The European List of Key Medicines for Medical Education: A Modified Delphi Study

Erik M. Donker[1,2,*], Pietro Spitaleri Timpone[3], David J. Brinkman[1,2], Milan C. Richir[1,2,4], Paraskevi Papaioannidou[5], Robert Likic[6], Emilio J. Sanz[7], Thierry Christiaens[8], João N. Costa[9,10], Fabrizio De Ponti[3], Milo Gatti[3], Ylva Böttiger[11], Cornelis Kramers[12,13], Rahul Pandit[14], Michiel A. van Agtmael[1,2] and Jelle Tichelaar[1,2,15], on behalf of the Network of Teachers in Pharmacotherapy

Rational prescribing is essential for the quality of health care. However, many final-year medical students and junior doctors lack prescribing competence to perform this task. The availability of a list of medicines that a junior doctor working in Europe should be able to independently prescribe safely and effectively without supervision could support and harmonize teaching and training in clinical pharmacology and therapeutics (CPT) in Europe. Therefore, our aim was to achieve consensus on such a list of medicines that are widely accessible in Europe. For this, we used a modified Delphi study method consisting of three parts. In part one, we created an initial list based on a literature search. In part two, a group of 64 coordinators in CPT education, selected via the Network of Teachers in Pharmacotherapy of the European Association for Clinical Pharmacology and Therapeutics, evaluated the accessibility of each medicine in his or her country, and provided a diverse group of experts willing to participate in the Delphi part. In part three, 463 experts from 24 European countries were invited to participate in a 2-round Delphi study. In total, 187 experts (40%) from 24 countries completed both rounds and evaluated 416 medicines, 98 of which were included in the final list. The top three Anatomical Therapeutic Chemical code groups were (1) cardiovascular system ($n = 23$), (2) anti-infective ($n = 21$), and (3) musculoskeletal system ($n = 11$). This European List of Key Medicines for Medical Education could be a starting point for country-specific lists and could be used for the training and assessment of CPT.

Study Highlights

WHAT IS THE CURRENT KNOWLEDGE ON THE TOPIC?

☑ Although there are lists of essential medicines, in many cases, these are out of date, country-specific, developed by a small group of experts, or do not focus on medical education. Recently, it has been proven that the Delphi method is a feasible way to reach consensus on a list of medicines for medical education in the Netherlands.

WHAT QUESTION DID THIS STUDY ADDRESS?

☑ This modified Delphi study was set up to identify a list of medicines that junior doctors working in Europe should be able to independently prescribe safely and effectively without direct supervision.

WHAT DOES THIS STUDY ADD TO OUR KNOWLEDGE?

☑ An expert panel of 187 health care professionals from 24 different European countries reached consensus on 98 medicines that junior doctors working in Europe should be able to independently prescribe safely and effectively. Additionally, we provide country-specific lists.

HOW MIGHT THIS CHANGE CLINICAL PHARMACOLOGY OR TRANSLATIONAL SCIENCE?

☑ The European List of Key Medicines for Medical Education will help to harmonize and modernize teaching and training in clinical pharmacology and therapeutics, and thereby improve the quality of care.

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[1]Unit Pharmacotherapy, Department of Internal Medicine, Amsterdam UMC, Vrije Universiteit, Amsterdam, The Netherlands; [2]Research and Expertise Centre in Pharmacotherapy Education (RECIPE), Amsterdam, The Netherlands; [3]Pharmacology Unit, Department of Medical and Surgical Sciences, Alma Mater Studiorum, University of Bologna, Bologna, Italy; [4]Department of Surgery, University Medical Center Utrecht, Utrecht, The Netherlands; [5]Department of Pharmacology, School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece; [6]Unit of Clinical Pharmacology, Department of Internal Medicine, University Hospital Centre Zagreb and University of Zagreb School of Medicine, Zagreb, Croatia; [7]School of Health Science, Universidad de La Laguna, and Hospital Universitario de Canarias (SCS), Santa Cruz de Tenerife, Spain; [8]Unit of Clinical Pharmacology, Department of Fundamental and Applied Medical Sciences, Ghent University, Ghent, Belgium; [9]Laboratory of Clinical Pharmacology and Therapeutics, University of Lisbon, Lisbon, Portugal; [10]Instituto de Medicina Molecular, Lisbon, Portugal; [11]Department of Medical and Health Sciences, Linköping University, Linköping, Sweden; [12]Department of Clinical Pharmacy, CWZ, Nijmegen, The Netherlands; [13]Department of Internal Medicine, Radboud University, Nijmegen, The Netherlands; [14]Department of Translational Neuroscience, UMC Utrecht Brain Center, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands; [15]Interprofessional Collaboration and Medication Safety at the Faculty of Health, Sports and Social Work, Inholland University of Applied Sciences, Amsterdam, The Netherlands. *Correspondence: Erik M. Donker (e.donker@amsterdamumc.nl)

Prescribing knowledge and skills are essential to the ability to prescribe safely and effectively in clinical practice. Yet, studies have shown that final-year medical students and junior doctors lack confidence and competence in prescribing, and that their prescribing knowledge and skills do not increase in the year after graduation.[1–6] Not surprisingly, junior doctors make the most prescribing errors in a hospital setting.[7,8] This is worrying, because their prescribing duties will become increasingly complex, largely due to the high number of patients on polypharmacy as a result of aging and chronic diseases. In recognition of this problem, in 2007, the European Association for Clinical Pharmacology and Therapeutics (EACPT) stated that teaching and training in clinical pharmacology and therapeutics (CPT) should be harmonized and modernized.[9] To this end, several (inter-)national projects were initiated. In the United Kingdom and the Netherlands, for example, a prescribing assessment was developed for final-year medical students, to verify their prescribing knowledge and skills.[10–12] Such assessments would be beneficial for all European medical schools, because it has shown to improve at least the prescribing knowledge of junior doctors.[13] We started the "European Prescribing Exam" (EuroPE$^+$) project in 2019,[14] an Erasmus+ project consistent with the goals of the EACPT.[15,16] EuroPE$^+$ is a 2-hour online assessment of prescribing knowledge and skills. The examination is based on previous consensus studies of key learning outcomes and essential diseases for CPT education, and on the Dutch National Pharmacotherapy Assessment.[10,11,17,18] It necessitates establishing a list of medicines that European junior doctors should be able to independently prescribe safely and effectively without direct supervision. Such a list could also be used to harmonize CPT education in Europe, it could be included in the revision of the World Health Organization (WHO) Guide to Good Prescribing,[19] and it could aid the program around the WHO Model List of Essential Medicines and thereby reduce healthcare expenditures and lower the environmental impact.[20,21] Although there are lists of medicines to improve medical education,[22–25] they are either out of date,[22,23] country specific,[24,25] or developed by a limited number of experts.[22,23,25] Therefore, the aim of this study was to reach consensus on a list of medicines that are widely prescribed and accessible in Europe, and which junior doctors working in Europe should be able to independently prescribe safely and effectively without direct supervision: the European List of Key Medicines for Medical Education.

METHODS

Study design

This study used a modified Delphi method, a method proven to be effective in achieving unambiguous consensus on the content of CPT curricula.[17,18,24,26–29] We showed recently that this method is a feasible way to reach consensus on a list of medicines for medical education in the Netherlands.[24] Usually, a Delphi study takes two or more rounds.[30] During each round, items or statements are scored by a panel of experts. Depending on the score, items are accepted or rejected for the final consensus list, or have to be re-evaluated in a next round. Our study was carried out between August 2021 and January 2022 and consisted of 3 parts (**Figure 1**). The study was approved by the Dutch Association for Medical Education Ethical Review Board (NERB: 2020.4.8) and the Medical Ethics Review Committee of Amsterdam University Medical Centers, location Vrije Universiteit (2020.335). Participation was voluntary. The full protocol has been published elsewhere[31]; here, we describe it briefly.

Part 1

In part one, an extensive list of potential medicines was created based on existing lists of medicines known to the authors, the WHO Model List of Essential Medicines, and the existing list of medicines of EuroPE$^+$ (**Table S1**).[22–25,32–36] The list was structured according to the WHO Anatomical Therapeutic Chemical (ATC) classification,[37] and for each medicine the most commonly used routes of administration were listed. Subsequently, we invited coordinators of CPT education from medical schools in Europe (countries $n = 33$ and coordinators $n = 393$) to participate in the Delphi study. The contact details of the coordinators were extracted from the Network of Teachers in Pharmacotherapy (NOTIP) of the EACPT.

Part 2

For part 2, an online questionnaire was developed in Castor Electronic Data Capture (Castor EDC) version 2022.3.1.2. Each coordinator indicated whether the medicines in the list were accessible in his or her country and were asked to add missing medicines they considered to be essential. Subsequently, to create a Delphi panel with multiple perspectives and specialties, the coordinators were asked to select the following healthcare professionals from their own university:

- Two experienced (≥ 3 years of teaching experience) CPT teachers of the undergraduate medical curriculum, at least one of whom is a registered clinical pharmacologist;
- Five healthcare professionals with clinical experience, preferably a surgeon, internist (e.g., general internist, gastroenterologist, pulmonologist, or cardiologist), general practitioner, geriatrician, and (hospital) pharmacist;
- Two recently graduated junior doctors (graduated ≤ 1 year ago) working in clinical practice and prescribing drugs on a daily basis.

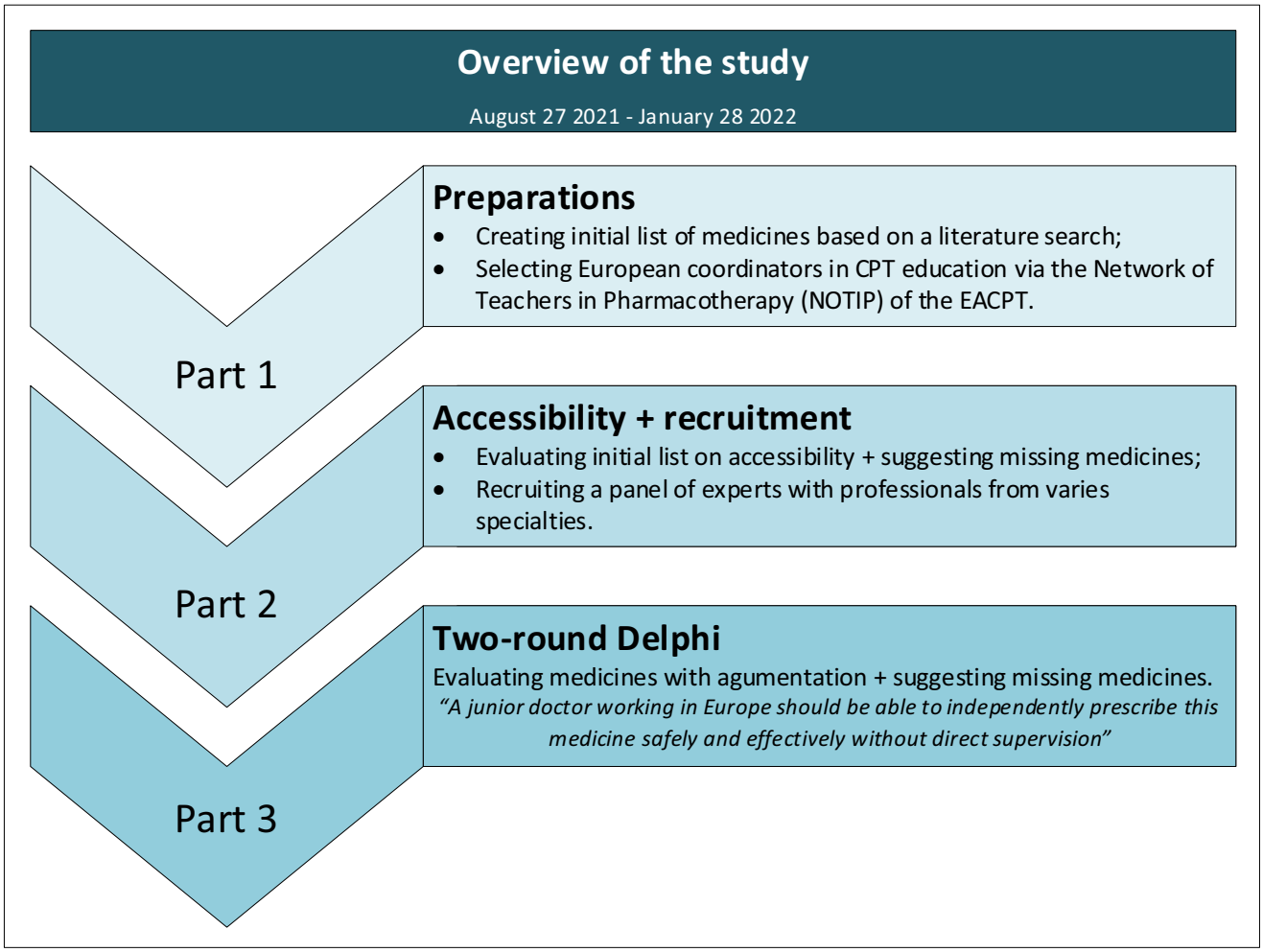

Figure 1 Overview of the study. CPT: Clinical pharmacology and therapeutics.

In the Netherlands, participants of a recent study with the same setup investigating the Dutch list of essential medicines for medical education were asked to participate in this study.[24] These participants signed an addendum to their informed consent form.

Part 3

Part three was the actual two-round Delphi part. In the first round, the coordinators and selected experts had 3 weeks to evaluate the following statement per medicine using a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree): "A junior doctor working in Europe should be able to independently prescribe this medicine safely and effectively without direct supervision." They were able to provide their arguments or suggest missing medicines in open text fields. In the second round (3 weeks), the newly suggested medicines and the medicines with partial agreement were (re)evaluated. The coordinators also had to indicate whether the newly suggested drugs were accessible in his or her country.

In round one, the Dutch participants only had to evaluate the medicines which were not evaluated during the Dutch study. For all other medicines, we used the raw data and asked the Dutch participants whether their answers were also applicable for the European situation. The Dutch participants participated in round two, as did the other experts.

Statistics

Because not all medicines are accessible in all European countries, we pragmatically chose to include the medicines that are accessible in > 80% of the European countries. In part 3, after Delphi round 1, all medicines rated 4 or 5 by ≥ 80% of the respondents were included in the European List of Key Medicines for Medical Education. Medicines rated 4 or 5 by ≥ 50% to < 80% of the respondents (partial agreement) were, together with the newly suggested medicines, reassessed in round 2. Medicines scored 4 or 5 by ≥ 80% of the respondents in round 2 were included in the final list. All other medicines were rejected. Country-specific lists are created when at least five experts of one country participated. Microsoft Excel 2016 (Microsoft, Albuquerque, NM, USA) was used to analyze data using descriptive statistics.

Patient and public involvement

No patients or public were involved in this study.

RESULTS

Demographics

In part 2, there were 64 (16%) coordinators of CPT education from 60 universities in 24 European countries who completed the questionnaire and provided 399 experts for part 3. In part 3,

Table 1 Demographics

		Phase III	
	Phase II: Coordinators (*N* = 64)	Round 1: Coordinators + experts (*N* = 209; Female *n* = 92)	Round 2: Coordinators + experts (*N* = 187; Female *n* = 84)
Country			
Belgium	2 (3.1%)	5 (2.4%)	5 (2.7%)
Bulgaria	4 (6.3%)	20 (9.5%)	17 (9.1%)
Croatia	1 (1.6%)	7 (3.3%)	6 (3.2%)
Cyprus	1 (1.6%)	1 (0.5%)	1 (0.5%)
Czech Republic	2 (3.1%)	11 (5.2%)	9 (4.8%)
Estonia	1 (1.6%)	1 (0.5%)	1 (0.5%)
Finland	1 (1.6%)	1 (0.5%)	1 (0.5%)
France	6 (9.4%)	25 (11.9%)	22 (11.8%)
Germany	9 (14.1%)	12 (5.7%)	11 (5.9%)
Greece	1 (1.6%)	4 (1.9%)	3 (1.6%)
Ireland	4 (6.3%)	6 (2.9%)	5 (2.7%)
Italy	5 (7.8%)	12 (5.7%)	11 (5.9%)
Latvia	2 (3.1%)	5 (2.4%)	4 (2.1%)
Malta	1 (1.6%)	7 (3.3%)	7 (3.7%)
Norway	1 (1.6%)	2 (1.0%)	2 (1.1%)
Poland	4 (6.3%)	11 (5.2%)	10 (5.4%)
Portugal	1 (1.6%)	5 (2.4%)	3 (1.6%)
Romania	3 (4.7%)	9 (4.3%)	7 (3.7%)
Serbia	1 (1.6%)	9 (4.3%)	8 (4.3%)
Slovenia	2 (3.1%)	7 (3.3%)	7 (3.7%)
Spain	5 (7.8%)	16 (7.6%)	14 (7.5%)
Sweden	1 (1.6%)	1 (0.5%)	1 (0.5%)
United Kingdom	6 (9.4%)	8 (3.8%)	8 (4.3%)
The Netherlands	–	25 (11.9%)	24 (12.9%)
Medical specialty			
Internal medicine	7 (10.9%)	46 (22.0%)	40 (21.4%)
Surgery	0 (0%)	6 (2.9%)	5 (2.7%)
Clinical pharmacology	46 (71.9%)	84 (40.2%)	76 (40.6%)
Family medicine	2 (3.1%)	17 (8.1%)	14 (7.5%)
Pharmacy	9 (14.1%)	22 (10.5%)	22 (11.8%)
Geriatrics	0 (0%)	11 (5.3%)	11 (5.9%)
Other	0 (0%)	23 (11.0%)	19 (10.1%)
Anesthesia and intensive care	–	3	3
Clinical laboratory	–	1	–
Dermatology	–	1	1
Emergency medicine	–	2	2
Endocrinology	–	1	–
Hematology	–	2	1
Infectious diseases	–	1	1
Nephrology	–	1	1
Neurology	–	1	1
None yet	–	1	1

(Continued)

Table 1 (Continued)

	Phase II: Coordinators (*N* = 64)	Phase III	
		Round 1: Coordinators + experts (*N* = 209; Female *n* = 92)	Round 2: Coordinators + experts (*N* = 187; Female *n* = 84)
Obstetrics-Gynecology	–	1	1
Ophthalmology	–	1	1
Pediatrics	–	4	4
Physical medicine and rehabilitation	–	1	0
Psychiatry	–	2	2
Current profession			
Medical specialist	40 (46.0%)	128 (61.2%)	108 (57.8%)
Pharmacist	6 (6.9%)	21 (10.1%)	21 (11.2%)
Resident	1 (1.1%)	15 (7.2%)	13 (7.0%)
Junior doctor	–	12 (5.7%)	11 (5.9%)
Teacher in CPT	37 (42.5%)	83 (39.7%)	75 (40.1%)
Other	3 (3.4%)	17 (8.1%)	16 (8.6%)
Experience			
Clinical experience	20 (0–45)	13 (0–45)	13 (0–45)
Teaching experience	20 (0–40)	10 (0–40)	10 (0–40)

Note: Data are presented as numbers and percentages (in brackets). Clinical and teaching experiences are expressed as median and range in years.
Abbreviation: CPT, clinical pharmacology and therapeutics.

a total of 187 (40%) coordinators ($n = 54$) and experts ($n = 133$) from 97 universities/hospitals in 24 countries completed the two Delphi rounds (**Table 1**).

The European List of Key Medicines for Medical Education

In part 1, a list of 385 items was created (**Table S1**). In part 2, there were 38 medicines that were removed from the list because the medicines were not accessible in ≥ 80% of the countries, and 69 newly suggested medicines were added. Hence, the list of medicines for part 3 contained 416 medicines (**Table S2**). The experts agreed to include 98 medicines in the final list: 88 were selected in round 1 and 10 in round 2 (**Table 2**). None of the 43 suggested medicines in round 1 were included in the final list (**Figure 2**). The top three ATC code groups were (1) cardiovascular system ($n = 23$), (2) anti-infective ($n = 21$), and (3) musculo-skeletal system ($n = 11$). Most included medicines are administered orally (65/98, 66%). See **Table S3** for the individual lists per country.

DISCUSSION

In this Delphi consensus study, an international panel of experts drew up a list of 98 medicines that are widely accessible in Europe and that junior doctors working in Europe should be able to independently prescribe, safely, and effectively after graduation without direct supervision. This European list of key medicines focusing on medical education is unique as it is based on input from CPT teachers, but also junior doctors, pharmacists, and medical specialists from 24 European countries. Existing lists are either solely based on frequently prescribed medicines, are country-specific, or were set up by a small group of experts.[22–25,32–36] The current list will form the basis for the European Prescribing Exam and will be a starting point for country-specific lists in Europe. Moreover, it will be available in other parts of the world because it will be included in the revision of the WHO Guide to Good Prescribing.[19] Its adoption will help innovate, modernize, and harmonize CPT education, which is one of the aims of the EACPT and the American Society for Clinical Pharmacology and Therapeutics.[9,38] Moreover, given the increasing costs of medicines, this list of key medicines for medical education might be a valuable addition to the WHO Model List of Essential Medicines and its program by teaching students to adhere to such lists with a view to trying to keep these medicines affordable and accessible in the future, which is needed in high income countries too.[21]

Strengths and limitations

As far as we know, this is the first European List of Key Medicines for Medical Education. It was compiled by a diverse group of experts from 24 European countries who worked in more than 20 different specialties (internists, surgeons, clinical pharmacologists, general practitioners, pharmacists, etc.). This provided an exhaustive view of the opinions and views of primary and secondary healthcare professionals. The inclusion of male and female junior doctors and consultants made the study participants representative of the prescribing professionals in and outside the hospitals. Another strength of this study is that the list not only consists of groups of medicines, but also individual medicines and their route of administration.

Table 2 Delphi scores for all included medicines

Drug names	Percentage score 4 or 5 Round 1	Percentage score 4 or 5 Round 2
A – Alimentary tract and metabolism (*N*=10)		
Omeprazole (oral)	97.6%	–
Pantoprazole (oral)	94.3%	–
Esomeprazole (oral)	89.5%	–
Ondansetron (oral)	83.7%	–
Metoclopramide (oral)	94.3%	–
Loperamide (oral)	90.4%	–
Macrogol (oral)	78.9%	83.4%
Lactulose (oral)	94.3%	–
Metformin (oral)	90.9%	–
Insulin (s.c.)	81.8%	–
B – Blood and blood forming units (*N*=10)		
Acetylsalicylic acid (oral)	96.7%	–
Clopidogrel (oral)	87.1%	–
Enoxaparin (s.c.)	80.9%	–
Vitamin K (oral)	85.6%	–
Saline 0.9% (i.v.)	94.3%	–
Glucose 5% (i.v.)	90.9%	–
Glucose 10% (i.v.)	80.4%	–
Ferrous sulphate (oral)	94.6%	–
Ferrous fumarate (oral)	89.5%	–
Folic acid (oral)	98.1%	–
C – Cardiovascular system (*N*=23)		
Enalapril (oral)	91.4%	–
Ramipril (oral)	88.9%	–
Lisinopril (oral)	83.7%	–
Perindopril (oral)	80.4%	–
Losartan (oral)	90.9%	–
Valsartan (oral)	88.5%	–
Candesartan (oral)	86.1%	–
Bisoprolol (oral)	89.9%	–
Metoprolol (oral)	89.9%	–
Atenolol (oral)	83.3%	–
Carvedilol (oral)	81.3%	–
Propranolol (oral)	81.3%	–
Nebivolol (oral)	80.0%	–
Amlodipine (oral)	92.3%	–
Furosemide (oral)	95.7%	–
Hydrochlorothiazide (oral)	91.4%	–
Furosemide (i.v.)	83.7%	–
Spironolactone (oral)	90.9%	–
Nitroglycerin (s.l.)	86.6%	–
Atorvastatin (oral)	94.3%	–
Simvastatin (oral)	90.4%	–
Rosuvastatin (oral)	86.6%	–
Pravastatin (oral)	81.3%	–
D – Dermatologics (*N*=7)		
Vaseline (dermal)	87.6%	–
Betamethasone (dermal)	85.1%	–
Hydrocortisone (dermal)	83.7%	–
Ketoconazole (dermal)	83.7%	–
Miconazole (dermal)	80.4%	–
Lidocaine cream (dermal)	78.0%	85.0%
Fusidic acid (dermal)	78.9%	82.9%
G – Genito-urinary system (*N*=1)		
Miconazole (dermal)	81.3%	–
H – Systemic hormonal preparations (*N*=2)		
Prednisone (oral)	83.7%	–
Prednisolone (oral)	79.9%	80.7%
J – Anti-infective (*N*=21)		
Amoxicillin (oral)	98.1%	–
Amoxicillin/clavulanic acid (oral)	97.2%	–
Amoxicillin/clavulanic acid (i.v.)	75.1%	84.0%
Ciprofloxacin (oral)	92.8%	–
Levofloxacin (oral)	80.9%	–
Clarithromycin (oral)	90.9%	–
Azithromycin (oral)	90.4%	
Clindamycin (oral)	82.3%	–
Doxycycline (oral)	88.5%	–
Co-trimoxazole (oral)	86.1%	–
Trimethoprim (oral)	77.5%	82.4%
Nitrofurantoin (oral)	80.9%	–
Metronidazole (oral) (antiparasitic)	90.9%	–
Fluconazole (oral)	87.6%	–
Metronidazole (oral) (antibiotic)	86.6%	–
Influenza vaccine (i.m.)	88.5%	–
COVID-19 vaccine (i.m.)	86.6%	–
Tetanus vaccine (i.m.)	84.7%	–
Diphtheria/poliomyelitis/ tetanus (i.m.)	80.9%	–
Anti-tetanus immunoglobulin (i.m.)	78.5%	84.5%
Acyclovir (oral)	86.6%	–
L - Antineoplastics (*N*=0)		
–	–	–

(Continued)

(Continued)

Table 2 (Continued)

Drug names	Percentage score 4 or 5 Round 1	Percentage score 4 or 5 Round 2
M – Musculo-skeletal system (*N* = 11)		
Paracetamol (oral)	99.5%	–
Paracetamol (rectal)	88.0%	–
Ibuprofen (oral)	99.0%	–
Diclofenac (oral)	94.7%	–
Naproxen (oral)	86.6%	–
Diclofenac (dermal)	80.7%	–
Ibuprofen (dermal)	80.4%	–
Tramadol (oral)	83.3%	–
Calcium with vitamin D (oral)	90.9%	–
Allopurinol (oral)	87.1%	–
Cholecalciferol (oral)	84.7%	–
N – Nervous system (*N* = 3)		
Diazepam (oral)	83.7%	–
Diazepam (rectal)	75.6%	83.4%
Thiamine (vitamin B1) (oral)	83.7%	–
R – Respiratory system (*N* = 9)		
Salbutamol (inhalation)	94.3%	–
Ipratropium (inhalation)	85.2%	–
Formoterol (inhalation)	82.3%	–
Salmeterol (inhalation)	81.3%	–
Budesonide (inhalation)	85.6%	–
Beclomethasone (inhalation)	83.7%	–
Fluticasone (inhalation)	80.4%	–
Cetirizine (oral)	88.9%	–
Loratadine (oral)	79.4%	84.0%
S – Sensory organs (*N* = 1)		
Artificial tears (e.g., dextran/hypromellose) (ocular)	79.4%	85.0%

Note: The routes of administration are in brackets (oral, rectal, inhalation, i.v. = intravenous, s.c. = subcutaneous, i.m. = intramuscular). *N* indicates the number of medicines per group.
Abbreviation: COVID-19, coronavirus disease 2019.

This provides teachers, but also students, detailed insight into the knowledge that students need to have. Nevertheless, when interpreting the results of this study several limitations must be kept in mind. First, the participants were approached via automatically generated emails from the online questionnaire program Castor EDC. Some emails may have ended up in the spam folder and may have been missed. We tried to avoid this problem by personally emailing participants, to make them aware of this potential problem. This might be a reason for the low participation in part 2 (response rate: 16%) and round 1 of part 3 (response rate: 45%), such that there were only 1 or 2 participants from some countries, thus limiting the generalizability of findings. Second, despite our efforts to reduce the length of the questionnaire, it took ~30 minutes to complete, which might have led to dropouts; however, we allowed participants to fill in the survey in more than one sitting. The 2 Delphi rounds had a response rate of 45% and 89%, respectively, which we believe is acceptable for such an international study. Third, even though this list is designed for newly graduated doctors, most participants were more experienced doctors. In fact, in both Delphi rounds, only 13% of the participants were either junior doctors or residents. Fourth, a relatively large number of experts were from the Netherlands. As a study with the same setup was performed in the Netherlands recently,[24] it was easier to recruit Dutch participants. Moreover, participation was less demanding for these participants because raw data of the Dutch study for round 1 could be re-used for the current study. Fifth, esomeprazole (oral) was erroneously not evaluated in round 2, even though it scored 61.7% in round 1. However, this error had little consequences because two other proton pump inhibitors (omeprazole and pantoprazole) are included.

Clinical implications

This European List of Key Medicines for Medical Education will be incorporated in the European Prescribing Exam in the coming year. Moreover, to enhance harmonization of the teaching and training in CPT, the list, together with country-specific lists, will be openly accessible in an easy editable document on the European Open Platform for Prescribing Education (www.prescribingeducation.eu),[39] and will be included in the revision of the WHO Guide to Good Prescribing,[40] which is expected to be published in 2024. This will provide CPT teachers worldwide with the opportunity to adjust the list according to their country-specific demands, and to incorporate it in their medical curriculum. It would be a good idea to use the list together with the Essential Drug Knowledge item list established by Brinkman *et al*.,[29] the list of essential diseases for prescribing, and the World Health Organization six-step,[18,19] in the early years of medical training, so that students can become acquainted with the medicines. Of course, the medical curriculum should not be limited to the current list, because it only contains medicines that a junior doctor should be able to prescribe without direct supervision. A broad knowledge of other medicines and their routes of administration is crucial as well, not only for rational and safe prescribing, but also for clinical and diagnostic reasoning. For example, only five medicines with an intravenous route of administration were included in the list (saline 0.9%, glucose 5%, glucose 10%, furosemide, and amoxicillin/clavulanic acid), even though, and especially in the hospital setting, a lot of other medicines are often administered intravenously. This is also one of the differences between the current list and existing ones. For example, the "core drug list" in the United Kingdom does not give the route of administration and that list also contains medicines that are mainly prescribed by a specialist (e.g., azathioprine and levodopa/carbidopa).[32] Less differences are observed between the current one and the WHO Model List of Essential Medicines. In our final

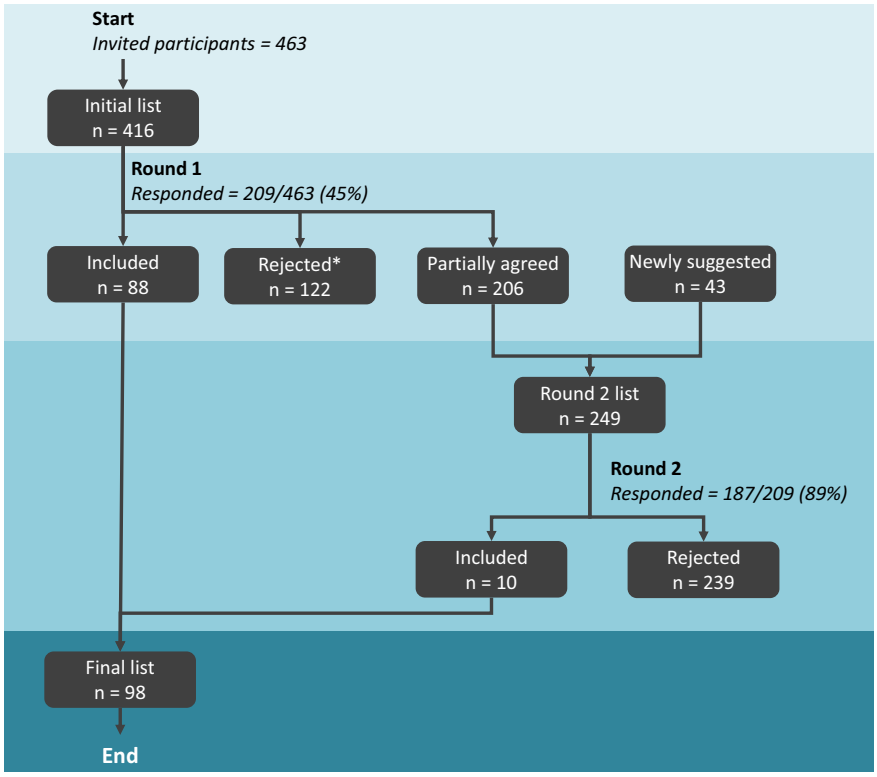

Figure 2 Overview of the results of the Delphi rounds. Response rates are indicated as percentages of invited participants. The number of drugs included, partially agreed, rejected or suggested are shown in gray boxes. *Including two drugs that are not accessible in ≥80% of the countries, and one medicine that was not re-assessed due to an error.

list, all medicines, or similar preparations, align with the WHO Model list of Essential Medicines, with the exception of only six: macrogrol, ketoconazole, fusidic acid, acyclovir, tramadol, and artificial tears.

A valid question is how this European List of Key Medicines for Medical Education should be kept up to date and by whom. The education working group of the EACPT will be the steering committee and could work together with coordinators in CPT education involved in this study to make country-specific changes to the list. The WHO Model List of Essential Medicines is updated every 2 years, whereas the Dutch list of essential medicines for medical education will be revised after an update of an existing guideline by a group of experts. We suggest that minor changes should be made once a year, whereas a more comprehensive update should be made every 2–3 years, together with the WHO Model List of Essential Medicines.

Remarkable findings

Interestingly, the list highlights differences in prescribing preferences and cultural differences, requiring the use of the country-specific lists, or country-specific adaptations. For example, the list does not contain a vitamin K antagonist, probably due to local differences (warfarin vs. acenocoumarol or phenprocoumon), but direct oral anticoagulants (DOACs) are also missing from the list. Deep vein thrombosis and atrial fibrillation are both included in the Dutch list of essential diseases for prescribing, and thus the inclusion of anticoagulants would have been logical. However, in some counties, such as Italy, until recently, only specialists were allowed to prescribe DOACs.[41] Differences in prescribing preferences and guidelines are also seen with blood glucose-lowering medicines. Only metformin is included, whereas commonly prescribed medicines, such as sulfonylurea (SU) derivates, and recently recommended medicines, such as sodium-glucose cotransporter-2 inhibitors, glucagon-like peptide-1 agonists, and dipeptidyl peptidase 4 inhibitors, are not.[42] In some European countries, SU derivates have been removed from prescribing guidelines,[43] whereas in others these medicines are still the second choice for patients without prior cardiovascular or renal disease. The list also does not include any hormonal contraceptives (closest: ethinylestradiol/levonorgestrel (oral) 65.1% and 59.9%, in rounds 1 and 2, respectively). Some experts stated that these medicines are mainly, or only, prescribed by gynecologists. However, in many countries, hormonal contraceptives are commonly prescribed by general practitioners, and contraceptives are not high-risk medicines.[44] For these reasons, hormonal contraceptives are included in the Dutch List of Essential Medicines for Medical Education.[24] Another difference between the European list and the Dutch one is that the European experts did not include antidepressants (e.g., citalopram and amitriptyline) and antipsychotics (e.g., haloperidol). In the Netherlands, but also in other European countries, these medicines are often prescribed by general practitioners, whereas most of the European experts were of the opinion that these medicines should be prescribed only by a specialist. Last, the list did not include triptans, even though

migraine is a common disease and world's second cause of disability in younger women.[45]

CONCLUSION

In this study, a large European panel of experts reached consensus on 98 medicines that junior doctors working in Europe should be able to independently prescribe safely and effectively without direct supervision. This European List of Key Medicines for Medical Education could be a starting point for country-specific lists, could be incorporated in both the European Prescribing Exam and the revision of the WHO Guide to Good Prescribing, and could aid the WHO Model List of Essential Medicines program. The list should be revised periodically to keep it up-to-date with guidelines and other new insights.

SUPPORTING INFORMATION

Supplementary information accompanies this paper on the *Clinical Pharmacology & Therapeutics* website (www.cpt-journal.com).

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CONFLICT OF INTEREST

The authors declared no competing interests for this work.

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AUTHOR CONTRIBUTIONS

E.M.D., P.S.T., D.J.B., J.T., and M.C.R. wrote the manuscript. All authors designed the research. E.M.D. and P.S.T. performed the research and analyzed the data.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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