is based on a standardized presentation of teaching materials and a systematic integration of relevant preclinical and clinical information, and that promotes self-study and provides feedback, would appear well-suited to achieving this goal. For the LUMC, the integration of pharmacology and pharmacotherapy training through the development of an ability-based education approach appears to have been successful, despite the fact that the assessment component lags behind the provision of the education. Future goals include continuing the development of the educational program and the institution of a more rigorous assessment schedule and the utilization of a variety of assessments in which to triangulate the results. In addition, there have been inquires to use this educational methodology for other basic subjects such as anatomy, physiology and pathology. However, the established pharmacology learning outcomes have become like a mission statement for those involved in the implementation of the program, nothing is done that does not lead to the student's learning of the outcomes. Furthermore, by building these solutions with colleagues from other faculties it will be possible to achieve a far higher level of efficiency, both nationally and internationally. Finally, the system is being introduced into education programs of the Leiden Committee on Postgraduate Education and into textbooks (16-18), which will provide a further stimulus to both the quality of the materials and the objectives of life-long integrated learning.

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CHAPTER 2

Development of visual pharmacology education across an integrated medical school curriculum

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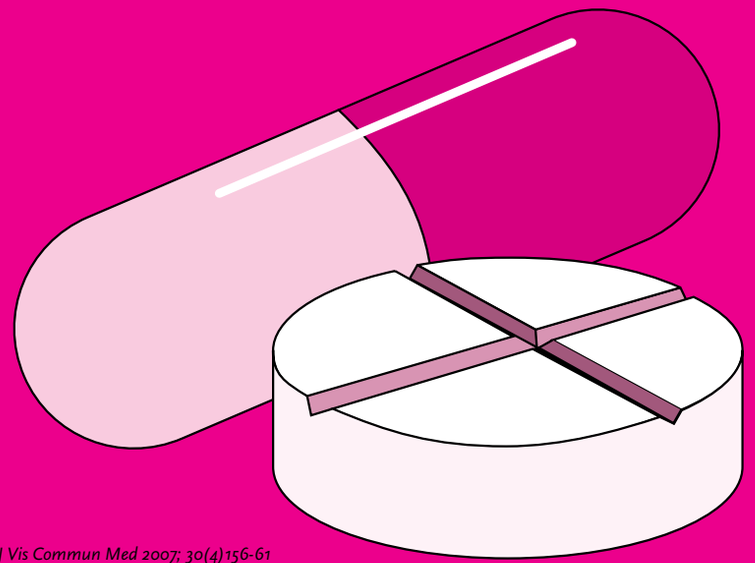

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ABSTRACT

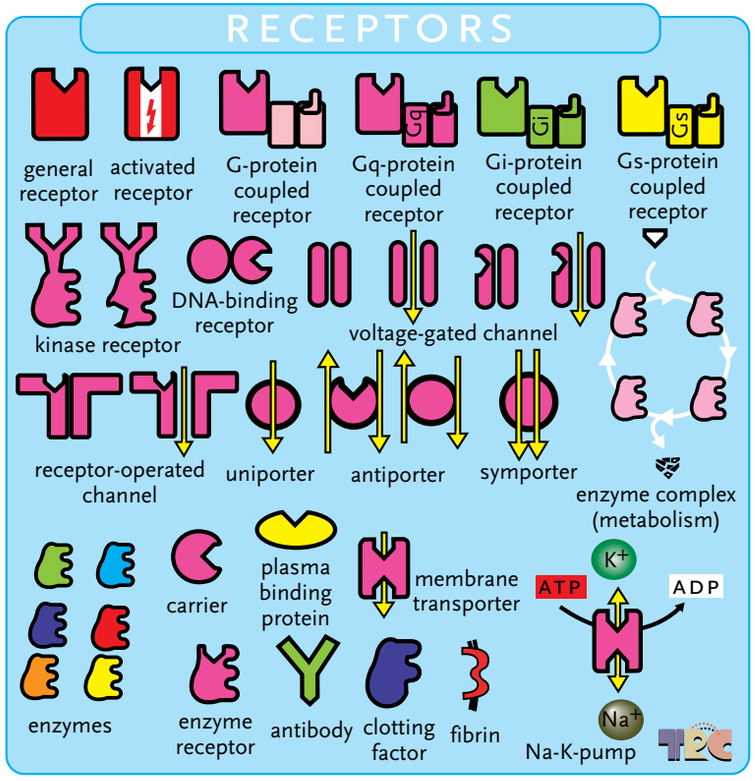
Background: Due to curricular integration in many medical schools, clinical pharmacology is no longer a dedicated course taught by clinical pharmacologists. This calls for new approaches to clinical pharmacology teaching, with aims to be 1) complete; 2) integrated with other subjects; and 3) presented 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.

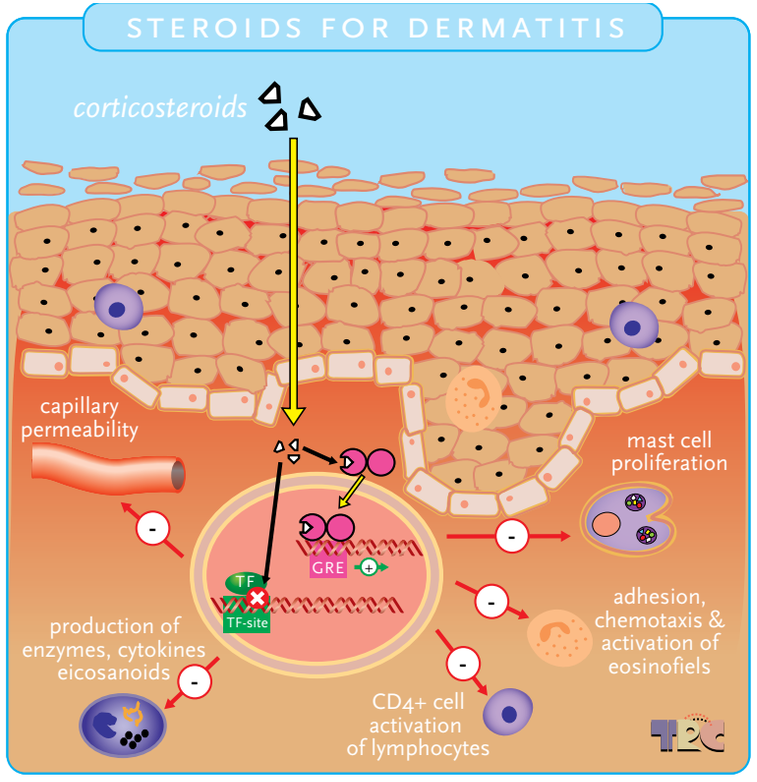
In the new curriculum at Leiden University Medical School (LUMC), students examine disease states in an integrated manner. This curriculum is based on the Calgary system of clinical presentations (4). The students evaluate the signs and symptoms, in a forward thinking model in order to determine the 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.

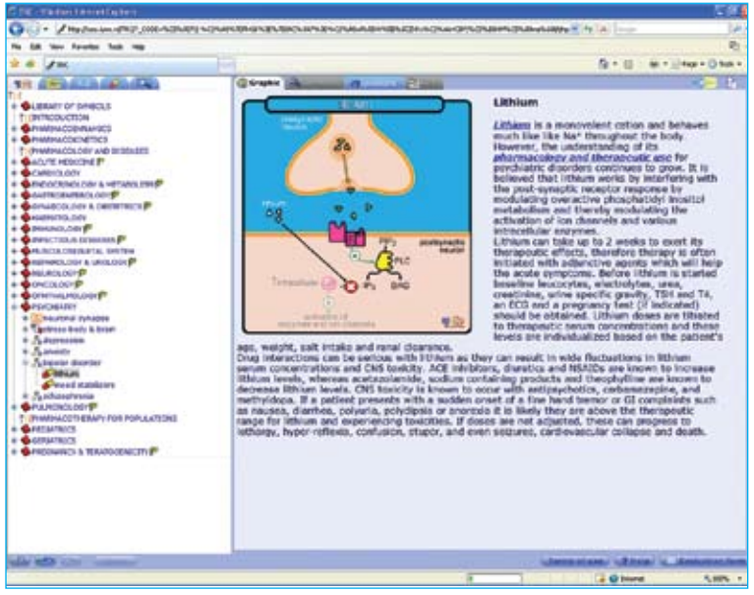
METHODS

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-

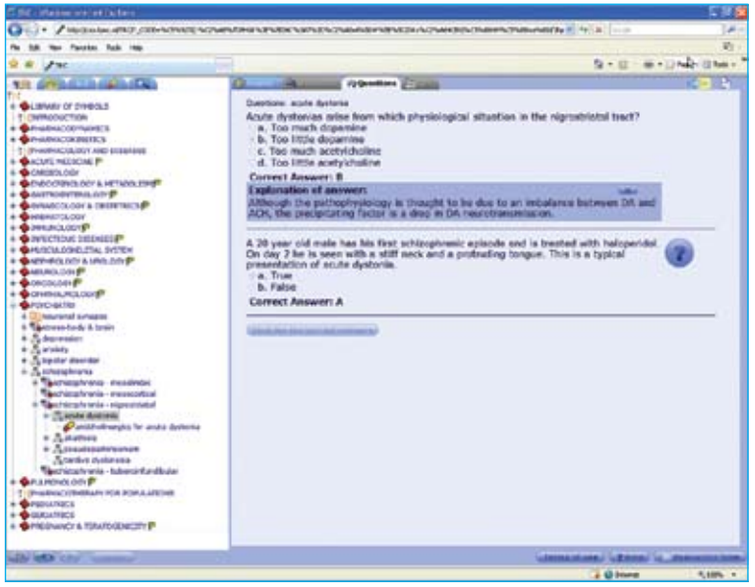
study. In addition, supportive text and charts with links to the relevant literature provides insights into the therapeutic utilization of the drug or drug class. On the second page, accessible by a tab, a few multiple-choice practice questions with explanations of the answers assess the students understanding 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*

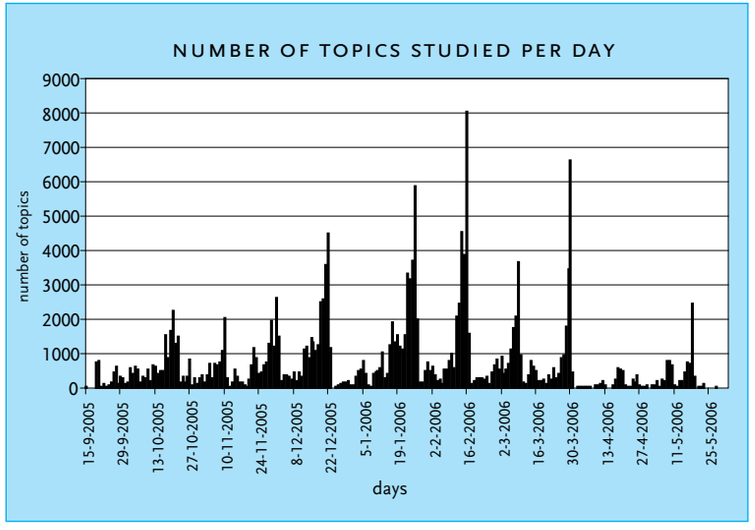


Table 2 *Log-in data per course (where data is available for both years)*

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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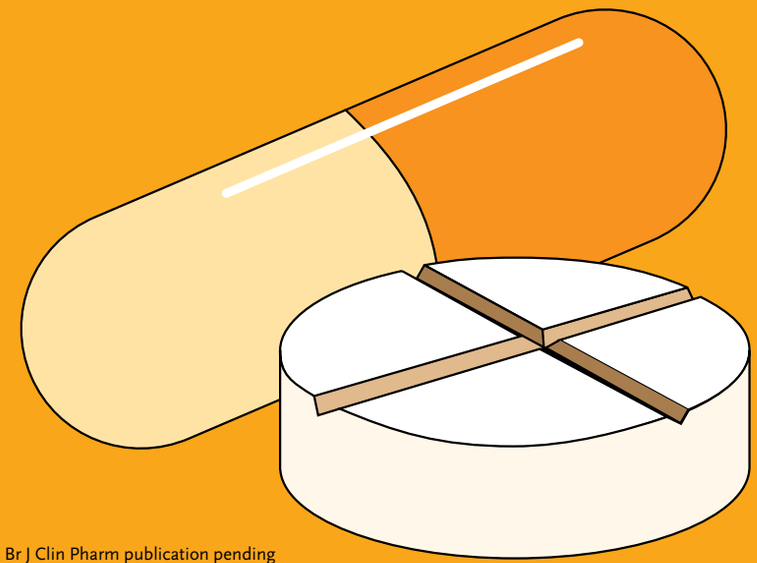
CHAPTER 3

Measuring learning from the TRC pharmacology e-learning program

Kari L. Franson [1,2]; Eline A. Dubois [2]; Marieke L. de Kam [1]; Adam F. Cohen [1,2]



Br J Clin Pharm publication pending

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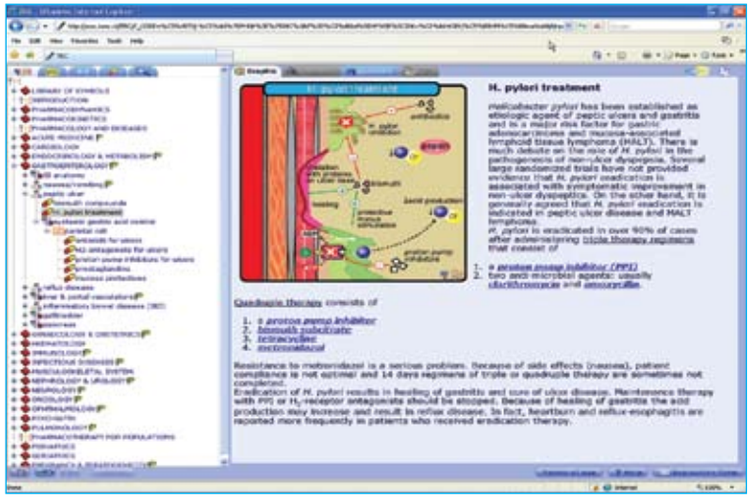
ABSTRACT

Background: Clinical pharmacology at the Leiden University Medical Center is primarily taught by the Teaching Resource Centre's (TRC) Pharmacology database. The TRC program contains schematic graphics using a unique icon language, explanation texts and feedback questions to explain pharmacology as it pertains to pathophysiology. Nearly each course of the curriculum has a chapter in the TRC database offered for self-study. Since using the TRC program is not compulsory, the question remains whether students benefit from using it.
Methods: We compared the parameters of log-in attempts and time-spent at each topic, to students' final exam grades. Instead of looking at the regression of time spent on TRC on grade for one course, we looked at the individual student regression of time spent on TRC for different courses on grades. Spending more time using the TRC being associated with higher grades within an individual is a more powerful result than between students within a course, as smart students are likely to spend more time using the TRC.
Results: Students increasingly used the program throughout the curriculum. More importantly, the time spent using the program showed that increased TRC use by an individual student is associated with a (small) increase in grade. As expected for a non-compulsory activity, better students (those with higher than average exam scores) logged-in to the TRC more frequently, but poorer students appeared to have a larger benefit.
Conclusions: An increase in TRC use by an individual student correlates with an increase in course grades.

INTRODUCTION

Self-study computer programs primarily teach pharmacology and pharmacotherapy at the Leiden University Medical Center. The Teaching Resource Centre (TRC) began to provide the computer-based education to medical students at a time when there was no formalized pharmacology education in the curriculum. The TRC Pharmacology database (http://coo.lumc.nl/TRC) is a program containing information on drug mechanisms of action as they pertain to physiology and pathophysiology (1,2). The TRC database consists of multiple topics for each course containing schematic graphics using a unique icon language (3), explanation texts and questions with feedback (figure 1). Students use the database as a part of a blended learning strategy in which they use the database to 1) learn pharmacological mechanisms, 2) review physiological mechanisms, and 3) complete therapeutic plans for electronic patient cases (4). Nearly each course of the curriculum has a chapter in the TRC database offered for self-study. However, the question remains, how can we evaluate our computer based teaching (CBT) program? Many groups evaluate how much students like the program, others evaluate

Figure 1 *The Teaching Resource Centre (TRC) database as it appears online*



the usage patterns and still others look for ways to measure learning. These methods all have their limitations. Student opinions are, of course, just opinions and tend to be biased (5). Typically, only students who like and enjoy the program answer the questionnaires, and are more likely to do so if they believe their comments will improve the course (6). In contrast, when evaluations are made a required part of the curriculum, they tend to be more negative (7). In addition, some studies use 5-point Likert scales which don't have sufficient sensitivity to show the differences between courses. Usage patterns can be helpful, as long as the CBT is used as a non-compulsory part of the course (8). We have kept the TRC database as a non-compulsory activity believing that if the CBT program is worthwhile, the students will use it. In a previous article (2) we have described how students began using the database after introduction. In this study, we showed that a majority of students use the program and that their activity increases as they approach the exam, indicating that the students perceive the program as a good study tool. However, can we measure that they have learned from the program? As a clinical pharmacology group, we typically evaluate the effectiveness of an intervention by randomized, double-blind placebo-controlled trials. Although this may be optimal, it is not practical, as it is difficult to maintain a control in different educational groups (9). Some students will invariably utilize whatever educational means to complete a course. The real difficulty comes from determining the appropriate measurement to use for the assessment (10). It is well recognized that most self-created assessments of an intervention will likely show an improvement. So we choose to use the final examination grades (the only form of summative assessment used

at Leiden) as a measurement of learning, which still remains a standard as a strong predictive factor for success on medical examinations (11), and a moderate predictor of clinical performance (12).

AIM

To determine (with as few confounding variables as possible) if student utilization of the TRC Pharmacology database relates to final examination grades.

METHODS

We evaluated students' TRC database utilization across the curriculum for two different years of study: 2003-2004 and 2005-2006. The 2003-2004 data represents student utilization of the TRC database when the program was still 'new' in the curriculum. The 2005-2006 data represents student utilization data for a CBT program that had been established and was generally accepted in the curriculum. All courses with pharmacological content in the TRC Pharmacology database were evaluated. The parameter of total time-spent reviewing TRC database material for a particular course was compared to the student's final exam grade in that course (scale of 0-10). Time spent using the database in 2003-2004 was determined separately from the 2005-2006 data. Because time spent on a topic can include non-study related activities (e.g. flicking through the program or getting a cup a coffee leaving the computer on), time spent on a topic was set to zero when very short (less than the fifth percentile of all times spent on a topic, in this case less than 3 seconds in 2003 or less than 2 seconds in 2005) or set to the 95th percentile when greater than the 95th percentile for the whole dataset (in this case more than 6 minutes in 2003 or 9 minutes in 2005). Student identification numbers that were used for logging into a particular topic but did not appear on the corresponding exam were deleted. Students who did not show up for the examination were given the grade of zero.

DATA ANALYSIS

Data from each course are initially evaluated by placing the data in a scatter plot of time spent versus final grade (An example using the results from the circulation course is shown in figure 2). For each course a linear regression analysis can be performed and for the circulation course it shows a slope of 0.034 with a p value of <0.001. What does this data mean? It looks like individuals who study more on the TRC database achieve higher grades, and thus increase the slope. But when a regression is used in this manner, the variability between the individual students greatly influences the slope. Could it be that smarter students study more and achieve higher grades, independent of the effect of the TRC database? One way to address this is to determine if on a per student basis, increased time leads to increased grades. Fortunately, we can do this assessment since we have repeated measures of the same students across the curriculum. However, because the average time required for students to study each course varied (some courses had more topics), we had to normalize the time spent studying by

Figure 2 *Scatter plot data with regression from the course Circulation (CIR)*

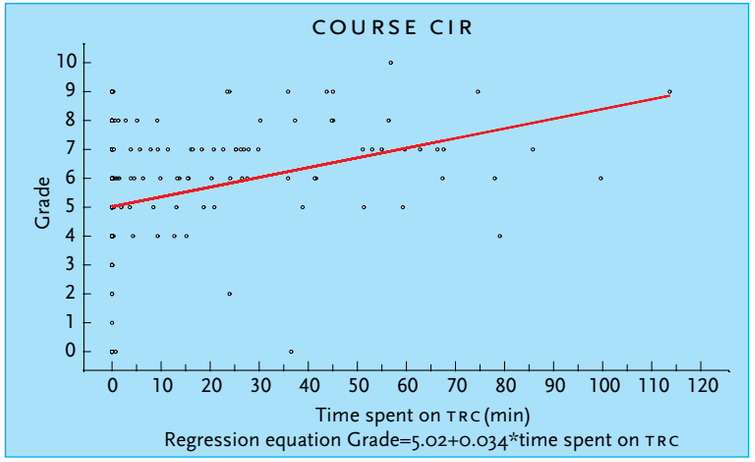
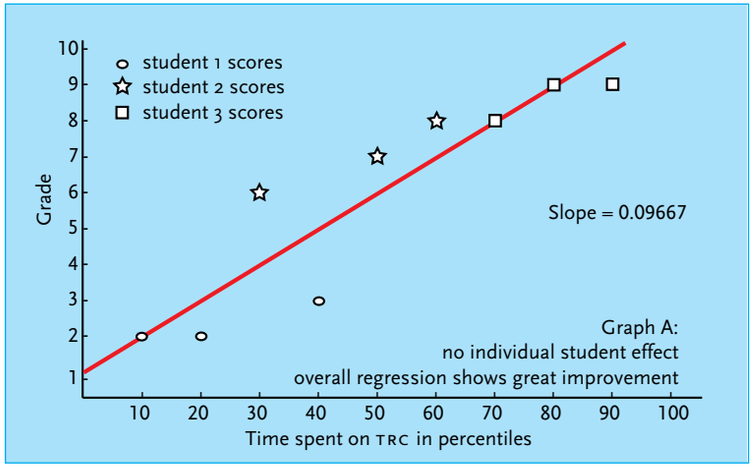


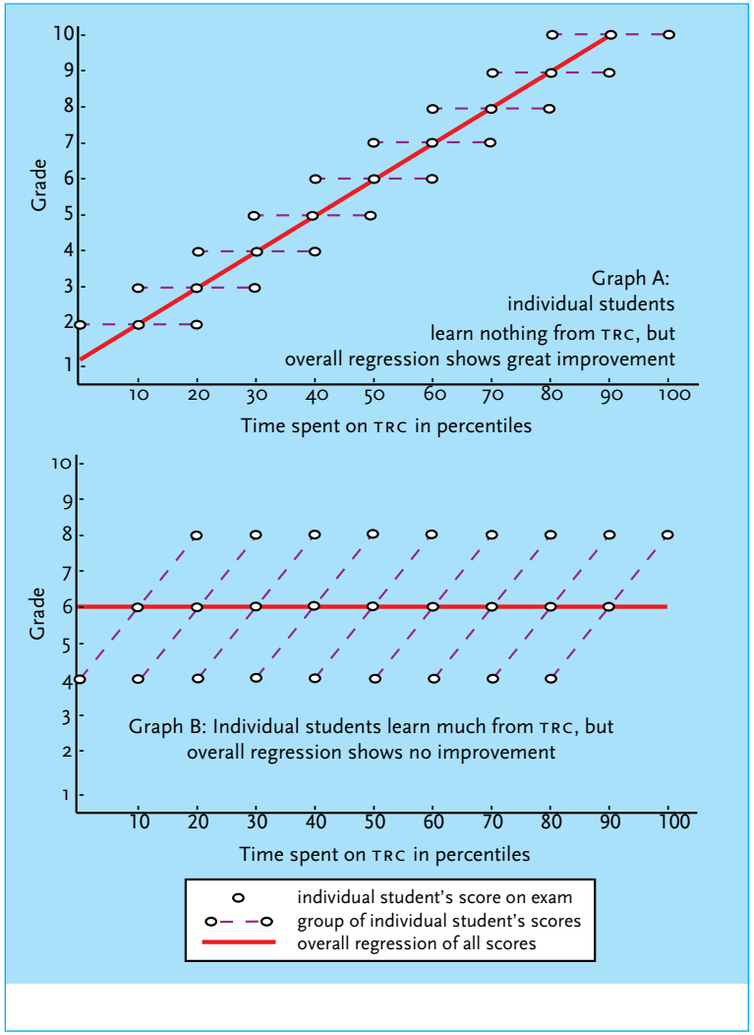
Figure 3 *Example of scatter plot of multiple students in multiple courses and the overall regression*



using the percentiles of time in which the student used the TRC database. At this point, the regression would look much like that shown in figure 3, an example of 9 data points from 3 students' grades in three different courses. But figure 4 shows an illustration of two extreme examples of how an individual student's data could be lost in the overall regression. So we analyzed all data together based on all the individual students' regression lines, and a new overall regression line was calculated taking into account

Figure 4

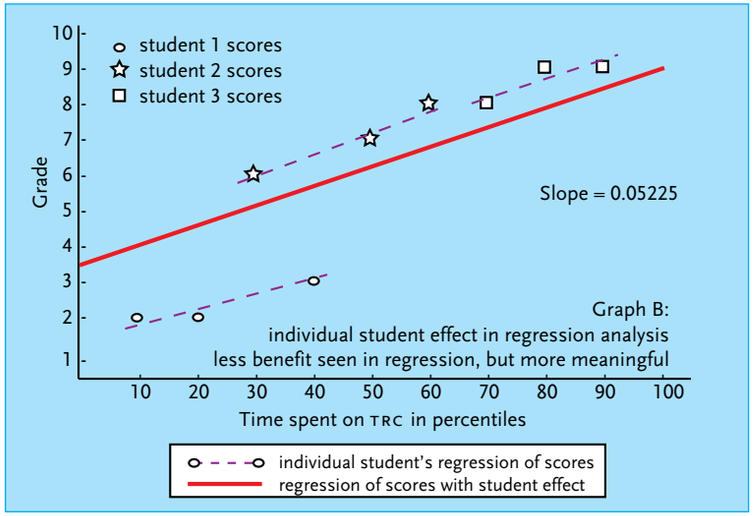
Illustration of two extreme scenarios in which a student's individual learning can be hidden in a general regression analysis



the influence of the individual student. But because some courses are more difficult than others, the effect of the different average grades per course was taken along as covariate in the analysis. Next to the overall regression line, the slope and intercept for each course are calculated (final example shown in figure 5). The slopes can be interpreted as a student who increases study time from one percentile to another will have an increase in grade equal to the slope. Finally, the grade regressions from study years 2003-2004 were compared to 2005-2006.

Figure 5

Example of scatter plot with individual students' regressions and the resulting overall regression



RESULTS

Time spent using the database in 2003-2004 was determined from more than 80,000 hits to the TRC by over 900 students. The 2005-2006 data consisted of more than 175,000 hits from nearly 1100 students. This absolute increase in student users of the TRC can be attributed to two factors, 1) the nearly 20% increase in enrolment across all the courses and 2) a 10% increase in TRC use.

The data from the all courses regression table (table 1) show that the average grades earned from students who did not look at the TRC database decreased from 6.3 to 5.9 between years 2004 and 2006. In addition, the net scores achieved by those students who used the program the longest decreased from 7.1 to 6.9. The data of grade by time using TRC in percentiles show the slopes to be 0.32 ($p<0.001$) and 0.55 ($p<0.001$) for the 2004 and

2006 years respectively (difference in slopes p=0.0014). Indicating that students could increase their grade by 0.3 in 2004 and 0.6 in 2006 if they spent to the 100th percentile of time on the TRC. The correlation between the estimated intercept and estimated slope for every subject of the year 2005-2006 was –0.51 (no p-value as the correlation is based on estimates). Thus, the lower the grade at the intercept, the greater the slope).

Table 1 *Results of the regression analysis across all courses for years 2003-2004 and 2005-2006*

Course	Slope		difference between slopes	p -value	Average grade of students in oth Percentile		Average grade of students in 95-100th Percentile		Average time (min) spent by students in 50th Percentile	
	2003	2006	2003	2006	2003	2006	2003	2006	2003	2006
General	**0.0032**	**0.0055**	**0.0023**	**0.001**	**6.3**	**5.9**	**7.1**	**6.9**		
Central nervous system	0.0004				6.2		5.2		5	
Chest	0.0046	0.0086	0.0040	0.071	6	5.6	7	7	57	52
Circulation		0.0091				5.6		6.4	23	
Developmental disorders	0				6.5		7.4		20	
Endocrinology	0.0056	0.0053	-0.0003	0.896	6.3	5.7	7.3	6.6	89	123
Gastroenterology	0.0016	-0.0002	-0.0018	0.424	6.3	6.6	7	7.5	71	34
Geriatrics	0.0044	0.0025	-0.0019	0.504	7.3	6.4	7.5	6.8	62	113
Immunology		0.0063				6.9		8.1	28	
Infectious diseases	0.0048	0.0055	0.0007	0.785	5.9	6	7	7.4	24	30
Molecular medicine		0.0088				5.3		7.2	28	
Movement disorders	0.0051	0.008	0.0029	0.203	5.8	5.3	6.7	6.4	31	51
Oncology	0.0027	0.0035	0.0007	0.753	6.7	6.7	7.4	7.2	24	49
Pathophysiology		0.0104				5		6.6	25	
Pediatrics	0.0002	0.0059	0.0057	0.029	7.1	6	7.9	7	15	13
Psychiatric diseases	-0.0008	0.0023	0.0031	0.182	6.1	6.1	6.7	6.4	26	75
Psychopathology	0.0023	0.0033	0.0010	0.721	6.5	6.2	7	6.8	9	19
Regulatory systems	0.0054	0.005	-0.0004	0.906	6	6	6.5	6.7	19	31
Renal & urology	0.0086	0.0079	-0.0007	0.760	6.3	5.5	7.8	6.3	11	25
Reproduction	0.0033	0.0021	-0.0012	0.669	6.3	6.3	6.5	7	7	45

DISCUSSION

This analysis shows a significant relationship between the time students spend using the TRC Pharmacology database and the ultimate grades they achieved in a course. In addition, the slope of the increase in course grades was larger in 2005-2006 when the results from the 2003-2004 and 2005-2006 years were compared. While no statement can be made that the students are improving in the courses due to the TRC program and the TRC program alone, the relationship exists, and exists for an (increasingly) large number of students and courses.

In this analysis we have tried to systematically eliminate the typical shortcomings described from the evaluations of other (computer-based) learning interventions (13). First of all, many other studies evaluate teaching interventions that are only implemented in individual courses where the sample sizes are often not larger than 100. If the studies are then designed as a controlled trial, the numbers of each 'treatment group' can quickly fall, decreasing the power. Thus, it is fortunate that so many students have logged in and used the TRC database in so many different courses. This has provided us with sufficient power to make the various analyses possible.

This analysis also did not take place in an artificial controlled experimental environment. Our study analyses the real-world results of TRC Pharmacology database (users versus non-users) and tries to take as many confounding factors into account as possible. The final examinations were written by the course coordinators and contained maximally 10 percent of questions focused on pharmacology. However, because the TRC contains summaries of anatomy, physiology and pathophysiology as related to pharmacology, it reinforces the students understanding of these topics as well. Thus, it is all the more interesting that students show an increase in grade when using the program. The external validity (and therefore generalisability) of the study is therefore higher than that of a study which creates it's own assessments of an educational intervention and controls the environment of the participants.

The internal validity is however lower for our study, as we cannot definitively say that the improvement in grades was the result of increased time studying the TRC. One option may have been to assess the other tools the students were exposed to or chose to use during their studies. In this case we would have to rely on a questionnaire of the student utilization of other interventions, and this type of self-reporting would be impossible to compare to the actual data collected from the back-end of a computer program.

Instead, we chose to have the students serve as their own controls. We assessed individual student's performance when they chose to use the TRC more or less in one course versus another. This individual user evaluation is the real strength of this analysis. Most other in-course evaluations artificially separate the students into control versus experimental groups which may

or may not be comparable. Or alternatively, the study may have the groups be self-selecting, where those students choosing to participate are obviously more motivated and perform better. Then there are the few studies which compare the results derived from a prediction of either having or not having participated in the intervention. Unfortunately, these studies are not able to demonstrate benefit from the studied intervention (14,15). Our study can not indicate what motivates an individual student to use the TRC more or less. One may also argue that the average increase in grade seems small, these courses run between three and six weeks, and the average median study time over all the courses is only 28 minutes. It appears that an extra hour of study may increase grades by a half a point which seems efficient.

Perhaps the most intriguing result is the existence of a negative correlation between the slope and intercept. The results indicate that the TRC seems particularly good for the student who chooses not to study in one course and receives a poor grade versus another where the student is motivated to study and receives a higher grade. Statistically, this makes sense, as bright students who always strive to achieve high scores, cannot improve much from increased use of the TRC Pharmacology database. As an illustration, if they chose to study a little in one course and receive a 9, and then choose to study more and receive a 10 in another, the slope is not large. Thus, the TRC Pharmacology database is probably most effective where it needs to be. It assists under-performing students to do better. In attempt to motivate these students to use the TRC database, these results were included into the opening page of the program in the Fall of 2007.

Lastly, it is important to note the improvements in grades achieved by TRC users between the 2003-2004 and 2005-2006 data. The results are not attributable to the often-cited grade inflation, as the average grades for students sitting for the exams fell between the two study years. A more possible explanation is found in the increasing percentage of TRC users and falling intercepts from 2003 to 2005. As more students use the TRC, those that don't use the program are found to earn lower grades. In addition, the database has not been static between the years. Due to continuous assessment of the feedback provided to us in the form of questionnaires and online comments, we (together with the course instructors) continuously updated the program. In situations where we had a poor relationship with the course materials in 2003-2004, we either increased the amount of relevant topics, or stopped participating in the course.

In summary

Students are increasingly using the TRC Pharmacology database program throughout the curriculum and demonstrating an increase in study efficiency. More importantly, an increase in TRC use by an individual student correlates with an increase in course grades without regard to student or course. Our ability to demonstrate the usefulness of our E -learning program was heavily dependent on the fact that the program was already being widely used in many courses and by many students. By continuously analyzing the utilization and performance of students using the program, we have been able to introduce improvements to the E-learning program that improve the students' learning efficiency.

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CHAPTER 4

Assessment of the manner in which physicians communicate therapeutic plans

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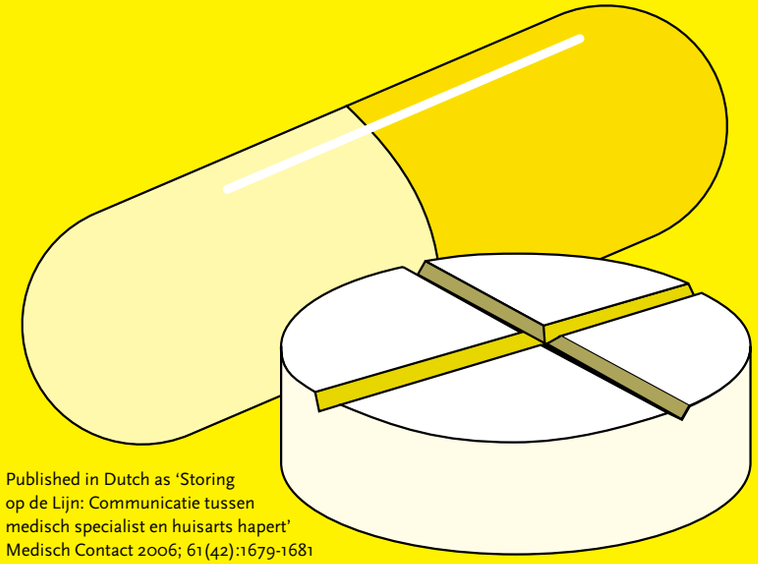

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ABSTRACT

Background: In the Netherlands, 170,000 patients yearly fall victim to poor medical communication, with 44% receiving inappropriate therapy as a result. This problem may be because physicians learn therapeutic communication skills and content by haphazard means.
Aim: To determine the extent specialists structure their reporting of therapeutic information to general practitioners (GP).
Methods: Eighty sequentially-received letters to a local GP practice were evaluated using two methods: the GP noted the timing of the letters and evaluated four areas using visual analogue scales; and investigators evaluated the letters based on criteria from the 'Problem Oriented Medical Record' endorsed by the American Medical Association.
Results: 48% of the letters were received within 4 weeks of the visit to the specialist. Most letters contained suitable diagnostic information based on assessments by the GP and investigators. However, the GP evaluation indicated that insufficient therapeutic information was provided in 42% of the letters and the investigator's found that information such as dosing, rationale and the determination of therapeutic efficacy were often missing.
Conclusions: A large percentage of letters contain insufficient therapeutic information based on assessments created using both local and international criteria. This suggests that physicians should practice and adapt a more structured form of communicating a therapeutic plan.

INTRODUCTION

There was a recent report from the Netherlands Patient Consumer Federation and National ICT-Institute in HealthCare that found that 170,000 patients yearly fall victim to medical errors, due to poor communication between general practitioners, medical specialists and pharmacists (1). The most common problem (in 44% of the cases) was caused by broken communication between the health care providers over the prescribed medications for a patient, which led to the patient receiving inappropriate therapy. Surprisingly, not all the cases were caused by miscommunication between the physician and the pharmacist, but more than half of these cases were caused by poor communication between physicians. This finding was supported by another report from the Inspectors of Healthcare which found that hundreds of people die in the Netherlands by receiving inappropriate therapy (2). Understandably, this has led to a great amount of unrest in society over the quality of the Dutch healthcare system (3-6). However, it has long been found in the (international) literature that medical errors are occurring (7-9) and that the reasons are multi-factorial. Medical professionals are increasingly confronted with an increasing number of diverse medicines (10) with increasing pressure to prescribe the newest and most potent drug (11,12). This is supported by evidence that patient's are more likely to suffer an adverse event if they used multiple drugs (13,14), multiple health care providers (15), and never had a structured evaluation to determine if there were drug-drug interactions (16,17).

So what can be done? One suggestion is that if we increase the drug and therapeutic knowledge, this will lead to an improvement in drug utilization. However, improved knowledge does not directly lead to an improvement of the physicians' ability to communicate that plan. It has been suggested that use of the electronic patient medical record can solve the communication problem (1). But this is unlikely, as the ability to communicate depends on both the form and the content of the electronic patient medical record. Currently, electronic patient medical records are limited to the sharing of patient data such as past medical history, medication lists, and results physical examinations and diagnostic tests (laboratory, radiological, et cetera) with limited possibilities for the documentation of a therapy plan. Physicians first need to learn a structured method in which to uniformly enter information regarding the therapy plan into a patient chart, then this format can be adopted by the electronic patient medical record.

One method endorsed by the American Medical Association to facilitate communication between health care providers is the use of the Problem-Oriented Medical Record (POMR) (18). The POMR uses a structured format for consistently presenting each medical problem that a patient may have. In the format, all available data (such as subjective and objective) with which the patient presents, is weighed and thoroughly evaluated (assessment) in order to develop a therapeutic plan (plan). This information is written in a concise form on a so-called 'SOAP' note: Subjective-Objective-Assessment-Plan.

It has been shown that medical records written using this format are more complete than those using free dictation format [19,20). The completeness of the data even leads to better outcomes for the patients. The impact of this was demonstrated in one study that compared the outcomes for patients suffering from any of the seven common diseases when records were formatted or freely transcribed and found that POMR may have improved the thoroughness of patient management (21). It is assumed that the improvement in patient outcomes seen occurred by decreasing the obscurity of the information in the free-form medical records, and providing a rationale for the patient-specific therapy plan.

In the Netherlands there is not a tradition of providing a structured approach for the solving and communicating of a treatment plan. Implicitly, it is assumed that a physician is capable of performing this task in a clear and unambiguous manner. However, with the increasing focus and reporting of the occurrence of medical errors, it seems an appropriate time to critically look at this assumption.

One option is to research how medical specialists (who also serve

at clinical preceptors) communicate a patient's therapy plan back to the referring primary care provider. These discharge letters or post-consultation letters serve as the most important communication tool in which physicians inform each other over their shared patients. Therefore we will review which information the medical specialist provides and if the information is sufficient for the referring physician to implement the intended therapy plan and make adjustments if necessary.

METHODS

This assessment was performed as a collaboration between the Centre for Human Drug Research (CHDR), and a general practitioners office in a community served by the Leiden University Medical Center. During the evaluation period, 80 sequentially received discharge letters or post-consultation letters were logged in and data regarding the date received versus visit date were recorded. The content of the letters were then evaluated in a structured manner using factual data by the general practitioner who was unaware of the background of the study. She determined if the letter was 'complete, clear, logical, and specific enough' to understand the following aspects: diagnostic evaluation, therapeutic evaluation, therapeutic approach, and the global assessment of the contents of the letter. The physician's assessment of these sections was scored using Visual Analogue Scales (VAS). The letters were then blinded for anonymity (protecting both the patient and the specialist who had written the note) by the staff at the general practitioners office and sent to the CHDR for review. All letters were assessed on 15 different aspects of communication using the POMR Note Criteria form (See Appendix A). This criteria form is a Dutch version of the expanded SOAP format assessment previously described (22).

STATISTICAL ANALYSIS

The VAS scores were determined by calculating the percentage of the line from the left of where the vertical mark was made by the physician. The VAS scores for the four aspects evaluated by the physician were reported as the median (with the minimum and maximum scores) as the data were not normally distributed.

For the POMR assessment, the percentage of the letters not meeting each of the criteria [-] were assessed (the evaluations of [v] and [+] were grouped as these letters were evaluated as either mostly meeting criteria or meeting criteria). The power determination was based on a previous review of POMR notes in a student population which found that 10% of students failed to meet criteria even for topics that were very familiar to them. Thus, in order to determine that the proportions of our sample were not achieved by chance, 80 notes were assessed. Finally, we have determined that having more than 20% of the notes not meeting criteria for a given topic to be the level of unacceptability.

RESULTS

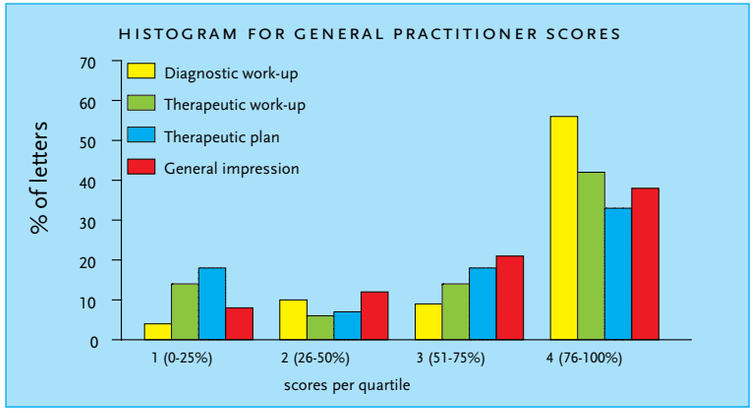
The time between the patient's visit to the specialist (or discharge from the hospital) and the receipt of the letter by the general practitioner is shown in table 1.

Table 1 *Duration between patient visit to the specialist and receipt of the letter by the general practitioner (* date of the patient's visit to the specialist not noted)*

Days	# letters	(% of total)
≤28	32	40.5
29-56	9	11.4
57-84	8	10.1
>84	17	21.5
Unknown*	14	16.5

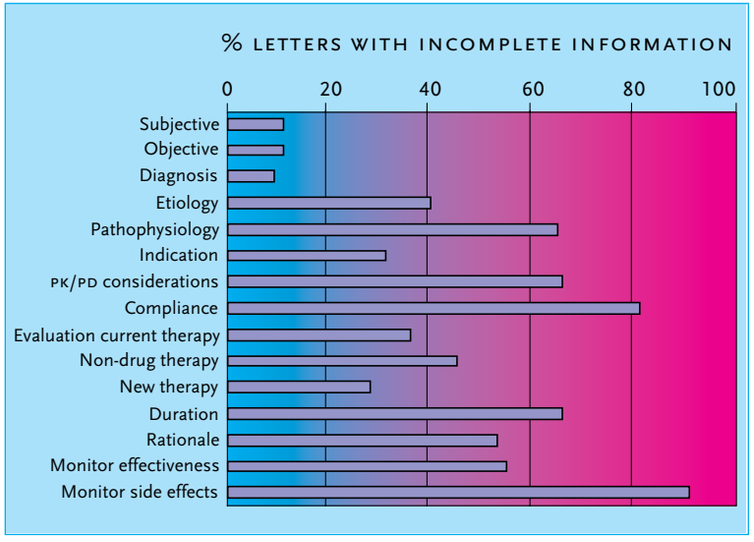
The general practitioner evaluated information regarding the diagnostic evaluation contained in the letters with a median score of 83 (min-max: 0-100; figure 1). Evaluation of the letters using the POMR note criteria form with regard to identifying the most important medical problem (or diagnosis) resulted in 89% of the letter providing adequate information (figure 2).

Figure 1 *Summary of the general practitioner's evaluation*



With regard to the communication of the therapy plan, in 20% of the letters, there was no information provided regarding any new or change in therapy. This does not mean that no change in therapy occurred, but it was simply not communicated. There was great variability in the content of the letters when the general practitioner was informed over the selected therapy and the rationale behind it. The median scores given the letters by the general practitioner for the information over the therapeutic evaluation was a 76 (0-100) and the scores earned for the therapeutic plan was only a 62 (0-100). If the scores are grouped per quartile (figure 1), then it is clear that 40-50% of the letters contain incomplete information over the therapy plan. The general impression by the general practitioner of the information communicated in the letters can be seen in the global impression scores where the median score was a 74 (0-100).

Figure 2 *Results from the evaluation using the POMR note criteria form*



The evaluation using the POMR shows that if a therapeutic plan is given in the letters, that it was poorly communicated (figure 2). Many of the specialists provide no information of the name of the drug and/or the dosing in their letters (36%), give no indication of the necessary monitoring for effectiveness of the treatments (55%), and rarely provide information over the monitoring of possible side effects which could be encountered (91%). This is despite the fact that the specialists gave no indication that they themselves would be following up with the patient. In 53% of the letters there was no information provided over the rationale behind the choice for the therapy plan.

CONCLUSIONS

This inventory demonstrates that a large percentage of letters written by medical specialists to inform their colleagues over a shared patient contains an insufficient amount of information. While most letters contain enough information regarding the diagnostic aspects for the problem for which the patient presented, there is a lack of information in order for the general practitioner to follow a complete and rational therapeutic plan. We recognize that a limitation of the study is that the evaluations could have been biased. Here, the researchers could have expected a poor outcome and thus gave the letters lower scores. But evaluation of letters was designed as such to evaluate if the information was present or not present (for example: was the dose of the drug provided? Yes or No). In addition, the general practitioner's scores were similar to the results of the researchers. This is surprising since one would expect that the general practitioner has a favourable relationship with the consulting physician (otherwise she would have consulted another physician). As such, in a blinded situation the assessment of the letters by the general practitioner might have been more critical.

The findings could be attributed to the fact that the medical specialists believe that the communication of the information regarding the treatment of the patient is unimportant, but that seems unlikely. A second and more plausible explanation could be that physicians learn a different process for communicating their diagnostic actions than they do for their therapeutic action plan. Physicians are taught a structured method for completion and communication of their diagnostic process. A great deal of attention is given during both preclinical as well as clinical portions of medical school to the process of completing the review of systems, performing a physical examination, and requesting additional diagnostic tests. Here is the large difference with regard to the place of (pharmaco) therapy education. There has long been many signals that the education in pharmacology and pharmacotherapy is receiving too little attention (6). The current study's results seem to indicate that the current generation of physicians is unable to communicate a rationale therapy plan. This may not be synonymous with the fact that physicians are unable to develop a rational therapeutic plan, but if it's not appropriately communicated, what is the difference?

The development of a therapeutic plan is a complex process where the physician makes decisions based on both implicit and explicit considerations. For example, if a physician chooses therapy which is not first line therapy due to a co-morbidity, it is not easy to communicate the rationale for the second choice in the plan, but it is essential. Our findings should serve to provide the stimulus to have physicians (and physicians in training) learn how to develop and communicate a therapeutic plan in the same manner in which they learn to develop and document the diagnostic process. The therapeutic plan then can be utilized as a basis for communication between colleagues in the hospitals (via the medical

chart) and the referring health care providers (via the discharge or post-consultation letters). For this process to be successfully implemented in practice, developing a (pharmaco) therapeutic plan needs to become inculcated into the way that the physician practices and as second nature as the diagnostic process.

To ensure this occurs, a nation-wide standard is being developed where the therapeutic plan is presented in a consistent manner. The therapeutic plan is undergoing validation (23,24), and extensive 'train-the-trainer' sessions are being employed by the various universities to implement the format. This consistent process of communicating a therapeutic plan serves not only to provide improved communication of the information between specialists and general practitioners, but can also serve as the template for communicating a therapeutic plan in the electronic medical records of the future.

Appendix A POMR CRITERIA FORM

(-) Letter does not meet the given criteria; letter requires changes. There are missing data or information is not understandable.
(v) Letter mostly meets the given criteria; it requires only a few clarifications.
(+) Letter meets the given criteria; it requires no changes and is helpful for the management of the patient.

	-	v	+
1. Describe the subjective evidence of disease i.e. complaints, symptoms,			
2. Describe the objective evidence of disease i.e. physical exam, laboratory results			
3. Identifies primary disease states and assesses status			
4. Determines (possible) aetiologies of the problem			
5. Describes pathophysiological mechanism(s) of the problem			
6. Compares pathophysiology to the pharmacology of current agents			
7. Assesses patient-specific pharmacokinetic/pharmacodynamic data			
8. Assesses patient compliance			
9. Indicates plan for current drug therapy			
10. Describes plan for non-pharmacologic therapy			
11. Identifies correct drug(s), dose, route, frequency			
12. Describes titration schedule and duration or endpoint (if necessary)			
13. Provides rationale for drug, dose, route, etc. by describing pharmacologic, pathophysiologic, and patient-specific data			
14. Identifies monitoring parameters for efficacy (pathophysiological symptoms)			
15. Identifies monitoring parameters for toxicity (pharmacological symptoms)			

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CHAPTER 5

Creating a culture of thoughtful prescribing

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ABSTRACT

Background: It has been recently reported in the Netherlands that 170,000 patients yearly fall victim to poor communication between health care professionals, with 44% of patients receiving inappropriate therapy as a result. Evidence indicates this problem may be due to physicians learning written communication skills and therapeutic content by unstructured means during training.
Aim: To introduce a structured format for creating and communicating therapeutic plans; to provide students opportunities for practice and feedback on their abilities.
Methods: We developed the Individualized Therapy Evaluation and Plan (ITEP) for therapeutic decision-making and communication based on the commonly used SOAP (Subjective Objective Assessment and Plan) note. The therapeutic plans from students of the 2003 cohort were assessed with one simple and one complex case using a 15-point criteria form. Over the next three years students were given more practice using the ITEP and the average score on the complex case was tracked and compared to the 2003 cohort.
Results: In cohort 2003, 82% satisfactorily completed the simple case, versus only 32% with the complex case. In subsequent years, the average scores on the complex case significantly improved from 3.8 to 6.8 with increasing practice.
Conclusions: Students know how to select a drug, but without practice using the ITEP do not know how to deal with multiple disease states.

INTRODUCTION

Worldwide, there is increasing evidence that medical errors arise from poor communication between health care providers (1-4). In the Netherlands, public concern rapidly increased when it was reported that 170,000 patients yearly fall victim to poor communication between health care professionals (5). This report found that poor communication between health care providers over the prescribed medications led to the patient receiving inappropriate therapy (in 44% of the cases) or no treatment at all (in 25% of the cases). Surprisingly, not all the cases were caused by miscommunication between the physician and the pharmacist, as more than half of these cases were caused by poor communication between physicians (5,6). Unfortunately, the report did not detail all the problems that occurred, it only provided examples for the categories the researchers used (6). Although the authors conclude that these patients suffered due to the poor communication of all medical information, their data clearly suggest that in 69% of the cases the insufficient transfer of the therapeutic information resulted in a problem.

This should not be surprising as in contrast to other aspects in medical charting (review of systems, physical examination, etc.); physicians learn a variety of methods for communicating therapeutic information. There is a growing body of literature that documents the lack of proper training of physicians in the area of rational drug prescribing (7-9). One method endorsed by the American Family Physicians to facilitate communication between health care providers is the use of the Problem-Oriented Medical Record (POMR) (10). The POMR uses a structured format (SOAP = Subjective, Objective, Assessment, Plan) for consistently presenting each medical problem that a patient may have. The POMR is widely used in the United States and it has been shown that records using this structured format are more complete than those using free dictation as a format (11,12). More importantly, other studies seem to support the hypothesis that the POMR may have improved the thoroughness of patient care when they evaluated the outcomes for patients (13,14).

In the Netherlands, there is no nationally (or even in our case, locally) accepted format for the medical charting of therapeutic information. At Leiden University Medical Center, it has been assumed that students will learn how to solve and communicate therapeutic plans from the traditional teaching model employed in medical schools: the apprenticeship. However, the therapeutic format employed as well as the success of the educational process will always vary depending on the site and mentor. In a previous study we determined the extent of the local problem by examining the therapeutic contents of consult letters written by specialists to the referring general practitioner (15). While most letters contained enough information regarding the diagnostic aspects for the problem for which the patient presented, there was insufficient information for the general practitioner to follow the therapeutic plan. Our findings provided the stimulus to have our medical students learn how to develop and communicate a therapeutic plan in the same manner in which they learn to develop and document the diagnostic process.

For this process to be successfully implemented in clinical practice, developing a therapeutic plan needs to become inculcated into the way a physician practices, and become as second nature as the diagnostic process. Educational evidence suggests that skills such as using a more structured patient reporting format needs to be introduced early in the curriculum in order to enhance adoption (16-18). Previously, another group attempted to systematize the teaching of POMR in second-year medical students. The results of their controlled study of two different instructional formats: self-instruction and workshop were determined by assessing the student's ability to convert a case to the POMR format. Their results suggest that all student groups attained an acceptable performance level no matter which format they experienced (19). Lastly, self-study assignments and assessments by which students can repeatedly practice and evaluate their performance have been shown to advance learning (20,21). Thus, our

goals were 1) to introduce early into the Leiden University Medical Center curriculum a structured format for communicating a therapeutic plan; 2) to give the students multiple opportunities throughout the curriculum (both pre-clinical and clinical) in which to practice and have feedback on their therapeutic planning skills, and 3) to assess how students perform when using the therapeutic plan format.

METHODS

Educational methodology

At Leiden University Medical Center we introduced a structured format called the Individualized Therapy Evaluation and Plan (ITEP) for students to apply therapeutic knowledge. The ITEP format is used to aid therapeutic decision-making and communication and is based on an expanded SOAP (Subjective Objective Assessment and Plan) note (22) from the POMR. The difference between the ITEP and the SOAP is that the ITEP minimizes the subjective and objectives portions of the SOAP, while expanding the assessment and plan sections to include more therapeutic information (see table 1). The assessment includes an evaluation of the clinical presentation, pathophysiology and current therapy that is patient-specific and relevant for that moment. The choices made for the plan for treatment and monitoring must include a rationale that is relevant to not only the patient, but also society (i.e. costs). The aim of using the ITEP during pharmacotherapy training is to give the students practice opportunities for drawing up and providing a rationale-based treatment plan for an individual patient. Students are provided the format as well as clear performance criteria (see Appendix A), so they can know how well they are performing this task during their practices. Repetitive and consistent utilization of this criteria form during self-, peer-, and instructor-evaluations allows the students to incorporate the therapeutic decision making process into their patient care practice.

Students are introduced to the writing of the ITEPs early in the curriculum (in the beginning of the second year) and continue to practice through their clerkships. The students' first experience with ITEP writing is in a workgroup situation where the students write an ITEP individually and their peers evaluate the ITEP based on the workgroup leader's feedback. The cases provided to the students are such that the patient presents with a clinical presentation that is typical for a particular disease state, and warrants treatment with the standard first-line therapy found in most treatment guidelines. This is to make sure that the students learn the pathophysiology of different disease states, understand the pharmacology of the most commonly used medications for that disease, and finally why one drug is considered to be the drug of choice. Individual student participation

Table 1 *The Individual Therapy Evaluation and Plan (ITEP) method for developing and communicating a therapy plan*

Evaluate the patient's disease states:
• Make a list of disease states and indicate the status of each
• Describe the aetiology / pathophysiological mechanism of each problem
• supported with the complaints, symptoms and results of the patient
Evaluate current therapy for each disease state:
• Determine if current therapy is effective and safe (without side effects)
• Support this by comparing the relationship between the pathophysiology
• of the medical problem with the mechanism of action of the therapy and
• evaluating the patient's complaints, signs and symptoms
Evaluation of patient-specific parameters that can influence therapy:
• Patient specific data (PK, allergies, side effects)
• Drug specific data (dose, cost, interactions)
• Disease specific data (drug-disease interactions)
• Patient compliance
Write a therapy plan based on your evaluation:
• Indicate your plan for current therapy (stop, continue, increase/decrease dose, etc
• Choose (if necessary) new therapy (non-drug, drug, surgical, etc.)
• Specify for each therapy the dose, route, frequency and duration
• Provide the rationale for your choice of therapy, dose, etc. Support this by describing
• the mechanism of action and impact of patient-specific data (as described above)
Monitor therapy plan:
• Describe the goals and monitoring parameters to determine efficacy
• (patient-specific pathophysiological symptoms) of the therapy
• Describe monitoring parameters to determine side effects and toxicity
• (pharmacological symptoms) of the therapy
• Establish appropriate time intervals and frequencies for these parameters

in the workgroup is ensured by the incorporation of an ITEP writing section on the course exam that is a follow-up moment of the case presented in the workgroup. The follow-up cases are based on a clinical situation in which the patient presents with a drug-related problem as described by Helpler and Strand (see table 2) (23,24). Because the types of (and solutions for) drug related problems are finite in number, students can study by predicting the patients' clinical presentation on the exam.

Throughout the rest of the curriculum, students are given opportunities to practice ITEP writing after either witnessing a patient presentation during

lecture or reviewing computerized 'paper' patient cases (covering various clinical presentations) and using an online editing program. The students then get feedback either 1) directly during the lecture, 2) from the online editing program, 3) through discussions during workgroups, or 4) in review sessions prior to the examinations. During the clerkship portion of the curriculum, the students write ITEPs for patients seen on rotations. During the internal medicine rotation for example, the students are instructed to write five ITEPs and direct their cases toward the most common disease states based on morbidity/mortality data (e.g. hypertension, diabetes, etc).

Table 2 *Drug related problems*

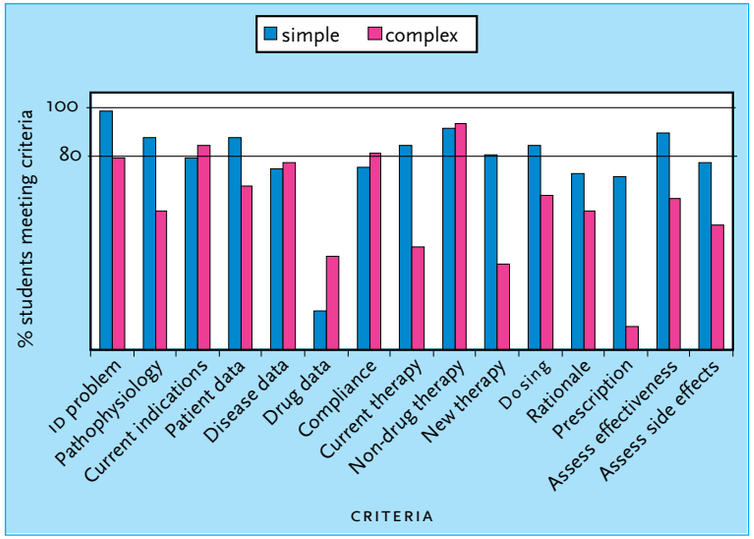
1	Untreated medical problem
2	Improper medication selection
3	Too little medication
4	Failure to receive medication
5	Too much medication
6	Adverse drug reaction
7	Drug interaction
8	Medication use with no indication

Evaluations

ASSESSMENT 1: During the first year of adoption (2003), students were taught the ITEP principles and then given computerized practice cases to study in the two final courses prior to clerkships. The assessment of this cohort of students served as a baseline to evaluate student performance when using the ITEP to solve two different therapeutic cases. The cases differed in topic and complexity: the paediatric case was simple with a single disease state; the geriatric case was complex with multiple disease states. On the paediatric ITEP exam, the student only had to determine that current non-drug therapy was not effective and that new drug therapy had to be started. On the geriatric ITEP exam, the student had to manage a drug-induced side effect, an under-treated disorder and a non-treated problem. The ITEP exams were blinded and then assessed using a 15-point criteria form spanning the therapeutic plan. The assessment determined if 1) the ITEP s were satisfactorily completed, and 2) which section of criteria was the most difficult for the students.

ASSESSMENT 2: In the subsequent years, each cohort of students increasingly followed the curricular plan as described in the education methodology section. As such, we tracked the number of ITEP cases with which the students had been assessed prior to taking the geriatrics exam with the complex case. The second assessment then tracked student performance on making a therapeutic plan on the complex geriatrics case, and compared to the students' performance on ITEP writing from the first year of adoption (cohort 2003).

Figure 1 *Percentage of students able to meet each criterion on the ITEP Criteria Form*



STATISTICAL ANALYSIS

For the first assessment, the percentage of student ITEPs not meeting each of the criteria (designated as [-] on the criteria form) was assessed (those ITEPs that were evaluated as either mostly meeting criteria [v] or meeting criteria [+] were grouped). Comparison between student cohorts 2003 and the years 2004, 2005 and 2006 was evaluated by using an analysis of variance after scores were normalized to ten.

RESULTS

ASSESSMENT 1: In the 2003 baseline cohort, 82% of the 221 students satisfactorily completed the simple case, while only 32% of 181 students did so with the complex case. Figure 1 shows the percentage of students able to meet each criterion when creating a therapeutic plan for a simple and complex case. For the simple case, the ITEP criteria analysis indentified only

drug interactions as something with which the students struggled. In this case nearly 85% of the students failed to see that the recognized 'drug-of-choice' had a potential for drug interactions. In the complex case, students only did slightly better at recognizing potential drug interactions, as still 61% had difficulties. Overall, more than 40% of students were unable to meet half of the criteria. In addition to identifying drug interactions, the students could not meet the criteria for assessing pathophysiology, and current drug therapy, as well as determining plans for current or new drug therapy, the proper dosing and indicating the goals or monitoring parameters for efficacy and toxicity of the plan.

ASSESSMENT 2: The results of assessment 2 are shown in table 3. The number of previous assessments using the ITEP format increased for each cohort of students. Each year's cohort of students also performed significantly better than the 2003 cohort which had little practice.

Table 3 *Data from the four cohorts taking the complex geriatrics exam*

	2003	2004	2005	2006
N students assessed	181	285	271	264
# of previous ITEP exams	1	2	4	8
Average score	3.83	4.79	6.53	6.76
Change from cohort 2003 (SE)	-	0.96 (0.27) p=0.0005	2.70 (0.27) p<0.0001	2.92 (0.28) p<0.0001

DISCUSSION

Our results suggest that the students were able to use the ITEP format for writing their therapeutic plans and that the continued use of the ITEP format in the curriculum improved the students' ability to solve case studies and communicate therapeutic plans. Our initial assessment of the first cohort indicated that students in their final courses prior to clerkships were able to solve simple cases. In addition, they were able to adopt the ITEP format for communicating the information fairly well. However, when given a case of a typical geriatric patient that involves multiple disease states and unresolved problems, the students struggled. While most of the criteria were not satisfactorily met for more than 20% of the students, certain criteria were rarely addressed appropriately by the students. These included assessment of the current therapy, determining appropriate new therapy, identifying potential drug interactions, and accurately writing a prescription.
To illustrate the types of problems the majority of students (57%) had with assessing current therapy, students often missed or identified the wrong drug causing a drug-induced problem (in this case side effects). Because of this, 64% students' new therapy plans would include starting a new less-effective drug for a well-treated condition, or starting the patient on another drug to solve the side effect. Regardless of the assessment or plan that the students developed, 61% did not identify the potential drug interactions that existed in their plans. Finally, most (90%) were unable to make a definitive decision regarding the therapy regimen they had chosen and thus wrote inappropriate prescriptions. Most commonly the students would forget frequency regimens, or only indicate dosing ranges instead of a specific dose, but sometimes their prescriptions would border on nonsense e.g. 'perhaps maybe the patient should be started on something like a broad spectrum antibiotic'.

The follow-up assessments that took place in the three years after the introduction of the ITEP in the curriculum had shown significant improvement in the students' abilities to use the ITEP to solve therapeutic problems. Students were now able to do a better job assessing current therapy and developing a therapy plan, but had become more lax at providing monitoring parameters for safety (criteria #15 of the ITEP).

We are encouraged by the progress that the students have made over time particularly in their ability to write more concise, definitive therapy plans. We think that using ITEPs for practice and for assessment has improved the pharmacotherapy education at our institution. Most institutions choose to assess students with multiple-choice questions in order to differentiate the students from strongest to weakest. However, we feel using the open questions in the ITEP format offers more: 1) It provides the students with practice and feedback on an activity that is applicable to the activities of a practicing physician; 2) it prevents students from using therapeutic algorithms to determine therapy in a cookbook fashion; 3) it provides training in good prescribing habits; 4) it addresses the problem of poor communication between clinicians which we hope will ultimately have an impact on patient care, and 5) it prepares students for the use of electronic patient medical records.

On this last point, it has previously been suggested that use of the electronic patient medical record can solve the communication problem (5). But this is unlikely, as the ability to communicate depends on both the form and the content of the electronic patient medical record. In addition, current electronic patient medical records are limited to the sharing of patient data such as past medical history, medication lists, and results of physical examinations and diagnostic tests (laboratory, radiological, et cetera) with limited possibilities for the documentation of a therapy plan. Physicians first need to learn a structured method in which to uniformly enter information regarding the therapy plan into a patient chart, then this format can be adopted by the electronic patient medical record.

LIMITATIONS

We recognize that the improvement in ITEP scores between the 2003 and 2006 cohorts could be attributed to a number of factors. First it is possible that the evaluations of the ITEP between the cohort years could have been biased. Unfortunately, the same cases could not be given between the years due to a change in course coordinators and focus of topics taught in the course. In addition, the evaluators could have expected a poorer outcome and thus gave lower scores at the outset or made the first case significantly harder. However, this would be unlikely, as this would have resulted in too many 'good' students having a poor grade. Conversely, if the second grade is graded too easy, too many 'poor' students would receive a passing grade. It is also impossible to attribute these findings to the impact of the introduction of the ITEP into the curriculum alone. Other possibilities outside the control of the researchers include: 1) the later cohorts could have consisted of stronger groups of students; 2) other changes in the curriculum had occurred between the cohorts, improving their abilities; 3) the students now knew the impact the ITEP had on their grades and studied more for the exam. Lastly, the ultimate goal of our educational intervention is to improve patient care by improving physicians' communication of therapeutic plans (as described in the background study for this paper (15)), but this assessment is not yet possible since the later cohorts have yet to achieve prescribing rights.

CONCLUSIONS

We were able to develop a new format (the ITEP) for students to use to develop and communicate therapy plans. With little practice, students could use the ITEP to develop simple therapy plans where they were only required to know how to start a drug of choice. However, they were not able to deal with difficult cases in which there were multiple problems or current therapy that is not working. After practicing with the ITEP throughout the curriculum, subsequent cohorts of students were able to greatly improve their ability to develop and communicate therapeutic plans for the more difficult cases.

Appendix A ITEP CRITERIA FORM

(-) ITEP does not meet the given criteria; ITEP requires changes. There are missing data or information is not understandable.
(v) ITEP mostly meets the given criteria; it requires only a few clarifications.
(+) ITEP meets the given criteria; it requires no changes and can be included in the chart of the patient.

		-	v	+
1	Identifies the medical problems and indicates the status			
2	Briefly describes the pathophysiology and supports it with the complaints, symptoms and examination results of the patient			
3	Evaluates current indications by comparing pathophysiology to the pharmacology			
4	Describes patient data (pharmacokinetic, allergies, ADR's) that can influence therapy			
5	Describes disease data (disease-therapy interactions) that can influence therapy			
6	Describes drug data (dosing, regimen, interactions) that can influence therapy			
7	Assesses patient compliance			
8	Indicates plan for current drug therapy			
9	Describes plan for non-pharmacologic/surgical therapy			
10	Chooses (if necessary) new drug therapy			
11	Identifies correct dose, route, frequency			
12	Provides rationale for drug, dose, route, etc.			
13	Writes a complete prescription			
14	Identifies monitoring parameters for efficacy			
15	Identifies monitoring parameters for toxicity			

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CHAPTER 6

Improving pharmacology education throughout a medical school curriculum: change from within

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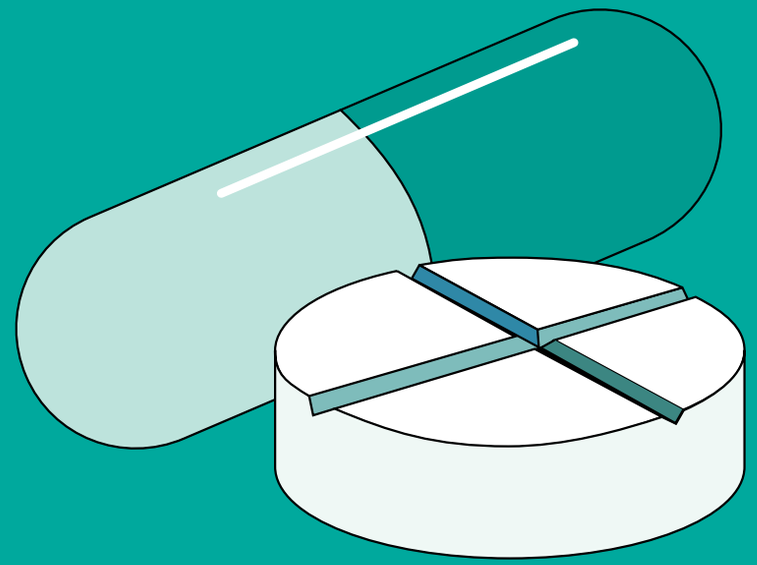

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ABSTRACT

Background: Given the explosion of new medicines, our aging population and the problems experienced today with inappropriate prescribing, improving the prescribing abilities of graduating physicians should be a priority for all schools of medicine. However, implementing an educational change in a medical school curriculum is a difficult and slow process. Is it possible for faculty members to learn change management processes to bring innovations more quickly to the curriculum?
Methods: This paper reviews the shortcomings of the current medical literature regarding instituting change from a faculty member's perspective. Combining a review of the literature and our own experience, a new approach for faculty members wanting to implement their own educational innovation in the curriculum is proposed. The approach includes a set of eight steps and identifies the factors associated with a successful implementation.
Conclusions: It is our hope that more educational changes will be assessed for their value to the curriculum and drive improvements in medical education in order to meet the needs of today's society.

INTRODUCTION

In 2004 the Dutch Inspectors of Healthcare found that hundreds of people each year die by receiving inappropriate therapy, and tens of thousands more are harmed (1). This report led to great alarm in Dutch society over the quality of their healthcare system (2-4). One newspaper headline even implicated medical schools for the problem by stating that 'Physicians learn little about medications' (5). Scientific reports indicate that medication errors are not limited to the Dutch population, but are an internationally occurring phenomenon (6-8). The use of medications in the Netherlands has expanded rapidly over the past several years, and in 2006, reached a record of 5.9 prescriptions per capita per year (9). These statistics are a reflection of the fact that as our society ages, it is increasingly attempting to keep mortality at bay through the utilization of medications. In 2005 the conceptual artist Damien Hirst captured this belief in his audacious exhibition 'The New Religion', an examination of society's illusion that medicines can postpone reality. Can physicians appropriately prescribe powerful new drugs to ward off death? No, not entirely, and not forever, of course. But, by improved pharmacological education and training for physicians, they will be able to maximize the potential of these medicines to improve and extend peoples' lives.

Given the explosion of new medicines, our aging population and the problems experienced today with inappropriate prescribing, improving the education of physicians should be a priority for all schools of medicine.

However, implementing an educational change in a medical school curriculum is a difficult task. A review of any medical education journal will provide numerous examples of various new educational strategies, most remain confined within the domains of individual courses. Can change occur across the curriculum in a disciplines-oriented organizational structure? In medical education there have been a few key papers directed toward the topic of curricular change. Some are insightful 'how to...' or conversely 'how not to...' articles (10-13), others describe the environment (14-16) or leadership (17-20) necessary to evoke change, and lastly there are the articles with hyperbolic titles such as ''No Fear' curricular change' (21), or 'Change, Stories of the Journey' (22). All these reports indicate that curricular change is a difficult and long process that requires careful and persistent management.

The purpose of the current paper is 1) to evaluate a few of the commonly used models for instituting change, and 2) in the context of our department's attempt to implement a new strategy for teaching pharmacology across the curriculum, describe how elements of these models either helped or failed in the development of a new model for creating change in a medical school curriculum. It is hoped that the new model facilitates more teachers to promulgate new teaching strategies into areas outside their expertise. It is foreseeable that this model would result in more innovative strategies being utilized and assessed across disciplines, and would subsequently enrich our understanding and increase the rate of advancement in the field of medical education.

REVIEWING MODELS FOR 'CHANGE'

The medical as well as non-medical literature was searched for articles providing guidance in managing change (often called 'change management' in business literature). The most basic model found was proposed by Lewin who was famous for his organizational theory which included three steps that were associated with 1) getting the organization ready to change (he termed this 'unfreezing'; 2) making the change, and 3) solidifying the change ('refreezing') (23). Most subsequent theories have used this model as a basis to either expand or refute the steps stated above. In 1979 John P. Kotter introduced the 'Eight steps to transforming your organization' (see table 1) to the business literature and it remains a commonly used model today (24). Kotter's step descriptions are more specific and describe the 'acts' that must be performed for success. A year later in 1980, Levine identified a four step process for change specific for implementing innovations in higher education, but also switched the focus from performing steps towards identifying the factors that led to failure (25). Since his seminal work, most published efforts in medical education have also focused on identifying factors associated with successful change rather than the process

necessary for a successful change. The largest amount of data comes from the 27 health education schools that reported their process of change as they attempted to meet the W. K. Kellogg Foundation's initiative to enhance training in primary care (21). This article provides many examples of the factors involved by creating change from the top (administration) and enforcing it down (toward faculty and ultimately students). But can teachers drive educational change? The recent thorough review of (curricular) change literature by Bland et al. (10) provides a set of characteristics associated with successfully managing a curricular change. Since Bland's review was written by summarizing currently available literature and from the perspective of creating change from the top down, they will be of little utility for teachers. As an example, it is recognized that change 'requires a redistribution of time and energy' and that the organization needs to provide rewards to encourage participation (10). Unfortunately, non-administrative faculty would have difficulty influencing the commonly used rewards mentioned in the article (salaries, recognitions, tenure and promotions). Which is why top administrative stakeholders –who have the resources- should be involved in change processes, as soon as possible.

Table 1 *John P. Kotter's 'Eight steps to transforming your organization' (24)*

1	Establishing a sense of urgency
2	Forming a powerful guiding coalition
3	Creating a vision
4	Communicating the vision
5	Empowering others to act on the vision
6	Planning for and creating short term wins
7	Consolidating improvements and producing still more changes
8	Institutionalizing new approaches

THE CONTEXT FOR OUR CURRICULAR CHANGE

Leiden University Medical Center had recently integrated the teaching of various disciplines across the curriculum. While basic sciences such as anatomy and physiology were integrated into the new courses, pharmacology had all but disappeared from the curriculum. In addition, due to time restraints, pharmacotherapy was to remain in the clinical portion of the curriculum. A few faculty members from the Department of Clinical Pharmacology recognized this would led to a deficit in student knowledge and decided to put forth effort to increase both pharmacology and pharmacotherapy education in all parts of the curriculum. The Teaching Resource Centre (TRC) was created to compile and create pharmacology and pharmacotherapy learning strategies to offer course coordinators and lecturers. But the question remained, how were these materials going to be incorporated throughout the curriculum?

Based on our review, a few key models were identified and assessed as being a useful guide for us to implement a change in the curriculum. We used Levine's process for implementing innovations in higher education which includes 1) recognizing the need for change; 2) planning; 3) implementing, and 4) institutionalizing, provided the backbone for our new model (25). John P. Kotter's 'Eight steps to transforming your organization' as described in the business literature (24) was used to establish more specific steps in the process. Finally, the factors we would need to consider in order to be successful were derived from the previously described literature review 'Curricular Change in Medical Schools: How to succeed' (10). Although these models and factors were used to guide the integration of our innovation into the curriculum, their implementation and success varied. As such, a new approach with the factors found to be important at each step was developed. This new approach is found in table 2; each step to be performed by the change agents (in this example, the TRC) is described in the body of this paper.

STEPS TO TRANSFORM THE CURRICULUM

Establishing the need for educational change

STEP 1: IDENTIFYING THE NEED FOR CHANGE. Both Levine and Kotter started their change process with this step by stating that change begins by establishing a sense of urgency. The need for the change can be established by the change agents when they examine the current environment and identify the crises or potential crises that the institution bears. In our case, we had no problem identifying a crisis with regard to pharmacology education; the lay press had done it for us. With increasing frequency, the press was publishing headlines declaring that doctors were not being trained to use medicines (5), and that their prescribing errors were increasingly hazardous to patients' health (2,3). Obviously, it was up to the medical schools to address this problem and nobody we encountered within the institution disagreed with this.

STEP 2: RECOGNIZING THE LIMITATIONS OF THE ENVIRONMENT. In the early stages of the change process the change agents need to determine if the environment will respond to a change effort. This is an institution-specific analysis of the potential barriers to implementing change. Many of the features listed by Bland et als. review (institution has a history of effective change, a loose organizational structure and a cooperative climate for collaboration) are likely to be relevant to any institution (10). But these are static features and the group or individual initiating the change only

Table 2 *Steps and factors to implement change throughout a medical curriculum as adapted from Kotter (24) and Bland (10)*

ESTABLISHING THE NEED FOR EDUCATIONAL CHANGE
Step 1: Identifying the need for change
- A crisis (or potential crisis) provides an opportunity to introduce the innovation
Step 2: Recognizing the limitations of the environment
- The institutional environment will accept change
- Obstacles to implementing the change are not insurmountable
PLANNING
Step 3: Creating the vision and strategies for implementing the change
- Link between vision and educational intervention is logical
- The outcomes and educational vision are short and easy-to-communicate
Step 4: Developing a supportive coalition
- Able to tap into a broad range of leadership styles
- People with considerable influence support the innovation
IMPLEMENTING
Step 5: Communicating the vision
- Opportunity for repeated, face-to-face communication
- Early-Adopters have been identified in the institution
- The innovation is able to reward those who embrace the change
- Demonstrations of the innovation and success are possible
Step 6: Working to remove the obstacles to success
- Able to adapt innovation in order to foster new collaborators
- Able to use logic to address non-existent blockades to adoption
Step 7: Demonstrating success
- Short-term results reward those that are supportive
- Successes are visible to those both inside and outside the institution
INSTITUTIONALIZING
Step 8: Solidifying the change to the point of sustainability
- Innovation is accepted by the authoritative body
- The educational change is able to resist new policies that are inconsistent
- Link between improved outcomes and innovation is apparent
- Support of resources necessary to continue work is garnered
- Plan for succession is in place

needs to consider them as far as to plan the best way to overcome them in later steps. At this step it is most important for the change agents to be certain that the goals of the change are consistent with the institution's goals.

Planning

STEP 3: CREATING THE VISION AND STRATEGIES FOR IMPLEMENTING THE CHANGE. In contrast to most change processes, the educational change agents are the innovators and have already formed the basic model for change and tested it in their own course(s). Thus, the teacher/innovator needs to solidify the vision and create the strategies for achieving the vision (Kotter's step 3) based on the evaluation process above. We thought that it would be difficult to have a solid and effective workgroup without a vision to drive the process. Thus, in our example, a vision for improving the prescribing habits of physicians through the provision of pharmacology education was created based on outcome-based educational principles. The vision centered around five learning outcomes (see table 3) that were simple enough to communicate to students, professors and practicing physicians. Interestingly, the importance of this step appears lost in Bland's features listed for curricular change (the closest feature is to ensure that the scope and complexity of the innovation is consistent with the curriculum). Perhaps this is because when academic leaders are instituting change, they are often not truly innovating, but implementing an innovation that has been invented elsewhere. In situations where the academic leader was instigating the innovation, the vision was clearly voiced and repeatedly expressed (26).

Table 3 *Five easily communicated outcomes*

	At the end of the curriculum the student can:
1	Explain pharmacological mechanisms of action;
2	Explain physiological/pathophysiological mechanisms of disease;
3	Critically analyze indications for drugs by comparing pharmacological and pathophysiological mechanisms;
4	Select drug therapy based on pharmacotherapeutic principles, and
5	Monitor drug therapy based on pharmacotherapeutic principles.

STEP 4: DEVELOPING A SUPPORTIVE COALITION. In the first step of the implementation process, those initiating the change should start to identify people who will help to promote the program. Bland et al. made it clear in their report 'Curricular Change: How to succeed…', that leadership is the most cited reason for either the success or failure of change management.

According to the business literature, a leader must be purposeful and adaptive (27), leading the change with insight into being able to alter the four organizational elements: formal structures, work processes, belief systems, and social relations (28). Bland felt that this was the reason that curricular change usually fell into the hands of those with leadership positions '...usually the dean, a senior faculty member with sponsorship of the dean, or a team of faculty representing the dean...' (10). However, according to Naylor in his review of leadership in academic medicine, managing knowledge workers requires inspiration, not supervision: 'Success is achieved by power of reason, not by reasons of power...Colleagues are influenced and persuaded, not coerced' (20). Thus, the change agents will have take on some qualities of a leader in order to drive the change forward, a challenge for which Naylor believes many are ill prepared. Several good resources are available to aid in this endeavour (29-32) and can be helpful to expand the teams array of leadership behaviours enhancing the likelihood of success (18). Lastly, both Bland and Kotter describe the most common pitfall of this step as not enlisting powerful enough people into the group. Although success is not dependent on the blessing of the top management, it certainly helps. Unfortunately for our group, the change was begun without support from the committee responsible for curricular change as they were trying to reduce educational hours in the pre-clinical curriculum. The new pharmacology education was therefore rolled out in a small number of courses with early-adopters with the philosophy was 'it's always easier to ask for forgiveness than permission' (33).

Implementing

There are three steps in the implementation phase which should be addressed in the appropriate order, but each step also needs to be constantly maintained throughout the phase.

STEP 5: COMMUNICATING THE VISION. The change agents need to continually and consistently spread the word with regard to the vision and strategies to others within the university. Here Bland suggests two clear methods for successful communication of the vision: face-to-face interactions and demonstrations of the teaching innovation (10). Selecting the right people to support the innovation should not be difficult if the change agents seek out those teachers who could be called 'early-adopters' according to the diffusion of innovations theory (34). Getting the right people lined up to embrace the change can be difficult, and perhaps more difficult in academia versus other organizations as academic physicians have a strong attachment to the legacy of the methods they use to teach. This is most probably due to the fact that their educational approaches are strongly attached to the knowledge they possess and their power is perceived to be lost with any decrease in knowledge. Academics are capable of seeing the value of change, but also may be more adverse to the possible threat it poses. Therefore, it is important to continue to motivate the early adopters with the types of reward that they seek: earned autonomy and public peer recognition (20) from the early successes described later in step six. In our example we first visited every course coordinator to offer our new teaching innovation to be used in their courses. Secondly, we chose the infection-method for spreading the education throughout the curriculum (i.e. wherever some course coordinator had heard good things about our methods, we would move in to transform their education). The thought was that the students who had been in a class with the new pharmacology content would move from one course to the next sharing their experiences and enthusiasm. However, this did not prove to be the case. We speculate that this process failed due to the persistent manner in which courses are taught in independent silos. Students approach each class as a new entity and see their role as passing the course before moving on to the next (35). Thus, we used our positive experiences with the early adopters (see step 6) to make modifications to our strategies and proceeded to make repeated visits to the remaining majority resistant to the change. Our goal was to have the number of courses utilizing our pharmacology content to grow to such a sufficient size that we could oppose any opposition that would develop in the future to thwart the change.

STEP 6: WORKING TO REMOVE THE OBSTACLES TO SUCCESS. Previously in the second step of this step-wise approach to managing change in a curriculum, the institutional factors that could hinder the success of the change effort were identified. During the implementation process, Kotter states that the change agents together with their supportive coalition should work to remove the obstacles to the transformation process, and encourage non-traditional ideas, activities and actions with regard to the innovation to foster it's acceptance (36). The top concern for every institution will be time. In the curricular change that Guze managed, she stated 'After all, the curriculum already is fixed in size, and any additional topic will mean that something else must give way' (37).

As to be expected, this can be the most exasperating step for instituting change, and it has been the step in which we have spent the most effort. In our example, we employed various techniques to empower the course coordinators to adopt the changes proposed. Most actions involved removing barriers where course coordinators perceived an extra time requirement. These included providing non-binding resources to the coordinators such as creating computer-based education methodologies for free according to the specifications of the coordinators, providing staff time to support the assessment of students learning of these methodologies, and creating and giving lectures on the topic of pharmacology in the course. We found that these commitments enabled us to introduce pharmacology

into the course and that the pharmacology remained even after our time commitments were greatly reduced.

STEP 7: DEMONSTRATING SUCCESS. In Kotter's '8 steps to Transforming your Organization' he states leaders should be planning for and creating short-term wins. Bland agrees with him. Her 'Features associated with enduring curricular change' include enlisting the participation of members of the institutional society, performing meaningful evaluations that enhance ownership of the project and finally rewarding those who participate in the innovation (10). So how can change agents within in a medical school environment reward those over the short term who have worked to implement the new strategies? In today's environment this is an easy task as there is increasing support for research into the effectiveness of educational interventions. For example, we measured the performance of students at baseline and have measured the effects of our efforts with a range of indices now accepted in the medical educational literature. In our experience, these types of wins only provide satisfaction for a job well done for the supportive coalition. Kotter missed the fact that these wins need to be communicated in a meaningful manner. Presentation of the research results will institute pride in the individuals involved. However, the presentation of research results at a national or international meeting does little to influence those working the problem back at the institution. One possible solution is to have course evaluation expanded beyond Likert scale based student evaluations and create opportunities for the presentation of meaningful data to curriculum committees (38). It is important to note that these short term wins will also be different from measuring the specific outcome of the innovation. For example we are unable to measure any change in the prescribing habits of physicians until a cohort goes through the curriculum and graduates, but we can show changes in teacher time, student use and effect on student's grades as a result of our pharmacology education.

Institutionalizing

STEP 8: SOLIDIFYING THE CHANGE TO THE POINT OF SUSTAINABILITY. Finally, in step 8 there is institutionalization of the new approach. At this point (perhaps after a few years of effort) any change could be considered the 'New way of teaching' according to Bland, but she does not provide any insights into the specific management of the institutionalization time period. Kotter, however, describes this step as the point of consolidating improvements and producing still more change. He warns that many change agents will try to declare victory too soon. We agree, as we have found that there is a big difference between a 'New way of teaching' and the 'Just the way we do things' culture described by Bland et al.. In his article, Kotter states that those who best communicate how the ways and means are linked to the results of the change will be most successful (36). In addition, the change needs to no longer be dependent on the leadership team, and the processes created by the change will continue even after those most identified with it move on. And this should be expected, as Hays mentions '- the people that negotiated the mission, designed the program and oversaw the pioneering phase – inevitably move on...seeking new opportunities for effecting change once the innovation is in place' (15). Also, if specific resources have been utilized in the implementation process, the innovator will need to shore up continued support from institutional leadership (38). It is in step eight that our example of changing pharmacology education currently resides. Although our strategies have been introduced throughout the curriculum, we are now working to change the systems, structures, and policies that are not consistent with our vision. People resistant to the change can seize upon any incongruency and lead the process down another path. For example, the effort to incorporate the new Bologna process (39) for harmonizing education throughout Europe has introduced a new hurdle to continuing our change process. The reason is that others were able to understand how our pharmacology education fit into the current curriculum, but question whether the methodologies are consistent with how the new bachelors and masters phases will be taught. Hence, we have plans to continue writing and promoting our vision for the time to come. It is still too early to determine how significant the impact will be, and thus the success. Our program has a lot of supporters, but as always, there are people trying to cling to the old way of teaching.

FINAL THOUGHTS

As our example of a cross-functional discipline has shown, cross-curricular educational changes can be initiated from within the ranks of the institution. We developed this new model for creating change as we felt it would be more appropriate than those written from an authoritative perspective. We hope that others who are in a similar position (i.e. poised to integrate a new educational process or method into the curriculum), can use the model and our experiences as a guide.

It is interesting to note that professional change managers from the business consulting profession claim that the best managers of change are those that remain objective. The stresses created from the small victories and set-backs experienced by the manager can often times inhibit the change effort and cause burn-out before the final step is reached. We need to remind ourselves of this risk as we manage change in the curriculum of medical schools. The teachers are very much aware of the potential outcomes and try to influence them. It is, therefore, imperative that a comprehensive assessment plan is simultaneously developed and followed along with the change program. Fortunately, the change agents often establish the need for

the change with data that could serve as a baseline for the outcomes that are be influenced and assessed. These outcomes can then be reassessed after the educational intervention has taken place, and they should be repeated over time and with each subsequent alteration based on the results. As an example, the TRC began by establishing that physicians associated with Leiden University did a poor job of communicating therapeutic information in referral letters, and correlated these results with the students' inability to do the same. We were able to introduce our educational changes in the curriculum based on the assumption that with increased knowledge and practice, medical students can improve their communication of therapeutic information. In the subsequent years, we have tracked both the teachers' adoption and students' use and learning of our new pharmacology learning strategies. When the data indicated a response less than we expected from either of these two constituencies, we altered our strategies for reaching them. However, what remains to be shown is that our original assumption regarding the relationship between knowledge and performance was correct, but this can only been shown when an entire cohort completes the curriculum.

Although managing the change process is laborious and a long if not continuous process, creating and communicating change should not be difficult for teachers who are accustomed to the task of educating young people to become professionals. It seems that managing change is much like teaching, as Goss states: 'Those who climb on the reinvention roller coaster are in for a challenging ride...Reinvention is a demanding up and down journey – an adventure, to be sure. And it is destined to be that way' (40).

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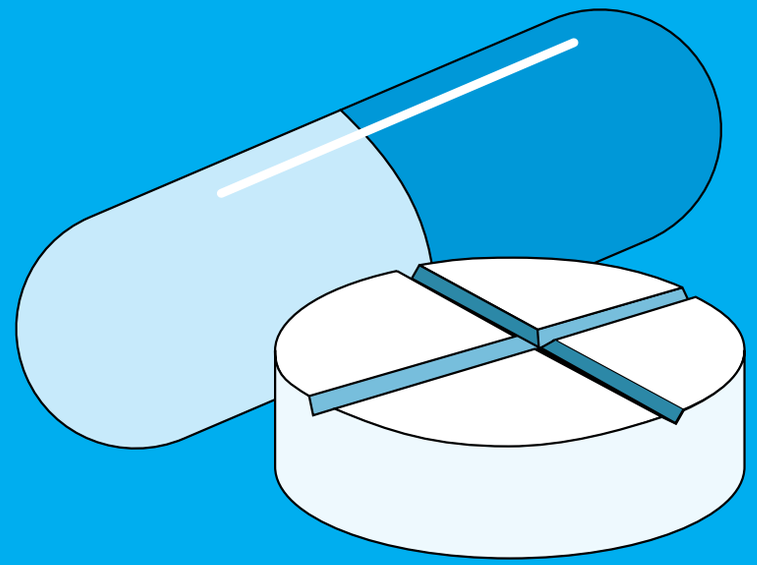
SUMMARY AND IMPLICATIONS

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



SUMMARY

The main objective of this thesis is to provide a conceptual framework for incorporating an educational innovation (a new approach to pharmaco-logy and pharmacotherapy education) in an integrated medical school curriculum. Medical school educational reform has fuelled the growing trend of curricular integration leaving some subjects like pharmacology and pharmacotherapy neglected. The hope is that with improved pharmacological knowledge and increased practice with making pharmacotherapy decisions, graduates of the Leiden University Medical Center (LUMC) will be better prepared to appropriately prescribe. The different chapters of this thesis describe the approach made by the Teaching Resource Center (TRC) to provide pharmacology and pharmacotherapy education to the LUMC. An attempt has been made to evaluate the impact of these educational strategies and interventions in a manner that goes beyond traditional assessment methods. Although not enough time has passed for a cohort of students to pass through an entire curriculum to make an assessment whether our graduates are better prescribers, the studies described in this thesis attempt to highlight both the positive and negative aspects of the approaches taken to reach this goal. This information can be used by other disciplines or institutions to assist in the introduction of a new learning strategy.

Evaluation of the environment at Leiden and in medical education

The introduction begins with a short history of pharmacological education both at Leiden University and abroad. The historical context is intended to provide the reader with a means to evaluate the environment in which our educational innovation took place. This is then followed by a discussion of three issues (competency development, curricular integration, and assessment) currently challenging medical education. The discussion provides further background information as to what the innovation attempted to achieve.

Determining the vision for integrating the pharmacological innovation

In chapter 1, the current curriculum at Leiden University Medical Center was reviewed and found to be compatible with the ability-based educational model. Five learning outcomes were established based on the following considerations:

1 what students are expected to be able to do upon completion of the curriculum;
2 what could be added to the current on-going curriculum and be viewed as relevant;
3 whether the outcomes could be taught, practiced, and assessed; and finally
4 what outcomes were consistent with the Dutch 'Training of Doctors: Blueprint 2001' for medical school education (1).

Two self-study learning strategies were developed that provided both the teaching material and training opportunities for students to realize the outcomes. The first is a computer-based teaching program that conveys pharmacology information (the TRC Pharmacology database). The second is a step-wise approach for creating a written therapy plan, the Individualized Therapy Evaluation and Plan or ITEP. Integration of the new pharmacology educational approach was planned to be a slow introduction into individual courses until all courses were adapted. At present more than 90% of identified courses and greater than 95% of the students in the curriculum use the TRC Pharmacology database, whereas 100% of students in 74% of identified courses have practiced making therapeutic plans with the ITEP.

Development and implementation of the pharmacology learning strategy: TRC Database

Chapter 2 begins with a review of the development of the TRC icon language which is used to create graphical descriptions of pharmacological mechanisms. Unfortunately, these illustrations were only provided in a loose-leaf format and were not being consistently used in the curriculum. The chapter provides a description of how a self-study computer program (a comprehensive database of the illustrations using the TRC icon language) provided pharmacological information throughout the curriculum. At the time of development, there were two major decisions to be made:

1 should individual students' use of the database be tracked, and
2 should the database be freely available on the internet?

It was decided to incorporate a so called 'back-end' to the database for recording student use and to place the TRC Pharmacology database on the web. These decisions provided the opportunity to see that students increasingly used the program over time (indicating they like using the database) and that their use (and the use by other universities) increased by offering it on the internet.

It was apparent from the results in chapter 2 that the students were using the TRC Pharmacology database, but were they learning anything from it? Chapter 3 takes advantage of the large amount of student utilization data to make unique assessments in terms of learning. Individual student use was compared to the final course grades and found an increase in TRC database use by an individual student was related with an increase in course grades without regard to student or course. The most encouraging result was the determination of an inverse relationship between the intercept (expected grade achieved if the student did not use the program) and

slope (the rate in rise of the course grade if use increased) of an individual student. This indicated that poor students benefit most from using the TRC database. Although it can be argued that there may be better assessments to use to evaluate student learning, course grades remain one of the strongest predictive factors for success on medical examinations. In addition, by continuously analyzing the utilization and performance of students using the program, improvements to the TRC Pharmacology database have been introduced in order to improve the students' learning efficiency.

Development and implementation of the pharmacotherapy learning strategy: ITEP

In order to create a pharmacotherapy learning strategy, we first did an assessment of the current practice of communicating a therapy plan in the local environment. This objective analysis was important since this aspect of the practice of medicine is often considered an art and thus susceptible to local dogma. Thus, this chapter describes the results of a survey of local physicians' abilities to communicate a therapeutic plan. The survey reviewed 80 letters written by specialists after a referral and assessed them based on local and international standards. As suspected, the letters were found to be deficient with regard to pharmacotherapy information (pharmacokinetic considerations, compliance, rationale of therapy, dosing regimen, or monitoring of effectiveness or side effects) by both assessments. There were also large differences in the manner in which the letters were written. It is possible to attribute these findings to the fact that the Netherlands does not have a standard format for developing and communicating a therapeutic plan. This is in contrast to the situation in the United States where the 'SOAP' (Subjective, Objective, Assessment and Plan) notes (2) are commonly used.

Using the information gleamed from chapter 4, a new format (the ITEP: Individualized Therapy Evaluation and Plan) for structuring pharmacotherapy plans was introduced into the LUMC curriculum. The ITEP method was created so that students could practice developing and writing a structured therapeutic plan. Chapter 5 describes the effect on student learning as the ITEPs were introduced into the curriculum. Comparisons were between cohorts of students just being introduced to the ITEP format and those who had multiple opportunities to practice earlier in the curriculum. Further comparisons were made between the students' ability to complete simple and complex pharmacotherapeutic cases. The results of the research indicate that after a short introduction, the students could use the ITEP and complete simple cases, but complex cases were too overwhelming. Many more students in the later cohorts, who had multiple opportunities to practice with the ITEP format, were able to complete the more complex case. These findings suggest that the ITEP should be introduced as early in the curriculum as possible to allow the student with multiple practice opportunities.

Getting the innovation integrated into the curriculum

The last chapter of the thesis describes the approach taken to get the above mentioned educational changes integrated in a mature medical curriculum. In contrast to most new educational efforts limited to one subject area, the changes mentioned in the previous chapters of this thesis had to be made in many courses across an integrated curriculum. This entailed a major curricular effort. A review of the literature with regard to integrating an educational innovation throughout a curriculum revealed that most major changes are coordinated by those high in the administration of the faculty. The literature also recommends that human resource departments should be involved, or that one needs to dedicate the necessary resources, in order to guarantee success. These sorts of recommendations would seem to indicate that an individual faculty member or department would find it difficult to undertake such a cross-curricular effort. Instead our experience shows us that there are other aspects that contribute to the success of curricular change. We demonstrated that one could focus on finding a small group of early adopters of the educational innovation and planning for small successes. By combining both literature resources and our experience, a new eight step process (with success factors identified for each step) was created to aid faculty members in getting their innovations into the curriculum.

IMPLICATIONS

In this thesis a process for incorporating pharmacology and pharmacotherapy education in an integrated curriculum is described and evaluated. This effort has resulted in a majority of courses and students at the Leiden University Medical Center using our educational strategy to improve pharmacological and pharmacotherapeutic knowledge and abilities. This represents the first time such an effort has been successful. In a recent report by Maxwell et al. the effort to get pharmacology incorporated across the curriculum was abandoned as '...it was too much effort, and too difficult to work with the various clinicians and scientists' (3). As a result, Maxwell et al. advocated the utilization of a self-study computer program called eDrug, using an approach much like the one described in this thesis (3). As stated previously in chapter 2, the TRC Pharmacology database is used by students from all the medical schools within the Netherlands and some access it from across the world. In addition, the illustrations created for the database are used in non-electronic media and are incorporated into three major

Dutch textbooks: Farmacologie [Pharmacology] by Sitsen (4), Algemene Farmacologie [General Pharmacology] by van Ree (5) and Leerboek Psychiatrie [Textbook Psychiatry] by Hengeveld (6).The TRC icon language also serves as the basis for the description of the mechanisms of action of new drugs in the Nederlands Tijdscrijft voor Geneeskunde [Dutch Journal of Medicine] (7). The use of the TRC Pharmacology database extends beyond the primary target group to include Dutch biomedical, biopharmaceutical, psychology and nursing students. Outside the Netherlands, the TRC database averages visits from 14 different countries each year. The result of this widespread use is an improvement in the program itself as collaborators often provide meaningful feedback that is unique to their point-of-view.

In contrast to the TRC database, the adoption of the ITEP learning strategy for creating a therapeutic plan has been mostly local. The ITEP format is used in the clinical courses as the method for practicing evaluating therapeutic options and creating a therapeutic plan. The clinical rotations of internal medicine and psychiatry have adopted the ITEP as the format for clerkship students to develop a therapeutic plan and to present to their mentors. The internal medicine department of the Leiden University Medical Center has gone so far as to alter the medical charts to allow for the ITEP s to be incorporated into the medical record. Currently the residents in internal medicine are receiving training in the use of the ITEP using a Train-the-Trainer model. Expansion into other departments has been limited by what has been deemed a lack of manpower to provide students with meaningful feedback.

In the fall of 2005 we made a proposal to a gathering of Dutch pharmacotherapeutic teachers to create a National standard for a therapeutic plan (8). The goal was to establish common outcomes for pharmacotherapy (in the form of a patient therapeutic plan) that would prepare students for their future tasks, and which could be assessed. After a series of sessions with this group, the proposal was accepted. This led to the development of the '6Step' treatment plan for use by all Dutch medical and pharmacy students (9). The various universities maintain the right to follow their own educational methods for pharmacotherapy, but all must converge on this agreed standard. It is fortunate that all have come to use an identical standard for this important educational outcome. As such, it will be easier to assess the educational strategies discussed in this paper as applied at Leiden University Medical Center against those implemented by other Dutch institutions.

FINAL THOUGHTS

Extensive efforts were made to systematically assess the students and teaching strategies detailed in this thesis. In order to evaluate the educational innovations we have chosen to follow the evaluation hierarchy as described by Kirkpatrick. The hierarchy assesses the power of the evaluation methods on four different levels. For example, on the first level only the student's reaction to the educational intervention is evaluated, whereas the implications that result from a change in students' behaviour are evaluated on the fourth. We have carefully considered these different levels when attempting to measure the influence of our innovation. Up to now, we have been able to evaluate up to level three: the effect of our educational intervention on the behavior of the students. But we are prepared to take the assessments further. For example, we will be able to measure if the physicians of the future are better able to document and communicate their therapeutic plans, as the current level of therapeutic communication by physicians in the community has already been established. Ultimately it is important to also evaluate the effects of our intervention on the fourth level. This unfortunately lays beyond our reach as much time must pass before we can determine if there are fewer admissions to hospitals secondary to medication errors, or if there is less money spent on inappropriate therapy, etc. The goal of our effects in the area of educational innovation should be to determine the impact of our strategies on the society at large.

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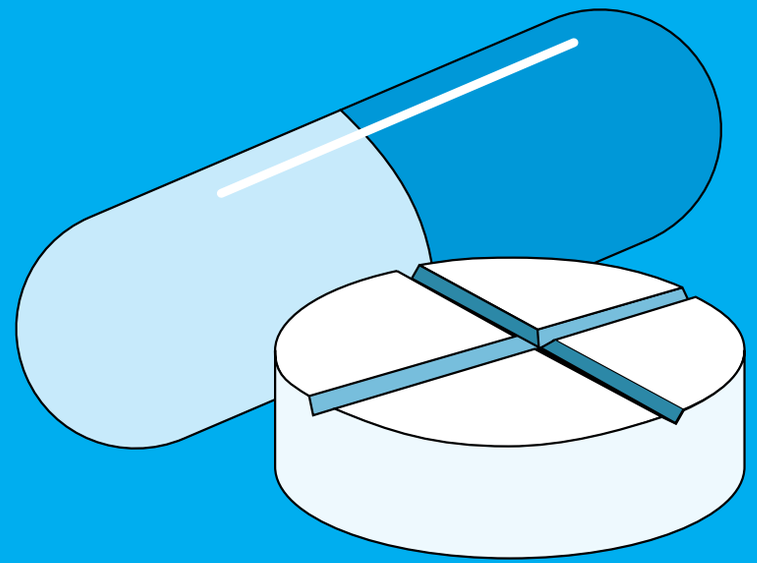
SAMENVATTING IN HET NEDERLANDS



SAMENVATTING

De conceptueel kunstenaar Damien Hirst gaf in zijn tentoonstelling 'New Religion' (2005) een controversiële kijk op het onvoorwaardelijke geloof in de geneeskunde en meer specifiek in de overtuiging dat pillen kunnen genezen. Ongetwijfeld werd hij daarbij geïnspireerd door het toenemende gebruik van geneesmiddelen zoals dat wereldwijd plaatsvindt. Ook in Nederland is het gebruik van geneesmiddelen de laatste jaren snel toegenomen. In 2006 werd een record bereikt van 5,9 recepten per Nederlander per jaar. De situatie dat meer geneesmiddelen worden voorgeschreven is niet zonder problemen. Zo is vastgesteld dat in de gehele westerse wereld fouten in de gezondheidszorg voor een groot gedeelte komen door medicijngebruik. Opvallend is dat de rol van voorschrijvende dokters hierbij een niet-te-verwaarlozen factor is. In Nederland heeft dit onder andere geleid tot rapporten van de Inspectie voor de Gezondheidszorg en publicaties in de media.

Het is dus van groot belang dat artsen meer dan ooit opgeleid worden om op een rationele en verantwoorde manier om te gaan met de medicijnen die zij willen gebruiken voor de behandeling van hun patiënten.

In dit proefschrift wordt een schets gegeven van het introduceren van een innovatie voor het onderwijs in de farmacologie en farmacotherapie. Deze innovatie vond plaats in het bestaande geïntegreerde medisch curriculum van het Leids Universitair Medisch Centrum (LUMC). In de verschillende hoofdstukken wordt de aanpak van het Teaching Resource Centre (TRC) uiteengezet, dat als voornaamste doel heeft het onderwijs in de farmacologie en farmacotherapie te ondersteunen. Daarnaast wordt beschreven op welke manier geprobeerd is studenten beter voor te bereiden op het nemen van farmacotherapeutische beslissingen.

Ook worden de resultaten beschreven van het onderzoek naar de effecten van de invoering van deze onderwijsvernieuwing. Daarbij werd ook gebruik gemaakt van andere dan de gebruikelijke methoden. Het onderzoek loopt nog niet lang genoeg om de effecten over een volledig curriculum te volgen. Het geeft wel inzicht in de positieve en negatieve aspecten van de invoering van de genoemde initiatieven. Deze informatie kan worden gebruikt bij de verdere invoering van de innovatie in het curriculum van het LUMC en is mogelijk een handreiking voor andere instituten en disciplines die onderwijshervormingen willen invoeren.

Evaluatie van de situatie in Leiden en in het medisch onderwijs: in het algemeen

De inleiding begint met een korte beschrijving van de geschiedenis van het onderwijs in de farmacologie zowel aan de Universiteit Leiden als in het buitenland. Met dit historisch overzicht kan de lezer zich een beeld vormen van de context waarin onze onderwijsinnovatie plaatsvond. Dit wordt gevolgd door een uiteenzetting van drie facetten die momenteel een concrete uitdaging vormen voor het medisch onderwijs namelijk: ontwikkeling van competenties, het aanbieden van een geïntegreerd curriculum en beoordeling van de studenten.

Visiebepaling voor de integratie van de farmacologische innovatie

In hoofdstuk 1 wordt een aantal kernaspecten van het curriculum van het Leids Universitair Medisch Centrum beschreven. Bij analyse hiervan blijkt dit aan te sluiten bij een op vaardigheden gebaseerd onderwijsmodel.
Er worden verschillende leerdoelen geformuleerd waarbij de volgende overwegingen belangrijk waren:

1. waartoe moet een student in staat zijn na het doorlopen van het curriculum
2. wat kan worden toegevoegd aan het huidige curriculum dat echt relevant is
3. kunnen de leerdoelen worden onderwezen, geoefend en beoordeeld;
4. zijn de leerdoelen in overeenstemming met de Nederlandse Raamplan 2001 Artsopleiding voor onderwijs aan de medische faculteiten.

Hiervoor werden twee zelfstudie-leerstrategieën ontwikkeld die studenten zowel het onderwijsmateriaal als de trainingsmogelijkheden bieden om deze doelen te realiseren. Het onderwijsmateriaal is een computerprogramma/database met essentiële farmacologische informatie die aansluit bij de fysiologie en de pathofysiologie zoals die voorkomt bij verschillende ziekten: de Teaching Resource Centre (TRC) Pharmacology database.

De training bestond uit het aanleren van een gestructureerde, stapsgewijze aanpak voor het maken van een behandelingsplan: 'de Individuele Therapie: Evaluatie en Plan' (ITEP). Het was de bedoeling de nieuwe onderwijsbenadering voor het onderwijs in farmacologie geleidelijk in te voeren in afzonderlijke onderdelen van het curriculum (blokcursussen) totdat alle blokcursussen waren aangepast.

Op dit moment wordt in meer dan 90% van de onderzochte blokcursussen in het curriculum de TRC Pharmacology database gebruikt door de docenten en door meer dan 95% van de studenten. Het maken van behandelingsplannen met behulp van de ITEP wordt door 100% van de studenten in 74% van de onderzochte blokcursussen gedaan.

Ontwikkeling en implementatie van de trc pharmacology database (leerstrategie farmacologie)

Hoofdstuk 2 begint met een bespreking van de ontwikkeling van de TRC -beeldtaal, die wordt gebruikt om farmacologische mechanismen grafisch weer te geven. Helaas werden deze afbeeldingen niet consequent gebruikt

in het curriculum. Het hoofdstuk beschrijft de manier waarop een computerprogramma voor zelfstudie (een volledige database van de afbeeldingen die de TRC -beeldtaal gebruiken) gedurende het gehele curriculum farmacologische informatie verschafte.
In de ontwikkelingsfase moesten er twee belangrijke beslissingen worden genomen:

1 moet het gebruik, door individuele studenten, van de database worden bijgehouden;
2 moet de database vrij toegankelijk zijn op het internet?

Er werd besloten een zgn. back-end database in te bouwen en om de TRC Pharmacology database op het web te plaatsen. Door de eerste beslissing werd genomen om het gebruik door studenten vast te leggen. Daarmee konden we vaststellen dat studenten het programma in de loop van de tijd meer gingen gebruiken. We denken dat dit een indicatie is dat de studenten de database graag gebruiken. Daarnaast bleek dat het gebruik van de database toenam (overigens ook door gebruikers verbonden aan andere universiteiten) vanaf het moment dat de database op het internet beschikbaar was.

De vraag of het intensievere gebruik van de database ook heeft bijgedragen aan een toename van de kennis van de studenten wordt behandeld in hoofdstuk 3. Daarin wordt beschreven hoe de gegevens over het gebruik door studenten door ons werden geanalyseerd om de leereffecten te beoordelen. Vergelijking van het gebruik door individuele studenten met de door hen behaalde eindcijfers voor een blokcursus laat een positief verband zien tussen toename van TRC database-gebruik en het behaalde cijfer voor de blokcursus. Het meest bemoedigende resultaat is de bevinding van de omgekeerde relatie tussen het intercept (het verwachte cijfer dat behaald zou worden als studenten het programma niet gebruikten) en de richtingscoëfficiënt (de mate waarin het cijfer steeg bij toenemend gebruik) bij individuele studenten. Dit geeft aan dat zwakke studenten het meest profiteren van het gebruik van de TRC Pharmacology database. Hoewel er ongetwijfeld andere manieren zijn om te beoordelen of studenten baat hebben bij de introductie van deze leermethode, is het onomstotelijk dat goede resultaten behaald voor de blokcursussen één van de sterkste voorspellers is voor het succesvol afleggen van het artsexamen. Bovendien zijn op grond van doorlopende analyses van het databasegebruik en de prestaties van studenten verbeteringen in de TRC Pharmacology database aangebracht om studenten te helpen om nog efficiënter te leren.

Ontwikkeling en implementatie van de ITEP (leerstrategie farmacotherapie)

Om een leerstrategie voor het onderwijs in farmacotherapie op te stellen deden we eerst onderzoek naar de toenmalige praktijk van het communiceren van therapieplannen tussen collega's. Deze objectieve evaluatie was nodig omdat we vaak stuitten op de opvatting dat het opstellen van een therapieplan als kunst wordt beschouwd.

In hoofdstuk 4 worden de resultaten beschreven van een onderzoek naar het vermogen van plaatselijke artsen om over een behandelingsplan te communiceren. Daartoe werden 80 brieven bestudeerd die waren geschreven door specialisten aan de verwijzer. De brieven werden beoordeeld op basis van lokale en internationale standaarden. De brieven schoten volgens beide beoordelingen tekort wat betreft wezenlijke farmacotherapeutische informatie (therapeutische overweging(en), dosering, controle van effectiviteit en/of bijwerkingen, farmacokinetische overwegingen, therapietrouw, etc.). Er waren ook opvallend grote verschillen in de manier waarop in de brieven een therapieplan werd beschreven. Wij vermoeden dat het aannemelijk is dat dit beide bevindingen te verklaren zijn omdat in Nederland geen standaard gebruikt wordt voor het ontwerpen en communiceren van het behandelplan voor een patiënt. Dit contrasteert met de situatie in de Verenigde Staten waarbij de zgn. 'SOAP notes' (Subjective, Objective, Assessment and Plan) algemeen worden gebruikt.

Op grond van deze informatie werd in het curriculum een nieuwe aanpak voor het ontwerpen van een farmacotherapeutisch plan de ITEP (Individuele Therapie: Evaluatie en Plan) geïntroduceerd. Deze ITEP -methode geeft de studenten de gelegenheid om te oefenen met opstellen van een gestructureerd en compleet behandelingsplan.

In hoofdstuk 5 wordt beschreven wat de effecten van de invoering van de ITEP waren. Er werd onderzocht of er een relatie is tussen de tijd van introductie van de ITEP in het curriculum en de kans dat studenten een geschikt behandelingsplan opstellen. Ook worden vergelijkingen beschreven tussen het maken van eenvoudige en complexe farmacotherapeutische casussen.

De uitkomsten van dit onderzoek suggereren dat het van essentieel belang is studenten zo vroeg mogelijk te laten oefenen met het ontwerpen van behandelplannen. Weliswaar is een korte introductie voldoende om eenvoudige casussen oplossen, maar dit is niet afdoende voor complexe casussen. In overeenstemming hiermee is de bevinding dat studenten die meerdere kansen hadden om te oefenen met ITEP, veel vaker complexere casussen tot een goed einde brachten.

Integratie van de innovatie in het curriculum

In het laatste hoofdstuk van dit proefschrift wordt beschreven hoe de bovenstaande veranderingen werden geïntegreerd in een bestaand medisch curriculum. In tegenstelling tot de meeste onderwijsvernieuwingen die gewoonlijk beperkt blijven tot één vakgebied, moesten de veranderingen in veel blokcursussen in een geïntegreerd curriculum worden doorgevoerd. Dit vereiste een grote operatie binnen het gehele curriculum.

Bestaande literatuur over de integratie van innovaties binnen een curriculum suggereert dat dit soort omvangrijke en/of wezenlijke veranderingen gewoonlijk worden gecoördineerd door leidinggevende personen in de faculteit. Verder wordt aanbevolen om bij dit type operaties ook ondersteunende diensten te betrekken om bijvoorbeeld voldoende menskracht en andere manieren van ondersteuning te waarborgen. De achterliggende gedachte voor deze aanbeveling is dat voor individuele docenten en/of vakgroepen vrijwel onmogelijk is om dit soort grote operaties vorm te geven.

Hoewel dit intuïtief waar is, leert onze ervaring dat andere aspecten minstens zo belangrijk zijn voor het welslagen van dit soort operaties. We betogen dat als geconcentreerd wordt op een kleine groep mensen die de vernieuwingen als eerste toepassen en op het behalen van kleine successen het zeer goed mogelijk is om majeure veranderingen door te voeren in een complex curriculum.

Op basis van deze ervaringen en gegevens uit de literatuur stellen we 8-stappenplan voor (met voor elke stap gedefinieerde succesfactoren) die mogelijk individuele docenten en/of vakgroepen kunnen helpen bij het implementeren van innovaties in een curriculum.

IMPLICATIES

In dit proefschrift wordt een proces beschreven voor het invoeren van een nieuwe aanpak voor het onderwijs in de farmacologie en farmacotherapie in een geïntegreerd curriculum. Ook worden de effecten van deze onderwijsvernieuwing geëvalueerd. De conclusie is dat onze inspanningen ertoe hebben geleid dat in de meerderheid van de blokcursussen en door vrijwel alle studenten aan het Leids Universitair Medisch Centrum onze onderwijsstrategie wordt gebruikt om farmacologische en farmacotherapeutische kennis over te dragen en te verwerven en kunnen studenten hun vaardigheden te verbeteren.

Zoals in hoofdstuk 2 aangegeven, wordt de TRC Pharmacology database gebruikt door studenten van alle medische faculteiten in Nederland en studenten in het buitenland. Daarnaast worden de afbeeldingen die voor de database zijn gemaakt gebruikt in niet-elektronische media en zijn ze opgenomen in drie belangrijke leerboeken in het Nederlandse taalgebied namelijk: ‘Farmacologie’ van Sitsen, ‘Algemene Farmacologie’ van Van Ree en het ‘Leerboek Psychiatrie’ van Hengeveld. De beeldtaal wordt ook gebruikt voor het beschrijven van het werkingsmechanisme van nieuwe geneesmiddelen in het ‘Nederlands Tijdschrift voor Geneeskunde’. Verder is gebleken dat naast de primaire doelgroep ook studenten van andere Nederlandse opleidingen de TRC Pharmacology database gebruiken. Dit betreft studenten die biomedische of biofarmaceutische wetenschappen studeren, maar ook studenten die psychologie of verpleegkunde studeren gebruiken de TRC Pharmacology database. Verder bleek dat de database gemiddeld door

personen uit 14 andere landen dan Nederland wordt bezocht. Vooral deze bezoekers geven vaak zinvolle feedback die uniek is voor hun vakspecifieke invalshoek.

In tegenstelling tot de TRC Pharmacology database wordt de ITEP -leerstrategie voornamelijk lokaal niveau gebruikt. De ITEP -formule wordt in de klinisch-georienteerde blokcursussen gebruikt als methode voor het oefenen van het evalueren van behandelingsopties en het opstellen van een behandelingsplan. Ook in de co-assistentschappen interne geneeskunde en psychiatrie is de ITEP ingevoerd als methode voor studenten om een behandelingsplan te maken en te bespreken met hun begeleiders. Deze invoering is niet beperkt gebleven tot de academische centra, maar wordt ook gebruikt in alle zgn. perifere ziekenhuizen. De afdeling interne geneeskunde van het Leids Universitair Medisch Centrum is zelfs overgegaan tot aanpassing van de lay-out van de medische statussen zodat de ITEP’s integraal kunnen worden opgenomen in het dossier. Ook worden momenteel arts-assistenten die in opleiding zijn tot specialist in de Interne Geneeskunde in het LUMC getraind in het gebruik van de ITEP. Uitbreiding naar andere afdelingen bleef beperkt vanwege een gebrek aan menskracht om de docenten voor te bereiden om samen met de co-assistenten de ITEP s te bespreken.

In het najaar van 2005 deden we een voorstel aan docenten die in Nederland verantwoordelijk zijn voor het onderwijs in de farmacotherapie om een nationale standaard voor een behandelingsplan op te stellen. Het doel was om gemeenschappelijke leerdoelen te formuleren voor de farmacotherapie (in de vorm van een patiëntbehandelingsplan) waarmee studenten goed worden voorbereid op hun toekomstige functie en die kunnen worden beoordeeld. Na onderling overleg werd ons voorstel door deze groep aangenomen. Dit heeft geleid tot een zgn. 6-stappen behandelingsplan voor het onderwijs aan alle Nederlandse studenten geneeskunde en farmacie. De verschillende universiteiten behouden uiteraard het recht om hun ‘eigen’ onderwijsmethoden te volgen om dit doel te bereiken. Verheugend is wel dat er een gemeenschappelijke en identieke uitkomstmaat is gedefinieerd die als eindterm voor het onderwijs in de farmacologie en farmacotherapie zal worden gebruikt. Daardoor zal het ook gemakkelijker worden de onderwijsstrategieën, zoals toegepast in het Leids Universitair Medisch Centrum, te beoordelen en te vergelijken met de strategieën die door andere Nederlandse instituten worden gebruikt.

EINDOVERWEGINGEN

In dit proefschrift is beschreven hoe twee onderwijsstrategieën zijn geïmplementeerd en is op een systematische manier het effect op de studenten voor wie het bedoeld was onderzocht. Voor het evalueren van de onderwijsvernieuwingen hebben we aansluiting gezocht bij de evaluatiemethoden zoals beschreven door Kirkpatrick. Met deze methode worden de effecten

van veranderingen op vier niveaus beoordeeld. In deze vier niveaus is een duidelijke hiërarchie; op het eerste niveau wordt alleen de reactie van de student beoordeeld en op het vierde niveau worden de implicaties van veranderingen in gedrag gemeten. Tot op heden hebben wij zorgvuldig deze niveaus gebruikt om de invloed van onze veranderingen te meten. Daarbij zijn we nu zover dat we de veranderingen in gedrag van de studenten meten. Ook hebben we de voorbereidingen getroffen voor verdere beoordelingen. We zullen namelijk gaan 'meten' of artsen in de toekomst beter hun behandelingsplannen documenteren en communiceren.

Uiteindelijk is het natuurlijk van belang ook de effecten op het vierde niveau vast te stellen. Helaas blijft dat buiten ons bereik omdat er veel tijd moet verstrijken voordat het mogelijk is om vast te stellen of er bijvoorbeeld minder opnames in het ziekenhuis plaatsvinden door vermijdbare fouten in het voorschrijven van medicatie, of er minder geld wordt besteed aan nutteloze geneesmiddelen, etc. Immers dat moet het einddoel zijn van al onze inspanningen op het gebeid van onderwijsinnovatie.

CURRICULUM VITAE

Kari Lanette Franson was born in Sacramento, California, United States on August 18th 1964. A Doctor of Pharmacy degree was conferred to her from the University of California, San Francisco in 1991. She then trained at the University of Illinois, Chicago Hospital and Clinics as a resident in Adult Internal Medicine in 1992 and completed a fellowship in Clinical Research/ Drug Development in 1993. Subsequently she moved to Saint Louis Missouri and held joint appointments as an Assistant Professor at the Saint Louis College of Pharmacy and Saint Louis University School of Medicine Department of Psychiatry. In 1996 she became a Board Certified Psychiatric Pharmacist. In 1997 she moved to California and became an Associate Professor of Pharmacy Practice at Western University of Health Sciences, Pomona and a Clinical Associate Professor of Geriatrics at the University of California, Irvine School of Medicine.

After moving to the Netherlands in late 2000, she became a senior clinical research scientist and the project coordinator of the Teaching Resource Centre at the Centre for Human Drug Research (CHDR) in 2001. She was registered as a Clinical Pharmacologist with the Dutch Society in 2006. The research described in this thesis was performed at the CHDR and Leiden University Medical Centre. She currently holds a position as Director of Education at the CHDR, and as an Associate Professor in association with the Department of Medicine at Leiden University Medical Centre.

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It is important to remember that the work of the TRC encompasses the efforts of more than just myself, and thus, I wish to acknowledge first and foremost that none of this would have been possible without my TRC colleagues.

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There would have been no integration of pharmacology into the curriculum without the support of those associated the LUMC itself. I remember the first faculty meeting I attended as I was surprised by the 'chronologically-endowed' faculty. It appeared that introducing E-learning to this group would be difficult. But the block committees associated with geriatrics, infectious diseases, and respiratory medicine had people with the necessary 'early adopter' mentality to use the E-learning TRC Pharmacology database and provide meaningful feedback during development. With the introduction of the ITEP -formatted therapy plans, once again the geriatrics block committee stepped forward to be a guinea pig. Now that our learning strategies are spread through the curriculum, there are truly countless people to thank for their collaboration and support. No one would have ever seen our TRC or ITEP computer-based learning strategies if it were not for the creative IT support from Andries de Man.

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