

How can community pharmacists improve antibiotic use among outpatients? A qualitative study of pharmacists' clinical reasoning

Céline Slekovec^{1,2,3*}, Louise Joly^{4,5} and Thierry Pelaccia^{6,7}

¹Faculty of Health Sciences, University Marie and Louis Pasteur, Besançon, France; ²Infection Prevention and Control Department, University Hospital, Besançon, France; ³UMR 6249 CNRS Chrono-environnement, University Marie and Louis Pasteur, Besançon, France; ⁴Department of General Practice/Family Medicine, Research Unit Primary Care & Health, Liège, Belgium; ⁵Faculty of Medicine, University of Liège, Liège, Belgium; ⁶Center for Training and Research in Health Sciences Education (CFRPS), Faculty of Medicine, University of Strasbourg, Strasbourg, France; ⁷Prehospital Emergency Care Service (SAMU 67), Strasbourg University Hospital, Strasbourg, France

*Corresponding author. E-mail: celine.bouvier@univ-fcomte.fr

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Background: Antibiotics are widely overused, with over 25% of prescriptions in primary care deemed unnecessary or inappropriate. In France, as in many countries, community pharmacists (CPs)—often in collaboration with prescribers—can modify inappropriate prescriptions or refuse to dispense antibiotics through pharmaceutical interventions (PIs). However, the role of PIs and the clinical reasoning underpinning pharmacists' decisions remain poorly described.

Aim: To identify the factors considered by CPs when making PIs related to antibiotic dispensing, and to explore how these factors influence their practice.

Methods: This qualitative study involved face-to-face interviews with French CPs. Data were analysed thematically using an integrative approach by two independent researchers.

Results: Fifteen interviews were conducted, with data saturation reached after the 10th. PIs followed several steps: identifying the need for intervention, proposing therapeutic alternatives where necessary, contacting the prescriber, ensuring traceability, dispensing antibiotics and providing patient counselling. Pharmacists' clinical reasoning was influenced by factors related to patients, prescribers, their professional environment and broader contextual elements. Some factors were specific to antibiotics, while others were more general.

Conclusions: PIs enable CPs to address inappropriate antibiotic prescribing and reduce unnecessary dispensing in outpatient settings. A better understanding of the factors influencing pharmacists' clinical reasoning—such as patient-related, prescriber-related and contextual determinants—could inform strategies to improve antibiotic use. These insights should be integrated into pharmacy education and professional development.

Introduction

The emergence of bacterial antibiotic resistance represents a major public health concern, with the potential to result in therapeutic impasses in the most severe cases.¹ Antibiotics are predominantly prescribed in community settings.² Data on outpatient prescriptions show that 25%–60% of general practitioners' (GPs) prescriptions are unnecessary,^{3–8} and 15%–33% are inappropriate.^{3,4,8} France ranks as the fifth highest consumer of antibiotics in Europe, despite a series of national initiatives—mainly targeting GPs—that have had limited overall impact.²

Antibiotics are mainly obtained from community pharmacies on prescription. Pharmacists are thus considered key gatekeepers in ensuring the appropriate use of antimicrobials.⁹ Pharmacist-led strategies to improve antibiotic use may include counselling patients on their treatment and alerting prescribers when contraindications or drug interactions are identified.¹⁰ However, the effectiveness of such interventions in outpatient settings remains variable, as highlighted by Lambert *et al.*¹¹ This variability may stem, in part, from the complexity of the clinical reasoning processes underpinning pharmacists' decisions—an area that remains underexplored.

While clinical reasoning has been extensively studied for nearly five decades, primarily among physicians and nurses,¹² it is still not well described within the pharmacy profession. The available literature is largely based on qualitative studies using think-aloud protocols in simulated scenarios or case-based exercises,^{13–17} with limited insight into reasoning processes in real-world practice.

A deeper understanding of pharmacists' clinical reasoning could enhance the training of both students and professionals, improve the quality of patient care and help reduce medication-related errors.¹⁸ Furthermore, investigating pharmaceutical interventions (PIs) through the lens of clinical reasoning may provide new avenues for optimizing antibiotic use in outpatient care.

Aim of the study

To identify the factors considered by community pharmacists (CPs), in real-life settings, when making PIs related to antibiotic dispensing, and to explore the impact of these factors on their practices.

Ethics approval

The study protocol has been approved by the Francophone International Society of Medical Education (SIFEM) N° 170324 in March 2024.

All respondents completed a written consent form prior to the interview.

Participant anonymity was ensured by removing identifying information from the transcripts and assigning a number to each participant. Audio recordings were discarded after transcription.

Methods

Method is reported according to the consolidated criteria for reporting qualitative research (COREQ) guidelines ([Supplementary data](#), available as [Supplementary data](#) at JAC-AMR Online: Table S1).¹⁹

Study setting

In this qualitative study, semi-structured individual interviews were conducted with CPs practicing in Franche-Comté or in Alsace, two regions in eastern France, which account for 847 pharmacies and 2528 CPs.

Study design

A guide for conducting interviews was developed, based on our prior experience and preliminary reflections, with the objective of eliciting factors influencing PI and their consequences on pharmacists' practices.

Following the initial three interviews, the interview guide was subjected to a comprehensive evaluation. This process involved the implementation of minor adjustments with the objective of enhancing the clarity of the questions and facilitating the exploration of more specific factors.

Study respondents

Study participants were French CPs. They were invited to participate in the study through emails sent by three regional pharmacy institutions (National Order of Pharmacists, Regional Pharmaceutical Association,

Network of Training Supervisors). Volunteer CPs, who received no financial compensation, were then contacted by email to schedule an interview.

None of the researchers involved in this study knew the CPs interviewed.

Data collection

Interviews were conducted in person between March and June 2024. The face-to-face format was preferred whenever possible, or online using Microsoft Teams. The interview was scheduled at a time the pharmacists perceived to be convenient and free of interruptions. One-on-one interviews were conducted in a private room at the pharmacists' workplace. All interviews were audio-recorded. To ensure consistent data collection, all interviews were conducted by the main researcher (CS). As an infection preventionist, pharmacist and teacher, CS was able to deepen the interview through her prior experience and knowledge of pharmacy practice and education. She also completed training in qualitative interviewing. Audio recordings were transcribed verbatim by the lead researcher (CS). The transcripts were sent to each participant for validation.

Each CP completed a demographic questionnaire prior to the interview.

Data analysis

Due to the limited literature on clinical reasoning in pharmacy, this study was based on generic models generally used to explore the clinical reasoning of healthcare workers, such as dual-process theory and the hypothetical-deductive model. The study particularly examined its socio-cognitive approaches. The researchers developed a guide for conducting interviews based on their prior experience and preliminary reflections, and they analysed the collected data using a general inductive approach. Data were analysed using NVivo 14 software. Two researchers (CS and LJ) independently double-coded 5 of the 15 interviews (the first three and two mid-process) to ensure consistency in code application and refine the coding framework. Discrepancies were discussed until consensus was achieved, and the codebook was adjusted accordingly. This partial double-coding approach followed established recommendations for enhancing reliability in qualitative data analysis.²⁰

Progress was regularly presented to a third researcher (TP) experienced in qualitative research, for validation. Codes were placed in categories, and categories were later conceptualized into broad themes with subthemes.

Interviews were conducted in sets of five and analysed iteratively. Additional sets were added until data saturation was reached, defined as the point at which no new themes emerged in at least two consecutive interviews.

Results

Participation and data analysis

Fifteen French CPs agreed to participate and were all interviewed. The study included 15 participants with a mean age of 44.7 years (range: 27–63). Twelve were women, and ten were licensed pharmacists. Eight participants practiced in rural areas, six in suburban neighbourhoods and one in the city centre. The average number of employees per pharmacy was seven (range: 2–13).

The average length of the interviews was 71 min (45–110 min). All interviews were conducted face-to-face, except one, which was conducted online using Microsoft Teams due to practical constraints.

The intercoder agreement rate was initially 57.1%, then 98.0% after adjustment of the analysis grid.

Table 1. Factors considered by the CPs according to the step of the PI)

Steps Factors	Indication of PI	Proposition of a therapeutic alternative	Prescriber's call	Traceability of the PI	Antibiotic dispensing and patient counselling
Patient	• Patients' background (<i>allergy, pregnancy, kidney or renal failure</i>) • Missing information on the prescription (<i>indication, complementary tests</i>)	• Patients' background (<i>allergy, pregnancy, kidney or renal failure</i>)		• Severity of the nonconformity (major or minor)	• Habits of antibiotic consumption • Attitude • Health literacy
Prescribers	• Type of exercise	• Habits of prescription • Type of exercise (<i>dentist</i>) • Prescribers' reachability (<i>hospital practitioners, secretary platform</i>)	• Habits of prescription • Prescribers' availability (<i>hospital practitioners, secretary platform</i>) • Prescribers 'way of communication	• Element of proof	
Pharmacist	• Knowledge (<i>initial and continuing training, local healthcare professional network</i>) • Deviation from guidelines • Peer-to-peer relationship	• Knowledge • Guideline • Peer-to-peer relationship		• Pedagogical intention • Valuing pharmaceutical activity	
Context	• Epidemic • Antibiotics shortage • Organizational factors • Geographical factors	• Antibiotics shortages		• Rush-hour • Duty	• Epidemic • Antibiotic shortage

PI, pharmaceutical intervention; **bold**: factors' categories more specific to antibiotic practices; *italic*: illustration of the category

Data saturation was observed at the 10th interview, i.e. no new categories or themes emerged in the subsequent five interviews. However, since verbatim analysis was conducted in sets of five interviews, saturation could only be confirmed after analysing the third set, corresponding to five additional interviews.

Factors considered by pharmacists for the implementation of PIs

PIs could be divided into different steps: assessment of the indication for a PI and, if required, proposition of a therapeutic alternative; prescriber's call; traceability of the PI; dispensing of the antibiotic and related patient counselling.

Table 1 summarizes the type of factors (factors related to the patients, the prescribers, the pharmacists or their colleagues and contextual factors) mentioned by CPs for each of the steps of the PI.

These factors could be specific to antibiotics or common to other pharmaceutical classes.

Table 2 summarizes the most relevant quote factors.

Indication of PIs

To assess the need for PI, CPs draw on their different areas of expertise. Most CPs reported that they did not receive specific training in PIs during their studies, and if they did, it was prescription analysis without contextual data. CPs reported that they had learned to manage PIs during their pharmacy internships.

Allergy and contraindication. Almost all CPs requested and tracked an antibiotic allergy history in the pharmacy software, making it possible to identify contraindicated antibiotics even when the prescriber is not aware of the patient's complete medical history (e.g. dentist, substitute physicians, etc.). Some of them also looked for data that might influence the dose of antibiotics prescribed, such as age, weight, pregnancy, kidney and liver function.

Deviation from guidelines. Few CPs reported being able to identify unnecessary antibiotic prescriptions in epidemic conditions and regretted the lack of use of rapid diagnostic tests.

Most pharmacists identified deviations from antibiotic recommendations (e.g. dosage and duration according to patient profile, e.g. age). When necessary, they consulted various antibiotic guidelines. Many pharmacists reported that they lacked diagnostic information that would allow them to suggest a relevant change to the prescriber. Almost all pharmacists asked the patient for the diagnosis. Some of them felt that information provided by a patient or caregiver could be unreliable due to a low level of understanding or knowledge. They might also ask prescribers for additional information.

The pharmacists working near the French border with Germany and Switzerland noted that the prescribing habits of foreign physicians differed from those of their French colleagues because of differences in antibiotic guidelines between countries.

Table 2. Main quotations related to the factors considered by CPs according to the step of the IP

Factors related to	Quotations
The patient	<u>Antibiotic allergy</u> 'We always ask if there are allergies for example, so necessarily when the patient we says he has an allergy and we're going to do an PI.' (Pharmacist 1)
	<u>Information linked to the diagnosis</u> 'We have people who come to us and say, "I have rhinopharyngitis, sinusitis and angina," and sometimes the flu [...] when we call the doctors for clarification, we find that it's not what they said, people have interpreted and repeated it in different ways.' (Pharmacist 5)
	<u>Information linked to complementary exam</u> 'So, if we have an 80-year-old patient on a drug with a narrow therapeutic range where we need to be able to adjust the dosage, we often don't know. The patient doesn't know. We can try to look at the DMP [i.e. "shared medical records", which are not used systematically], where there's often not much. So, we're groping our way forward.' (Pharmacist 11) 'Mom says he has strep throat. Of course, there's no such thing as bacterial angina in a 3-year-old. No test has been done.' (Pharmacist 11)
The prescribers	<u>Habits of prescription</u> 'Amoxycyline 1 g, morning 8 days. So, that alerted my pharmaceutical assistant who came immediately see me because in a 1 g just like this 8 days... it was weird [...] he has thought of something...' - Interviewer "Because he is a prescriber who does not always prescribe amoxycillin 1 g once a day?" - "Yes, three times a day and always three times a day so it is that he must have thought of something'.' (Pharmacist 12) 'We find that when we talk to people, "Yes, she tested me. So, we know which doctors are doing the testing. By and large it's the younger doctors. And the older doctors don't test.' (Pharmacist 14) 'I think they [the new prescribers] would be more in line with the indications or dosages. "... "Younger doctors may be more inclined to listen to us. I agree. Without looking down on us and thinking we're just pharmacists who don't have much to say. We're often misunderstood.' (Pharmacist 10)
	<u>Prescribers' reachability</u> 'It was a weekend, I had called the doctor across the street to get an opinion on another prescription because I couldn't get anyone.' (Pharmacist 1) 'I've already called the center, well 3966, to get medical advice on what to do in a situation where I don't have all the information.' (Pharmacist 10)
The pharmacists	<u>Knowledge</u> 'Already in our studies we know about pathologies. We know about treatments. After that, we don't diagnose, but we know. From what we hear, we can get an idea. And then maybe, I would say, it's a little experience we have with the prescribers, we know they use a molecule. If they're missing something, we know what they're using as an alternative. So, it depends on the prescribers and also on our experience, I think'. (Pharmacist 14) 'If you have also been trained recently, you will be aware that things evolve. It is not possible to train for everything all of the time.' (Pharmacist 3)
	<u>Guideline</u> 'It's already happened to us on Saturdays, when we don't have the TBA, um... the doctor isn't there, he's not working. We can't leave the patient all weekend with nothing. So, we make a note of it. That's precisely why I've already used Antibioclic® [i.e. a French online guideline based on the French society of infectious diseases recommendation] for to try and find the 2nd intention.' (Pharmacist 3)
The contextual factors	<u>Epidemic context</u> 'We have the example of whooping cough, for example, which is an epidemic, and we have a lot of it. So, they always put in Clarithromycin, but we ran out. Well, what else can we offer in the same family?' (Pharmacist 15) 'Teleconsultation terminals, there's a lot of them, they've tried to put them everywhere, so the more they multiply...so we've done quite a few during the epidemic periods' (Pharmacist 5) 'I know there are some treatments that don't necessarily seem very appropriate to me, especially during flu season when we have doctors who are systematically giving ATBs to people who are diagnosed with the flu.' (Pharmacist 5)
	<u>Antibiotic shortage</u> 'For instance, dentists utilize spiramycin-metronidazole. Due to a significant shortage, we had to recalculate. I have spiramycin alone, and I have metronidazole alone. How much do we make?' (Pharmacist 5) 'we're already going to call our colleagues. Then, as far as the patients can travel, that's it. So, we call the four, well, the three other pharmacies in [name of cities] or a little bit further away. And then, when we've done the rounds and haven't found what we're looking for, when we've questioned all our suppliers, when we've called the pharmaceutical companies in certain cases, as a last resort, we call the doctor to modify the prescription, change the treatment.' (Pharmacist 14)

Some pharmacists were also influenced by the specialty of the prescriber. Specialists as hospital practitioners were considered as a pledge of trust, while pharmacists were more vigilant with GPs, substitute physicians, or dentists. One of them also considered the deviation from prescribing habits of the same prescriber.

Factors influencing decision

Proposition of a therapeutic alternative. Pharmacists said they used knowledge gained from their initial training, internships or continuing education (e.g. reading professional journals, training provided by laboratories or local professional networks) to determine the best therapeutic alternative.

Some pharmacists also considered personal physicians' prescribing habits to suggest alternatives more likely to be accepted or to fill in missing information, such as duration of treatment.

Most pharmacists said that dentists seemed less comfortable suggesting alternatives when the antibiotic could not be dispensed. In such cases, they often asked the pharmacists to 'do as they please'.

Most pharmacists reported difficulties related to antibiotic shortages. Half of the pharmacists reported implementing an alternative strategy, either internally or externally, to honour the original prescription before contacting the prescriber to request a molecule change. Some of them informed the prescriber of the antibiotics available in stock before the prescriber validated an alternative.

Prescriber's call. Prescription changes were routinely discussed with the prescriber. CPs often distinguished two types of prescribers according to their antibiotic prescribing habits. They distinguished between 'old' and 'new' prescribers. CPs described the old prescribers as the most likely to prescribe outside the norm, to have a strong doctor-patient relationship and to be contemptuous of pharmacists. Conversely, the new physicians were described as better prescribers, with a superficial relationship with their patients and with better listening to CPs. When a prescription change was necessary, CPs called prescribers regardless of their representation, but they reported that old prescribers were generally unwilling to switch.

Whatever their age, many CPs said that the role of the pharmacist in preventing antibiotic resistance was important. However, newly qualified CPs seemed to have a more egalitarian and complementary view of the roles of pharmacists and physicians, while the comments of older CPs reflected a sense of medical hegemony.

Several CPs reported difficulty reaching prescribers outside of physician office hours. Half of the CPs explained that they overcame this difficulty by having the prescriber's direct telephone number. Some of them found the presence of a secretary to be an obstacle to communicating with the physician. Some pharmacists reported using a secure messaging service, but regretted its low use by prescribers and higher response time. A number of CPs reported difficulties in contacting hospital prescribers due to uncertainty about their identity (e.g. a trainee signing for the senior prescriber).

If the prescriber could not be contacted in time to avoid compromising the patient's care, particularly in the case of an allergy or other noncompliance with a high risk to the patient, some CPs

asked for a referral to another prescriber in the same specialty among their acquaintances or, as a last resort, to the emergency services.

Traceability of the PI. All CPs reported tracking the change on the prescription, but only the most relevant PIs were also tracked on a dedicated support (national electronic folder or local ring binder) because it was time-consuming. This was the case when the pharmacist disagreed with the prescriber and wanted to record it formally, or when the CPs wanted to keep this prescription as a learning tool.

The tracking on a dedicated support could be delayed in case of lack of time (e.g. duty, rush hour).

Antibiotic dispensing and patient counselling. CPs who identified unnecessary prescriptions, such as antibiotics for influenza, regretted being forced by regulation to dispense unnecessary antibiotics in the absence of pharmacological arguments. One CP mentioned being unable to object to dispensing, but still attempted to regulate the number of boxes dispensed.

CPs took time to explain to patients how to take their treatment, any side effects and how to limit them. They also made patients aware of the risk of self-medication and the importance of returning unused treatments to the pharmacy. One CP also pointed out that this over-the-counter information was important because it was not always given during consultations.

Some CPs felt that the messages about the correct use of antibiotics were useless with patients who are heavy users. They sometimes mentioned a form of complicity on the part of the prescriber in responding to patients' requests for antibiotic prescriptions. Some CPs took little or no time for counselling, depending on the patient's attitude (pressure, anger), but may take more time for patients with low health literacy.

Discussion

PI in antibiotic dispensing is a complex process influenced by various factors. These include the prescription, the roles of the patient, prescriber and pharmacist and contextual elements, some of which apply to all drug classes.

The factors identified in our study were similar to those identified by Mertens *et al.*²¹ in a study of pharmacists' clinical decision making in contexts not specific to antibiotic dispensing. The factors considered by the PI process in our study, like those identified by Mertens *et al.*, can be explored using the COM-B system (capability, opportunity, motivation, behaviour), which identifies three factors to enable behaviour change²²: (i) Capability (i.e. knowledge and guidelines, pharmacists' involvement in the appropriate use of antibiotics), (ii) opportunity (i.e. antibiotic shortage or epidemic context) and (iii) motivation (i.e. pharmacists' perception of the value of their role, interprofessional collaboration). Given that all community antibiotic prescriptions are filled in a pharmacy, pharmacist input could be instrumental in driving practice changes that would have a significant impact not only on pharmacists themselves, but also on prescribers and patients. Since June 2024, French CPs have had the opportunity to prescribe antibiotics in specific cases of angina of adults and children over 10 years or cystitis of women aged 16–60 years.^{23,24} These new missions are accompanied by

mandatory training. It would be appropriate to combine this training with additional training on the role of pharmacists in the proper use of antibiotics, which would include the presentation of the factors identified in this study to improve the quality of PIs and antibiotic practices.

Factors related to prescribing highlight the need for CPs to have information related to the antibiotic indication (i.e. diagnosis, ancillary tests). These data are key elements, especially when formulating alternatives. Indeed, the same antibiotic may be prescribed for different indications; the name of the molecule alone may not allow identifying relevant alternatives according to the antimicrobial guideline.

CPs deduced the indication from data on the patient's current prescriptions, from his/her behaviour, from information provided by the patient, and from additional tests, if available. Each of these sources introduces a degree of uncertainty that complicates the pharmacist's analysis and leads to suggestions that may be irrelevant. The antibiotic indication is subject to medical secrecy and must be shared securely, and cannot simply be written on the prescription. In the hospital environment, pharmacists have access to all patient data (diagnosis, ancillary tests, follow-up data) through the hospital software. A similar approach could be implemented in the community, particularly by optimizing the use of shared medical records, which already exist in France but are still underutilized. This kind of information sharing in outpatient have proved its interest.²⁵

This study showed that CPs' practices contribute to the prudent use of antibiotics through the expectations described in the European Commission report.⁹ However, the practices of the CPs included in this study were heterogeneous, suggesting the importance of considering specific and diverse needs when proposing a training programme.

Pharmacists use their knowledge and various guidelines to suggest changes in antibiotic, dose or duration. Several of them use an online national guideline that is widely used by both prescribers and pharmacists (i.e. Antibioticlic®). Using the same reference could facilitate communication between these actors, which is a key point to a constructive relationship. The physician-pharmacist relationship would also be improved by a better knowledge of their respective roles and missions. This can be promoted through joint activities such as interprofessional congresses or the discovery of their respective practice conditions. For example, two French universities (i.e. Lille and Lyon) have implemented interprofessional placements consisting of the observation of general practice and community pharmacy by sixth year pharmacy students and general practice residents, respectively, over two days. This type of training must be evaluated and, according to the results of this evaluation, generalized to other university. Beyond these initiatives in initial education, interprofessional collaboration has also been studied in healthcare practice. A study published in 2022 highlighted the benefits of interprofessional collaboration between physicians, nurses and pharmacists in hospital settings, particularly regarding the optimization of antibiotic therapies.²⁶ In primary care, a Cochrane review conducted in 2017 listed different types of interprofessional cooperation, such as the use of interprofessional checklists, regular interprofessional meetings, or interprofessional rounds.²⁷ Although this review did not allow firm conclusions about the effectiveness of these approaches, the authors underlined the

increasing number of studies exploring interprofessional practice in recent years, which reflects a growing interest in developing and evaluating such collaborative strategies.

The study also showed that pharmacists were able to identify unjustified antibiotic prescriptions, particularly those for viral infections. However, French legislation does not allow pharmacists to refuse to fill a prescription in the absence of pharmacological arguments. It would therefore be necessary to find new ways of thinking that would enable pharmacists to oppose the prescription of really unnecessary antibiotics, which can account for up to 50%–60% of antibiotic prescriptions in France.^{3,4} In practice, pharmacists play a key advisory role in optimizing antibiotic use. They engage with prescribers to assess the necessity of antimicrobial therapy and, when indicated, to suggest narrower-spectrum alternatives. Pharmacists also contribute to improving adherence by recommending formulations and dosing regimens suited to patients' lifestyles and by providing clear instructions for correct use. Furthermore, they promote responsible antibiotic practices by preventing self-medication, encouraging the return of unused drugs, and, in some settings, dispensing antibiotics in unit doses. These actions illustrate pharmacists' active contribution to antibiotic stewardship in the community, even within the limits of their prescribing authority.

Strength of the study

This study was conducted among CPs in France, the fifth largest consumers of antibiotics in Europe in 2023.²

Our diverse population of CPs, including all ages, genders, both owners and assistant pharmacists, training supervisors or not and practice setting (rural or urban), reflects the diversity of pharmaceutical practice. The sample size ensured data saturation. Dual coding by two researchers reduced bias in data interpretation thus ensuring greater credibility.

This study offered a new approach to the exploration of the pharmaceutical clinical reasoning, integrating the use of real-life data.

Limitation of the study

We cannot exclude a selection bias, so the pharmacists included in this study may not be representative of the general population of CPs. However, part of the participants were particularly interested in the topic of antibiotics, while others were more interested in the PI. This double topic could reduce this bias by including not only pharmacists interested in antibiotics.

Our study consisted of interviews examining recent PIs related to antibiotic dispensing by pharmacists. This method is subject to recall bias; however, the interviews were supported by the prescriptions concerned, which helped to limit this bias.

Conclusion

PIs can contribute to optimizing antibiotic prescribing and reducing unnecessary dispensing in the outpatient setting. A better understanding by pharmacists of contextual, patient and prescriber factors that influence their clinical reasoning could further improve antibiotics use. Teaching these factors to pharmacy students could therefore be an interesting avenue for training. This study also highlights the benefits of clarifying roles, sharing

medical diagnosis with pharmacists, and harmonizing guidelines between prescribers and pharmacists.

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Transparency declarations

None to declare.

Author contributions

Céline Slekovec: conceptualization, methodology, data analysis, investigation, data curation, writing original draft. Louise Joly: data analysis, writing original draft. Thierry Pelaccia: conceptualization, writing—review & editing, supervision.

Supplementary data

Table S1 is available as Supplementary data at [JAC-AMR](https://www.jac-amr.com) Online.

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