Clinical reasoning by pharmacists: fostering clinical decision-making and interprofessional collaboration in pharmacy practice and education

Mertens-Stutterheim, J.F.

CLINICAL REASONING BY PHARMACISTS

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Josephine F. Mertens-Stutterheim

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Promotor

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Co-promotores

Dr. V.H.M. Deneer	Utrecht University
Dr. T.G.H. Kempen	Utrecht University

Promotiecommissie

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Education is not the filling of a pail, but the lighting of a fire.
- William Butler Yeats

Contents

Chapter 1

General introduction

General introduction

Pharmacists play a critical role in ensuring safe and effective pharmacotherapy. Cases like the one described below highlight the importance of clinical reasoning by pharmacists and the value of interprofessional collaboration (IPC). This thesis explores how pharmacists make clinical decisions and how education could foster their competence development in clinical reasoning and IPC.

A 78-year-old woman visits the community pharmacy after seeing her general practitioner, who prescribed her diclofenac, a non-steroidal anti-inflammatory drug (NSAID), for arthritis. The pain in her hands prevents her from working in the garden, a hobby that she deeply enjoys. Upon reviewing the prescription, the pharmacist notices that no gastric protection was prescribed alongside diclofenac. Recognizing that older adults using NSAIDs face an increased risk of gastrointestinal complications—such as perforation, ulcers, or bleeding—the pharmacist considers the potential benefits of adding gastric protection, such as pantoprazole, to reduce these risks. Based on established agreements with the general practitioner, the pharmacist is authorized to autonomously dispense gastric protection when clinically indicated. Before proceeding, the pharmacist engages the patient in a consult to explain the risks and benefits of pantoprazole, explore alternative analgesic options (e.g. paracetamol or a topical NSAID), and understand her preferences. Through this shared decision-making, the patient agrees, and the pharmacist dispenses pantoprazole alongside the diclofenac.

What goes through the pharmacist's mind when addressing this patient case? How does the pharmacist identify potential risks and benefits in this situation? What cognitive steps shape the pharmacists' clinical decision-making process when considering the most appropriate pharmacotherapeutic treatment? Which factors influence this process? And how can educators better support pharmacists and pharmacy students in addressing cases like this, fostering clinical reasoning and interprofessional collaboration, and ultimately improving patient care?

Clinical reasoning in health professions

Impact on patient care

Clinical reasoning is a complex yet essential competence for all healthcare professionals, forming the foundation of accurate clinical decision-making (CDM) in the evaluation and management of patients' medical problems.[1,2] It represents the core thinking process that drives CDM, involving a nonlinear series of cognitive processes.[2] These cognitive processes are mental activities through

which healthcare professionals gather, interpret, and apply knowledge, enabling them to make sound clinical decisions.[2] These decisions are critical for optimizing patient care, which has become increasingly complex due to healthcare trends such as aging populations, multimorbidity, and the expanding range of treatment options. Specifically, therapeutic decision-making has become more intricate, with increasing challenges in managing pharmacotherapy and addressing the prevalence of polypharmacy. The first step toward optimal care is making a correct diagnosis; however, wrong, missed or delayed diagnoses occur in approximately 5% of adult outpatient population annually in the United States.[3] Even when diagnoses are accurate, up to 45% of patients with acute or chronic medical conditions do not receive recommended evidence-based care, including treatment and follow-up.[4] Diagnostic and management errors, including medication-related errors, can lead to patient harm, reduced quality of life, and increased healthcare costs, with a notable proportion being preventable.[5-11] For instance, a systematic review by El Morabet et al. reported medication-related hospital readmissions ranging from 3% to 64% (median 21%, interquartile range (IQR) 14–23%) with preventability rates varying between 5% to 87% (median 69%, IQR 19–84%).[8] Improving the use and quality of guidelines alone, however, seems insufficient to reduce management errors; therapeutic decision-making extends beyond merely following guidelines.[12] It requires clinical reasoning to account for specific patient characteristics, such as comorbidities and co-medication, disease severity, drug properties, clinical context, and patient preferences, in order to determine the most appropriate treatment.[12] The extent to which errors stem from erroneous clinical reasoning, as opposed to external environmental factors, remains unclear. However, multiple studies indicate that reasoning errors, alongside deficits in knowledge and technical skills, play a significant role.[13-16] Many errors are associated with the inherent challenges of human thinking under conditions of complexity, uncertainty, and time pressure.[13,17] Enhancing clinicians' clinical reasoning competence may reduce preventable patient harm, underscoring the need for a deeper understanding of clinical reasoning and its application in practice. Additionally, individual performance is influenced by collective contexts and interpersonal skills.[18] Research identifies inadequate intra- or interprofessional communication and teamwork as frequent contributory factors to medication-related errors.[19,20] Healthcare professionals have been reported to work alongside one another rather than collaboratively, which limits communication about medication.[21] Thinking along with other professions and understanding their clinical reasoning perspectives can improve the ability to distinguish main from side issues, anticipate the information needs of others, lower consultation thresholds, and facilitate joint problem-solving.[22] This highlights the importance of fostering

healthcare professionals' competencies in both clinical reasoning and IPC to reduce preventable harm and improve patient outcomes.

Clinical reasoning as a concept

Research on clinical reasoning has increased significantly over the last five decades, particularly in medicine and nursing.[1,2,23-25] However, a unified understanding of the concept remains elusive–even within these professions.[26,27] It is important to distinguish between a *definition* and a *concept*: a definition implies a full, agreed-upon understanding of a term, whereas a concept is broader and more abstract, encompassing multiple perspectives and interpretations. Given the complexity, context-dependence, and evolving nature of clinical reasoning, it may be more appropriate to view it as a concept rather than something that can be strictly defined.[1,28] Two examples illustrate its evolving nature. First, as demographic and contextual factors increasingly influence clinical decisions–often shaped by healthcare team dynamics, patient preferences, and the broader healthcare environment–the conceptualizations of clinical reasoning have evolved to encompass not only internal cognitive activities but also social and contextual elements.[25,29,30] In this context, *shared decision-making* has emerged as a critical component, integrating the expertise of various health professionals with the preferences of patients to deliver patient-centered care.[31] Second, as healthcare practice has become more team-based, the concept of clinical reasoning is shifting from a predominantly individual cognitive process to a shared, interprofessional activity.[25,30] Engaging with other professions and understanding their reasoning perspectives fosters this shift, facilitating collaborative decision-making.[27] This interprofessional approach is reshaping how clinical reasoning is conceptualized, practiced, and taught across healthcare settings.

In addition to its conceptual ambiguity, the term *clinical reasoning* is often used interchangeably with other terms, such as problem-solving, critical thinking, clinical judgment, and decision-making.[32] While problem-solving and critical thinking are considered general skills relevant across various professions, clinical reasoning typically applies to specific healthcare situations. Both critical thinking and clinical reasoning are context-, setting-, and knowledge-dependent, requiring metacognitive skills.[33] However, clinical reasoning builds upon critical thinking by emphasizing the integration of biomedical knowledge, clinical evidence, prior experience, and collaboration with others, making it unique to healthcare professionals.[33] Clinical judgment and decision-making, in turn, can be viewed as the observable actions and outcomes of clinical reasoning.[2]

The literature often identifies four distinct types of clinical reasoning in clinical practice: *diagnostic reasoning* (What is the matter with my patient?), *etiological reasoning* (How did this problem arise?), *prognostic reasoning* (What will be the course of this problem and what can we achieve?), and *therapeutic* or *management reasoning* (What can we do about it?).[34] In drug-related scenarios, *pharmacokinetic and -dynamic reasoning* may also be used, focusing on understanding pharmacokinetic parameters in relation to pharmacodynamics to explain drug disposition and effects.[35] Research, education, and communication about clinical reasoning are complicated by the numerous terms and varied conceptualizations in use.[25,29,36] Other health professions, such as physiotherapists and osteopaths, also encounter challenges in achieving conceptual clarity around clinical reasoning.[28,30,37] In pharmacy, the conceptualization of clinical reasoning has remained largely unexplored, which forms a key focus of this thesis.

Clinical reasoning in pharmacy practice

Clinical reasoning is a relatively new concept in the field of pharmacy. Over the past few decades, the role of pharmacists has evolved significantly, making clinical reasoning an essential aspect of modern pharmacy practice. Traditionally, pharmacists are responsible for tasks like compounding and dispensing medication, stock management, and quality assurance. With the growing significance of manufacturer-produced medicines with strong pharmacological effects and potential risks, clinical risk management (e.g. dosage control, drug-drug and drug-disease interaction checks) became an increasingly important responsibility of pharmacists. Nowadays, their role extends to providing clinical services in both primary and secondary care settings.[38] These services, which involve direct or indirect patient interaction, include managing minor ailments, conducting comprehensive medication management or clinical medication reviews, and–in some countries–engaging in independent medication prescribing.[39-42] Cipolle et al.[43] defined these services as *Cognitive Pharmaceutical Services*, which involve "the use of specialized knowledge by the pharmacist for the patient or healthcare professionals for the purpose of promoting effective and safe drug therapy." As the scope of pharmacists' roles continues to expand, the number and variety of clinical services are expected to increase. Despite this shift towards more clinical responsibilities, the traditional task of dispensing medication remains central to pharmacy practice.[44,45] Cipolle's definition suggests that clinical services go beyond merely dispensing and even clinical risk management.[45] However, even tasks like dispensing require–besides technical skills–pharmacists to engage in cognitive processes to gather, interpret, and apply information to ensure the safe and effective use of medication.[44] All clinical services in pharmacy practice, including dispensing medication, require

effective clinical reasoning to meet patients' medication needs and improve their overall quality of life. While pharmacists are taking on more autonomous roles, clinical practice is simultaneously becoming increasingly interprofessional. This shift requires pharmacists to adapt their clinical reasoning to not only address individual patient needs but also align with the activities and dynamics with other healthcare professionals, such as general practitioners, medical specialists, and nurse practitioners.[2] Despite these changes, clinical reasoning by pharmacists remains underexplored. The comparisons and distinctions between pharmacists' clinical reasoning and that of other healthcare professionals are unclear, as much of what we know about pharmacists' clinical reasoning is based on studies from other health disciplines.[44] To address this gap, developing a clear concept of clinical reasoning by pharmacists–supported by an understanding of its underlying cognitive processes–would strengthen pharmacy education and empower pharmacists to effectively provide clinical services in practice.

Learning and teaching clinical reasoning

Learning clinical reasoning

Learning clinical reasoning is considered an imperative component of education across health professions. In the Netherlands, this competence is embedded in accreditation standards for educational programs in professions such as medicine, nursing, physiotherapy, and pharmacy.[46-49] To embed competence development effectively in educational programs, it is important to understand and foster the underlying cognitive processes.[50] A widely accepted framework for this is Kahneman's theory,[51] which distinguishes between two cognitive modes or approaches: *intuitive reasoning* (System 1 thinking) and *analytical reasoning* (System 2 thinking). Intuitive reasoning is fast and relies on pattern recognition, whereas analytical reasoning is slower and systematic, involving hypothesis generation or testing.[51] Literature states that novices tend to rely more on analytical reasoning due to their limited experience, working through problems step by step.[2] With continued exposure and practice, they can develop the ability to recognize patterns, transitioning to faster, more intuitive reasoning.[52] Expert clinicians are said to predominantly rely on intuitive reasoning, switching to analytical approaches when encountering complex or unfamiliar cases.[52,53] Clinical reasoning development begins early in medical education, where students focus on building a foundation of extensive biomedical knowledge, gradually forming a semantic network of interconnected concepts.[2] This foundational phase demands substantial time and effort, particularly in integrating knowledge across domains such as (patho)physiology, microbiology, biochemistry, and pharmacology.[2] As this phase progresses, students begin *knowledge encapsulation*, a process that organizes

clusters of knowledge and facilitates automatic reasoning between concepts.[54] They then transition to developing structured knowledge in long term memory known as *illness scripts*. These scripts consist of three components: (i) the patient and contextual factors, (ii) the pathophysiological process, and (ii) the signs and symptoms of a disease.[2,55] With experience, students can refine and enrich these scripts, enabling faster, less effortful reasoning.[56] Building on illness scripts, therapy scripts can emerge to guide treatment decisions.[53] Therapy scripts consists of six components: (i) the problem to be solved, (ii) management options, (iii) preferences, values, and constraints, (iv) education needs, (v) interpersonal interactions, and (vi) encounter flow.[57] However, the use of these therapy scripts and the approaches employed in therapeutic reasoning are underexplored. As students prepare for real-world practice, *contextual learning* becomes essential, allowing them to apply theoretical knowledge in authentic, complex situations. With the shift towards more practice-based education, students can engage in supervised real-world experiences, a process known as *experiential learning*.[58] These experiences expose them to realistic uncertainties and foster *perceptual learning*, helping them develop that "gut feeling".[2,59-61] Particularly in practice settings, *self-regulated learning* is important in developing clinical reasoning by setting objectives, seeking feedback, and reflecting on their experiences.[62,63] As students progress in their education, interprofessional education (IPE) becomes increasingly important, enabling students to understand and appreciate the clinical reasoning approaches of other healthcare professionals.[22,64] IPE involves two or more health professions learning with, from, and about each other, fostering collaboration to enhance decision-making skills and broaden perspectives on patient care.[18] Additionally, grounded in contact theory, IPE brings individuals from diverse backgrounds together, which can modify stereotypes and attitudes toward ingroups and outgroups, ultimately strengthening IPC.[65] As students transition from novice to more expert, the role of the educator shifts from that of a lecturer to a facilitator of learning, allowing them to construct meaning from their own experiences.[25] This learner-centered approach promotes the development of clinical reasoning in real-world settings, helping them become more effective in making clinical decisions that benefit their patients.

Clinical reasoning in pharmacy education

The importance of clinical reasoning is widely emphasized in competence standards for pharmacy educational programs in countries such as the United States,[66] the United Kingdom,[67] New Zealand,[68] and the Netherlands.[46] There appears to be broad consensus of its importance among accreditation bodies, pharmacy educators, and other stakeholders. However, a recent review by Elvén et al. on clinical reasoning curricula across health professions' education found no literature specific to

pharmacy curricula.[50] While a few educational models for clinical reasoning have been described,[69-71] no definitive best practices currently exist for teaching or assessing clinical reasoning in pharmacy education.[33] Although standards of practice documents, such as the Pharmacists' Patient Care Process described by the Joint Commission of Pharmacy Practitioners,[72] often outline valuable action-oriented steps for providing clinical services, they were not designed to foster CDM in pharmacists and pharmacy students. In the Netherlands, pharmacy education comprises a six-year academic curriculum, including a three-year bachelor's degree and three-year master's degree in pharmacy, which is unique in Europe.[73] The bachelor's curriculum establishes a strong foundation in pharmaceutical and natural sciences, with content-driven courses preparing students for the master's curriculum.[46] Among the three Dutch master's curricula in pharmacy, two integrate experiential learning alongside problem-based courses, while the third offers problem-based courses followed by internships afterwards.[73] Although all master's curricula address clinical reasoning, their approaches vary and lack a consistent, evidence-based model. Postgraduate pharmacy education in the Netherlands encompasses continuing education courses and specialized training programs. These practice-based programs include a two-year training in community pharmacy, a four-year training in hospital pharmacy, and a recently developed two-year specialization program for experienced community pharmacists in geriatrics, cardiovascular disease, and other fields.[74-76] While these programs address clinical reasoning, none currently utilize a validated model to enhance this competence. This highlights the need for structured, evidence-based approaches to teaching clinical reasoning at all levels of pharmacy education. Furthermore, pharmacists require enough insight into other healthcare professionals' reasoning to identify potential conflicts or synergies between treatment approaches.[2] To foster this interprofessional mindset, IPE initiatives have been introduced in Dutch educational programs. However, effectively integrating these initiatives are considered challenging, and their impact has yet to be studied.

Challenges in learning and teaching clinical reasoning

The scarcity of clinical reasoning being explicitly and comprehensively taught in health professions curricula may result from its inherent complexity, multidimensionality, and the lack of consensus on its conceptualization across and within healthcare professions. [32,50,77-79] Without explicit teaching, clinical reasoning risks becoming a "black box" phenomenon that students are left to navigate on their own.[77,80] However, teaching clinical reasoning poses multiple challenges. One major issue is the lack of practical guidelines and effective teaching strategies to enhance this competence.[81] Educators in both academic and clinical settings are often not

specifically trained to teach or guide clinical reasoning.[81] Additionally, educators may find it difficult to articulate their advanced reasoning, making it harder for novices to grasp the underlying thought processes.[82] This disconnect highlights the need for structured guidance, supported by practical resources and training, to better equip educators in both academic and clinical settings. Assessing clinical reasoning also poses difficulties, as current methods often prioritize foundational knowledge recall and the "right" answer over evaluating the reasoning process itself.[81,82] While foundational knowledge remains essential, this approach risks overlooking the context-dependent nature of clinical reasoning, where different situations may lead to equally valid outcomes. This underscores the importance of focusing on the reasoning process, in addition to the foundational knowledge. Further barriers to implement clinical reasoning in a curriculum include challenges related to infrastructure, motivation, and culture.[81] For example, lack of a supportive "error culture" and resistance to change can hinder efforts to innovate and improve clinical reasoning education.[81] Furthermore, a challenge lies in teaching students to reason independently within their own professions while also preparing them for IPC. While working with peers from other healthcare professions during IPE shows promise, effectively integrating it remains challenging at micro (teaching, e.g. faculty development), meso (institutional, e.g. administrative processes), and macro (systemic, e.g. social and cultural values) levels.[83]

Research paradigms

Given the predominantly qualitative nature of this thesis, it is important to clarify the research paradigms through which knowledge and reality are approached. This thesis adopts constructivist and post-positivist paradigms to explore CDM and educational experiences in pharmacy. Traditionally, pharmacy research has been grounded in positivism, where knowledge is validated through statistical significance, and reality is viewed as objective and measurable. This paradigm remains invaluable in areas like drug trials and pharmacoeconomics. However, the complexity of CDM and the nuanced impact of educational interventions necessitate alternative perspectives. The constructivist paradigm emphasizes that knowledge is co-constructed through interactions between researchers and participants, shaped by context, time, place, and experience.[84,85] This perspective is particularly relevant for examining the cognitive processes underlying pharmacists' CDM and the factors influencing this process. Similarly, educational experiences are shaped by dynamic interactions between students, educators, and the learning environment. By embracing this paradigm, we acknowledge the inherent subjectivity in interpreting findings, as knowledge is mediated through the perspectives of both researchers and participants. Post-positivism complements this paradigm

by recognizing the existence of an external reality, while acknowledging that our understanding of it is fallible and shaped by biases.[84,85] To explore how educational interventions influence CDM and IPC, we use a combination of qualitative and quantitative methods. While quantitative data reveal patterns and correlations, they are interpreted within the broader, subjective context provided by qualitative insights. By embracing both constructivist and post-positivist paradigms, this thesis seeks to offer a more comprehensive understanding of CDM and educational experiences designed to foster CDM and IPC.

Thesis aim

The aim of this thesis is to explore and understand the concept of clinical reasoning by pharmacists–an essential competence for effective CDM–and to explore the cognitive processes and factors influencing pharmacists' CDM in patient care. Additionally, it focuses on developing and evaluating educational interventions aimed at fostering CDM and IPC, ultimately improving patient care.

Chapter outline

Chapter 2 presents a scoping review with primary studies on the cognitive processes involved in clinical reasoning by pharmacists and their conceptualization. **Chapter 3** provides a detailed exploration of the cognitive processes underlying CDM among Dutch pharmacists across primary, secondary, and tertiary care settings. **Chapter 4** explores the factors influencing their CDM in patient care.

Chapter 5, 6, and 7 focus on the designed (post)academic educational interventions to foster CDM and IPC. **Chapter 5** includes the model to support CDM along with a teaching and learning guide in Dutch. **Chapter 6** explores undergraduates and postgraduates' perceptions of how the model supports their CDM when addressing patient cases. **Chapter 7** evaluates the IPE Pharmacotherapy program involving medical and pharmacy students. Finally, **Chapter 8** provides a reflection on the key findings and discusses their implications for pharmacy practice and (post)academic education, along with recommendations for future research.

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Chapter 2

Clinical reasoning by pharmacists: a scoping review

Josephine F. Mertens
Ellen S. Koster
Vera H.M. Deneer
Marcel L. Bouvy
Teun van Gelder

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Abstract

Background

Clinical reasoning is considered a core competency for pharmacists, but there is a lack of conceptual clarity that complicates teaching and assessment. This scoping review was conducted to identify, map and examine evidence on used cognitive processes and their conceptualization of clinical reasoning by pharmacists.

Methods

In March 2021, seven databases were searched for relevant primary research studies. Included were studies that examined cognitive processes in pharmacists while addressing a clinical scenario in a pharmacy-related setting. Using descriptive analysis, study characteristics, conceptualizations, operationalizations and key study findings were mapped, summarized and examined. Results were reported using PRISMA-ScR.

Results

From 2252 abstracts, 13 studies were included that examined clinical reasoning in the context of forming a diagnosis (n=9) or determining medication appropriateness (n=4). Most studies conceptualized clinical reasoning as a context-dependent cognitive process whereby pharmacists apply and integrate knowledge and clinical experience to interpret available clinical data. Different terms labelled pharmacists' reasoning that showed both analytical and intuitive approaches to clinical scenarios, either separately or combined as dual process. Medication review studies reported a predominance of analytical reasoning. The majority of diagnosis-forming studies in primary care identified no distinct cognitive reasoning pattern when addressing selfcare scenarios.

Implications

This overview reflects a small but growing body of research on clinical reasoning by pharmacists. It is recommended that this competence be taught by explicating and reflecting on clinical reasoning as separate stage of the clinical decision-making process with transparent cognitive processes.

Background

Clinical reasoning is considered a core competency for health professionals, including pharmacists.[1-4] Clinical reasoning is relatively new to pharmacists when compared to physicians, as the pharmacy profession evolved into a more clinical profession during the past decades by providing more clinical services. Clinical pharmacy services are those that involve direct or indirect patient observation. Pharmacists now provide a wide range of clinical services in each country, including minor ailments management, comprehensive medication management, and independent medication prescribing.[5] The number and variety of services available are expected to increase in the coming years.[6-10] As a result, pharmacists' roles will shift even more from compounding and distributing medication towards providing clinical services. These services require effective clinical reasoning in order to address patients' medication needs and improve their quality of life.[11] For example, when using the Pharmacists' Patient Care Process in clinical services, clinical reasoning is valued throughout the five sequential steps (i.e. Collect, Assess, Plan, Implement, and Follow up).[1,12] Thus, clinical reasoning in pharmacy practice and clinical reasoning education have become essential.[13] Despite its acknowledged importance, an unified understanding of clinical reasoning by pharmacists is lacking.

The literature on clinical reasoning is broad and diverse, with roots in the work by Newell,[14] Elstein,[15] Barrows,[16] and, more recently, Croskerry.[17] The two cornerstone approaches to clinical reasoning described in the literature are intuitive reasoning (or System 1) and analytical reasoning (or System 2).[15] Intuitive reasoning is fast and effortless as it engages automatically, with health professionals acting on intuition or recognized patterns.[17] In contrast, analytical reasoning is slower and requires more mental effort as it involves deliberate, systematic thinking.[17] The most extensively described analytical approaches in medical education and practice are forward reasoning and hypothetico-deductive reasoning.[18-20] The former is a cognitive process whereby data is analyzed to generate an hypothesis, whereas the latter starts with a hypothesis and involves the use or analysis of data to test deductively whether the hypothesis is correct or incorrect.[18-20] Approaching each case analytically is inefficient given the limited time per patient and the health professional's maximum cognitive capacity.[1] Fortunately, repeated analytical processing can eventually lead to a faster intuitive response demanding less mental effort.[17] However, relying on intuitive reasoning is more vulnerable to error.[17] Novice physicians and medical students tend to approach cases more analytically, until they gain enough experience and expertise to work more intuitively.[1] According to available research among physicians, with increasing experience and expertise, physicians can mentally shift from basic science to representations and structures

of knowledge, frequently referred to as illness and therapy scripts.[21,22] Expert physicians tend to rely on intuitive reasoning and use an analytical approach with more complicated and unfamiliar cases.[1,21] According to recent research, the two fundamental approaches are not always conducted as two dichotomous systems.[23,24] The dual process theory states that the two approaches can be conducted jointly to address clinical problems.[23,24] Notwithstanding the broad and substantive literature on clinical reasoning, it is primarily based on research among physicians, leaving limited understanding of used cognitive processes by pharmacists. Despite the extensive research in the field of medicine, little consensus exists on the definition of clinical reasoning by physicians.[25] Other health professions also struggle to conceptualize clinical reasoning, such as physiotherapists and osteopaths.[26,27] Heterogeneous and ambiguous terminology is stated to hinder conceptual clarity.[25,28] Recently, Young et al.[28] identified 110 terms in the literature of various health professions that refer to or are related to clinical reasoning, such as "clinical decision-making", "problem-solving" and "critical thinking". Heterogeneous and ambiguous use of terms in education may result in significant differences in how students and teachers collectively comprehend clinical reasoning, resulting in differences in the focus of teaching and assessment.[29] A clear concept of clinical reasoning within pharmacy, supported by transparent cognitive processes, will contribute to the few existing models and future teaching strategies in pharmacy education.[30-34] Furthermore, conceptual clarity of clinical reasoning within a healthcare profession could also contribute to interprofessional education and collaboration.[35] This scoping review was conducted to identify, map and examine the evidence on used cognitive processes and their conceptualization of clinical reasoning by pharmacists in order to improve conceptual clarity within pharmacy.

Methods

The scoping review method was chosen as the study objective involves exploring the extent of literature, mapping and summarizing the evidence and clarifying a key concept.[36] A study protocol to conduct this scoping review was developed by the assembled multidisciplinary research team with expertise in medical education and specific expertise in pharmacy practice (JM, MB, VD), medical practice (TvG) and qualitative research methods (EK). The scoping review was conducted in congruence with the Preferred Reporting Items for Systematic reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR).[37]

Search strategy

Two team members (JM, EK) independently selected 45 potentially relevant terms from a list of 110 terms related to clinical reasoning categorized by Young et al.,[28] such as "critical thinking", "clinical judgement" and "problem-solving". Terms such as "surgical decision-making" and "accuracy" were excluded from the search strategy because they were thought to provide non-relevant search results to the study objective, When it was likely that relevant search results would be found with a single term, the redundant term was removed. For example, the term "diagnostic reasoning" was included in the search strategy, but the term "diagnosis" was not. Disagreements were resolved through consultation of a third team member (TvG). An experienced medical information specialist compiled the full search strategy based on these terms, which was then further refined by the research team. On March 18, 2012, the search was conducted using the following electronic databases: MEDLINE (PubMed), Embase (OVID), Emcare (OVID), ERIC (OVID), Web of Science, COCHCRANE Library, and Academic Search Premier (EBSCOhost). Appendix 1 contains selected terms and details of the search strategy used for MEDLINE (PubMed) database. In addition, the reference and cross-reference lists of the included articles were screened for relevant articles.

Inclusion and exclusion criteria

In order to summarize and examine what has been studied on the used cognitive processes in clinical reasoning (or surrogate term), only primary studies were included. Other article types (such as reviews) and studied concepts (such as moral reasoning) were excluded. Included studies had to involve pharmacists and/or pharmacy students as the population, and they had to address a simulated or real-life clinical scenario in a pharmacy-related setting. Studies that were included had to explore used cognitive processes during clinical reasoning; otherwise, studies were excluded. Studies that conducted clinical reasoning assessment methods without further exploration of used cognitive processes, for example, were excluded. Only full-text studies, published in peer-reviewed journals and in English were considered for inclusion. As search results were expected to be limited, no publication cut-off date was set.

Study selection

Following the search, all identified articles were collated and imported into EndNote X9 (Clarivate Analytics, PA, USA), with duplicates removed. To assess eligibility of the study selection, a random sample of 25 titles and abstracts was screened by three members of the research team independently (inclusion, exclusion, unsure). Discrepancies and uncertainties were resolved through discussion, and inclusion and exclusion criteria were modified. A second randomly selected sample was screened

in order to reach consensus on more than 75% as established for respecting eligibility for inclusion.[36] For 90% of the sample, consensus was reached. The remaining uncertainties (10%) were resolved through discussion. Thereafter, the same reviewer (JM) screened all identified articles for full text retrieval. The full text of selected studies were assessed in detail against the inclusion criteria. A second reviewer (EK) was consulted when there was uncertainty at any stage of the selection process. A PRISMA-ScR flow diagram is used to report search results (Figure 1).

Data extraction

The following data were extracted in an Excel spread sheet: study characteristics and operationalization (year, first author, study objective, study design, participants, settings and case scenarios), conceptualization of clinical reasoning (terminology, definition, underpinning theoretic and/or conceptual framework), and study findings deemed relevant to the review questions (process steps, cognitive processes, other results and interpretation of results). Two team members (JM, EK) extracted data of three key studies for the draft version of the data extraction spread sheet.[38-40] Any disagreements between JM and EK were resolved through discussion. The other team members were involved in the discussion as needed. The first author (JM) charted the data from the remaining studies, and the results were reviewed by the second author (EK). As a result of this iterative process, the data extraction sheet was regularly modified.

Data analysis

First, study characteristics were described. Extracted data on conceptualization and operationalization were summarized and descriptively analyzed to report how the included studies approached clinical reasoning. Key study findings on used cognitive processes were also summarized and descriptively analyzed. As a scoping review, study quality was not formally assessed.[36] The findings were discussed in the light of relevant clinical reasoning theories, as well as how the findings helped to improve conceptual clarity in pharmacy.

Results

Study inclusion

After removing duplicates, the search strategy yielded a total of 2252 articles. Reference lists and cross-reference screening yielded five additional studies, including recent studies not yet included in the databases searched. Following the inclusion and exclusion criteria, 34 full text articles were assessed on eligibility, with 13 being included for analysis (see Figure 1).

Characteristics of included studies

All included studies (n=13) examined the cognitive processes that occur during clinical reasoning among pharmacists in practice, not pharmacy students. All studies were published after 2008 with an upward trend in the number of publications over time. Studies were predominantly conducted in primary care (n=11).[38,39,41-49] Only the pharmacists studied by Abuzour et al.[50] were licensed to prescribe independently. The majority of the studies (n=6) were conducted in the United Kingdom, with five studies associated to the same research group.[41,42,44,48,49]

Conceptualization, operationalization and cognitive processes

Table 1 summarizes conceptualization, operationalization and key study findings on cognitive processes during clinical reasoning by pharmacists as reported by the selected studies.

Conceptualization

Two main categories of study contexts emerged: diagnosis-forming and medication review. The first category of studies examined clinical reasoning by pharmacists when forming a diagnosis (n=9), whereby pharmacists identify a disease or condition based on its signs and symptoms, such as during referral and triage in community pharmacies, detecting adverse drug events, or when providing specialty care.[40-45,48-50] Diagnosis-forming was followed by treatment planning when pharmacists were licensed to prescribe (n=1) and in selfcare (n=5).[41,42,45,48-50] The second category of studies examined pharmacists' cognitive processes when reviewing medication after diagnosis had been made and treatment had been planned by a physician (n=4).[38,39,46,47] Three of these studies examined community pharmacists determining medication appropriateness after receiving prescriptions in order to dispense medicines, which included checking for appropriate indication, effectiveness, safety, and adherence.[38,39,46] The remaining medication review study examined clinical pharmacists who provide comprehensive medication management services in order to optimize therapy.[40,47]

Terminology as used by included studies is shown in Table 1. In this relatively small selection of studies, the term "clinical reasoning" was used to describe the concept most frequently (n=8).[38,43,44,46-50] Four of these studies used the terms "clinical reasoning" and "clinical decision-making interchangeably".[38,39,44,49] Five studies solely used the term "clinical decision-making".[40-42,45,46] Two studies used the terms "diagnostic reasoning" and "diagnostic decision-making" to describe the concept as well.[43,48]

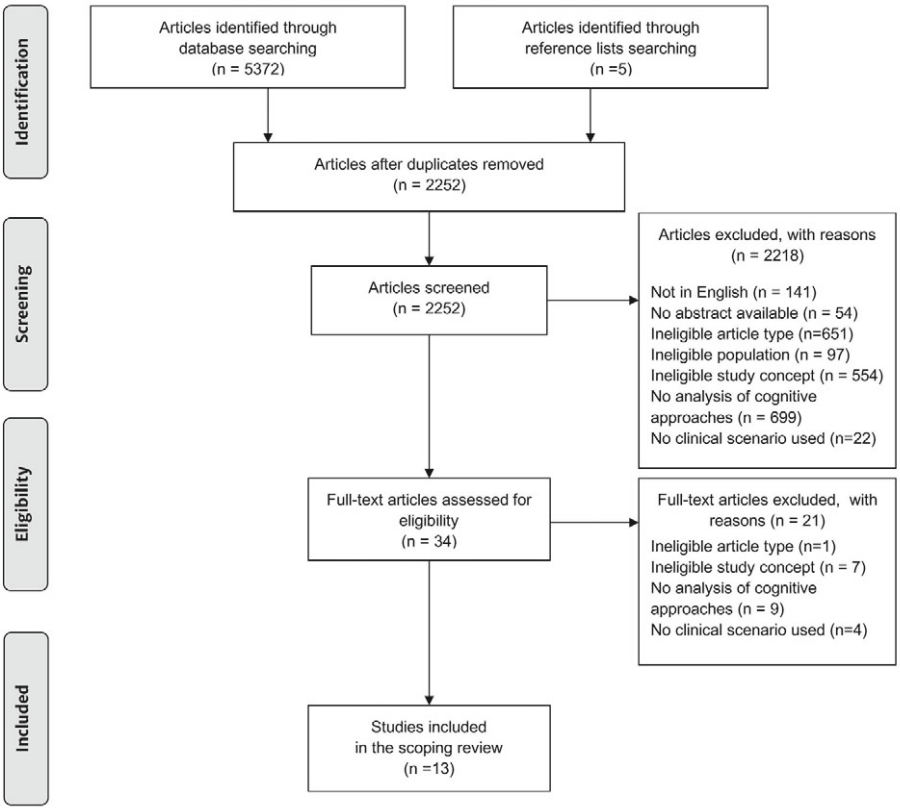

Figure 1. Search results and study selection and inclusion process

Explicitly mentioned conceptual definitions (n=7) revealed similarities and differences (see Table 1).[38,39,43,47-50] When summarizing the similarities, clinical reasoning can be described as a complex cognitive process whereby pharmacists applied and integrated knowledge and clinical experience to interpret all available clinical data. A difference among the definitions provided concerned 'making the decision'. Several studies, including the study of Haider et al.,[43] considered clinical reasoning as a step or stage in the clinical decision-making process (n=3).[43,47,50] This clinical reasoning stage involved the curation of gathered information and the formulation of a feasible set of options. Following stages often included option selection and collaborative planning with the patient or other health professionals. In these studies, the actual decision-making was considered separate from reasoning.[43,47,50] Other studies, such as the study of Croft et al.,[38] integrated decision-making into the clinical reasoning process (n=6).[38,39,41,46,48,49] When not made explicitly, it remained often unclear how the authors viewed clinical reasoning in relation to decision-making (n=4).[40,42,44,45]

All studies, except for Mallinder et al.,[45] mentioned underlying cognitive processes theories that could help in understanding the authors' conceptualization of clinical reasoning and interpreting their reported study findings. Table 1 summarizes the major underlying theories discussed, with several studies explaining intuitive and analytical cognitive processes as single processes (n=7),[40-42,44,46,49,50] while others mentioned the dual process theory solely or additional to intuitive and analytical cognitive processes (n=5).[38,39,43,45,48]

Operationalization

The think-aloud method was most frequently used to study pharmacists' cognitive processes (n=9).[38-41,44-46,48,50] Except for the study of Phansalkar et al., [40] which examined think-alouds during focus groups , participants in all studies were thinking aloud individually. Think-alouds were often followed by semi-structured interviews (n=4).[38,41,45,50] Bhogal et al.[42] and Oliviera et al.[47] conducted semi-structured interviews after observing patient-pharmacist consultations without thinking aloud. Haider et al.[43] conducted surveys to study cognitive processes. Think-aloud data was mostly approached inductively to understand underlying reasoning addressing a clinical scenario (n=6).[39,44-46,48,50] In contrast, Croft et al.[38] used a deductive approach for direct content analysis providing initial coding categories based on the clinical reasoning cycle for nursing practice. The operationalized variables, i.e. cases and study settings, differed between the studies. While the majority of included studies were conducted in primary care (n=11), only Abuzour et al.[50] and Phansalkar et al.[40] were conducted in secondary care and tertiary care, respectively. Several studies observed direct (simulated) pharmacist-patient interaction (n=8).[38,39,41,42,44,46-48] The remaining studies used paper cases (n=5).[40,43,45,49,50] Case content varied across studies and depended on context. Detailed information on used case scenarios and study settings was often lacking.[40,42,44,46-50] Cases were stated to be practice-based in all studies. Pilot tests were frequently conducted for case scenarios.[38,39,41,44,45,48]

Table 1. Conceptualizations, operationalizations and key findings of included studies.

	CONCEPTUALIZATION		
First author (country, year of publication)	**Main term(s) used to describe concept** *Definition, if provided explicitly*	**Context**	**Main underlying theories of cognitive processes mentioned**
Abuzour[50] (United Kingdom, 2018)	Clinical reasoning *Context-dependent way of thinking and decision-making in professional practice to guide practice actions*	Diagnosis-forming and therapy planning	Information Processing Theory (Newell) Hypothetico-deductive approach (Elstein and Schwarz)
Akhtar[41] (United Kingdom, 2015)	Clinical decision-making	Diagnosis-forming and therapy planning	Hypothetico-deductive approach Pattern recognition (Elstein and Schwarz)
Bhogal[42] (United Kingdom, 2013)	Decision-making	Diagnosis-forming and therapy planning	Pattern recognition
Croft[38] (Australia, 2018)	Clinical reasoning Clinical decision-making *Complex process of thinking and decision-making that depends on the ability of humans to process, memorise, recall and synthesize huge amounts of data.*	Medication review and dispensing	Hypothetico-deductive approach Intuitive-humanist model Combination of intuition and analysis (Linn)
Haider[43] (Australia, 2020)	Clinical reasoning Diagnostic reasoning *Cognitive processes involved in reaching a clinical decision*	Diagnosis-forming	Dual process theory
Iqbal[44] (United Kingdom, 2013)	Clinical reasoning Decision-making	Diagnosis-forming	Hypothetico-deductive approach Pattern recognition (Elstein and Schwarz)
Mallinder[45] (New Zealand, 2021)	Clinical decision-making	Diagnosis-forming and therapy planning	Dual process theory (Croskerry) System 1 (pattern recognition) System 2 (analytical)
Nusair[46] (Canada, 2017)	Clinical decision-making	Medication review and dispensing	Intuitive thinking (Croskerry)

OPERATIONALIZATION				KEY FINDINGS
Population (n)	**Summarized methods**	**Case(s)**	**Setting**	**Summarized key findings on used cognitive processes**
Pharmacist and nurse independent prescribers in secondary care (n=10)	Concurrent think-aloud, followed by semi-structured interviews	Three cases per participant in clinical therapeutic areas of choice	Paper cases in private area at participant's work or over the phone	Hypothetico-deductive approach Semantic qualifiers
Community pharmacists (n=10)	Concurrent think-aloud, followed by semi-structured interviews	Case on dyspepsia	Role-played by author at community pharmacy of participant	No distinct cognitive pattern
Community pharmacists (n=5)	Observed consultations, followed by semi-structured interviews	5 real-life consultations	At community pharmacy of participant	Pattern recognition
Community pharmacists (n=10)	Concurrent think-aloud, followed by semi-structured interviews with video-stimulated retrospective think-aloud	Prescription from GP for insulin and antibiotics with risk of ADR	Simulated patient in a simulated community pharmacy	Hypothetico-deductive approach Predictive reasoning Forward reasoning
Pharmacists in primary care (n=29)	Survey	3 case scenarios for absolute CVD risk assessment	Digital	Anchoring bias Framing effect
Community pharmacists (n=4)	Concurrent think-aloud	Case on sub-arachnoid hemorrhage	Role-played by the researcher in unknown setting	No distinct cognitive pattern
Community pharmacists (n=15)	Concurrent think-aloud, followed by semi-structured interviews	Case on bacterial conjunctivitis	Paper case at participant's work	Dual process (pattern recognition and analytical)
Community pharmacists (n=9)	Survey, audio-recorded consultations and concurrent think-aloud	15 real-life think-alouds and 15 real-life consultations	Private consult rooms in community pharmacy of participant	Intuition (refill bias)

Table 1. continued

	CONCEPTUALIZATION		
First author (country, year of publication)	**Main term(s) used to describe concept** *Definition, if provided explicitly*	**Context**	**Main underlying theories of cognitive processes mentioned**
Nusair[39] (Canada, 2019)	Clinical reasoning Clinical decision-making *Cognitive process through which practitioners apply their knowledge and clinical experience in assessing and managing patients' medical problems*	Medication review and dispensing	System 1 or intuitive (automaticity, intuition, pattern recognition) System 2 or analytical (forward-chaining, hypothetico-deductive, if/then) Dual process theory Hindsight reasoning (Hoffman)
Oliviera[47] (Brasil, 2020)	Clinical reasoning *Complex cognitive process that uses formal and informal thinking strategies to gather and analyze patient information, evaluate the importance of this information, and weigh alternative actions*	Medication review	
Phansalkar[40] (Northern America, 2009)	Decision-making	Diagnosis-forming	Hypothetico-deductive approach Pattern recognition Problem-solving by instances or prototypes (Elstein and Schwarz)
Rutter[48] (United Kingdom, 2013)	Clinical reasoning Diagnostic clinical decision-making *Process by which medical practitioners make clinical decisions (and thus a diagnosis)*	Diagnosis-forming and therapy planning	Hypothetico-deductive approach Pattern recognition Combined in the cognitive continuum theory (Offredy)
Sinopoulou[49] (United Kingdom, 2017)	Clinical reasoning Clinical decision-making *A dynamic rather than a static process, in which evidence-based knowledge serves to recognize and interpret clinical data and practical experience allows to integrate all available information into forming a diagnosis.*	Diagnosis-forming and therapy planning	Forward reasoning Problem-solving by instances Pattern recognition (Elstein and Schwarz)

OPERATIONALIZATION				KEY FINDINGS
Population (n)	**Summarized methods**	**Case(s)**	**Setting**	**Summarized key findings on used cognitive processes**
Community pharmacists (n=17)	Concurrent and retrospective think-aloud	Prescription from GP to collect an ARB after an ADR on an ACE-I	Simulated patient in a private consult room in the community pharmacy of participant	(1) Forward-reasoning (2) Hypothetico-deductive approach Also no distinct or multiple cognitive approaches possible In retrospective, dual process Hindsight reasoning
Clinical pharmacists (n=11)	Observed consultations, followed by semi-structured interviews	14 real-life consultations 11 interviews	At primary care, specialty or university clinic or public pharmacy of participant	Hypothetico-deductive approach
Clinical pharmacists in tertiary care (n=5)	Think-aloud during focus groups	Cases on hypo/ hyperkaliemia, somnolence and constipation	Sections of patient records discussed during focus group in hospital	Hypothetico-deductive approach Pattern recognition (prototype matching)
Community pharmacists (n=10)	Concurrent think-aloud	Case on urticaria on the right forearm	Role-played by author at community pharmacy of participant	No distinct cognitive pattern
Community pharmacists (n=8)	Semi-structured interviews	Case on headache	At place of participants' choice	No distinct cognitive pattern

Cognitive processes

Three medication review studies (Croft et al.,[38] Nusair et al.,[39] and Oliviera et al.[47]) reported pharmacists' predominant use of analytical approaches, primarily hypothetico-deductive approach and forward-reasoning.[38,39,47] In the study by Oliviera et al.,[47] for example, study participants used a hypothetico-deductive approach while waiting for serum concentration lab results to confirm or refute their hypothesis to change the pharmacotherapy. Forward-reasoning was used, for instance, by community pharmacists involved in the study by Nusair et al.,[39] to address safety concerns by verifying and collecting data before reaching a conclusion. Intuitive processes were reported less frequently in these studies and mostly in addition to analytical processes (dual process).[38,39,47] Participants in these studies, for example, frequently made assumptions about an unknown indication based on associated medication, pattern recognition, or pharmacology.[39] In another study, Nusair et al.,[46] hypothesized that intuition could explain why pharmacists signed off prescriptions before determining the therapy was indicated, effective, safe, and manageable. Especially when it came to refill prescriptions, pharmacists assumed therapy's efficacy, which could have resulted in premature closure.[46]

The majority of diagnosis-forming studies in primary care identified no distinct cognitive reasoning patterns when addressing selfcare scenarios (n=5).[41,43,44,48,49] Instead, these studies indicated that community pharmacists relied heavily on protocol-led information gathering strategies, particularly the WWHAM-method (Who is it for?; What are the symptoms?; How long have the symptoms been present?; Any other medication being used at the moment?; and what Medication has been tried already?).[41,42,44,48,49] In their study, Akthar et al.[41] reported that pharmacists who used this acronym approach exclusively did not achieve the expected outcome (n=7) compared to pharmacists who relied on matching the patient's signs and symptoms to their previous experience and knowledge (n=3). According to Iqbal et al.,[44] their participants did not embody a clinical reasoning approach because they did not connect any of the information gathered. Biases and knowledge gaps have been reported to contribute to community pharmacists' poor diagnostic reasoning.[41,43,44,48,49] A recent study in New Zealand, on the other hand, identified pattern recognition combined with analytical approaches working through a bacterial conjunctivitis scenario providing the prescription-only medicine chloramphenicol.[45] A small pilot-study in the United Kingdom also identified pattern recognition as cognitive pattern used by community pharmacists working through a dyspepsia case.[42] In secondary care, Abuzour et al.[50] reported that among prescribing pharmacists addressing prescribing scenarios, the use of hypothetico-deductive reasoning combined with semantic qualifiers (adverbs or adjectives)

facilitated access to their illness and therapy scripts. According to Phansalkar et al.,[40] clinical pharmacists in tertiairy care used information from patients' medical records to form hypotheses about possible adverse drug events and validated them (i.e., hypothetico-deductive reasoning). In addition, they reported that pharmacists matched the case data with a mental prototype, necessitating additional information and their ability to make implicit judgments in order to complete the clinical picture beyond the data presented in the case scenario (i.e., pattern recognition).[40]

Despite providing clinical services, four studies reported that community pharmacists' reasoning was frequently technical and product-oriented.[39,41,46,49] According to Nusair et al. [46], when community pharmacists focused more on the patient during medication review, medication was checked for safety rather than indication, effectiveness and adherence. Clinical pharmacists, according to Olivera et al.,[47] approached patients more holistically when providing comprehensive medication management services. In addition to reasoning-related cognitive processes, several studies reported that pharmacists reflected on their own thoughts and actions (n=4).[38,39,41,50]

Implications

The studies included in this review reflect a growing field of research on clinical reasoning by pharmacists, which is consistent with the profession's shift toward a more patient-centered approach. Furthermore, the use of clinical reasoning by pharmacists in various contexts corresponds to the broadening scope of clinical services in pharmacy practice. To effectively teach clinical reasoning–an essential skill for providing these services–it is important to clarify the concept of clinical reasoning by pharmacists.

Conceptualization

In line with most included studies, we conceptualize clinical reasoning as a context-dependent stage of the pharmacists' clinical decision-making process whereby pharmacists apply and integrate knowledge and clinical experience to interpret all available clinical data. This conceptualization is consistent with the clinical decision-making model in pharmacy proposed by Wright et al.[13] Clinical reasoning is used in this model, which focuses on the cognitive processes required for clinical decision-making, to construct patient-centered therapeutic options based on the information gathered in the preceding information gathering stage.[13] The following clinical judgment stage entails weighing-up these therapeutic options and ranking them based on their impact in order to select the preferred option.[13] Afterwards, the decision is made in collaboration with other health professionals and the

patient in the final stage.[13] Although several studies integrated clinical judgment and decision-making in the clinical reasoning process, we recommend that these be separated in the clinical decision-making process in accordance with the model of Wright et al.[13] While keeping the overall process in mind, explicating these cognitive stages separately can contribute to teaching and learning because each stage requires specific skills and can benefit from targeted teaching strategies.[35,51] In addition to Wrights' model, in order to improve clarity in terminology, we recommend putting clinical reasoning into context and purpose of reasoning by distinguishing "diagnostic reasoning" from "therapeutic reasoning" in terms of diagnosis-forming and, therapy planning and medication review. Others, such as Young et al.[29], advocate for being explicit about the intended meaning of the term used. Physicians' reasoning in diagnosis-forming is already often referred to as "diagnostic reasoning" and characterized as the thinking process of 'sorting through a cluster of features presented by a patient and accurately assigning a diagnostic label'.[17,52] In two included studies, the term "diagnostic reasoning" was also used to identify pharmacists' thoughts during diagnosis-forming. The term "therapeutic reasoning" is already often used when physicians think about appropriate patient therapy.[21] Surprisingly, none of the included studies referred to pharmacists' thoughts in therapy planning or medication review as "therapeutic reasoning". The distinction between clinical reasoning subtypes, in our opinion, could contribute in learning and teaching this stage of the clinical decision-making process, as well as interprofessional communication. Moreover, our conceptualization of clinical reasoning in pharmacy can be further enriched by future research, particularly by comparing it to conceptualizations of related health professions. The observed technical and product-oriented focus in pharmacists' reasoning, for example, raises questions on domain specificity, as well as how the patient is involved in this stage of the clinical decision-making process. It also remains unclear how pharmacists handle clinical uncertainties in their reasoning.

Cognitive processes

Both analytical and intuitive cognitive processes were reported by the included studies, either separately or combined as dual process. When determining medication appropriateness, an analytical approach was reported predominantly to an intuitive approach, which is unsurprisingly given their scientific pharmaceutical education.[45] Because intuitive reasoning is more prone to error, pharmacists may have taken a more cautious analytical approach on purpose, as determining medication appropriateness after receiving prescriptions can be viewed as risk management or a safety net for prescribers.[45] It is also possible that the pharmacists' predominant analytical approach was influenced by the complexity of the studied scenario, which

would be similar to expert physicians who use analytical reasoning in complex cases.[45] Whereas physicians tend to rely more on intuitive reasoning with more years of experience, it appears that pharmacists' analytical predominant approach was unrelated, as the participants in the included medication review studies had varying years of experience. However, more research on clinical reasoning development is required. A pharmacist's inability to trust their intuition may also contribute to their analytical preference in medication review studies.[45] Because the cases in these studies were stated to be practice-based and often tested, an analytical preference due to unfamiliarity with the underlying disease or medicines would be less likely. Because there is frequently a lack of case data, a small number of studies and participants per study, and heterogeneity in operationalization, interpreting these results on a dominant analytical approach should be done with caution. Furthermore, because intuitive processes are more difficult to detect using think aloud methods and interviews as operationalization of the concept, underreporting of intuitive approaches in studies is possible.[39] Nonetheless, more patient encounters by pharmacists may enrich therapy scripts, increasing reliance on intuitive reasoning and making processes become more efficient.[21] Reflection on cognitive processes used and awareness of the possibility of bias are recommended to reduce the risk of errors.[53] Because only a few studies reported that pharmacists reflected on their thoughts and actions during the process, encouraging (metacognitive) reflection in pharmacy practice and education is recommended.

Even though several diagnosis-forming studies observed analytical and intuitive processes among pharmacists, the majority of primary care studies identified no distinct cognitive reasoning pattern when community pharmacists relied solely on the WWHAM-method to address selfcare scenarios. Using only this type of mnemonic is in forming a diagnosis is insufficient, because mnemonics are not intended to assist the pharmacist in curating the information gathered in establishing a diagnosis.[54] As mnemonics are still widely used in pharmacy education to address selfcare scenarios,[55] additional teaching strategies to improve diagnostic reasoning are advised. Although these studies were all conducted in the United Kingdom and were related to the same research group, the findings are relevant to this qualitative research, as well as to practice and education in other countries. Improving diagnostic reasoning in selfcare is important given the rise in over-the-counter availability of prescription medicines and it may establish pharmacists' position as the most easily accessible health professional in selfcare even further.

Teaching strategies

Teaching strategies should be developed to help students acquire the necessary knowledge, skills and attitude, which may vary depending on the context of clinical reasoning.[13] More research is needed among pharmacists and pharmacy students to determine what knowledge, skills, attitude and conditions are required. As the closest related health professional, it could be possible to adapt existing medical teaching strategies to help pharmacy students improve their clinical reasoning skills. Tietze, for example, integrated Subjective-Objective-Assessment-Planning (SOAPing) processes with pharmacy-specific elements in her course to guide students in making individual therapeutic recommendations.[33] The recent model of Rutter and Harrison can be used to guide the development of teaching strategies for how to reach a differential diagnosis in pharmacy practice.[54] Their model included the creation of illness scripts to recognize patterns in future patient selfcare encounters. Particularly in the context of diagnosis-forming, adapting medical teaching strategies could be beneficial. More research is needed, however, to determine the effectiveness of teaching strategies adapted from other health professions. Due to the lack of research among pharmacy students, it is unknown whether their cognitive processes differ from those of pharmacists. It is possible that different teaching strategies are required at different stages of education.[56]

Strengths and limitations

A rigorous design was used for this scoping review, which included an established research framework, a comprehensive search method, and a well-documented selection process. Although a broad search was intended, the search method or selection may be insufficient or key sources may be incorrectly excluded. The selection of studies was influenced by choice of terminology in the search strategy and by authors of the studies. Excluding unavailable and non-peer reviewed full-text articles, as well as non-English written articles, may have led to potential bias. However, based on the titles and journals of these articles, missing relevant studies are unlikely. Limiting to primary research among pharmacists or pharmacy students excluded theoretical articles and research among other health professionals. This, however, aided in focusing on studies that examined cognitive processes as they were used by pharmacists in practice, as well as improving our understanding of this concept in this health profession. Future research focusing on comparisons with health professions conceptualizations may enrich our understanding of clinical reasoning by pharmacists. It has to be taken into account that primary studies among pharmacists were grounded on theoretical articles and research conducted among other health professionals, which could have led to cognitive bias. The variety and often missing data of terminology, definitions, operationalized variables, and study

findings associated with clinical reasoning by pharmacists challenged the qualitative data analysis. The heterogeneity in pharmacists' type, level of care, education and roles or tasks in health care settings made data analysis even more difficult as these factors could potentially influence clinical reasoning. Future research should examine how these factors affect clinical reasoning, such as the potential differences between pharmacists working in primary care and pharmacists working in secondary and tertiary care. Because the studies were primarily conducted in primary care, more research is needed to reflect on clinical reasoning across the entire profession. Furthermore, the relatively large number of studies associated to the same research group could have resulted in potential bias. However, because this was a scoping review without a formal quality assessment, all available studies were mapped and summarized, and all available data was used to improve the understanding of the key concept. Furthermore, the knowledge gap on clinical reasoning development was caused by a lack of data on expertise and studies on used cognitive processes involving pharmacy students. Future research involving pharmacy students, novices and experts would improve understanding of clinical reasoning as a dynamic process. No hard conclusions can be drawn due to the heterogeneity, small number of participants, and small selection of studies. Notwithstanding its limitations, these findings improved our understanding of clinical reasoning by pharmacists.

Recommendations for pharmacy education

Based on this scoping review, the following recommendations for pharmacy are made: (1) Explicate each stage of the clinical decision-making process, including clinical reasoning, with transparent cognitive processes; (2) Contextualize clinical reasoning by using the terms "diagnostic reasoning" and "therapeutic reasoning"; (3) Develop teaching strategies to help students and pharmacists improve their diagnostic reasoning when addressing self-care scenarios; (4) Encourage (metacognitive) reflection on clinical decision-making.

This scoping review provided an overview of studies that examined the use of cognitive processes in clinical reasoning in pharmacy practice, whereby pharmacists apply and integrate knowledge and clinical experience to interpret all available clinical data as part of the clinical decision-making process. Pharmacists showed analytical and intuitive approaches during clinical reasoning, either separately or combined as dual process. Using the terms "diagnostic reasoning" and "therapeutic reasoning" to explicate clinical reasoning in diagnosis-forming and, respectively, therapy planning and medication review, could improve conceptual clarity in pharmacy practice, research, and education.

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Conflict of interest

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Appendix 1

Search strategy

Table 1. Selected terms for search strategy

Category	Selected term
Overall	Clinical reasoning
	(Clinical) Decision making
Purpose/goal of reasoning	Diagnostic reasoning
	Clinical problem-solving
	Diagnostic thinking
	Diagnostic decision making
	Treatment decision making
	Therapeutic reasoning
Outcome of reasoning	Choice of treatment
Reasoning performance	Competency
	Clinical competence
	Clinical performance
	Adaptive expertise
	Cognitive expertise
	Expert reasoning
	Expertise
	Medical expertise
Reasoning processes	Hypothetico-deductive reasoning
	Bayesian probabilistic thinking
	Intuition
	Pattern recognition
	Inductive and deductive reasoning
	Analytic reasoning
	Analytical thinking
	Backward forward reasoning
	Backward reasoning
	Cognitive processes
	Critical appraisal
	Higher order thinking
	Intuitive reasoning
	Medical information processing
	Pattern matching
	“Street diagnosis” or in the blink of the eye

Table 1. continued

Category	Selected term
	Metacognition
	Reasoning strategies
	Reflective thinking skills
	Self-monitoring
Reasoning skills	Critical thinking
	Clinical skills
	Cognitive skill
	Critical analysis
	Critical reasoning
	Reasoning
	Reasoning skills
Context of reasoning	Situational judgement
	Situation awareness
	Informed decision making

Table 2. Search strategy conducted on 15th of March 2021 using the search database MEDLINE (PubMed)

Search query	Records retrieved
(("Clinical reasoning"[tiab] OR "Diagnostic reasoning"[tiab] OR "Clinical problem-solving"[tiab] OR "Diagnostic thinking"[tiab] OR "Diagnostic decision making"[tiab] OR "Treatment decision making"[tiab] OR "Therapeutic reasoning"[tiab] OR "Choice of treatment"[tiab] OR "Competency"[tiab] OR "Clinical competence"[tiab] OR "Clinical performance"[tiab] OR "Adaptive expertise"[tiab] OR "Cognitive expertise"[tiab] OR "Expert reasoning"[tiab] OR "Expertise"[tiab] OR "Medical expertise"[tiab] OR "Hypothetico-deductive reasoning"[tiab] OR "Bayesian probabilistic thinking"[tiab] OR "Intuition"[tiab] OR "Pattern recognition"[tiab] OR "Inductive reasoning"[tiab] OR "deductive reasoning"[tiab] OR "Analytic reasoning"[tiab] OR "Analytical thinking"[tiab] OR "Backward forward reasoning"[tiab] OR "Backward reasoning"[tiab] OR "Cognitive processes"[tiab] OR "Cognitive process"[tiab] OR "Critical appraisal"[tiab] OR "Higher order thinking"[tiab] OR "Intuitive reasoning"[tiab] OR "Medical information processing"[tiab] OR "Pattern matching"[tiab] OR "Street diagnosis"[tiab] OR "blink of the eye"[tiab] OR "Metacognition"[tiab] OR "Reasoning strategies"[tiab] OR "Reasoning strategy"[tiab] OR "Reflective thinking skills"[tiab] OR "Reflective thinking skill"[tiab] OR "Self-monitoring"[tiab] OR "Critical thinking"[tiab] OR "Clinical skills"[tiab] OR "Clinical skill"[tiab] OR "Cognitive skills"[tiab] OR "Cognitive skill"[tiab] OR "Critical analysis"[tiab] OR "Critical reasoning"[tiab] OR "Reasoning"[tiab] OR "Reasoning skills"[tiab] OR "Reasoning skill"[tiab] OR "Situational judgement"[tiab] OR "Situation awareness"[tiab] OR "Situational awareness"[tiab] OR "Informed decision making"[tiab] OR "Professional Competence"[majr] OR "Clinical Competence"[majr] OR "Intuition"[majr] OR "Pattern Recognition, Physiological"[majr] OR "Metacognition"[majr] OR (("Thinking"[majr] OR "Clinical Decision Making"[majr]) AND "Professional Role"[majr]) OR "therapeutic decision making"[tiab] OR "decision making"[ti] OR "clinical decision making"[tiab]) AND ("Pharmacists"[Majr] OR "Pharmacists"[ti] OR "Pharmacist"[ti] OR "Pharmacy"[Majr] OR "Pharmacies"[Majr] OR "pharmacy"[ti] OR "pharmacies"[ti]) NOT (("Review"[ptyp] OR "review"[ti] OR "editorial"[pt] OR "comment"[pt] OR "systematic"[sb]) NOT ("Clinical Study"[ptyp] OR "trial"[ti] OR "RCT"[ti])))	1467

Chapter 3

Cognitive processes in pharmacists' clinical decision-making

Josephine F. Mertens
Thomas G.H. Kempen
Ellen S. Koster
Vera H.M. Deneer
Marcel L. Bouvy
Teun van Gelder

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Abstract

Background

Pharmacists' clinical decision-making is a core process in pharmaceutical care. However, the practical aspects and effective teaching methods of this process remain largely unexplored.

Objective

To examine the cognitive processes involved in pharmacists' perceptions of how they make clinical decisions in pharmacy practice.

Methods

Semi-structured, face-to-face interviews were conducted with pharmacists working in community, outpatient, and hospital care in the Netherlands between August and December 2021. Participants were explicitly asked for examples when asked how they make clinical decisions in practice and how they teach this to others. After transcribing audio-recorded interviews, an inductive thematic analysis was conducted to identify cognitive processes. A theoretical model of clinical decision-making was then used and adapted to structure the identified processes.

Results

In total, 21 cognitive processes were identified from interviews with 16 pharmacists working in community (n=5), outpatient (n=2), and hospital care (n=9). These cognitive processes were organized into 8 steps of the adapted theoretical model, i.e. problem and demand for care consideration, information collection, clinical reasoning, clinical judgment, shared decision-making, implementation, outcomes evaluation, and reflection. Pharmacists struggled to articulate their clinical decision-making and went back-and-forth in their explanations of this process. All pharmacists emphasized the importance of identifying the problem and described how they collect information through reviewing, gathering, recalling, and investigating. Clinical reasoning entailed various cognitive processes, of which comprehending the problem in the patient's context was deemed challenging at times. Pharmacists seemed least active in evaluating patient outcomes and reflecting on these outcomes.

Conclusions

Pharmacists use multiple cognitive processes when making clinical decisions in pharmacy practice, and their back-and-forth explanations emphasize its dynamic nature. This study adds to a greater understanding of how pharmacists make clinical decisions and to the development of a theoretical model that describes this process, which can be used in pharmacy practice and education.

Introduction

Clinical decision-making (CDM) is a critical, dynamic process that healthcare professionals apply in daily clinical practice to support patient care.[1] Effective CDM entails step-by-step cognitive processes that include assessing patients, collecting and processing information, and deciding on an appropriate course of action.[2] As medication experts, pharmacists are regularly involved in making clinical decisions concerning drug therapy, a process also known as "therapeutic decision-making."[3,4] This process differs from diagnostic decision-making, which is typically performed by physicians and refers to the process of arriving at a final diagnosis. In literature, the terms "problem-solving" and "clinical reasoning" are often used interchangeably with CDM.[1] In this study, CDM is conceptualized as a series of cognitive processes and skills that enable pharmacists to make patient-centred, clinical decisions in the context of pharmacy practice.[4] While problem-solving can be viewed as a broader concept applicable to various contexts, CDM directly impacts patient care and well-being. Moreover, clinical reasoning is employed differently from CDM in this study since it is conceptualized as a context-dependent step of CDM whereby pharmacists apply and integrate knowledge and clinical experience to interpret all available clinical data.[3]

Pharmacists' roles have evolved over the past decades with increased focus on clinical care as a core professional duty in pharmaceutical care and increased responsibility for clinical decisions as a result of CDM. For the development of effective CDM teaching methods to support pharmacists' professional role, it is crucial to gain a comprehensive understanding of the cognitive processes utilized by pharmacists who are engaged in clinical roles in pharmacy practice. Therefore, the objective of this study was to examine the cognitive processes involved in pharmacists' perceptions of how they make clinical decisions in pharmacy practice in order to contribute to pharmacy practice and education.

Methods

Theoretical framework

There is no universal CDM model that fits all health professions, settings, and individuals.[1] Models in other health professions include the clinical reasoning cycle in nursing,[5] the biopsychosocial model that underpins physiotherapist's assessment and management of a patient,[6] and the conceptual CDM framework in dentistry.[7] There are similarities and differences reflecting the overlapping but different goals of the professions.[1] To our knowledge, there is no internationally recognized and comprehensive theoretical framework for CDM in pharmacy practice and education.

Therefore, a theoretical CDM model was previously developed and implemented at the University of Leiden's Master of Pharmacy program (Appendix 1). This 8-step patient-centred model is based on earlier work on pharmacists' decision-making,[3,4,8-10] and on the clinical reasoning cycle in nursing,[5] as it aligned well with the drug dispensing process in a community pharmacy, according to Croft et al.[10] The CDM model incorporates the Pharmacists' Patient Care Process (i.e. collect, assess, plan, implement, and follow-up)[11] plus three additional steps for educational purposes. The first additional step is the "consideration of the patient problem and care demand" to start the decision-making process. Second, following the framework proposed by Wright et al.,[4] the benefit-risk assessment of the most viable treatment options based on the gathered information, is incorporated in the model as the distinctive step "clinical judgment". Third, "reflection" has been added as a step to emphasize its importance in scrutinizing cognitive processes and mitigating the potential impact of biases, ultimately reducing the risk of errors.[12] However, it is unclear whether and how all of these processes are employed by pharmacists who are currently providing pharmaceutical care. A better understanding of the cognitive processes involved in CDM in pharmacy practice may support pharmacists' professional role development and teaching in both undergraduate and postgraduate curricula.

Study design and setting

This was a qualitative study with semi-structured interviews in community pharmacy, outpatient pharmacy, and hospital pharmacy in the Netherlands. In all pharmacy settings, Dutch pharmacists are non-prescribing health professionals and considered a member of multidisciplinary healthcare teams. This study focused on the cognitive processes involved in pharmacists' CDM. A separate study on the factors influencing pharmacists' CDM, based on the same interview data, has been published elsewhere.[13]

Participant sampling and recruitment

In research team meetings, pharmacists were purposefully sampled from the research team's professional network to assure participants from community, outpatient, and hospital care. Furthermore, sample characteristics for clinical experience and PhD degrees differed on purpose because these factors may affect their cognitive processes used in CDM and their explanations of the process.[13] Afterwards, the principal researcher and interviewer (JM) recruited pharmacists by email. Additionally, snowball sampling was used to reach a community pharmacist beyond the professional network of JM, also community pharmacist. Before completing the Consent Form, potential participants were emailed a Participant Information Sheet describing the purpose of the interview and study objectives,

and they were given the opportunity to ask questions regarding the research. Participating pharmacists were free to leave the study at any time and were not compensated for their participation. The interview was set up at a time that the pharmacists thought was convenient and free of disruptions.

Data collection

Based on the previously conducted literature review,[3] a semi-structured interview guide was developed with questions related to how pharmacists make clinical decisions in practice, how they teach this to others in practice, and what factors influence this process. The interview guide allowed to obtain multiple decision-making examples from each participant to ensure there would be enough data for analysis and drawing conclusions about the population sampled. Following the first two interviews, the interview guide was evaluated, and minor changes were made to ensure that the questions were understandable. The final interview guide in English is included in Appendix 2.

The interviews were held face-to-face between August and December 2021, either in-person or online using Microsoft Teams. The pharmacists' workplace provided a private space for in-person interviews. All interviews were audio recorded and lasted between 45 and 60 minutes. All interviews were performed by JM to guarantee consistency in data collection. JM was able to expand the inquiry as a pharmacist and educator by anticipating responses based on prior experience and understanding of pharmacy practice and education. She had also completed a qualitative interviewing training course. A final-year pharmacy student transcribed the audio recordings verbatim. JM checked 10% of the transcripts for accuracy at random intervals.

Data analysis

First, an inductive approach was used for thematic analysis, with open and exploratory coding through systematic (re)reading and independent parallel coding (JM and one of two final-year pharmacy students) using qualitative data analysis software (ATLAS.ti version 22). Discrepancies in coding were resolved by group discussion or consultation with a third researcher (EK) experienced in qualitative research. Interviews were conducted until data saturation occurred, defined as at least two interviews with no new themes relevant to the research purpose, according to the researchers. Themes were iteratively developed and adapted by the research team with pharmacy practice experience in primary care (JM, TK, MB), in hospital care (TK, VD) and with medical experience (TvG). Afterwards, the theoretical CDM model (Appendix 1) was used and adapted to structure the identified themes (cognitive processes).

Ethics and privacy

The Institutional Review Board at Utrecht University, the Netherlands, approved this work (registration number: UPF2111, date: 28-09-2021). The findings were reported in accordance with the requirements of the COnsolidated Criteria for REporting Qualitative Research (COREQ) (Appendix 3). All participants provided written informed consent prior to the interview. The anonymity of the participants was ensured by deleting identifying information from the transcripts and providing a study-number to each participant.

Results

Fifteen pharmacists were approached through the researchers' network for participation, one pharmacist was recruited through snowballing, and all agreed to participate. After interviewing five community pharmacists (CP1-5), two outpatient pharmacists (OP1-2), and nine hospital pharmacists focused on inpatients (HP1-9), the research team settled on data saturation as no new themes emerged in the final three interviews. Half of the participants (n=8) had a PhD degree and there were different years of clinical work experience among the participants (Table 1).

Table 1. Demographic characteristics of the study participants.

Participant characteristic	Number (n=16)
Gender	
Female	10
Male	6
Pharmacy care setting	
Community pharmacy	5
Outpatient pharmacy	2
Hospital pharmacy	9
Additional degree	
PhD	8
Years of clinical work experience	
0-5	5
6-10	6
11-15	2
>15	3

Pharmacists acknowledged that their CDM skills were honed through years of experience. While they recognized the significance of this process in their work as pharmacists, they often did not consciously contemplate on the intricacies of this process. At times, they faced difficulty in articulating the precise terms to describe their decision-making and used metaphors like "automatic pilot" to convey its nature. Despite these linguistic limitations, 21 themes were identified to illustrate

which cognitive processes pharmacists use to make clinical decisions in practice. The identified cognitive processes were organized into one of the eight steps in the theoretical model for CDM (Table 2), taking into account that pharmacists went back and forth in their explanations of conducted steps. Two steps of the model (step 3 and 6) were adapted to best fit the empirical data.

Step 1. Patient problem and demand for care consideration

All participants mentioned that their CDM process begins with a pharmacotherapeutic problem or with a question from a patient or other health professional. These problems and questions were not always straightforward, and it was critical for pharmacists to "figure out the question behind the question" (CP2, HP3, HP5, HP6, HP7). Many pharmacists reported that they initially consider the situational context in which the potential problem emerges by listening to the patient or other health professionals, including their pharmacy technicians. They may already estimate the type of patient, prescriber, and problem based on this information to determine the problem's urgency and "can I help as pharmacist?" (CP1, CP3, CP5). Some pharmacists emphasized the importance to consider the patient's demand for care, which may differ from the pharmacotherapeutic problem or drug-related question and is not always readily available to pharmacists.

Step 2. Information collection

All pharmacists provided explanations of how they collect information about the patient, their conditions, and their medicines. They review current information, such as lab results and medication history in patient records, and gather new information through patient and physician consultation. Additionally, they recall theoretical knowledge and previous patient experiences, and investigate new information by searching the literature. Some pharmacists emphasized the importance of balancing between acquiring sufficient information to make well-informed decisions and avoiding the accumulation of unnecessary data. Limited or inaccurate information rendered CDM more challenging.

Step 3. Clinical reasoning

Pharmacists described various cognitive processes for using and integrating existing knowledge and experience to interpret the collected information. In this clinical reasoning step, pharmacists recognized, for example, abnormal lab results, treatment-guideline inconsistencies, and missing data. When information gaps were identified, pharmacists could (re)consult the patient, health professionals and other information sources to gain more information (hence, going back to Step 2). Multiple pharmacists stated that, when assessing all available information, they distinguish

relevant from irrelevant information and prioritise information to increase efficiency in decision-making. When multiple problems are present, it was also considered important to prioritise the problem itself. Furthermore, several pharmacists stated linking information to identify patterns of information. These patterns were mostly identified in pharmaceutical information, but they were also identified in clinical and contextual information. Another identified cognitive process is matching, whereby pharmacists reported to match conditions, symptoms, medications and lab results to acquire structure and identify mismatches and information gaps, particularly when conducting medication reviews. Inferring was also identified as a cognitive process used by pharmacists when forming deductions using their pharmacological knowledge. For instance, HP4 stated to use the medication as starting point and think pharmacologically to make sense out of a case. Pharmacists also described interpreting available information to comprehend the problem in the patient's context, "because I just want to understand why such a thing is" (HP1), as well as to predict the problem's consequences and its clinical relevance in this context. However, pharmacists often face challenges in grasping the clinical relevance of a theoretical problem. Because problems are not always clear in Step 1, pharmacists synthesized available information to determine the patient's definitive problem, including its consequences and clinical relevance.

Step 4. Clinical judgment

Prior to making a clinical judgment about the (non-) therapeutic options to address the problem, pharmacists indicated that they first establish the desired outcome and timeframe. This, together with the patient's context, was then used to do a benefit-risk assessment. Several pharmacists emphasized that before they can decide on the most appropriate option, all potential options should be mapped.

Step 5. Shared decision-making

Pharmacists explained that they select the most appropriate option based on their clinical judgment when this is clear to them. To clarify this for oneself, CP4 asks herself for instance, "Can I justify dispensing this medication?". If so, she decides on dispensing the medication autonomously as a course of action in shared agreement with the prescriber and the patient. When pharmacists are unable to decide on a course of action autonomously, e.g. when a drug prescription is needed or patients' preferences on pharmaceutical formulation are required, they seek collaboration with prescribers and/or patients to conduct shared decision-making. However, prescribers may not always regard pharmacists' recommendations to be the most appropriate option, which is deemed "difficult at times" (CP5). Primary care pharmacists described patient involvement in decision-making more than hospital pharmacists.

Table 2. Clinical decision-making process steps with cognitive processes and representative interview extracts.

Steps	Cognitive processes	Representative interview extracts
1. Problem and demand for care consideration	**Identifying** problem and demand for care	*"What is the problem according to the patient?" – CP2* *"What's the problem? Is there a problem with the medication or not? Signals reach me in different ways, e.g. through alerts from clinical risk management systems and directly through questions from the clinic. Take for example the problem of a drug interaction with an antibiotic: I can consider whether I can combine it or not, but the first question is whether there is an infection present." – HP5*
	Describing situational context	*"When someone arrives, I observe that person. [..] Looking at how old someone is, seeing if they are mobile, seeing if they are calm or not calm. I observe the patient holistically." – CP5* *"The cardiologist calls or it's a lot of physician assistants here, eh, because some of them are also fresh out of school. So I actually take that [physician's specialism or seniority] into account in my decision-making."– HP5*
2. Information collection	**Reviewing** current patient information	*"I review if I correctly extracted patient's care demand." – HP9* *"What is her medication? If that is used at all, so definitely something to check, whether she takes it." – CP2*
	Gathering new patient information	*"I call the physician to know what the indication of the therapy is."- CP4* *"How is the patient doing?" – HP5*
	Recalling knowledge	*"It's something in your head; what you have previously heard or seen is a common side effect of a certain medicine." – CP1* *"I just know by heart that some drugs have a very long half-life. So then I also know immediately that it doesn't matter when you determine blood levels." – HP1*
	Investigating new information, e.g. in drug information database	*"While you're reviewing that patient information, you're consulting other sources as well. Drug resources that can provide some background information." – HP8* *"Of course, you sometimes have drugs that pass by that you think: huh, never heard of it. Well, I always look up what it is." – CP3*
3. Clinical reasoning*	**Recognising** normal from abnormal information, inconsistencies and information gaps	*"You look–if it is relevant for that drug–at a target value. Is the patient set up as it should be according to treatment guidelines? Or should it be more intensive? Or less intensive?" – CP2* *"It depends on the knowledge you have at that moment and of which you think: oh, but I still want to know this. And then I ask it myself, if I find anything missing." – HP3*
	Distinguishing relevant from irrelevant information	*"Framing what is currently important information and what is not. So distinguishing main from side issues." – CP5* *"I'm not thinking about the advice at all right now, but what information do I have and is it relevant to the advice I'll be giving later." – HP1*

Table 2. continued

Steps	Cognitive processes	Representative interview extracts
	Prioritising information by ranking its importance	*"I prioritize [what I will discuss with the physician], based on previous medication reviews, experiences and what the patient considers most important at that moment." – CP5* *"We have an urgent matter and something with which we may be able to do something in the long run." – CP2*
	Relating information to identify patterns of information	*" During patient consultations, I frequently have cogs running in my head thinking 'oh, that would probably have something to do with that.' [..] I have had patients with similar complaints and who improved [after amlodipin adjustment]. It's in my head like calcium channel blockers. I don't have a specific patient [in my head]. " – CP1* *"If you see a PPI without indication and you know that the person is receiving stomach protection, for example, because he had acetylsalicylic acid, which was taken off at some point and the PPI remained. Well, then it is sometimes very clear, that someone has simply forgotten to stop the PPI." – OP1* *"I see that the kidney function is not so good. So shouldn't you also stop taking a NSAID?" – HP5*
	Matching similar information and/or identify a mismatch	*"I'm juxtaposing conditions with the medication, and juxtaposing the lab and all that data with the input from the conversation." – CP1* *"Then you first sort the medication with the disease. [..] because otherwise you don't know what someone does or does not have an indication for. [..] Or is there over- or undertreatment?" – HP3*
	Inferring to form deductions that follow logically by interpreting information	*"I'm just a logical reasoner. I will think more from pharmacokinetics, from what I think makes sense what you see in a drug blood level, for example, and in an exposure, and what advice I give." – HP1* *"Can it be logically explained? [..] Can, for example, a side effect be explained using the mechanism of action?" – CP4*
	Comprehending the problem in the patient's context	*"What does the ECG actually say? Which medicine is involved and how do you interpret this? [..] Is there actually a problem?" – OP2* *"I try to see, although sometimes difficult, what the clinical relevance of that interaction is to this patient" – CP3*
	Synthesising information to formulate definitive patient's problem	*"Concentrate certain issues into a clear question." – OP1* *"I try to summarize for the physician and yourself with the goal to clarify the demand for care and the problem statement." – HP3*
4. Clinical judgment	**Establishing** desired outcome and timeframe	*"It's a different consideration if you are going to start something that in turn causes many side effects, because then you have to place that in the context of all other side effects and whether you consider that risk acceptable." – HP9* *"I need input from the physician on how they want to proceed with that patient. For example, when you're dealing with a terminal patient and they will not continue to treat." – HP2*
	Weighing-up benefits and risks of all available (non-)therapeutic options	*"It's important to weigh the risks and benefits of a drug for the patient." – CP1* *"In your mind, you constantly make a judgement of which is worse: this or that?" – HP3*

Table 2. continued

Steps	Cognitive processes	Representative interview extracts
5. Shared decision-making	**Selecting** most appropriate option to optimise patient outcomes in patient context, if necessary with other health professionals and/or patient	*"What is the best of these 3 options? And it is not always black and white, and as a pharmacist you are quite far from the patient, so you can also present the options to a nurse or a physician. And say, in this case option A would be best, and in that case option B will be best." – HP2* *"In all uncertainty you try to come to the best substantiated advice possible, because you never have all the information." – HP9*
	Deciding on course of action with other health professionals and/or patient	*"A decision made jointly, with respect for both the perspective of the doctor and the patient." – OP1* *"And what do you [the patient] think if we stop taking medication that we now agree together is no longer useful? That will be the decision I will further work with." – CP5* *"To come to a decision, we pharmacists find that difficult. Because it's very often a grey area, I hardly ever say "do this". [..] It is quite often giving the physician the options and presenting the best option, but you also mention the other options as well and then you hope to come to a decision together in a conversation." – HP4*
6. Implementation*	**Communicating** verbally and/or in writing the decision	*"You inform the patient: if [the complaint] doesn't improve or if it gets worse, contact the physician or me." – CP1* *"I'm documenting it [..] and if you [physician] act differently and a problem arises, then at least I have shared everything with you about this." – HP5*
7. Outcomes evaluation	**Evaluating** outcomes	*"Depending on the adjustment, I will monitor him or the physician or the patient himself. [..] If there's a decision for which I can be of value at the follow-up moment, then I monitor it. If we have to measure a blood pressure, then it does not make much sense for me to monitor that." – CP5* *"I do it on occasion. But very often, in the rush of the day, [follow ups] are the first things you think: it's not a priority," – OP1*
8. Reflection	**Contemplating** what has been learned, what has been done well, and what could have been done differently	*"Sometimes, a physician might not respond very nicely. Or sometimes the physician does. You think about that for a moment: hey, how come? [..] You should definitely reflect on yourself." – OP2* *"You're making some sort of assumption that okay, it's a gynaecologist so she has experience with it, so she must have consciously taken this risk, so to speak, and already discussed it with the patient. [..] Sometimes you go by that assumption, but with a baby to be born, I think it's nice to hear it anyway, even though the doctor thought that was a bit exaggerated" – CP4*

CP = community pharmacist, OP = outpatient pharmacist, HP = hospital pharmacist.
* Adapted from the preliminary model to best fit the empirical data: from "3. Problem analysis" to "3. Clinical reasoning" and from "6. Act" to "6. Implementation".

Hospital pharmacists explained that they inquired into patients' perspectives through other health professionals. When pharmacists are uncertain about the most appropriate option, they present their judgment to other health professionals to select the most appropriate option and jointly decide on the course of action.

Step 6. Implementation

When a course of action is decided upon, pharmacists implement it by communicating verbally and in writing with other health professionals and/or the patient. Many pharmacists emphasized the importance of considering how and what you communicate verbally and in writing, as well as adjusting your communication to the receiver. Pharmacists also stressed the need of documenting the decision-making process and outcome in the patient record, especially when there are differing viewpoints on the best course of action.

Step 7. Outcomes evaluation

Few pharmacists stated that they occasionally evaluate outcomes by following up on the clinical course through patient and physician consultation, and by reviewing patient records which are available to hospital and outpatient pharmacists. When pharmacists evaluate outcomes, they determine the impact of their decisions and utilize this information to reflect on their CDM (step 8). Multiple pharmacists stated that they do not evaluate outcomes sufficiently.

Step 8. Reflection

Several pharmacists mentioned the importance of self-reflection and critical thinking in CDM. Many pharmacists reported being aware of biases due to a lack of clinical data and assumptions they make. Aside from clinical outcomes, positive and negative feedback from patients and health professionals is used to contemplate what has been learned, what has been done well, and what could have done differently. Both intra- and interprofessional case reflection is deemed useful, and should be done more often according to the pharmacists.

Discussion

From pharmacists' perceptions, 21 cognitive processes were identified that are involved in their CDM. These cognitive processes were organized into a theoretical model consisting of eight steps. While each step is presented as a separate and distinct element in the model, pharmacists went back-and-forth in their explanations of these steps and sometimes combined steps. These explanations underline that CDM is a dynamic process.[1,5] Pharmacists struggled to articulate this process

properly and used metaphors to convey its nature. This struggle was also described by Anakin et al.,[14] who interviewed primary care pharmacists in New Zealand about their decision-making skills.

In this study, pharmacists explained that their CDM started with problem identification (Step 1), which fits with the theories on the broader concept of problem-solving.[15] Early problem identification is important for triggering therapy scripts, which are high-level, precompiled, conceptual knowledge structures of the courses of action that a health professional can take to address a patients' healthcare problem.[16] Synthesizing a definitive problem based on gathered information is included in Step 3. Starting the model with problem identification differs from other models, for example the model of the clinical reasoning process in nursing and the pharmacists' decision-making models in drug dispensing and medication reviews.[5,10,17] These models start with considering patient or prescription context, which would stimulate an holistic approach. Considering situational context is also described by pharmacists in this study and is incorporated in Step 1. Similar to the study of Anakin et al.,[14] the information collecting step (Step 2) was described in detail. Data availability influences pharmacists' CDM.[13] Croft et al. identified similar cognitive processes in pharmacists' thinking process in drug dispensing to retrieve and process information and identify therapeutic problems.[10] Additionally, we identified inferring to form deductions that follow logically by interpreting information, comprehending the problem and predicting an outcome. These cognitive processes are also found in nurses' clinical reasoning.[5] In the preliminary model, Step 3 was labelled "problem analysis", which seemed to focus on problem assessment only. Therefore, in our opinion, "problem analysis" had the risk of narrowing pharmacists' scope of information collection and assessment. The authors decided that "clinical reasoning" was more appropriate because the information that was gathered included information that encompasses more than just theory, such as information on the situational context, and clinical reasoning is conceptualized to interpret all of the information that is available. Labelling this step as "clinical reasoning" is coherent to the model of Wright et al.,[4] which is used in the interview study by Anakin et al.[14] The clinical judgment step (Step 4) involves a trade-off between the benefits and hazards of any option, and is based on ambiguity and uncertainty, which pharmacists find challenging.[4,13,14] A recent study also showed that pharmacy students did not routinely consider multiple reasoned options before committing to a therapeutic recommendation.[18] Making clinical judgment a separate model step emphasizes its importance in CDM and supports the development of specific teaching strategies for pharmacists and pharmacy students.[4] For example, thinking aloud by supervisors how they conduct clinical judgment considering multiple reasoned options including

their uncertainties would benefit students' learning process.[19] Shared decision-making (Step 5) begins, according to the literature, when the health professional communicates with other health professionals and/or the patient the need to consider the available options as a team.[17] According to this study, there is occasionally a lack of a team approach in pharmacy practice, which is driven by suboptimal collaboration with other health professionals, a pharmacist's uncertainty or reluctance in making decisions, and the absence of patient involvement in decision-making.[13] The latter is also stated by Towle et al.,[20] who described that health professionals do not always offer options to patients and that options are rarely provided fully, coherently and unbiased. As patients must have the knowledge and power to participate in this process, the pharmacist should provide patients the information they need to make informed decisions and empower them during the process.[21,22] In the preliminary model, step 6 was labelled "act", which largely referred to drug dispensing. The term "implementation" was deemed more appropriate for developing a model based on cognitive processes as well as a more general model that is not immediately related to drug dispensing. Although pharmacists in this study explained to communicate verbally and in writing, different studies show that documentation by pharmacists in patients' records could be improved.[23,24] Furthermore, pharmacists may identify decisions that are (in)effective by evaluating outcomes (Step 7), which gives feedback for future CDM. However, pharmacists explicitly mentioned incorporating this cognitive process insufficiently into their decision-making. Time constraints, a lack of data, and the absence of a defined and active role in patient follow-up are considered barriers to evaluate outcomes.[13] Additionally, based on these study findings, it seems that pharmacists are aware of the benefits of reflection (Step 8). However, they also stated that they should engage in this reflective behaviour more, emphasizing the need of a separate step in the model. Particularly in teaching and learning CDM, reflection is necessary to promote self-awareness and to identify strengths, opportunities for learning, and personal bias.[25]

Strengths and limitations

The inclusion of pharmacists working in community, outpatient, and hospital care with varying years of clinical work experience and PhD degrees is considered a strength of this study. Selection bias, however, might have been introduced through recruitment through the research team's professional network. A substantial proportion of participants hold a PhD degree, which might suggest that they are accustomed to scrutinizing their clinical actions from a more detached perspective. However, even these participants encountered challenges in expressing the process of clinical reasoning. This difficulty could be more pronounced among pharmacists with limited research experience. For consistency, this study employed a well-

defined interview guide, used by a single interviewer who was also a community pharmacist. To reduce the impact of researcher bias and preconceptions, data analysis was addressed collaboratively. Although having a pharmacist as an interviewer gave the interviewer the opportunity to go deeper into the themes, this may have influenced participants' responses, for example through encouraging socially desirable behaviour.[26] Additionally, a community pharmacist as interviewer might have led to data saturation with a higher proportion of participants working in secondary care pharmacists than primary care. However, the overall mutual cognitive processes involved in CDM are highlighted by reaching data saturation with this heterogenous sample. Depending on the pharmacy setting and experience, there may be variations in the cognitive processes used, just as there may be variations per case. However, the model's uniformity is considered valuable for pharmacy practice and education. Pharmacists' perceptions of how they make clinical decisions retrospectively may have been impacted by cognitive biases. Cognitive processes, for example, could have been missed due to the lack of articulating. Think-aloud sessions could strengthen this work, but articulation remains a challenge.

Implications for practice, education, and further research

As pharmacists sometimes struggled to find words to describe their CDM, a theoretical model could help to articulate this process in a structured way. Although context differs, the cognitive processes identified in this study seem similar for pharmacists working in primary and in secondary care. This model is therefore likely to be applicable to any pharmacy setting. Pharmacists may use this model to discuss cases during intra- and interprofessional peer reflection and teach CDM to pharmacy students during internships. As experts are more likely to conduct cognitive processes in CDM intuitively, a model could help them to make these seemingly automatic cognitive processes explicit and clear to students.[5] Our study findings can also be used by pharmacy educators to develop teaching strategies focused on CDM as a whole, dynamic process in a structured way, and on specific steps and cognitive processes, e.g. evaluating outcomes. Based on research on expertise development in medicine, students and health professionals in different phases of their education could benefit from different teaching strategies.[27] For example, more experienced pharmacists could benefit from using the model to think more slowly about their thinking process and increase their awareness on potential cognitive biases such as premature closing.[28] Future research should focus on testing this model with specific teaching strategies when used in education among pharmacists and pharmacy students.

Conclusion

Pharmacists use multiple cognitive processes when making clinical decisions in pharmacy practice. Cognitive processes were identified in each of the 8 steps of the adapted CDM model; problem and demand for care consideration, information collection, clinical reasoning, clinical judgment, shared decision-making, implementation, outcomes evaluation, and reflection. Pharmacists struggled to explain CDM and their back-and-forth explanations emphasize its dynamic nature. This study adds to a greater understanding of how pharmacists make clinical decisions in community, outpatient and hospital pharmacy practice and to the development of a uniform, theoretical model that describes this process, which may be useful in pharmacy practice and education.

Acknowledgments

We would like to thank all of the pharmacists who participated in this study, as well as Dr. Adrianne Faber for her contribution to the model and student researchers Salma Bouzeryouh and Mirella Ujkanovic for their assistance with data processing.

Declaration of Competing Interest

None.

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Appendix 1: Clinical decision-making model

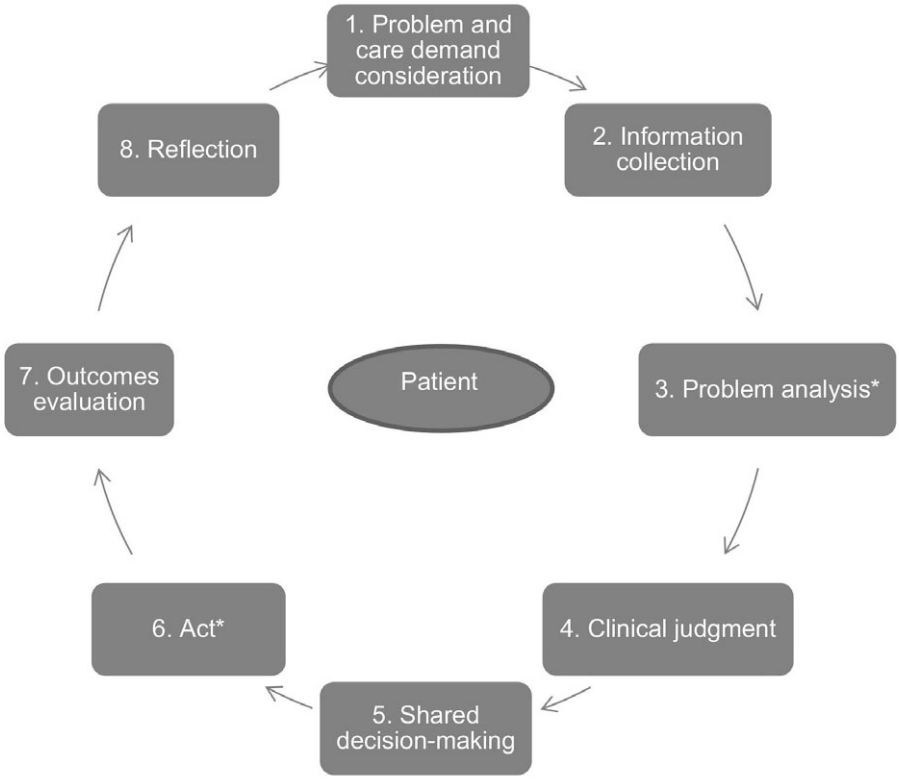

Figure 2. Preliminary clinical decision-making model
*Step 3. Problem analysis and step 6. Act are altered to step 3. Clinical reasoning and step 6. Implementation, respectively, to best fit the empirical data.

Because there is no widely recognized and comprehensive clinical decision-making model for pharmacy practice and education, the authors developed a theoretical model together with another academic pharmacy educator to teach this core process to pharmacy students. Figure 1 shows this preliminary clinical decision-making model, which is based on earlier work on pharmacists' decision-making [1,6-8], and on the clinical reasoning model to educate nursing students developed by Levett-Jones et al.[3] This 8-step patient-centred CDM model incorporates the Pharmacists' Patient Care Process (i.e. collect, assess, plan, implement, and follow-up)[9], as well as three additional (sub)steps for teaching purposes. The preliminary CDM model was implemented at the University of Leiden's Master of Pharmacy program in 2021. Based on the findings of this study, the model is adapted and will be tested among pharmacy students.

Appendix 2: Interview guide

Translated to English

Thank you for giving us the opportunity to interview you for our study on clinical decision-making among pharmacists. The questions I would like to ask during this interview regard how you, as a pharmacist, come to a decision when addressing a patient case: which thinking steps do you make? As a pharmacist, researcher and teacher, I am interested in this topic. There are no right or wrong answers here. The interview will last for about 45 minutes and consists of a number of questions regarding decision-making.

Your participation in this study is voluntary and your answers will be treated confidentially. You can stop or withdraw from the interview at any time. This interview will be recorded so that the interview is transcribed accurately. The recording will be deleted at the end of the study. Do you have any questions beforehand? Shall we begin?

a. Professional experience and clinical role

- How many years have you been working as a pharmacist in pharmaceutical patient care?
- Which of your current pharmacy activities are directly related to the patient? (prescription processing, medication review, etc.)

b. Process of clinical decision-making

- What thinking steps do you take in these activities to come to a clinical decision?
    - Does this process differ between the different work activities? If so, how?
- What do you need to make a decision?
- What do you use to make a decision?
    - Dig deeper: knowledge, skills, attitude, preconditions
    - What would you like to improve?
- What hinders your clinical decision-making?
- What facilitates your clinical decision-making?
- What do you need from the physician to make a decision?
- What does the physician need from you?
- Is the patient involved in your decision making? If so, how?
- What do you need from the patient to make a decision?

c. Learning and teaching clinical decision-making

- Are you an educator of pharmacists or pharmacy students? If so:
  - How do you teach others to deal with patient cases?
  - How do you rate this among others?
  - What do you think an educator needs to teach this?
    - Dig deeper: knowledge, skills, attitude, preconditions
  - Example of a successful training moment?

Your experience from practice have already been very helpful, thank you. Did I forget to ask something in your opinion, or do you want to add something?
Thank you very much for your time and answers to our questions. We will send you the transcript afterward. If you have any questions or comments regarding our conversation and/or the transcript, please do not hesitate to contact us.

Appendix 3: Consolidated criteria for reporting qualitative studies (COREQ): 32–item checklist

No	Item	Guide questions/description	Check?
		Domain 1: Research team and reflexivity	
		Personal Characteristics	
1.	Interviewer/ facilitator	Which author/s conducted the interviews?	JM
2.	Credentials	What were the researcher's credentials? *E.g. PhD, MD*	JM is PharmD
3.	Occupation	What was their occupation at the time of the study?	Researcher and senior lecturer with previous experience as community pharmacist in community pharmacy and as non-dispensing pharmacist working in a general practice
4.	Gender	Was the researcher male or female?	Female
5.	Experience and training	What experience or training did the researcher have?	Training qualitative interviewing
		Relationship with participants	
6.	Relationship established	Was a relationship established prior to study commencement?	Several participants within professional network, others just with e-mail prior to start study
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? e.*g. personal goals*, *reasons for doing the research*	Participants were informed about the research and its reasons for doing the research by invitation letter.
8.	Interviewer characteristics	What characteristics were reported about the interviewer/ facilitator? e.g. *Bias*, *assumptions*, *reasons and interests in the research topic*	Researcher introduced herself at the start of the interview. She reported her reasons and interests in the research topic to the participants.
		Domain 2: study design	
		Theoretical framework	
9.	Methodological orientation and Theory	What methodological orientation was stated to underpin the study? *e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis*	First, inductive thematical analysis, informed by other studies and literature. Then, a theoretical model was used to structure emerged themes.
		Participant selection	
10.	Sampling	How were participants selected? *e.g. purposive, convenience, consecutive, snowball*	Participants were purposely recruited through the professional network of the research team, and snowball sampling.

No	Item	Guide questions/description	Check?
11.	Method of approach	How were participants approached? e.*g. face-to-face*, *telephone*, *mail*, *email*	Participants were approached by e-mail.
12.	Sample size	How many participants were in the study?	16
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	All agreed and no participants dropped out after inclusion.
		Setting	
14.	Setting of data collection	Where was the data collected? *e.g. home*, *clinic*, *workplace*	The data was collected in the workplace of the participant or in an online setting.
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	During 5 interviews, the research student was present as well.
16.	Description of sample	What are the important characteristics of the sample? *e.g. demographic data*, *date*	Pharmacists of both community, outpatient and hospital care are represented in the sample. Participants differed in gender, age and years of experience and their research experience.
		Data collection	
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	The interview guide was not pilot tested, but after the first two interviews, evaluation of the interview guide took place together with the research team consisting of community and hospital pharmacists and a physician.
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes, audio-recording was be used to collect the data.
20.	Field notes	Were field notes made during and/or after the interview?	Yes, JM made field notes.
21.	Duration	What was the duration of the interviews?	The duration of interviews was between 45 and 60 minutes.
22.	Data saturation	Was data saturation discussed?	Yes, data saturation was decided upon as no new themes emerged in the final three interviews.
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	A summary of the findings was returned to participants for comment and/or correction if wanted by the participant.

No	Item	Guide questions/description	Check?
		Domain 3: analysis and findings	
		Data analysis	
24.	Number of data coders	How many data coders coded the data?	Two persons (JM and student) independently coded all transcripts
25.	Description of the coding tree	Did authors provide a description of the coding tree?	The coding tree was inductively developed and is available upon request from the first author.
26.	Derivation of themes	Were themes identified in advance or derived from the data?	Themes were derived from the data.
27.	Software	What software, if applicable, was used to manage the data?	Atlas.ti version 22 was used to manage the data.
28.	Participant checking	Did participants provide feedback on the findings?	No
		Reporting	
29.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? e.*g. participant number*	Participant quotations were presented to illustrate the findings by participant number per discipline.
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31.	Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes

Chapter 4

Factors influencing pharmacists' clinical decision-making in pharmacy practice

Josephine F. Mertens
Ellen S. Koster
Vera H.M. Deneer
Marcel L. Bouvy
Teun van Gelder

Research in Social and Administrative Pharmacy 2023; 19: 1267-1277

Abstract

Background

Pharmacists' clinical decision-making is considered a core process of pharmaceutical care in pharmacy practice, but little is known about the factors influencing this process.

Objective

To identify factors influencing clinical decision-making among pharmacists working in pharmacy practice.

Methods

Semi-structured interviews were conducted with pharmacists working in primary, secondary, and tertiary care settings in the Netherlands between August and December 2021. A thematical analysis was conducted using an inductive approach. The emerged themes were categorized into the Capability–Opportunity-Motivation–Behaviour (COM-B) model domains.

Results

In total, 16 pharmacists working in primary care (n=7), secondary care (n=4) or tertiary care (n=5) were interviewed. Factors influencing pharmacists' capability to make clinical decisions are a broad theoretical knowledge base, clinical experience, and skills, including contextualizing data, clinical reasoning, and clinical judgment. The pharmacy setting, data availability, rules and regulations, intra- and interprofessional collaboration, education, patient perspectives, and time are mentioned as factors influencing their opportunity. Factors influencing pharmacists' motivation are confidence, curiosity, critical thinking, and responsibility.

Conclusions

The reported factors covered all domains of the COM-B model, implying that clinical decision-making is influenced by a combination of pharmacists' capability, opportunity, and motivation. Addressing these different factors in pharmacy practice and education may improve pharmacists' clinical decision-making, thereby improving patient outcomes.

Introduction

Pharmaceutical care has become more complex in recent decades due to factors such as the aging population and an increasing number of patients with multimorbidity and polypharmacy. As pharmaceutical care becomes more demanding, pharmacists are needed to play a more clinical role in supporting patients who require pharmaceutical care.[1,2] Already in many countries, pharmacists are expected to be active members of the healthcare team with direct responsibility for designing, implementing and evaluating therapeutic treatment plans.[3] In order to provide high-quality pharmaceutical care in a clinical role, clinical decision-making is considered a core process.[1,4]

Clinical decision-making (CDM) in pharmacy practice is conceptualized as a set of cognitive processes and abilities that enables pharmacists in all practice settings to make patient-centred, therapeutic decisions.[5] Pharmacists usually interact with patients and health professionals when a diagnostic label has been assigned but drug treatment may not yet have been started or has limited efficacy.[5] By making appropriate decisions related to drug treatment, pharmacists can optimize medicine use and improve patient outcomes.[6] In comparison to pharmacy, CDM in medical research and education is more extensively investigated and focuses on diagnostics rather than therapeutics.[7,8]

When attempting to improve decision-making, individual's decision-making attributes and contextual factors, in addition to elements of the immediate clinical problem such as complexity, must be considered.[9] In pharmacy, little is known about pharmacists' attributes and contextual factors influencing clinical decision-making. Understanding more about what pharmacists need, what hinders and facilitates them in clinical decision-making would help address this in pharmacy practice and education, thereby improving this process and patient outcomes. Therefore, this study aims to identify factors influencing clinical decision-making among Dutch pharmacists working in primary, secondary and tertiary care.

Methods

Study setting

In this qualitative study, semi-structured interviews were conducted among practicing pharmacists working in clinical roles in primary, secondary, and tertiary care settings in the Netherlands. In this country, there are approximately 1900 community pharmacies and 90 outpatient pharmacies (primary care), with 1.5 full

time equivalent (FTE) pharmacists supervising a pharmacy team of approximately five technicians and some supporting staff.[10] Outpatient pharmacies are located in hospitals but serve outpatients, such as at hospital discharge or after an outpatient clinic visit.[11] In addition, several expensive drugs that are part of the hospital budget can only be dispensed through outpatient pharmacies.[11] In the Netherlands, hospital pharmacists, several also with additional training as a clinical pharmacologist, provide inpatient care within teams of multiple pharmacists and technicians in approximately 60 general hospitals at 100 locations (secondary care) and six academic hospitals (tertiary care).[11] In all types of care settings, Dutch pharmacists are non-prescribing health professionals and considered a member of multidisciplinary healthcare teams. Direct pharmaceutical care activities, including patient encounters, have increased in all levels of care over the years, alongside tasks like dispensing medication.[12] For example, as in other countries, hospital pharmacists are becoming more prevalent on hospital wards and (specialized) clinics.[13]

Study design

Based on the literature, including the authors' previous conducted scoping review, an interview guide was developed to elicit factors influencing pharmacists' clinical decision-making.[5] This interview guide contained questions asking participating pharmacists what they need to conduct CDM, as well as what hinders and facilitates them, also when learning and teaching this process. After the first two interviews, the interview guide was evaluated, and minor adjustments were made to ensure comprehensibility of the questions. Appendix 1 contains the final interview guide in English.

Participant recruitment

Pharmacists were purposely recruited through the research team's professional network to ensure participants of both from primary, secondary and tertiary care and with different years of experience, and snowball sampling was used. Potential participants received a Participant Information Sheet outlining the purpose of the interview and study objectives by email and given opportunity to ask questions about the research before signing the Consent Form. Participating pharmacists could withdraw from the study at any time and they received no incentive for participating.

Data collection

Interviews were conducted face-to-face between August and December 2021, mostly in-person or online using Microsoft Teams. The interview was scheduled at a time the pharmacists perceived to be convenient and free of interruptions. In-person interviews were conducted in a private room at the pharmacists' workplace. All interviews were

audio-recorded and lasted approximately 45 to 60 minutes. To ensure consistent data collection, all interviews were conducted by the main researcher (JM). As pharmacist and educator, JM was able to deepen the questioning by anticipating to responses using prior experience and knowledge of pharmacy practice and education. She also completed a training on qualitative interviewing. Audio-recordings were transcribed verbatim by an undergraduate Master of Pharmacy student (SB). Transcripts were reviewed for accuracy at random intervals by JM.

Data analysis

As literature is limited, collected data was thematically analysed using a general inductive approach that was open and exploratory in nature. Themes were identified through systematically (re)reading, and independent parallel coding (JM and student SB or MU) using qualitative data analysis software (ATLAS.ti version 22). Discrepancies in coded text passages and code names were resolved through discussion together or with a third researcher (EK) experienced in qualitative research. Codes were placed in categories, and categories were later conceptualized into broad themes with subthemes. The emerged (sub)themes were discussed and further refined with the other researchers with pharmacy practice experience in primary care (MB) and secondary and tertiary care (VD) and medical experience (TvG). Interviews were conducted until data saturation occurred, when additional incoming interview data provided no new information related to the research objective, i.e. no new themes for at least two interviews. During data analysis, the authors realized that the Capability Opportunity Motivation - Behaviour (COM-B) model would be a useful framework for categorizing emerged themes.[14] The COM-B model states that behaviour results from the interaction between the individuals' capability, opportunity and motivation.[14] These components can also be influenced by behaviour.[14] The COM-B model is frequently used to identify barriers and facilitators in behaviour and was therefore selected for this study to categorize emerged factors influencing CDM reported by the participating pharmacists.[15-17]

Ethics and privacy

Approval for this study was granted by the Institutional Review Board of the University of Utrecht (UPF2111). Results were reported according to the COnsolidated criteria for REporting Qualitative research (COREQ) guidelines (Appendix 2).[18] Participants anonymity was ensured by removing identifying information in the transcripts and assigning a pseudonym to the names of each participant in all data.

Results

In total, 16 Dutch pharmacists were sequentially approached for participation, and all agreed. After interviewing five pharmacists working in a community pharmacy, two in an outpatient pharmacy, four in secondary care settings, and five in tertiary care settings, the research team decided on data saturation as no new themes emerged in final three interviews. The demographic characteristics of the participants are listed in Table 1.

Table 1. Demographic characteristics of the study participants.

Participant characteristic	Number (n=16)
Gender	
Female	10
Male	6
Pharmacy discipline	
Community pharmacy	5
Outpatient pharmacy	2
Hospital pharmacy	
Secondary care	4
Tertiary care	5
Additional degree	
PhD	8
Years of clinical work experience	
0-5	5
6-10	6
11-15	2
>15	3

Figure 1 summarizes how the emerged themes of factors influencing CDM perceived by participants are categorized into the COM-B model domains. These themes are discussed accordingly in the paragraphs below and illustrated with quotes.

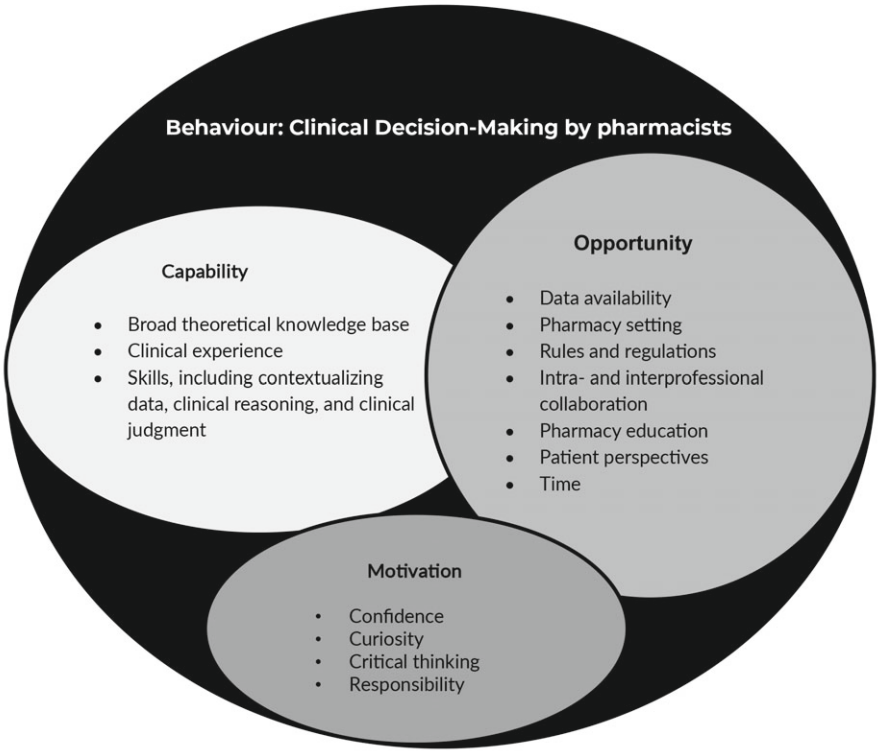

Figure 1. An overview of how the emerged themes of factors influencing CDM are categorized into the domains of the COM-B model.

Capability

The emerged themes related to pharmacists' individual capability to conduct clinical decision-making include knowledge, clinical experience and skills.

Theme: Broad theoretical knowledge base

According to the participating pharmacists, sufficient theoretical knowledge on medical and pharmaceutical concepts is a prerequisite for making clinical decisions. Especially knowledge of pharmacokinetic and pharmacodynamic concepts is considered important.

'When I use an information source I just look at the pharmacokinetics of medication. [..] Pharmacokinetic information is a very important factor to consider in your decision-making. [..] And if a patient experiences a lot of side effects, what does this patient apparently need less? Considering this patients' experience, what do you have to try to avoid with receptor occupation? [..] I think it would be good to integrate this more in daily morning reports and education.' – Sanne, hospital pharmacist, 5 years of clinical work experience

Following their pharmacy education, pharmacists reported having general knowledge of pharmacology as well as specific therapeutic groups. Moreover, they were able to retrieve additional information when needed. A broad theoretical knowledge base was stated as being required for pharmacists in order to deal with a wide range of questions.

'You need to know something about everything, because you are asked such a large range of questions. You can look up the details. As a pharmacist, you have to be an allrounder.' – Christel, community pharmacist, 8 years of clinical work experience

Being a generalist is valued, but it can lead to superficial knowledge, which can impede clinical decision-making according to several pharmacists.

'That's the problem of our profession: it's so terribly broad. I can advise a rheumatologist about DMARDS, but a rheumatologist knows much more about that, which is sometimes difficult and that is something I run into.' – Tom, hospital pharmacist, 3 years of clinical work experience

They stated lifelong learning as essential for keeping this broad knowledge base up to date.

'Like nowadays, that ferrous fumarate should be used twice a week instead of twice daily, that's interesting. So you have to keep up your knowledge base all the time.' – Elizabeth, community pharmacist, 21 years of clinical work experience

Theme: Clinical experience

In addition to theoretical knowledge, clinical experience was reported to increase efficiency when making clinical decisions.

'I occasionally spend 15 minutes on a case, where a colleague that has done it already ten times is done within five minutes. I do not have the experience, so I do not dare take the risk and want to make sure I do it right, and then I am just another fifteen or thirty minutes down the road.' – Tom, hospital pharmacist, 3 years of clinical work experience

Pharmacists with more experience reported approaching cases more intuitively, especially when the cases were less complex and dealt with frequently.

'I almost say I conduct it as an "automatic pilot". Often with the less complicated things, because you have to deal frequently with the same drug safety monitoring signals from

your information systems.' – Daphne, hospital pharmacist, 10 years of clinical work experience

In general, pharmacists perceived that the more clinical experience they had, the more accurate the decision, although some pharmacists were also aware of potential bias in their approach as experience grows, such as availability bias and the negativity effect.

'I believe you grow from knowledge and experience. That you build it up, and once you've had a particular case a number of times, of course it's never going to be exactly the same case, but then you get a little more feel for it, and you might know a little bit more what the risks of a decision might be. Look, after you've given advice and someone develops, for example terrible neutropenia [..], then you will be much more cautious the next time. So I believe that also plays a significant role.' – Sanne, hospital pharmacist, 5 years of clinical work experience

Several pharmacists reported that limited patient contact resulted in a more theoretical approach to cases.

'I think what's wrong with a lot of pharmacists and with me, is that, we have limited patient contact. [..] So you have a lot of theoretical knowledge about medication. [..] You know that this side effect can occur, but patients go more often with symptoms to their physician. Then as pharmacists, you don't know how it presents in practice, within how many days... [..] Which makes it difficult to make a decision and to advice a patient or physician.' – Rose, community pharmacist, 5 years of clinical work experience

Following up on patients' clinical outcomes after therapeutic decisions could help pharmacists gain more clinical experience. However, according to the pharmacists in this study, follow-up of the clinical course after a consultation is not a common practice for pharmacists.

'I would prefer to follow-up patients more often. I do not do that. It just doesn't work in time. I would like that.' – Iris, hospital pharmacist, 10 years of clinical work experience

Theme: Skills

Aside from theoretical and experiential knowledge, a variety of skills was mentioned influencing CDM. Interviewed pharmacists emphasized the importance of communication skills, such as when contacting patients or physicians to collect information. They indicated that questions from both patients and physicians are

not always straightforward. As a result, they had to rely on their communication skills combined with knowledge to figure out what was wrong.

'You need to be able to figure out the question behind the question. [..] So I believe communication is essential. But you can only figure out the question, I think, if you have enough knowledge.' – Brian, hospital pharmacist, 11 years of clinical work experience

Academic skills such as using sources and filtering relevant information were also mentioned as influencing pharmacists' CDM capabilities. These skills were aided by research as a PhD-candidate. Participating pharmacists described extensive use of guidelines and protocols in their decision-making, particularly at the start of their careers. When experience has grown, guidelines and protocols are used less frequently and specifically with more complex cases.

'I was used to do it with a conversation protocol. And now, you don't necessarily need that conversation protocol anymore. [..] Because you've done it more than 100 times, it's pretty much in your head. So you actually just go into the conversation yourself with these questions in mind and sometimes it goes a little differently than you... one time is different from the next, so to speak. – Sophie, community pharmacist, 8 years of clinical work experience

Cognitive processes are also named important, such as critical thinking, clinical reasoning and clinical judgment. Within clinical reasoning, whereby pharmacists must apply and integrate knowledge and clinical experience to interpret all available clinical data, several participants reported to reason starting upon their theoretical knowledge of medication.

'I reason very much from the medication. And I think a physician almost never does that. He thinks–well maybe at the very bottom of the differential diagnosis maybe it says "due to drug use" and for me it starts with that.' – Louise, hospital pharmacist, 18 years of clinical work experience

Contextualizing data–from theory to practice–was deemed difficult, especially when clinical experience, patient data, and clinical data were lacking.

'If you actually get that piece of patients' clinical data, I think a lot of our theoretical considerations are nonsense. Then you think "oh god", there is so much going on and then I'm going to say "get rid of the benzodiazepine". I will just keep my mouth shut. [..]

Then it helps to think "how important is it really to mess with the patient's medication.' – Elizabeth, community pharmacist, 21 years of clinical work experience

Furthermore, clinical judgment is regarded as an important cognitive skill in clinical decision-making because it requires pharmacists to weigh the benefits and drawbacks of potential therapeutic options and choose the best option for a specific patient. However, selecting the best option and making the actual decision is considered difficult, especially when the best option is not evident.

'If there are several correct answers, I sometimes find it very difficult to make the decision. Because that's what I miss in pharmacy education: decision-making.' – Tom, hospital pharmacist, 3 years of clinical work experience

Opportunity

The emerged themes associated with the opportunity of pharmacists to conduct CDM include data availability, pharmacy setting, rules and regulation, intra- and interprofessional collaboration, education, patient perspectives, and time.

Theme: Data availability

Data availability to pharmacists was mentioned as critical for CDM; however, pharmacists reported that data was frequently limited. When patient or clinical data, such as indications, lab values, and clinical state, were missing, it was deemed difficult to contextualize the problem and decide on the most appropriate therapeutic option for that patient in that specific context. Community pharmacists specifically mentioned the need for data on indications when performing medication reviews. According to participants working in an outpatient pharmacy or a hospital pharmacy, access to medical records, provided sufficient data to make a clinical decision in most cases. Participants, however, reported relying on other health professionals for data, such as the clinical state of the patient.

'We stand relatively far from the patient. You only have textual information on the patient–that is not always accurate and complete –to make a good decision.' – James, hospital pharmacist, 2 years of clinical work experience

Pharmacists stated that their CDM process is initiated and supported by information systems software. In addition to their information software, pharmacists frequently used resources such as guidelines and databases, whereby more resources are available in secondary care, particularly databases containing primary literature. Furthermore, several participants reported being aware of the available information

systems' suboptimal performance. For instance, drug alerts are not generated when treatment is omitted, which could lead to overseeing potential pharmacotherapeutic problems. When there is a lack of supporting information from their software or evidence from literature, making a decision becomes more complex.

'Because you never have all of the information, you try to give the best substantiated advice you can in the face of uncertainty.' – Iris, hospital pharmacist, 10 years of clinical work experience

Theme: Pharmacy setting

Several factors associated with the pharmacy setting are reported by the pharmacists to influence CDM. Most patient consultations of community pharmacists are ad hoc, which may impede data collection because they are dependent on the pharmacist's and the patient's time, and also on the ability to use consultation rooms for patient consultations.

'The pharmacy setting is sometimes difficult [..] Sometimes patients experience poor privacy in the pharmacy [..] So you have to make an appointment with these patients or take them separately. It would be very nice if this could change.' Rose, community pharmacist, 5 years of clinical work experience

In the Dutch pharmacy setting, pharmacists supervise a team of pharmacy technicians and pharmacy consultants who have more patient contact and make clinical decisions under your responsibility, which was described as difficult at times to supervise.

'You just don't stand behind the counter all day. You join in with the team of pharmacy technicians when it is very busy or when the presence of a pharmacist is required.' – Elizabeth, community pharmacist, 21 years of clinical work experience

Theme: Rules and regulations

Rules and regulations were also mentioned to hamper pharmacists' CDM process at times. Most medical data are unavailable to pharmacists due to privacy laws and regulations. To have medical data relevant to pharmacists' CDM available, they need patients' approval and the cooperation of physicians to exchange this data. This is mentioned as a barrier to clinical decision-making, particularly in primary care. The dependence on patients' approval, which must be done actively by the patient in order to exchange dispensing data with community pharmacies, is regarded as a barrier, particularly in outpatient pharmacies.

'A lot of patients in the outpatient pharmacy are not regular patients. So in this case, we didn't know how long the patient was using citalopram and other medication. Dispensing data from the community pharmacy are not always accessible. You need the patients' approval for this.' – Arif, outpatient pharmacist, 6 years of clinical work experience

As Dutch pharmacists lack prescribing rights, they are dependent on prescribers to alter prescriptions. Some community pharmacists reported that this limitation impedes clinical decision-making, particularly when it comes to helping patients quickly.

'Because often you need the physician to really make a decision. If something in the medication needs change, you already need a physician, because we can't just change that ourselves.' – Sophie, community pharmacist, 8 years of clinical work experience

Despite these rules, pharmacists reported altering prescriptions themselves in a few cases. In these cases, an agreement with physicians was made that pharmacists were allowed to alter specific prescriptions, for example adding laxatives when patients are using opioids, or when things were "very obvious", for example with antibiotic treatment dosages for children.

'Changing the amoxicillin dosage for children in an antibiotic treatment. I'm not going to call [the physician] every time for this anymore. Or in the case of nystatin suspension. The very logic things. When it is that obvious that the prescription isn't right, I alter it.' – Elizabeth, community pharmacist, 21 years of clinical work experience

Furthermore, although the extensive use of guidelines and protocols, pharmacists also emphasized the importance of thinking beyond guidelines and protocols and deviating when necessary.

'Within the protocol you have the freedom to deviate from protocol based on your expert opinion as pharmacist. So, I think you should do that.' Tom, hospital pharmacist, 3 years of clinical work experience

In addition, reimbursement of clinical services provided by pharmacists is also said to have an impact on their process. Patient consultations, for example, are frequently unpaid or underpaid, which may lead to the participants or the institution failing to prioritize these activities.

'This clinical service is unpaid, but you do it anyway. So you have to make it visible to the hospital. However, that is very difficult.' – Iris, hospital pharmacist, 10 years of clinical work experience

Theme: Inter- and intraprofessional collaboration

According to pharmacists, good collaboration is required both within the pharmacy organization (intraprofessionally) and with other health professionals (interprofessionally). However, multiple participants reported poor collaboration with other health professionals, mainly physicians, which had a negative impact on their CDM. They struggled with feelings of dependency, limited and difficult contact, a lack of mutual trust and an overall negative attitude towards pharmacists both in primary and secondary care.

'It is sometimes hard, because you think: why don't you follow my advice? But that is just the case then, and I will tell that to the patient.' – Christel, community pharmacist, 8 years of clinical work experience

On the other hand, several participants noticed a positive change in physicians' attitude towards pharmacists over the years and reported good interprofessional collaboration.

'I also think that with the new generation [physicians], collaboration is much more paramount than before. The complexity also makes it necessary.' – Brian, hospital pharmacist, 11 years of clinical work experience

'In the case I suspect a side effect of medication, physicians in our setting are very accessible and it is easy to briefly decide on this together.' – Gerard, community pharmacist, 3 years of clinical work experience

The advantages of working in a team with multiple pharmacists were emphasized by participants. The ability to seek assistance and input from other pharmacists, also interdisciplinary pharmacists or those from other pharmacies, is greatly valued. When a pharmacist was the only pharmacist on-site, colleagues were desired.

'You can evaluate this on a patient level and on a higher level with colleague pharmacists. That was valuable to me. In the first years of my professional career I didn't have colleague pharmacists with whom I could evaluate this.' – Christel, community pharmacist, 8 years of clinical work experience

Although the possibility of peer consultation was considered as valuable, it was not done frequently.

'I've occasionally asked a colleague, for example, to prepare the same medication review [..] When it's really complicated, and if there is time, I walk over to one of the hospital pharmacists to think along. But it could happen more frequently for me.' – Charlotte, outpatient pharmacist, 7 years of clinical work experience

According to the interviewed pharmacists, peer consultation requires a working environment where people can make mistakes and help each other to improve their skills.

'I think you get feedback if you ask it yourself during the daily handover or from your supervisor or just some conversational sparring with a colleague.. but really on your decision-making. It happens, but limited. I think we can learn a lot there and improve. [..] I hope that we can be more accessible and say 'hey, why have you done this? [..] That you dare to ask questions and be more vulnerable.' – Sanne, hospital pharmacist, 5 years of clinical work experience

Theme: Education

During their pharmacy education, pharmacists stated that they gained the necessary knowledge and skills that served as the foundation for clinical decision-making.

"Of course, as a pharmacist, you just have a certain expertise and completed pharmacy education and a lot of knowledge about medication. As a result, you rely on that knowledge to advice the patient." – Sophie, community pharmacist, 8 years of clinical work experience

Pharmacists emphasized the significance of learning in (simulated) clinical practice, although training in CDM differed per pharmacy. The lack of having didactic methods to guide themselves and others in clinical decision-making was reported by several participants. Learning from peers, supervisors and other health professionals was highly valued and could be expanded in academic and clinical settings.

'I learned it in practice. I think that all my tools were given in my pharmacy education, but I think that in clinical practice and all of the moments with my supervisor and the way we talk to each other about daily patient care has made me use all those tools properly.' – Brian, hospital pharmacist, 11 years of clinical work experience

Theme: Patient perspectives

Participating pharmacists were unequivocal in their belief that patient' needs and wishes influence CDM. If the decision remained responsible, all participants attempted to include patient wishes and preferences in a clinical decision. Whereas interviewed community pharmacists directly involve the patient in the process; hospital pharmacists mostly involve patient perspectives through physicians, nurses or the medical record. Participants, however, reported that contextualizing data was difficult when they had indirect patient contact or when data was missing.

'Sometimes you have to do it with very limited information, without patient consultation, and then you might go too fast, and you pass the fact that there is a person behind it.' – Charlotte, outpatient pharmacist, 7 years of clinical work experience

According to the participants, particularly community pharmacists, the pharmacist-patient relationship influenced clinical decision-making as well. Community pharmacists mentioned the importance of a good relationship with the patient as both important for data collection and shared decision making.

'I hope that my previous patient consultations have established a trusting relationship. [..] I try to maintain an equal relationship with the patient, so that they feel comfortable coming to you when they are not well.' – Christel, community pharmacist, 8 years of clinical work experience

Pharmacists in all levels of care regret having limited contact with patients. In comparison to the physician and nurses, they report feeling more distant from the patient. However, one hospital pharmacist stated that patient contact must remain relevant and efficient while not complicating the care team because the patient is being seen by multiple health professionals.

'On the one hand, I'd like to have contact more frequently than I have been. On the other hand, if the pediatrician can easily consults us about a specific clinical question and I don't have to stand at the front of the bed, then that's completely fine with me.' – Yousef, hospital pharmacist, 20 years of clinical work experience

Theme: Time

When there is enough time, each step in the process is carried out more thoroughly. However, according to the participants, decisions must often be made under time constraints. A community pharmacist stated that she struggles with the large number of patients who require care in her pharmacy.

'If you have time and thoroughly check each prescription, you can ask a question about each patient. So sometimes I get a little stuck in that myself.' – Elizabeth, community pharmacist, 21 years of clinical work experience

Other pharmacists emphasized the importance of time balance.

'You just don't have the time to check everything. Because if you really want to do it properly, it takes 2 hours to retrieve all relevant information, ask everything to the physician… that just takes a lot of time, time that you do not have.' – Tom, hospital pharmacist, 3 years of clinical work experience

Motivation

The emerged themes associated with automatic or reflective cognitive processes to influence CDM among pharmacists are confidence, curiosity, critical thinking, and responsibility.

Theme: Confidence

The majority of pharmacists expressed "a need for certainty" as well as difficulty dealing with uncertainty in decision-making. They struggled when the decision was not supported by evidence and remained "in the grey area".

'The decision always remains an educated guess.' – Brian, hospital pharmacist, 11 years of clinical work experience

When they were unsure or feeling unconfident, pharmacists interviewed said they needed assurance that their clinical decision did not expose the patient to unnecessary risks.

'I only deliver when I'm 100% certain it has no risk.' – Arif, outpatient pharmacist, 6 years of clinical work experience

As a result, pharmacists reported to conduct a more thorough literature search, as well as contact other health professionals for advice and shared decision-making.

'It has to be 100% sure and if there is any doubt then you definitely show that doubt. While of course physicians say when in doubt, well, if it's about 70% sure, then this is the plan. So we are a bit more uncertain about that. We may be a bit more honest, but I think that really suits our profession.' – Sanne, hospital pharmacist, 5 years of clinical work experience

Several pharmacists reported that their confidence grew over time, in part due to follow up on clinical decisions. One hospital pharmacist suggested that dealing with uncertainties and delivering your advice with confidence be addressed more in pharmacy education.

'How can you bring your advice with confidence? Because doctors learn that too and we learn that little. We are much more concerned with the doubt in our rhetoric.'– Tom, hospital pharmacist, 3 years of clinical work experience

Theme: Curiosity

Being genuinely interested in the well-being of patients and the perspectives of other health professionals has been mentioned as influencing CDM.

'I think you should be genuinely interested in someone, to be intrinsically motivated to help someone.' – Sophie, community pharmacist, 8 years of clinical work experience

Additionally, curiosity, for example in case of abnormal patterns in medication use, was frequently reported to influence CDM, particularly data collection. However, pharmacists have also stated that their curiosity sometimes led to an excessive efforts of data collection. As a result, finding a balance between gathering enough information to make an informed decision and avoiding gathering unnecessary data would be critical.

'First of all I think curiosity is of influence, because you come across a lot of things that you just don't know and you have to be curious. And I think, and that is difficult, that you have to find a balance between on one hand gathering enough information to formulate a good advice, but you have to do that within a certain amount of time.' – James, hospital pharmacist, 2 years of clinical work experience

Theme: Critical thinking

Pharmacists described critical thinking as both an academic skill and an attitude that influences CDM. Being critical of others' decisions, such as treatment selection, is cited as an important factor in pharmacists' decision-making that increased over time.

Because you have more experience, I believe you are more likely to question things more quickly, to be more critical of them, or to ask more questions.' – Daphne, hospital pharmacist, 10 years of clinical work experience

Furthermore, being critical and reflecting on the decision-making process helps the participants in improving their competencies. Interviewed pharmacists stated that they fostered this critical attitude in students and residents as they learned to make clinical decisions.

'A kind of supervisor-dwarf on your shoulder that asks questions all the time. [..] Why does this patient get an antibiotic, why this one, [..] how clinically relevant is the drug-drug interaction? – Brian, hospital pharmacist, 11 years of clinical work experience

Theme: Responsibility

When it came to dispensing medication to patients, most participants were clear that this was their autonomous decision and responsibility. Pharmacists frequently reported asking themselves, "Can I hand over the medication responsibly?". When in doubt, so related to confidence, pharmacists reported that they would like confirmation of the prescriber that they could hand over the medication responsibly.

'Where I always find that very difficult is with the QT-extension. Because we don't feel it at all. I call a lot about this with physicians, because I don't want to burn my fingers on that.' – Elizabeth, community pharmacist, 21 years of clinical work experience

When the pharmacist felt that the treatment needed to be changed or considered, they advised prescribers to change the treatment, which was not always agreed upon.

'I don't feel like playing a cop. So, I give advice and how compelling it is depends on the high-risk drug and the situation.' –Louise, hospital pharmacist, 18 years of clinical work experience

The importance of knowing your responsibility as pharmacist was stated as well as knowing and respecting each other's responsibilities, which was not always felt.

'I think that it is a bit pharmacist-specific, that we often feel a bit subordinate to physicians.' – Charlotte, outpatient pharmacist, 7 years of clinical work experience

However, most pharmacists emphasized the benefits of the shared physician-pharmacist responsibility on the patient' treatment.

'You have to do it together. That's also part of the fun. You are never truly solely responsible; you share responsibility.' – Arif, outpatient pharmacist, 6 years of clinical work experience

Discussion

Clinical decision-making in pharmacy is described by pharmacists in this study as a complex process, influenced by a wide range of factors covering the interconnected domains of capability, opportunity and motivation. Many of the factors influencing pharmacists' CDM are similar to those influencing the CDM of other health professionals.[9,19-22] The ability to detect and comprehend how factors influence CDM is required in learning and teaching making appropriate clinical decisions.[9]

According to pharmacists, integrating theoretical knowledge, skills, and clinical experience is important to their capability to conduct effective CDM. This emphasizes that CDM is more than just applying theoretical knowledge or performing technical skills.[20] When learning and teaching the integration of these aspects, contextualization should be addressed more, as pharmacists found this difficult. Pharmacokinetic and pharmacodynamic concepts, for example, should be taught and learned sufficiently because this is a specific knowledge area of pharmacists and is valuable to other health professionals because physicians, for instance, are assumed to have limited knowledge in this field.[23-26] Additionally, implementing these concepts in a clinical context is important to support pharmacists making connections between the abstract properties of a drug and patient characteristics and specific conditions in order to decide on the most appropriate pharmacotherapy. Addressing contextualization aligns with the current shift in the pharmacy profession and education from product-oriented to patient-oriented.

The development of CDM in practice settings, as pharmacists in this study emphasized, supports the implementation of experiential learning in undergraduate pharmacy education, in which students apply integrated knowledge to a real-world setting and reflect on it.[27] Other studies also emphasize the importance of incorporating the practical context into the CDM process.[28-30] Real-world cases or situational activities in academic course material can introduce students to the ambiguity, uncertainty, and complexity of clinical practice, preparing them for experiential learning.[31] Aside from students' real-world experiences, the role of educators in academic and clinical settings is critical as a student learns from their CDM by sharing observations and explaining one's thought process.[30,31] Supporting educators in both settings with didactic methods and training to foster CDM is necessary.[30,32,33] Furthermore, following up on the patients' clinical course, evaluating outcomes and reflecting on the process can enhance pharmacists' and pharmacy students' CDM, which can be accomplished through self-reflection, peer-reflection, and through dialogue and inquiry from peers, educators, and other (future) health professionals.[31] This dialogue and inquiry could be aided by the development of

a model that provides educators and pharmacy students with a well-articulated process that includes explicit terminology for discussing process steps and justifying clinical decisions.

Considering that CDM occurs in a multidisciplinary team, learning about, with and over each other will contribute to this process.[34] Interprofessional education is considered a strong stimulus for future collaboration between pharmacists and other health professionals.[35] This type of education has a positive impact on learners' opinions, satisfaction and attitudes towards other health professions, thereby also improving knowledge on and respecting each other's responsibilities.[35]

The opportunity for pharmacists to conduct CDM is hindered by a lack of relevant patient and clinical data through patients, other health professionals and information systems. In part this is the result of unconnected information systems, partly due to privacy laws protecting patient health information. Community pharmacists reported the lack of data more often than pharmacists working in an outpatient or hospital pharmacy, mostly because they have access to medical records. Increasing the amount of relevant patient and clinical data available through patient monitoring, interprofessional collaboration, and connected information systems could improve data availability, and therefore, CDM. It should be noted, however, that clinical decisions are fraught by uncertainty since not all of the information required to make decisions is or can be known,[9] so pharmacists must deal with uncertainties. However, these findings suggest that pharmacists are unconfident when faced with uncertainty and risks, leading to the need for approval from others, all of which are discussed as barrier to pharmacy practice change by Rosenthal et al.[36] This study revealed confidence as an important factor in pharmacists' motivation in CDM, which resulted from: (a) evaluating their level of knowledge, particularly when evidence is lacking and the decision remains "in the grey area"; (b) having experienced success and failure; and (c) knowing the likely responses to interventions, as well as the likelihood and manner in which adverse events occur. Although research with other health professions like physicians has linked confidence to experience,[9] more experienced pharmacists in this study also acknowledged struggling with ambiguity. These findings indicate a need to address dealing with uncertainties and risks, and making the actual decision and taking responsibility for this decision, in both under- and postgraduate pharmacy education. Anakin et al.[37] reported this lack of confidence also when they interviewed community pharmacists in New Zealand about their clinical decision-making. Gregory et al. described in another study that Canadian pharmacists frequently relied on interpersonal relationships to achieve outcomes, and deferred to others' authority to avoid decision-making

and potential conflicts.[38] This was also reported by Abuzour et al. that explored factors influencing secondary care pharmacist independent prescribers' CDM in the United Kingdom.[39] In a survey of non-medical prescribers conducted by Cope et al.,[40] nurses and physiotherapists reported prescribing autonomously more frequently than pharmacists, implying that barriers to self-confidence and willingness to take responsibility are more prevalent in pharmacists. Frankel and Austin identified six barriers to pharmacists' self-confidence and responsibility development: hierarchy of the medical system, role definitions, evolution of responsibility, ownership of decisions for confidence building, quality and consequences of mentorship and personality traits upon admission at the university.[41] Addressing these barriers in pharmacy practice and education would improve these factors influencing CDM. To make physicians and students more "comfortable with uncertainties" Ilgen et al. proposed to (1) adopt a deliberatively iterative and flexible construction of how patients' problems are defined, approached, and managed, (2) encourage forward planning and monitoring, and (3) encourage clinical preceptors to reflect upon the underpinnings of their own 'comfort' in uncertain situations.[42] These recommendations may also help pharmacists feel more at ease with uncertainty. Working through problems with a high degree of ambiguity jointly, for example, to arrive at the most appropriate decision improves this aspect in pharmacy students.[31,37] Forward planning and monitoring of patients' clinical course is still uncommon in pharmacy practice, resulting in limited experiences with clinical decision success and failure. However, in the current health system, increasing patient monitoring is hindered at times by the pharmacy setting.

In comparison to the rest of Europe, the Netherlands has few pharmacists per inhabitants providing pharmaceutical care in primary, secondary, or tertiary care settings.[43,44] Furthermore, these pharmacists have significant organizational and logistical tasks, limiting their opportunity to increase patient encounters.[2] The presence of hospital pharmacists on wards and in clinics, for example, may improve pharmacists' CDM and thus patient outcomes by shifting their tasks more towards providing direct pharmaceutical care with more patient encounters. According to a recent study, an outpatient medication consultation with a hospital pharmacist resulted in significantly fewer medication-related problems in liver transplant recipients.[45] Another example is adding a non-dispensing pharmacist to general practitioners teams, where they would have more patient encounters, access to patient records and close collaboration with physicians.[46] This model is currently being investigated for possible implementation in the Netherlands.

Strength and limitations

Few qualitative studies on pharmacists' clinical decision-making have been conducted, and this is the first study in the Netherlands. The findings are relevant to similar pharmacy care settings, such as those found in Scandinavian countries, because pharmacists working in other settings may experience different factors influencing their CDM. The inclusion of pharmacists working in primary, secondary, and tertiary care with varying years of clinical work experience is considered a strength of this study. Recruitment through the research team's professional network and snowball effect could have induced population bias. For example, a high proportion of pharmacists had conducted research as a PhD-candidate. Based on these findings, it would be interesting to study in depth the impact of clinical work experience in general and in specific domains, as well as other participant characteristics, on each factor. For consistency, this study employed a well-defined guide for the interviews, which were conducted by a single interviewer that was also a pharmacist. Although having a pharmacist as an interviewer gave the interviewer the opportunity to go deeper into the themes, this may have influenced participants' responses, for example by overreporting of socially desirable behavior.[47] Despite efforts to reassure participants that the interview was not a test of their decision-making ability, this may have resulted in biased responses with intentional or unintentionally erroneous responses. Although answering open questions was more valuable to our research questions, the retrospective reflections of the decision-making processes by the pharmacists may have been impacted by cognitive biases. Further research using think-alouds will strengthen this work. To reduce the impact of researcher bias and preconceptions, data analysis was addressed collaboratively, with the COM-B model serving as the theoretical framework.

Conclusion

The reported factors covered all domains of the COM-B model, implying that clinical decision-making is influenced by the combination of pharmacists' capability, opportunity, and motivation. Implementing CDM in under- and postgraduate pharmacy education while encouraging the integration of theoretical knowledge, skills, and clinical experience will contribute to pharmacists' capability. Pharmacists' CDM is hindered by a lack of relevant patient and clinical data, which could be improved by increasing access to relevant patient and clinical data through more patient encounters, collaboration with other health professionals, and connected information systems. However, dealing with uncertainties and risks should be addressed in pharmacy education as well. Furthermore, following up on the patients' clinical course, evaluating outcomes, and reflecting on the process will foster

pharmacists to contextualize theoretical knowledge, which was found difficult. Addressing influencing factors in pharmacy practice and education may improve pharmacists' clinical decision-making, resulting in better patient outcomes.

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Declaration of Competing Interest

None.

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Appendix 1: Interview guide

Translated to English

Thank you for giving us the opportunity to interview you for our study on clinical decision-making among pharmacists. The questions I would like to ask during this interview regard how you, as a pharmacist, come to a decision when addressing a patient case: which thinking steps do you make? As a pharmacist, researcher and teacher, I am interested in this topic. There are no right or wrong answers here. The interview will last for about 45 minutes and consists of a number of questions regarding decision-making.

Your participation in this study is voluntary and your answers will be treated confidentially. You can stop or withdraw from the interview at any time. This interview will be recorded so that the interview is transcribed accurately. The recording will be deleted at the end of the study. Do you have any questions beforehand? Shall we begin?

a. Professional experience and clinical role

- How many years have you been working as a pharmacist in pharmaceutical patient care?
- Which of your current pharmacy activities are directly related to the patient? (prescription processing, medication review, etc.)

b. Process of clinical decision-making

- What thinking steps do you take in these activities to come to a clinical decision?
    - Does this process differ between the different work activities? If so, how?
- What do you need to make a decision?
- What do you use to make a decision?
    - Dig deeper: knowledge, skills, attitude, preconditions
    - What would you like to improve?
- What hinders your clinical decision-making?
- What facilitates your clinical decision-making?
- What do you need from the physician to make a decision?
- What does the physician need from you?
- Is the patient involved in your decision making? If so, how?
- What do you need from the patient to make a decision?

c. Learning and teaching clinical decision-making

- Are you an educator of pharmacists or pharmacy students? If so:
  - How do you teach others to deal with patient cases?
  - How do you rate this among others?
  - What do you think an educator needs to teach this?
    - Dig deeper: knowledge, skills, attitude, preconditions
  - Example of a successful training moment?

Your experience from practice have already been very helpful, thank you. Did I forget to ask something in your opinion, or do you want to add something?
Thank you very much for your time and answers to our questions. We will send you the transcript afterward. If you have any questions or comments regarding our conversation and/or the transcript, please do not hesitate to contact us.

Appendix 2: Consolidated criteria for reporting qualitative studies (COREQ): 32–item checklist

No	Item	Guide questions/description	Check?
		Domain 1: Research team and reflexivity	
		Personal Characteristics	
1.	Interviewer/ facilitator	Which author/s conducted the interviews?	JM
2.	Credentials	What were the researcher's credentials? *E.g. PhD, MD*	JM is PharmD
3.	Occupation	What was their occupation at the time of the study?	Researcher and senior lecturer
4.	Gender	Was the researcher male or female?	Female
5.	Experience and training	What experience or training did the researcher have?	Training qualitative interviewing
		Relationship with participants	
6.	Relationship established	Was a relationship established prior to study commencement?	Several participants within professional network, others just with e-mail prior to start study
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? e.*g. personal goals*, *reasons for doing the research*	Participants were informed about the research by invitation letter.
8.	Interviewer characteristics	What characteristics were reported about the interviewer/ facilitator? e.g. *Bias*, *assumptions*, *reasons and interests in the research topic*	Researcher introduced herself at the start of the interview. She reported her reasons and interests in the research topic to the participants.
		Domain 2: study design	
		Theoretical framework	
9.	Methodological orientation and Theory	What methodological orientation was stated to underpin the study? *e.g. grounded theory*, *discourse analysis*, *ethnography*, *phenomenology*, *content analysis*	At first, grounded theory. However, when themes emerged, COM-B model was considered suitable for the categorization of themes.
Participant selection			
10.	Sampling	How were participants selected? *e.g. purposive*, *convenience*, *consecutive*, *snowball*	Participants were approached through the professional network of the research team.
11.	Method of approach	How were participants approached? e.*g. face-to-face*, *telephone*, *mail*, *email*	Participants were approached by e-mail.
12.	Sample size	How many participants were in the study?	16

No	Item	Guide questions/description	Check?
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	No participants dropped out after inclusion.
		Setting	
14.	Setting of data collection	Where was the data collected? *e.g. home, clinic, workplace*	The data was collected in the workplace of the participant or in an online setting.
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	During 5 interviews the research student was present as well.
16.	Description of sample	What are the important characteristics of the sample? *e.g. demographic data, date*	Pharmacists of both primary, secondary and tertiary care are represented in the sample. Participants differed in gender, age and years of experience.
		Data collection	
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	The interview guide was not pilot tested, but after the first two interviews evaluation of the interview guide took place together with the research team consisting of community and hospital pharmacists and a physician.
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes, audio-recording was be used to collect the data.
20.	Field notes	Were field notes made during and/or after the interview?	Yes, JM made field notes.
21.	Duration	What was the duration of the interviews?	The duration of interviews was between 45 and 60 minutes.
22.	Data saturation	Was data saturation discussed?	Data saturation was discussed with the team after 10 interviews and after 15 interviews.
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	A summary of the findings was returned to participants for comment and/or correction if wanted by the participant.
		Domain 3: analysis and findings	
		Data analysis	
24.	Number of data coders	How many data coders coded the data?	Two persons (JM and student) independently coded all transcripts
25.	Description of the coding tree	Did authors provide a description of the coding tree?	The coding tree was inductively developed and is available upon request from the first author.

No	Item	Guide questions/description	Check?
26.	Derivation of themes	Were themes identified in advance or derived from the data?	Themes were derived from the data.
27.	Software	What software, if applicable, was used to manage the data?	Atlas.ti version 22 was used to manage the data.
28.	Participant checking	Did participants provide feedback on the findings?	No
		Reporting	
29.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? e.*g. participant number*	Participant quotations were presented to illustrate the findings by using a pseudonym.
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31.	Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes.

Abbreviations: COM-B model = Capability Opportunity Motivation – Behaviour model

Chapter 5.

Klinische besluitvorming in de farmacie: Handreiking voor docenten en opleiders

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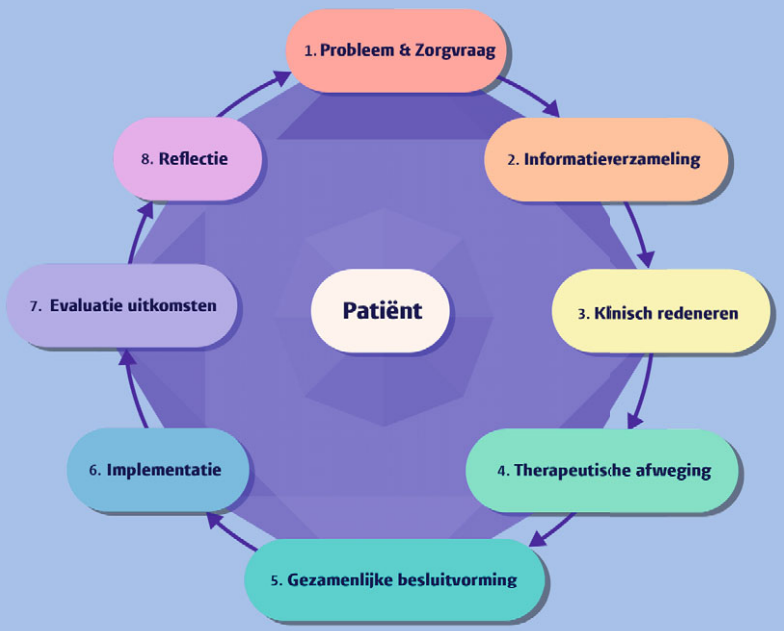
Klinische besluitvorming in de farmacie

Handreiking voor docenten en opleiders



Universiteit Leiden

Josephine Mertens[1], Thomas Kempen[2], Vera Deneer[2], Marcel Bouvy[2] en Teun van Gelder[1]

[1]Afdeling Klinische Farmacie en Toxicologie, Leids Universitair Medisch Centrum

[2]Afdeling Farmaco-epidemiologie en Klinische Farmacologie, Universiteit Utrecht

OEC KNMP

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Handreiking Klinische besluitvorming in de farmacie

Introductie

Klinische besluitvorming is een essentieel proces in de farmaceutische zorg en omvat een reeks denkprocessen en vaardigheden die apothekers in staat stellen om patiëntgerichte beslissingen te nemen. Klinisch redeneren is hierin belangrijk; met een professionele attitude integreren apothekers kennis en vaardigheden om de beschikbare informatie te interpreteren. Met betrekking tot de structuur laat klinische besluitvorming zich het beste beschrijven als een cyclisch proces met acht stappen dat start met een patiëntgerelateerd probleem of gezondheidsvraagstuk. Dit kan een klacht of symptoom zijn waar de patiënt mee kampt, maar vaker zal er een (potentieel) farmacotherapeutisch probleem zijn waar de apotheker een beslissing over moet nemen, bijvoorbeeld naar aanleiding van een recept. Bij klinische besluitvorming staan de zorgvraag, context en wensen van de patiënt centraal. Het is een dynamisch proces, waarbij zowel binnen een stap als tussen de stappen heen en weer kan worden bewogen. Denkprocessen kunnen bovendien onbewust en gecombineerd plaatsvinden, zeker bij meer ervaren apothekers. Voor farmaciestudenten biedt het ontwikkelde 8-stappenmodel structuur om het proces van klinische besluitvorming zich eigen te maken. Door deze stappen te expliciteren en gestructureerd te doorlopen gaan studenten van onbewust onbekwaam naar (on)bewust bekwaam. Het model is complementair aan de WHO 6-step voor rationeel voorschrijven voor geneeskundestudenten, maar omvat een breder scala aan (niet-)medicamenteuze interventies. Bovendien worden studenten en apothekers door dit 8-stappenmodel ook aangemoedigd om kritisch na te denken over de wijze waarop zij klinische beslissingen nemen, met de nadruk om dit samen met de patiënt en andere zorgverleners te doen, en hoe dit van invloed is op de farmaceutische zorg die wordt verleend aan de individuele patiënt.

Doel en doelgroep van deze handreiking

De handreiking *Klinische besluitvorming in de farmacie* is een hulpmiddel dat specifiek is ontworpen voor docenten en opleiders die betrokken zijn bij de (door)ontwikkeling van klinische besluitvorming van apothekers in academisch en/of postacademisch farmacieonderwijs. Deze handreiking voorziet docenten en opleiders van relevante informatie, gerichte vragen en tips voor het (post)academisch onderwijs om hen te ondersteunen bij deze begeleiding. Deze handreiking kan gebruikt worden in diverse onderwijswerkvormen, zoals *case-based learning*, *problem-based learning*, simulatietraining en intercollegiale toetsing, en tijdens werkplekleren met passende mate van zelfstandigheid. Deze handreiking is ontwikkeld door experts uit de farmacie en geneeskunde op basis van hun professionele en onderwijservaring, kennis van onderwijstheorieën en praktijkgericht onderzoek met gelden van de KNMP. Voor studenten en apothekers zelf is het *Handvat voor Klinische besluitvorming* in de farmacie ontwikkeld met het 8-stappenmodel inclusief ondersteunende vragen (zie Appendix 1). Ook is een voorbeeld beschikbaar ter illustratie van de denkprocessen (zie Appendix 2). Met deze ontwikkelde hulpmiddelen wordt beoogd de klinische besluitvorming door apothekers te verbeteren en daarmee de kwaliteit van farmaceutische zorg te verhogen.

Voor vragen of meer informatie kunt u contact opnemen met Josephine Mertens (j.f.mertens@lumc.nl).

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Klinische besluitvorming in de (vervolg)opleidingen

Klinische besluitvorming dient te worden onderwezen, beoefend en beoordeeld in het farmaciecurriculum om studenten voor te bereiden op de praktijk. Tijdens de bacheloropleiding leggen studenten het fundament voor biomedische en farmaceutische kennis en inzicht, evenals de vaardigheden en professionele attitude die nodig zijn voor de ontwikkeling van klinische besluitvorming. Gedurende de masteropleiding bouwen de studenten voort op dit fundament door competenties te ontwikkelen binnen de zeven competentiedomeinen zoals beschreven in het Raamplan Farmacie (2016). Ze leren kennis en vaardigheden toe te passen en professioneel te handelen om kwalitatief hoogstaande, doeltreffende, doelmatige en veilige farmaceutische patiëntenzorg te leveren. Voor klinische besluitvorming moeten studenten farmaceutische deskundigheid integreren met competenties uit andere competentiegebieden. Het kader bevat een voorstel voor twee aanvullende eindtermen voor de masteropleiding Farmacie die direct gerelateerd zijn aan klinische besluitvorming binnen het competentiegebied Farmaceutische Deskundigheid. Wij adviseren de begrippen “klinische besluitvorming” en “klinisch redeneren” expliciet te maken respectievelijk aan te scherpen (zie Begrippenlijst). Als gerelateerde eindtermen worden gestructureerd per stap van ons model, dan verhoogt dat naar onze mening de leesbaarheid van het Raamplan Farmacie.
Tijdens de masteropleiding Farmacie oefenen studenten doorlopend en opbouwend (gedeeltes van) het proces van klinische besluitvorming met patiëntencasuïstiek in het cursorisch onderwijs en tijdens de farmaceutische coschappen met *experience-based learning*. Studenten moeten zowel formatieve als summatieve feedback van zowel docenten als praktijkopleiders ontvangen om de ontwikkeling van competenties te bevorderen en ervoor te zorgen dat eindtermen kunnen worden behaald. Deze handreiking kan hiervoor worden gebruikt en ook als basis dienen voor de ontwikkeling van toets- en beoordelingsinstrumenten, zoals rubrics. Op deze manier wordt geborgd dat studenten bij het behalen van de eindtermen bekwaam zijn om als basisapotheker klinische beslissingen te nemen.

Voorstel voor aanvullende eindtermen voor de Master Farmacie

Competentiegebied Farmaceutische Deskundigheid
Binnen het taakgebied *farmaceutische patiëntenzorg* is de basisapotheker in staat om:

- patiëntgericht en contextafhankelijk te denken om klinische beslissingen te maken samen met de patiënt en andere zorgverleners, ook bij onzekerheden die inherent zijn aan de klinische praktijk;
- de verschillende stappen in het proces van klinische besluitvorming op adequate wijze toe te passen gebruikmakende van de andere competenties genoemd van het competentiegebied Farmaceutische Deskundigheid. (Optie: gerelateerde competenties uit het Raamplan Farmacie (2016) per stap structuren.)

De competentiegebieden van de opleiding tot basisapotheker komen vrijwel volledig overeen met de competentiegebieden voor de vervolgopleidingen tot openbaar apotheker specialist en tot ziekenhuisapotheker, behalve dat farmaceutische deskundigheid verdiept en vertaald wordt naar een voor de beroepspraktijk noodzakelijk vermogen om kennis, vaardigheden en attitude onder tijdsdruk in uiteenlopende beroepssituaties toe te passen (farmaceutisch handelen). De vervolgopleidingen richten zich dan ook specifiek op farmaceutisch handelen in beroepssituaties van toenemende complexiteit en tijdsdruk, waarop ook het postacademisch onderwijs over klinische besluitvorming zich kan richten. Ons inziens is het voorstel voor aanvullende eindtermen met betrekking tot klinische besluitvorming en het gebruik van het model en deze handreiking ook relevant voor de vervolgopleidingen.

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Legenda

 Denkprocessen als activiteiten in iedere stap

 Ondersteunende vragen voor studenten, apothekers en docenten

 Tips voor het (post)academisch onderwijs

 Valkuilen van studenten en apothekers

Begrippenlijst

Klinische besluitvorming – Dynamisch proces bestaande uit een reeks denkprocessen en vaardigheden die apothekers in staat stellen om patiëntgerichte beslissingen te nemen.

Klinisch redeneren – Kerncompetentie in het proces van klinische besluitvorming, waarbij de apotheker met een professionele attitude kennis en vaardigheden integreert om informatie bij vraagstukken van gezondheid en ziekte en de inbreng van de individuele patiënt te interpreteren. Klinisch redeneren kan worden toegepast in elke stap van klinische besluitvorming, maar is het belangrijkst in stap 3.

Patiënt – In deze handreiking wordt gesproken over patiënt, maar hier kan ook burger met een zorgvraag worden gelezen. Ook kan de patiënt worden vertegenwoordigd door bijvoorbeeld een mantelzorger.

Probleem – Een situatie of vraagstuk dat de gezondheid van een patiënt (potentieel) beïnvloedt. Dit kan variëren van een specifieke klacht of symptoom waar de patiënt mee kampt tot een (potentieel) farmacotherapeutisch probleem waarbij de apotheker betrokken is. Het probleem kan zich bijvoorbeeld presenteren bij het verwerken van een recept, in gesprek met een andere zorgverlener of als onderdeel van een medicatiebeoordeling.

Valkuilen / bias – Tijdens klinische besluitvorming kunnen verschillende valkuilen en biases optreden. Een veelvoorkomende bias is bijvoorbeeld de neiging om informatie te zoeken, te interpreteren of te onthouden die de bestaande overtuigingen bevestigt (*confirmation bias*). Een andere valkuil is het te snel trekken van conclusies of stoppen met het verzamelen van gegevens voordat alle relevante informatie is verkregen (*premature closing*). Het is van belang deze valkuilen en biases te (h)erkennen en stappen te ondernemen om ze te verminderen, zoals het stimuleren van een open en veilige leercultuur.

Zorgvraag – De zorgbehoefte van een individuele patiënt die ten grondslag ligt aan het probleem.

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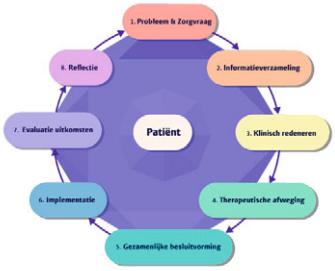

Stap 1. Probleem & zorgvraag

Identificeer het probleem en de zorgvraag van de patiënt.
Beschrijf de situatie.

Wat is het probleem?
Wat is de zorgvraag van de patiënt?
Wat is de context waarin het probleem zich voordoet? Denk aan: eerstelijns- of tweedelijnszorg, urgentie, relatie tot patiënt, specialisme voorschrijver

- Gebruik voor studenten realistische casuïstiek met de ambiguïteit, onzekerheid en complexiteit van de praktijk.
- Laat de casusinbrenger en/of peer het probleem en de zorgvraag in 1 of 2 zinnen hardop formuleren. Gebruik medisch jargon bij het formuleren van het probleem en blijf bij de zorgvraag dichtbij de verwoording van de patiënt.
- Erken en benoem de potentiële effecten van variabelen uit de praktijk, zoals ethische en financiële dilemma's, maar behoud focus op de leerdoelen van je onderwijswerkvorm.

Onvoldoende helder hebben van het (potentieel) probleem en de zorgvraag van de patiënt, die niet hetzelfde hoeven te zijn
Te snel naar volgende stap(pen) (*premature closing*)
Onvoldoende focus op het klinische probleem door invloed van ethische en/of financiële dilemma's

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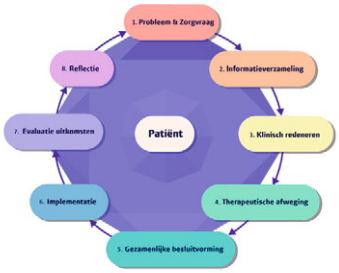

Stap 2. Informatie inwinnen

Bekijk de huidige patiëntinformatie.
Verzamel nieuwe patiëntinformatie.
Herinner voorkennis en eerdere ervaringen.
Raadpleeg informatiebronnen.

Welke patiëntgegevens heb je nodig en wat ontbreekt? Denk aan:

- patiëntkenmerken, zoals leeftijd, geslacht, laaggeletterdheid, zwangerschap;
- wensen, ideeën, zorgen, verwachtingen;
- medische gegevens, incl. diagnoses, klinisch beeld en behandeldoelen;
- labwaarden, lichamelijk onderzoek, overige meetgegevens, genotypes relevant voor farmacogenetica;
- medicatiegebruik: actueel, historie, allergieën, therapietrouw.

Via wie kun je ontbrekende patiëntgegevens verkrijgen? Denk aan patiënt zelf, ouders/verzorgers, mantelzorg, thuiszorg, huisarts, specialist(en), POH, collega-apothekers.
Wat weet je al over het probleem?
Welke ervaring heb je al met vergelijkbare situaties?
Wat weet je nog niet en welke achtergrondinformatie heb je daarvoor nodig? Denk aan (patho)fysiologie, beloop, risicofactoren en geneesmiddelinformatie, incl. farmacokinetiek en -dynamiek, effectiviteit, veiligheid, toepasbaarheid, doelmatigheid, kosten.
Waar vind je de wetenschappelijke onderbouwing bij deze achtergrondinformatie? Denk aan bijv. (details bij) behandelrichtlijnen, KNMP Kennisbank (incl. risicoanalyse), PubMed, LAREB, SmPC-tekst, TDM Monografieën, Oralia VTGM, Kinderformularium, contact met GIC en fabrikant.

- Stimuleer nieuwsgierigheid en rechtstreeks contact met de patiënt, ouders/verzorgers, mantelzorgers en/of andere zorgverleners.
- Verstrek bij studenten vervolginformatie pas nadat de juiste vragen zijn gesteld (*serial-cue approach*). Voeg bewust irrelevante informatie aan een casus toe en/of laat relevante informatie weg.
- Laat de reden toelichten om díe specifieke informatie te verzamelen.
- Stimuleer het ontwikkelen van hypotheses met actieve bevestigings- of verwerpingstrategieën. Laat informatie benoemen die leidde tot verwerping of behoud van de hypothese.

Onvoldoende informatie voor compleet beeld.
Verzanden in (het zoeken naar) informatie.
Informatieverzameling onvoldoende aangepast aan het probleem en de context en onvoldoende gericht om onderscheidende kenmerken te identificeren.

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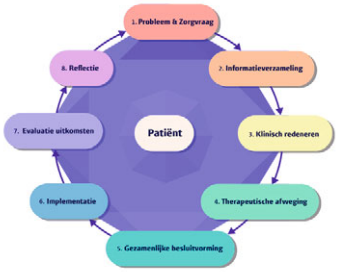

Stap 3. Klinisch redeneren

Herken normale en abnormale informatie, inconsistenties en/of ontbrekende informatie.
Onderscheid relevante van irrelevante informatie.
Prioriteer de informatie door het op belang te rangschikken.
Relateer informatie om patronen te identificeren.
Verbind vergelijkbare informatie en/of identificeer een verkeerde combinatie.
Beredeneer wat logisch volgt uit de informatie.
Begrijp het probleem in de context van de patiënt.
Formuleer het definitieve probleem door informatie samen te voegen.

Welke informatie is normaal en afwijkend?
Welke informatie is (in)consistent?
Wat ontbreekt nog / is onzeker?
Welke informatie is (ir)relevant?
Welke informatie is het meest van belang?
Welke verbanden zijn er? Denk aan: (in)effectiviteit, (potentiële) bijwerkingen, voorschrijfcascades, therapie(on)trouw.
Wat past (niet) bij elkaar? Denk aan: onder- en overbehandeling, labwaarden bij klachten/ medicijnen, contra-indicatie, interactie, gebruik.
Wat kun je afleiden uit de beschikbare informatie? Denk aan: indicaties, invloed farmacokinetiek en -dynamiek.
Wat is het risico voor deze patiënt in deze context? En hoe groot is dit risico?
Wat is het probleem op basis van jouw interpretatie van de beschikbare informatie? Welk probleem ligt er eventueel ten grondslag aan de vraag of het gepresenteerde probleem?

- Laat studenten (al in de bacheloropleiding) de denkstappen gericht en apart oefenen, bijvoorbeeld met e-modules.
- Laat studenten bij een casus hardop denken en benoem de denkstappen die worden gemaakt. Niet elke denkstap is passend bij iedere casus en dikwijls aansluitend op verkregen informatie in stap 2.
- Faciliteer het leggen van verbanden tussen de patiënt, geneesmiddelen en labwaarden, bijv. door een *mindmap* te tekenen en ordeningstabellen te gebruiken.
- Het gebruik van impliciete screeningsmethoden (zoals de farmacotherapeutische analyse uit de STRIP) en expliciete screeningsmethoden (zoals de STOPP-START-criteria) kan met name studenten helpen in deze stap. Bespreek het nut en de valkuilen. Stimuleer het vermogen om zelfstandig, kritisch en flexibel te denken.
- Stimuleer patroonherkenning bij studenten door te helpen veelvoorkomende en ongebruikelijke situaties te identificeren. Bespreek het nut en de valkuilen.
- Maak een eventueel pluis/ niet-pluisgevoel concreet en vraag naar de achtergrond ervan. Bespreek het nut en de valkuilen.
- Stimuleer het behoud van een open blik, verduidelijk aannames en misconcepties.
- Laat aan het einde van deze stap het probleem en de zorgvraag nogmaals hardop formuleren in 1-2 zinnen. Bespreek eventuele aanpassingen.
- Beschrijf een andere interpretatie van de klinische situatie en vraag waarom deze beredenering waarschijnlijker of minder waarschijnlijk is.
- Bespreek als rolmodel hardop jouw eigen klinisch redeneren met gebruikte denkprocessen en hoe jij omgaat met klinische onzekerheden.

Missen van verbanden
Tunnelvisie (onderdeel van *confirmation bias*)
Te veel vertrouwen op checklists en/of intuïtie
Onvoldoende concreet risico voor de individuele patiënt in diens context
Onjuiste inschatting van de klinische relevantie van het risico
Oncomfortabel zijn met onzekerheden

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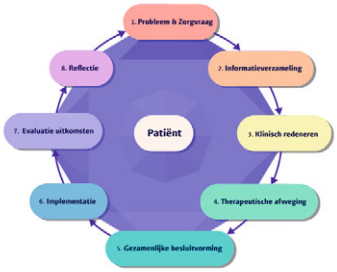

Stap 4. Therapeutische afweging

Bepaal de gewenste uitkomst en behandeltermijn.
Overweeg de voordelen en nadelen van alle mogelijke (niet-)medicamenteuze opties.

Wat is de gewenste uitkomst voor de patiënt? En op welke termijn?
Wat zijn alle mogelijke (niet-) medicamenteuze opties voor het probleem?
Wat zijn voor- en nadelen van elke optie?
Hoe zwaar weegt elk aspect mee in jouw afweging?
Hoe beïnvloeden de wensen/behoeften en context van de patiënt jouw afweging?

- Behandel met studenten casuïstiek zonder evident antwoord wat de beste optie is. Faciliteer het leren omgaan met grijze gebieden.
- Stimuleer breed te denken om alle verschillende opties te overwegen, voorbij de richtlijnen en met de opties om niet te behandelen en niet-medicamenteuze opties.

Te weinig opties overwogen.
Te zwaar meewegen van medicamenteuze opties ten opzichte van niet-medicamenteus.
Zwart-wit denken of te strak aan richtlijnen houden.
Te weinig rekening gehouden met de wensen/behoeften en context van de patiënt.

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Stap 5. Gezamenlijke besluitvorming

Selecteer de meest geschikte behandeloptie, bij voorkeur met de patiënt en eventueel met andere zorgverleners.
Besluit over de aanpak met de patiënt en/of andere zorgverleners.

Wat is/zijn de meest geschikte optie(s) voor het probleem in deze context?
Wat is het concrete behandelvoorstel, incl. dosering, toedieningsvorm, gebruiksadvies?
Wat besluit je samen met patiënt/ouders/mantelzorger en/of andere zorgverleners?
Indien afwijkend van jouw voorstel, wat is de reden?
Hoe dient de patiënt te worden gemonitord (op welke parameters, door wie en wanneer)?

- Moedig studenten aan om zich te committeren aan één optie (zelfs als deze onzeker is) om vastberadenheid te ontwikkelen bij het worstelen met moeilijke keuzes. Laat onzekerheden en overwegingen expliciteren.
- Oefen gezamenlijke besluitvorming met simulatiepatiënten en -artsen. Laat deze rollen ook spelen door studenten.
- Stimuleer voor effectieve interprofessionele communicatie het gebruik van de SBAR(R)-methode (Situation, Background, Assessment, Recommendation (Repeat)).
- Faciliteer interprofessioneel onderwijs om te leren over, van en met andere (toekomstig) zorgverleners. Laat studenten van verschillende zorgopleidingen bijvoorbeeld een zorgplan opstellen na een gezamenlijk gesprek met de patiënt.
- Stel de vraag “wat als….?” Varieer de casuskenmerken zoals patiëntvoorkeuren, comedicatie en afwijkende labparameters.

Te weinig rekening gehouden met wensen/voorkeuren en context van de patiënt.
Geen concrete opties voorleggen en/of besluit te veel aan anderen overlaten.

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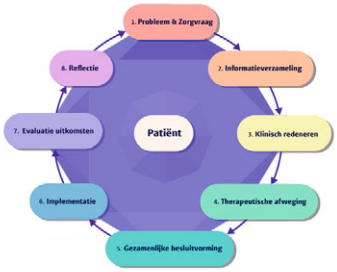

Stap 6. Implementatie

Communiceer mondeling en/of schriftelijk over het besluit.

Hoe communiceer je het besluit naar/met de patiënt/mantelzorger?
Met wie communiceer je nog meer? En wat?
Wat, waar en hoe documenteer je over het probleem, zorgvraag, proces, besluit en afspraken?
Hoe blijf jij op de hoogte van de (vervolg)acties en de uitkomsten?
Welke verantwoordelijkheid neem jij in de follow up?

- Stimuleer schriftelijk interprofessioneel communiceren op gestructureerde wijze, ook mogelijk via de SBAR-methode. Laat studenten oefenen met schriftelijke reacties en beoordeel ook de vastlegging in het patiëntendossier.
- Geef na een consult ook feedback op de competentie Organisatie, bijv. door opleiders met een Korte Praktijk Beoordeling of door medestudenten in de rol van arts.

Te veel details communiceren
Onvoldoende concrete afspraken

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Stap 7. Evaluatie uitkomsten

Evalueer uitkomsten.

Wat zijn de uitkomsten van het besluit?
Probleem opgelost en/of zorgvraag beantwoord?

- Stimuleer het monitoren van de patiënt (follow-up) door bijvoorbeeld contact op te nemen met de patiënt en/of andere zorgverleners om klinische ervaring op te doen en inzicht te krijgen in de uitkomsten van besluiten (scriptontwikkeling).
- Ontwikkel of maak gebruik van casuïstiek specifiek gericht op (of met als startpunt) de evaluatie van een eerder besluit.

Onvoldoende frequent of onvolledige follow-up uitvoeren.
Te veel monitoren uit onzekerheid.

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Stap 8. Reflectie

Beschouw wat je hebt geleerd, wat er goed ging en wat anders had gekund.

Wat heb je geleerd?
Wat behoud je?
Wat ga je anders doen per competentiegebied?
Wat heb je nodig om dat te bereiken? Hoe ga je dat evalueren?

- Bied een open en veilig leerklimaat aan, waarbij naast het delen van successen ook het delen van fouten en suboptimale uitkomsten wordt aangemoedigd.
- Stimuleer het vragen van feedback aan medestudenten en opleiders, maar ook aan de patiënt en andere zorgverleners.
- Geef constructieve feedback op het proces en de wijze van klinisch redeneren, niet alleen op de uitkomst.
- Identificeer en bespreek bias die van invloed kunnen zijn, zoals *premature closing* en *confirmation bias*.
- Motiveer de student om haalbare, maar uitdagende persoonlijke leerdoelen te formuleren en borg dat deze worden opgevolgd (constructieve frictie).
- Laat de student de SMART-geformuleerde leerdoelen koppelen aan competentiegebieden. In sommige portfoliosystemen is de voortgang op competentiegebied dan ook te volgen door de student en begeleiders.

Feedback valkuilen, zowel voor de gever als ontvanger, zoals onvoldoende concrete feedback (en daar niet op doorvragen), feedback vanuit een eenzijdig perspectief, defensief reageren op feedback en geen vervolgacties koppelen aan de ontvangen feedback
Naast *premature closing* en *confirmation bias* komt overschatting van de nauwkeurigheid van de diagnose of behandeling voor (*overconfidence bias*). Ook hoe de situatie wordt gepresenteerd (*framing effect*) of vooroordelen over een patiënt (*visceral bias*) kunnen objectieve besluitvorming belemmeren.

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Contact: Josephine Mertens j.f.mertens@lumc.nl
Grafisch design: Lars Rietkerk

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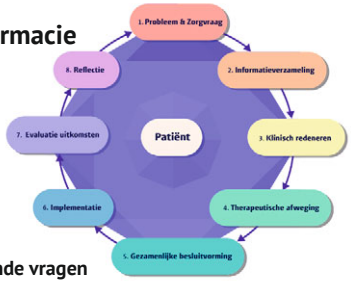
Appendix 1

Handvat voor klinische besluitvorming in de farmacie



Stappen	Denkproces	Ondersteunende vragen
Stap 1. Probleem & zorgvraag	**Identificeer** het probleem en de zorgvraag	Wat is het probleem? Wat is de zorgvraag van de patiënt?
	Beschrijf de situatie	Wat is de context waarin het probleem zich voordoet? Denk aan eerstelijns- of tweedelijnszorg, urgentie, relatie tot patiënt, type voorschrijver.
Stap 2. Informatie-verzameling	**Bekijk** de huidige patiëntgegevens	Welke patiëntgegevens heb je nodig en welke ontbreekt? Denk aan: • patiëntkenmerken, zoals leeftijd, geslacht, laaggeletterdheid, zwangerschap • wensen, ideeën, zorgen, verwachtingen • medische gegevens, incl. diagnoses, klinisch beeld en behandeldoelen • labwaarden, overige meetgegevens, lichamelijk onderzoek, genotypes relevant voor farmacogenetica • medicatiegebruik: actueel, historie, allergieën, therapietrouw
	Verzamel aanvullende patiëntgegevens	Via wie kan je ontbrekende patiëntinformatie verkrijgen? Denk aan patiënt zelf, mantelzorg, thuiszorg, huisarts, specialist(en), POH, apothekers (uit andere (ziekenhuis)apotheken)
	Herinner voorkennis en eerdere ervaringen	Wat weet je al van het probleem? Welke ervaring heb je al met vergelijkbare situaties?
	Raadpleeg informatiebronnen	Wat weet je nog niet en welke achtergrondinformatie heb je daarvoor nodig? Denk aan (patho)fysiologie, beloop, risicofactoren en geneesmiddelinformatie, incl. farmacokinetiek en -dynamiek (FK/FD), effectiviteit, veiligheid, toepasbaarheid, doelmatigheid, kosten Waar vind je de wetenschappelijke onderbouwing bij deze achtergrondinformatie? Denk aan (details bij) behandelrichtlijnen, KNMP Kennisbank (incl. risicoanalyse), PubMed, LAREB, SmPC-tekst, TDM Monografieën, Oralia VTGM, Kinderformularium, contact GIC en fabrikant.

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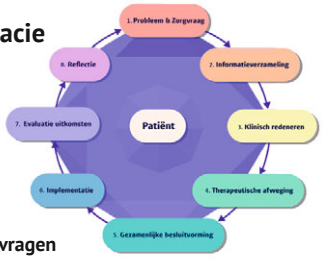
Handvat voor klinische besluitvorming in de farmacie



Stappen	Denkproces	Ondersteunende vragen
Stap 3. Klinisch redeneren	**Herken** normale en afwijkende gegevens, inconsistenties en/of ontbrekende informatie	Welke informatie is normaal en afwijkend? Welke informatie is (in)consistent? Wat ontbreekt nog/ is onzeker?
	Onderscheid relevante van irrelevante	Welke informatie is (ir)relevant?
	Prioriteer de informatie door het op belang te rangschikken	Welke informatie is het meest van belang?
	Relateer informatie om patronen te identificeren	Welke verbanden zijn er? Denk aan: (in)effectiviteit, (potentiële) bijwerkingen, voorschrijfcascades, therapie(on)trouw
	Verbind vergelijkbare informatie en/of identificeer een verkeerde combinatie	Wat past (niet) bij elkaar? Denk aan: onder- en overbehandeling, labwaarden bij klachten/ medicijnen, contra-indicatie, interactie, gebruik
	Beredeneer wat logisch volgt uit de informatie	Wat kan je afleiden uit de beschikbare informatie? Denk aan: indicaties, invloed FK/FD
	Begrijp het probleem probleem met het risico in de context van de patiënt	Wat is het risico voor deze patiënt in deze context?
	Formuleer het definitieve probleem door informatie samen te voegen	Wat is het probleem op basis van jouw interpretatie van de beschikbare informatie? En hoe groot is dit risico? Is het risico klinisch relevant?
Stap 4. Therapeutische afweging	**Bepaal** de gewenste uitkomst en behandeltermijn	Wat is de gewenste uitkomst voor de patiënt? En op welke termijn?
	Overweeg de voordelen en nadelen van alle mogelijke (niet-)medicamenteuze opties	Wat zijn alle mogelijke (niet-) medicamenteuze opties voor het probleem? Wat zijn voor- en nadelen van elke optie? Hoe zwaar weegt elk aspect mee in jouw afweging? Hoe beïnvloeden de wensen/behoeften en context van de patiënt jouw afweging?

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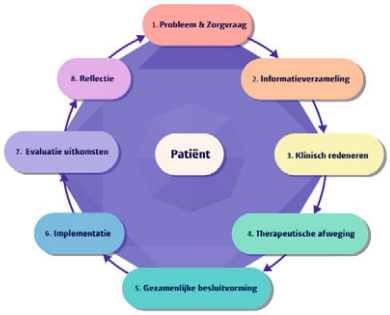
Handvat voor klinische besluitvorming in de farmacie



Stappen	Denkproces	Ondersteunende vragen
Stap 5. Gezamenlijke besluitvorming	**Selecteer** de meest geschikte behandeloptie, bij voorkeur met de patiënt en eventueel met andere zorgverleners **Besluit** over de aanpak met andere zorgverleners en/of de patiëntinformatie	Wat is/zijn de meest geschikte optie(s) voor het probleem en de zorgvraag in deze context? Wat is het concrete behandelvoorstel, incl. dosering, toedieningsvorm, gebruiksadvies? Wat besluit je samen met de patiënt/mantelzorger en/of met andere zorgverleners? Indien afwijkend van jouw voorstel, wat is de reden? Hoe dient de patiënt te worden gemonitord (op welke parameters, door wie en wanneer)?
Stap 6. Implementatie	**Communiceer** mondeling en/of schriftelijk over het besluit	Hoe communiceer je het besluit naar/met de patiënt/mantelzorger? Met wie communiceer je nog meer? En wat? Wat, waar en hoe documenteer je over het probleem, zorgvraag, proces, besluit en afspraken? Hoe blijf jij op de hoogte van de (vervolg)acties en de uitkomsten? Welke verantwoordelijkheid neem jij in de follow up?
Stap 7. Evaluatie uitkomsten	**Evalueer** uitkomsten	Wat zijn de uitkomsten van het besluit? Probleem opgelost en zorgvraag beantwoord?
Stap 8. Reflectie	**Beschouw** wat je hebt geleerd, wat er goed ging en wat anders had gekund	Wat heb je geleerd? Wat behoud je? Wat ga je anders doen per competentiegebied? Wat heb je nodig om dat te bereiken? Hoe ga je dat evalueren?

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Appendix 2

Dit is een voorbeeld van een gesprek tussen de apotheker in opleiding tot openbaar apotheker specialist (apotheker) en diens apotheker-opleider (opleider) naar aanleiding van een klinisch besluit. Hierbij worden enkele cognitieve processen (licht grijs) en onderwijsstrategieën (donkergrijs) getoond ter illustratie van het besluitvormingsproces.

Op vrijdagmiddag ontving de apotheker voor een 83-jarige patiënt met een vastgelegde contra-indicatie "verlengd QT-intervalsyndroom" een recept voor mirtazapine 1 maal daags 15 mg 14 stuks. Vanwege het risico op QT-verlenging door mirtazapine werd een medicatiebewakingssignaal in het AIS gegenereerd. Vanuit de studie herinnerde de apotheker zich dat bij een verlengd QT-intervalsyndroom de medicatiebewakingssignalen serieus moeten worden genomen vanwege het risico op Torsade de Pointes wat een hoge mortaliteit kent. De reden van voorschrijven en de zorgvraag zijn in eerste instantie onduidelijk, maar werden duidelijker na contact met de familie van de patiënt. De patiënt zou kampen met psychische onrust en instabiliteit.

In het medicatiedossier zag de apotheker dat de patiënt eerder lorazepam had gebruikt, maar mirtazapine was nieuw. De apotheker vroeg zich af of de contra-indicatie terecht was, want die staan wel vaker foutief in dossiers. De familie wist niet zeker of hij een verlengd QT-intervalsyndroom had of bepaalde medicijnen niet mocht van de cardioloog. De apotheker zocht op welke patiëntkenmerken het risico op QT-verlenging verder zouden verhogen. Ze bekeek de labwaarden, waarbij ze geen relevante afwijkende labwaarden constateerde. Ze zag in het actueel medicatieoverzicht dat de patiënt digoxine en furosemide gebruikte. Daar leidde de apotheker uit af dat er sprake was van een cardiovasculaire morbiditeit. De apotheker vond het onduidelijk wat het daadwerkelijke risico op QT-verlenging was voor deze patiënt, maar wilde dit risico niet lopen.

Tijdens het bespreken van de casus, beseft de opleider dat zij meer ervaring heeft in het besluiten onder tijdsdruk en meer comfortabel is met het omgaan met onzekerheden en risico's. De opleider stelt de apotheker gerust dat dit soort onzekerheden vaker optreden en dat klinische situaties vaak niet zwart/wit zijn en niet zonder risico's kunnen zijn.

De apotheker en opleider bespreken de casus verder. De apotheker belde met de huisartsenpraktijk om het risico te bespreken op basis van deze informatie en om een benzodiazepineagonist als alternatief voor te stellen. De voorschrijvend huisarts was al naar huis en andere huisartsen wilden niet beslissen. De apotheker belde de voorschrijver op zijn mobiele nummer, die vervolgens het verlengd QT-intervalsyndroom bevestigde en aangaf ondanks het risico toch graag mirtazapine te willen proberen. Daarop adviseerde de apotheker een ECG van het hart te maken bij de start en na het bereiken van steady state om de invloed van mirtazapine op het QT-interval te meten. Op de KNMP Kennisbank zag de apotheker dat de halfwaardetijd van mirtazapine 20-40 uur is. De apotheker gebruikte deze informatie om te beredeneren dat na ongeveer 5 dagen steady state optreedt en daarmee de QT-verlenging (4-5x t0,5=CSS 5 dagen). De huisarts gaf aan dat een start ECG nu niet mogelijk was en dat patiënt onder controle is bij de cardiologie en dat zij een ECG kunnen maken na het weekend. Na overeenstemming met de familie, werd mirtazapine afgeleverd. De apotheker denkt na hoe ze dit besluit het beste kan vastleggen in het dossier. Na het weekend nam de apotheker contact op met de cardiologie. De apotheker belde maandag met de familie om de ECG-afspraak door te geven, waarop de familie aangaf dat mirtazapine was gestopt omdat het niet werkte. Dit kwam onverwachts voor de apotheker.

De opleider vraagt haar het probleem met de zorgvraag in twee zinnen samen te vatten. Ze vraagt wat de apotheker had verwacht van het effect van mirtazapine op de zorgvraag? Wat zijn voor- en nadelen van de benzodiazepineagonist bij deze patiënt? Heb je andere opties zoals haloperidol overwogen? De opleider bespreekt de valkuil om de zorgvraag uit het oog te verliezen en benadrukt het behoud van een breed perspectief. De apotheker reflecteert op de ervaring van haar farmaceutisch handelen in acute situaties en omgaan met onzekerheden en risico's met de les om onder tijdsdruk niet te veel mee te gaan in beslissingen zonder voldoende overweging. De opleider vertelt dat zij de voor- en nadelen van verschillende opties afweegt voorafgaand aan een gesprek met de huisarts, zodat ze kan anticiperen op informatie uit dit gesprek. De apotheker benadert de huisarts om de casus te bespreken en om te vragen hoe het nu gaat met de patiënt. Ook stelt ze een persoonlijk leerdoel op en stelt voor om hier over een maand op terug te komen.

Identificeer het probleem

Herinner eerdere ervaringen

Herken normale en afwijkende gegevens en **onderscheid** relevante van irrelevante informatie

Benadruk grijze gebied

Weer terug naar de stap Informatie-verzameling (dynamisch proces)

Vat het probleem met zorgvraag samen

Bespreek valkuilen

Deel jouw denkstappen en handelswijze

Borg het persoonlijk leerproces

Herinner voorkennis

Verzamel aanvullende gegevens over het klinisch beeld

Raadpleeg informatie-bronnen

Beredeneer indicatie

Begrijp het probleem met het risico in de context van de patiënt

Besluit samen

Communiceer schriftelijk

Stimuleer denken met een breed perspectief

Reflecteer op denken en handelen in verschillende competentie-gebieden

Evalueer uitkomsten

Universiteit Utrecht

Chapter 6

Pharmacists and pharmacy students' perceptions on how a new teaching model supports their clinical decision-making

Josephine F. Mertens
Thomas G.H. Kempen
Ellen S. Koster
Vera H.M. Deneer
Marcel L. Bouvy
Teun van Gelder

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Abstract

Background and purpose

Clinical decision-making (CDM) is crucial in pharmacy practice, necessitating effective teaching in undergraduate and postgraduate pharmacy education. This study aims to explore undergraduates and postgraduates' perceptions of how a new teaching model supports their CDM when addressing patient cases.

Educational activity and setting

Implemented in a full-day CDM course for pharmacy students and a half-day course for pharmacists in the Netherlands, the model, accompanied by a learning guide, facilitated CDM in patient cases. Eight courses were conducted between September 2022 to June 2023, followed by an online survey measuring participants' agreement on how the model supported their CDM, using a 5-point Likert scale. Additionally, three open-ended questions were included to elicit learning outcomes and self-development opportunities.

Findings

Of 175 invited participants, 159 (91%) completed the survey. Most agreed the teaching model supported their CDM, particularly in considering the patient's healthcare needs and context (96%), and exploring all available options (96%). Participants found the model provided a clear structure (97%), and fostered critical thinking (93%). The most frequently mentioned learning outcomes and self-development opportunities included collecting sufficient relevant information, maintaining a broad perspective, and decelerating the process to avoid premature closure.

Summary

Participants agreed that the teaching model helped them to make clinical decisions. Both undergraduate and postgraduate pharmacy education could possibly benefit from the teaching model's implementation in supporting pharmacy students and pharmacists conducting CDM in pharmacy practice.

Background and purpose

Clinical decision-making (CDM) is an essential and dynamic process employed by healthcare professionals, including pharmacists, in daily clinical patient care.[1] As medication experts actively engaging in CDM, pharmacists play a pivotal role in patient care. CDM encompasses cognitive processes and abilities that enable pharmacists to make patient-centred decisions in daily pharmacy practice.[2] Clinical reasoning, a fundamental component of CDM, involves the integration of knowledge with clinical expertise to interpret available data within diagnostic contexts ("diagnostic reasoning") and therapeutic contexts ("therapeutic reasoning").[2,3] Pharmacists primarily engage in therapeutic reasoning to determine the most appropriate drug therapy tailored to individual patients within varying circumstances.[2,4] Although diagnostic reasoning typically falls within the domain of physicians, pharmacists also participate in this aspect within the pharmacy context, such as in self-care and assessing the causality of adverse drug events.[2,5,6]

With an increased emphasis on clinical care, as outlined in the Pharmacists' Patient Care Process (PPCP), there is a growing recognition of the importance of CDM in pharmacy education.[4,7,8] However, despite its significance, there is less agreement on how it should be effectively taught in undergraduate and postgraduate pharmacy education.[4,9] The PCPP framework provides insight into the "what" and "why" of a pharmacist's patient care but lacks guidance on the "how", specifically the cognitive processes and behaviors required to conduct the process steps effectively.[8,10] In our previous study, cognitive processes that pharmacists use in their CDM are identified.[11] In order to ensure competent pharmacists, educators must consider how to support the development of these cognitive processes in undergraduates and postgraduates.[10,12] However, this task is not without its challenges, which are prevalent across multiple pharmacy education programs and may manifest differently depending on institutional contexts and educational strategies. For example, challenges arose in transitioning pharmacy students from memorizing content for exams to developing the cognitive processes required for clinical practice.[13-15] These challenges became apparent when pharmacy curricula were redesigned with a heightened emphasis on experience-based learning that necessitates a shift towards cultivating CDM competencies. While clinical knowledge remains essential, the ability to apply that knowledge properly in CDM to provide patient care is crucial.[14] In a previous study, we identified a need for a structured approach to teaching and learning CDM.[16] While such an approach could be beneficial, there's a risk that rigid adherence to process steps may hinder effective CDM.[10] It has been reported that mnemonic techniques, for instance, may unintentionally discourage pharmacists from engaging in CDM.[5,17] Therefore, it's important that a structured

educational approach encourages open-ended thinking.[10] Another challenge are the diverse needs of students and pharmacists, as clinical reasoning is transformative by nature.[10] Hence, a deliberate consideration of educational strategies is imperative to effectively teach CDM.[18]

Model design

In response to these challenges and identified need, our research focused on the development and implementation of an 8-step patient-centered CDM model (Figure 1). Drawing from the PCPP framework and informed by prior research on decision-making,[2,4,8,11,16,19-21] the model provides a systematic framework for navigating the complexities of CDM. While each step is presented as a separate and distinct element in the model following a numeric order, CDM is a dynamic process allowing for back-and-forth movement between steps and sometimes combining steps.[11] Each step within the model encapsulates specific cognitive processes integral to effective CDM. To aid in the implementation of the model, a complementary CDM learning guide that incorporates these cognitive processes along with prompting questions was developed. This guide serves as a tool for both pharmacists and students, facilitating the execution of cognitive processes at each step of the model. The CDM learning guide along with an example is included in appendix A. To integrate the model with its guide into educational courses, various educational strategies were employed, including early problem identification, fostering metacognitive skills, collaborative dialogue, and providing opportunities for dealing with uncertainties in clinical practice.[10,22-24]

The primary objective of this study was to explore undergraduates and postgraduates' perceptions of how this teaching model supports their CDM when addressing patient cases. By delving into these perceptions, we aimed to contribute valuable insights to enhance teaching and learning of CDM in pharmacy education, ultimately fostering the development of competent and confident pharmacists who are equipped to navigate the complexities of patient care.

Educational activity and setting

Setting

As mandated by Dutch law, the Netherlands offers a six-year academic pharmacy curriculum consisting of a three-year bachelor's and three-year master's, which is unique in Europe.[25] One of three master's curricula in pharmacy offered in the Netherlands, the Leiden University curriculum integrates experience-based

learning with the CanMEDS model as the organizing concept.[25] In order to teach undergraduate pharmacy students how to approach, address, and solve patient problems and to prepare them for their internships, the CDM teaching model was introduced to them in a new full-day course at the start of their Master of Pharmacy curriculum. The model with its learning guide was also integrated into internship assignments to explicitly use them in practice. In the third year of the curriculum, coinciding with students' final internship, the CDM model was also integrated into a new half-day course. In order to improve their CDM, this course aimed to instil a critical thinking mindset in them toward both themselves and their peers. With comparable learning objectives, the CDM teaching model was integrated into a half-day course into two newly developed national postgraduate pharmacy curricula at the Charlotte Jacobs Institute. These curricula comprise a two-year postgraduate program for community pharmacy residents and the two-year postgraduate program for community pharmacists with specializations in areas such as geriatrics and cardiovascular disease. The former is typically undertaken by registered pharmacists with less than three years of work experience, while the latter is designed for those with minimum of three years of experience as registered community pharmacist. Alongside workplace-based training, centralized courses are organized for all postgraduates, including the CDM course.

Course design

In both undergraduate and postgraduate courses, the model was explained using an instructional video that undergraduates and postgraduates must watch before using the model to support CDM in addressing patient cases. All course attendees had access to the CDM model along with the learning guide comprising prompting questions in a fillable PDF format. First-year master's students were given access to an additional video featuring an educator thinking aloud while working through an example case using the model, as well as an online learning program. This allowed them to engage in CDM practice before attending class. The program actively introduced process elements and used an example case to interactively apply the model. During class, first-year master's students, equipped with prior knowledge of the conditions and (non-)pharmacological treatment options associated with the cases, actively applied the model to theoretical patient scenarios. When they asked the right questions, more information was provided by the educator (serial-cue approach). The educator actively encouraged and guided students in their CDM processes, offering constructive feedback on both the content and the CDM process itself. Subsequently, the model was integrated into internship assignments, with students strongly encouraged to implement it in their practical experiences. For the half-day course, third-year master's students, community pharmacy residents, and

specialist pharmacist trainees applied the model to address patient cases during their internships or in pharmacy practice after viewing the educational video. They had not learned this model prior to these courses. They were required to make a presentation about their case following the model steps to present it to their peers. Within the classroom, they deliberated on their own patient cases, receiving peer feedback on both content and process under the supervision of experienced clinical pharmacy educators.

Survey design

To evaluate the CDM teaching model, two authors, JM and EK, developed a survey consisting of 14 items focused on the steps and general aspects of the model. Participants utilized a 4-point Likert scale, with a "don't know" option as the fifth response, to express their level of agreement or disagreement with the items. Additionally, three open-ended questions were included to gather insights into self-perceived learning outcomes (“What have you learned utilizing this model?”), self-development opportunities (“What do you want to improve in your approach to clinical problems?”), and suggestions for enhancing the model (“What are your suggestions/ comments to improve this model?”). The survey underwent testing by two final-year pharmacy students, resulting in textual adjustments for clarity. Participant characteristics, including gender, year of study, and work experience, were also collected through the survey. The survey is included in appendix B.

Survey data collection

Following approval of the study protocol by the Institutional Review Board at the University of Utrecht (UPF2215), data collection occurred during eight courses spanning from September 2022 to June 2023. Of these, one course comprised first-year master’s students, one included third-year master’s students, five included community pharmacy residents, and one included specialist pharmacist trainees. All course attendees were invited to participate voluntarily and anonymously. At the end of each course, attendees received a digital link providing more information about the research. Those who agreed to participate, using a digital informed consent form, could complete the survey on their computer or phone with an expected fill in time of five minutes. Survey data was digitally collected using Microsoft Forms and stored directly on the LUMC secured storage computer drives.

Survey data analysis

Using SPSS (version 27), the closed-ended items are presented descriptively in terms of frequencies and percentages. Utilizing Atlas.ti (version 23), the qualitative data on self-perceived learning outcomes and self-development opportunities was

thematically coded using an inductive approach. Response frequency and a quote that supports each identified theme are shown. Group analyses were conducted to identify variations in experiences among undergraduates and postgraduates with the CDM model. Despite the anonymous processing of survey data, certain responses may be associated with specific individuals due to participant characteristics' combination. Consequently, responses are presented in aggregated form.

Table 1. Study participants' characteristics

Participants' characteristics	Number of participants n=159 (%)
Group	
Undergraduates	47 (30%)
First-year students	42 (26%)
Third-year students	5 (3%)
Postgraduates	112 (70%)
Community pharmacy residents	104 (65%)
Specialized pharmacist trainees	8 (5%)
Gender	
Male	30 (19%)
Female	126 (79%)
Non-binary	1 (1%)
Prefer not to say	2 (1%)
Work experience	
None	49 (31%)
0-1 year	38 (24%)
1-2 years	52 (33%)
2-5 years	10 (6%)
>5 years	9 (6%)

Findings

Out of all 175 attendees, comprising of 45 first-year students, 5 third-year students, 113 community pharmacy residents, and 12 specialist pharmacist trainees, 159 attendees completed the survey directly following the eight courses (response rate 91%). The average time to complete the digital survey was 3.5 minutes. Table 1 shows the study participants' characteristics. Table 2 shows the survey responses per participant group. The responses are condensed by combining the response numbers of 'Strongly agree' and 'Agree' on a 5-point Likert agreement scale, for the convenience of data interpretation and presentation. Given the overlap between the self-perceived learning outcomes and self-development opportunities, Table 3 illustrates the 13 identified themes along with the aggregated supporting responses to the first two open-ended questions, along with their response frequencies. Numerous responses were associated with multiple themes, resulting in a total of 453 response codes from the 159 participants. On average, responses of these

two open-ended questions comprised 11 words. Suggestions for enhancing the model, as provided in response to the third open-ended question, are interwoven throughout the text.

Table 2. CDM model survey scores

Related CDM model's step	Survey item	No. undergraduates that responded "strongly agree" or "agree" (%) (n=47)	No. postgraduates that responded "strongly agree" or "agree" (%) (n=112)
Step 1	The model helps me see the problem in the light of the patient's healthcare need and context.	46 (97.8%)	106 (94.6%)
Step 2	The model supports me in gathering information.	44 (93.6%)	88 (78.6%)
Step 3	The model helps me form connections.	41 (87,3%)	84 (75%)
	The model helps me understand (potential) risks in the context of the patient.	42 (89.4%)	96 (85.7%)
Step 4	The model encourages me to consider all different options for the problem.	44 (93.6%)	108 (96.4%)
Step 5	The model supports me in selecting the most appropriate option in the context of the patient.	40 (85.1%)	87 (83%)
	The model helps me make clinical decisions, if necessary, in collaboration with other healthcare providers and/or the patient.	41 (87.2%)	100 (89.3%)
Step 6	The model supports my oral and written communication with others.	31 (60.3%)	65 (58%)
Step 7	The model encourages me to evaluate the patient and the outcomes of the decision.	32 (68.1%)	98 (87.5%)
Step 8	The model stimulates reflection in me.	41 (87.3%)	100 (89.3%)
General aspects	The model provides me with a clear structure for addressing clinical problems.	45 (95.7%)	109 (97.3%)
	The model helps me maintain a broad and open perspective.	37 (78.7%)	102 (91.2%)
	The model stimulates critical thinking in me.	43 (91.5%)	105 (93.8%)
	I will apply the model in practice.	41 (87.2%)	94 (83.9%)

According to the participants, the CDM model helped in approaching problems from the perspective of the patient's healthcare needs and context, which is related to the model's initial step (step 1). Emphasizing clarity on the patient's problem and healthcare needs, alongside patient-centeredness, emerged as recurring themes, often highlighted as valuable learning outcomes and self-development opportunities. Additionally, a substantial majority of participants acknowledged the model's facilitation of various cognitive processes involved in CDM. These encompassed collecting information (step 2), forming connections (step 3), contextualizing risks and benefits (step 3), exploring all available therapeutic options (step 4), selecting the most appropriate option (step 5), engaging in shared decision-making with fellow health professionals and/or the patient (step 5), and evaluating outcomes (step 7). The collection of sufficient relevant information (step 2) was the most frequently mentioned learning outcome and self-development opportunity by both under- and postgraduates. The evaluation of outcomes (step 7) was also frequently mentioned as learning outcome and self-development opportunity, mainly by postgraduates. Furthermore, while over half of the participants expressed agreement of the model's efficacy in fostering effective communication (step 6), suggestions were made to intensify patient engagement within the framework. Encouragement for reflective practice regarding the CDM process (step 8) was evident, alongside the model's role in fostering critical thinking. The latter was frequently mentioned as learning outcome by students. Participants of both groups also highlighted the model's capacity to cultivate a broad and open mindset and mentioned this frequently as learning outcome and self-development opportunity. Moreover, participants agreed to the model's provision of a structured framework for navigating clinical cases, with a structured problem approach emerging prominently as a learning outcome. Students made particular mention of this learning outcome, with male participants mentioning it twice as frequently as female participants did. Responses to other themes were evenly distributed by gender, with the exception of those pertaining to confidence. These responses were only made by female participants. Despite the widespread inclination to employ the model in practice, concerns were raised regarding the potential time constraints associated with this application. However, for postgraduates, the perceived deceleration of the CDM process through model utilization was seen as a notable learning outcome and self-development opportunity to avoid premature closure. Furthermore, some students expressed a preference for additional prompting questions within the learning guide to augment their engagement with the model. For example, to specify which literature sources to consider and when to derive information from the patient.

Table 3. Identified themes of self-perceived learning outcomes and self-development opportunities with supporting open-ended survey responses and response frequencies

Theme	Supporting survey responses	No. responses included theme (n=453) (%)
Sufficient relevant information collection	"I especially learned to look critically at all the information I already have available, what I still need to know and where I can get that information from. It also ensures that I can consult with fellow healthcare professionals with a structured and complete story." –postgraduate	100 (22.1%)
Maintain a broad perspective	"Utilizing this model prevents me from having a tunnel vision, keeping an open mind and looking beyond the healthcare question." – postgraduate	94 (20.8%)
Process deceleration to avoid premature closure	[Utilizing this model, I learned to..] "draw conclusions/make assumptions less quick. Gather more information before making a decision." – postgraduate	75 (16.6%)
Structured problem approach	[Utilizing this model, I learned to..] "master the step-by-step thinking process of clinical decision-making. This way you look at the problem in a structured way and can compare options." – undergraduate	36 (7.9%)
Outcomes evaluation	"Previously, I thought the follow-up of a case was less important, but I have now changed my mind because the follow-up is an important step in gaining experience in special/deviating situations for the future." – postgraduate	33 (7.3%)
Problem and healthcare needs clarity	"I want to have a more detailed picture of healthcare demand and take a moment to consider the actual problem." – postgraduate	28 (6.2%)
Intra- and interprofessional collaboration	"I would like to be able to delve deeper into the case studies, where sparring with other pharmacists plays an important role in gaining insights from other perspectives." – postgraduate	19 (4.2%)
Patient involvement	[Utilizing this model, I learned to..] "include the patient in all considerations." – postgraduate	17 (3.8%)
Critical thinking	"I learned how to think critically about prescription drugs and the problems (side effects, interactions, contraindications) they can cause." – undergraduate	17 (3.8%)
Patient-centeredness	"To focus more on the patient's care needs, instead of just the problem I encounter." – postgraduate	14 (3.1%)
Confidence	"I want to stand by my decision more, and not get stuck in doubt." – postgraduate	14 (3.1%)
Self-reflection	"I have learned to slow down and clarify in between, and to reflect on my own actions." – postgraduate	4 (0.9%)
Documentation	[Utilizing this model, I learned to..] "documenting a thought process step by step so that I can always justify myself" – undergraduate	2 (0.4%)

Discussion

Study findings reveal a generally positive attitude among surveyed pharmacists and pharmacy students towards the utilization of the CDM teaching model in their decision-making processes. Participants' agreement with items related to the model's eight steps and their overall positive perception suggest its efficacy in supporting their decision-making processes. The identified themes underscore the participants' growing understanding that CDM is a multifaceted competence requiring a combination of knowledge, skills, and attitude, with the acquisition of sufficient relevant information being of paramount importance. In practice, pharmacists often encounter situations where information is lacking.[16,26,27] This challenge is addressed by the model and its learning guide, which emphasizes the importance of collecting additional information through contact with patients and/or other health professionals, as well as by conducting literature and database searches before proceeding to subsequent steps. However, pharmacists must also cope with uncertainties when making decisions because clinical decisions are fraught with uncertainties, as not all of the information needed to make decisions will be available.[1] Especially assessing potential benefits and risks amidst uncertainty has been reported as challenging for pharmacists.[16,28] This aspect could be supported by targeted teaching strategies like having educators think aloud about how they conduct clinical judgment while taking into account multiple reasoned options and uncertainties, and working through problems with a high degree of ambiguity together to arrive at the most appropriate decision.[10,29,30] Besides role modelling ambiguity, educators could consider revising assessments methods that force correct answers.[30,31] These kind of strategies are included in a guide for educators, which has been created to better support educators in teaching CDM. The authors can provide the educator's guide in Dutch upon request.

Furthermore, the identified themes of self-perceived learning outcomes and self-development opportunities underscore the evolving role of patient involvement and patient-centeredness in contemporary pharmacy practices.[32] These study findings align with current trends emphasizing shared decision-making, but also that health professionals often face challenges in this process with patients and other health professionals.[16,33,34] Targeted educational activities focusing on this aspect, such as conducting medication reviews interprofessionally at a student run clinic, hold promise in enhancing health professionals' competencies in this regard.[35]

Consistent with our previous interview study,[16] not all pharmacists perceived "outcomes evaluation" (step 7) as a priority. However, the significance of implementing this step into practice is highlighted by the realization of the possible

advantages of evaluating patient outcomes, such as improving clinical experience, getting more comfortable with uncertainties, and fostering patient relationships.[30] Notably, undergraduates exhibited a relatively low agreement with the teaching model's stimulation of evaluating outcomes, likely due to their limited experience in pharmacy practice. As they progress through their education and gain exposure, it is anticipated that their perceptions in this regard may evolve.

The relatively lower agreement with "implementation" (step 6), despite participants recognizing the model's contribution to communication, highlights the multifaceted nature of the model's impact. While not specifically designed as a communication tool, participants noted its role in clarifying and articulating thoughts – a skill essential in professional practice. Prompting questions in the learning guide were modified, and teaching strategies were added to the educator's guide to further promote interprofessional communication.

Previous research suggests that gender is one of the many factors influencing CDM.[16,31,36,37] In this study, only female participants reported learning outcomes related to confidence, while more male participants found the structured approach using the model beneficial. More research is needed to fully understand the impact of gender on CDM and develop appropriate teaching strategies. Given that women constitute the majority of participants in Dutch pharmacy curricula – for instance, 82% of 50 first-year Master of Pharmacy students at Leiden University in 2023 – educators could consider implementing more strategies aimed to boost self-confidence. Besides previously mentioned strategies to improve CDM, these strategies may include simulated patient case scenarios, role-playing scenarios, and structured reflection activities.[30,31,38]

Between under- and postgraduates, survey item agreement and identified themes were mostly similar. Differences between undergraduate and postgraduate perspectives primarily revolved around efficiency. The time spent on CDM per case typically decreases with increasing clinical expertise since the procedure is internalized and cognitive processes are performed more quickly, sometimes even combining or skipping (sub)steps.[39] While undergraduates sought efficiency in decision-making, postgraduates valued the model's role in decelerating the process, facilitating thorough and effective decision-making. In contrast to the undergraduate pharmacy curriculum, the model was included in postgraduate curricula as a single, stand-alone course. Recognizing the positive survey results, there is a commitment to integrating CDM courses more comprehensively into these curricula. This shift necessitates attention to teaching the educators in undergraduate and postgraduate

pharmacy education. The developed learning guide for students holds promise in aiding these educators, in addition to the developed educator's guide that includes teaching strategies. In our opinion, this teaching model complements existing frameworks and models tailored to specific pharmacy services, such as the patient care process for delivering comprehensive medication management and self-care.[4,5,8,11,40] As integration of this teaching model grows in pharmacy education, continuous evaluation and refinement are essential to ensure its relevance and adaptability across varied clinical settings.

Limitations

A limitation of the study is that it focuses primarily on perspectives, self-perceived learning outcomes, and self-development opportunities, which may not fully capture the objective effectiveness of the teaching model in supporting decision-making processes. Future research could complement these findings by incorporating objective measures of decision-making performance to provide a more comprehensive assessment of the model's efficacy. Although participants were asked to give their opinion about the model, not the course, their opinion about the course could have influenced the results. There is a risk of social desirability bias in participants' responses, although efforts were made to minimize this risk by emphasizing voluntary participation, ensuring anonymity and confidentiality, and reassuring participants that their honest feedback was valuable for enhancing the model. Since the survey was completed online and included few open-ended questions with relatively short open answers, 3.5 minutes was a very reasonable amount of time to complete. Including questions with Likert scale responses presented in a random order would have been advantageous and feasible within the preferable timeframe of five minutes. This approach could have reduced any bias brought about by response order effects, further enhancing the results' reliability. The study also acknowledges the limitation of conducting the survey with first-year students after the course, prior to their first internship. While this approach provides insight into their initial perceptions, it does not capture their experiences during internships and how they apply the model in practice. Conversely, feedback from third-year students who did have internship experiences and who still showed a positive response adds depth to the study, although the number of students in this subgroup was small. Limited prior knowledge among pharmacy students can impact their ability to comprehend complex concepts such as clinical reasoning and decision-making. It may also affect their engagement and motivation, as they might need to invest more time and effort to grasp the material. This could result in variability in their perception of the presented material, with some students finding it more challenging than others. It's important for educators to acknowledge and

address this by providing appropriate support and guidance to enhance the learning experience for all students. Given that the number of pharmacists with more than five years of experience was also low, it would be interesting to explore in future research how the model benefits decision-making across different career stages.

Summary

Both pharmacists and pharmacy students unanimously agreed that the presented CDM model, accompanied by a learning guide and embedded in courses, supported their decision-making processes. The positive reception from both groups suggests that this teaching model offers a valuable tool for conducting clinical decision-making.

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Conflict of interest

None.

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Appendix A. CDM learning guide with an example

Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
Problem and demand for care consideration	**Identifying** problem and demand for care	What is the problem? What is the patient's care question?	An 83-year-old patient is prescribed tamsulosin, but it may be contraindicated in this patient due to liver cirrhosis
	Describing situational context	What is the situation in which the problem occurs? Consider primary or secondary care, urgency, relationship to the patient, type of prescriber	Electronic prescription received in community pharmacy Prescribed by GP
Information collection	**Reviewing** current patient's clinical data	What patient data do you need and what is missing? Consider: Patient characteristics, such as age, gender, low literacy, pregnancy. Desires, ideas, concerns, expectations. Medical data, including diagnoses, clinical picture, and treatment goals. Laboratory values, other measurement data, physical examination, genotypes relevant to pharmacogenetics. Medication use: current, history, allergies, adherence	Older patient, living alone, receiving home care Current medication use: antihypertensive drugs, cholesterol-lowering medication, vitamins and minerals Lab values (measured 1 week ago): eGFR 52 ml/min, Na 142 mmol/L, K 4.2 mmol/L No history of tamsulosin use or other related substances Missing: indication for tamsulosin? Missing: severity of liver cirrhosis / Child-Pugh score? Missing: other measurement data like blood pressure
	Gathering additional patient's clinical data	Through whom can you obtain missing patient data? Consider: the patient themselves, parents/ caregivers, informal caregivers, home care, general practitioner, specialist(s), practice nurse, colleague pharmacists (from other (hospital) pharmacies)	Gathered additional lab data through GP (measured 1 week ago): Bilirubin 22 umol/L (ref. <20.5 umol/L) Albumin 39 g/L (ref. 34-54 g/L) INR 1.1 Patient's complaints: high frequency urination (16x/day), weaker urine stream, and dripping after urination. No symptoms related to severe liver cirrhosis (ascites or encephalopathy). Patient wants to play cards with friends "without running to the toilet every 10 minutes"

Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
	Recalling knowledge	What do you already know about the problem? What experience do you have with similar situations?	Knowledge: only in moderate or severe liver cirrhosis (Child-Pugh class B or C) drug adjustments necessary because liver has high reserve and regenerative capacity Experience: unfamiliar with patients with liver cirrhosis in practice
	Investigating new information, e.g. in drug information database	What do you still not know and what background information do you need for that? Consider: (patho)physiology, course, risk factors, and drug information, including PK, PD, effectiveness, safety, applicability, costs Where can you find the scientific support for this background information? Consider: treatment guidelines, drug information databases (including risk analysis), PubMed, pharmacovigilance centre, SmPC text, TDM monographs, formularies	Tamsulosin PK: Partially metabolized in the liver and primarily excreted in the urine, with 4-9% of the dose being eliminated unchanged Drug information database (1): tamsulosin is contra-indicated in patients with severe liver cirrhosis Drug information database (2): unknown safety of tamsulosin use in liver cirrhosis patients Tamsulosin is effective in reducing LUTS, although relatively small
Clinical reasoning	**Recognising** normal from abnormal patient data, inconsistencies and information gaps	Which information is normal and abnormal? Which information is (in)consistent? What is still missing/ uncertain?	Normal: eGFR, Na, K, INR, albumin, no ascites or encephalopathy Abnormal: bilirubin, lower urinary tract symptoms Uncertain: tamsulosin effectiveness and safety in patients with liver cirrhosis
	Distinguishing relevant from irrelevant information	Which information is (ir)relevant?	Relevant to determine Child-Pugh score are bilirubin, albumin, and INR and related clinical symptoms
	Prioritising information by ranking its importance	Which information is most important?	Due to the lack of evidence on tamsulosin effectiveness and safety, PK data in combination with estimated Child-Pugh score is important
	Relating information to identify patterns of information	What connections are there? Consider: (in)effectiveness, (potential) side effects, prescribing cascades, therapy (non)adherence	Patients with high blood pressure may experience LUTS, potential ineffectiveness antihypertensive drugs or therapy nonadherence?

Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
	Matching similar information and/or identify a mismatch	What fits (not) together? Consider: under- and over-treatment, lab values with symptoms/medications, contraindication, interaction, use	Elevated bilirubin levels indicate decreased liver function, combined with other lab values and absence of clinical symptoms "just" mild decrease of liver function: Child-Pugh score A
	Inferring to form deductions that follow logically by interpreting information	What can you deduce from the available information? Consider: indications, influence PK/PD	Tamsulosin indicated for LUTS Due to potentially decreased metabolization of tamsulosin, serum concentration is increased and therefore, the risk of side effects
	Comprehending the problem in the patient's context	What is the risk for this patient in this context? And how big is this risk? Is the risk clinically relevant?	Risk of side effects is increased, such as dizziness, ejaculation disorders, headaches, hypotension and angio-oedema Unknown how big this risk is for this patient and whether this is clinically relevant
	Synthesising information to formulate definitive patient's problem	What is the problem based on your interpretation of the available information? What problem may underlie the question or the presented problem?	An 83-year-old patient with liver cirrhosis (Child-Pugh score A) and LUTS is prescribed tamsulosin, which may lead to higher risk of side effects
Clinical judgment	**Establishing** desired outcome and timeframe	What is the desired outcome for the patient? And in what timeframe?	Patients wants to decrease LUTS using a drug with acceptable side effects, as quickly as possible
	Weighing-up benefits and risks of all available (non-)therapeutic options	What are all possible (non-)medication options to address the problem? What are the pros and cons of each option? How heavily does each aspect weigh in your consideration? How do the patient's needs/wants and context influence your consideration?	Not using tamsulosin: + no risk of side effects, - care question Using tamsulosin: + potential effect LUTS, + care question, - mild effect expected, - risk of side effects, but not contra-indicated Other alfa-blocker: same as tamsulosin Non-medical strategies, such as dietary advices, physiotherapy: + no risk of side effects tamsulosin, - only indicated with mild LUTS Patient's preference to drug trial for LUTS

Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
Shared decision-making	**Selecting** most appropriate option to optimise patient outcomes in patient context, preferably with the patient and if necessary with other health professionals	What is/are the most suitable option(s) for the problem and care question in this context? What is the treatment plan, including dosage, administration form, usage advice?	In correspondence with patient, acceptable risk of side effects Two-week trial with tamsulosin 0.4mg 1 retard tablet in the morning after breakfast
	Deciding on course of action with other health professionals and/or patient	What do you decide together with the patient/ caregiver and/or with other healthcare providers? If different from your plan, what is the reason? How should the patient be monitored (which parameters, by whom, and when)?	Decision made together with patient GP informed of plan and agrees Monitoring effectiveness and safety by GP and pharmacist after 2 weeks, then 6 weeks, maximum treatment 6 months
Implementation	**Communicating** verbally and/or in writing the decision	How do you communicate the decision to/with the patient/caregiver? With whom else do you communicate? And what? What, where, and how do you document about the problem, care question, process, decision, and agreements? How do you stay informed about the (follow-up) actions and outcomes? What responsibility do you take in the follow-up?	Directly communication to patient and GP Documenting process, decision and plan in patient record Meeting scheduled with patient after 2 weeks and with GP to discuss patient
Outcomes evaluation	**Evaluating** outcomes	What are the outcomes of the decision? Is the problem solved and the care question answered?	Patient LUTS is decreased (urinary frequency lowered to 8 times with a stronger urine stream), therefore content with treatment plan: plays cards again without bathroom breaks Patient feels dizzy when getting up out of a chair (orthostatic hypotension). No further side effects noted. Recommended to slow down movements. Discussed complaints with GP and advised to review blood pressure.

Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
Reflection	**Contemplating** what has been learned, what has been done well, and what could have been done differently	What have you learned? What will you retain? What will you do differently per CanMeds competency? What do you need to achieve that? How will you evaluate it?	Felt uncertain when evidence was lacking to take the risk, but based on pharmacokinetics and closely monitoring outcomes, you can help the patient to answer his care question. Following up with the patient helps to see what the drug does in practice.

CanMeds: Canadian medical education directions for specialists, GP: general practitioner, eGFR: estimated glomerular filtration ratio, INR: international normalized ratio, K: serum potassium concentration, LUTS: lower urinary tract symptoms, Na: serum sodium concentration, PD: pharmacodynamic drug parameters, PK: pharmacokinetic drug parameters, ref: reference intervals, SmPC: summary of product characteristics, TDM: therapeutic drug monitoring

* Some of the prompting questions have been changed in response to input from study participants and other users.

** Example is based on an educational assignment by a third-year pharmacy student, not claiming to be complete or accurate.

Appendix B. CDM model survey

Translated to English

As a pharmacist, you are confronted with pharmacotherapy-related problems on a daily basis. You are required to make a clinical decision about the most suitable therapy for each individual patient. In most cases, and preferably, you make this decision in collaboration with other healthcare providers and the patient.

To support clinical decision-making of (future) pharmacists, we have developed a model with an additional guide of questions for each step in the clinical decision-making process: Problem and care demand consideration> Information collection > Clinical reasoning > Clinical judgment > Shared decision-making > Implementation > Evaluating outcomes > Reflection. *[Model is shown digitally]* This cyclical model, with the patient at the centre, can help you structure, deepen, and broaden your thought process when approaching a case for a clinical decision.

To further develop and apply this model in practice and education, we would like to hear your opinion on the model and ask some general questions. There are no right or wrong answers. All data will be processed anonymously and will not influence other results. Completing this questionnaire will take approximately 5 minutes. Thank you in advance for your participation!

Click on this button to agree to participate in this study and process your answers anonymously.

[Questionnaire begins]

I identify myself as... Male/ Female/ Non-binary/ Prefer not to say
I am... Master's Pharmacy student/ Community pharmacist resident/ Specialist pharmacist trainee

- Follow-up question for students: In which year of the Master's Pharmacy program are you? Year 1/ Year 2/ Year 3

How many years of work experience do you have in a pharmacy? 0, <1, 1-2, 2-3, 3-4, 4-5, >5

To what extent do you agree or disagree with the following items about the model for clinical decision-making by pharmacists?

5-point scale: Strongly agree/ Agree/ Disagree/ Strongly disagree/ Don't know

- The model helps me see the problem in the light of the patient's healthcare need and context.
- The model supports me in gathering information.
- The model helps me form connections.
- The model helps me understand (potential) risks in the context of the patient.
- The model encourages me to consider all different options for the problem.
- The model supports me in selecting the most appropriate option in the context of the patient.
- The model helps me make clinical decisions, if necessary, in collaboration with other healthcare providers and/or the patient.
- The model supports my oral and written communication with others.
- The model encourages me to evaluate the patient and the outcomes of the decision.
- The model stimulates reflection in me.
- The model provides me with a clear structure for addressing clinical problems.
- The model helps me maintain a broad and open perspective.
- The model stimulates critical thinking in me.
- I will apply the model in practice.

Open-ended questions:

1. What have you learned utilizing this model?
2. What do you want to improve in your approach to clinical problems?
3. What are your suggestions/ comments to improve this model?

Chapter 7

Evaluation of an interprofessional education program involving medical and pharmacy students: A mixed-method study

Josephine F. Mertens
Marleen H.M. Hessel
Thomas G.H. Kempen
Stefan Böhringer
Adriaan F. Norbart
Chris W. Walinga
Teun van Gelder

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Abstract

Background

Effective pharmacotherapy requires strong collaboration between physicians and pharmacists, highlighting the need for interprofessional education (IPE) in university curricula. This study evaluated the impact of an IPE program on medical and pharmacy students, focusing on their perceived development of interprofessional collaborative competencies, perceived learning outcomes, and clinical collaboration perceptions.

Methods

A mixed-method approach was employed to evaluate an IPE program that consisted of three mandatory activities with increased complexity and autonomy, that were integrated into the medical and pharmacy students' curricula. From September 2022 to June 2023, using a retrospective pre-post approach, students rated their competence levels after an educational activity using the Interprofessional Collaborative Competency Attainment Scale (ICCAS). The participants also answered open-ended survey questions about their learning outcomes. Medical students participated in both uniprofessional education (UPE) and IPE, while pharmacy students participated exclusively in IPE. Effect sizes for competency development were estimated, and subgroup analyses were performed to examine the impact of multiple IPE activities. Semi-structured interviews provided additional qualitative insights, which were analyzed using thematic analysis.

Results

Of the 309 surveys completed (response rate 64%, with 274 medical and 35 pharmacy students), all 21 ICCAS items showed statistically significant improvement in both UPE (n=127) and IPE (n=182) ($p < 0.05$). While effect sizes for UPE were small across all items, IPE had medium effect sizes for six items and large effect sizes for two items. Overall, students rated themselves as more capable of interprofessional collaboration after IPE, with 55% (n=124) reporting feeling 'somewhat better' and 6% (n=14) feeling 'much better,' compared to 16% (n=12) and 0%, respectively, after UPE. Competency development seems to improve slightly with an increased number of IPE activities. Pharmacy students reported somewhat higher post-activity scores than medical students did. Qualitative data from open-ended survey responses and interviews with six medical students and four pharmacy students highlighted a deeper understanding of professional roles and a greater appreciation for collaborative work through this program.

Conclusions

This IPE program focused on pharmacotherapy improved self-perceived interprofessional collaborative competencies among medical and pharmacy students. Through multiple interprofessional activities, students can develop a deeper understanding of professional roles and improve collaborative skills.

Background

Collaboration between physicians and pharmacists is important for optimizing patient care, ensuring that pharmacotherapy is appropriate, safe, effective, and tailored to each patient's specific health needs. This collaboration extends beyond dispensing medication after prescribing; it encompasses a broader range of responsibilities for both health professionals, directly contributing to improved health outcomes. By working together, physicians and pharmacists can reduce the risk of medication errors, which are a significant cause of adverse health outcomes.[1,2] To ensure that medical and pharmacy graduates are competent to collaborate effectively in practice, many accreditation bodies encourage the integration of interprofessional education (IPE) into university curricula.[3-6] IPE involves two or more health professions learning with, from, and about each other to enhance collaboration and, thereby, quality of care.[7] Growing evidence suggests that IPE enhances learners' opinions, satisfaction, and attitudes toward interprofessional collaboration (IPC).[8-10] A recent scoping review supported the positive relationship between IPE and several key quality health measures, including medical errors and mortality.[11] Specifically for medical and pharmacy students, Reumerman et al. demonstrated improved clinical outcomes through an interprofessional student-run medication review program.[12] Nevertheless, despite the promising outcomes associated with IPE, evidence supporting its superiority over uniprofessional education (UPE) remains limited.[8] This limitation is primarily due to the descriptive and noncomparative nature of related studies.[8]

Despite the reported positive outcomes and the increasing prevalence of IPE activities within healthcare student curricula, there remains room for improvement in the design of these programs to enhance learning outcomes.[8] For instance, aligning students' skills and self-awareness of professional identity can enhance learning in an interprofessional setting.[9] An effective IPE program should also incorporate problem-based learning or other interactive learning modalities, ensure mandatory participation in IPE activities, and strive to improve interaction among students from different health professions.[13] In their most recent report, the Interprofessional Education Collaborative (IPEC) emphasizes that IPE programs should be integrated into curricula and span the entire curriculum length, with activities that increase in depth and complexity, to collectively result in meaningful outcomes.[14] These and other recommendations were considered in the design and implementation of an IPE program focused on pharmacotherapy, and engaging medical and pharmacy students in collaborative learning activities. This study aimed to evaluate the impact of this IPE program on medical and pharmacy students' perceived development of

interprofessional collaborative competencies, perceived learning outcomes, and perceptions of collaboration in clinical practice.

Methods

Study design

To evaluate the impact of the IPE program focused on pharmacotherapy, a mixed-method study was conducted. Initially, data were collected using a survey, which provided a broad overview of the program's effects. To gain deeper insights into students' perceptions of IPC between physicians and pharmacists, semi-structured interviews were then carried out. Our approach was grounded in a constructivist paradigm.[15] The results are reported using the Mixed Methods Appraisal Tool (MMAT) (Appendix 1).[16]

Setting

In the Netherlands, both the medical and pharmacy curricula span six years, and are divided into a three-year bachelor's and a three-year master's curriculum. The bachelor's curricula focus on theoretical knowledge, while the master's curricula for both disciplines include multiple internships in diverse healthcare settings, interspersed with weeks of classroom-based teaching. The IPE program, involving both medical and pharmacy students, was initially designed in 2017 at the Leiden University Medical Center (LUMC) and has been gradually developed and implemented in both master's curricula at this faculty. Integrated throughout their curricula, the program covers a range of clinical areas, increasing in complexity and autonomy. This structured progression is considered relevant for allowing students to develop competencies in various clinical situations over time, providing multiple perspectives on the importance of IPC and its application in real-world settings. Table 1 outlines the three mandatory activities, detailing the estimated time and learning objectives. In the first activity, in the first year of their master's, students are tasked with developing healthcare plans for paper-based patient cases related to myocardial infarction, type 2 diabetes mellitus with hypertension, and kidney failure, using the WHO-6-step method.[17] These three cases, created through discussions with medical and pharmacy experts, are aligned with topics previously covered in their curricula. In small groups, students address one case and present their findings to the others, while actively participating in discussions about the cases presented by the other groups. For the second activity, in their second master's year, students engage in discussions on two paper-based patient cases focusing on pharmacogenetics via digital consultation. For the third activity, students conduct a medication review when

visiting a polypharmacy patient in primary practice. This activity takes place when pharmacy students are in their third master's year, and medical students are at the end of their second master's year, where they conclude their mandatory internships. They collaboratively present their healthcare plan to other students and educators from both professions. Subsequently, the healthcare plan is discussed with the patient, their general practitioner, and their community pharmacist. Due to the greater number of medical students than pharmacy students, medical students participate in the described activities both inter- and uniprofessionally, while pharmacy students participate exclusively in interprofessional activities. Despite some activities being performed uniprofessionally, all learning activities focus on IPC. In each concluding group activity, educators from both professions are present to provide content feedback and facilitate reflection on collaboration. Particularly in instances where no pharmacy student is present, educators elaborate on the pharmacy profession and the role of the pharmacist in these activities in clinical practice.

Table 1. Interprofessional education program focusing on pharmacotherapy, integrated into the medical and pharmacy master curricula

Activity	Description of learning activity	Time	Learning objectives
1	Self-preparation through e-learning with introductory assignments for both professions Informal lunch with assignments Collaborative treatment plan development for paper-based patient cases on campus Joint treatment plan presentation, followed by content discussion and reflecting on collaboration	0,5h 1h 3h 2h	• Get to know each other's curriculum and profession • Get to know each other's sources, way of thinking, and working methods • Experience how to work together on a pharmacotherapeutic treatment plan
2	Self-preparation for paper-based pharmacogenetics cases Digital consultation for discussing testing, results, and treatment plans Content discussion, followed by collaboration reflection	1h 1h 1h	• Get to know each other's sources and working methods around pharmacogenetics • Learn how to work and communicate together • Experience how to work together in an interprofessional consult
3	Preparation visit polypharmacy patient in primary care Conducting medication review Healthcare plan development Healthcare plan presentation, followed by content discussion and collaboration reflection Healthcare plan discussion with patient and healthcare providers	2h 2h 2h 3h 1h	• Get to know each other's working methods of clinical reasoning in practice • Experience how to work together in practice • Experience how to complement each other in practice

Study population

The study population consisted of medical and pharmacy students who held a bachelor's degree in medicine or pharmacy, ensuring (partial) professional identity formation. Both groups of students began the program in their first year of their three-year master's curricula. A group of no more than 25 medical students commenced the program every four weeks. Depending on their schedules and alignment with the pharmacy curriculum, they participated in the learning activity either interprofessionally with pharmacy students or uniprofessionally with only medical students. Given that the LUMC admits only 50 pharmacy students annually, the allocation of pharmacy students to activities was strategically planned to maximize opportunities for interaction with medical students. This approach resulted in eight pharmacy students joining 25 medical students to work on cases in the first IPE activity (IPE1), which occurred six times per year. Similarly, UPE1 also occurred six times per year. For the second activity, 75% of the scheduled activities involved six pharmacy students working with 25 medical students (IPE2). The remaining 25% of activities involved medical students only (UPE2). Four to six medical students from each group of 25 (approximately 20%) conducted a medication review in collaboration with a pharmacy student (IPE3), while the remaining medical students performed a medication review uniprofessionally, with the option of consulting a community pharmacist in clinical practice (UPE3). While it cannot be guaranteed, it is assumed that all medical students participate in at least one interprofessional activity with pharmacy students at some point during their curriculum.

Surveys

Over a ten-month period (September 2022 to June 2023), all participants of the three mandatory activities received the Interprofessional Collaborative Competency Attainment Scale (ICCAS), a validated 21-item self-report tool designed to assess the perceived development of interprofessional core competencies.[18] Based on the competencies reflected in the Canadian Interprofessional Health Collaborative (CIHC) framework,[19] this scale evaluates proficiency in the following competency domains: Communication, Collaboration, Roles and Responsibilities, Collaborative Patient-Centered Approach, Conflict Management, and Team Functioning. The ICCAS employs a retrospective pre-test and post-test self-assessment design, in which participants rate their competence development after the learning activity, reflecting on their levels both before and after the experience. The ICCAS underwent translation from English to Dutch using scale names familiar to the students. Four students tested the comprehensibility of the translated ICCAS, resulting in minor textual adjustments. In addition to the ICCAS, demographic data were

collected including gender, age, study type, and prior involvement in mandatory IPE Pharmacotherapy learning activities to assess the impact of this program throughout the curricula. To further evaluate learning outcomes, three open-ended questions were incorporated into the survey, prompting participants to reflect on their learning experiences, their contributions to the learning experiences of peers, and the application of acquired knowledge and insights in practice. Conducted at the end of each activity (UPE or IPE), the paper-based survey aimed to maximize response rates and facilitate accurate recollection by capturing participants' immediate feedback. The English survey is included in Appendix 2.

Survey data analysis

The demographic data were subjected to descriptive analysis. To compare the development in interprofessional competency (pre-test vs post-test) at the level of each specific item for the entire cohort of students, paired student's t-tests were conducted using SPSS version 27. A predetermined significance level of $p<0.05$ was considered statistically significant. Effect sizes were determined using Cohen's d, with values exceeding 0.8 interpreted as indicating a large effect size, values between 0.5 and 0.79 indicating a moderate effect size, and values below 0.5 indicating a small effect size. These effect size interpretations were comparable with those observed in the validation study of the revised ICCAS tool.[20] For a Cohen's d of 0.5, 33 participants is sufficient to reach a power of 80%. To compare the scores on each item across all IPE activities between medical and pharmacy students, independent samples t-tests were conducted to compare the means of two independent groups (medical and pharmacy students) regarding a continuous variable (ICCAS scores). Linear regression analysis was conducted to explore the relationship between ICCAS scores and the number of IPE activities followed, with the number of activities as the independent variable. This method can establish a linear relationship between continuous dependent variables (ICCAS scores) and a continuous independent variable (number of IPE activities), helping to quantify how the number of activities influences changes in students' perceived competencies. Sensitivity analysis was performed to assess the impact of missing data, which were assumed to be missing completely at random. To assess the internal consistency of the translated ICCAS, Cronbach's Alpha was calculated, with a value above 0.7 considered acceptable.[21] Qualitative data from open-ended questions about students' perceived learning outcomes were analyzed inductively using thematic analysis, informed by the AMEE Guide on thematic analysis of qualitative data.[22] Themes were identified through systematic (re)reading and independent parallel coding by JM and student KK. Discrepancies in code names were resolved through discussion, either between the coders or with a third researcher (MH). Themes

were constructed by JM by analyzing, combining, and comparing codes, and were then discussed with MH and TK. Atlas.ti version 22 was used to support the analysis process. The information power to evaluate perceived learning outcomes was anticipated to be achieved with the planned number of participants for the quantitative analysis.[23] Due to the absence of personally identifiable data, it was not possible to link responses across multiple surveys. As a result, the potential for clustering of responses from students taking the survey multiple times was not accounted for in the data analysis.

Interviews

To gain deeper insights into how this program involving multiple IPE activities influenced students' perceptions of IPC, semi-structured interviews were conducted with medical and pharmacy students who had participated in multiple activities. Invitations were randomly sent to students who participated in IPE activities between October 2023 and April 2024. Participants were invited by a research student after the activity to avoid influencing their participation or experience during the activity. The interviewed students did not participate in the survey study. The face-to-face interviews were conducted as soon as possible after the IPE activity in a private room on campus or via video call using *Microsoft Teams*. The interviews were conducted by research students (RV and LN) with experience in conducting interviews under the guidance of JM and MH. Based on the obtained quantitative and qualitative survey data, a semi-structured interview guide was developed (Appendix 3). This guide included questions about how multiple IPE activities influenced students' perceptions of IPC in clinical practice. After the first two interviews, the interview guide was evaluated and minor adjustments were made. The interviews were audio recorded, transcribed verbatim manually, and anonymized by the research students, with a pseudonym assigned to each participant to ensure confidentiality. Transcripts were randomly checked by JM at intervals, with each transcript reviewed twice.

Interview data analysis

The interview transcripts were analyzed inductively using thematic analysis, guided by the AMEE guide on thematic analysis of qualitative data.[22] Themes were identified through systematical (re)reading and independent parallel coding by JM and either MH or research student RV. Discrepancies in coded text passages and code names were resolved through discussion, either between the coders or with a third researcher. Themes were constructed by JM by analyzing, combining, and comparing codes, and were then discussed with MH and TK, followed by further refinement with CW, AN, and TvK. Atlas.ti version 23 was used to support the

analysis process. After identifying themes from the data, these were then categorized into four competency domains from the most recent IPEC framework: Values and Ethics, Communication, Roles and Responsibility, and Teams and Teamwork.[14] This deductive step allowed us to align the emergent themes with a widely recognized framework, facilitating comparison with the literature and providing clearer insight into how this program influenced students' perceptions in essential collaborative domains. The categorized themes are presented in a table alongside supporting responses. Sampling continued until JM and MH determined that data sufficiency to evaluate students' perceptions of interprofessional collaboration had been reached.[23] This decision ensured representation from at least two pharmacy students and two medical students immediately following IPE2, and two students from each discipline following IPE3.

Reflexivity

The research team for this study comprises two pharmacists (JM, TK), two medical doctors (CW, TvG), one biomedical scientist (MH), one biomedical data scientist (SB), and one educational specialist (AN). Working within a constructivist epistemology,[24] the team was carefully assembled to ensure a diverse range of perspectives. Each member has prior research experience and is actively engaged in health professions education. To mitigate the potential for socially desirable answers, the data was collected by research students. Specifically, survey data collection was conducted by a pharmacy research student, while interviews were conducted by a research student specializing in pharmaceutical business administration at the Utrecht University of Applied Sciences and a medical student from the LUMC, both of whom are in the Netherlands. None of the research students had direct educational relationships with the participants, encouraging them to openly share their experiences and perceptions.

Results

Survey group characteristics

During the study period, 18 educational activities were organized within the program: five for activity 1, six for activity 2, and seven for activity 3. In total, 485 students (432 medical students and 53 pharmacy students) attended these educational activities. Of these attendees, 309 students (274 medical students and 35 pharmacy students) completed the survey, resulting in a response rate of 64%. Of these surveys, 5% of the data was missing, for example, because only post-activity scores were filled in. The results of the sensitivity analysis using mean

imputation – replacing missing values with the mean value of the non-missing values of the variable – indicated that the impact of the missing data did not change conclusions in terms of statistically significant study outcomes (Appendix 4). Table 2 presents the characteristics of the surveyed students. Gender and year of birth did not differ statistically significant between medical and pharmacy students (p=0.793 and p=0.49, respectively). The majority of students were female, which is consistent with the gender distribution in both medical (≈60%) and pharmacy (≈80%) curricula in the Netherlands.[25,26] Among the 274 medical students who completed the survey, 127 completed it following a UPE activity, while 147 did so after an IPE activity. All 35 pharmacy students completed the survey following an IPE activity. In terms of participation in IPE activities within the program, 146 students experienced IPE once, 56 experienced two IPE activities, and 29 participated in three.

Table 2. Survey group characteristics

Characteristic	Medical students n=274 (%)	Pharmacy students n=35 (%)
Female	198 (72%)	27 (77%)
Year of birth		
1998 – 2001	180 (66%)	21 (60%)
Before 1998	85 (31%)	13 (37%)
No. IPE Pharmacotherapy program participated activities		
None	78 (28%)	0 (0%)
Once	134 (49%)	12 (34%)
Twice	50 (18%)	6 (17%)
Three times	12 (44%)	17 (49%)

Survey results

All 20 ICCAS items across the competency domains demonstrated statistically significant improvements with both UPE and IPE (Table 3). For the UPE ICCAS item scores, the effect sizes were small (Cohen's d values 0.06-0.39; ≤0.5: small). In contrast, the IPE ICCAS item scores showed greater variability in effect sizes (Cohen's d range 0.12-1.05; ≤0.5: small, >0.5- <0.8: medium, ≥0.8: large), with several items exhibiting medium to large effects. Specifically, medium effect sizes were noted for items 6 and 7 (Collaboration), 11 (Roles and Responsibilities), 13 and 14 (Collaborative Patient-Centered Approach), and 19 (Team Functioning). Items 8 (Collaboration) and 12 (Roles and Responsibilities) showed large effect sizes. The competency domains with solely small effect sizes were Communication and Conflict Management. Overall (21st ICCAS item), students rated themselves as more capable of interprofessional collaboration after IPE. Specifically, 55% (n=124) reported feeling 'somewhat better', and 6% (n=14) felt 'much better,' compared to 16% (n=12) and 0%, respectively, after UPE. Self-assessed competence level

differences pre- and post-activities seemed to increase with the number of IPE activities students had participated in within this program, although the difference was not statistically significant (Figure 1). While pre-activity self-ratings were generally comparable, the competence level differences between pre- and post-activities tended to be slightly smaller for medical students than for pharmacy students (Figure 2). Statistically significant differences between the two groups were observed in the following items: items 3 (0.13 vs. 0.34; $p = 0.01$) and 5 (0.21 vs. 0.44; $p = 0.02$) (Communication), items 7 (0.33 vs. 0.65; $p = 0.01$) and 8 (0.48 vs. 0.77; $p = 0.01$) (Collaboration), items 9 (0.23 vs. 0.50; $p = 0.05$), 10 (0.10 vs. 0.43; $p = 0.01$), 11 (0.49 vs. 1.00; $p < 0.01$) and 12 (0.49 vs. 0.97; $p < 0.01$) (Roles and Responsibilities), and item 20 (0.27 vs. 0.60; $p = 0.01$) (Team Functioning). Furthermore, four medical students reported lower post-activity scores on multiple ICCAS items. The translated ICCAS demonstrated high internal consistency, with Cronbach's Alpha values of 0.934 for all items following IPE activities and 0.944 for all items following UPE activities.

The open-ended survey questions resulted in eight themes on perceived learning outcomes. Table 4 presents these themes alongside supporting student responses. The learning outcome themes varied across educational activities and aligned with the learning objectives. Following all UPE activities and IPE1, students primarily reported content and skill-focused learning outcomes, whereas IPE2 learning outcomes shifted toward learning from each other's perspectives. After IPE3, students indicated an understanding of their own role, the other's role, and how to complement each other in practice. Overall, similar themes emerged in the responses of both medical and pharmacy students. Medical students frequently emphasized the patient perspective, which was complemented by pharmacy students' responses, which provided more subject-specific content that aligned with the learning outcomes reported by the medical students.

Table 3. Survey item scores pre- and post-activities conducted uniprofessionally or interprofessionally

Competency domains	Item	UPE (n=127)		Cohen's d	Effect interpretation**	IPE (n=182)		Cohen's d	Effect interpretation**
		Pre-activity mean (SD)*	Post-activity mean (SD)*			Pre-activity mean (SD)*	Post-activity mean (SD)*		
Communication	1	3.52 (0.71)	3.68 (0.80)	0.21	Small	3.62 (0.84)	3.94 (0.74)	0.41	Small
	2	3.88 (0.65)	3.98 (0.75)	0.14	Small	4.03 (0.68)	4.24 (0.62)	0.32	Small
	3	3.76 (0.71)	3.87 (0.76)	0.15	Small	3.97 (0.67)	4.10 (0.05)	0.28	Small
	4	3.57 (0.66)	3.70 (0.71)	0.19	Small	3.62 (0.77)	3.85 (0.74)	0.31	Small
	5	3.52 (0.68)	3.72 (0.71)	0.29	Small	3.69 (0.71)	3.94 (0.70)	0.36	Small
Collaboration	6	3.39 (0.79)	3.66 (0.79)	0.34	Small	3.40 (0.90)	3.87 (0.83)	0.54	Medium
	7	3.61 (0.74)	3.8 (0.70)	0.26	Small	3.62 (0.81)	4.11 (0.75)	0.63	Medium
	8	3.56 (0.80)	3.88 (0.85)	0.39	Small	3.58 (0.77)	4.24 (0.73)	0.88	Large
Roles and Responsibilities	9	3.63 (0.68)	3.8 (0.69)	0.25	Small	3.75 (0.78)	4.08 (0.68)	0.45	Small
	10	3.98 (0.69)	4.06 (0.67)	0.12	Small	4.05 (0.74)	4.23 (0.64)	0.26	Small
	11	3.72 (0.68)	3.98 (0.70)	0.38	Small	3.73 (0.75)	4.28 (0.65)	0.78	Medium
	12	3.66 (0.63)	3.94 (0.72)	0.41	Small	3.57 (0.73)	4.30 (0.66)	1.05	Large
Collaborative Patient-Centered Approach	13	3.25 (0.86)	3.59 (0.92)	0.38	Small	3.39 (0.89)	3.93 (0.83)	0.63	Medium
	14	3.28 (0.82)	3.57 (0.85)	0.35	Small	3.40 (0.84)	3.88 (0.83)	0.57	Medium
	15	3.41 (1.02)	3.57 (1.06)	0.15	Small	3.69 (1.03)	3.86 (1.03)	0.17	Small
Conflict Management	16	3.86 (0.83)	3.99 (0.83)	0.16	Small	4.09 (0.68)	4.34 (0.64)	0.39	Small
	17	3.83 (0.74)	3.99 (0.75)	0.21	Small	4.10 (0.66)	4.31 (0.67)	0.32	Small
	18	3.79 (0.786)	3.84 (0.784)	0.06	Small	4.11 (0.78)	4.20 (0.78)	0.12	Small
Team Functioning	19	3.35 (0.74)	3.59 (0.81)	0.31	Small	3.54 (0.75)	4.01 (0.76)	0.62	Medium
	20	3.30 (0.88)	3.47 (0.97)	0.18	Small	3.40 (0.83)	3.80 (0.88)	0.47	Small

UPE: Uniprofessional Education. IPE: Interprofessional Education. SD: Standard Deviation.
The thick border lines indicate the items for which the effect size interpretation differs between UPE and IPE.
* p-value for paired t-test of pre-activity vs post-activity scores <0.05 for all comparisons
** Effect interpretation: Cohen's d ≤0.5: small, >0.5-<0.8 medium, ≥0.8: large

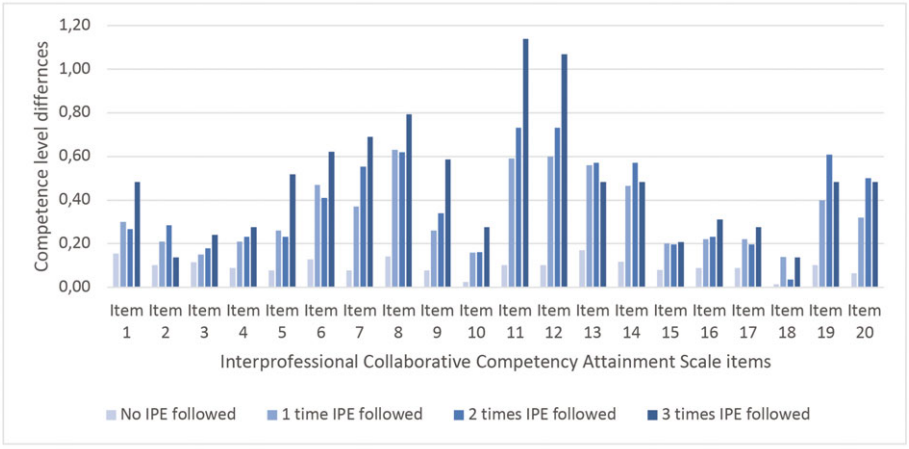

Figure 1. Differences in competence levels pre- and post-activities per number of interprofessional education activities participated

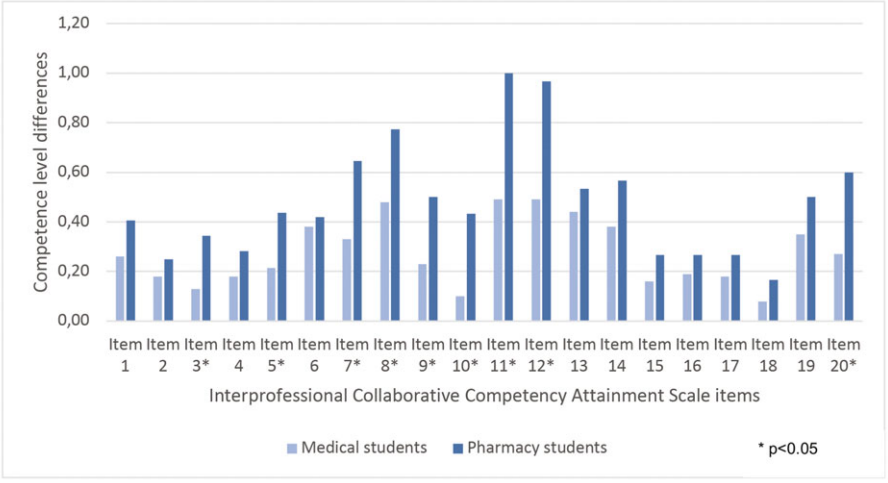

Figure 2. Survey items competence level differences pre- and post- interprofessional education activities per study type

Table 4. Themes on perceived learning outcomes with supporting survey responses

Themes	Supporting survey responses
Content	"[I learned] how certain diuretics work, that lots of drugs influence diabetes and vice versa." – medical student
Skills in approaching patient cases	"Where to find information about drugs." – medical student
Collaboration	"Interprofessional consultation is important in reaching an efficient care plan that is also better for the patient." – pharmacy student
Each other's knowledge and way of thinking	"What pharmacists/pharmacy students know/don't know and where their focus lies. How they view patients and problems." – medical student
Multiple perspectives	"I got to know the different perspective of medical students and learned to use it." – pharmacy student
Considering patient perspectives	"It's not always black and white, and patient perspectives matter"- pharmacy student
How to complement each other	"Consultation with other professionals provides new insights. By working well together, you can quickly fill gaps in knowledge." – medical student
Roles and responsibilities	"I learned about their roles and tasks, where physicians and pharmacists have shared responsibility." – medical student

Interview student characteristics

To gain deeper insights into how this program influenced students' perceptions of IPC between physicians and pharmacists, six medical students (4 female, 2 male) and four pharmacy students (3 female, 1 male) participated in interviews, each lasting approximately 30 minutes. Data sufficiency was determined after interviewing two pharmacy students and three medical students immediately following IPE2, and two pharmacy students and three medical students following IPE3.

Interview results

Thirteen themes emerged from the interview data, and were subsequently categorized into the four competency domains (Table 5).

Within the Values and Ethics domain, the interview responses revealed a growing recognition and appreciation of each profession's contribution to patient care. Although initial perceptions of hierarchy were present, students from both professions described a process of building mutual respect and trust. According to the students, the program facilitated this shift, allowing them to recognize the significance of each other's expertise and perspectives, and the value they both bring to patient care.

Considering Roles and Responsibilities, students frequently reported a growing understanding of the distinct roles and expertise that physicians and pharmacists have in patient care. Medical students valued the pharmacists' deep knowledge of medication, while pharmacy students appreciated physicians' diagnostic skills. The program's IPE activities facilitated in helping students become familiar and comfortable with collaborative work, learning when and how to effectively seek each other's expertise. This mutual recognition of specialized knowledge led to a more complementary approach, in which students reported learning to use each other's strengths to enhance patient outcomes.

Within the Communication domain, both medical and pharmacy students emphasized the importance of aligning goals and communicating effectively to integrate their different perspectives in patient care. Pharmacy students tended to focus more on medication management, while medical students adopted a broader, more holistic view of patient care. One medical student highlighted the value of listening to each other and making space for each other's expertise. Moreover, students recognized that using a common professional language is important for effective interprofessional collaboration, as it facilitates clearer communication and reduces the potential for misunderstandings.

Considering Teams and Teamwork, the responses indicated that the program encouraged reflection on both individual and team dynamics, preparing students for their future professional roles. Students gained a deeper understanding of each other's work methods and identified potential challenges in their collaboration, such as differing access to information. For instance, one student noted that physicians often lack detailed information on medication availability, making collaboration with pharmacists essential during drug shortages. Both groups recognized the importance of mutual support and shared leadership, emphasizing that increased awareness and confidence in their own roles, as well as in each other's roles, can significantly enhance teamwork and, ultimately, patient care.

Table 5. Interview responses on how this program influenced medical and pharmacy students' perceptions of interprofessional collaboration

Competency domains	Themes	Supporting interview responses
Values and Ethics	Navigating perceived hierarchy	"Maybe it sounds a bit derogatory, but it's like they have a sort of assistant role, while they have their own piece. They also just do their work in the pharmacy. They are not just there for us to call, they are not just sitting around waiting for that." – Dennis, medical student
		"I find it unpleasant to say, but I will say it anyway: the arrogance, especially the arrogance in thinking that they can solve everything on their own and that they see us as pharmacists, as being a step below them or something." – Judith, pharmacy student
	Building mutual respect and trust	"[I took away from this program] trust in the pharmacist's skills and professionalism." – Dennis, medical student
		"We were surprised on both sides about each other's knowledge and also the extent to which we could rely on each other." – Simon, pharmacy student
	Valuing each other's expertise	"[I would describe the pharmacist] as a very important player in the entire medical process of the patient. Really like a colleague we couldn't do without." – Rosalie, medical student
		"For the understanding between pharmacy students and medical students, it is a nice addition. You should continue doing it annually so that you really come to see each other's added value." – Emily, pharmacy student
	Valuing multiple perspectives	"Normally you are alone with medical students, so you are quite in a bubble. So I think it is good that you are now also learning to work more with people from other fields. It broadens your view of things." – Olivia, medical student
		"I think it is very nice, especially when you visit a patient as physician and pharmacist, so as medical student and pharmacy student, that you see that we look quite specifically at medication and the physician looks more at the patient in whole."- Simon, pharmacy student

Table 5. continued

Competency domains	Themes	Supporting interview responses
Roles and Responsibilities	Understanding each other's knowledge areas	"Whereas we only learn 'You give this medication for this disease', they know a bit deeper about the mechanism of action, the interaction with other medications, how it is metabolized, and how certain side effects occur. And, at least for me, knowledge kind of stops at some point, where they could still help us more whether to advise something or not based on those underlying processes." – Olivia, medical student
		"They are really competent and knowledgeable in terms of making a diagnosis, but not always in terms of medications." – Emily, pharmacy student
	Understanding each other's roles and responsibilities	"In terms of the stereotypical image in my head, the pharmacist focused, more in black and white, on which medications could not be taken together or on determining the dosages for each medication. And it is true to a large extent that they are very medication-oriented, but in the end they do much, much more than what I thought." – Sander, medical student
		"You can learn from each other about what you can approach each other for. [..] That you understand better how everyone plays their own role." – Emily, pharmacy student
	Utilizing each other to improve health outcomes	"What I liked was that we, as medical students, needed information that could only be obtained from a database available to pharmacy students. So, we really needed them to answer our questions, and they use entirely different sources and resources than we have access to, which means that collaboration is extremely important, also in the future." – Rosalie, medical student
		"I felt that we complemented each other, like 'but have you looked at those medicines? Maybe you have a relationship with the condition and the patient's symptoms are caused by this'. But they also told things about conditions that I knew nothing about. So it really complemented each other, which was very nice to work together." – Judith, pharmacy student

Table 5. continued

Competency domains	Themes	Supporting interview responses
Communication	Aligning goals	"What is feasible then? Say if they, for example, found better alternative medication that you also look a bit more at what is feasible if you have the whole picture of the patient. [..] So maybe look a bit broader, zoom out a bit more." – Olivia, medical student
		"The physician looks more at the patient as a whole. [..] And looks a bit more at what a patient wants. I think that is something nice for pharmacists to learn. It is not always a solution to remove or add medication if it is not necessary for that patient." – Simon, pharmacy student
	Listening to each other	"I think the most important thing is that you know where to let them have their expertise. So that you also give the other person a bit of space to give their advice, that you know that you don't always have the best, that we also have our part, but that you also give room to their expertise to make their plan and then see how you can come together with those two plans to the best plan for the patient." – Olivia, medical student
	Communicating effectively in a common language	"What I mainly learned from it is that we already speak the same language as physicians and pharmacists and that we can build on that." – Simon, pharmacy student
		"It has taught me that good collaboration and teamwork is really crucial. Because at the end you are going to decide what is best for the patient and if we do not communicate well together, nothing will come of it." – Judith, pharmacy student

Table 5. continued

Competency domains	Themes	Supporting interview responses
Teams and Teamwork	Reflecting on work methods and challenges	"What I took from it, it's good to be aware that they don't have an episode list—I think that's something I just hadn't realized. And how their approach is affected by this, so they really look closely to see if they can come up with a logical indication for everything." – Sandra, medical student
		"Physicians do not have much time for consultation. [..] So having good contact with physicians is sometimes quite a challenge." – Emily, pharmacy student
	Self-reflection	"I think, when I become a basic physician soon, that I will be aware that I can call the pharmacist and that I don't always have to ask my supervisor for everything. But I'm not sure if I can do that for every medication question... it's always about asking for help, you know... But I think it could give me a lot of peace if I did it more, and I'm gradually realizing that more and more." – Sander, medical student
		"I am worth the same. I have the knowledge about medication, so I can share it and ensure that patients receive the best care." – Judith, pharmacy student
	Sharing leadership	"You have to continue to work together and that we are also partly dependent on pharmacists in certain steps, that we cannot take at all, that we do not know enough about as a physician." – Rosalie, medical student
		"I think I always found it difficult to express my opinion at the beginning, but this time it was much better. So as the IPE moments progressed, I really started giving my advice more quickly and sometimes even took the lead. So, I think I have improved that leadership competency." – Emma, pharmacy student

IPE: Interprofessional Education

Discussion

This study evaluated the impact of an IPE program on the perceived development of interprofessional collaborative competencies among medical and pharmacy students in the Netherlands. The findings demonstrate that participation in this IPE program significantly enhanced students' self-assessed competencies across various domains, i.e., in Collaboration, Roles and Responsibilities, a Collaborative Patient-Centered Approach, and Team Functioning. These findings align with the program's learning objectives and the broader goals of IPE, which aim to break down professional silos and promote a more integrated approach to patient care.[27]

UPE activities, such as e-learning modules focused on the other profession and instruction from educators from both professions, were found to be valuable. Although the effect sizes were small, the improvements across all the ICCAS items following UPE highlights the effectiveness of this program in enhancing interprofessional collaborative competencies among medical students. However, the larger effect sizes observed with IPE activities indicate that direct collaboration with peers from different professions adds substantial value in preparing students for collaborative clinical practice. This finding is consistent with previous studies that emphasize the superiority of IPE over UPE in fostering interprofessional collaboration skills.[28-30]

Despite significant improvement, the effect sizes for the competency domains of Communication and Conflict Management were smaller than those for the other domains. This could be because none of the activities were explicitly designed to practise communication techniques or address conflict resolution within interprofessional teams. Future iterations of the program will benefit from incorporating targeted interventions, such as simulation-based learning or role-playing exercises, to specifically develop these skills.[31,32]

Although self-assessed competence levels improved slightly with increased participation in IPE activities, the observed differences were minor and not statistically significant. The interview responses supported the cumulative benefits of multiple interprofessional learning activities, aligning with recommendations for integrating a variety of IPE activities throughout healthcare curricula to enhance learning outcomes.[33,34] To gain a more comprehensive understanding of how multiple IPE activities impact competence development, alternative study designs, such as multi-center, cluster-randomized longitudinal studies, would be beneficial.

Notably, pharmacy students scored themselves higher on multiple ICCAS items post-activity compared to medical students. This difference might suggest a systematic bias, as the groups had different mean scores. One possible explanation could be the disproportionate ratio of students involved in the activities; with one pharmacy student often collaborating with five or six medical students in IPE1 and IPE2, pharmacy students may gain more from these interactions, potentially leading to inflated self-assessments. It is also possible that pharmacy students have more exposure to or emphasis on the importance of IPC during their education, especially during internships, compared to medical students, as suggested by the interview findings. Therefore, pharmacy students may inherently value IPC more highly than medical students, which could influence their participation in activities and their

self-assessed competence development scores. Studies have shown that differences in attitudes toward physician-pharmacist collaboration exist, with pharmacists often demonstrating a stronger commitment to collaborative practice.[35-37] Moreover, four medical students reported lower post-activity scores on multiple ICCAS items, possibly indicating increased awareness leading to more critical self-assessment as a result of IPE activities. This phenomenon has been observed in other studies, including that of Teuwen et al.,[38] who used the ICCAS to measure self-perceived competence development among undergraduate medical and nursing students following IPE activities.

The interviews provided deeper insights into students' perceptions of IPC between pharmacists and physicians, complementing the learning outcomes identified from the surveys. While the surveys highlighted the concrete skills and knowledge gained, the interviews revealed the complexities of navigating perceived hierarchies, building mutual respect, and recognizing each profession's unique contributions. As intended, the program fostered greater self-awareness of professional identity by encouraging students to reflect on and understand both their own roles and those of their peers. This awareness was coupled with increased confidence in their respective roles, which is important for contributing effectively to IPC. Pharmacy students, in particular, described how they gained confidence in their knowledge and roles through the program, learned to express their ideas and concerns more and took greater responsibility. These insights could also help clarify, among other factors, why certain ICCAS item scores differed between pharmacy and medical students. The interview data enriched our understanding of interprofessional dynamics and highlighted areas for further development in interprofessional education, such as enhancing mutual respect and refining collaborative practices in clinical settings, as well as with other professions.

Limitations

Although this mixed-methods study provides valuable insights and addresses the shortcomings of previous research in this field, it has several limitations. The use of self-reported measures, such as the ICCAS tool, may be subject to response biases, including social desirability and recall bias. Meaningful comparisons between UPE and IPE among students from two professions are limited, as the validation of ICCAS included a diverse sample of students and practitioners from more than 19 professions.[18] Additionally, using a non-validated translation of the ICCAS and adjusting scale names to those familiar to Dutch students, may introduce measurement and cultural biases. These factors could affect the accuracy and reliability of self-assessments and the comparability of results, although competence

development was still measured on a 5-point scale. Using the ICCAS tool in this setting presented challenges in determining the extent to which multiple IPE activities contributed to competence development. Despite the relatively high response rate, non-response bias cannot be entirely ruled out. Statistically, the analysis did not account for multiple testing or potential clustering (multiple surveys per student), which might lead to an increased number of false positives. However, the high correlation among many outcomes suggested that a Bonferroni correction might be overly conservative. The effect of clustering is estimated to be limited, although its influence on the results cannot be entirely ruled out. In addition to the quantitative limitations, the qualitative component of the study also has limitations. While JM and MH determined that the information power was sufficient and the focused research question reduced the need for many interviews, the small sample may still limit the generalizability of the findings. The interview data are subject to interpretation, which could introduce researcher bias. Although randomly invited, participants who agreed to the interview may represent those with particularly strong opinions or experiences, potentially skewing the results. Overall, the generalizability of the findings may be constrained by the specific context of the program and the healthcare education system in the Netherlands.

Conclusion

This IPE program focusing on pharmacotherapy significantly improved self-perceived interprofessional collaborative competencies among medical and pharmacy students, particularly in the competency domains of Collaboration, Roles and Responsibilities, a Collaborative Patient-Centered Approach, and Team Functioning. The results suggest that repeated exposure to interprofessional learning activities, which increase in complexity and autonomy, fosters competence development. The interviews provided additional insights into students' perceptions of IPC, emphasizing the need to address hierarchical perceptions and promote mutual respect. Future iterations of this and other programs should incorporate targeted interventions to address these aspects and improve competency domains with smaller effect sizes. Future research is needed to determine whether these competencies are sustained and effectively applied in professional practice post-graduation, thereby contributing to the development of collaboratively competent physicians and pharmacists and enhancing patient care.

Abbreviations

IPE	Interprofessional Education
UPE	Uniprofessional Education
IPC	Interprofessional Collaboration
LUMC	Leiden University Medical Center
IPEC	Interprofessional Education Collaborative
ICCAS	Interprofessional Collaborative Competency Attainment Scale
CIHC	Canadian Interprofessional Health Collaborative

Declarations

Ethical approval and consent to participate

Approval for this survey study, with an amendment to conduct interviews, was granted by the Ethics Review Board of the Netherlands Association for Medical Education (case numbers 2022.4.3 resp. 2023.7.4). Prior to the survey, students were informed about the research and invited to participate by a research student at the onset of each learning activity. Interview participants received written information with the invitational e-mail from a research student prior to the interview. All participating students consented to take part in the study by signing a consent form. Survey and interview data were handled anonymously and had no impact on competency assessment or any other aspect of their education.

Consent for publication

Not applicable.

Availability of data and material

Available upon request from the corresponding author.

Competing interests

The authors declare no competing interests.

Funding

Not applicable.

Authors' contributions

JM: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing- Original Draft, Writing- Review & Editing, Visualization. MH: Conceptualization, Methodology, Investigation. TK: Investigation, Writing- Review & Editing, Visualization. SB: Formal analysis, Writing- Review & Editing. AN: Conceptualization, Methodology, Writing- Review & Editing. CW: Conceptualization, Methodology, Investigation, Writing- Review & Editing. TvG: Conceptualization, Writing- Review & Editing, Supervision, Project administration.

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Clinical Trial Number

Not applicable.

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Appendix 1. Mixed Methods Appraisal Tool (MMAT)

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	S1. Are there clear research questions?	x			
	S2. Do the collected data allow to address the research questions?	x			
1. Qualitative	1.2. Are the qualitative data collection methods adequate to address the research question?	x			
	1.3. Are the findings adequately derived from the data?	x			
	1.4. Is the interpretation of results sufficiently substantiated by data?	x			
	1.5. Is there coherence between qualitative data sources. collection. analysis and interpretation?	x			
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed?				*n.a.*
	2.2. Are the groups comparable at baseline?				
	2.3. Are there complete outcome data?				
	2.4. Are outcome assessors blinded to the intervention provided?				
	2.5 Did the participants adhere to the assigned intervention?				
3. Quantitative non-randomized	3.1. Are the participants representative of the target population?	x			
	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?	x			
	3.3. Are there complete outcome data?	x			
	3.4. Are the confounders accounted for in the design and analysis?	x			
	3.5. During the study period. is the intervention administered (or exposure occurred) as intended?	x			

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't tell	Comments
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question?	x			
	4.2. Is the sample representative of the target population?	x			
	4.3. Are the measurements appropriate?	x			
	4.4. Is the risk of nonresponse bias low?	x			
	4.5. Is the statistical analysis appropriate to answer the research question?	x			
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?	x			
	5.2. Are the different components of the study effectively integrated to answer the research question?	x			
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	x			
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	x			
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	x			

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Appendix 2. Survey

Translated to English

Thank you for participating in our study on the impact of interprofessional and uniprofessional pharmacotherapy education. We are interested in the development of competencies when pharmacy and medical students engage in this education together (interprofessional education - IPE) compared to education with only medical students (uniprofessional education - UPE). We are also interested in the effect of participating in multiple joint educational sessions throughout the master's programs (longitudinal program). The completed questionnaires will be fully anonymized and take approximately 10 minutes to fill out.

I identify as … (circle one)	Male/Female/Non-binary/Prefer not to say
My birth year is … (fill in)	
I am studying … (circle one)	Medicine/Pharmacy

Which UPE or IPE session have you attended. **including the current session**?

Year 1– Lunch together and discuss cases of atrial fibrillation, Type 2 diabetes mellitus with hypertension, and kidney failure. (circle one)	IPE/ UPE/ not attended
Year 2– Pharmacogenetic patient cases with online interprofessional consultation (circle one)	IPE/ UPE/ not attended
Year 3– Medication review (circle one)	IPE/ UPE/ not attended
Did you visit the patient during IPE3 (circle one)	Yes/ No/ Not applicable

There are 20 statements across 6 competency domains. Please use the scale below to rate your skills before and after attending the IPE or UPE educational session. Your responses to these questions will not affect your final grade or the completion of this course. There are no right or wrong answers. So please be as honest as possible. The statements address general competencies. so even if you completed all the educational sessions alone. You can still evaluate yourself on the statements asked.

1 = Poor	2 = Fair	3 = Sufficient	4 = More than sufficient	5 = Good

Statements	Before participating in the IPE/UPE activity					After participating in the IPE/UPE activity				
Communication	**Before**					**After**				
	P	**F**	**S**	**M**	**G**	**P**	**F**	**S**	**M**	**G**
I promote effective communication among the different students in a team.	1	2	3	4	5	1	2	3	4	5
I actively listen to the problems and concerns of other students.	1	2	3	4	5	1	2	3	4	5
I express my ideas and concerns without being judgmental towards others.	1	2	3	4	5	1	2	3	4	5
I provide constructive feedback to other students.	1	2	3	4	5	1	2	3	4	5
I express my ideas and concerns clearly and concisely.	1	2	3	4	5	1	2	3	4	5
Collaboration	**Before**					**After**				
	P	**F**	**S**	**M**	**G**	**P**	**F**	**S**	**M**	**G**
I seek out other students to address problems.	1	2	3	4	5	1	2	3	4	5
I work effectively with other students to improve care.	1	2	3	4	5	1	2	3	4	5
I learn with, from, and about other students to improve care.	1	2	3	4	5	1	2	3	4	5
Roles and Responsibilities	**Before**					**After**				
	P	**F**	**S**	**M**	**G**	**P**	**F**	**S**	**M**	**G**
I can identify and describe my capabilities that contribute to a team.	1	2	3	4	5	1	2	3	4	5
I take responsibility for my contribution to a team.	1	2	3	4	5	1	2	3	4	5
I understand the capabilities and contributions of other students in a team.	1	2	3	4	5	1	2	3	4	5
I recognize how the skills and knowledge of others complement or overlap with my own skills and knowledge.	1	2	3	4	5	1	2	3	4	5
Collaborative Patient-Centered Approach	**Before**					**After**				
	P	**F**	**S**	**M**	**G**	**P**	**F**	**S**	**M**	**G**
I use a team approach to get a comprehensive picture of the patient's health situation.	1	2	3	4	5	1	2	3	4	5

1 = Poor	2 = Fair	3 = Sufficient	4 = More than sufficient	5 = Good

Statements	Before participating in the IPE/UPE activity					After participating in the IPE/UPE activity				
I use a team approach to meet the care needs of the patient.	1	2	3	4	5	1	2	3	4	5
I involve the patient/family in decision-making.	1	2	3	4	5	1	2	3	4	5
Conflict Management	**Before**					**After**				
	P	**F**	**S**	**M**	**G**	**P**	**F**	**S**	**M**	**G**
I actively listen to the perspectives of other students.	1	2	3	4	5	1	2	3	4	5
I consider the ideas of other students.	1	2	3	4	5	1	2	3	4	5
I address team conflicts in a respectful manner.	1	2	3	4	5	1	2	3	4	5
Team Functioning	**Before**					**After**				
	P	**F**	**S**	**M**	**G**	**P**	**F**	**S**	**M**	**G**
I develop an effective care plan in a team.	1	2	3	4	5	1	2	3	4	5
I negotiate responsibilities within overlapping work areas in a team.	1	2	3	4	5	1	2	3	4	5
Overall										
Compared to the time before the current learning activity, how do you rate your ability to collaborate interprofessionally?	Much worse now ❑									
	Somewhat worse now ❑									
	About the same ❑									
	Somewhat better now ❑									
	Much better now ❑									

Below are 3 open-ended questions (fill in):

What have you learned from the other students?

What do you think you have taught the other students?

What is the most memorable thing from the educational session that you will take with you into your future as a healthcare professional?

Thank you for completing this survey!

Appendix 3. Interview guide

Translated to English

Thank you for the opportunity to interview you about the interprofessional pharmacotherapy education with medical students together with pharmacy students. The questions I would like to ask are about your experiences with this education. both the session you just had and previous interprofessional education in your master's program. As a pharmacy student. I am conducting my research project on this topic to learn more about the impact of interprofessional education on your perspective on the collaboration between doctors and pharmacists. There are no right or wrong answers. The interview will take approximately 30 minutes.

Your participation in this study is voluntary. has no impact on your academic performance. and your responses will be treated confidentially. You can stop the interview at any time or withdraw afterward. Interviews are recorded to ensure accurate transcription. The recording will be deleted after the study is completed. Do you have any questions beforehand?

Shall we begin?

1. Study and IPE activity

    a. Review consent form with participant's characteristics

2. Multiple IPE activities

    a. What do you think about having activities together with medical/pharmacy students?
    b. What did you think of these IPE activities?
        i. What did you learn? Example?
        ii. What stuck with you the most? Example?
    c. What do you think about having multiple activities together with medical/pharmacy students?
        i. Why? In what way better/worse?
        ii. How has attending multiple IPE activities influenced how you will collaborate interprofessionally?
        iii. In what area have you developed the most regarding what is needed to collaborate?
    d. Suppose there had been only one IPE activity. What difference would that have made? Follow-up: Explore both positive and negative consequences.

3. Collaboration

    a. How was the collaboration with students from the other profession during these IPE activities?
        i. Can you give an example?
        ii. How did this collaboration help you?
        iii. What was a barrier for you in this collaboration? (Apart from practical information)
        iv. Did that change with attending multiple IPE activities?
        v. What did you learn from the other student?
    b. How do you now view the collaboration between doctors and pharmacists in practice?
    c. How would you describe the other healthcare professional?
    d. What do you gain from the other healthcare professional in practice?
    e. What do you think hinders collaboration in practice?
        i. What would help the collaboration?
        ii. How has the education influenced this? And specifically. multiple IPE activities?

4. Conclusion

    Your experiences help to further improve the education. for which we are grateful. Is there anything I forgot to ask for your opinion. or would you like to add something?

Thank you very much for your time and answers to our questions. If you have any questions or comments following our conversation. please feel free to contact us. If we have any further questions. may we contact you about them?

Appendix 4 Sensitivity analysis

Post-interprofessional education (IPE)-activity self-assessed survey item score means were calculated using pairwise deletion for missing data and imputed means. The data showed minimal differences between the two methods, indicating that missing data did not significantly affect the IPE assessment results. Additional sensitivity analyses are available upon request from the author.

Competency domains	Item	IPE (pairwise deletion)			IPE (imputed means)		
		n	Pre-activity mean (SD)*	Post-activity mean (SD)*	n	Pre-activity mean (SD)*	Post-activity mean (SD)*
Communication	1	171	3.62 (0.84)	3.94 (0.74)	182	3.62 (0.82)	3.93 (0.71)
	2	172	4.03 (0.68)	4.24 (0.62)	182	4.03 (0.66)	4.23 (0.60)
	3	172	3.97 (0.67)	4.10 (0.05)	182	3.96 (0.65)	4.10 (0.64)
	4	172	3.62 (0.77)	3.85 (0.74)	182	3.62 (0.74)	3.85 (0.72)
	5	172	3.69 (0.71)	3.94 (0.70)	182	3.68 (0.69)	3.94 (0.68)
Collaboration	6	171	3.40 (0.90)	3.87 (0.83)	182	3.40 (0.87)	3.87 (0.80)
	7	171	3.62 (0.81)	4.11 (0.75)	182	3.62 (0.78)	4.10 (0.73)
	8	171	3.58 (0.77)	4.24 (0.73)	182	3.58 (0.75)	4.23 (0.71)
Roles and Responsibilities	9	169	3.75 (0.78)	4.08 (0.68)	182	3.75 (0.75)	4.07 (0.65)
	10	169	4.05 (0.74)	4.23 (0.64)	182	4.05 (0.72)	4.22 (0.61)
	11	169	3.73 (0.75)	4.28 (0.65)	182	3.72 (0.73)	4.27 (0.62)
	12	169	3.57 (0.73)	4.30 (0.66)	182	3.57 (0.70)	4.29 (0.64)
Collaborative Patient-Centered Approach	13	167	3.39 (0.89)	3.93 (0.83)	182	3.38 (0.85)	3.92 (0.79)
	14	167	3.40 (0.84)	3.88 (0.83)	182	3.40 (0.81)	3.87 (0.79)
	15	167	3.69 (1.03)	3.86 (1.03)	182	3.68 (0.99)	3.85 (0.99)
Conflict Management	16	169	4.09 (0.68)	4.34 (0.64)	182	4.09 (0.65)	4.33 (0.62)
	17	169	4.10 (0.66)	4.31 (0.67)	182	4.09 (0.64)	4.30 (0.65)
	18	169	4.11 (0.78)	4.20 (0.78)	182	4.10 (0.75)	3.54 (0.72)
Team Functioning	19	169	3.54 (0.75)	4.01 (0.76)	182	3.54 (0.72)	3.99 (0.80)
	20	169	3.40 (0.83)	3.80 (0.88)	182	3.40 (0.80)	3.80 (0.84)

* p-value for paired t-test of pre-activity vs post-activity scores <0.05 for all comparisons

Chapter 8

General discussion

General discussion

This thesis explored the concept of clinical reasoning by pharmacists—an essential competence for effective clinical decision-making (CDM)—and examined the cognitive processes and factors influencing pharmacists' CDM in patient care. Furthermore, it evaluated educational interventions designed to foster CDM and interprofessional collaboration (IPC). This chapter reflects on key findings through the lens of the model developed in this thesis, and discusses implications for future research, (post)academic education, and pharmacy practice.

Conceptualization of clinical reasoning by pharmacists

In our scoping review, pharmacists' clinical reasoning is conceptualized as an integral, context-dependent stage of CDM, involving the integration and application of knowledge and clinical experience to interpret data (Chapter 2).[1] Building on this conceptualization and other literature, we developed a pharmacy-specific model to explicitly support CDM among pharmacists and pharmacy students (Figure 1). Using semi-structured interviews with Dutch pharmacists, we adapted this theoretical model (Chapter 3).[2] Our structured and comprehensive model addresses a gap in existing models, many of which lack the transferability needed for effective application in pharmacy.[3] The cyclical model outlines eight steps in the CDM process: problem and healthcare need consideration, information collection, clinical reasoning, clinical judgment, shared decision-making, implementation, outcomes evaluation, and reflection. The iterative and non-linear nature of CDM, also observed in our semi-structured interviews with pharmacists (Chapter 3),[2] highlights how practitioners often move back and forth between steps. While this fluidity reflects real-world practice, a stepwise model provides structure, acting as a cognitive forcing strategy to guide thought processes—particularly for students and novice practitioners.[4] Clinical reasoning becomes most prominent after collecting information, which is why the third step of the model is specifically designated as the *clinical reasoning* step. To ensure applicability across diverse scenarios and settings, the model intentionally uses the term *clinical reasoning* rather than limiting it to diagnostic or therapeutic reasoning. Although, distinguishing between *diagnostic reasoning* (identifying or ruling out conditions, such as in self-care scenarios and potential adverse drug reactions) and *therapeutic reasoning* (assessing therapy appropriateness and planning treatment) could enhance conceptual clarity.

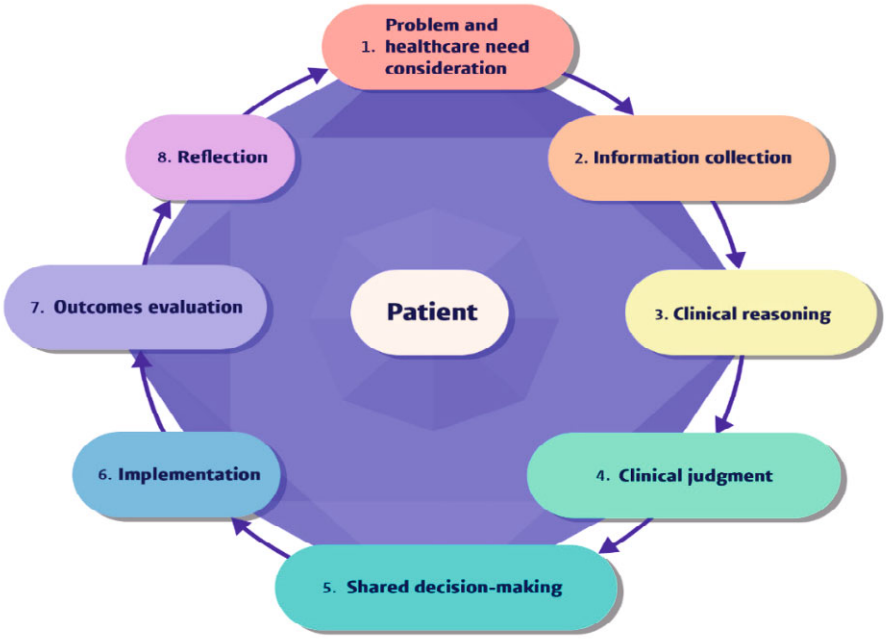

Figure 1. Designed model to support clinical decision-making among pharmacists and pharmacy students

While our conceptualization effectively incorporates the internal cognitive processes of reasoning, the model aligns with evolving perspectives that highlight the influence of social and contextual elements on clinical reasoning and its emergence as a shared, interprofessional activity.[5-7] These perspectives are reflected in model steps such as shared decision-making, where pharmacists collaborate with patients and other healthcare professionals to achieve optimal treatment outcomes. This collaboration requires pharmacists to articulate their reasoning effectively while considering the clinical perspectives of other team members. This broader perspective emphasizes how the process is shaped not only by individual expertise but also by team dynamics, patient preferences, and the healthcare environment.[5] It underscores the importance of fostering reasoning approaches that are both profession-specific and adaptable to team-based contexts. The distinction between diagnostic and therapeutic reasoning can further support this adaptability, as they clarify the pharmacist's role in both identifying potential conditions and optimizing treatment plans.

The constructivist paradigm guided the conceptualization of clinical reasoning and the development of the CDM model, recognizing that knowledge and understanding of reasoning are co-constructed through interactions between researchers and participants. Complementing this, post-positivist orientation emphasized integrating theory with empirical evidence to strengthen the model's rigor and applicability,

while acknowledging that alternative models may emerge based on different contexts and perspectives.

Reasoning approaches: intuitive and analytical processes

Based on our scoping review, pharmacists employ both intuitive and analytical reasoning processes, either separately or as part of dual processing, depending on the clinical scenario (Chapter 2).[1] Intuitive reasoning, often referred to as System 1 thinking, relies on pattern recognition and is commonly applied in routine or familiar scenarios. Analytical reasoning, or System 2 thinking, involves generating and testing hypotheses and is predominantly used in complex cases, such as when conducting clinical medication reviews.[8-10] A recent narrative review describes how prescribers use pattern recognition via therapy scripts to make an initial therapeutic decision.[11] This automatic response may then be evaluated by metacognitive processes, and when deemed incorrect or incomplete, a slower, more deliberate analytical process is employed.[11] Although Dutch pharmacists are non-prescribers, our findings on dual processing suggest that a similar approach applies to their therapeutic reasoning.

While medication review studies predominantly emphasized analytical reasoning, diagnosis-forming studies in primary care showed less consistent cognitive patterns, particularly in self-care scenarios.[12-17] Other studies further illustrate the variability in pharmacists' reasoning approaches when addressing self-care scenarios.[18,19] For example, a comparative analysis of community pharmacists' reasoning in Malta and the Philippines identified analytical approaches, such as if/then reasoning and forward-chaining, with variations depending on whether patients sought specific medicines or advice during minor ailments.[18] Similarly, a study on allergic rhinitis self-care advice in Dutch community pharmacies showed that using the WWHAM mnemonic (Who is it for?; What are the symptoms?; How long have the symptoms been present?; Any other medication being used at the moment?; What medication has been tried already?) may be insufficient to ensure accurate advice, particularly when no follow-up questions are asked about symptoms.[19] Reliance on mnemonics was also observed in pharmacy student decision-making regarding over-the-counter medicine supply.[20] While mnemonics can offer a structured approach, they are often insufficient for ensuring the depth of reasoning required for accurate diagnosis and appropriate advice. While patient satisfaction with self-care advice provided by pharmacies is generally high, concerns persist in literature regarding reasoning accuracy for forming diagnosis and providing appropriate advice.[12,15,16,21] These gaps underscore the need for improved educational strategies for pharmacists, pharmacy students, and technicians, also considering the growing trend toward prescribing roles for pharmacists.[22,23] Educational frameworks must focus on

applying mnemonics in combination with deeper reasoning skills that integrate both intuitive and analytical processes. Our adaptable reasoning framework, alongside the context-specific framework developed by Rutter and Harrison,[24] offer valuable tools to guide and enhance education and practice in this diagnosis-forming context.

At the time of our scoping review, no studies focused specifically on pharmacy students' clinical reasoning processes. Recent studies, however, show parallels between the reasoning approaches of students and practicing pharmacists in therapeutic contexts.[25,26] For example, one study found that analytical reasoning dominated among pharmacy students in the context of acute care conditions,[26] while another observed a mix of analytical and intuitive cognitive approaches in antibiotic stewardship cases, with analytical approaches leading to better performance and decisiveness.[25] As educators, we observe significant variation in students' reasoning approaches. While some demonstrate strong analytical reasoning—sometimes even surpassing that of practicing pharmacists—others struggle with a structured approach. Additionally, metacognitive skills are not always fully developed. This suggests that further emphasis on both structured decision-making and self-regulated learning is needed to enhance students' ability to regulate and refine their reasoning processes.

Our model, combined with the learning guide, encourages both analytical and intuitive reasoning processes, reflecting the dynamic nature of clinical reasoning. To ensure comprehensibility and practical application, reasoning approaches are not explicitly included in the model itself. Instead, the learning guide supports the integration of both approaches, enabling pharmacists and pharmacy students to adapt their reasoning to the demands of different clinical situations.

Cognitive processes involved in CDM

Through 16 semi-structured interviews with pharmacists from community, outpatient, and hospital settings, 21 cognitive processes involved in pharmacists' CDM were identified (Chapter 3).[2] These findings informed the adaptation of the theoretical model and the development of a learning guide, organizing these processes into eight steps. Consistent with our constructivist and post-positivist paradigms, we acknowledge that participants' perspectives and the researchers' interpretations played a central role in identifying these cognitive processes. Also, participants often found it difficult to articulate the cognitive processes involved in clinical reasoning, complicating their identification. Furthermore, the lack of standardization in cognitive process terminology highlights the context-dependent and interpretative nature of this research, with terminology potentially varying across studies and frameworks.

Pharmacists in our interview study consistently emphasized the importance of identifying the patient's problem and collecting relevant information, which involved cognitive processes such as reviewing, gathering, recalling, and investigating.[2] Clinical reasoning stood out as particularly challenging, with pharmacists struggling to contextualize problems within the patient's unique circumstances. Given that difficulties in finding and using information from clinical guidelines contribute to medication errors,[27] some of which associated with substantial patient harm, these skills require focused educational attention. Notably, limited attention was given to evaluating patient outcomes after implementing decisions and reflecting on these outcomes–key steps for refining CDM. Unlike physicians, pharmacists rarely conduct follow-up consultations to assess the impact of their decisions. As a result, they often lack direct feedback on key clinical outcomes, such as potassium level changes when initiating a potassium-sparing diuretic or blood pressure responses to therapy modifications. This limited outcome feedback may contribute to a more cautious and conservative decision-making approach. Hospital pharmacists, who have access to patient records, often track laboratory parameters after providing consults, such as monitoring drug levels, kidney function, or liver enzymes. However, direct follow-up with prescribers or patients to gather additional contextual information remains uncommon. Recognizing the value of these follow-up consultations and integrating them systematically into practice could enhance pharmacists' CDM by creating essential feedback loops to refine their illness and therapy scripts.

The importance of information collection and the challenges in clinical reasoning were also highlighted in a study analysing students' cognitive and metacognitive processes in therapeutic reasoning.[26] In this study, the majority of students' efforts (69%) focused on gathering information, while much less attention was given to processing (13%), making assessments (7%), synthesizing information (1%), and formulating recommendations (4%).[26] The iterative nature of information gathering observed in our study mirrors these findings, where pharmacists frequently moved back and forth between steps.[2,26] While thorough information collection is crucial for informed decision-making, excessive data gathering can be inefficient, particularly in time-sensitive clinical settings. Pharmacists must develop the ability to recognize when sufficient information has been collected to make a well-reasoned decision, balancing thoroughness with efficiency. Inefficient reasoning processes, such as collecting unnecessary details or failing to synthesize information in a timely manner, can delay decision-making and reduce clinical effectiveness. Conversely, premature closure–reaching a decision too quickly without adequate consideration–poses risks to patient safety. Students in the referenced study employed metacognitive processes such as double-checking and planning next

steps to regulate their reasoning.[26] These strategies, as emphasized in other studies, are critical for developing therapy scripts and effective CDM.[11,28,29] Pharmacists in our study also engaged in metacognitive processes,[2] though less explicitly than students, suggesting that self-regulated learning should be more deliberately fostered throughout training. Our model incorporates reflection as a distinct step to promote deeper learning and continuous improvement. Moreover, fostering active monitoring and planning throughout the entire process is important to help pharmacists refine their CDM while ensuring efficiency in clinical practice.

Challenges in synthesizing information and premature closure were observed in both our interviews (Chapter 3) and educational activities (Chapter 6).[2,30] These findings resonate with other reasoning studies amongst pharmacists and pharmacy students.[13,26,31] Cognitive biases present an additional layer of complexity in clinical reasoning.[32] Over 100 potential biases can affect clinical reasoning, with common examples in pharmacy practice including premature closure, availability bias (focusing on conditions or drug-related problems seen most frequently), and confirmation bias (focusing on data that supports a leading hypothesis while disregarding contradictory information).[33] Although cognitive biases were not explicitly mentioned in our interviews, their impact is evident in broader healthcare literature and research, such as studies highlighting biases when working with patients from low socioeconomic backgrounds.[34] This area remains largely unexplored in pharmacy research, warranting further investigation. Our model, particularly the steps of clinical reasoning and reflection, provides a foundation for addressing these biases. Educational interventions should incorporate strategies to help pharmacists and students recognize reasoning errors and apply debiasing techniques. Literature recommends both generic and context-specific approaches, such as becoming familiar with common reasoning pitfalls and tailoring debiasing strategies to specific clinical scenarios.[35,36] Moreover, involving patients, families, and caregivers in shared decision-making aligns with the model's emphasis on collaboration and can mitigate biases.[35] Encouraging patients to voice concerns and recognize potential errors fosters a collaborative approach to improving clinical decision quality, particularly in situations of uncertainty.[35]

Factors influencing pharmacists' CDM

Framed within a constructivist and post-positivist paradigm, semi-structured interviews with 16 Dutch pharmacists working in primary, secondary, and tertiary care settings revealed several interrelated factors influencing their engagement with the steps of the model (Chapter 4).[37] These factors were categorized according to the COM-B model: capability, opportunity, and motivation (Figure 2). Capability refers to

the pharmacists' knowledge, clinical experience, and skills, which directly influence their ability to navigate through the steps of the model. These foundational elements are particularly critical in the information collection, clinical reasoning, and judgement steps, as pharmacists emphasized the challenge of integrating diverse patient data into actionable decisions. Opportunity encompasses external factors such as the practice setting, data availability, intra- and interprofessional collaboration, and patient perspectives. These factors shaped pharmacists' ability to apply CDM in practice, particularly in information collection and shared decision-making steps. For example, the lack of comprehensive clinical patient data, including medical histories and lab results, particularly hindered community pharmacists from making fully informed decisions. Motivation involves internal factors—confidence, curiosity, critical thinking, and a sense of responsibility—that influence pharmacists' engagement with CDM. Ambiguity and uncertainty, in particular, affected pharmacists' confidence in decision-making. For instance, when evidence was lacking or conflicting, and the decision remained unclear, often falling "in the grey area," pharmacists experienced hesitation and sought approval from others before proceeding.

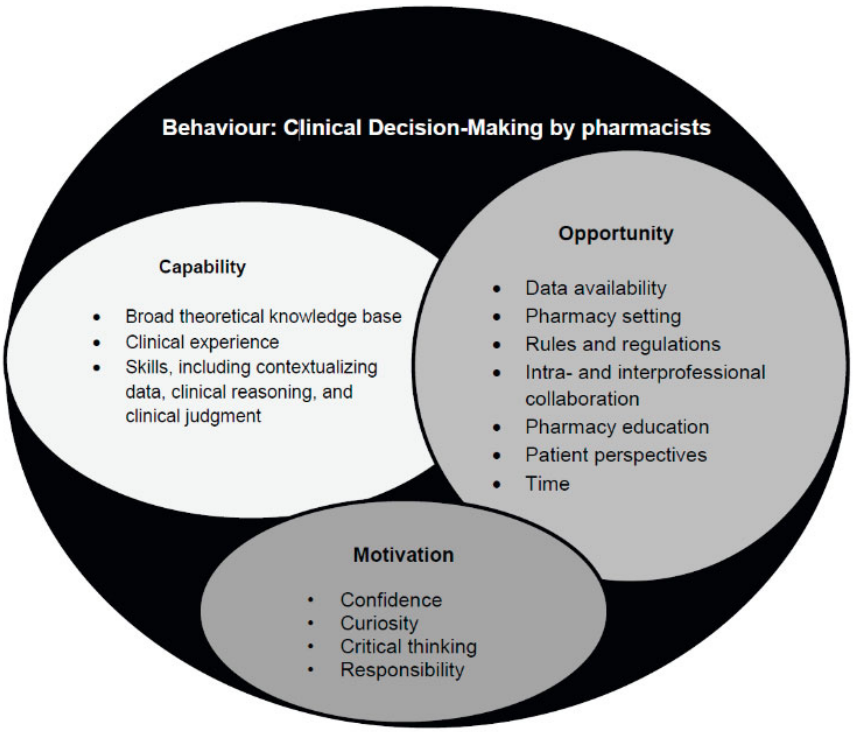

Figure 2. An overview of how the emerged themes of factors influencing clinical decision-making are categorized into the domains of the Capability-Opportunity-Motivation-Behaviour model

Insights from recent studies enrich our understanding of how specific contexts influence pharmacists' CDM. For instance, in prescribing or reviewing sleeping pills in primary care, factors such as patient perspectives, time constraints, data availability, rules and regulations, and pharmacists' self-perceived roles–such as being risk-averse–aligned with our findings.[38] In this context, moral dilemmas often arose when pharmacists had to balance adherence to guidelines with compassionate care. While it may seem compassionate to provide immediate relief through such medication, this approach might not truly help the patient in the long term and could potentially lead to further complications or dependence, reinforcing the need for a broader consideration of patient outcomes. This highlights the importance of shared decision-making in our model, as these dilemmas often require balancing immediate patient relief with long-term health goals. These findings underscore the interplay between clinical and moral reasoning in pharmacists' decision-making. Moral reasoning requires reflection on ethical principles like autonomy and beneficence, alongside professional virtues such as trustworthiness, to ensure decisions align with patient values and broader ethical considerations.[39] Addressing these dilemmas calls for structured approaches and support in developing confidence and flexibility in decision-making.[40] Furthermore, studies in the context of providing self-care advice also emphasized the significance of the information collection and clinical reasoning steps.[19,41] Challenges such as insufficient knowledge when guidelines are updated and the delegation of advice to pharmacy technicians impacted pharmacists' ability to provide accurate and personalized recommendations in self-care.[41] These findings underscore the need to strengthen the earlier steps of the model to ensure robust downstream decision-making. Additionally, the lack of reimbursement was mentioned in this study as a significant factor affecting CDM in this context.[41]

Supporting CDM among pharmacists and pharmacy students

Our research highlighted the need for structured models and educational strategies to support CDM among pharmacists and pharmacy students.[1,2,37] To address this, we developed a learning guide accompanying the model that integrates identified cognitive processes with tailored supporting questions. Additionally, we designed a teacher guide that provides educational strategies and tools for academic and clinical educators. These resources, informed by our findings, educational experiences, and insights from the literature, are presented in Dutch in Chapter 5. The English version of the learning guide, including an example case by a pharmacy student, is presented in Chapter 6.

The model and learning guide were integrated into a full-day CDM course for pharmacy students and a half-day course for pharmacists in the Netherlands, enabling them to apply diagnostic and therapeutic reasoning depending on the clinical scenario. To evaluate how the model supported their CDM, we conducted a survey study (Chapter 6).[30] Among 159 participants who completed the survey, the majority agreed that the model supported their CDM, particularly in considering the patient's healthcare needs and context (96%) and exploring all available options (96%). Pharmacy students especially appreciated the model's clear structure for guiding their thought processes. However, students initially found the material extensive and struggled to identify relevant supporting questions for specific cases, particularly during information collection. While this improved with practice, it remains a key focus requiring tailored teaching strategies. The model and learning guide have already been further integrated into the three-year master's curriculum at Leiden University. For instance, using E-modules that focus on applying the entire CDM process and specific steps in various contexts, such as cardiovascular risk management. Pharmacy students also use the model during their pharmaceutical internships to approach patient cases, discuss them with clinical educators, and engage in on-campus activities with peers and academic educators. This experiential learning progresses in complexity throughout their curriculum. To further support the implementation of CDM teaching, academic educators participated in a short training session, while clinical educators received a webinar and instructional video. The teaching and learning guide has also been shared with educators from other universities. Future plans include developing hands-on training for both academic and clinical educators across all three Dutch universities, ensuring broader adoption and sustained impact of the model. In the postacademic training for community pharmacy, residents often struggled to succinctly formulate problems and healthcare needs, which is important for interprofessional communication and patient-centred care. Educators, including the primary researcher, provide targeted support to address these challenges. Additionally, the simultaneous process of information collection and clinical reasoning sometimes hindered their ability to present their case in a structured manner, as they tended to integrate these steps intuitively. As moderators, we help residents navigate this challenge as well as encouraging them to maintain a broad perspective and decelerate decision-making to avoid premature closure–another challenge identified by the residents. This approach helps prevent tunnel vision and "jumping to conclusions", which can compromise clinical judgment. Residents report that evaluating decision outcomes through follow-up consultations is especially valuable, as it enriches their therapy scripts and enhances the patient-pharmacist relationship. However, time constraints and reimbursement issues hinders them to integrate these consults in standard practice.

In postacademic continuing education courses, the model has also been adopted for peer sessions with experienced community pharmacists. These sessions, enriched by expert input–including perspectives from physicians–were particularly valued for broadening pharmacists' perspectives and enhancing IPC. Feedback from students, pharmacists and educators continues to inform improvements to ensure the educational material remains effective. Ongoing development of content for both undergraduate and postgraduate pharmacy programs is planned.

Positioning our model to support CDM in light of other models

Various models exist to support CDM across healthcare professions, with only a limited number specifically designed for pharmacists. These models illustrate CDM in various ways, such as separating "subprocesses" or "phases" of reasoning, outlining sequences of "cognitive tasks", or providing a "schema" for CDM.[3] Despite differences in terminology, they commonly emphasize thinking processes, including analysis, synthesis, and evaluation.[3] Our model was designed as a generic and adaptable framework that integrates patient-specific information while supporting reasoning across diverse scenarios and settings. A key feature of our model is its emphasis on the cyclical nature of decision-making, where the evaluation of outcomes and reflection are distinct, yet interconnected steps that influence subsequent decisions. Appendix 1 discusses the key models that informed the development of our framework, such as the clinical reasoning cycle in nursing and the Systematic Tool to Reduce Inappropriate Prescribing (STRIP),[42,43] as well as other recently developed models. Unlike context-specific models, our approach offers a structured yet flexible guide applicable to a wide range of clinical environments. For example, Croft's framework for medication supply, though valuable, addresses a narrower context and served as one of the influences on our model's design.[8] More recent models have been developed to meet the needs of specific settings, such as the DRIP (DRug, Indication, Patient) framework, which is particularly valuable in hospital care settings,[44] or to support specific target groups, such as prescribers engaged in therapeutic reasoning.[11] While these models provide valuable, context-specific guidance, they complement rather than replace our broader approach. Some elements of these models are integrated into our framework, while others can be used alongside it to address specific needs. In addition to implicit models, explicit models–such as the STOP-START criteria for identifying inappropriate prescribing in older adults–provide targeted support for specific aspects of CDM and can complement broader frameworks like ours.[45]

Supporting IPC among pharmacy students

Incorporating interprofessional education (IPE)—activities where two or more healthcare professions learn about, from, and with each other—can help align individual reasoning processes with shared interprofessional goals, fostering better IPC between pharmacists and physicians. To this end, we developed a pharmacotherapy-focused program, integrating three mandatory activities of increasing complexity and autonomy into the curricula of medical and pharmacy students. A mixed-methods study assessed the program's impact on students' self-perceived competence, learning outcomes, and attitudes toward IPC (Chapter 7).[46] Using a retrospective pre-post approach with the Interprofessional Collaborative Competency Attainment Scale (ICCAS), we observed significant improvements across all 21 competency items, particularly in the competency domains of Collaboration, Roles and Responsibilities, a Collaborative Patient-Centred Approach, and Team Functioning. The three program activities were conducted either together (IPE) or, due to the limited number of pharmacy students, with just medical students, referred to as uniprofessional education (UPE). The results showed medium to large effect sizes for multiple competencies with IPE, emphasizing the added value of interprofessional learning compared to UPE, which yielded only small effect sizes. Pharmacy students reported slightly higher post-activity scores, likely due to their greater exposure to or emphasis on the importance of IPC during their education, especially during internships, compared to medical students. Qualitative data showed that students gained a deeper understanding of professional roles and a greater appreciation for collaborative practice. For instance, students reported an increased understanding of how their peers reason and the specific information they require to conduct clinical reasoning—such as pharmacists' lack of access to episode lists versus medical students' limited knowledge of the availability of dosage forms. Active reflection on current and ideal collaboration practices further enhanced students' ability to navigate interprofessional challenges in practice. Repeated exposure to interprofessional learning activities, increasing in complexity and autonomy, seems to foster sustained competence development.

Implementing the IPE program at Leiden University presented multiple challenges on micro-, meso- and macrolevels. At the micro level, academic teachers were often not trained to foster IPC amongst students and were sometimes not used to IPC themselves as healthcare professional. This highlights the need for Teach-the-Teacher programs. At the meso level, logistical challenges arose in coordinating IPE activities within full curricula. Differences in student numbers between pharmacy and medical programs required meticulous planning to ensure meaningful interactions. Tailoring activities to match students' varying knowledge and skill levels

across professions was also essential for balancing contributions and maximizing learning opportunities. The delivery format emerged as another important factor. While online formats offered flexibility, physical interactions appeared more effective in competence development and deepening collaboration. At the macro level, successful implementation demanded significant time and resources to manage scheduling, communication, and logistical complexities, underscoring the need for sustained institutional support for IPE programs. Embedding IPE activities as mandatory components of standard curricula ensures consistent prioritization and participation. However, achieving this requires a shared vision across institutions and disciplines, with clearly defined learning objectives that align with collaborative patient care.

Strengths and limitations

The strengths and limitations of each study are discussed in detail in their respective chapters. This thesis contributes to the growing body of knowledge on clinical reasoning by pharmacists, an underexplored area compared to professions like medicine and nursing. A key strength of this thesis is that it integrates theoretical insights from existing literature with findings from real-world practice, incorporating the perspectives of both practicing pharmacists and students. Unlike much of the existing research on clinical reasoning education, which primarily focuses on university-level teaching, this thesis broadens the scope by including participants from post-academic pharmacy education and utilizing patient cases and real-life contexts. Additionally, the research employed diverse methods, including interviews and surveys, to enhance rigor and trustworthiness. The studies were designed with a thorough understanding of the current state of pharmacy practice and education, driven by a clear ambition to improve both. The exploratory nature of the studies, guided by constructivist and post-positivism paradigms, means the interpretation of results may vary depending on researchers' perspectives.[47] The research team acknowledges that its diverse backgrounds inevitably influenced perspectives and interpretations. Enriched by interdisciplinary expertise from two universities and multiple disciplines, including pharmaceutical, medical, and educational disciplines, this collaboration strengthened the credibility of the findings. To mitigate potential biases and broaden our views, we consulted a multidisciplinary advisory panel with expertise in pharmacy, medicine, research, and education, and incorporated ongoing feedback from educators within Dutch pharmacy programs. This reflexive approach deepened our understanding of the educational and practical implications. However, certain limitations should be considered. A major challenge in researching CDM is the difficulty of directly observing the process in practice, particularly under real-world conditions where factors such as time constraints influence decision-

making. While some cognitive processes can be observed through behaviour or articulated by participants, they are also shaped by unseen and unconscious mental and contextual influences, making them difficult to capture. This thesis largely relied on self-reported data, which may not fully reflect actual cognitive processes in clinical settings. While valuable for understanding participants' perspectives, self-reported data used to evaluate educational interventions presents a limitation, as it does not provide objective measures of competency development. Furthermore, the structured nature of educational activities allows students to conduct CDM and collaborate in a controlled environment, which does not fully replicate the complexities of reasoning and IPC under real-world conditions.

Implications for research, education and practice

Fostering CDM and IPC among pharmacists requires a clear understanding of clinical reasoning and the implementation of targeted educational strategies in both under- and postgraduate pharmacy education. To address the identified gaps and enhance pharmacy education, further research is needed in the following areas:

- **The impact of cognitive biases on pharmacists' CDM:**
  Further research should examine how cognitive biases affect pharmacists' decision-making in different contexts. Identifying common biases and their influence on clinical decisions would support the development of educational interventions that enhance awareness and provide mitigation strategies.
- **Comparative analyses of reasoning processes across healthcare professions**:
  Research using think-aloud techniques could provide insights into how clinical reasoning is applied and adapted in interprofessional settings. Understanding how different professionals reason in collaborative decision-making would inform IPE strategies and strengthen pharmacists' ability to integrate their reasoning within healthcare teams.
- **Application of cognitive processes when addressing cases in practice**:
  Investigating how pharmacy students apply key cognitive processes—such as recognizing, distinguishing, prioritizing, relating, matching, inferring, comprehending, and synthesizing information—when addressing patient cases in practice would offer valuable insights into reasoning development. Findings could help refine educational strategies and ensure the learning guide effectively supports reasoning in real-world situations. Additionally, research should explore how pharmacists manage multiple, complex cases simultaneously and make decisions under pressure. Investigating how they prioritize tasks and determine where to focus their attention in such contexts will better reflect the dynamic nature of decision-making in daily practice.

- **The impact of educational strategies on CDM**:
  The effectiveness of educational strategies for fostering CDM could be better demonstrated by incorporating objective measures, such as Objective Structured Clinical Examinations (OSCEs). These measures could provide more robust evidence of how different approaches contribute to CDM development and serve as assessment tools in pharmacy curricula. However, further research is needed to determine which objective measures are most suitable for evaluating CDM.
- **Long-term impact of IPE programs on IPC in practice**:
  While our study demonstrated short-term improvements in students' IPC competencies, the extent to which IPE experiences translate into effective collaboration in professional practice remains unclear. Longitudinal studies tracking graduates into practice could provide valuable insights into how IPE influences IPC over time.

Recommendations for education and practice

Building on the findings discussed earlier in this chapter, we propose the following recommendations for (post)academic education and pharmacy practice:

1. **Explicitly teach clinical reasoning as integral to CDM**:
   Emphasize clinical reasoning as a central concept throughout the curriculum, recognizing its essential role in CDM and as a core competence for pharmacists. Promote contextual learning through authentic cases that reflect real-world practice and experiential learning, while encouraging outcome evaluation and reflection. Our model and accompanying learning guide can serve as valuable resources to support this process.
2. **Distinguish between diagnostic and therapeutic reasoning**:
   Improve learner comprehension and interprofessional communication by clearly defining the differences between these two distinct clinical reasoning contexts.
3. **Foster both intuitive and analytical reasoning, as well as metacognitive processes:**
   Support students using the cognitive processes required to navigate clinical scenarios across diverse contexts. Additionally, encourage metacognitive processes by promoting self-reflection, critical evaluation of one's reasoning–including the recognition of potential cognitive biases–and seeking constructive feedback, as individuals often struggle to accurately assess their own performance.

4. **Combine generic CDM frameworks with context-specific models and tools when applicable:**
   Build on our generic model as a foundation, incorporating context-specific frameworks and tools to enhance decision-making accuracy. For example, in self-care scenarios, frameworks like Rutter's and tools such as the WWHAM mnemonic can support more precise decision-making.
5. **Implement "Teach-the-Teachers" programs:**
   Equip academic and clinical educators with the knowledge, skills, and attitude needed to effectively teach and mentor pharmacists and students in CDM and IPC, utilizing resources such as our teaching guide.
6. **Integrate CDM and IPE programs progressively and cohesively throughout the curriculum**:
   Interrelate courses, practice, and curricula across health professions, gradually increasing the complexity of activities as students advance in their studies.
7. **Enhance collaboration between educational institutions:**
   Our research incorporated feedback from educators across Dutch pharmacy programs, valuing such collaborations in advancing educational practices. Further collaboration could involve sharing resources and expertise, including utilizing existing CDM and IPE programs or collaboratively developing new ones.
8. **Secure financial support for pharmacist consultations, including follow-up consults:**
   Ensure pharmacists have adequate resources and time to deliver comprehensive patient care while refining their CDM by evaluating decision outcomes.
9. **Promote lifelong learning in CDM:**
   Encourage pharmacists to engage in peer group sessions and interprofessional team meetings that provide feedback on clinical decisions with an open environment for sharing successes, suboptimal decisions, and failures constructively.
10. **Address hierarchical perceptions in health professions:**
    Integrate strategies into health professions curricula and practice settings to challenge hierarchical dynamics and foster more equitable, collaborative interprofessional relationships.

Conclusion

This thesis contributes to the understanding how pharmacists make clinical decisions in pharmacy practice by conceptualizing clinical reasoning, identifying the cognitive processes involved, and identifying the factors influencing this process. The findings provide valuable insights into the complexity and context-dependent nature of

clinical reasoning, highlighting the importance of tailored educational strategies that empower pharmacists to make sound decisions when providing clinical services in pharmacy practice. The evidence-informed model and accompanying learning and teaching guide presented in this thesis offer practical tools to foster CDM among pharmacists and pharmacy students. Additionally, the IPE program, with its pharmacotherapy focus and curriculum-wide activities, demonstrates promise in developing competencies essential for IPC. By fostering CDM and IPC, these contributions can enhance both pharmacy education and practice, ultimately improving patient outcomes.

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Appendix 1. Clinical decision-making models and their relation to our model

Model	Short description	Relation to our model
Key models informing our model		
WHO 6-step (De Vries et al., 1996)[48]	1. Define the patient's problem 2. Specify the therapeutic objective 3. Choose your standard treatment and verify the suitability of your treatment 4. Start treatment 5. Give information, instructions, and warnings 6. Monitor treatment	The WHO 6-step as guide to good prescribing informed our approach to structured therapeutic decision-making. However, our model extends its application beyond prescribing to include the possibility for diagnostic reasoning, shared decision-making, and reflection, making it more applicable for pharmacy practice and education.
Clinical reasoning cycle to support nursing students (Levett-Jones et al., 2010)[42]	1. Consider the patient situation 2. Collect cues/ information 3. Process information 4. Identify problems/ issues 5. Establish goal/s 6. Take action 7. Evaluate outcomes 8. Reflect on process and new learning	This cyclical process, commonly used in nursing education, informed our model by emphasizing structured reasoning steps. While there are similarities, such as focusing on evaluation and reflection, a notable difference lies in the starting point. For pharmacists, the process often begins with a (potential) problem rather than identifying it later. Additionally, the action-oriented "implementation" step in our model reflects the pharmacist's role in medication-related interventions, contrasting with hands-on care provided by nurses.
Community pharmacists' clinical reasoning in medication supply (Croft et al., 2017)[8]	1. Consider prescription in context 2. Retrieving information 3. Processing information 4. Identifying medication-related issues 5. Collaborative planning 6. Decision-making 7. Reflection	The phases in this model focus on medication supply in community pharmacy settings, based on empirical evidence. These phases with underlying cognitive processes align closely with our steps and identified cognitive processes, but our framework extends beyond this context to encompass reasoning across diverse scenarios and pharmacy settings.

Model	Short description	Relation to our model
Clinical reasoning model for pharmacy students (Tietze, 2019)[49]	1. Begin the SOAPing process Develop the patient problem list Prioritise the patient problems 2. Apply the clinical reasoning process Goals, clinical questions, assumptions and point of view Guiding patient data Relevant guidelines and current literature Factors influencing drug selection Implications and consequences 3. Complete the SOAPing process Select specific drug and nondrug regimens (drug, dose, route, interval, duration), and provide rationale(s) Create a monitoring plan (specific monitoring parameters, target outcomes and frequencies) Monitor the patient	This theoretical model, which uses the SOAPing (Subjective, Objective, Assessment, Plan) structure commonly applied by physicians, informed the development of our model. Although it also focuses on monitoring, our model provides a cyclical framework that supports reflection and learning more.
Clinical decision-making model in pharmacy practice (Wright et al., 2019)[50]	1. Information gathering 2. Clinical reasoning 3. Clinical judgment 4. Decision	Like this theoretical model, we distinguish between clinical reasoning and clinical judgment as separate steps in the clinical decision-making process. Both models place the patient at the centre, emphasizing that decisions should be guided by the patient's unique needs and context. While both models are cyclical, our model adds “outcome evaluation” and “reflection” as distinct steps for educational purposes.
Clinical reasoning cycle for self-care scenarios in the community pharmacy (Rutter and Harrison, 2020)[24]	1. Information gathering 2. Problem representation 3. Differential diagnosis 4. Continued information gathering 5. Problem refinement 6. Examination and investigation 7. Review of symptoms/ red flags 8. Management and safety netting	This model focuses on diagnostic reasoning in self-care contexts, where red flags and safety netting are key, while our model covers the entire clinical decision-making process, with a stronger focus on therapeutic management. The authors highlight ongoing information gathering for diagnosis, which is integrated into our learning guide. Our model includes "outcomes evaluation" and "reflection" steps, absent in this model and not commonly practiced, but deemed valuable for students and novice pharmacists to assess treatment effectiveness and inform future decisions.

Model	Short description	Relation to our model
Systematic Tool to Reduce Inappropriate Prescribing (STRIP) (Leendertse et al, 2020) [51]	1. Preparation: Select patients and collect relevant information. 2. Pharmacotherapeutic anamnesis: Gather and document the patient's medication history. 3. Pharmacotherapeutic analysis: Evaluate the medication regimen for appropriateness, effectiveness, and safety. 4. Collaborative treatment plan: Develop a pharmacotherapeutic treatment plan through physician-pharmacist consultation. 5. Patient consultation: Finalize the treatment plan in collaboration with the patient. 6. Follow-up and monitoring: Implement the plan and monitor for outcomes and adjustments.	STRIP provides detailed steps for addressing inappropriate prescribing, particularly in medication reviews. While many aspects, such as shared decision-making and follow-up, align closely with our model, the latter offers a broader application. Reflection is a distinct step in our model, emphasizing its educational purpose and fostering deeper learning.
Recently developed models		
Conceptual model of management reasoning (Cook et al., 2023)[52]	1. Instantiation of management script 2. Identify options, begin to teach patient 3. Shared decision-making 4. Ongoing monitoring & adjustment Overarching processes: (1) personalized to the patient, and (2) occurring between individuals	This model is based on physician-patient consultations regarding the management of an individual patient, encompassing decisions about treatment, further testing, follow-up visits, and the allocation of limited resources. While not specific to pharmacists, parallels can be drawn between its steps and underlying processes. For instance, its emphasis on interprofessional collaboration and patient preferences aligns with our model, though ours refines these concepts into actionable steps for teaching and practice.
Therapeutic reasoning model in pharmacy students (Walker et al., 2023)[26]	1. Gathering and reviewing information 2. Analysing information 3. Formulating hypothesis Overarching monitoring and controlling metacognitive processes	Based on empirical evidence, this model consists of three phases supported by cognitive processes closely aligned with those we identified. As their model is grounded in academic settings, it does not incorporate outcome evaluation or the shared decision-making with other healthcare professionals and patients. While they emphasize metacognitive processes throughout, their model lacks a distinct reflection phase.

Model	Short description	Relation to our model
Pharmacists' clinical reasoning during medication review (Guignard et al., 2024)[53]	1. Identify early cues 2. Determine the objectives of the encounter 3. Categorize for the purpose of action 4. Implement alternative strategies 5. Implement purposeful action 6. Evaluate the results Overarching processes: "Organize knowledge or clinical action" and "Regulate one's own cognitive process"	While their graphical representation explicitly integrates underlying cognitive processes during medication review–many of which align with those identified in our research–we opted to prioritize comprehensibility and practical application for pharmacy practice and education. Instead of embedding these cognitive processes directly into our model, we included them in an accompanying learning guide to facilitate effective application. This approach ensures the model remains user-friendly while addressing the cognitive processes through supplementary educational materials.
European model of therapeutic reasoning (Hartjes et al., 2024)[11]	1. Diagnosis 2. Therapy goal 3. A. Therapy script Type 1: Non-analytical Type 2a: analyzing Type 1 Type 2b: Analytical Chosen Therapy 4. Patient communication 5. Start therapy 6. Monitor therapy Metacognition at Type 2 and adapting therapy scripts	This theoretical model designed for (future) prescribers links clinical practice, therapeutic reasoning, and contextual learning. While it includes reasoning approaches assumed for prescribers—likely similar to those used by pharmacists and valuable for educational purposes—these approaches are not explicitly integrated into our model to enhance its clarity and applicability across diagnostic and therapeutic reasoning. Additionally, since pharmacists typically collaborate with prescribers in therapy selection and initiation, our model places greater emphasis on shared decision-making to reflect this interprofessional dynamic.
DRIP framework for clinical pharmaceutical reasoning (van der Sijs and Mulder, 2024)[44]	DRug, Indication, and Patient-related factors, plus stepwise approach: 1. Summarize the medication problem/question 2. Map all relevant patient and drug characteristics and consult trustworthy information sources 3. Interpret lab values and patient parameters taking into account context, history, and comedication 4. Weigh the benefits and risks of possible solutions, including implications of stopping drugs on drug-drug interactions and therapeutic drug monitoring 5. Test for feasibility on practical, financial, social, and sustainability levels 6. Discuss the options with the healthcare professional, conclude and record in the patient file 7. Follow-up and learning	The content-focused approach of the DRIP-related factors serves as a valuable tool, especially in hospital settings. Most factors included in the DRIP framework are integrated in our learning guide through supporting questions, except for toxicology and extravasation, which are specific to hospital settings. Their step-wise approach is expert-opinion based and aligns mostly with our model. The DRIP framework's steps for weighing benefits and risks and testing feasibility align closely with the clinical judgment step in our model. However, our model explicitly addresses reflection as a distinct step to emphasize this metacognitive process. It also highlights shared decision-making with patients, which is less common practice in hospital pharmacy. Additionally, we include a distinct step for implementation to point out accompanying activities and emphasize specific educational strategies, such as medicine dispensing and practicing documenting decisions in patient records.

DRIP: DRug, Indication, Patient.; SOAP: Subjective, Objective, Assessment, Plan; STRIP: Systematic Tool to Reduce Inappropriate Prescribing; WHO: World Health Organization.

Appendices

SUMMARY

Clinical reasoning is a core competence for pharmacists and forms the foundation for effective clinical decision-making (CDM)–a complex interplay of cognitive processes and skills that enable pharmacists to make patient-centered clinical decisions in the pharmacy practice. However, the conceptualization of clinical reasoning remains unclear, and its application in pharmacy practice is less studied compared to other health professions. This lack of clarity presents challenges for effectively teaching and learning clinical reasoning and CDM within pharmacy education. Furthermore, understanding and integrating the clinical reasoning approaches of professionals from other health professions, such as physicians, are important for strengthening interprofessional collaboration (IPC). Therefore, this thesis aims to enhance the understanding of clinical reasoning by pharmacists, identify the cognitive processes involved in CDM, examine influencing factors, and evaluate educational interventions designed to foster CDM and IPC.

Chapter 2 presents a scoping review that maps and examines the existing literature on pharmacists' clinical reasoning. The review identified 13 primary research studies analyzing cognitive processes in pharmacists. Findings indicate that pharmacists employ both analytical and intuitive reasoning processes, sometimes separately, but often combined as dual processing. Studies on medication reviews reported a predominance of analytical reasoning, whereas those on diagnosis formation in primary care revealed no distinct cognitive patterns, particularly in self-care scenarios. Pharmacists' clinical reasoning is conceptualized as a context-dependent cognitive process that integrates knowledge and experience to interpret clinical data. This conceptualization informed the development of a pharmacy-specific CDM model, explicitly outlining clinical reasoning as a separate step within the decision-making process.

Chapter 3 explores pharmacists' CDM through semi-structured interviews with 16 pharmacists across community, outpatient, and hospital settings. Analysis of these interviews identified 21 cognitive processes, which were structured into eight steps within the adapted CDM model: problem and healthcare need consideration, information collection, clinical reasoning, clinical judgment, shared decision-making, implementation, outcomes evaluation, and reflection. Pharmacists emphasized the importance of correctly identifying the patient's problem and collecting relevant information, often moving back and forth between steps. Clinical reasoning emerged as particularly challenging, with difficulties in contextualizing problems within the patient's circumstances. Additionally, limited attention was given to evaluating

patient outcomes and reflecting on decisions—key steps necessary for refining and improving CDM.

Chapter 4 examines the factors influencing CDM, as identified through interviews with the same 16 Dutch pharmacists. These interrelated factors were mapped using the Capability–Opportunity–Motivation–Behaviour (COM-B) model. Pharmacists' capability to make clinical decisions was shaped by their theoretical knowledge base, clinical experience, and skills. Opportunities for engaging in CDM were influenced by the practice setting, data availability, rules and regulations, intra- and interprofessional collaboration, patient perspectives, and time constraints. Motivation was driven by confidence, curiosity, critical thinking, and a sense of responsibility. These findings underscore the importance of addressing individual and systemic influences to strengthen CDM.

Chapter 5 includes the CDM model developed in this thesis, accompanied by a learning guide and educational strategies tailored for clinical and academic educators. The learning guide explicitly integrates the cognitive processes identified in our earlier study and provides structured support reasoning across diverse scenarios, settings, and training level.

Chapter 6 evaluates pharmacy students' and pharmacists' perceptions of the educational value of the model and learning guide when addressing patient cases. A survey study with 159 participants revealed that most agreed the model supported their CDM, particularly in considering the patient's healthcare needs and context, and exploring all available options. Key learning outcomes and self-development opportunities included collecting sufficient relevant information and maintaining a broad perspective. Survey item agreement and identified themes were largely consistent between undergraduate and postgraduate participants. Undergraduates particularly valued the model for providing a clear structure and fostering critical thinking, while postgraduates appreciated its role in decelerating the decision-making process to ensure thoroughness, effectiveness, and avoidance of premature closure. Postgraduates also emphasized the value of evaluating outcomes as part of the decision-making process. Feedback from continued implementation in both undergraduate and postgraduate education is helping to refine the educational resources and activities, ensuring their ongoing relevance and applicability.

Chapter 7 evaluates the impact of educational program focused on pharmacotherapy, designed to strengthen IPC as pharmacists and physicians in practice. The program included three mandatory activities of increasing complexity, embedded with both

curricula at the Leiden University Medical Center (LUMC). Due to the larger number of medical students compared to pharmacy students, medical students participated in both interprofessional (IPE) and uniprofessional (UPE) activities, while pharmacy students exclusively participated in IPE activities. A mixed-methods study evaluated the program's impact on self-perceived competence levels, learning outcomes, and attitudes toward IPC. Results from the Interprofessional Collaborative Competency Attainment Scale (ICCAS) revealed significant improvements across all 21 competency items for both UPE and IPE activities. However, while UPE demonstrated small effect sizes across all items, IPE showed medium effect sizes for six items and large effect sizes for two items. Overall, students rated themselves as more capable of IPC after IPE compared to UPE, underscoring the added value of interprofessional learning. Additionally, competence development appeared to improve with an increased number of IPE activities. Pharmacy students reported slightly higher post-activity scores than medical students, potentially reflecting greater exposure to or emphasis on IPC within their education. Both student groups highlighted learning outcomes, with medical students often focusing on the patient perspective and pharmacy students providing complementary, subject-specific content that aligned with the learning outcomes noted by medical students. Qualitative findings further demonstrated that the program fostered a deeper understanding of professional roles and enhanced appreciation for collaborative work. Future efforts will aim to expand IPE activities and train educators to better support IPC competence development.

Synthesizing the thesis findings through the CDM model, **Chapter 8** discusses the findings and highlights their implications for future research, (post)academic education, and pharmacy practice. Although the research largely relies on self-reported data, the integration of theoretical insights with practice-based findings, supported by multidisciplinary expertise, reinforces the rigor and relevance of its findings. In conclusion, this thesis enhances our understanding of pharmacists' CDM by conceptualizing clinical reasoning, identifying the cognitive processes involved, and examining the factors that influence them. The evidence-informed CDM model and learning guide provide practical tools to foster CDM in pharmacy students and pharmacists. Furthermore, the IPE program shows promise in fostering IPC competencies. Collectively, these contributions have the potential to advance pharmacy education and practice, ultimately improving patient care outcomes.

NEDERLANDSE SAMENVATTING

Klinisch redeneren is een kerncompetentie van apothekers en vormt de basis voor effectieve klinische besluitvorming (CDM)–een complex samenspel van cognitieve processen en vaardigheden waarmee apothekers patiëntgerichte klinische beslissingen kunnen nemen. Het concept van klinisch redeneren is echter onduidelijk, en de toepassing ervan is onder apothekers minder onderzocht in vergelijking met andere gezondheidsberoepen. Dit gebrek aan duidelijkheid belemmert het effectief onderwijzen en leren van klinisch redeneren in het farmacieonderwijs. Bovendien is het begrijpen en integreren van de klinisch redeneerwijzen van professionals uit andere beroepsgroepen, zoals artsen, belangrijk voor het versterken van interprofessionele samenwerking (IPC). Dit proefschrift heeft als doel het begrip van klinisch redeneren door apothekers te vergroten, de cognitieve processen binnen CDM te identificeren, de beïnvloedende factoren te onderzoeken en educatieve interventies te evalueren die gericht zijn op het bevorderen van CDM en IPC.

Hoofdstuk 2 beschrijft een scoping review die de bestaande literatuur over klinisch redeneren door apothekers in kaart brengt. De review identificeerde 13 studies die cognitieve processen bij apothekers onderzochten. De resultaten wijzen erop dat apothekers zowel analytische als intuïtieve redeneerprocessen gebruiken, soms afzonderlijk, maar vaak gecombineerd als tweeledig proces. Bij het uitvoeren van medicatiebeoordelingen werd vaker analytisch redeneren gerapporteerd, terwijl bij diagnosevorming in de eerstelijnszorg, met name bij zelfzorgscenario's, geen duidelijke redeneerpatronen werden geïdentificeerd. Het concept van klinisch redeneren wordt beschreven als een contextafhankelijk cognitief proces waarbij kennis en ervaring worden geïntegreerd om de beschikbare informatie te interpreteren. Deze conceptualisatie heeft bijgedragen aan de ontwikkeling van een CDM-model gericht op de farmacie, waarin klinisch redeneren expliciet wordt gepositioneerd als een afzonderlijke stap binnen het besluitvormingsproces.

Hoofdstuk 3 onderzoekt het besluitvormingsproces van apothekers aan de hand van semigestructureerde interviews met 16 apothekers uit de openbare, poliklinische en ziekenhuisapotheek. Analyse van deze interviews leidde tot de identificatie van 21 cognitieve processen, die werden gestructureerd in acht stappen binnen het aangepaste CDM-model: het nagaan van het probleem en de zorgvraag, informatieverzameling, klinisch redeneren, therapeutische afweging, gezamenlijke besluitvorming, implementatie, evaluatie van uitkomsten en reflectie. Apothekers benadrukten het belang van het correct identificeren van het probleem van de patiënt en het verzamelen van relevante informatie, waarbij ze vaak heen en weer

gingen tussen stappen. Klinisch redeneren bleek bijzonder uitdagend, vooral bij het contextualiseren van problemen binnen de unieke omstandigheden van de patiënt. Bovendien werd er weinig aandacht besteed aan het evalueren van patiëntuitkomsten en het reflecteren op beslissingen—cruciale stappen voor het verfijnen en verbeteren van CDM.

In **Hoofdstuk 4** worden de factoren beschreven die CDM beïnvloeden, zoals geïdentificeerd in de interviews met dezelfde 16 Nederlandse apothekers. Deze onderling verbonden factoren werden gecategoriseerd aan de hand van het Capability–Opportunity–Motivation–Behaviour (COM-B)-model. De capaciteit van apothekers om klinische beslissingen te nemen werd gevormd door hun theoretische kennis, klinische ervaring en vaardigheden. De mogelijkheden om deel te nemen aan CDM werden beïnvloed door de werkomgeving, beschikbaarheid van gegevens, wet- en regelgeving, intra- en interprofessionele samenwerking, patiëntperspectieven en tijdsdruk. Motivatie werd gedreven door zelfvertrouwen, nieuwsgierigheid, kritisch denken en verantwoordelijkheidsgevoel. Deze bevindingen benadrukken het belang van het aanpakken van zowel interne als externe invloeden om CDM te versterken.

Hoofdstuk 5 bevat het CDM-model dat in dit proefschrift is ontwikkeld, samen met een bijbehorende leergids ("het handvat") voor studenten en een handreiking met educatieve strategieën gericht op docenten en opleiders. De leergids integreert expliciet de eerder geïdentificeerde cognitieve processen en biedt gestructureerde ondersteuning voor klinisch redeneren in diverse scenario's, settings en opleidingsniveaus.

In **Hoofdstuk 6** worden de percepties van farmaciestudenten en apothekers geëvalueerd over de educatieve waarde van het model en de leergids bij het aanpakken van patiëntcasuïstiek. Uit een vragenlijstonderzoek onder 159 deelnemers bleek dat de meeste respondenten vonden dat het model hun CDM ondersteunde, met name bij het rekening houden met de zorgvraag en context van de patiënt en het verkennen van alle beschikbare opties. Belangrijke leeruitkomsten en ontwikkelingsmogelijkheden waren onder meer het verzamelen van voldoende relevante informatie en het behouden van een brede blik. De uitkomsten op de stellingen en de geïdentificeerde thema's waren grotendeels consistent tussen studenten en apothekers. Studenten waardeerden het model vooral vanwege de duidelijke structuur en het stimuleren van kritisch denken, terwijl apothekers de waarde benadrukten van het vertragen van het besluitvormingsproces om grondigheid, effectiviteit en het voorkomen van voortijdige conclusies te waarborgen. Daarnaast onderstreepten apothekers het belang van het evalueren

van uitkomsten als onderdeel van het besluitvormingsproces. Feedback vanuit de voortdurende implementatie in zowel het academisch als het postacademisch onderwijs helpt bij het verfijnen van de leergids, de handreiking voor docenten en opleiders, en de onderwijsactiviteiten, waardoor hun voortdurende relevantie en toepasbaarheid worden gewaarborgd.

Hoofdstuk 7 evalueert de impact van een onderwijsprogramma gericht op farmacotherapie, ontworpen om de uiteindelijke samenwerking als apotheker en arts te versterken. Het programma omvat drie verplichte activiteiten met toenemende complexiteit, geïntegreerd in beide curricula van het Leids Universitair Medisch Centrum (LUMC). Vanwege het grotere aantal geneeskundestudenten in vergelijking met farmaciestudenten namen geneeskundestudenten deel aan zowel interprofessionele onderwijsactiviteiten (IPE), samen met farmaciestudenten, als aan uniprofessionele onderwijsactiviteiten (UPE), zonder farmaciestudenten. Farmaciestudenten daarentegen participeerden uitsluitend in interprofessionele activiteiten samen met geneeskundestudenten. Een mixed-methods studie evalueerde de impact van het programma op zelfgerapporteerde competentieniveaus, leeruitkomsten, en attitude ten aanzien van IPC. Resultaten van de Interprofessional Collaborative Competency Attainment Scale (ICCAS) toonden significante verbeteringen in alle 21 competentie-items na zowel UPE als IPE-activiteiten. Hoewel UPE alleen kleine effectgroottes liet zien, had IPE medium effectgroottes voor zes items en grote effectgroottes voor twee items. In het algemeen beschouwden de studenten zichzelf als meer capabel in IPC na IPE activiteiten vergeleken met UPE activiteiten, wat de toegevoegde waarde van interprofessioneel leren benadrukt. Daarnaast leek de ontwikkeling van competenties toe te nemen naarmate studenten meer IPE-activiteiten volgden. Farmaciestudenten rapporteerden na de activiteiten iets hogere scores dan geneeskundestudenten, mogelijk omdat hun opleiding meer nadruk legt op interprofessionele samenwerking (IPC) of omdat zij hier tijdens hun opleiding vaker mee in aanraking komen. De leeruitkomsten waren vrijwel gelijk tussen beide studentgroepen, waarbij geneeskundestudenten vaak de nadruk legden op het patiëntperspectief en farmaciestudenten aanvullende, vakinhoudelijke inzichten boden. De interviews toonden verder aan dat het programma leidde tot een dieper begrip van professionele rollen en hogere waardering voor IPC. Toekomstige inspanningen zullen gericht zijn op het uitbreiden van IPE-activiteiten en het trainen van docenten om de ontwikkeling van competenties voor IPC te ondersteunen.

In **Hoofdstuk 8** worden de bevindingen van dit proefschrift geïntegreerd en besproken vanuit het perspectief van het CDM-model. Daarnaast worden de implicaties voor toekomstig onderzoek, (post)academisch onderwijs en de

farmaceutische praktijk belicht. Hoewel het onderzoek grotendeels afhankelijk is van zelfgerapporteerde gegevens, versterkt de integratie van theoretische inzichten met praktijkgerichte bevindingen, ondersteund door multidisciplinaire expertise, de validiteit en relevantie van de resultaten. Concluderend draagt dit proefschrift bij aan het begrip van hoe apothekers klinische beslissingen nemen door klinisch redeneren te conceptualiseren, de betrokken cognitieve processen te identificeren en de factoren te onderzoeken die dit proces beïnvloeden. Het ontwikkelde CDM-model met de leergids bieden praktische hulpmiddelen om CDM te ondersteunen bij farmaciestudenten en apothekers. Bovendien kan het ontworpen IPE-programma de ontwikkeling van IPC-competenties ondersteunen. Deze bijdragen hebben het potentieel om het farmacieonderwijs en de praktijk te verbeteren en daarmee de uitkomsten voor patiënten te optimaliseren.

CURRICULUM VITAE

Josephine Mertens-Stutterheim was born on June 29, 1986, in Voorburg, the Netherlands. As the daughter of two community pharmacists, she grew up between pills and potions, fascinated by the effects of drugs on the human body and inspired by the diverse and complex tasks performed in community pharmacies.

After completing her secondary education at Christelijk Gymnasium Sorghvliet in The Hague in 2004, Josephine pursued a bachelor's degree in Pharmaceutical Sciences at Utrecht University. Upon earning her bachelor's degree, she spent a winter season in Austria as ski instructor. In 2008, she began her master's degree in Pharmaceutical Sciences at Utrecht University. During her master's program, Josephine conducted a research internship at the pharmacy department of Amsterdam University Medical Centre (location AMC), focusing on the impact of a ward-based pharmacy team on preventable adverse drug events in surgical patients using quality indicators (SUREPILL study). She graduated with her Master's degree in 2011 and subsequently completed her postgraduate training as a community pharmacist resident, working at the Schinkel Apotheek in Amsterdam.

In 2013, Josephine began a postgraduate training program as a non-dispensing pharmacist in a general practice setting, where she experienced firsthand the significant role pharmacists can play in patient care. This experience, combined with her growing expertise, inspired her in 2015 to collaborate with a small team, under the initiative of prof. dr. Henk-Jan Guchelaar, to develop a new patient-centered Master of Pharmacy curriculum at the Leiden University Medical Centre (LUMC).

Since 2016, Josephine has worked as a senior lecturer, guiding pharmacy students in experience-based learning, professional identity formation and the development of competencies such as communication, interprofessional collaboration, and clinical reasoning. She also teaches in postgraduate training programs for community pharmacy residents, community pharmacists specializing in specific areas, and clinical pharmacists.

In 2020, Josephine began her PhD journey as part-time PhD-student at the LUMC in collaboration with Utrecht University, aiming to contribute to evidence-informed education for pharmacists and pharmacy students. Since 2023, she has served as a board member of the Leids Academisch Netwerk Apothekers (LANA), dedicated to advancing patient care through collaboration and innovation in education, research,

and pharmaceutical practice. She finds great fulfillment in combining teaching with research and intends to continue this path.

Josephine lives in Amsterdam with her husband, Bram Mertens-Stutterheim, and their 3 children.

PORTFOLIO

Presentations		
2021	Poster presentation at the fall congress of the Koninklijke Nederlandse Maatschappij ter Bevordering der Pharmacie (KNMP)	Online only
2022	Oral presentation at the annual congress of the Nederlandse Vereniging voor Medisch Onderwijs (NVMO)	Maastricht, the Netherlands
2022	Oral presentation at the Summer Congress of the International Pharmaceutical Federation (FIP)	Utrecht, the Netherlands
2022	Poster presentation at the annual congress of the European Society of Clinical Pharmacists (ESCP)	Prague, the Czech Republic
2023	Oral presentation at a meeting with pharmacy staff and community pharmacists connected to University of Otago	Dunedin, New Zealand
2023	Oral presentation at the annual congress of the NVMO	Egmond aan Zee, the Netherlands
2023	Poster presentation at the annual congress of the International Association for Health Professions Education (AMEE)	Glasgow, United Kingdom
2023	Oral presentation at the congress of Praktijk Research In Samenwerking Met Apothekers (PRISMA)	Amersfoort, the Netherlands
2023	Oral presentation (conducted by co-promotor) at annual meeting of the Dutch Society of Hospital Pharmacy (NVZA)	Arnhem, the Netherlands
2024	Oral presentation at meeting of the LUMC Education and Research Network (LEARN)	Leiden, the Netherlands
2024	Oral presentation at the annual congress of the NVMO	Egmond aan Zee, the Netherlands
2024	Poster presentation at the annual congress of the European Association for Clinical Pharmacology and Therapeutics (EACPT)	Rotterdam, the Netherlands
2024	Invited speaker at the symposium of the Medische Faculteit der Leidse Studenten (MFLS)	Leiden, the Netherlands
2024	Oral presentation at a meeting of Leids Academisch Netwerk Apothekers (LANA)	Online only
2024	Oral presentation at meeting of the LEARN	Leiden, the Netherlands
2024	Invited speaker at Combi-Consult symposium prior to the thesis defense of dr. V.A.M. Meijvis	Utrecht, the Netherlands
2024	Oral presentation at the congress of PRISMA	Amsterdam, the Netherlands

Courses and lectures		
2021	Academic writing for PhDs	Leiden University
2021	Scientific integrity	Leiden University
2021	Qualitative interviewing	Leiden University

2021	Basiscursus regelgeving en Organisatie Klinisch Onderzoek (BROK)	Leiden University Medical Centre
2022	Scientific integrity	NVMO
2022	Survey research: Design, implementation and data processing	Summer school, Utrecht University

Teaching activities

Supervision of research projects

2021	MSc Thesis	Salma Bouzeryouh
2022	MSc Thesis	Mirella Ujkanovic
2023	MSc Thesis	Kevin Kroeze
2023	BSc Thesis	Robin Vissers

Teaching courses and workshops directly related to PhD

2017- Present	Interprofessional Education Pharmacotherapy: several activities throughout curriculum	MSc. Pharmacy, MSc. Medicine, Leiden University
	Clinical reasoning by pharmacists-workshop	MSc. Pharmacy, University of Gent
2022- Present	Clinical decision-making (CDM): several courses throughout curriculum	MSc. Pharmacy, Leiden University
2022-Present	CDM in community pharmacy practice	Community pharmacist training program, Charlotte Jacobs Institute, KNMP
2022	E-module CDM in patients with multiple cardiovascular diseases	MSc. Pharmacy, Leiden University
2022-Present	CDM as community pharmacists specializing in specific areas, including geriatrics	Community pharmacists training program, Charlotte Jacobs Institute, KNMP
2023	Workshop Consulting with patients	ESCP congress
2023	E-module CDM step-by-step	MSc. Pharmacy, Leiden University
2024	Webinar/ video for starting clinical educators to support students' CDM	MSc. Pharmacy, Leiden University
2025	CDM for clinical pharmacists in primary care	POINT-i program, Julius Centre, UMC Utrecht

PUBLICATIONS

Mertens JF, Koster ES, Deneer VHM, Bouvy ML, van Gelder T. Clinical reasoning by pharmacists: A scoping review. *Curr Pharm Teach Learn.* 2022;14(10):1326-1336. doi:10.1016/j.cptl.2022.09.011

Mertens JF, Kempen TGH, Koster ES, Deneer VHM, Bouvy ML, van Gelder T. Cognitive processes in pharmacists' clinical decision-making. *Res Social Adm Pharm.* 2023; doi:10.1016/j.sapharm.2023.10.007

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Mertens JF, Kempen TGH, Koster ES, Deneer VHM, Bouvy ML, van Gelder T. Pharmacists and pharmacy students' perceptions on how a new teaching model supports their clinical decision-making. *Curr Pharm Teach Learn.* 2024;16(10):102136. doi:10.1016/j.cptl.2024.102136

Mertens JF, Koster ES, Deneer VHM, Kempen TGH, Bouvy ML, van Gelder T. Meer focus op klinische besluitvorming in de onderwijs. *Pharm Weekbl.* 2024; 4.

Mertens JF, Hessel MHM, Kempen TGH, et al. Evaluation of an interprofessional education program involving medical and pharmacy students: a mixed-method study. *BMC Med Educ.* 2025;25(1):48. doi:10.1186/s12909-024-06574-w

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