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

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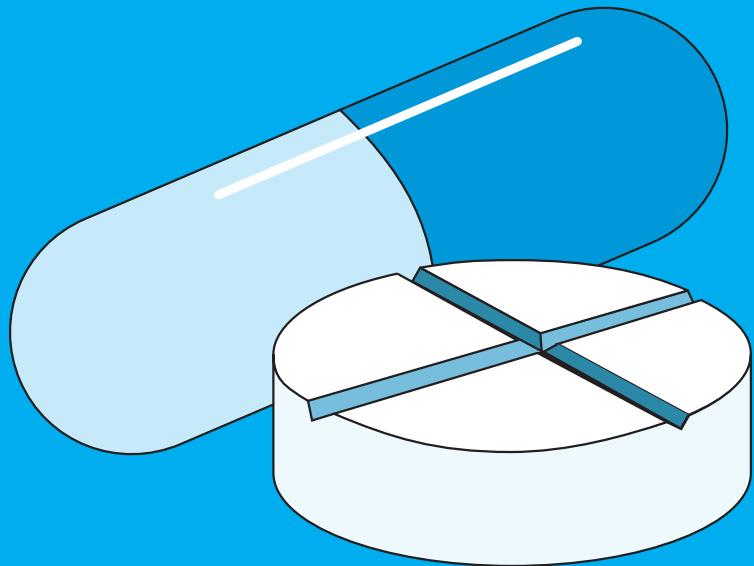
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INTRODUCTION

Provision and assessment
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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



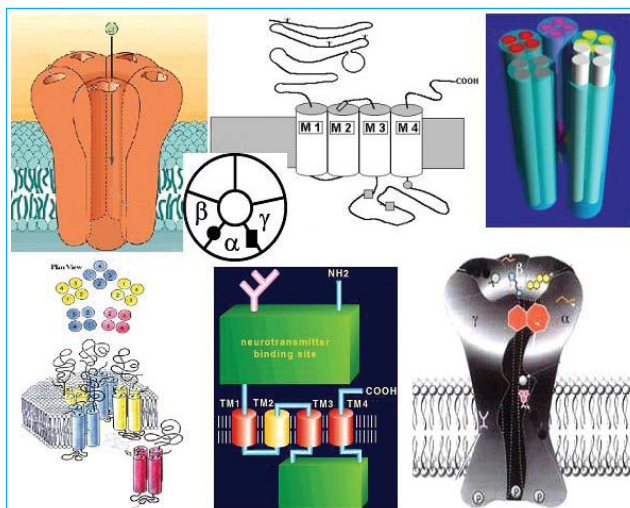
Pharmacology courses became lecture and laboratory practicum intensive with demonstrations of drug actions in either tissue or entire animals (8).

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 sheer 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

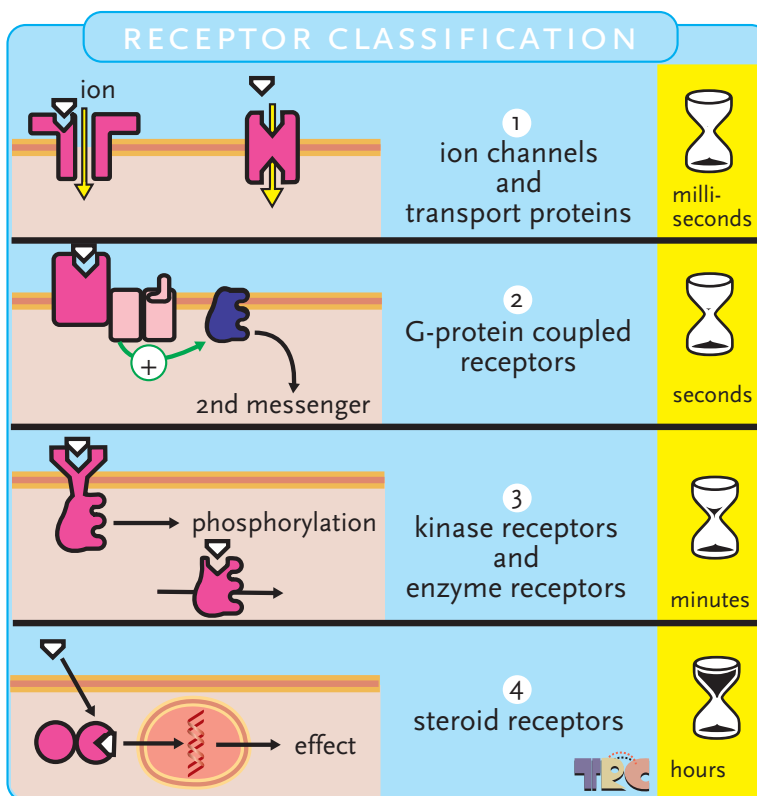
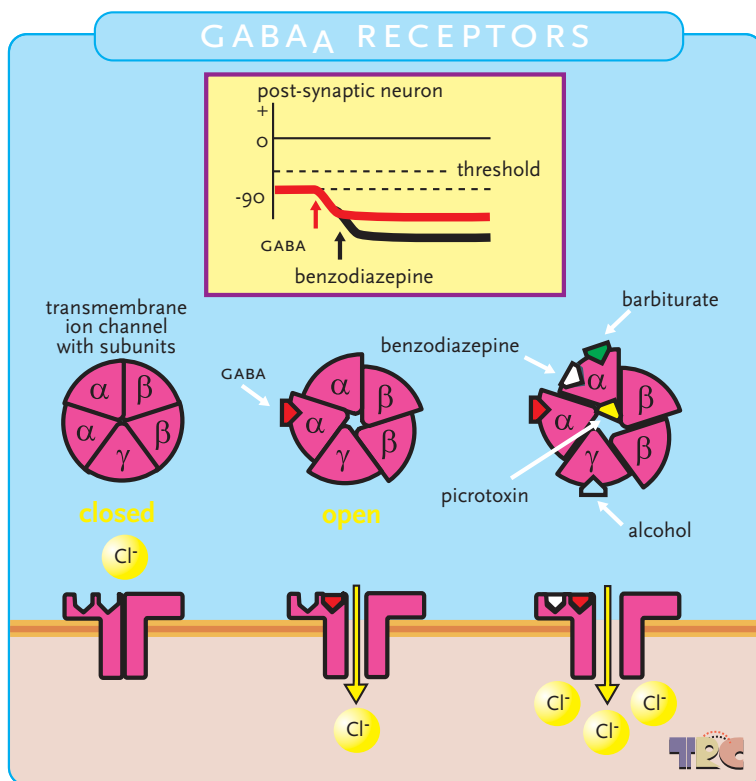


Figure 2-b

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 it is 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 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)



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



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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