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Developing a competency-based curriculum in basic and clinical pharmacology - a Delphi study among physicians

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Running title

Competency-based pharmacology curriculum

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Abstract

A new curriculum is planned for the medical school at Lund University, Sweden.

Pharmacology, in a broad sense, has been identified as a subject that needs to be strengthened based on needs in the health care system. The aim was to identify the competencies in basic and clinical pharmacology that a newly qualified physician needs.

Using a modified three-round Delphi technique, 31 physicians were invited to list necessary competencies (round 1). After content analysis, these panel members classified the list by importance on two occasions (rounds 2 and 3) using a 4-point scale (4 = necessary, 3 = desirable, 2 = useful, 1 = not necessary). Competencies with the highest ranks based on necessity were retained.

Thirty physicians accepted the invitation and 25 (83%) of them completed all three rounds. Round 1 resulted in 258 suggestions, which were subsequently reduced to 95 competencies. Of these 95 competencies, 40 were considered necessary by at least 75% of the panel members. The degree of consensus increased between round 2 and round 3.

Using a modified Delphi technique we identified 40 competencies that could be transferred to learning outcomes for a new curriculum in basic and clinical pharmacology at medical school.

Introduction and background

Undergraduate medical curricula have changed over recent years and their development continues [1]. Problem-based curricula [2, 3] and more recently outcome-based or competency-based curricula have become common [4, 5]. In Europe this trend was strengthened by the Tuning projects for medicine [6] and the so-called Bologna agreement [7]. Previously, curricula were often subject- or discipline-based. After the introduction of problem-based or outcome-based curricula there have been concerns that students lack knowledge in certain subjects, e.g. pharmacology [8].

Students' long-term retention of basic science knowledge may be about 50%, which explains some lack of knowledge of subjects taught in preclinical years [9]. A return to pharmacology in later years has been proposed to improve the situation [10]. Perceived clinical relevance increased retention of basic scientific knowledge [11]. Morrow et al. showed that students perceived that they lacked competence in several areas, and that the differences between schools indicated differences in curricula [12]. Michel et al. showed that there was no difference in knowledge of pharmacology between lecture- and problem-based teaching [13].

Basic pharmacology is comprised of, e.g. the general mechanisms of action of drugs at a molecular, cellular, tissue and organ level, whereas clinical pharmacology is the scientific discipline that involves all aspects of the relationship between drugs and humans [14].

Clinical pharmacology is supposed to be an important part of all clinical education. However, since pathophysiology, clinical reasoning and diagnoses dominate teaching in the clinical disciplines, smaller subjects such as clinical pharmacology may attract less attention from both teachers and students. In most European countries there are a limited number of clinical

pharmacologists [15]. In a 2007 meeting, by the European Association of Clinical Pharmacology and Therapeutics and British Pharmacological Society, it was stated that 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 [16].

Development of learning outcomes in clinical pharmacology may increase attention on this subject. There are reports on such development [8, 10, 17, 18]. Flockhart et al. have developed a core curriculum in clinical pharmacology for year 4 in a 4-year curriculum [10], and Naritoko and Faingold one for the same year that is more focused on drugs [17].

In 2002 Orme et al. suggested a core curriculum in pharmacology for Europe, because of the perceived lack of pharmacological knowledge in medicine graduates [8]. They suggested using an approach based on either drugs or diseases. Richir et al have used context –learning as an effective way to teach how to prescribe rationally [19]. Ross and Loke have developed a prescribing curriculum for undergraduate medical education in the UK [20].

There still seems to be a need to define what learning outcomes are necessary when graduating from medical school. Such outcomes can be used in any curriculum design, as long as a careful blueprint is designed to make sure that students progress towards the final learning outcomes. This study was initiated in order to develop such learning outcomes in pharmacology.

The aim of this study was to identify the core competencies in basic and clinical pharmacology that a newly qualified physician requires. These competencies will form the basis for planning the new curriculum in pharmacology.

Materials and Methods

The study was performed in January to May 2014. A modified Delphi technique, previously used by our group [21] and based on other publications [22-25], was used in this study. The method is based on suggestions from a panel. In its original form, selected panel members are asked to express their opinion on the matter at hand in a qualitative round. The results of this round are then used to make a quantitative questionnaire that is returned to the panel for grading. The results are compiled and sent to the panel members for comparison with their own answers and reconsideration of their opinions. These rounds continue until consensus is achieved. However, because the response rate tends to drop with each round, consensus has to be defined in some other way (see below). The panel members are not known to each other, and should thus not be influenced by differences in power or position. The identities of the panel members are known to the researchers, but full confidentiality is maintained.

In this study, we asked the panel to identify the necessary competencies in pharmacotherapy for recently graduated physicians. The survey was conducted with Artisan Global Media software (Växjö, Sweden). The participants were sent an e-mail with a link to the survey. The first round was followed by two successive questionnaires.

Setting

In Sweden the requirements for a medical degree and a license to practise medicine are decided by the government [26]. The medical education has to fulfil the minimum requirements for medical education in Directive 2005/36/EC of the European Parliament and of the Council [27]. Undergraduate medical education lasts for 5.5 years followed by a 1.5-year internship.

Panel

We selected the panel from among physicians, in hospitals and primary care, based on interest in the field of clinical pharmacology or therapeutics. A letter was sent to selected representatives, from the four most southern health care regions in Sweden, to give us names of physicians in postgraduate education and/or with specific interest in the field of clinical pharmacology or therapeutics. Our panel was chosen based on the suggestions put forward by the selected representatives. There were no clinical pharmacologists in our panel. In this study we focused on the needs as perceived by clinicians, without involvement in teaching of clinical pharmacology.

We based our decision to have at least 20 participants in the panel on literature reports [22-25].

We identified 31 physicians and invited them to participate by phone or in personal meetings. A total of 30 accepted the invitation, received an information letter and provided formal consent. All of the participants had an MD degree and worked as physicians within the Swedish health care system (Table 1).

Procedure

In the first round, all panel members were asked to list the competencies they considered necessary for a recently graduated physician. Two researchers (PH, GE) independently performed content analysis of the suggested competencies [28] and agreed on a list of categorized competencies.

The second round was a quantitative questionnaire comprising the competencies identified in round one. The panel members were asked to classify the competencies on a four-point scale

(1 = not necessary, 2 = useful, 3 = desirable, 4 = necessary). When we received no response we sent out two reminders.

The third round was identical to the second, but included the results of the previous round as the percentages of the participants choosing each score for each question. An example is given in Table 2.

Consensus definition

To determine the importance of each skill we ranked them based on the number of participants who chose each score: “necessary”, followed by “desirable” and finally “useful”.

We decided in advance to use only two rounds of questionnaires after the qualitative round, so as to not overburden our panel and possibly reduce response rates. There is no mandated agreement in the existing literature on specific criteria to use to determine when consensus has been achieved [18], i.e. when to stop a Delphi study [29]. We defined consensus as 75% of the participants agreeing that the competency was necessary after the second round of questionnaires [30].

The final list of necessary competencies was arranged into four categories (basic pharmacology, clinical pharmacology, communication & professional judgement) and rephrased to provide a list of learning outcomes to be used as final outcomes in the medical school curriculum.

Results

The communication between the researchers and the panel is outlined in Figure 1. In the first round, 28 of the 30 panel members made suggestions. All 28 received the questionnaires in

the second and third rounds; 26 answered the questionnaire in the second and 25 in the third round.

The panel suggested 258 competencies in the first round, many of them being similar or almost identical. After content analysis and categorization, a list of 95 different competencies was identified.

In the third round, the questionnaire used in the second round was sent to the panel with feedback, and 40 of the 95 competencies were considered necessary by at least 75% of the panel members (our definition of consensus) (Table 3). For 93 of the 95 competencies, the disagreement decreased from round 2 to round 3. The participants thus came to have a high degree of agreement on which competencies were necessary and which ones were not. The results of the assessment in the third round for all 95 competencies are presented in the Appendix.

We considered seven of the competencies as generic within the medical profession and not specific to pharmacology (Table 3). They were thus excluded from the final list of learning outcomes for basic- and clinical pharmacology.

Discussion

In this study we identified necessary competencies in basic-and clinical pharmacology for recently graduated physicians, as judged by physicians with special interest in the field of drug treatment. The degree of consensus and the average score for necessity increased during the Delphi process.

At present there is no standard pharmacology curriculum in Sweden and no specific part of

the current teaching program has been deemed unnecessary. Many of the competencies focus on knowledge of pharmacodynamics and pharmacokinetics, but it is also emphasised that physicians should be able to interpret information sources and also be aware of rules and responsibilities regarding drug treatment. The increasing concerns about drug-related problems in the elderly, as well as overprescribing of antibiotics, are reflected in our results. The importance of prescribing for elderly patients has been highlighted in a 2010 report by the International Union of Basic and Clinical Pharmacology [14].

For this study we have focused on what competencies are required – not how these competencies should be acquired. Previous studies have shown that context learning [19, 31] or the WHO-6-step method [32] could be effective. The WHO-6-step method has been proven to be effective according to a systematic review since it has been tested in a wide variety of international settings, whereas other interventions have been tested in single centers only [33].

An interesting result is that the participants were defining and rating competencies in pharmacology, yet seven of the 40 competencies they agreed to be necessary were generic, e.g. “Be able to communicate with other doctors”. We found the same thing in previous studies [21, 34]. This indicates that these generic competencies are considered important and difficult to separate from the context in which they are applied.

Walley and Webb developed core content on clinical pharmacology for a separate course using the Delphi technique [18]. They focused on delivery of the course, i.e. when different parts of basic pharmacology, clinical pharmacology and therapeutics should be taught and by whom. Clinical pharmacologists should be involved in defining the course content, but not necessarily in directing or delivering it, according to Walley and Webb. In that study all eight

participants were clinical pharmacologists, whereas in our study we chose not to include any clinical pharmacologists. We believe it is important to identify the general needs of knowledge in basic and clinical pharmacology for all students. In a similar way Kilroy and Mooney determined the pharmacological knowledge required in emergency medicine [35].

In this study we identified competencies in pharmacology which can be used for courses in basic and clinical pharmacology, or for courses that integrate pharmacology with other disciplines. The identified competencies may be considered to be of importance in the education of physicians in other countries. Adjustments may be needed depending on the curriculum in different medical schools.

We believe that this method of identifying competencies in pharmacology could be transferred to other subjects within medical school training.

Strengths and limitations

We used a modified three-round Delphi technique. A total of 25 physicians reached consensus in identifying competencies in pharmacology that could be transferred to learning outcomes.

The response rate was high.

We chose not to include any clinical pharmacologists in our panel. The reason for this is that almost all clinical pharmacologists, within the health care system in Sweden, work at university hospitals and are typically involved in the education of undergraduate students. In this study we did not want the opinions of current teachers in pharmacology.

We focused on required competencies among newly qualified physicians in general. To identify these competencies, panel members with different specialties were chosen on the

recommendation by representatives from four health care regions. Had we asked clinical pharmacologists to participate it is possible the focus might have been more from the perspective of a clinical pharmacologist, instead of the needs of a newly qualified physician. We believe that we have adhered to the quality standards for reporting of Delphi studies recommended by Diamond et al. [30].

It is a challenge to select the content and learning outcomes for undergraduate medical education. The disciplines increase in both number and the amount of knowledge available. The learning outcomes must focus on the following: what is necessary for a recently graduated doctor to know, what they should be able to do in their first years in the profession and on what is needed as a base in all specialties. When specialists design the necessary content it tends to include the knowledge needed by the specialists themselves. When all this is put together in undergraduate medical education the result is curriculum overload [4, 36]. All specialists have their set of competencies in pharmacology and undergraduate education cannot just be the sum of these. We therefore selected panel members who were considered “broad” in their pharmacology competence, concentrating on family medicine and interns. Our study has some weaknesses. The Delphi technique depends on consensus. Issues that are considered very important by some, but not all participants, may be eliminated. Also, the number of panel members that participated might not have been optimal. We do not know if having more or fewer panel members would have improved the validity of our results.

We do not have any data on the panel members’ teaching experience. For this study we have focused on what competencies are required – not how these competencies should be acquired. Agreement on the necessity of most of the listed competencies was high in this study. This may have been a result of the selection of physicians with an interest in clinical

pharmacology. Selection of physicians with other specialties could have yielded a different result. A potentially interesting next step would be to send the questionnaire to a larger number of physicians also outside Sweden.

Our study defines the competencies that are considered necessary by our choice of participants. If other groups of participants had been included these competencies might have been different. Other sources of input could of course be useful e.g. clinical pharmacologists, pharmacists or researchers within drug development. To also get these inputs it might be better to make separate studies since the Delphi technique depends on consensus.

A weakness when constructing a curriculum is that we are designing the curriculum of tomorrow based on the knowledge of today. This could explain the rather conservative results of our study. It is of course difficult to predict what new possibilities and threats physicians will face regarding pharmacology as well as other subjects. There is no final curriculum but instead it is a continuous development.

In conclusion we identified 40 competencies that a newly qualified physician needs and that could be transferred to learning outcomes for a new curriculum in clinical pharmacology.

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Figures and Tables

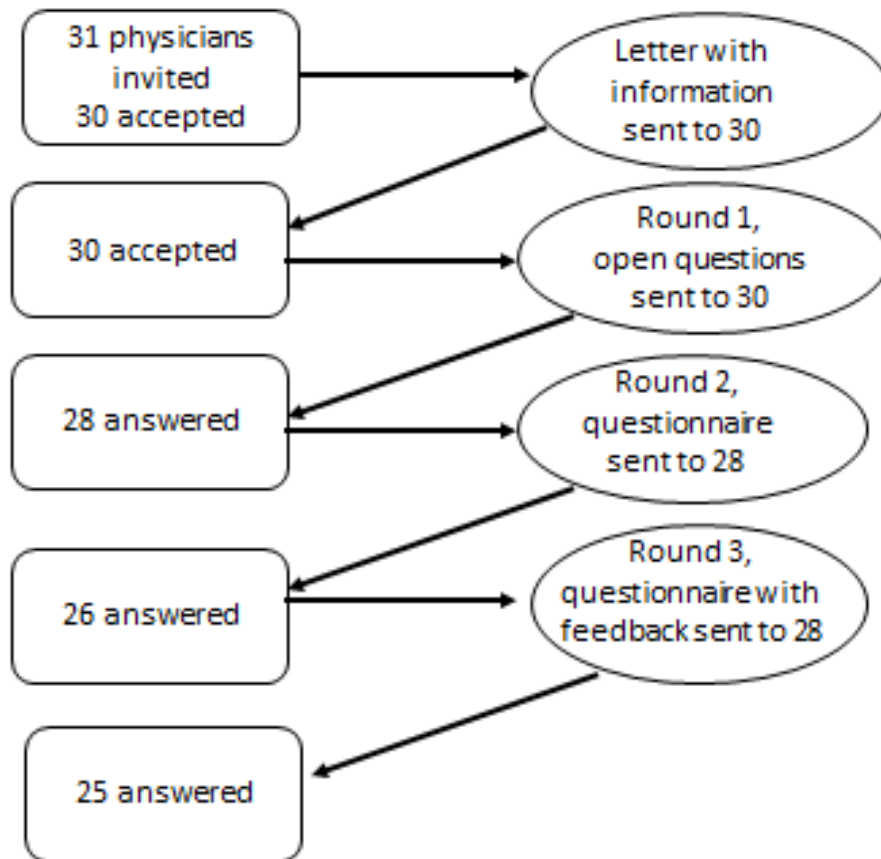


Figure 1. Results of the communication between researchers and panel members in the three Delphi rounds

Table 1. Clinical specialities and experience of the participants

| Participant number | Speciality | Experience level* |
|--------------------|--------------------------------|-------------------|
| 1 | Family medicine | Long |
| 2 | Family medicine | Long |
| 3 | Family medicine | Long |
| 4 | Internal medicine and diabetes | Long |
| 5 | Infectious diseases | Long |
| 6 | Anaesthesiology | Short |
| 7 | Family medicine | Short |
| 8 | Internal medicine | Short |
| 9 | Psychiatry | Short |
| 10 | Family medicine | Long |
| 11 | Family medicine and cardiology | Long |
| 12 | Family medicine | Long |
| 13 | Internal medicine | Long |
| 14 | Family medicine | Long |
| 15 | Family medicine | Long |
| 16 | Family medicine | Long |
| 17 | Internal medicine | Long |
| 18 | Psychiatry | Long |
| 19 | Geriatrics | Long |
| 20 | Geriatrics | Long |
| 21 | Internal medicine | Long |
| 22 | Anaesthesiology | Long |
| 23 | Family medicine | Long |
| 24 | Geriatrics | Long |
| 25 | Otorhinolaryngology | Long |
| 26 | No speciality yet (intern) | Short |
| 27 | No speciality yet (intern) | Short |
| 28 | No speciality yet (intern) | Short |
| 29 | No speciality yet (intern) | Short |
| 30 | Infectious diseases | Long |

*Long: more than 10 years of clinical work as a physician

Table 2. Examples from the questionnaire for the third Delphi round

| How important is the following competency for a newly graduated physician | Place a cross in the empty column for one of the following options. The percentages indicate how the options were graded in the previous round. | | | | | | | |
|---|---|--|--------|--|-----------|--|-----------|--|
| | Not necessary | | Useful | | Desirable | | Necessary | |
| Understand when drug treatment should be modified according to patient age | 0% | | 11.5% | | 46.2% | | 42.3% | |
| Be able to adjust drug treatment according to the patient's kidney function | 0% | | 3.8% | | 46.2% | | 50% | |
| Understand the meaning of therapeutic window | 3.8% | | 3.8% | | 23.1% | | 69.2% | |

The panel members were given the following instructions: “For each of the listed competencies, reflect on the grading by the other experts in the second round. Then indicate the importance of each given competency.”

Table 3. Competencies that more than 75% of the panel members considered necessary. Data are presented as the number of panel members' answer to each statement.

| “A newly qualified doctor should...” | Category | Not necessary | Useful | Desirable | Necessary | Number |
|--|------------------------|----------------------|---------------|------------------|------------------|---------------|
| 1. Be able to communicate with other doctors ^a | Communication | 0 | 0 | 0 | 25 | 25 |
| 2. Be able to document drug prescribing | Communication | 0 | 0 | 0 | 25 | 25 |
| 3. Be able to prescribe drugs | Communication | 0 | 0 | 0 | 25 | 25 |
| 4. Be able to adjust drug treatment according to the patient's kidney function | Clinical pharmacology | 0 | 0 | 1 | 24 | 25 |
| 5. Understand when drug treatment should be modified because of pregnancy | Clinical pharmacology | 0 | 0 | 1 | 24 | 25 |
| 6. Understand the development of antibiotic resistance | Basic pharmacology | 0 | 0 | 0 | 24 | 24 |
| 7. Be able to communicate with other health care personnel ^a | Communication | 0 | 0 | 0 | 24 | 24 |
| 8. Be able to find information about contraindications | Professional judgement | 0 | 0 | 0 | 24 | 24 |
| 9. Be aware of the limits of their own knowledge and know when they need to consult a colleague ^a | Professional judgement | 0 | 0 | 0 | 24 | 24 |
| 10. Be aware of the limits of their own knowledge and be able to find relevant information ^a | Professional judgement | 0 | 0 | 0 | 24 | 24 |
| 11. Be able to interpret text in FASS ^b | Professional judgement | 0 | 0 | 0 | 24 | 24 |
| 12. Understand a doctor's responsibility for drug treatment | Professional judgement | 1 | 0 | 0 | 24 | 25 |
| 13. Understand drug-related problems | Clinical pharmacology | 0 | 0 | 2 | 23 | 25 |
| 14. Understand problems due to overdose or toxicity | Clinical pharmacology | 0 | 0 | 2 | 23 | 25 |
| 15. Know the meaning of the term abstinence | Clinical pharmacology | 0 | 0 | 2 | 23 | 25 |
| 16. Be able to create an alliance with the patient ^a | Communication | 0 | 0 | 2 | 23 | 25 |
| 17. Know which preparations form the basis of treatment for common emergencies | Clinical pharmacology | 0 | 0 | 2 | 23 | 25 |
| 18. Know which preparations form the basis of treatment for diabetes | Clinical pharmacology | 0 | 0 | 2 | 23 | 25 |
| 19. Know which preparations form the basis of treatment for | Clinical pharmacology | 0 | 0 | 2 | 23 | 25 |

| | | | | | | |
|--|------------------------|---|---|---|----|----|
| hypertension | | | | | | |
| 20. Be able to use e-prescriptions | Communication | 0 | 0 | 2 | 23 | 25 |
| 21. Be aware of the risks of dependence | Clinical pharmacology | 0 | 0 | 1 | 23 | 24 |
| 22. Understand contraindications | Clinical pharmacology | 0 | 0 | 1 | 23 | 24 |
| 23. Be able to record a medication history | Clinical pharmacology | 0 | 0 | 0 | 23 | 23 |
| 24. Know the meaning of half-life | Basic pharmacology | 0 | 0 | 3 | 22 | 25 |
| 25. Identify combinations of drugs that are particularly inappropriate | Clinical pharmacology | 0 | 0 | 3 | 22 | 25 |
| 26. Understand when drug treatment should be modified according to patient age | Clinical pharmacology | 0 | 0 | 3 | 22 | 25 |
| 27. Know which principles apply to the choice of antibiotics for common infections | Clinical pharmacology | 0 | 0 | 3 | 22 | 25 |
| 28. Be able to apply prescription rules | Professional judgement | 0 | 0 | 1 | 22 | 23 |
| 29. Be able to inform the patient about the choice of treatment ^a | Communication | 0 | 0 | 4 | 21 | 25 |
| 30. Understand the dose-effect relationship | Clinical pharmacology | 0 | 1 | 3 | 21 | 25 |
| 31. Be able to motivate the patient to comply [with treatment] ^a | Communication | 0 | 0 | 5 | 20 | 25 |
| 32. Be able to inform the patient about possible side effects | Communication | 0 | 0 | 5 | 20 | 25 |
| 33. Know which preparations form the basis of treatment for other common diseases | Clinical pharmacology | 0 | 0 | 5 | 20 | 25 |
| 34. Understand drug lists | Professional judgement | 0 | 0 | 5 | 20 | 25 |
| 35. Understand the importance of compliance for evaluating drug efficacy | Professional judgement | 0 | 1 | 4 | 20 | 25 |
| 36. Understand drugs' mechanisms of action | Basic pharmacology | 0 | 0 | 4 | 20 | 24 |
| 37. Know which principles apply to the treatment of pain | Clinical pharmacology | 0 | 0 | 4 | 20 | 24 |
| 38. Understand the meaning of therapeutic window | Clinical pharmacology | 0 | 0 | 6 | 19 | 25 |
| 39. Know the need for concentration determination for certain drugs | Basic pharmacology | 0 | 1 | 5 | 19 | 25 |
| 40. Understand [drug] tolerance | Basic pharmacology | 0 | 0 | 4 | 19 | 23 |

^a Competencies that apply to all subjects in medical school

^b FASS: Product information on pharmaceuticals that are approved by the pharmaceutical marketing holders in collaboration (www.fass.se)