



# Community pharmacists' clinical reasoning: a protocol analysis

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## Abstract

**Background** There are two fundamental approaches to clinical reasoning, intuitive and analytical. These approaches have yet to be well explored to describe how pharmacists make decisions to determine medication appropriateness. **Objective** (1) to identify the cognitive actions (i.e., operators) that pharmacists employ when they move from one cue (i.e., concept) to another, and (2) to describe the overall clinical reasoning approach taken by pharmacists when checking for medication appropriateness. **Setting** Pharmacists from a chain pharmacy in Canada were invited to participate in this study. **Method** Data was collected in private rooms using video recordings to capture simulated patient–pharmacist interactions of a new prescription medication. A simulated case scenario was used to gather two types of verbal reports, concurrent think-aloud and structured retrospective think-aloud from pharmacists. All verbal reports were video-recorded, transcribed verbatim, and analyzed using protocol analysis. **Main outcome measure** Pharmacists' reasoning approaches when making medication appropriateness decisions. **Results** A total of 17 pharmacists participated. Pharmacists were most likely to use analytical clinical reasoning approaches when checking prescriptions and three used no clinical reasoning. When the pharmacists were asked specific questions regarding the decision-making model for pharmacy (i.e., check for indication, efficacy, safety, and adherence), 50% reported using analytical decision-making approaches, with a third of the decisions being made in hindsight. **Conclusion** The majority of the pharmacists followed an analytical decision-making approach to clinical reasoning. When the pharmacists were asked prompting questions about their medication-related decisions, they employed a combination of intuitive and analytical approaches. The pharmacists had the competency to check for medication appropriateness; though this knowledge was mostly restructured during the process of hindsight reasoning.

**Keywords** Clinical decision making · Community pharmacy services · Observation · Patient simulation · Pharmacist

## Impacts on Practice

- While community pharmacists demonstrated the ability to assess medication appropriateness, this is not incorporated into routine practice when checking a prescription of completeness and accuracy.

- Pharmacy software design may consider prompts to encourage pharmacist to assess for medication appropriateness during routine prescription dispensing activities.

## Introduction

In light of the global increase in life expectancy and the complexity of medication needs, the role of pharmacists worldwide is expanding. Pharmacists' responsibilities are not limited to the technical activities of dispensing and preparing a prescribed drug [1]. Rather, pharmacists must ensure the safe and effective use of medication by checking for medication appropriateness, monitoring drug therapy, and resolving drug-related problems (DRPs) [2]. Daily, a typical community pharmacist will use their clinical reasoning skills to make hundreds of clinical decisions regarding medication appropriateness (i.e., decide if the medication

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indicated is safe and effective for an individual patient and if the patient will adhere to therapy) [3]. However, self-report studies and observational studies have reported that, due to several factors, community pharmacists may not fully engage in decisions regarding medication appropriateness and miss opportunities to elicit patient information necessary for making tailored decisions [4–6]. Pharmacist workflow is often cited as a barrier for these gaps in practice [7]; however, another potential factor may be pharmacists' application of clinical reasoning skills.

Clinical reasoning is defined as the cognitive process through which practitioners apply their knowledge and clinical experience in assessing and managing patients' medical problems [8]. By understanding pharmacists' clinical reasoning, strategies may be identified to help pharmacists detect, prevent, and address drug-related problems (DRPs).

Several studies have characterized pharmacists' clinical reasoning using verbal reports in the context of diagnostic decisions [9–11], adverse drug reactions [12], ethical scenarios, and ambulatory care [13]. Moreover, these studies characterized the information pharmacists gathered [10, 11], their engagement in decision-making [14], the clinical skills they used [10, 11], and the clinical reasoning approaches they took (i.e., logical [12] or intuitive [11, 12]). In all of these studies, the participating pharmacists were asked to report their thoughts aloud while performing a task, followed by data transcription and thematic analysis. While thematic analysis offers a general description of clinical reasoning in the social and practical context, it does not describe how clinical reasoning actually takes place at the cognitive level with specific analytic elements such as concepts and operators [15].

Protocol analysis, a widely used technique, could be used to assess the clinical reasoning of pharmacists when checking medication appropriateness. Protocol analysis is guided by the Information Processing Theory, which states that verbal reports provide an accurate reflection of short-term memory and the information being processed at the time of problem-solving or decision-making [16]. Thus, a detailed analysis of verbal reports can provide insight into the clinical reasoning processes of pharmacists. Concerns have been raised regarding the completeness and accuracy of verbal reports and the extent to which these reports convey the intuitive knowledge of clinicians [17]. Ericsson and Simon [18] have argued that reported data may nonetheless provide valuable insight into intuitive thoughts that are otherwise difficult to access.

Furthermore, unlike thematic analysis, protocol analysis provides in-depth descriptions of the objects of clinical reasoning (i.e., concepts such as date of birth, medical history, or medication allergy) and how pharmacists move from one concept to another (i.e., operators) [16]. Operators are the cognitive actions that characterize the clinical

reasoning process. For example, the operator “conclude” refers to a definitive decision and the formation of a statement about a problem choice. The aggregation of operators to solve a particular problem provides a map for cognitive thinking and reasoning approaches.

The literature on clinical reasoning and cognitive psychology has identified two fundamental approaches to reasoning: intuitive (i.e., heuristic) and analytical [19]. Intuitive reasoning requires little mental effort, with clinicians acting on assumptions, feelings, or hunches in a nonlinear fashion (i.e., based on intuition). This approach utilizes few operators, such as review [15, 20], and can be characterized as quick, automatic, and internalized (i.e., automaticity). In contrast, analytical reasoning is systematic and slow, requiring higher levels of mental awareness and effort [19]. This approach often involves acquiring data and then interpreting it to generate and evaluate a hypothesis [21]. For example, decisions made using the following order of operators suggest analytical reasoning: “verify”, “explain”, “collect”, “infer”, and “conclude”. Analytical and intuitive reasoning are not always mutually exclusive; according to the dual process theory, the two approaches can be employed in conjunction to make decisions [22]. Expert clinicians tend to rely on intuitive reasoning and resort to analytical reasoning with unfamiliar cases, while novices mostly use analytical reasoning until they acquire a sufficient level of expertise [23].

In summary, given that clinical reasoning is a major determinant of a clinician's ability to practice, it is important to understand how clinical reasoning is used by pharmacists when evaluating medication appropriateness [24]. Assessing medication appropriateness is particularly important for 70% of pharmacists [25] who practice in community pharmacies and support patients' medication needs.

## Aim of the study

The overall objective was to describe pharmacists' clinical reasoning when checking for medication appropriateness in a community practice setting. The specific objectives were: (1) to identify the cognitive actions (i.e., operators) that pharmacists employ when they move from one cue (i.e., concept) to another, and (2) to describe the overall clinical reasoning approach taken by pharmacists when checking for medication appropriateness.

## Ethics approval

The study protocol has been approved by the Health Research Ethics Board (HREB) at the University of Alberta (No. Pro00047085) in May 2014.

## Method

### Design

This is an exploratory-descriptive study. In this study, we used protocol analysis to assess the clinical reasoning of pharmacists in order to obtain an in-depth description of the objects of clinical reasoning (i.e., concepts) and identify the cognitive actions that characterize the clinical reasoning process (i.e., operators) in relation to standardized patient simulation. In order to gain more insight into the clinical reasoning of pharmacists, we collected two types of verbal reports, known as concurrent think-aloud (CTA) and retrospective think-aloud (RTA).

### Sample

The study sample was part of a sample for a larger study aimed at evaluating pharmacists' communication styles before and after receiving training on a communication model. In the larger study, managers from a chain pharmacy were asked to invite and identify pharmacists in their chain who were willing to participate. In this study, we used the verbal reports from the baseline data set (i.e., pre-training) to avoid any biases that may have emerged during training. This data set was collected in September 2014.

### Procedure

The data was collected in the private consult rooms of the pharmacies and at the pharmacists' convenience. Further, it was collected by one of the researchers in the study, namely MBN, following a standardized protocol.

### Simulation

Think-aloud studies have often used simulated patients (i.e., patient actors) to minimize variations between real-life patients and to avoid data contamination (e.g., interruption or distraction) [26, 27]. The simulated case used in this study was based on a real-life patient case ("Appendix 1"). The simulated patient had two clear drug-related problems, namely adverse drug reaction (i.e., dry cough induced by Ramipril) and unnecessary drug (i.e., cough suppressant). The case provided the participating pharmacists with several opportunities to interact with the patient and decide if the medication was clinically appropriate (i.e., indicated, effective, safe, and manageable). The simulated case, which was reviewed by two experts in pharmacy practice, was designed to simulate routine care and was thus not intended to have the pharmacists make significant interventions. The

participating pharmacists were instructed to assess the simulated patient just like they would in their daily practice. They were also expected to detect the drug-related problems and resolve them (e.g., stop the cough suppressant), assure the patient that the dry cough would be resolved once the Ramipril was stopped and the new medication (i.e., Candesartan) was started, and educate the patient on how to measure blood pressure regularly to ensure the efficacy of the new medication. We also provided the pharmacists with a hard copy of a simulated prescription, a pharmacy computer printout, and a medication vial to mimic typical practice.

The simulation consisted of three stages. In the first stage of the simulation, the pharmacists were asked to accept the prescription and gather typical information from the simulated patient (i.e., drop-off consultation) as if they were a new patient at their pharmacy. In the second stage of the simulation, the pharmacists were asked to verbalize their thoughts while evaluating the prescription as if it were a real prescription in their daily practice (i.e., concurrent think-aloud). The pharmacists were asked to verbalize what they were thinking about, looking at, and doing, as if they were explaining this task to a junior pharmacy student. This stage was designed to provide insight into the pharmacists' internal clinical reasoning. In order to guide the pharmacists and prevent the sole focus from being based on dispensing tasks, the researcher stated, "I want you to verbalize how you are going to process the prescription and check for appropriateness." In the third stage of the simulation, the pharmacists spoke with the simulated patient (i.e., pick-up consultation) so that they could ask any further questions and provide patient information. The pharmacists were not given any time limits to complete any of the three stages of the simulation.

### Verbal reports

Two verbal reports were collected, one concurrent think-aloud (CTA) and one structured retrospective think-aloud (RTA). The CTA verbal reports were collected during the process of evaluating the medication in the second part of the simulation as described above. This was intended to provide insight into pharmacists thoughts when assessing a prescription.

The structured RTA, on the other hand, aimed to capture the pharmacists' reasoning specifically around medication appropriateness (i.e., indication, effectiveness, safety, and manageability) and to provide insight into any thoughts that were not verbalized during the CTA. The structured RTA verbal reports were collected from the pharmacists immediately after the simulation. A researcher asked the pharmacists four questions adapted from the pharmacotherapy work-up [3]. These four questions were: "How did you decide that the medication was safe for this patient?"; "How did you

decide that the medication was indicated?"; "How did you decide that the medication was effective?"; and "How did you decide that the patient is going to adhere to therapy?" Video recordings were used to capture all patient–pharmacist interactions and the CTA and structured RTA sessions. All recordings were transcribed and checked for accuracy. Transcripts were divided into segments which consisted of a single word, phrase, or a full-sentence that referred to a specific action. If required, transcripts of the conversations between the pharmacists and the patients (i.e., drop-off and pick-up consultations) were reviewed to clarify findings.

## Protocol analysis

Protocol analysis was used to meet the first research objective (i.e., examine concepts and operators) and the second research objective (i.e., identify clinical reasoning approaches). As Newell and Simon describe, protocol analysis is a method used to analyze verbal data and gain insight into cognitive thinking [16]. It has been modified so that it may be applied in clinical reasoning studies (i.e., refined protocol analysis) [28]. There were three steps involved in the refined protocol analysis: (1) identifying the main concepts verbalized by the pharmacists (i.e., referring phrase analysis), (2) identifying the operators used (i.e., assertional analysis), and (3) identifying the clinical reasoning approach taken (i.e., script analysis). Our work was guided by the most recent clinical protocol analysis by Hoffman et al. [15] MBN, LMG, and MKC conducted the protocol analysis on the segmented transcription of the verbal reports.

In the *referring phrase* analysis, a code (i.e., concepts) was assigned to each segment to describe the information verbalized by the pharmacists. Concepts included ideas such as patient medical information and drug information, as well as physical objectives such as prescription and vial label. These concepts identified the segments in the verbal reports that were tailored to medication appropriateness (indication, effectiveness, safety, and adherence). The research team assigned initial codes for five transcripts, and MBN coded the remaining data. New concepts emerged as the coding progressed, and others were redefined or re-coded after repeated examination of the transcripts.

*Assertional analysis* was used to identify operators by labelling how the pharmacists progressed from one concept to the next. Operators are cognitive strategies that represent each step of a pharmacist's reasoning during the reasoning process [15]. For example, the operator "verify" was labelled when the pharmacist confirmed the accuracy of a specific fact (e.g., if the pharmacist checked the prescription with the vial label). Operator codes were established using pre-existing literature [15, 29, 30] and were adapted as needed.

A problem behaviour graph was created for each transcript to illustrate the order of the operators (Fig. 1).

During the *script analysis* stage, we reviewed the problem graph to determine the order of the operators and identify the overall clinical reasoning approach taken by each pharmacist. For example, if the pharmacist used the forward chaining approach, we would expect the initial operators to include "review", "explain", and "collect" which would be followed by "infer" or "conclude" to show how the initial operators led to a decision. This flow of operators would indicate a systematic process (Table 1). We applied clinical reasoning approaches described in the existing literature and adapted their definitions to fit the pharmacists' decision-making processes. Examples of different forms of analytical and intuitive clinical reasoning are detailed in Table 1.

## Results

### Participants

Seventeen pharmacists participated in the study. They worked full-time in eight different pharmacies in a large urban Canadian city. Nine of the participants (53%) were female, and the mean age  $\pm$  SD of the participants was  $33.4 \pm 7.1$  years old, with an average of 9.1 years of experience. Five of the participants had ten or more years of experience.

### Objective 1: concepts

Overall, 45 different concepts were identified from the referring phrase analysis. These concepts were grouped into 10 categories (Table 2), five of which referred to the pharmacists' patient care activities. The remaining five categories were technical in nature and referred to the dispensing activities reported by the pharmacists (e.g., packaging, and labelling). The majority of the concepts identified in the CTA were of a technical nature (59.8%; Table 2) and did not contribute to clinical decisions and the related script analysis. On the other hand, the structured RTA contains over 95% clinical concepts (Table 2), as researchers prompted pharmacists to focus on these areas. The majority of the clinical decisions were tailored to checking medication safety and effectiveness.

### Objective 1: operators

In the assertional analysis, we identified 13 different operators which were used to connect concepts. The most commonly identified operators in the CTA were "verify" (43%)

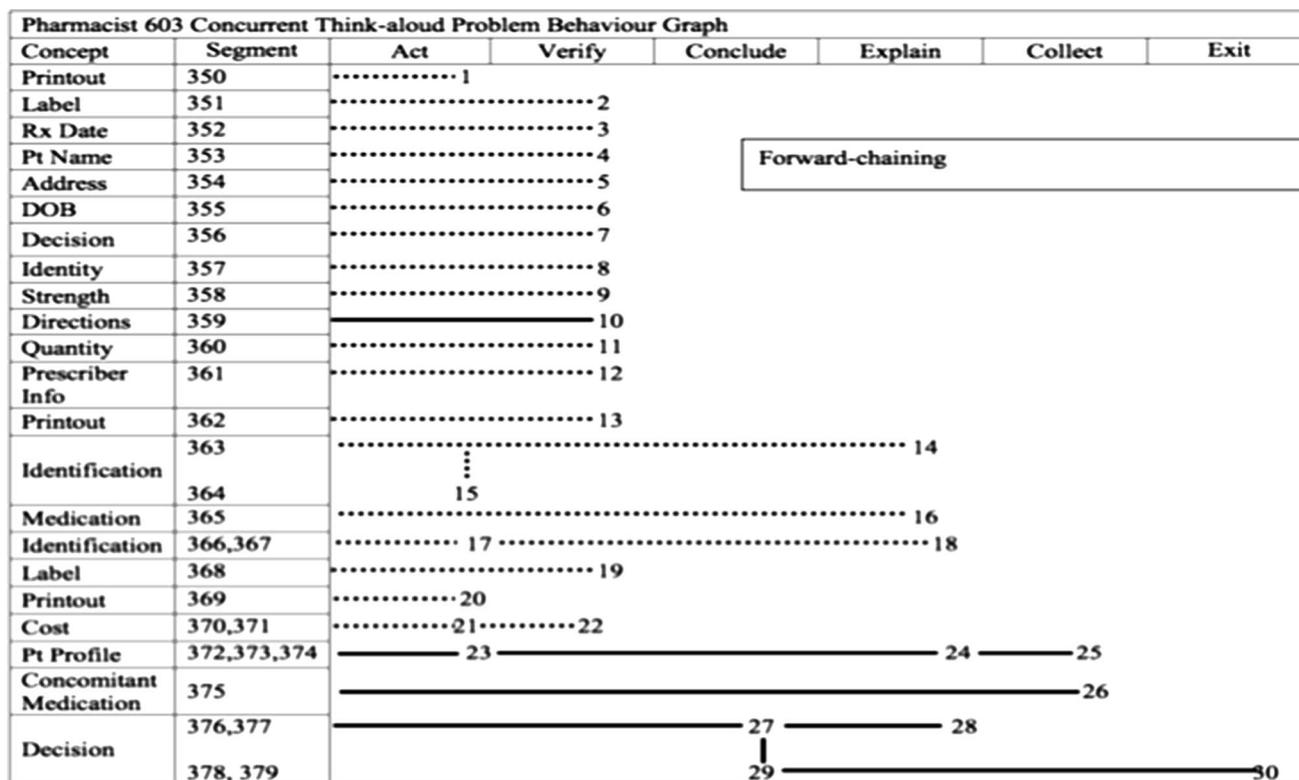


Fig. 1 An example of a problem behaviour graph. The X axis represents the operators in order of their appearance. In the Y axis, the identified concept of each segment was recorded in sequential order.

A line was drawn from the concept of each segment to the operator identified for that phrase and numbered in sequential order according to their appearance in transcripts

and “act (22.4%), which were primarily associated with technical concepts (Table 3). When checking prescriptions during the simulation, pharmacists’ cognitive thinking was tailored to technical duties rather than patient care activities such as checking for medication appropriateness. The operators identified in the CTA (e.g., act, explain, review; Table 3) suggests that pharmacists follow a systematic approach and rely less on operators which may suggest an intuitive approach (e.g., predict, assume; Table 3).

Two operators were reported exclusively in the RTA (i.e., overlooked and match). The operator “match” was used when the pharmacists described matching the current patient or situation to similar previous patients or situations (i.e., pattern recognition). Eight pharmacists reported that they “overlooked” at least one of the medication appropriateness elements. “Overlooked” refers to the pharmacist acknowledging that they did not check for something or commenting on what they could have done differently (i.e., “I guess I should have....”). This operator emerged in the RTA sessions, as the participants were prompted with questions.

### Objective 2: clinical reasoning approaches

In the script analysis, we described the aggregation of operators to form a clinical reasoning approach, as defined in Table 1. We only included the clinical concepts and their corresponding operators (i.e., solid lines; Fig. 1), as they aligned with our research objectives on clinical reasoning. Verbatim examples of clinical reasoning approaches are presented in Boxes 1–4. In the CTA, all pharmacists followed an analytical approach using multiple operators to reach a decision or a conclusion (i.e., forward-chaining approach; Table 3). Twelve pharmacists used forward-chaining to check for medication safety (Box 1), one used it to check for medication effectiveness, and one used it in relation to the main drug-related problem (i.e., cough). Three of the pharmacists showed no evidence of using any clinical reasoning approach (i.e., RPh 301, 602, and 801), as they were focused on verifying technical concepts or reviewing medication directions.

**Table 1** Definitions for clinical reasoning approaches

Clinical reasoning approach	Definition
(1) System 1 or intuitive	
(a) Automaticity	This approach is characterized by being quick, automatic, and internalized. In RTA, pharmacists who followed this approach made decisions or assumptions without verbalizing a clear justification or reasoning behind these decisions or assumptions
(b) Intuition	This is a non-analytical approach in which decisions are made in a few steps and with little to no awareness. Participants who used this approach mainly relied on few operators, such as “verify” and “review”
(c) Pattern Recognition	Pharmacists who used this approach matched the current patient to past patients or predicted outcomes based on previous similar experiences. The main operator used to identify this approach was “match”
(2) System 2 or analytical	
(a) Forward -chaining	In this approach, pharmacists followed an analytical approach using multiple operators to reach a decision or a conclusion. In this approach, pharmacists had operators close to the following order: 1) “verify” or “review; then 2) “explain”; then 3) “act” or “collect”; then 4) “infer”; then 5) “conclude”
(b) Hypothetico-deductive	In this approach, pharmacists followed a backward analytical approach using multiple operators starting with a decision or a conclusion and then proceeded with analyzing or justifying it. In this approach, pharmacists had operators engaging largely in the following order: 1) “conclude” or “infer”; then 2) “review” or “act”; then 3) “explain”; then 4) “predict”
(c) If/then	In the if/then approach, pharmacist’s decisions or prediction of outcomes relied on a particular condition. This approach does not involve a particular number or order of operators, but it was identified by examining the segments and identifying instances that looked like “if... then...”
(3) Dual process theory	In this approach, pharmacists do not use systems 1 and 2 mutually exclusive. Both systems are employed jointly to make a decision
(4) Hindsight reasoning	In this approach, pharmacists reported thoughts in RTA that did not occur in the CTA sessions. These thoughts are characterized by pharmacists acknowledging “overlooked” concepts, or providing new thoughts that were not reported in the simulation and CTA sessions

\* Adapted from Hoffman K. A comparison of decision-making by “expert” and “novice” nurses in the clinical setting, monitoring patient haemodynamic status post abdominal aortic aneurysm surgery.[Dissertation]. Sydney: University of Technology; 2007

#### Box 1: Example of a forward-chaining reasoning approach in CTA

*RPh 101 [28 years old, male, 3 years of experience]*

“First thing I’ll be looking for is any allergies that could potentially interact with this medication (1) so the patient let us know that they’re allergic to penicillin (2) so nothing there (3) I just checked the prescription to the hard copy here (4)\* so the name would be correct (5)\* doctor (6)\* checking their needs here (7)\* the medication if it’s appropriate and (8) it’s an appropriate change from what he was getting previously (9) so from Altace to the Candesartan (10) so that’s okay (11) Then I’d go to PharmaNet (12) and make sure there’s not any other medications (13) that he didn’t tell me about (14) that could potentially interact with this one (15) anything that could cause extreme hypotension (16) because that seems to be an issue here and (17) that is it so I’ll call the patient back (18).”

The operators used were “explain” (1), “review” (2), “conclude” (3), “act” (4), “verify” (5), “verify” (6), “verify” (7), “explain” (8), “infer” (9), “review” (10), “conclude” (11), “act” (12), “collect” (13), “explain” (14), “infer” (15), “infer” (16), “explain” (17), “exit” (18)

\*\* Segments 4–7 are technical segments and were not included in the script analysis

In the RTA sessions, a total of 71 clinical decision approaches were identified (Table 4). The majority of these

decisions were made using analytical reasoning (56.3%), predominantly using a forward-chaining approach (38%). The analytical reasoning approaches were primarily used in regard to indication, safety, and adherence-related decisions. The participants also used a hypothetico-deductive reasoning approach in 14% of the decisions, mainly using operators in the order illustrated in Box 2.

#### Box 2: Example of a hypothetico-deductive reasoning approach

*RPh 701 [40 years old, male, 17 years of experience]*

“It’s not an ACE inhibitor and safe(1), it’s a reasonable dose, it’s not super high, it’s not super low (2), He was already on 10 mg Ramipril(3). so it’s not like he was on a weak antihypertensive (4), so he was already having significant blood pressure lowering effects from the Ramipril (5), so I didn’t think starting at 16 was much of a risk (6)[um] The risk, in my mind, would have been if he had taken this too early, given the spacing from his last dose of Ramipril (7), which is why I asked him when he took his last dose (8) I want to make sure that he’s not taking two antihypertensives too close together (9), or else his blood pressure might drop down a little too much in the first day. (10)”

The operators used were “conclude” (1), “infer” (2), “review” (3), “infer” (4), “review” (5), “infer” (6), “review” (7), “explain” (8), “verify” (9), and “explain” (10)

**Table 2** Frequency of concepts identified in concurrent and retrospective think-aloud

Category	CTA concept	Total %	RTA concepts	Total %
Drug information*	Drug identification number, expiry date, label, identification, vial, quantity	91 (20.1%)	n/a	–
Patient* Note: CTA is technical and RTA is clinical	Patient address, patient info, patient contact info, date of birth, patient gender, patient name, personal health number	53 (11.7%)	Patient competency, patient interest, faith in patient, patient information was evident	16 (4.5%)
Prescription Information*	Prescriber Info, Prescription, Prescription Date	68 (15%)	n/a	–
Hardcopy*	Printout, printout notes, technical check	35 (7.7%)	n/a	–
Business related*	services, bag, cost	23 (5.1%)	n/a	–
Patient medical and medication history	Previous treatment, previous usage, medication history, past medical history, concomitant medication, patient age	25 (5.5%)	Patient age, allergies, blood pressure, medication history, physician assessment, past medical history, previous adherence, previous treatment, daily routine, alternative therapy, outcome	119 (33.1%)
Medication Related	Strength, Refills, Identity, Medication, Directions, Dose, Clinical Effect	68 (15%)	Clinical effect, medication, directions, dose, compare treatments, equivalent dose, mechanism of action, quantity, refill	93 (25.9%)
Adverse drug reaction	Side effect, allergies, cough, drug-drug interaction	25 (5.5%)	Cough, drug-drug interaction, side effect	31 (8.6%)
Decision and follow-up	Decision, follow Up	51 (11.3%)	Decision, follow up, assertion	96 (26.7%)
Electronic records	Electronic health record, patient profile	13 (2.9%)	Drug information resource, electronic health record	4 (1.1%)

\*Technical information

CTA concurrent think-aloud, RTA structured retrospective think-aloud

The emergence of the “overlooked” operator indicated a new type of reasoning in 32.4% of the decisions made in the RTA (i.e., hindsight reasoning). This type of reasoning refers to the decisions that the pharmacists made following their interaction with the simulated patient in the RTA sessions. Some pharmacists reported that they had overlooked some decisions during the simulation, and if they could repeat it, they would deal with the case in a different manner. Hindsight reasoning was verified by reviewing the consultation (drop off and pick up) and CTA sessions to ensure the “overlooked” operators were not present. Over half of the hindsight decisions were made using the analytical approaches (Box 3) and were decisions that were primarily related to medication effectiveness (Table 4).

Box 3: Example of hindsight reasoning expressed with forward-chaining

*RPh 102 [55 years old, female, 33 years of experience]*

“ [um] Well, now I am not sure if I did do that (1), [um] I think that the [um] was not allergic to anything (2), so we know the patient hopefully won't be allergic to this individual thing (3), because [um] he has an indication of no allergies (4), [um] It should be fine (5). [um] The doctor has determined the strength (6), so I guess that's according to what the blood pressure was taken in the office (7), and [um] now I can't remember what strength (8), or I guess it wasn't told what strength the Altace was, just that it was Altace (9), [um] so I'm assuming maybe it was, like, 10 mg Altace (10), that would be hopefully a comparable dose [um] (11) and [um] just to reiterate that it can cause dizziness (12) and that hopefully he won't [um] have a fall or pass out from standing up too quickly (13).”

The operators used were “overlooked” (1), “assume” (2), “predict” (3), “explain” (4), “conclude” (5), “review” (6), “review” (7), “review” (8), “overlooked” (9), “assume” (10), “predict” (11), “review” (12), and “predict” (13)

**Table 3** Frequency of operators identified in concurrent and retrospective think-aloud

Operator	Definition	CTA Total (%)	Structured RTA				Total %
			Indicated	Effective	Safe	Compliance	
Verify	Confirmation of accuracy of a specific fact	194 (42.9%)	–	–	2	–	2 (0.6%)
Act	A description of what pharmacists are doing or thinking of doing	101 (22.4%)	1	2	–	15	18 (5%)
Explain	Give reasoning for what they are doing or how things work, as well as rationalizing their choices, actions and decision	70 (15.5%)	8	27	15	22	72 (20.1%)
Review	Name facts, context or objects as well as going over patient data and information provided in the case scenario or profile	30 (6.6%)	14	10	33	11	68 (18.9%)
Conclude	Make a definitive decision and making a statement about a problem choice	22 (4.9%)	7	14	19	8	46 (12.8%)
Collect	Gathering more information from patient, electronic records, and drug information resources	13 (2.9%)	7	1	3	3	14 (3.9%)
Exit	Pharmacists giving cue that they are done checking the prescription and they are ready to end the concurrent think-aloud session	10 (2.2%)	–	–	–	–	–
Infer	Making an assessment based on connecting information or evidence	8 (1.8%)	15	16	19	14	65 (18.1%)
Predict	Expecting or guessing an outcome	2 (0.4%)	–	9	3	6	18 (5.0%)
Assume	Making a judgment or a decision based on a hunch	1 (0.2%)	3	–	2	5	10 (2.8%)
Plan	Pharmacists describing a step that will be taken in the future to achieve a care or monitoring plan	1 (0.2%)	–	4	–	8	12 (3.3%)
Overlooked	Ignoring or disregarding making a judgment. This operator appeared in the retrospective data as pharmacists were promoted with questions	–	2	11	5	6	25 (7%)
Match	Making a connection between current situation and past situations or current patient to past patients	–	1	3	4	1	9 (2.5%)

CTA concurrent think-aloud, RTA structured retrospective think-aloud

The pharmacists had taken an intuitive reasoning approach for 7% of the decisions made in the RTAs, and all of these decisions had been related to indication and safety (Table 4). One pharmacist (RPh 201; Box 4) used automaticity, and when she did so, she internalized decisions in a quick fashion and with no justification; meanwhile, when another pharmacist (RPh 702; Box 4) used intuition, she provided a justification. Two pharmacists employed pattern recognition in hindsight, an approach which was associated with the operator “match” (Box 4).

The dual process approach was employed three times in the structured RTA. This emerged when the pharmacists used the analytical and intuitive approaches to make a decision. If we combine the results of all four questions in the structured RTA and consider them as one chain of decisions related to medication appropriateness, seven out of the seventeen pharmacists followed the dual process.

#### Box 4: Examples of intuitive approaches

##### Automaticity

RPh 201 [38 years old, female, 16 year of experience] “because they were needing it for blood pressure” (1)

One operator was used, “infer” (1)

##### Intuition

RPh 702 [33 years old, female, 9 year of experience] “Cause I keep saying “It’s for your blood pressure,” and he’d be saying (1) “no, it’s not”, so I guess that’s a safe assumption he is taking it for blood pressure. (2)”

The operators used were “explain” (1), and “assume” (2)

##### Pattern recognition approach

RPh 201 “[um] Well it’s commonly used [um] if somebody does get a cough from from one of the ACE inhibitors (1). So this is usually the next [um] alternative (2)”

This represents a pattern recognition approach. The operators used were “match” (1), and “infer” (2)

**Table 4** Pharmacists' clinical reasoning approaches for checking medication appropriateness

System	Approach	CTA* Total (%)	Structured RTA				
			Indicated	effectiveness	safety	Compliance	total %
System 1 (intuitive, heuristics)	Intuition	–	1	–	1	–	2 (2.8%)
	Automaticity	–	1	–	–	–	1 (1.4%)
	Pattern Recognition	–	–	–	2	–	2 (2.8%)
	Total	–	2	–	3	–	5 (7%)
System 2 (analytical)	Hypothetico-deductive	–	2	2	4	2	10 (14%)
	Forward-chaining	14 100%	9	3	7	8	27 (38%)
	If/then	–	–	–	1	2	3 (4.2%)
	Total	14 100%	11	5	12	12	40 (56.3%)
Dual process theory (system 1 and 2)		–	1	–	2	–	3 (4.2%)
Hindsight reasoning	Intuition	n/a	–	–	–	–	0
	Automaticity		2	–	–	1	3 (4.2%)
	Pattern recognition		–	2	–	1	3 (4.2%)
	Hypothetico-deductive		2	4	–	1	7 (9.9%)
	Forward-chaining		1	2	–	–	3 (4.2%)
	If/then		–	2	–	–	2 (2.8%)
	No clinical reasoning		–	2	–	3	5 (7%)
	<i>Total</i>			5	12	–	6

\*Three pharmacists did not employ clinical reasoning during the CTA,

## Discussion

A simulation study was used to explore pharmacists' clinical reasoning approaches. When checking prescriptions, the participating pharmacists were most likely to use analytical reasoning approaches. When the pharmacists were asked specific questions regarding the decision-making model for pharmacy (i.e., check for indication, efficacy, safety, and adherence), they predominantly reported taking analytical decision-making approaches, with a third of the decisions being made in hindsight. Hindsight reasoning has not been reported in the previous literature on clinical reasoning. These findings should be understood in light of the broader context of pharmacy and the literature on clinical reasoning.

## Concepts and operators

The majority of the concepts and operators identified in the CTA were technical in nature, which is in line with the existing literature on the typical practice of community

pharmacists [4]. Pharmacists may be missing opportunities to assess the clinical appropriateness of medications. On the other hand, it is possible that the pharmacists had used intuitive reasoning and were not able to verbalize clinical reasoning during the simulation. Nevertheless, in the RTA, eight out of the seventeen participants stated that they had “overlooked” one or more items in the simulation, which suggests that pharmacists may not have considered some clinical issues.

Since these elements did not appear on the computer printouts, they needed to be checked with the patient, followed by a cognitive assessment by the pharmacist.

Pharmacists in previous studies have demonstrated a structured, sequential approach in a formulaic or routine manner [4, 10, 11, 31]. Historically, pharmacy workflow developed processes to ensure the accurate preparation of medications. Similarly, the computer printouts provided in our simulation prompted the pharmacists to verify technical concepts (e.g., patient demographics, prescriber information, quantities, and cost) and safety concepts (i.e., allergies and

interactions). These printouts could be adapted to nudge pharmacists to collect relevant information and check for medication appropriateness in a structured approach and a routine manner. However, we cannot rely on computer printouts to be the sole prompt for pharmacists to check for medication appropriateness. Since pharmacists predominately cross-check (i.e., verify) the elements of computer printouts, they may not be routinely using critical thinking at this time. During the RTA sessions, the participating pharmacists applied a higher level of critical thinking when they were asked open-ended clinical questions. They also reported an increased number of clinical related concepts and operators (e.g., “infer”, and “review”) and a slightly decreased number of technical operators (i.e., “verify” and “act”) than they did in the CTAs.

Moreover, the emergence of the operator “overlooked” in the RTA data was a significant finding in this study. When the participating pharmacists reported that they had “overlooked” a concept, they meant that they had not thought about this concept before. It is possible that when the pharmacists were asked open questions regarding medication appropriateness in the structured RTA, the element of surprise prompted them to reconstruct novel thoughts [32]. Other concepts which appeared in the RTA and not in the CTA may signify intuitive thinking that was more difficult to verbalize. Overall, the reported hindsight thoughts suggest that the participating pharmacists had the clinical knowledge and expertise to evaluate medication appropriateness but did not express this knowledge in the CTA session.

Pharmacists are encouraged to document all interactions with patients. Pharmacists could incorporate open-ended questions about medication appropriateness into the documentation format as a prompt to apply clinical reasoning. The open-ended questions on the documentation format could possibly mimic the RTA sessions in this study. Any hindsight thoughts that emerge at the documentation level will give the pharmacist the opportunity to review any potentially overlooked decisions.

### Clinical reasoning approaches

The literature on clinical reasoning in pharmacy is limited. To our knowledge, there are no studies that suggest what is the most appropriate clinical approach. In this section, we will discuss the clinical reasoning approaches identified in this study.

The majority of the pharmacists’ decisions were made based on analytical approaches. Even when the pharmacists reported decisions made in hindsight, they primarily relied on analytical approaches. Analytical reasoning has previously been identified in the pharmacy literature [12, 13]. Phansalkar et al. [12] suggested that expert clinical pharmacists follow analytical reasoning approach using the

information on patients’ charts to make hypotheses about possible adverse drug events and validate them (i.e., hypothetico-deductive approach). Bartels, on the other hand, suggested that experienced pharmacists make decisions through constant internal experimentation and reflection activities in which pharmacists start with gathering “objective” and “context-related knowledge” followed by a modification step. In the modification step, pharmacists perform a continuous dialogue and reframing of unsolved problems until they reach a clinical decision [13]. Evidence from the nursing literature suggests that novices are more likely to apply a *hypothetico-deductive or backward clinical reasoning approach* [15, 33, 34], as they have less domain-specific knowledge and may look for the information to support their initial decision [15, 35]. Experts, on the other hand, anticipate problems and collect the information they need to validate their hypotheses [15]. Decisions made using the *if/then approach* were classified it as being a part of analytical reasoning [36] although this approach has not been widely discussed in the clinical reasoning literature [15, 37, 38].

The pharmacists in this study occasionally made *intuitive* (i.e., little effort to explain decisions) and *automatic* reasoning approaches (i.e. one step without explanation, typically using “assume” as an operator). This distinction between automaticity and intuition have been reported in the nursing literature [15, 20]. *Pattern Recognition* only appeared in the structured RTA data; however, it is possible that intuitive reasoning may not have been reliably reported in the CTA as only heeded traces (i.e., what the subject is attending to or aware of) could be captured [17, 18] and Pattern recognition is associated with higher diagnostic success than the analytical approach [39]. Experienced pharmacists sometimes make decisions driven by pattern recognition based on prior experience with similar patients [12, 13].

Furthermore, some of the pharmacists in this study employed the dual process approach. Over the past decade, the dual process theory has become more prominent, as it solves the dilemma of the two approaches and explains the puzzling findings in the clinical reasoning literature [19, 40]. Studies suggest that clinicians can switch from one approach to another in their daily practice, depending on their circumstances and on the complexity of cases [19, 41].

The nature of clinical reasoning in pharmacy does not constrain pharmacists to one reasoning approach. Pharmacists are required to check for indication, effectiveness, safety, and adherence, and each of these decisions may require different cognitive thinking approaches. Some of these decisions may also require pharmacists to use multiple operators. Adherence, for example, may require pharmacists to collect, review, and infer. An indication may be more intuitive, as pharmacists may assume indication based on concomitant medications, pattern recognition, or the pharmacology of the medication. Expertise may support

pharmacists' use of intuitive reasoning for some elements of medication appropriateness. However, some elements may require pharmacists to be analytical regardless of their level of expertise (i.e., complex issues around medication safety, adherence, and effectiveness).

### Limitations

This study provides a preliminary understanding of the reasoning approaches used by pharmacists. Though our sample size is comparable to studies of a similar nature [15], the findings not intended to be generalizable due to the exploratory nature. The two primary threats to verbal protocols are reactivity and nonveridicality [42]. Reactivity is similar to the Hawthorne effect, where the task and observation alter the findings [43]. Veridicality is concerned with the completeness (omission) and accuracy (commission) of verbal reports [18]. Nonveridicality can reduce the trustworthiness of the verbal reports since they may not accurately reflect the participants' thoughts. Moreover, there is a tendency to reconstruct in RTA or a false recall of thoughts and events [38]. To reduce these threats, we trained the participating pharmacists to think-aloud, collected two types of verbal reports, and conducted the RTA immediately after the simulated case to avoid the reconstruction of answers [17]. The pharmacists were also asked to directly describe their thoughts and not explain them. Simulated patients have often been used under realistic conditions to control extraneous variables, thus maximizing external validity and ensuring generalizability [44]. Clinical simulations have the disadvantage of providing incomplete representations and not capturing all of the variables found in the clinical environment.

### Conclusion

When pharmacists assessed a medication therapy during a patient simulation, their cognitive activities were predominantly related to technical tasks. For the clinical tasks, the majority of the pharmacists followed an analytical decision-making approach to clinical reasoning. When the pharmacists were retrospectively asked prompting questions about their medication-related decisions, they used a combination of intuitive (e.g., “match” operator) and analytical decision-making approaches. The combined protocol analysis on both concurrent and retrospective think-alouds demonstrates that the pharmacists had the competency and knowledge to check for medication appropriateness. However, this knowledge was mostly restructured during the process of hindsight reasoning.

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## Appendix 1: Simulated case

### Case summary

Simulated patient (SP) enters the pharmacy with a new prescription of Candesartan 16 mg, the patient is new to the pharmacy and has a history of hypertension and dyslipidemia. The patient was experiencing dry cough with previously prescribed medication (Ramipril 10 mg) so his physician switched him to a different class. The patient reports that he tried OTC cough preparation but it did not work. The patient was hesitant to take the new medication, this comes out when the SP says that he is afraid that the new medication will cause the cough too.

### Main drug related problem(s)

SP has just been prescribed Candesartan 16 mg for his hypertension by his family physician. SP was on Ramipril 10 mg before and his doctor switched him to Candesartan due to dry cough caused by Ramipril. SP is taking cough suppressant to manage the cough and he is not sure if the new medication will cause the same problem or not and he is hesitant to take it.

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