Chapter 8

General discussion

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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.

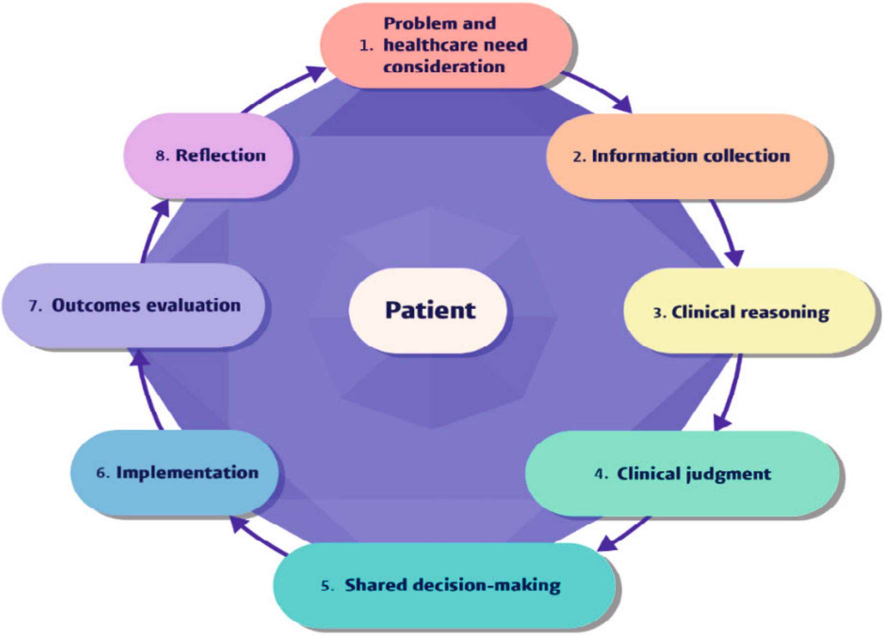

Figure 1. Designed model to support clinical decision-making among pharmacists and pharmacy students

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.

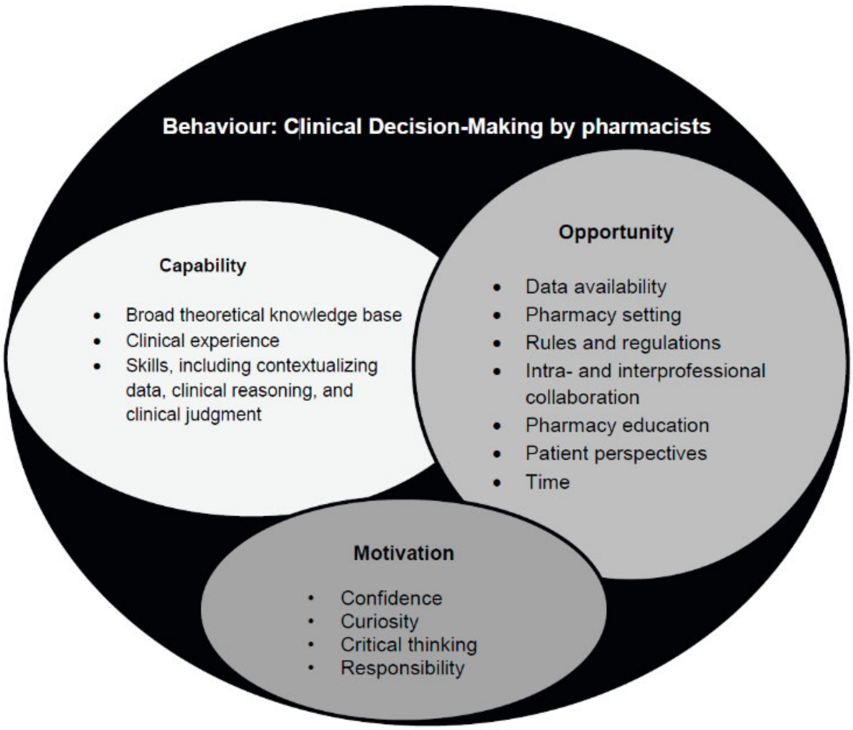

Figure 2. An overview of how the emerged themes of factors influencing clinical decision-making are categorized into the domains of the Capability-Opportunity-Motivation-Behaviour model

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.

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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.