IMPLEMENTATION OF CLINICAL PHARMACOLOGY COURSE IN THE CURRICULUM FOR PREGRADUATE MEDICAL STUDENTS AND ITS VITAL IMPORTANCE

1Tesfaye H., 2Berry D., 3Prokesova V., 4Allegaert K.

1Department of clinical Biochemistry and Pathobiochemistry, Division of Clinical Pharmacology, Faculty Hospital in Motol, 2nd Faculty of Medicine, Charles University, Prague, Czech Republic.
2Medical Toxicology Unit, St Thomas' Hospital, London, United Kingdom
3Faculty Hospital in Motol, Prague, Czech Republic
4Neonatal Intensive Care Unit University Hospitals Leuven, Belgium

Abstract—Background: General pharmacology is usually taught as a preclinical subject during the early years of studying medicine. In most countries the practice of medicine begins in the years before graduation and in some cases medication errors are blamed on newly qualified young Physicians who have not had a thorough grounding in Clinical Pharmacology, therapeutic drug monitoring (TDM), and Clinical Toxicology, when treating special populations and clinical conditions in particular. The aim of this paper is to demonstrate new and visible way of better educating medical students for better medicine utilization and optimal patient care by case oriented interactive teaching and learning methodology. Methods: The optional course on clinical pharmacology has been announced within a site of Medical faculty and Faculty Hospital for voluntary attendees from 5th year students of medicine, who are interested. The course has been scheduled for 5 days taking 3 hours each day. Last hour on each day was scheduled for individual case solving and discussion in the model of grand round. Each attendee evaluates his own self after the end of the course without name identification to help improvement. Results: The attendees number was 100% of the plan plus one student, who personally applied despite no computer facility. Students, who completed the course (100%) concluded that they recommend the course to their junior colleagues as very beneficial. Vast majority of the students stated that the course added to their knowledge markedly. Each student managed case solving individually and the discussion on cases by the whole attendees resembling grand round. The gran-roud style method in the course has been evaluated as the better way and non-boring form of teaching and learning. Conclusions: In the modern medical practice and the era of evidence based medicine, students may learn from many sources including best founded scientific literatures, books, both in hard paper copy or electronic forms. Within all ocean of theoretical information the student hardly conceive enough skill of patient management with rational pharmacotherapy. Therefore the method of teaching clinical pharmacology including therapeutic drug monitoring and clinical toxicology before graduation may help not only alertness of the young physicians, but mainly the patient to be cared for. Our pilot experience may help to model the future clinical pharmacology curriculum at pregraduate level in medical faculties.

Keywords— Pregraduate, Clinical Pharmacology Teaching, TDM, Drugs in Special Population

1. INTRODUCTION

Pharmacology, as a basic medical science discipline, provides the scientific basis of therapeutics, i.e. the scientific foundation for safe and rational prescribing of drugs, however clinical pharmacology is even more
Recent Researches in Medicine and Medical Chemistry

Surveys of graduating medical students and/or recently graduated physicians from medical schools raise significant concerns about the quality and quantity of clinical pharmacology instruction, whereas compared with the relative abundance of information about the instruction of basic pharmacology in medical schools, little information exists about similar curricular content of clinical pharmacology, which highlights lack of information and encourages clinical pharmacology educators to address this matter. [1] Junior doctors feel poorly prepared by their training in Clinical Pharmacology and Therapeutics and commonly make prescribing errors. According to the very interesting study conducted by O'Shaughnessy et al. [2] 30 of the 32 UK medical schools responded, 60% of schools have a Clinical Pharmacology and Therapeutics (CPT) course although in 72% this was an integrated vertical theme. At 70% of schools pharmacologists have overall responsibility for CPT teaching (clinical 67%, non-clinical 33%); at 20% teaching is run by a non-specialist clinician and at 7% by a pharmacist. Teaching is commonly delivered by other clinicians (87%) and clinical pharmacists (80%) using lectures (90%). [2] The evidence reporting that medical graduates lack skills in safe and effective drug prescribing may be warrants a simple educational approach, using a task analysis of drug prescribing, is applied to identify desired attitudes which should be incorporated into a basic pharmacology course for medical students. [3] At a Conference held in Oxford on 20-22 June 2011, a group of senior clinical pharmacologists and their junior colleagues, other medical specialists, and pharmacists discussed an agenda for UK clinical pharmacology for the next 5 years, addressing several points recommendations integration and closer collaborations with pharmacologists, clinical pharmacists, other prescribers, and pharmaceutical companies (e.g. through joint training programmes) are desirable and coverage attention to neglected areas, such as general practice, paediatrics, obstetrics, geriatrics, anaesthetics, cancer, and immunology. Emissaries Trainees to spread the word. [4] The principle of stepping out of conventional settings and actively seeking collaboration with other groups beyond pharmacology discipline may enhance the profile of the discipline as an Australian experience demonstrates. [5] Likic et al. [6] investigated final-semester students’ perceptions of their training in relation to prescribing in two Croatian medical schools with different clinical pharmacology (CPT) teaching styles, after the training, students completed a paper questionnaire on prescribing skills and knowledge of pharmacotherapy and found that only half of the student cohort felt confident about their ability to prescribe medicines, and few had practiced this skill during their medical training. Medication errors are common in general practice and in hospitals, so that both errors in the act of writing (prescription errors) and prescribing faults due to erroneous medical decisions can result in harm to patients. Thus any step in the prescribing process can generate errors, while inadequate knowledge or incompetence and incomplete information about clinical characteristics and previous treatment of individual patients can result in prescribing faults, including the use of potentially inappropriate medications may be of vital importance. [7] Many errors occur as a result of poor oral or written communications. Enhanced communication skills and better interactions among members of the health care team and the patient are essential. Faculty systems must be redesigned, and seamless, computerized integrated medication delivery must be instituted by health care professionals adequately trained to use such technological advances. Sloppy handwritten prescriptions should be replaced by computerized physician order entry, a very effective technique for reducing prescribing/ordering errors, but another far less expensive yet effective change would involve writing all drug orders in plain English, rather than continuing to use the elitists’ arcane Latin words and shorthand abbreviations that are subject to misinterpretation. After all, effective communication is best accomplished when it is clear and simple. [8] Despite an introduction to era of an evidence based medicine, various drug categories are prescribed without thinking much about over all outcomes including adverse drug reactions. Prescription errors are very common, specially with fresh doctors, being the basic problem which contributes to the irrational prescribing is the medical students are not adequately instructed. [9] Thus, those who are less knowledgeable in rational prescribing continue to make medication errors leading to increased, risk of adverse drug reactions poor health outcomes. [10] There are many indicators that Young doctors of nearly graduating future physicians need a firm grounding in the principles of rational prescribing for better drug utilization and quality health care. Principles of good prescribing are based on sound knowledge and understanding of the pathophysiology of the disease to be treated, and the knowledge of risks and benefits of the medicine. [11] Poor prescribing is common among youn physicians all over the globe. The public, lay media, and the medical profession have raised serious concerns over the high incidence of errors of drug prescribing which compromise patient safety, including death of some patients, attributed mainly to inadequate teaching of medical pharmacology and, consequently, to medical graduates lacking skills in safe and effective drug prescribing warranting unhealthy effect meaning poor health outcomes. For instance THE
TELEGRAPH published in Britain cites prominent specialists for credibility of its title „Young doctors' poor drugs training is killing patients”. On this issue the newspaper cites’ Patients are dying because young doctors no longer receive adequate training in prescribing drugs as leading pharmacologists and eminent specialists said knowledge of how to use drugs was alarmingly low among medical students and junior doctors at a time when increasingly complicated medications were being taken by more people. Research suggests that significant number of hospital admissions is caused by adverse reactions to drugs, most of which are avoidable and one study results estimated cost of the problem to the National Health Service of UK at £466 million.[13]. Furthermore, according to the news, “Prof Rawlins, who is a professor of clinical pharmacology at Newcastle University, said: "There has been a decline in the teaching of pharmacology and that has an effect on basic drug safety so that the competence of young doctors in prescribing is a very serious problem. In 2003 there were 68 specialists practising clinical pharmacology and therapeutics (CPT) in Britain, while the total number of medical specialists increased by 79 per cent between 1993 and 2003, in CPT it dropped 24 per cent. [12] There is no doubt about that a substantial proportion of that is undoubtedly avoidable if medical schools could be training much better and safer doctors. The results of retrospective data analysis from two hospitals in UK published some years ago pointed out that 1,225 patients aged 17 or over out of 18,820 were admitted as a result of adverse drug reactions. [13] Another recent study estimates that adverse drug reactions cause 5.8% of admissions in medical departments. [14] The problem is not limited to developed countries, where many drugs are available, but in areas where resources are relatively limited as an Indian based study[15] assessing the knowledge of intern doctors in the government medical college on the principles of good prescribing shows that knowledge of good prescribing by the interns is deficient, stating that only 47.06% of students were able to identify life threatening disease as the conditions that could enhance benefit: risk ratio of a medicine. [15] Another developing country based study results assessing the knowledge of final year medical students about good prescribing and the application of this knowledge to their prescribing skills also suggests that the final year medical students would require theoretical and practical teaching of principles of rational prescribing to improve their prescribing knowledge and skills. [16] According to one study result from Nepal, it was suggested that educational intervention becomes effective in improving prescribing practices if combined with a managerial intervention such as peer-group discussion. [17] Although, only few are published, evidence of poor prescribing is widespread including overuse of medicines, underuse of effective medicines, events of avoidable adverse drug reactions. [19] Junior doctors may be responsible for much of the prescribing that takes place in hospitals and are implicated in many of the adverse medication events, while analysis of such events suggests that lack of knowledge and training underlies many of them and dedicated training can make changes. It is a matter of increasing concern that recent changes to undergraduate medical education may have reduced exposure to clinical pharmacology, a discipline dedicated to optimal practice in relation to medicines. There is also expert provided view of how the learning objectives of better medicine practice might be achieved, and identify the key elements of a core curriculum in prescribing and therapeutics. [20] Another recently paper from UK concluded that Clinical Pharmacology and Therapeutics (CPT) teaching in the medical schools is very diverse and most schools do not assess the performance of their graduates as prescribers and there is a lack of evidence that many of the teaching approaches employed are suitable for the development of prescribing skills [2] It is vital that developments in CPT teaching are driven by validated, real-world assessments of the prescribing skills of medical students and newly qualified doctors. As a continuation to general pharmacology education, before the student is exposed to clinical problem solving, certain aspects of clinical pharmacology questions should be raised as components of rational prescribing. This should mainly focus on rational medicine prescribing based on evidence, risk/benefit measures, factors affecting the benefit: risk ratio, age and other differences in relation to health and disease to influence prescription (pediatric versus geriatric doses in contrast to others, dosage forms, dose modification needs and its justifications among others. [18] [20], [21] In the past decade, there has been an increase in both the total number of suspected ADRs reported in children and a wide range of them were associated with fatalities in children. [22] According to a retrospective study from The University of Aberdeen, Aberdeen, United Kingdom, foundation year 1 (fresh) doctors believe that their undergraduate and postgraduate training in CPT is insufficient to prescribe safely and rationally indicating that the training of junior doctors in the rational and safe use of medicines should be increased. In contrast, over 75% of respondents in the study reported high levels of confidence for the unsupervised use of warfarin, nonsteroidal analgesics and opiate analgesics, while in retrospect, fresh doctors would like more undergraduate teaching in prescribing for special patient groups, ADRs, drug interactions, together with CPT in their postgraduate teaching
programme is not surprising. [23] Fact highlighting unpreparedness of medical students and junior doctors for safe use of drugs in their practice. In a prospective questionnaire survey of the views of foundation programme young doctors (FY 1) coming towards the end of their first year in training, almost half of respondents (41%) believed that their undergraduate training had not equipped them to prescribe rationally or safely, and more than a third reported encountering specific prescribing problems such as special patient groups, drug errors, and drug toxicity during routine work. Three-quarters (74%) reported witnessing an adverse drug reaction, and 55% a drug-drug interaction, many of which although avoidable had resulted in patient morbidity or mortality. 60% of respondents stated that they had not been taught in sufficient detail about how to avoid ADRs, or drug-drug interactions during their undergraduate years, and more than half (56%) about prescribing and ensuring patient safety during their postgraduate year. [9] Good prescribing skill is built on a sound knowledge of medicines, an understanding of the principles of clinical pharmacology, knowledge of pathophysiology of the disease and correct diagnosis, the ability to make judgements concerning risks and benefits, and profound experience. Poor prescribing is probably the most common cause of preventable medication errors in hospitals, and many of these events involve junior doctors who have recently graduated. [20]

The challenge is probably greater now than ever before, because of Medical education has changed radically changing medical education in the last two decades, reflecting concerns about an overburdened curriculum and lack of focus on social science and these changes have resulted in less teaching in clinical pharmacology and practical prescribing as guaranteed features of undergraduate training and assessment. [24] Evidence of poor prescribing is widespread including overuse of medicines, underuse of effective medicines, avoidable adverse drug reactions and medication errors. Junior doctors who have recently graduated are responsible for much of the prescribing that takes place in hospitals and are implicated in many of the adverse medication events. Analysis of such events suggests that lack of knowledge and training underlies many of them and it has been shown that dedicated training can increase prescribing performance. In the context of these problems, it is a matter of increasing concern that recent changes to undergraduate medical education may have reduced exposure to clinical pharmacology, a discipline dedicated to optimal practice in relation to medicines. [18] Skills junior doctors must demonstrate include being able to prescribe drugs appropriately, take accurate patient drug histories and recognise the sources of medication error and ways to minimise it.” However, some media even skandelize it to saying “Hundreds dying because doctors lack training in prescribing drugs” as one [12], [25] of course, adhering and adding to well known expert words [26] The purpose of the presented paper is to demonstrate new and visible way of exposing medical students to better medicine and patient care by case oriented interactive teaching and learning at a Medical Faculty and Faculty Hospital with a capacity of around 500 beds and all kind of medical specialities holding accreditation and certification according to national and international standards.

2. Methods

This optional clinical pharmacology course was offered to interested 5th year medical students to attend on a voluntary basis. The course was scheduled for 5 days with 3 hours of class contact each day. The final hour on each day was scheduled for individual case solving and discussion in the manner of a grand round. Attendees evaluated the course content anonymously to identify areas that can be improved.

3. RESULTS

The course was 100% occupied (9 students) and an additional student personally applied despite not having access to computer facilities. 100% of students completed the course and they all concluded that they would recommend it to junior colleagues as very beneficial. Two of the students stated that the course increased their knowledge a little and the rest agreed that the course increased their knowledge a lot. Each student managed to solve cases individually and the Grand Round type of interactive case discussion involving all students was evaluated as the best way of teaching and learning process to improve the preparedness of the future young physicians to better handle medicines to achieve the best health outcomes. Accordingly, each attendee managed to solve concrete clinical problems beginning from the differential diagnosis up to decision of appropriate therapy.
Students attended the course from countries in Europe and North America. International students, who attended the course were from different countries in Europe and North America as indicated in the figure (Fig. 1) evaluated the course anonymously in summary as very useful (Table 1) below.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses</th>
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<tbody>
<tr>
<td>1. I understand the principles of clinical pharmacology. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>2. I understand the fundamentals of good clinical practice. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>3. I am familiar with the human drug trial phases and their goals. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>4. I understand standard operation procedures to prescribe. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>5. I am aware of PK/PD problems in special population. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>6. I do care to avoid avoidable drug interactions. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>7. I understand the importance and benefits of TDM. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>8. The course added to my knowledge: a) a little b) nothing c) markedly</td>
<td>80% markedly, 20% a little</td>
</tr>
<tr>
<td>9. I recommend the course to my junior colleagues. Yes/No</td>
<td>100 % Yes</td>
</tr>
<tr>
<td>10. The time given was: a) enough b) short c) long</td>
<td>100 % enough</td>
</tr>
</tbody>
</table>

Table 1: Anonymous evaluation of the optional course in clinical pharmacology by the students.

4. DISCUSSION

Although further studies are needed to explore the impact of team-based learning on additional performance, based on feedback from students and on recommendations of academic bodies, Zgheib et al. [27] introduced twice-monthly "rational prescribing" sessions during the required internal medicine rotation in year 4 of medical school recommended it as an effective alternative for teaching clinical pharmacology in medical schools. In the Editorial page of BMJ Aronson et al [9] highlighted the fact demonstrating medical students and junior doctors unpreparedness for prescribing drugs for the patients they need to care for safely. When these patients are babies and children this problem is even more pronounced since these patients are at higher risk of prescribing errors than adults [28] and have fewer internal reserves to compensate if they occur. In children there is no such thing as a standard dose, most need to be calculated on an individual patient basis taking into account the gestational and postnatal age, weight and/or body surface area. Drug selection and doses need to take into account the dynamic changes in pharmacokinetic and pharmacodynamic maturity of the patient and the potential for drug toxicity which can be different to adult patients. The need to use drugs which are unlicensed or off label for the majority of paediatric patients in hospital [29, 30] and a significant proportion in the community [31] also means that suitable licensed products and prescribing information are not always readily available. The condition in treating elderly people may show even more catastrophic sene as these populations of patients are prone to drug induced harms due to agerelated changes and associated polmorbidity, which in turn carries the risk of exposure to polypharmac [32] Despite, known health hazards and significant economoc loss, poor prescribing goes on as published recently [10]. Thus profound training in clinical pharmacology including therapeutic drug monitoring may improve safe use of drugs to improve health outcomes. Teaching in different medical schools may be very diverse and schools do not assess the performance of their graduates as prescribers and there is a lack of evidence that many of the teaching approaches employed are suitable for the development of prescribing skills. So, it is of vital importance that developments in clinical pharmacology teaching are driven by validated, real-world assessments of the prescribing skills of medical students and newly qualified doctors as already suggested. [2] In our project, the optional clinical pharmacology course was offered to interested 5th year medical students to attend on a voluntary basis. The course was scheduled for 5 days with 3 hours of class contact each day (Table 2). The program was enriched with vitally important aspects of clinical pharmacology including therapeutic drug monitoring (TDM) and clinical toxicology with practical demonstrations and application of dose adjustment with computer assisted modelling. Most drugs used in paediatrics and even more critically in neonatology have never been specifically studied and to prescribe neonatal therapy simple adapting from adults therapy could lead to severe adverse events, while many operational steps, that the use of drugs demands, often lead health-care professional to make mistakes. [33] Furthermore, neonates are highly vulnerable to medication errors because of their extensive exposure to medications in the neonatal intensive care unit (NICU), the general lack of evidence on pharmacotherapeutic interventions in neonates and the lack of neonate-specific formulations. [34] In health care procedures medication is the most common health-care intervention, and the errors arising out of its usage and are among avoidable causes of iatrogenic injuries with no exception in neonates. Indian authors Jain et al. [35] did a retrospective chart review of neonatal prescriptions written in the 4 months and
concluded that medication errors are common in neonatology; more so, in emergency departments than in the neonatal intensive care units. Given the problematic area of the neonatal pharmacology and age derived uniqueness, the lecture dealing with the topic of special population clinical pharmacology is suggested to be of particular importance. The lecture and case notes delivered by Clinical pharmacist was also of great importance covering the topic of pharmacovigilance. Beyond the knowledge of early phases of the clinical trial it is vital to make sure that before a new medicinal product is placed on the market, all available information on its safety and efficacy comes only from clinical trials. Despite intensive research conducted in animals and during clinical trials in humans, some adverse reactions may be identified only after the product is used by a large number of people. The conditions under which patients and medicines are studied may not necessarily reflect the way medicines are used in hospitals or outpatient practices following their placement on the market. For this reason it is very important to monitor the safety of medicinal products also after their marketing – and this is the subject of pharmacovigilance, where freshly graduating medical doctors have lack of information indeed. Pharmacovigilance process dealing with the monitoring of use of medicinal products in everyday clinical practice, may enable identifying previously unidentified adverse reactions or a change in the nature of adverse reactions. Risk-benefit assessment of medicinal products, which helps to decide what action, if necessary, is essential for a safer use of medicinal products and has been discussed in the course.

Table 2: The Optional Clinical Pharmacology course programme (sylabus) recommended to 5th year and above Medical students

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
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<tbody>
<tr>
<td>Introduction to Clinical Pharmacology</td>
<td>Standard operation procedures</td>
<td>Special population</td>
<td>Drug-drug interaction and methods</td>
<td>Importance of pharmacovigilance</td>
</tr>
<tr>
<td>Good Clinical practice</td>
<td>Pharmacovigilance</td>
<td>Drug therapy</td>
<td>Therapeutic decision making</td>
<td>Therapeutic drug monitoring</td>
</tr>
<tr>
<td>Phases of Clinical trials in human subjects</td>
<td>Pharmacokinetic variables</td>
<td>Pregnancy significance</td>
<td>Therapeutic drug monitoring</td>
<td>Therapeutic drug monitoring</td>
</tr>
<tr>
<td>Pharmaceutical aspects and clinical importance of bioequivalence study</td>
<td>Pharmacokinetic variables</td>
<td>Pharmacodynamic variables</td>
<td>Therapeutic drug monitoring</td>
<td>Therapeutic drug monitoring</td>
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The final hour on each day was scheduled for individual case solving and discussion in the manner of a grand round. Each attendee evaluated the course content anonymously to identify areas that can be improved.

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Reference


