Key curricular outcomes for clinical pharmacology and therapeutics education in Europe: A modified Delphi study

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Background and goal
Prescribing drugs safely and effectively is a fundamental skill that medical graduates must acquire, because after graduation they will prescribe drugs on a daily basis, often with minimal supervision. Effective undergraduate education in clinical pharmacology and therapeutics (CPT) is therefore essential. However, recent studies have shown that final-year medical students in Europe lack essential prescribing competencies and that there is marked variation in quantity and quality of CPT education within and between European countries.\textsuperscript{1,2} This has potential consequences for patient safety. To redress this situation, a collaborative effort is required to harmonise and modernise the CPT teaching and assessment at a European level. A first step towards an unified core curriculum is to define key curricular outcomes that European medical students should have acquired at the point of graduation. Previous studies on this topic lack methodological quality, sufficient details and are merely focused on local settings in the UK\textsuperscript{1,8}, the Netherlands\textsuperscript{9} and Sweden.\textsuperscript{10} In this modified Delphi study, we aim to establish key curricular outcomes for teaching and assessing clinical pharmacology and therapeutics during the undergraduate medical curriculum in Europe.
Methods

Study design
This is a modified two-round Delphi study. First, a literature search on key curricular outcomes for CPT education is conducted. Based on this search, a list of key curricular outcomes for CPT education during the undergraduate medical curriculum in Europe is constructed by the research team. Subsequently, European experts in clinical pharmacology and medical education will be selected and invited to participate in a consensus panel. The panel will evaluate the list of curricular outcomes in two consecutive questionnaire rounds. Finally, a face-to-face meeting will be held during the EACPT congress 2017 in Prague to discuss the results of the Delphi process and reach final consensus.

Questionnaire development
Based on previous studies\(^3\)-\(^13\), a list of ±250 key curricular outcomes for CPT education during the undergraduate medical curriculum in Europe has been developed by the research team (Appendix A). The list is divided in core knowledge and understanding (21 categories), skills (13 categories) and attitudes (4 categories). Based on this list, a web-based questionnaire (using \(www.surveymonkey.com\)) will be developed and tested in a pilot study with CPT teachers from several European medical schools.

Expert panel
±200 experts from 32 European countries (European Union plus Iceland, Liechtenstein, Norway, Switzerland) will be invited to participate in a consensus panel. The panel consists of clinical pharmacologists (trainees), as well as medical doctors of primary and secondary care with experience in medical education. Primarily those are targeted with interest in CPT education and who are member of the EACPT, NOTIP and/or EACPT Young Clinical Pharmacologists. Experts should preferably have participated in previous studies\(^1\),\(^2\) and attend the EACPT congress 2017 in Prague. Participants will receive an invitation by e-mail containing information about the study’s general objective and background and instructions for participation. Participation is anonymous and voluntary; confidentiality is guaranteed.

Data collection
The modified Delphi method consists of two consecutive rounds. In the first round, participants are asked to give each included item a score of 1 to 5 (1= not at all important, 2= little important, 3= neutral, 4= somewhat important, 5= very important). Also, they are asked to indicate whether the item should be acquired during preclinical years (bachelor’s degree) or clinical/clerkship years (master’s degree). They can also change item wording or add new items if they feel these are missing. Per category, panel members can also give arguments for their choice in a separate text box. In the second round, participants are presented with the items from Round 1 plus the additional suggested items, with each item being shown with the consensus score awarded in the first round and a summary of the arguments. Respondents are asked to reconsider their score in the light of the group opinion and given to opportunity to change it. They are also asked to score the newly suggested items provided by other experts and given to chance to suggest wording changes or additional items. Individual scores will be kept confidential. Participants will have 3 weeks to complete each round (see planning). Each round will take approximately 45-60 minutes to complete. It is possible to temporarily save answers and finish the questionnaire later. A reminder will be send after week 1 and 2. During the EACPT congress in Prague 2017, a 2-hour face-to-face meeting will be held to discuss the results of Delphi rounds and to reach final consensus on the list. Experts who have completed all questionnaire rounds are invited to attend this meeting.
Data analysis
Consensus for inclusion is a score of ≥4.5. Curricular outcomes with a score <4.0 will be excluded. Panellists are asked to reconsider outcomes, specifically those items which score between 4.0 and 4.5 score in Round 1. Those outcomes that subsequently score ≥4.5 are added to the final list of outcomes and those that do not will be excluded. Data will be collected online and analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA).

Output
The output of this study is a list of key curricular outcomes for teaching and assessing CPT during undergraduate medical curricula in Europe. This final list of outcomes will be disseminated among all European medical schools and will serve as a basis for a unified core curriculum in CPT in Europe.

Ethical considerations
This study protocol has been approved by the Dutch Ethics Review Board of Medical Education (NVMO-ERB 860). An online informed consent will be obtained from each participant prior to inclusion.

Planning
1 – 28 February  Writing study protocol
1 – 31 March  Obtaining ethical approval and developing study materials
1 – 30 April  Inviting expert panel
1 May – 21 May  Round 1
22 May – 11 June  Round 2
12 June – 24 June  First data analysis
25 June  Panel meeting at EACPT congress Prague 2017
26 June – 31 July  Final data analysis
1 August – 30 September  Writing manuscript
1 – 15 October  Reviewing manuscript
16 – 31 October  Adapting and submitting manuscript
1 November – 31 December  Disseminating results

References


APPENDIX A. KEY CURRICULAR OUTCOMES FOR CLINICAL PHARMACOLOGY AND THERAPEUTICS EDUCATION IN EUROPE

CORE KNOWLEDGE AND UNDERSTANDING (n= 21)

1. Introduction to clinical pharmacology and therapeutics

1.1 Introduction
- Explain the terms pharmacology, clinical pharmacology and therapeutics.
- Recognize the breadth of topics embraced by clinical pharmacology.
- Recognize the importance of clinical pharmacology as the scientific discipline that underpins a rational approach to prescribing medicines.

1.2 Drugs in healthcare and society
- Explain the terms drug and medicine.
- Explain the extent of medicines use within the relevant country.
- Recognize the impact of prescription drugs in society.
- Explain the extent of illicit drug use and its public health consequences.

2. Pharmacodynamics

2.1 Mechanisms of drug action
- Define the term pharmacodynamics.
- Identify molecular targets for drug action including receptors, ion channels, enzymes and transporters.
- Identify cellular mechanisms of action including excitation, contraction and secretion.
- Describe how these actions translate into responses at the tissue and organ level.

2.2 Dose-response relationships
- Explain the relationship between drug dose and response.
- Define the terms agonist, antagonist and partial agonist.
- Explain the effect of antagonists on the dose–response curve of an agonist.
- Explain the assessment of receptor selectivity.
- Define the terms efficacy and potency.
- Define the term ‘therapeutic index’.
- Describe the phenomena of desensitization and tolerance.

3. Pharmacokinetics

3.1 Introduction to pharmacokinetics
- Explain the term pharmacokinetics.
- Explain the four phases of pharmacokinetics.
- Explain why an understanding of pharmacokinetics is relevant to prescribers.
3.2 Drug absorption
- Explain the mechanisms of drug movement across physiological barriers.
- Explain fundamental differences between various routes of drug administration.
- Describe first pass metabolism and its importance.
- Describe how one drug can influence the absorption of another.

3.3 Drug distribution
- Explain the distribution of drugs across body compartments.
- Define volume of distribution and its clinical relevance.
- Explain how the distribution of a drug influences its pharmacokinetics.

3.4 Drug elimination (metabolism and excretion)
- Define phase I and II metabolism.
- Explain the important role of the liver in drug metabolism.
- Explain why drug metabolism is a potential point of interaction between drugs.
- Explain the important routes of drug excretion from the body.

3.5 Concentration-time relationships
- Describe the typical concentration–time curve for a drug with first order kinetics.
- Explain the importance of zero order (saturation) kinetics.
- Define clearance and half-life and their clinical relevance.
- Define bioavailability and its clinical relevance.

3.6 Repeated drug dosing
- Explain the pharmacokinetic factors that determine choice of dose, route, frequency, and duration of drug administration.
- Explain the pharmacokinetics of repeated dosing including time to ‘steady-state’.
- Explain fundamental differences between drugs with long and short half-lives.
- Explain the rationale for loading doses.

4. Individual variability in the response to drugs

4.1 Overview
- Identify the main factors influencing variability in response.
- Explain how different pharmaceutical factors produce variation in response.
- Explain how altered pharmacokinetic handling of drugs produces variation in response.
- Explain how pharmacogenetic variation can influence the response to drugs.
- Explain how pharmacodynamic factors can affect drug response (e.g. receptor sensitivity, tolerance, organdisease).

4.2 Pharmacokinetic variability
- Identify important groups of patients where pharmacokinetic handling of drugs altered is altered.
- Explain in each of the cases above why handling is altered.
4.3 **Pharmacogenetic variability**
- Identify common ways in which genetic variation influences the handling and response to drugs.
- Provide common examples where pharmacogenetic variation influences prescribing.
- Explain how increasing knowledge of pharmacogenetic variation will influence future prescribing practice.

5. **Adherence, compliance and concordance**

5.1 **Adherence to medication**
- Define the terms adherence and compliance, separating them from concordance.
- Explain the scale of non-adherence and its consequences.
- Explain the importance of patient consent in the adherence to therapy.
- Identify measures to improve poor adherence whether intentional or unintentional.
- Make an accurate assessment of adherence to medication.

5.2 **Concordance – partnership with patient**
- Define the term concordance.
- Describe the influence of patients’ beliefs on adherence.
- Identify the barriers to achieving shared decision making with patients.
- Explain ways in which concordance can be improved (e.g. presenting accessible information).
- Describe how to discuss the benefits and risks of drug therapy with patients.
- Describe how to explore patients’ views and wishes in relation to drug treatment.

6. **Therapeutic drug monitoring**

6.1 **Overview**
- Explain the importance of monitoring the impact of drug therapy.
- Describe the ways in which therapy can be monitored including clinical outcomes, pharmacodynamics responses and plasma drug concentrations.
- Identify the prerequisites, advantages and disadvantages of each approach.
- Identify common examples of where monitoring drug concentrations are important.

6.2 **Using drug effect**
- Identify ways in which drug effects can be measured.
- Explain why the impact of drugs on clinical outcomes is difficult to measure.
- Identify the difference between a surrogate and hard outcome.
- Explain what makes a good surrogate outcome.

6.3 **Using drug concentration**
- Explain the variable relation between dose and plasma drug concentration, and between drug
concentration and clinical effect.
- Describe the characteristics that make a drug suitable for monitoring by measurement of concentration.
- List common medicines whose use is facilitated by measurement of drug concentration
- Describe the practicalities of measuring plasma drug concentrations.
- Explain how to interpret drug concentration measurements appropriately.
- Explain how to adjust dosage in light of drug concentration measurements.

7. Adverse drug reactions

7.1 Basic principles
- Define an adverse drug reaction and other adverse outcomes of drug therapy.
- Explain the frequency of adverse drug reactions in primary and secondary care and their impact on public health.
- Explain why all drugs have both beneficial and adverse effects.
- Describe the common classification of adverse drug reactions (e.g. ABCDE).
- Explain the alternative classification based on dose, timing and susceptibility (e.g. DOTS).

7.2 Drug allergy
- Discuss risk factors for allergy/anaphylaxis.
- List medicines that are commonly implicated in allergic reactions.
- Explain how to identify and characterize an allergic drug reaction.
- Explain the importance of accurate diagnosis and recording of allergic reactions to drugs.
- Explain the precautions that should be taken to prevent allergic reactions.

7.3 Diagnosis, interpretation and management
- Describe the principles of assessing drugs as a possible cause of new symptoms and signs.
- Explain how to respond if an adverse drug reaction is suspected.
- Explain how to manage a suspected adverse drug reaction.

7.4 Avoiding adverse drug reactions
- Describe important risk factors that predict susceptibility to adverse drug reactions.
- Describe how identification of those risk factors can influence prescribing decisions.
- Identify sources of information about adverse drug reactions.
- Explain the importance of warnings and monitoring in preventing adverse reactions.

7.5 Pharmacovigilance
- Explain the ways in which adverse drug reactions can be identified (e.g. drug development, voluntary reporting, record linkage).
- Explain why the adverse drug reaction profile of individual drugs is unclear at launch.
- Discuss the importance of and the prescriber’s responsibility in pharmacovigilance.
- Describe how to report a suspected adverse drug reaction using the national pharmacovigilance.

8. Drug interactions and contraindications

8.1 Interactions
- Understand the epidemiology of drug interactions.
- Explain the potential for interacting drugs to cause beneficial and harmful effects.
- Recognize the main ways in which interactions occur (e.g. pharmaceutical, pharmacokinetic, pharmacodynamic).
- Explain why the potential for drug interactions is increasing.
- Identify sources of information about drug interactions to inform prescribing.
- Explain how to predict and avoid drug interactions.
- Explain how to adjust drug dosage in anticipation of a drug interaction that cannot be avoided.

8.2 Liver metabolism
- Explain the importance of liver cytochromes as a point of drug clearance.
- Identify the importance of liver metabolism as a point of interaction between drugs.
- Explain how liver enzyme metabolism can be inhibited and the impact this has on drug handling.
- Explain how liver enzyme metabolism can be induced and the impact this has on drug handling.

8.3 Contraindications
- Understand the epidemiology of drug contraindications.
- Explain the potential for drug contraindications to cause harmful effects.
- Explain why the potential for drug contraindications is increasing.
- Identify sources of information about drug contraindications to inform prescribing.
- Identify how to avoid drug contraindications.

9. Medication errors

9.1 Frequency and causes
- Define medication errors, including subtypes.
- Describe human error theory in simple terms.
- Identify individual and systems factors leading to error.
- Describe how medication errors are reported.
- Explain how to respond when a medication error is discovered.

9.2 Prevention
- Explain how prescribers can reduce errors.
- Explain the importance of collaboration with pharmacists in preventing errors.
- Explain how to identify and correct errors.
- Describe the role of electronic prescribing and other approaches in reducing prescribing error.
10. Drug development and regulation

10.1 Drug development
- Explain in simple terms how drugs are discovered.
- Explain the various stages of development (preclinical, phase I to phase IV).
- Explain the risks and costs involved in developing drugs.

10.2 Clinical trials
- Classify the different forms of clinical trial and explain their advantages and disadvantages.
- Describe the requirements of a good clinical trial including consent, ethics, bias, statistics and dissemination of information.

10.3 Drug regulation
- Explain why drugs need to be regulated.
- Identify the major regulatory authorities in the relevant country and Europe (i.e. European Medicines Agency).
- Describe the approval process for new drugs in simple terms.
- Explain the importance of market exclusivity and patents.
- Explain how drug sales can be protected when patents expire.

10.4 Drug marketing
- Explain the basics of how drugs are marketed by the pharmaceutical industry.
- Explain the legal constraints on the marketing process.
- Recognize the role of the code of conduct of the relevant country.
- Describe the potential for the marketing process to change attitudes.
- Identify the uses and abuses of the drug promotion process.

11. Medicines management

11.1 National processes
- Describe how new medicines are assessed on the basis of safety, efficacy and cost-effectiveness.
- Describe the basic principles of pharmacoeconomic assessments.

11.2 Local processes
- Describe the role of local drug and therapeutics committees.
- Explain the role of local formularies and guidelines in the choice and use of medicines.
- Identify the factors that influence individual prescribing choices and why these have to be limited (e.g. cost, antibiotic resistance).
- Explain the responsibility of prescribers to avoid wasteful prescribing and consumption of limited resources.

11.3 National formularies
- Explain the reasons for creating limited lists of medicines.
- Explain the processes involved in creating a national formulary.
- Identify the important issues relating to coordination of prescribing in primary and secondary care.
- Explain the limitations of the information contained in the national formulary.

11.4 Guidelines
- Describe the definition and purpose of a clinical guideline.
- Explain some of the potential limitations and harms of clinical guidelines.
- Describe the optimal development, dissemination and implementation of clinical guidelines.
- Describe the legal standing of guidelines.

12. Evidence based prescribing

12.1 Overview
- Explain the extent of the evidence base.
- Explain the terms randomized controlled trial, cohort study, case control study, systematic review and meta-analysis.
- Identify different kinds of evidence and their hierarchy in terms of validity.
- Explain the limitations of applying clinical trial data to individual patients.
- Explain the importance of keeping one’s prescribing practice up to date with advances in medical knowledge.

12.2 Critical appraisal of clinical studies
- Describe the process of critical appraisal of clinical studies.
- Explain the approach to identifying methodological flaws, including sources of bias.
- Differentiate between true and surrogate endpoints.
- Explain the concept of external validity and problems with extrapolating clinical trial results.

12.3 Finding reliable information about drugs
- Identify important information resources that might inform prescribing decisions.
- Explaining how prescribers can keep up to date with change.
- Identify potential sources of unreliable information.

13. Ethical and legal aspects of prescribing

13.1 Legal aspects of prescribing
- Explain the legal categorisation of drugs into general sales list, pharmacy medicines, prescription only medicines and controlled drugs.
- Explain who is entitled to prescribe medicines and the legal requirements involved.
- Explain who is entitled to supply medicines and the legal requirements involved.
- Describe the legal requirements associated with prescribing controlled drugs.
- Explain common ways that drugs can be supplied illegally (e.g. internet pharmacy).
13.2 Prescribing outside marketing authorization
- Recognize the circumstances in which drugs are prescribed ‘off-label’.
- Explain the additional responsibilities associated with prescribing ‘unlicensed’ or ‘off-label’ medicines.
- Describe what information should be given to patients to allow them to make informed decisions about ‘off-label’ treatment.

13.3 Ethical aspects of prescribing
- Explain the responsibilities of prescribing in a resource limited healthcare system.
- Describe the sometimes conflicting responsibilities to individual patients and the wider healthcare community.
- Explain the reasons for adhering to therapeutic guidelines and drug formularies, as appropriate.
- Explain why it is important to recognize limits of competence and to ask for help when needed.
- Explain the responsibility of all prescribers to update their knowledge.

14. Prescribing for patients with special requirements

14.1 Prescribing for elderly patients
- Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in elderly patients.
- List common medicines to which elderly patients are especially likely to respond differently.
- Explain where to find relevant information about choosing and adjusting drug dosage in elderly patients.
- Explain the principles that underlie prescribing in the elderly, including influences of aging and polypharmacy.

14.2 Prescribing for patients with impaired liver function
- Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in patients with impaired liver function.
- List common medicines that are especially likely to cause harm to patients with impaired liver function.
- Discuss the principals involved in selecting medicines and designing dosage regimens for patients with impaired liver function.
- Explain where to find relevant information about choosing and adjusting drug dosage in patients with impaired liver function.

14.3 Prescribing for patients with impaired renal function
- Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in patients with impaired renal function.
- List common medicines that are especially likely to cause harm to patients with impaired renal function.
- Discuss the principals involved in selecting medicines and designing dosage regimens for...
patients with impaired renal function.
- Explain where to find relevant information about choosing and adjusting drug dosage in patients with impaired renal function.

14.4 Prescribing for pregnant women and women of childbearing potential
- Explain the reasons for caution when prescribing for pregnant women and women of childbearing potential.
- Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in pregnancy.
- List common medicines to which pregnant women are especially likely to respond differently.
- Describe the possible effects of drugs on the developing foetus, in relation to the stage of gestation.
- Explain the principles involved in selecting medicines and designing dosage regimens for pregnant women and women of child-bearing potential.
- Explain where to find relevant information about choosing and adjusting drug dosage in pregnant women and women of child-bearing potential.

14.5 Prescribing during lactation
- Explain the reasons for caution when prescribing for women who are breast feeding.
- List common medicines that are especially likely to cause harm to the newborn as a result of transmission via breast milk.
- Discuss the principals involved in selecting medicines and designing dosage regimens for women who are breast feeding.
- Explain where to find relevant information about choosing and adjusting drug dosage in women who are breast feeding.

14.6 Prescribing for children
- Describe how altered physiology, pharmacokinetic handling and pharmacodynamic response occur in children.
- List common medicines to which children are especially likely to respond differently.
- Explain where to find relevant information about choosing and adjusting drug dosage in children.
- Explain the principles that underlie prescribing in children.

15. Rational prescribing

15.1 Rational approach to prescribing
- Explain the importance of individualizing the prescription.
- Explain how to establish a standard treatment / P-drug for a diagnosis.
- Describe the selection of an appropriate medicine based on its comparative efficacy, safety, convenience and cost.
- Explain the importance of identifying diagnosis (if possible) and therapeutic objectives.
- Describe the factors that influence the choice of formulation, dose, route, frequency and
duration of treatment.
- Provide examples of irrational prescribing.

15.2 Dose selection
- Explain the importance of accurate calculation of drug dosage, especially for intravenous infusions.
- Interpret different expressions of drug concentration or dose and be able to convert them.
- Calculate appropriate doses for individual patients, based on age, body weight and surface area.
- Explain how to select drug dosage using widely available nomograms.
- Identify factors that may necessitate amendments of standard doses.

16. Clinical toxicology

16.1 Principles of assessing poisoned patients
- Explain the epidemiology of poisoning.
- Describe the principles of assessment of a poisoned patient.
- Discuss the role of urine and blood sampling in poisoned patients.
- Describe the clinical features of overdosage with commonly used medicines (e.g. paracetamol, salicylates, tricyclic antidepressants, opioids and benzodiazepines), including poisoning syndromes.

16.2 Principles of treating poisoned patients
- Describe the principles involved in treating a poisoned patient.
- Explain how to access and obtain information from the National Poisons Information Service.
- List drugs and toxins to which effective antidotes are available.
- Explain the means by which the elimination of drugs or toxins can be hastened, including decontamination.

17. Misuse of drug

- List drugs that are commonly misused (e.g. alcohol, cannabis, ecstasy, hallucinogens, nicotine, volatile solvents, cocaine, opiates) and some of their important pharmacodynamics effects.
- Explain the legal classification of drugs.
- Describe the epidemiology of drug misuse in the population.
- Define tolerance, physical dependence and psychological dependence.

18. Commonly used drugs

- Explain the main mechanism of action at the level of the active substance.
- Explain appropriate indications for use in primary and secondary care.
- Identify drug interactions at drug class level.
- Define contraindications with clinically severe outcomes.
- Describe common and severe or potentially lethal side effects.
- Describe appropriate routes of administration.
19. **Common therapeutics problems**

- Management of common acute and chronic therapeutic problems.

20. **Complementary and alternative medicine**

- Describe the extent of the popularity of complementary therapeutic approaches.
- Identify the motivations that lead patients to seek complementary and alternative therapies.
- Describe common therapies used by practitioners of complementary and alternative medicine and the evidence for their efficacy and safety.
- Explain the potential of complementary and alternative medicines to cause adverse effects.
- Describe common complementary and alternative medicines which interact with prescription drugs (e.g. St. John’s wort).
- Describe the regulation of complementary and alternative medicines.

21. **Use of antibiotics and antibiotic resistance**

- Understand the development of antibiotic resistance.
- Know how to interpret sensitive, low-grade resistance, high-grade resistance, outpatient strains vs. inpatient strains and trends over time.
CORE SKILLS (n= 13)

1. Medication history taking

- Elicit and record an accurate medication history, including current and recent medicines, to support effective medicines reconciliation.
- Identify, where possible, for each drug the original indication, formulation, dose, route, duration and effects.
- Make an assessment of adherence to a medication regimen.
- Ensure that over the counter, complementary medicines and the contraceptive pill are specifically included.
- Obtain a history of misuse of drugs and recognize which patient may have such problems.
- Identify alternative sources of information about current treatment, understand the limits of information sources and compensating for them.
- Interpret the medication history so that allergies and ADRs can be identified (distinguish between a history of drug allergy and intolerance).
- Identify common potentially important drug contraindications and interactions.

2. Prescribe a new medicine

2.1 Prescribe drugs safely, effectively and economically

- Define patient’s problem(s) to be treated.
- Define the therapeutic objective(s) for new therapy.
- Develop a list of possible treatments (i.e. standard treatment or P-drugs) for a diagnosis.
- Consider risks and benefits of specific drug therapies.
- Recognize drugs with a narrow therapeutic index or high potential for serious adverse effects/interactions, and take appropriate precautions when prescribing them.
- Follow clinical guidelines, protocols and formularies where appropriate.

2.2 Write prescriptions that take into account the needs of individual patients

- Check the drug suitability for a patient by considering possible contraindications, drug–drug interactions, previous ADRs, any special circumstances, age and gender, and diseases.
- Prescribing drugs for patient with special requirements (e.g. elderly, children, pregnancy and breast-feeding, renal and liver failure).
- Prescribe high risk medicines (e.g. oxygen, warfarin, insulin, opioids, intravenous fluids).
- Choose the appropriate formulation, dose, route, frequency and duration of a drug.
- Interpret data that is relevant to prescribing decisions (e.g. renal function, drug concentrations).
- Find the most commonly described clinically important pharmacogenetics syndromes that produce atypical patient responses to medications.

2.3 Write prescriptions that take into account the needs of individual patients

- Document the rationale for new prescribing decisions in patient notes.
- Recognize the potential for medication errors and take steps to reduce the risks.
- Recognize situations where their prescribing skills are not sufficient, and seek advice before proceeding.

3. **Calculate drug doses**

- Calculate appropriate doses for individual patients by weight and body surface area, and based on a normogram.
- Calculate the strength of an infusion based on the required rate of drug administration.
- Convert doses between common units and convert between concentrations expressed as percentage and mass.

4. **Prescription writing**

4.1 *Prescribe on electronic hospital in-patient prescription charts*
- Write an unambiguous, legible, complete and legal (electronic) prescription, including approved drug name, appropriate form and route, correct dose, any other necessary instructions, patient and prescriber details, date and signature.
- Avoid abbreviations and other ambiguities when writing a (electronic) prescription.
- Prescribe ‘once only’, regular and ‘as required’ medicines.

4.2 *Prescribing on other documentation*
- Prescribe on (electronic) hospital supplementary prescription charts.
- Prescribe ‘to take out’ drugs on discharge from hospital.
- Prescribe on general practice prescription forms.
- Keep accurate records of prescriptions and responses.
- Cancel prescriptions appropriately.

5. **Non-drug therapy**

- Use nondrug therapy where appropriate (e.g. physical exercise, good nutrition and self-regulation techniques).

6. **Communication**

5.1 *Discussing prescribing options with patients*
- Communicate treatment plan (i.e. effects of drugs, possible side effects, warnings) and instructions (i.e. when to take, how to take, what duration) to patient, at a suitable level of information.
- Engage in shared decision making where appropriate, including obtaining informed consent.
- Assess and improve drug adherence, compliance and concordance.

5.2 *Discussing prescribing decisions with colleagues*
- Communicate treatment plans and monitoring arrangements clearly with other members of staff and hospital pharmacist, in both verbal and written/electronic form.
- Keep accurate written records of management plans.
- Write accurate discharge prescriptions and letter to general practitioner and follow-up institutions (e.g. nursing home, rehabilitation centre).

7. **Reviewing prescriptions**

- Reviewing current lists of prescribed medicines on indication, contraindications, interactions, suitability and costs.
- Identify and correct prescribing errors.
- Identify and manage inappropriate prescribing.

8. **Adverse drug reactions**

- Assess and manage common ADRs and interactions in the context of current clinical situation.
- Report a suspected ADR using the national pharmacovigilance
- Find information about adverse drug reactions.
- Recognizing and treating presentations of drug allergies and acute anaphylaxis.

9. **Clinical toxicology**

- Managing overdosage with commonly used medicines (e.g. paracetamol, salicylates, tricyclic antidepressants, opioids and benzodiazepines).
- Find information from national Poisons Information Services.

10. **Obtaining information from guidelines and protocols to support prescribing**

- Find and interpret information from the Summary of Product Characteristics.
- Find and interpret relevant drug information from the paper and online national formularies and protocols.
- Access and interpret reliable drug information from medical journal and medical databases.

11. **Drug administration**

9.1 **Administering parenteral medicines**
- Preparing drugs for parenteral administration including mixing and dissolving drugs.
- Administer drugs by subcutaneous injection.
- Administer drugs by intramuscular injection.
- Administer drugs by intravenous injection.
- Administer drugs by intravenous infusion pumps.
- Administer drugs using an inhaler.

9.2 **Administering medicines by other routes**
- Administer drugs using a nebulizer.
- Administer drugs to the eye.
- Administer drugs to the ear.
- Administer drugs to the nose.
- Administer drugs to the skin.

12. Clinical pharmacokinetics

- Apply knowledge of how a particular pharmacokinetic profile of a drug would alter the way in which it should be prescribed in common clinical problems (e.g. loading and maintenance dose).
- Indicate how alterations of renal and hepatic function might alter the pharmacokinetics of a drug.
- Find relevant pharmacokinetic data for common medicines.

13. Monitoring medication

- Identify which therapeutic effect to observe.
- Establishing parameters with which to monitor therapeutic effect (e.g. clinical outcomes, plasma drug concentrations, laboratory tests).
- Request measurements of drug concentrations at optimal times for appropriate indications.
- Incorporating valid results into revised therapeutics regimens.
CORE ATTITUDES (n= 4)

1. Risk-benefit analysis

- Recognizing that there are risks and benefits associated with all drug treatments.
- Recognizing that risks and benefits may differ between patients, depending on a variety of factors.
- Recognizing that doctors should monitor the impact of the drugs they prescribe.

2. Recognizing personal limitations in knowledge

- Recognizing the need to seek further information about drugs when faced with unfamiliar prescribing problems.

3. Recognition of balanced approach to the introduction of new drugs

- Recognizing the need to update prescribing practices.
- Recognizing the need to assess the benefits and hazards of new therapies.
- Ensuring that patients benefit when possible from advances in medical knowledge.
- Knowing the limitations of applying clinical trial data to individual patients and compensate for them.

4. A new prescription as an experiment

- Students should develop the attitude that every prescription is really a carefully designed experiment that can produce a useful clinical effect, toxicity, or both.