Making better prescribers during a context-based pharmacotherapy learning programme

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Summary and General discussion

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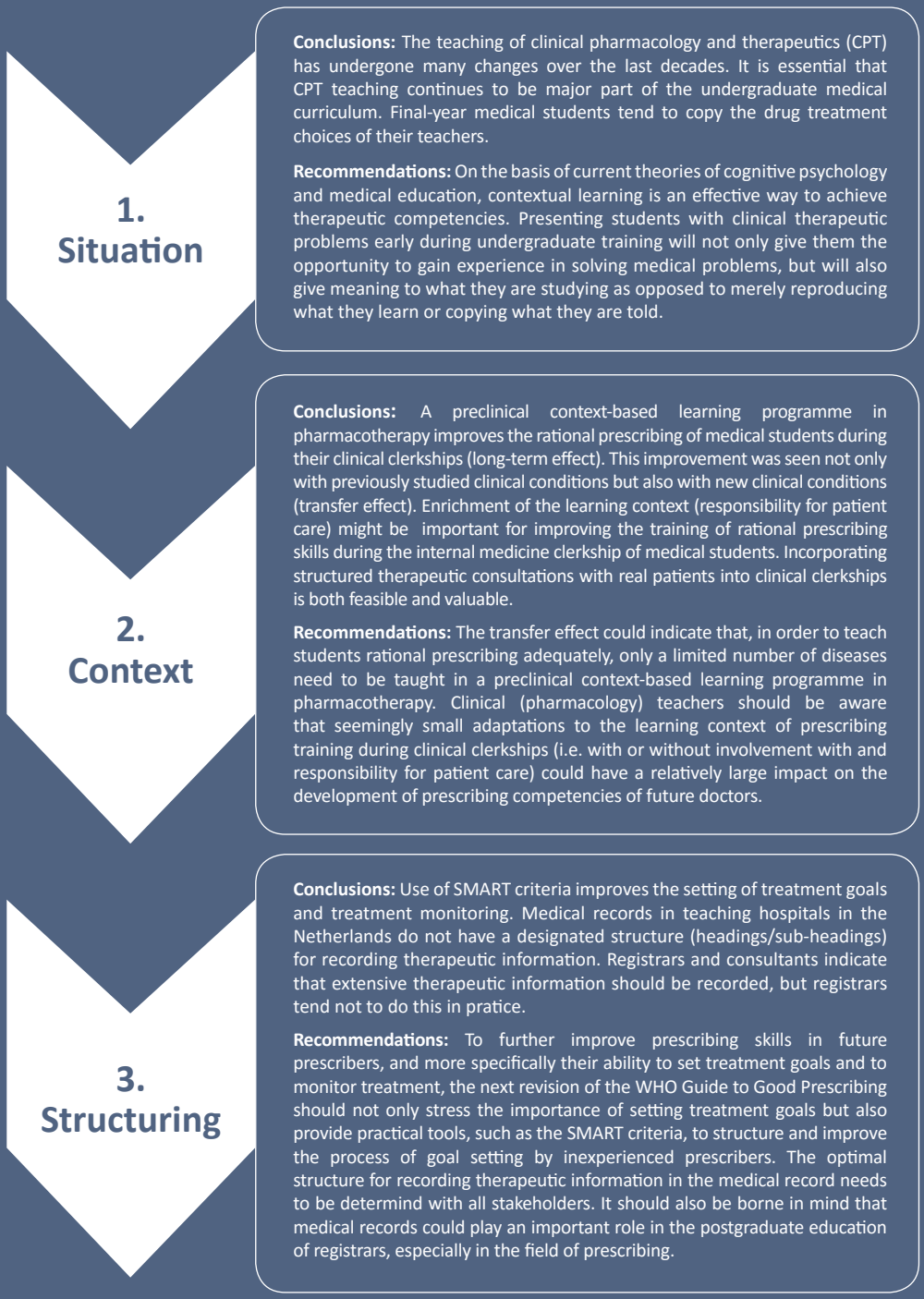

Figure 1 | Summary of conclusions and recommendations of this thesis

1. SUMMARY

Doctors should be able to prescribe rationally, and this is especially true for junior doctors, who are responsible for the bulk of prescriptions for patients in hospital.[1-3] Therefore, medical curricula should prepare undergraduate medical students for this important and difficult task. However, many studies have reported that junior doctors feel particularly unprepared for their new and challenging prescribing responsibilities.[4-10] Furthermore, according to their clinical teachers (i.e. consultants and specialist registrars), first-year junior doctors in the UK 'were deemed not well prepared for prescribing'. [11] Moreover, a study from 2015 showed that junior doctors (one or two years in training) were more than twice as likely to prescribe erroneously than more experienced medical consultants. [3] This is consistent with an error rate of up to 10.3% of medication orders made by junior doctors reported in the Equip study in 2009.[1]

Several studies have reported that medical graduates considered that their undergraduate education did not prepare them sufficiently for their prescribing responsibilities as junior doctors.[7;12-14] The Equip study suggested that educational innovations should be introduced to ease the transition from non-prescriber (undergraduate student) to prescriber (junior doctor), as a way to reduce the prescribing errors of junior doctors.[1;15] Unfortunately, little is known about what these innovations should be in practice. Two reviews [16;17] suggested that there is a strong need for explorative studies on which to base the design of curricula for teaching and training prescribing skills. McLellan et al. suggested that the way forward for teaching prescribing skills is to design interventions based on a real-life context. [18] Medical students should be observed and evaluated in the context of their future workplace. In order to develop an understanding of what works and under which conditions, we need to investigate educational interventions that encourage the development of expertise in rational prescribing.[18]

This was the motivation for the studies described in this thesis, the main objective of which was "to investigate and explore the possibilities of improving the rational prescribing behaviour of medical students in a context-based pharmacotherapy learning programme based on the WHO 6-step method". The following research questions were derived from this main objective:

1. What is the current **situation** regarding the development of clinical pharmacology and therapeutics (CPT) education and are there differences in the therapeutic decision-making process of inexperienced and experienced prescribers?
2. Does a preclinical **context-**based pharmacotherapy learning programme have a long-term and transferable effect on the rational prescribing competencies of medical students? What is the influence of the level of realism of the learning **context** during clinical clerkships on the prescribing competencies of medical students, and is it feasible to incorporate structured therapeutic consultations with real patients into clinical clerkships?
3. Does further **structuring** of one of the steps of the WHO 6-step method (treatment goal) affect the prescribing skills of medical students? To what extent are medical records structured for therapeutic information in teaching hospitals in the Netherlands, which therapeutic data do registrars and clinical consultants consider important to record in the medical record, and to what extent do registrars record this information themselves?

This chapter summarizes and discusses the answers to these questions, placing them in a broader perspective. Figure 1 shows the main findings and recommendations. On the basis of the current literature and the findings of this thesis, we also present a composite theoretical/conceptual model which describes the relationships between the normative rational pharmacotherapeutic process in clinical practice (WHO 6 step), therapeutic reasoning (by experienced and non-experienced prescribers), and context-based learning, a model which can form the basis for future research and educational innovations. We conclude this chapter with some practical implications and future perspectives, based on our findings.

Situation

Chapter 2

In order to describe the current situation in clinical pharmacology and therapeutics (CPT) education, we reviewed the literature on CPT teaching of the last 40–50 years, with emphasis on the therapeutic reasoning of undergraduate medical students. The rational prescribing of drugs is an essential skill that medical doctors should have acquired by the time they practise medicine. Clinical pharmacologists have an important role in the development of these skills, by teaching undergraduate medical students CPT. Even though CPT teaching has undergone many changes over the last decades, it is essential that it continues to be a major part of the undergraduate medical curriculum. This chapter describes the learning objectives for teaching therapeutic knowledge and skills to undergraduate medical students, with emphasis on therapeutic decision-making. Subsequently, on the basis of current theories of cognitive psychology and medical education, context-based learning is presented as an effective way to teach/train therapeutic skills. Lastly, an example of a CPT curriculum is presented.

Chapter 3

In order to investigate possible differences in the therapeutic decision-making process of inexperienced and experienced prescribers, we performed a nationwide study of the therapeutic decision-making process of medical students and their teachers (GPs and clinical specialists). We found that medical teachers mainly based their drug choice on clinical experience and drug-related factors, whereas final-year medical students mainly based their drug choice on examples provided by their medical teachers. It is therefore essential that medical teachers clearly explain to their students how they arrive at a specific drug choice since medical students tend to copy the therapeutic drug choices of their teachers, mainly because of a lack of experience. Presenting students with clinical therapeutic problems early during undergraduate training will not only give them a chance to gain experience in solving medical problems, but will also give meaning to what they are studying, as opposed to merely reproducing what they learn or copying what they are told.

Context

Chapter 4

In order to investigate whether a preclinical context-based learning programme in pharmacotherapy has a long-term and transferable effect on the rational prescribing competence of medical students, we performed an observational study during the clinical phase of the medical curriculum. A large group of students followed the entire programme (n = 197), a control group did not follow the programme (n = 33), one group followed the programme for one year, and another group followed

the programme for two years. Preclinical pharmacotherapy context-based learning was found to improve the rational prescribing of medical students during their clinical clerkship in internal medicine (long-term effect). This improvement was seen not only for the clinical diseases taught during the pharmacotherapy curriculum, but also for other diseases. This implies that students not only remember the specific information they have learned during training but are also able to apply the acquired skills to new situations (transfer effect).

Chapter 5

In order to explore the possible effect of the level of realism of context-based learning on the prescribing competence of medical students during clinical clerkships, we investigated, in an exploratory study, the optimal learning context for prescribing competencies in the clinical phase of the medical curriculum. We found that increasing the realism of context-based learning improved the rational prescribing skills of medical students during their clinical clerkship in internal medicine. Clinical (pharmacology) teachers should be aware that seemingly small adaptations to the learning context of prescribing training during clinical clerkships (i.e. with or without involvement in and responsibility for patient care) might have a relatively large impact on the prescribing competence of future doctors.

Chapter 6

We studied the feasibility of incorporating structured therapeutic consultations into the clinical clerkship internal medicine. These consultations were considered feasible if students were able to draw up a therapeutic plan and carry out a consultation, and if students and their supervisors considered therapeutic consultations workable and useful. This study showed that incorporating a structured therapeutic consultation with a real patient into the clinical clerkship internal medicine was both feasible and valuable. This may be an important step to improving the prescribing skills and attitudes of junior doctors and residents and to reducing their prescribing errors after graduation.

Structure

Chapter 7

In order to study the effect of further structuring of one of the steps of the WHO 6-step method (treatment goal) on the prescribing skills of medical students, we performed a prospective, randomized controlled minimal intervention study with one control and two intervention groups (WHO group and SMART group). Second-year medical students were asked to complete a WHO 6-step treatment plan for four written case reports of patients with asthma. The treatment plans were assessed using a standard scoring sheet developed by a Delphi procedure among respiratory physicians from all eight university medical centres in the Netherlands. Use of the SMART criteria improved the ability of students to set treatment goals and to monitor treatment. Better setting of treatment goals was associated with better treatment monitoring. SMART criteria might be an effective way to improve the setting of treatment goals and could be included in the next edition of the WHO Guide to Good Prescribing.

Chapter 8

Lastly, to investigate to what extent medical records are structured (i.e. preformatted with relevant headings) in terms of therapeutic information, which therapeutic data registrars and clinical consultants consider should be recorded, and to what extent registrars record this information themselves, we carried out a multicentre observational study in the internal medicine outpatient

clinic of five teaching hospitals in the Netherlands. What was considered relevant information and actual recording of therapeutic information were compared with the information provided for a reference list of 35 therapeutic items based on the WHO Guide to Good Prescribing (e.g. drug name, drug dosage, indication for drug, check for contraindications). The structure and content of current paper and electronic medical records was found not to be adequate. While both registrars and consultants agreed on the importance of recording most of the 35 therapeutic items, registrars failed to record most of this information in practice.

2. COMPOSITE THEORETICAL MODEL OF (PHARMACO) THERAPEUTIC PRACTICE, REASONING, AND LEARNING

In order to improve our understanding of successful educational strategies to ease the transition from medical student to junior doctor with regard to prescribing responsibilities, we need to broaden the way we look at CPT teaching. Prescribing is a complex task in which doctors need to combine various high-level cognitive processes. We argue that the development of successful strategies to teach prescribing is more complex than just providing a 6-step normative model of therapeutic reasoning (WHO 6 step). We think that, in addition to the WHO 6-step model, a strategy for teaching prescribing should incorporate the hypothetical model of therapeutic reasoning and the concept of contextual learning. Such a strategy or model could serve as a framework for future research and educational innovations. It would combine current knowledge of the normative WHO 6 step model, knowledge (and hypotheses) of the differences in therapeutic reasoning between experienced and inexperienced prescribers, and knowledge of essential components of the learning context. This type of composite model would enable us to understand the relationship between those three (hypothetical) models.

Description of the three individual models

Model 1: WHO 6-step

The WHO 6-step method is a normative model for therapeutic reasoning and prescribing and provides a six-step guide to the process of rational prescribing (see table 1). All six steps are partly based on the core learning objectives formulated by Nierenberg and Walley, namely, knowledge, skills, and attitudes.[19;20] The six steps are: Step 1, define the patient's problem; Step 2, specify the therapeutic objective; Step 3, choose a (drug) treatment, taking all relevant patient characteristics into account; Step 4, "write a prescription;" Step 5, give information to the patient; and Step 6, take monitoring measurements. After step 6, the therapeutic process begins again after monitoring results have been obtained. The WHO 6-step method is used worldwide, [16;21;22] and in all eight medical schools in the Netherlands,[23] to stimulate the rational prescribing of medication. The WHO 6-step has been shown to improve prescribing.[16;22]

Table 1 | World Health Organization 6-step model of rational prescribing [24]

Steps	Description
Step 1	Define the patient's problem
Step 2	Specify the therapeutic objective
Step 3a	Choose your standard treatment (P-drug)
Step 3b	Verify the suitability of your treatment (P-drug)
Step 4	Start the treatment
Step 5	Give information, instructions and warnings
Step 6	Monitor (and stop?) treatment

Model 2: Therapeutic reasoning

Given the similarities between therapeutic and diagnostic reasoning, it is possible to construct a hypothetical model of therapeutic reasoning (Figure 2).[25;26] Once the diagnosis has been established, one or more treatment scripts will be called up from memory. In order to determine the right treatment and based on the amount of experience the doctor has, an analytical or non-analytical process will start. This process is similar to the process of diagnostic reasoning. The chosen treatment and its effect will contribute to the modification of the existing treatment scripts or may result in a new treatment script. In psychological studies of judgement and choice, the non-analytic and analytic processes are termed system 1 (non-analytical) and system 2 (analytical), respectively. [27;28] Experts often make decisions based on the non-analytical system 1, which is characterized by fast, unconscious, intuitive, experience-based, effortless, and implicit judgements governed by habit and recognition. [25;27] In contrast, non-experts often make decisions based on the analytical system 2, which is characterized by the fact that it is slow, conscious, systematic, theory-based, effortful, and explicit. [25;27]

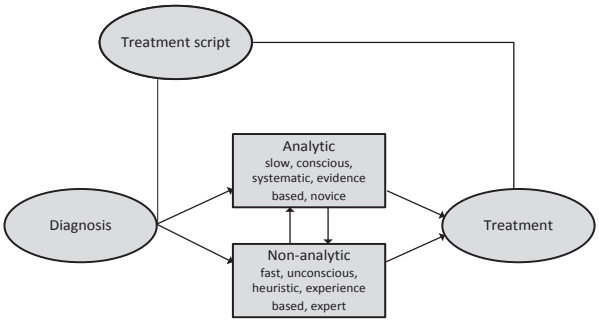

Figure 2 | Hypothetical model of therapeutic reasoning [25;26]

Model 3: Contextual learning

Contextual learning is defined as learning in a setting that is similar to the setting of the future profession.[29] Gaining and simultaneously applying knowledge in practice is essential for learning (figure 3). In many ways, contextual learning seems to be more effective than sequential learning, in which learning and applying knowledge are distinct activities.[30;31] The greater effectiveness of contextual learning can be explained in terms of cognitive psychology and medical problem-solving theory,[30;32] by which the way in which knowledge is stored in the brain is essential for its recall and application. Therefore, storing knowledge in combination with the situation in which this knowledge will be applied benefits the speed and quality with which the information is recalled.[30;33;33]

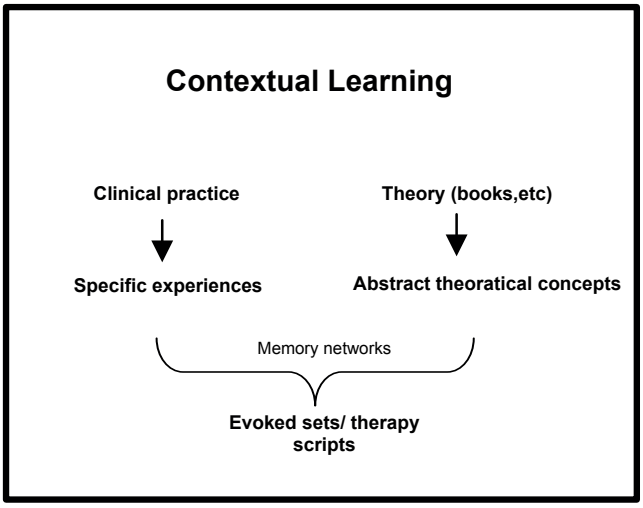

Figure 3 | Model of contextual learning in which knowledge is gained and at the same time applied in clinical practice

Description of our composite theoretical model

Drawing on the literature and our findings, we developed a composite theoretical/conceptual model (figure 4) that describes the relationships between the normative rational pharmacotherapeutic process in clinical practice (WHO 6 step), therapeutic reasoning (in experienced and non-experienced prescribers), and contextual learning. With minor modification of the three hypothetical models, the composite model provides insight into the relationship between the three (hypothetical) models and can form a framework for future research and educational innovation.

Modifications and new insights based on this thesis

Normative therapeutic process (WHO 6 step) (yellow box)

The horizontal core of the composite model consists of model 1, the WHO 6-step (yellow box), which describes the normative pharmacotherapeutic process in clinical practice.[24] As described earlier, inexperienced prescribers as non-experts make therapeutic decisions based on a slow analytical process of reasoning. However, our brains always try to create shortcuts to make decision-making easier and faster. This is perfectly illustrated by the findings presented in chapter 3, which showed that during clinical clerkships students tended to copy the therapy choices of their clinical teachers

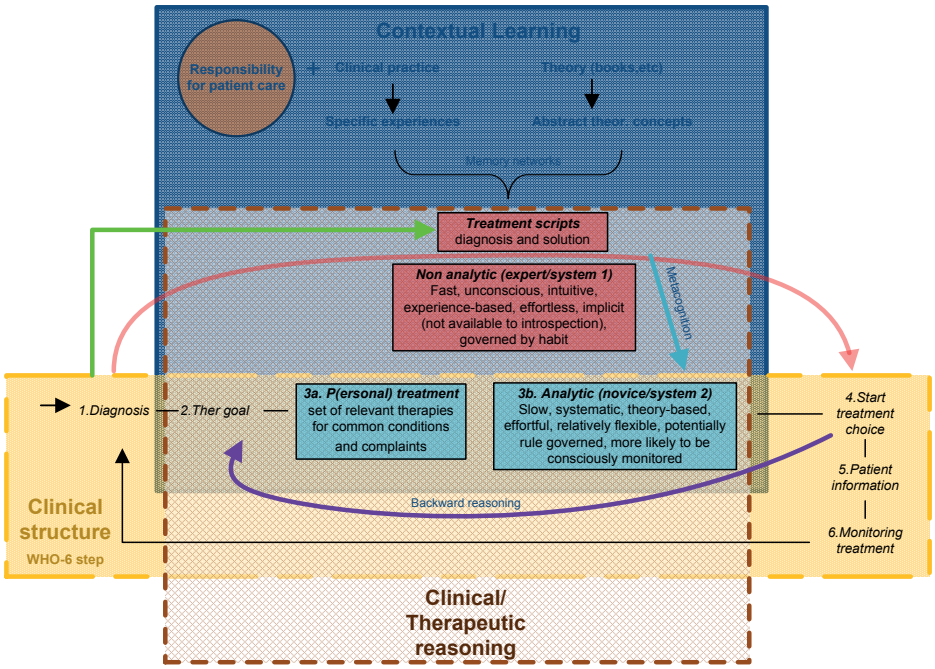

Figure 4 | Current understanding of how students and junior doctors learn to prescribe drugs can be summarized in a composite model based on three separate models, namely, the normative rational pharmacotherapeutic process in clinical practice (WHO 6 step), therapeutic reasoning (in experienced and non-experienced prescribers), and contextual learning

as a way to creating a shortcut in the therapeutic process. Although this might speed up the therapeutic process, it might be dangerous if students do not know the reason why a specific therapy was chosen and could lead to inappropriate therapeutic decisions when students treat new patients with the same disease but with other patient characteristics (such as age, pregnancy, comorbidity, and comedication) in the future. It is essential that clinical teachers clearly explain why they chose a specific treatment, so as to prevent students from storing incorrect or incomplete treatment scripts in their memory. Experts may find it difficult to explain the arguments underlying their therapy choices because they probably made their decision unconsciously and non-analytically. This problem might be resolved by using the *'backward reasoning'* technique, whereby experts try to formulate and reconstruct the arguments for their decision afterwards. '*Backward reasoning*' has been added to the composed model as a purple arrow (figure 4). Another way to prevent copying behaviour is to present students with clinical therapeutic problems early during undergraduate training (for example, role play sessions), to give them a chance to gain experience in solving medical problems.

In the study presented in chapter 4, we found that a preclinical training programme based on the WHO 6-step method not only had a short-term effect directly after programme completion [34] but also had a *long term and transfer effect* – the improvement in rational prescribing persisted during

ensuing clinical clerkships (long-term effect), showing that students could apply this ability to new clinical situations (transfer effect).

Lastly, the studies described in chapters 6 and 7 showed that providing *additional structure*, for example, SMART criteria in treatment goal setting (step 2 of the WHO 6 step) and structuring the recording of therapeutic information in the medical record, might facilitate the pharmacotherapeutic reasoning of inexperienced prescribers in clinical practice.

Therapeutic reasoning (brown box)
The first minor but important difference in the composite model compared with the earlier described hypothetical model of therapeutic reasoning (figure 2) is that 'P(ersonal) treatments' are specifically linked to analytical system 2, and '*treatment scripts*' to the non-analytical and intuitive system 1. In the hypothetical model of Bissessur et al,[25] treatment scripts are linked to both systems. However, a 'treatment script' can be defined as the intuitive recognition of a combination of diagnosis, specific patient factors (e.g. age, comorbidity, etc), and the best pharmacotherapy in that specific situation/case. Therefore, treatment scripts do not fit in the analytical system in which therapeutic options are explicitly compared to each other. This is in line with previous psychological research on the intuitive decisions taken by experienced decision-makers working under pressure in real-life situations (fire commanders, paramedics, and others making split-second decisions on the job).[35] These studies show that experienced decision-makers rarely need to choose between options because in most cases only a single option (solution) comes to their mind.[27;35] Although it has not been studied extensively,[36] we have no reason to believe that the situation is different when doctors make intuitive therapeutic decisions.

As our brains have a limited overall capacity for mental effort, intuitive decision-making is essential to enable a person to function in a professional environment with complex tasks that need to be performed under time pressure. Moreover, it has been argued that skilled decision-makers often do better when they trust their intuition than when they engage in slow analytical reasoning processes.[27;37] However, intuitive decision-making is not always flawless and is sometimes influenced by cognitive errors or bias.[38;39] Therefore, one of the important tasks of system 2 (effortful) is to monitor the quality of both systems, including the correction of cognitive errors.[27;40;41] In cognitive psychology, this process of monitoring is known as *metacognition* (added to our model and indicated with a blue arrow between system 1 and 2) [17;42] or 'slowing down when you should'.[17;43]

Being aware of the characteristics of systems 1 and 2, it is of course the question whether pharmacotherapy education should focus on system 1 or system 2. We, as well as McLellan et al, argue that medical education should ensure that students become, as much as possible, experts in prescribing before they enter medical practice.[17] Until now, most pharmacotherapeutic educational interventions have focused on the development of analytical reasoning processes (system 2: slow, conscious, systematic), for example as part of the worldwide used WHO 6-step method,[16;22;24] instead of focusing on creating the learning conditions that support and accelerate the acquisition of therapeutic reasoning as an expert.

Contextual learning (blue box)

The contextual learning framework is ideal for understanding which learning conditions encourage the development of expertise (i.e. rich and easily accessible treatment scripts). As described in chapter 5, context is much more than just the physical environment in which learning takes place, and (clinical) teachers can enrich the learning context with subtle adjustments. For example, as illustrated in figure 4 by the green arrow (between the WHO 6 step and the treatment scripts), one way to create treatment scripts is by the frequent training of prescribing skills (e.g. during role play sessions) and thereby analytical completion of the WHO 6-step process. However, we argue that the most effective way to create rich and easily accessible treatment scripts is by training in real practice with *real responsibility for patient care* (added to the contextual learning model). In chapter 5, we described the added value of this real responsibility during the clinical training of prescribing skills. Finally, in chapter 6, we showed that incorporating structured therapeutic consultations with real responsibility for patient care into the clinical clerkships is both feasible and valuable.

Conclusion

The overlap of the three models shows that treatment scripts and P-(ersonal) treatment play a crucial role in how a student learns to choose a treatment for individual patients, both analytically and non-analytically. We argue that the most efficient way to develop rich and easily accessible treatment scripts is by gaining experience in prescribing in real clinical practice as early as possible during medical training. Teachers should be aware that seemingly small adaptations to the learning context of prescribing training during clinical clerkships (i.e. with or without responsibility for patient care) could have a relatively large impact on the development of prescribing competencies. Medical education should promote the development of students' prescribing skills and competence as early as possible, at least by the end of the undergraduate curriculum, because recently graduated doctors write a large proportion of prescriptions in hospitals. This requires rich and easily accessible therapy scripts, which can only be achieved by gaining experience in prescribing for real patients.

3. PRACTICAL IMPLICATIONS AND FUTURE PERSPECTIVES FOR EDUCATION (IN CLINICAL PRACTICE), RESEARCH, AND ORGANIZATION

The studies described in this thesis investigated the possibilities of improving the rational prescribing of medical students by means of a context-based learning programme in pharmacotherapy based on the WHO six-step method. Many of the studies highlighted the importance of understanding successful contextual educational strategies and differences in the therapeutic reasoning of inexperienced and experienced prescribers, in order to ease the transition from medical student to junior doctor with regard to prescribing responsibilities. We conclude the thesis with a summary of the practical implications and future perspectives of our findings for CPT education (in clinical practice), research, and organization.

Education

1. Clinical teachers should be aware that medical students copy their drug choices during clinical clerkships. Teachers should therefore explicitly discuss the arguments underlying their choice of drug, even though as experts they probably did not make their choice consciously or analytically. Backward reasoning might help them to explain their 'intuitively made' choices to students. This can ensure that fewer 'false' or 'incomplete' therapy scripts are stored in memory, which might lead to fewer prescribing errors in the future.

2. Medical education should promote the development of therapeutic (and diagnostic) reasoning in students. To date, most pharmacotherapeutic educational interventions have focused on the development of analytical reasoning (system 2: non-expert, slow, conscious, effortful, systematic) instead of focusing on the creation of learning conditions that encourage therapeutic reasoning as an expert.

3. Students should be given the opportunity to train the whole task of prescribing medications [17] in the complex context of real practice and with responsibility for patient care. This leads to an earlier and better development of richer and more easily accessible treatment scripts before medical students have prescribing responsibilities as junior doctors. Teachers should be aware that seemingly small adaptations to the learning context of prescribing training during clinical clerkships (i.e. with or without responsibility for patient care) could have a relatively large impact on the prescribing competencies of future doctors. While the studies of this thesis focused in particular on training during clinical clerkships, we think that training pharmacotherapeutic skills with real responsibility for patient care should start as early as possible (from the first year of the medical curriculum). An interesting method to achieve this might be learner-centred student-run clinics (LC-SRC), in which teams of medical students (1st–5th year) are responsible for the therapeutic care of real patients.[44] A recent systematic review of student outcomes after participation in student-run clinics (SRC), which are common in North America, where they provide care for uninsured patients,[45] showed that students appreciated the early training opportunity, and that the quality of care provide in SRCs was adequate. However, little is known about the effect of SRC participation on students' skills/knowledge.[45;46] The LC-SRC project started in 2013 at the VU University Medical Center, in an internal medicine outpatient clinic (the first SRC with insured patients),

is feasible, based on the opinions of students, patients, and clinical supervisors.[44;46] On the basis of this preliminary success, the LC-SRC project has recently been extended to include other initiatives: a student-run cardiovascular risk management programme, carried out in a general practitioner's office, student-led management and treatment of thyroid diseases, and student-led assessment of adverse drug reaction reports in collaboration with the Netherlands Pharmacovigilance Centre Lareb.[46] The effects of these LC-SRCs are currently being investigated.

4. Where necessary, additional structure should be provided to help inexperienced prescribers prescribe rationally, for example, by setting treatment goals and recording therapeutic information in the medical record. SMART criteria might be an effective way to improve treatment goal setting and could be included in the next edition of the WHO Guide to Good Prescribing. The recording of therapeutic information in the medical record in a structured manner might improve medication safety and the training of new generations of prescribers. Therefore, the necessity, optimal content, and effect of having a structured section in the medical record for therapeutic information needs to be determined.

Future research

5. In this chapter, we presented a composite theoretical/conceptual model (figure 4) that describes the relationships between the normative rational pharmacotherapeutic process in clinical practice (WHO 6 step), therapeutic reasoning (in experienced and non-experienced prescribers), and context-based learning to prescribe. This framework, which could be used for future research and educational innovations, not only provides insight into the relationships and the overlap between the three existing models, but also helps us to identify gaps in our understanding of the conceptual model. This leads, among others, to the following research questions that need to be answered in the future:

    - To what extent does learning in real practice with responsibility for patient care (for example in a LC-SRC) accelerate the development of rich and easily accessible treatment scripts?
    - What is the influence of learning with responsibility for patient care in the earliest phases of the medical curriculum (for example the 1st year)?
    - What are the differences in therapeutic reasoning between non experienced, medium experienced, and experienced prescribers of medication?
    - Is metacognition or 'slowing down when you should' trainable in therapeutic decisions?
    - To what extent will a structured discussion of drug choices between trainee doctors and their supervisors (e.g. GPs in training) lead to better (rich and easily accessible) therapy scripts?
    - What is the optimal content and effect of having a structured section for therapeutic information in the medical record? And is this structure helpful for inexperienced prescribers, such as interns and physicians in training?

Organization

6. As described in chapter 2, it is difficult to get sufficient support from policy-makers, such as faculty boards, for a CPT curriculum. To achieve a successful, longitudinal (years 1–6) and integrated CPT curriculum, the input of other professionals, such as doctors, pharmacists, and the local Institute of Education and Training, is needed because clinical pharmacologists cannot and should not work on this alone. But the most important input is that of medical students. Therefore our main recommendation concerning the organization of CPT education is to enable students to play a significant role in organizing, conducting, and investigating CPT education.

In many European medical schools, the department of pharmacology and clinical pharmacology is often small and staff may think they are not able to deliver a relatively labour-intensive contextual learning programme in pharmacology (i.e. role-play sessions, working groups, student run clinics, etc). This 'problem' can be resolved by actively involving students in CPT teaching. The section Pharmacotherapy, of the department Internal Medicine, at the VU University Medical Center has 20 years of experience with active student involvement. Student assistants play a crucial role in providing the energy and ideas for constant change and innovation, and the section Pharmacotherapy organizes a master class in pharmacotherapy. The master class is for students who have shown particular aptitude during pharmacotherapy training sessions and is led by three student coordinators (who have previously followed the master class). Participants are trained to teach according to the WHO 6-step method [47] and receive additional training for small-group teaching from the Department of Teacher Professionalization of the VUmc School of Medical Sciences. These participants then give pharmacotherapy training to younger (at least one year below them) students, under the supervision and coaching of experienced teachers. The student teachers are also trained by clinical experts (such as clinical pharmacologists, clinical specialists and pharmacists) to deepen their knowledge and therapeutic reasoning skills with regard to specific clinical cases. Besides explicit training for teaching sessions, other activities are organized for master class participants, such as in-depth sessions on interesting topics such as drugs, toxicology, drug dosing in patients with renal impairment, and visits to drug development facilities.

The central role of students in organizing, conducting, and investigating CPT education is a win-win venture for both students and faculty (departments). It allows students to gain a deeper understanding of clinical pharmacology and teaching (including research and development of education), and it provides the department with a constant supply of new energy and willingness to develop and improve education with and for students. Lastly, the involvement of students in this way in all facets of education gives them the responsibility for dealing with real (educational) problems, which hopefully will lead to a generation of doctors who remain intrinsically motivated teachers throughout their careers.

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