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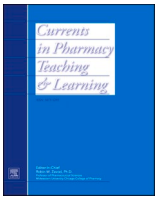

Pharmacists and pharmacy students' perceptions on how a new teaching model supports their clinical decision-making

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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,

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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 (Fig. 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]

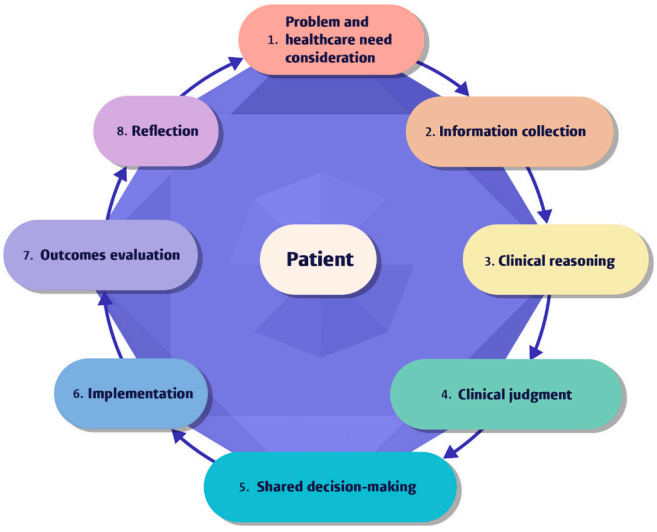

Fig. 1. Model to support clinical decision-making among pharmacists and pharmacy students.

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 6-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 towards 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.

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 min. 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.

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

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%)

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%)

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%)

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.

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 min 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.

Disclosure statement

This study received an unconditional grant from the Royal Dutch Pharmacists Association ('Koninklijke Nederlandse Maatschappij ter bevordering der Pharmacie' (KNMP)).

Contribution to literature

This article contributes to the literature by presenting a structured clinical decision-making (CDM) model tailored for pharmacy education. Through surveying both students and pharmacists, it explores their perceptions of how the model supports their CDM processes. The study identifies key learning outcomes and self-development opportunities associated with CDM, shedding light on the model's efficacy in fostering competent pharmacists. Additionally, it highlights the importance of integrating CDM education comprehensively into undergraduate and postgraduate pharmacy curricula.

Declaration of Competing Interest

None.

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Appendix A. CDM learning guide with an example

Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
1. 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
2. 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 (16×/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 min"
	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

(*continued on next page*)

(*continued*)

Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
			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
3. Clinical reasoning	**Recognizing** 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?
	Matching similar information and/or identify a mismatch	What fits (not) together? Consider: under- and over-treatment, lab values with symptoms/ medications,	Elevated bilirubin levels indicate decreased liver function, combined with other lab values and absence of clinical symptoms "just" mild

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Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
		contraindication, interaction, use	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
4. 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
5. 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 0.4 mg 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	Decision made together with patient GP informed of plan and agrees

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Steps	Cognitive processes	Prompting questions*	Example by pharmacy student**
		providers? If different from your plan, what is the reason? How should the patient be monitored (which parameters, by whom, and when)?	Monitoring effectiveness and safety by GP and pharmacist after 2 weeks, then 6 weeks, maximum treatment 6 months
6. 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
7. 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.
8. 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 min. 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

o 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?

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