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Cognitive processes in pharmacists' clinical decision-making

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ABSTRACT

Background: Pharmacists' clinical decision-making is a core process in pharmaceutical care. However, the practical aspects and effective teaching methods of this process remain largely unexplored.
Objective: To examine the cognitive processes involved in pharmacists' perceptions of how they make clinical decisions in pharmacy practice.
Methods: Semi-structured, face-to-face interviews were conducted with pharmacists working in community, outpatient, and hospital care in the Netherlands between August and December 2021. Participants were explicitly asked for examples when asked how they make clinical decisions in practice and how they teach this to others. After transcribing audio-recorded interviews, an inductive thematic analysis was conducted to identify cognitive processes. A theoretical model of clinical decision-making was then used and adapted to structure the identified processes.
Results: In total, 21 cognitive processes were identified from interviews with 16 pharmacists working in community (n = 5), outpatient (n = 2), and hospital care (n = 9). These cognitive processes were organized into 8 steps of the adapted theoretical model, i.e. problem and demand for care consideration, information collection, clinical reasoning, clinical judgment, shared decision-making, implementation, outcomes evaluation, and reflection. Pharmacists struggled to articulate their clinical decision-making and went back-and-forth in their explanations of this process. All pharmacists emphasized the importance of identifying the problem and described how they collect information through reviewing, gathering, recalling, and investigating. Clinical reasoning entailed various cognitive processes, of which comprehending the problem in the patient's context was deemed challenging at times. Pharmacists seemed least active in evaluating patient outcomes and reflecting on these outcomes.
Conclusions: Pharmacists use multiple cognitive processes when making clinical decisions in pharmacy practice, and their back-and-forth explanations emphasize its dynamic nature. This study adds to a greater understanding of how pharmacists make clinical decisions and to the development of a theoretical model that describes this process, which can be used in pharmacy practice and education.

1. Introduction

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

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integrate knowledge and clinical experience to interpret all available clinical data.[3]

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

2. Methods

2.1. Theoretical framework

There is no universal CDM model that fits all health professions, settings, and individuals.[1] Models in other health professions include the clinical reasoning cycle in nursing,[5] the biopsychosocial model that underpins physiotherapist's assessment and management of a patient,[6] and the conceptual CDM framework in dentistry.[7] There are similarities and differences reflecting the overlapping but different goals of the professions.[1] To our knowledge, there is no internationally recognized and comprehensive theoretical framework for CDM in pharmacy practice and education. Therefore, a theoretical CDM model was previously developed and implemented at the University of Leiden's Master of Pharmacy programme (Appendix 1). This 8-step patient-centred model is based on earlier work on pharmacists' decision-making,[3,4,8–10] and on the clinical reasoning cycle in nursing,[5] as it aligned well with the drug dispensing process in a community pharmacy, according to Croft et al.[10] The CDM model incorporates the Pharmacists' Patient Care Process (i.e. collect, assess, plan, implement, and follow-up)[11] plus three additional steps for educational purposes. The first additional step is the "consideration of the patient problem and care demand" to start the decision-making process. Second, following the framework proposed by Wright et al.,[4] the benefit-risk assessment of the most viable treatment options based on the gathered information, is incorporated in the model as the distinctive step "clinical judgment". Third, "reflection" has been added as a step to emphasize its importance in scrutinizing cognitive processes and mitigating the potential impact of biases, ultimately reducing the risk of errors.[12] However, it is unclear whether and how all of these processes are employed by pharmacists who are currently providing pharmaceutical care. A better understanding of the cognitive processes involved in CDM in pharmacy practice may support pharmacists' professional role development and teaching in both undergraduate and postgraduate curricula.

2.2. Study design and setting

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

2.3. Participant sampling and recruitment

In research team meetings, pharmacists participants were purposefully sampled from the research team's professional network to assure participants from community, outpatient, and hospital care. Furthermore, sample characteristics for clinical experience and PhD degrees differed on purpose because these factors may affect their cognitive processes used in CDM and their explanations of the process.[13] Afterwards, the principal researcher and interviewer (JM) recruited pharmacists by email. Additionally, snowball sampling was used to reach a community pharmacist beyond the professional network of JM, also community pharmacist. Before completing the Consent Form, potential participants were emailed a Participant Information Sheet describing the purpose of the interview and study objectives, and they were given the opportunity to ask questions regarding the research. Participating pharmacists were free to leave the study at any time and were not compensated for their participation. The interview was set up at a time that the pharmacists thought was convenient and free of disruptions.

2.4. Data collection

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

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

2.5. Data analysis

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

Table 1
Demographic characteristics of the study participants.

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

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

Steps	Cognitive processes	Representative interview extracts
1. Problem and demand for care consideration	**Identifying** problem and demand for care	*"What is the problem according to the patient?" – CP2* *"What's the problem? Is there a problem with the medication or not? Signals reach me in different ways, e.g. through alerts from clinical risk management systems and directly through questions from the clinic. Take for example the problem of a drug interaction with an antibiotic: I can consider whether I can combine it or not, but the first question is whether there is an infection present." – HP5*
	Describing situational context	*"When someone arrives, I observe that person. [..] Looking at how old someone is, seeing if they are mobile, seeing if they are calm or not calm. I observe the patient holistically." – CP5* *"The cardiologist calls or it's a lot of physician assistants here, eh, because some of them are also fresh out of school. So I actually take that [physician's specialism or seniority] into account in my decision-making."– HP5*
2. Information collection	**Reviewing** current patient information	*"I review if I correctly extracted patient's care demand." – HP9* *"What is her medication? If that is used at all, so definitely something to check, whether she takes it." – CP2* *"I call the physician to know what the indication of the therapy is."- CP4*
	Gathering new patient information	*"How is the patient doing?" – HP5*
	Recalling knowledge	*"It's something in your head; what you have previously heard or seen is a common side effect of a certain medicine." – CP1* *"I just know by heart that some drugs have a very long half-life. So then I also know immediately that it doesn't matter when you determine blood levels." – HP1*
	Investigating new information, e.g. in drug information database	*"While you're reviewing that patient information, you're consulting other sources as well. Drug resources that can provide some background information." – HP8* *"Of course, you sometimes have drugs that pass by that you think: huh, never heard of it. Well, I always look up what it is." – CP3*
3. Clinical reasoning[a]	**Recognising** normal from abnormal information, inconsistencies and information gaps	*"You look - if it is relevant for that drug - at a target value. Is the patient set up as it should be according to treatment guidelines? Or should it be more intensive? Or less intensive?" – CP2* *"It depends on the knowledge you have at that moment and of which you think: oh, but I still want to know this. And then I ask it myself, if I find anything missing." – HP3*
	Distinguishing relevant from irrelevant information	*"Framing what is currently important information and what is not. So distinguishing main from side issues." – CP5* *"I'm not thinking about the advice at all right now, but what information do I have and is it relevant to the advice I'll be giving later." – HP1*
	9. **Prioritising** information by ranking its importance	*"I prioritise [what I will discuss with the physician], based on previous medication reviews, experiences and what the patient considers most important at that moment." – CP5* *"We have an urgent matter and something with which we may be able to do something in the long run." – CP2*
	Relating information to identify patterns of information	*" During patient consultations, I frequently have cogs running in my head thinking 'oh, that would probably have something to do with that.' [..] I have had patients with similar complaints and who improved [after amlodipin adjustment]. It's in my head like calcium channel blockers. I don't have a specific patient [in my head]. " – CP1* *"If you see a PPI without indication and you know that the person is receiving stomach protection, for example, because he had acetylsalicylic acid, which was taken off at some point and the PPI remained. Well, then it is sometimes very clear, that someone has simply forgotten to stop the PPI." – OP1* *"I see that the kidney function is not so good. So shouldn't you also stop taking a NSAID?" – HP5*
	Matching similar information and/or identify a mismatch	*"I'm juxtaposing conditions with the medication, and juxtaposing the lab and all that data with the input from the conversation." – CP1* *"Then you first sort the medication with the disease. [..] because otherwise you don't know what someone does or does not have an indication for. [..] Or is there over- or undertreatment?" – HP3*
	Inferring to form deductions that follow logically by interpreting information	*"I'm just a logical reasoner. I will think more from pharmacokinetics, from what I think makes sense what you see in a drug blood level, for example, and in an exposure, and what advice I give." – HP1* *"Can it be logically explained? [..] Can, for example, a side effect be explained using the mechanism of action?" – CP4*
	Comprehending the problem in the patient's context	*"What does the ECG actually say? Which medicine is involved and how do you interpret this? [..] Is there actually a problem?" – OP2* *"I try to see, although sometimes difficult, what the clinical relevance of that interaction is to this patient" – CP3* *"Concentrate certain issues into a clear question." – OP1*
	Synthesizing information to formulate definitive patient's problem	*"I try to summarize for the physician and yourself with the goal to clarify the demand for care and the problem statement." – HP3*
4. Clinical judgment	**Establishing** desired outcome and timeframe	*"It's a different consideration if you are going to start something that in turn causes many side effects, because then you have to place that in the context of all other side effects and whether you consider that risk acceptable." – HP9* *"I need input from the physician on how they want to proceed with that patient. For example, when you're dealing with a terminal patient and they will not continue to treat." – HP2*

(*continued on next page*)

Table 2 (*continued*)

Steps	Cognitive processes	Representative interview extracts
	Weighing-up benefits and risks of all available (non-) therapeutic options	*"It's important to weigh the risks and benefits of a drug for the patient." – CP1* *"In your mind, you constantly make a judgement of which is worse: this or that?" – HP3*
5. **Shared decision-making**	**Selecting** most appropriate option to optimise patient outcomes in patient context, if necessary with other health professionals and/or patient	*"What is the best of these 3 options? And it is not always black and white, and as a pharmacist you are quite far from the patient, so you can also present the options to a nurse or a physician. And say, in this case option A would be best, and in that case option B will be best." – HP2* *"In all uncertainty you try to come to the best substantiated advice possible, because you never have all the information." – HP9*
	Deciding on course of action with other health professionals and/or patient	*"A decision made jointly, with respect for both the perspective of the doctor and the patient." – OP1* *"And what do you [the patient] think if we stop taking medication that we now agree together is no longer useful? That will be the decision I will further work with." – CP5* *"To come to a decision, we pharmacists find that difficult. Because it's very often a grey area, I hardly ever say "do this". [..] It is quite often giving the physician the options and presenting the best option, but you also mention the other options as well and then you hope to come to a decision together in a conversation." – HP4*
6. Implementation[a]	**Communicating** verbally and/or in writing the decision	*"You inform the patient: if [the complaint] doesn't improve or if it gets worse, contact the physician or me." – CP1* *"I'm documenting it [..] and if you [physician] act differently and a problem arises, then at least I have shared everything with you about this." – HP5*
7. Outcomes evaluation	**Evaluating** outcomes	*"Depending on the adjustment, I will monitor him or the physician or the patient himself. [..] If there's a decision for which I can be of value at the follow-up moment, then I monitor it. If we have to measure a blood pressure, then it does not make much sense for me to monitor that." – CP5* *"I do it on occasion. But very often, in the rush of the day, [follow ups] are the first things you think: it's not a priority," – OP1*
8. Reflection	**Contemplating** what has been learned, what has been done well, and what could have been done differently	*"Sometimes, a physician might not respond very nicely. Or sometimes the physician does. You think about that for a moment: hey, how come? [..] You should definitely reflect on yourself." – OP2* *"You're making some sort of assumption that okay, it's a gynaecologist so she has experience with it, so she must have consciously taken this risk, so to speak, and already discussed it with the patient. [..] Sometimes you go by that assumption, but with a baby to be born, I think it's nice to hear it anyway, even though the doctor thought that was a bit exaggerated" – CP4*

CP = community pharmacist, OP = outpatient pharmacist, HP = hospital pharmacist.

[a] Adapted from the preliminary model to best fit the empirical data: from "3. Problem analysis" to "3. Clinical reasoning" and from "6. Act" to "6. Implementation".

experience (TvG). Afterwards, the theoretical CDM model (Appendix 1) was used and adapted to structure the identified themes (cognitive processes).

2.6. Ethics and privacy

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

3. Results

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

Pharmacists acknowledged that their CDM skills were honed through years of experience. While they recognized the significance of this process in their work as pharmacists, they often did not consciously contemplate on the intricacies of this process. At times, they faced difficulty in articulating the precise terms to describe their decision-making and used metaphors like "automatic pilot" to convey its nature. Despite these linguistic limitations, 21 themes were identified to illustrate which cognitive processes pharmacists use to make clinical decisions in practice. The identified cognitive processes were organized into one of the eight steps in the theoretical model for CDM (Table 2), taking into account that pharmacists went back and forth in their explanations of conducted steps. Two steps of the model (step 3 and 6) were adapted to best fit the empirical data.

Step 1. Patient problem and demand for care consideration

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

Step 2. Information collection

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

Step 3. Clinical reasoning

Pharmacists described various cognitive processes for using and integrating existing knowledge and experience to interpret the collected information. In this clinical reasoning step, pharmacists recognized, for example, abnormal lab results, treatment-guideline inconsistencies, and missing data. When information gaps were identified, pharmacists could (re)consult the patient, health professionals and other information sources to gain more information (hence, going back to Step 2). Multiple pharmacists stated that, when assessing all available information, they distinguish relevant from irrelevant information and prioritise information to increase efficiency in decision-making. When multiple problems are present, it was also considered important to prioritise the problem itself. Furthermore, several pharmacists stated linking information to identify patterns of information. These patterns were mostly identified in pharmaceutical information, but they were also identified in clinical and contextual information. Another identified cognitive process is matching, whereby pharmacists reported to match conditions, symptoms, medications and lab results to acquire structure and identify mismatches and information gaps, particularly when conducting medication reviews. Inferring was also identified as a cognitive process used by pharmacists when forming deductions using their pharmacological knowledge. For instance, HP4 stated to use the medication as starting point and think pharmacologically to make sense out of a case. Pharmacists also described interpreting available information to comprehend the problem in the patient's context, "because I just want to understand why such a thing is" (HP1), as well as to predict the problem's consequences and its clinical relevance in this context. However, pharmacists often face challenges in grasping the clinical relevance of a theoretical problem. Because problems are not always clear in Step 1, pharmacists synthesized available information to determine the patient's definitive problem, including its consequences and clinical relevance.

Step 4. Clinical judgment

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

Step 5. Shared decision-making

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

Step 6. Implementation

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

Step 7. Outcomes evaluation

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

Step 8. Reflection

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

4. Discussion

From pharmacists' perceptions, 21 cognitive processes were identified that are involved in their CDM. These cognitive processes were organized into a theoretical model consisting of eight steps. While each step is presented as a separate and distinct element in the model, pharmacists went back-and-forth in their explanations of these steps and sometimes combined steps. These explanations underline that CDM is a dynamic process.[1,5] Pharmacists struggled to articulate this process properly and used metaphors to convey its nature. This struggle was also described by Anakin et al.,[14] who interviewed primary care pharmacists in New Zealand about their decision-making skills.

In this study, pharmacists explained that their CDM started with problem identification (Step 1), which fits with the theories on the broader concept of problem-solving.[15] Early problem identification is important for triggering therapy scripts, which are high-level, precompiled, conceptual knowledge structures of the courses of action that a health professional can take to address a patients' healthcare problem.[16] Synthesizing a definitive problem based on gathered information is included in Step 3. Starting the model with problem identification differs from other models, for example the model of the clinical reasoning process in nursing and the pharmacists' decision-making models in drug dispensing and medication reviews.[5,10,17] These

models start with considering patient or prescription context, which would stimulate an holistic approach. Considering situational context is also described by pharmacists in this study and is incorporated in Step 1. Similar to the study of Anakin et al.,[14] the information collecting step (Step 2) was described in detail. Data availability influences pharmacists' CDM.[13] Croft et al. identified similar cognitive processes in pharmacists' thinking process in drug dispensing to retrieve and process information and identify therapeutic problems.[10] Additionally, we identified inferring to form deductions that follow logically by interpreting information, comprehending the problem and predicting an outcome. These cognitive processes are also found in nurses' clinical reasoning.[5] In the preliminary model, Step 3 was labelled "problem analysis", which seemed to focus on problem assessment only. Therefore, in our opinion, "problem analysis" had the risk of narrowing pharmacists' scope of information collection and assessment. The authors decided that "clinical reasoning" was more appropriate because the information that was gathered included information that encompasses more than just theory, such as information on the situational context, and clinical reasoning is conceptualized to interpret all of the information that is available. Labelling this step as "clinical reasoning" is coherent to the model of Wright et al.,[4] which is used in the interview study by Anakin et al.[14] The clinical judgment step (Step 4) involves a trade-off between the benefits and hazards of any option, and is based on ambiguity and uncertainty, which pharmacists find challenging.[4,13,14] A recent study also showed that pharmacy students did not routinely consider multiple reasoned options before committing to a therapeutic recommendation.[18] Making clinical judgment a separate model step emphasizes its importance in CDM and supports the development of specific teaching strategies for pharmacists and pharmacy students.[4] For example, thinking aloud by supervisors how they conduct clinical judgment considering multiple reasoned options including their uncertainties would benefit students' learning process.[19] Shared decision-making (Step 5) begins, according to the literature, when the health professional communicates with other health professionals and/or the patient the need to consider the available options as a team.[17] According to this study, there is occasionally a lack of a team approach in pharmacy practice, which is driven by suboptimal collaboration with other health professionals, a pharmacist's uncertainty or reluctance in making decisions, and the absence of patient involvement in decision-making.[13] The latter is also stated by Towle et al.,[20] who described that health professionals do not always offer options to patients and that options are rarely provided fully, coherently and unbiased. As patients must have the knowledge and power to participate in this process, the pharmacist should provide patients the information they need to make informed decisions and empower them during the process.[21,22] In the preliminary model, step 6 was labelled "act", which largely referred to drug dispensing. The term "implementation" was deemed more appropriate for developing a model based on cognitive processes as well as a more general model that is not immediately related to drug dispensing. Although pharmacists in this study explained to communicate verbally and in writing, different studies show that documentation by pharmacists in patients' records could be improved.[23,24] Furthermore, pharmacists may identify decisions that are (in)effective by evaluating outcomes (Step 7), which gives feedback for future CDM. However, pharmacists explicitly mentioned incorporating this cognitive process insufficiently into their decision-making. Time constraints, a lack of data, and the absence of a defined and active role in patient follow-up are considered barriers to evaluate outcomes.[13] Additionally, based on these study findings, it seems that pharmacists are aware of the benefits of reflection (Step 8). However, they also stated that they should engage in this reflective behaviour more, emphasizing the need of a separate step in the model. Particularly in teaching and learning CDM, reflection is necessary to promote self-awareness and to identify strengths, opportunities for learning, and personal bias.[25]

4.1. Strengths and limitations

The inclusion of pharmacists working in community, outpatient, and hospital care with varying years of clinical work experience and PhD degrees is considered a strength of this study. Selection bias, however, might have been introduced through recruitment through the research team's professional network. A substantial proportion of participants hold a PhD degree, which might suggest that they are accustomed to scrutinizing their clinical actions from a more detached perspective. However, even these participants encountered challenges in expressing the process of clinical reasoning. This difficulty could be more pronounced among pharmacists with limited research experience. For consistency, this study employed a well-defined interview guide, used by a single interviewer who was also a community pharmacist. To reduce the impact of researcher bias and preconceptions, data analysis was addressed collaboratively. Although having a pharmacist as an interviewer gave the interviewer the opportunity to go deeper into the themes, this may have influenced participants' responses, for example through encouraging socially desirable behaviour.[26] Additionally, a community pharmacist as interviewer might have led to data saturation with a higher proportion of participants working in secondary care pharmacists than primary care. However, the overall mutual cognitive processes involved in CDM are highlighted by reaching data saturation with this heterogenous sample. Depending on the pharmacy setting and experience, there may be variations in the cognitive processes used, just as there may be variations per case. However, the model's uniformity is considered valuable for pharmacy practice and education. Pharmacists' perceptions of how they make clinical decisions retrospectively may have been impacted by cognitive biases. Cognitive processes, for example, could have been missed due to the lack of articulating. Think-aloud sessions could strengthen this work, but articulation remains a challenge.

4.2. Implications for practice, education, and further research

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

5. Conclusion

Pharmacists use multiple cognitive processes when making clinical decisions in pharmacy practice. Cognitive processes were identified in each of the 8 steps of the adapted CDM model; problem and demand for care consideration, information collection, clinical reasoning, clinical judgment, shared decision-making, implementation, outcomes evaluation, and reflection. Pharmacists struggled to explain CDM and their

back-and-forth explanations emphasize its dynamic nature. This study adds to a greater understanding of how pharmacists make clinical decisions in community, outpatient and hospital pharmacy practice and to the development of a uniform, theoretical model that describes this process, which may be useful in pharmacy practice and education.

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CRediT author statement

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Declaration of competing interest

None.

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Appendix 1. Clinical decision-making model

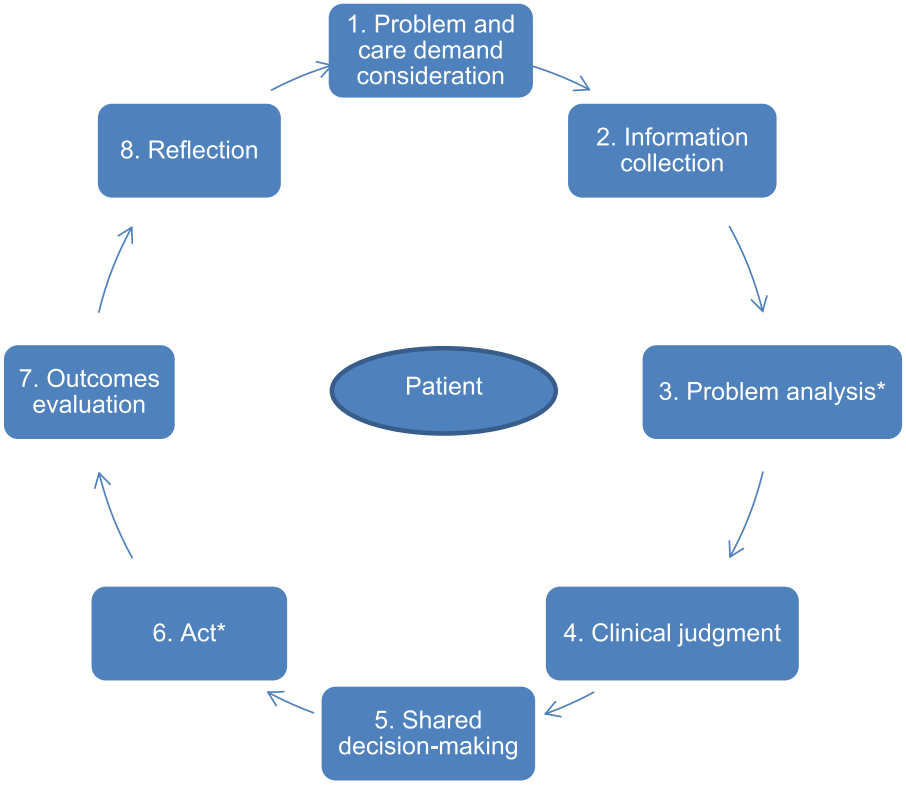

Fig. 1. Preliminary clinical decision-making model * Step 3. Problem analysis and step 6. Act are altered to step 3. Clinical reasoning and step 6. Implementation, respectively, to best fit the empirical data.

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

Appendix 2. Interview guide

(translated to English)

Thank you for giving us the opportunity to interview you for our study on clinical decision-making among pharmacists. The questions I would like to ask during this interview regard how you, as a pharmacist, come to a decision when addressing a patient case: which thinking steps do you make? As

a pharmacist, researcher and teacher, I am interested in this topic. There are no right or wrong answers here. The interview will last for about 45 min and consists of a number of questions regarding decision-making.

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

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

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

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

Your experience from practice have already been very helpful, thank you. Did I forget to ask something in your opinion, or do you want to add something?

Thank you very much for your time and answers to our questions. We will send you the transcript afterwards. If you have any questions or comments regarding our conversation and/or the transcript, please do not hesitate to contact us.

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

No	Item	Guide questions/description	Check?
Domain 1: Research team and reflexivity			
Personal Characteristics			
1.	Interviewer/facilitator	Which author/s conducted the interviews?	JM
2.	Credentials	What were the researcher's credentials? E.g. PhD, MD	JM is PharmD
3.	Occupation	What was their occupation at the time of the study?	Researcher and senior lecturer with previous experience as community pharmacist in community pharmacy and as non-dispensing pharmacist working in a general practice
4.	Gender	Was the researcher male or female?	Female
5.	Experience and training	What experience or training did the researcher have?	Training qualitative interviewing
Relationship with participants			
6.	Relationship established	Was a relationship established prior to study commencement?	Several participants within professional network, others just with e-mail prior to start study
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	Participants were informed about the research and its reasons for doing the research by invitation letter.
8.	Interviewer characteristics	What characteristics were reported about the interviewer/ facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	Researcher introduced herself at the start of the interview. She reported her reasons and interests in the research topic to the participants.
Domain 2: study design			
Theoretical framework			
9.	Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	First, inductive thematical analysis, informed by other studies and literature. Then, a theoretical model was used to structure emerged themes.
Participant selection			
10.	Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Participants were purposely recruited through the professional network of the research team, and snowball sampling.
11.	Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	Participants were approached by e-mail.
12.	Sample size	How many participants were in the study?	16
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	All agreed and no participants dropped out after inclusion.
Setting			

(*continued on next page*)

(*continued*)

No	Item	Guide questions/description	Check?
Domain 1: Research team and reflexivity			
14.	Setting of data collection	Where was the data collected? *e.g.* home, clinic, workplace	The data was collected in the workplace of the participant or in an online setting.
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	During 5 interviews, the research student was present as well.
16.	Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	Pharmacists of both community, outpatient and hospital care are represented in the sample. Participants differed in gender, age and years of experience and their research experience.
Data collection			
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	The interview guide was not pilot tested, but after the first two interviews, evaluation of the interview guide took place together with the research team consisting of community and hospital pharmacists and a physician.
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes, audio-recording was be used to collect the data.
20.	Field notes	Were field notes made during and/or after the interview?	Yes, JM made field notes.
21.	Duration	What was the duration of the interviews?	The duration of interviews was between 45 and 60 min.
22.	Data saturation	Was data saturation discussed?	Yes, data saturation was decided upon as no new themes emerged in the final three interviews.
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	A summary of the findings was returned to participants for comment and/or correction if wanted by the participant.
Domain 3: analysis and findings			
Data analysis			
24.	Number of data coders	How many data coders coded the data?	Two persons (JM and student) independently coded all transcripts
25.	Description of the coding tree	Did authors provide a description of the coding tree?	The coding tree was inductively developed and is available upon request from the first author.
26.	Derivation of themes	Were themes identified in advance or derived from the data?	Themes were derived from the data.
27.	Software	What software, if applicable, was used to manage the data?	Atlas.ti version 22 was used to manage the data.
28.	Participant checking	Did participants provide feedback on the findings?	No
Reporting			
29.	Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Participant quotations were presented to illustrate the findings by participant number per discipline.
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31.	Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes

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