RESEARCH

Antimicrobial prescribing in French nursing homes and interventions for antimicrobial stewardship: a qualitative study

Marie Hamard[1,2,3*], Claire Durand[3], Laurène Deconinck[2], Claire Amaris Hobson[2], François-Xavier Lescure[2,3], Yazdan Yazdanpanah[2,3], Nathan Peiffer-Smadja[2,3,4*] and Agathe Raynaud-Simon[1]

Abstract

Background Overuse of antibiotics is frequent in nursing homes (NHs) leading to adverse events and selection of resistant bacteria. Antimicrobial stewardship interventions showed heterogeneous effects on reducing inappropriate use of antimicrobials in NHs.

Objectives This study aimed (1) to analyze antimicrobial prescribing determinants in NHs; (2) to identify which resources for antimicrobial prescribing are used by NHs' physicians (3) understand which antimicrobial stewardship interventions are required and how they should be implemented in NHs.

Methods We conducted individual semi-directed interviews with NHs' prescribing physicians in Ile-de-France, France. A thematic content analysis was conducted iteratively.

Results Thirteen interviews were conducted. Participants were mostly women, with a median age of 48 years and a median professional experience in NHs of three years. Participants included medical coordinators, general practitioners and salaried physicians. Main determinants of antimicrobial prescribing in NHs were the perceived risk of infectious complications and discomfort in residents, the difficulty in obtaining microbiological samples and the lack of healthcare professionals to monitor patients. Most participants reported using national guidelines and electronic decision support systems to guide their antimicrobial prescribing. Institutional constraints accentuate situations

---

Why does this matter? Considering an aging population and the growing burden of antimicrobial resistance, it is urgent to develop and optimize the implementation of antimicrobial stewardship interventions in nursing homes.

*Correspondence:
Marie Hamard
marie.hamard@aphp.fr
Nathan Peiffer-Smadja
nathan.peiffer-smadja@aphp.fr
Full list of author information is available at the end of the article

Introduction

On a daily basis, almost 5% of the Nursing Homes (NHs) residents receive antimicrobials and close to a third of them for prophylaxis purpose [1]. Recent global meta-analysis suggested that only 28% of antimicrobial prescriptions are appropriate in NHs [2]. Antimicrobials misuse increase the occurrence of iatrogenic adverse events including *Clostridioides difficile* infection and contribute to the emergence of antimicrobial resistance [3–6] (AMR). AMR is considered by the World Health Organization as one of the major threats for human health [6]. AMR rates are higher in NHs than in the community settings [7–9]. For example, in France in 2020, 3.3% of

of doubt and prompt physicians to prescribe antimicrobials "just in case" despite the will to follow guidelines and the known risks of antimicrobial misuse. Physicians stated that proper antimicrobial use in NHs would require a major effort but was not judged a priority as compared to other medical issues. Producing guidelines tailored to the NH's context, performing good practice audits with feedback on antimicrobial prescribing, and reinforcing multidisciplinary relationships and discussions between city and hospital professionals were cited as potential interventions. The role of the medical coordinator was described as central. According to physicians, collaboration among stakeholders, providing support and training during the process might prove effective strategies to ensure successful implementation.

Conclusion Antimicrobial prescribing is a complex decision-making process involving different factors and actors in NHs. Tailored guidelines, good practice audits, strengthened multidisciplinary collaboration were proposed as key AMS interventions. Physicians emphasized the central role of the medical coordinator supported by stakeholder engagement, collaboration, training and ongoing support for successful implementation.

Key points

- According to physicians working in French NHs, antimicrobial prescribing in nursing homes depends on the resident's characteristics, the environmental context and resources, the nursing staff professional role and the perceived consequences of antimicrobial prescribing by the physicians.
- Nursing home physicians feel quite comfortable with antimicrobial prescribing in everyday situations and may not feel that improving antimicrobial prescribing is a top priority.
- Developing new guidelines tailored to the nursing homes context, providing audit, feedback on antimicrobial prescribing and straightening multidisciplinary relationships, were perceived by French physicians working in NHs as good leverage to improve antimicrobial prescribing.

Escherichia coli strains were resistant to third-generation cephalosporins in the community as compared to 10.2% in NHs [10].

Antimicrobial stewardship (AMS) is defined as the interventions promoting wise antimicrobial use in order to prevent from adverse events associated with their prescription, including the emergence of resistance. In hospitals, AMS interventions have been shown to improve the adherence to guidelines, reduce the length of hospital stays and decrease the incidence of resistant bacterial strains carriage and infections without increasing hospital readmission and mortality [11, 12]. These results encouraged the government and scientific agencies to enhance implementation of AMS interventions in NHs [13–15]. While some studies suggest an impact of AMS on reducing antimicrobial misuse in NHs, others show no significant effects [16–19]. Most of these interventions focused on urinary tract infections and effective studies generally included multidisciplinary and multimodal interventions [16].

A recent systematic review of quantitative studies summarizing factors influencing the volume and inappropriate prescribing of antimicrobials in nursing homes highlights the fact that it depends on multiple factors forming a complex conceptual framework [20]. Residents in NHs are more vulnerable to infections due to decreased functional capacity, changes in immunity, comorbidities, and sharing facilities with others [21]. Microbiological samples are often difficult to obtain in older patients. Indeed, resident characteristic such as history or potential signs of infection, presence of invasive device or limited life expectancy tend to increase antimicrobial prescribing [3, 22].

Prescribing behaviors also influence antimicrobial prescribing as previous high prescription rate is associated with higher antimicrobial prescribing [23]. Moreover, as in other settings, physicians might prescribe antimicrobials "just in case", even if it means overprescribing, rather than addressing the potential side effects or the public health problem of emerging resistance including in palliative care [24–27].

Organizational factors such as high staff turnover or the prevalence of out-of-hours medical visits have a negative influence on antimicrobial prescribing. Thus, prescriptions tend to be inaccurate when made by telephone or when the doctor has not examined the resident [28]. In addition, antimicrobial prescribing is lower when there is an in-house coordinating physician and more appropriate when there is a strong nursing presence [20].

Lack of time, resources, and qualified personnel in NHs limit the sustainable adoption of AMS interventions [29]. Moreover, the content of AMS interventions and implementation strategies described in the literature are rarely tailored to the specific NH context. This context is specific to each facility, and varies greatly from one country and healthcare system to another. In particular, considering specific resident profile, organizational constraints (including the presence of a medical coordinator able to lead the project) and availability of support devices (e.g. pharmacy, laboratory, radiology or infectious diseases

counseling) would probably enable better adoption and sustainability of AMS interventions [30]. Physicians' ability to tolerate uncertainty and make decisions also vary between countries and may be key elements in the success of AMS interventions [31]. Added to this is the need to work on motivation to change behaviors and stakeholders' buy in [17]. Overall, successfully implemented interventions often show only temporary results, not exceeding one-year post-intervention [28].

This study aimed (1) to analyze antimicrobial prescribing determinants in NHs; (2) to examine potential resources for antimicrobial prescribing (e.g. clinical decision support systems, brochures, etc.), whether in use or not, in order to determine the resources available and their potential limitations; (3) to understand which antimicrobial stewardship interventions are required and how they should be implemented in NHs according to NHs professionals.

Methods
This study employed a qualitative approach through the use of semi-structured interviews. The study is reported in accordance with the Consolidated criteria for reporting qualitative research (COREQ) check-list [32].

Study participants
Participants were licensed prescribing physicians working in NHs in the Ile-de-France region in France. NHs usually employ a medical coordinator and a nurse coordinator who are in charge of organizing residents' healthcare. The general practitioner (GP) of each resident is the doctor in charge of the resident's medical management and prescribing. Residents are free to choose their own GP, who may not be one of the NH's practitioners. Some NHs employ salaried physicians in addition to the GPs.

In 2019, the Ile de France region numbers 698 facilities, with a total capacity of 64,196 beds. Forty-three are public, 569 are private, including 342 for-profit. In France, we count 10,525 facilities, 17.8% have 41–60 beds, 26.9% have 61–80 beds, 20.5% have 81–100 beds, 12.4% have 101–200, 1.6% more than 200 beds. There are 5024 medical coordinators, 2152 of whom work on a full-time equivalent basis (i.e. 0.28 per 100 beds). This figure is close to 0.50 per 100 beds in private facilities and 0.30 per 100 beds in public facilities. A total of 2244/7990 (28%) have access to an in-house pharmacy, and 937/2147 (42.5%) claim to have their own in-house pharmacy. A total of 1878/8783 (21%) report having a 24-hour nursing presence [33].

Participants included medical coordinators, salaried physicians or GPs as long as they prescribed antimicrobials in NHs. Participants were first recruited through the mobile geriatric outpatient teams of three academic hospitals in Paris. These mobile geriatric outpatient teams intervened in 19 NHs in four departments in France. All eligible physicians working in these NHs were approached by phone and/or email and invited to participate. The only exclusion criterion was refusal to participate in the study. Using snowball sampling, all participants were asked to propose to other colleagues working in NHs to take part in the study. Sample size was not predetermined but interviews were analyzed iteratively and conducted until data saturation. The data saturation was collectively discussed after ten interviews. Participants, while providing specific elements at times depending on their position or location, generally expressed themselves homogeneously on the topics discussed. Written and oral consent were obtained from participants prior to each interview. Physicians who left invitations unanswered did not give a reason. We did not select participants according to their profile or the characteristics of the nursing home. No relationship between the authors and participants was established before the study commencement.

Interview schedule
The interview guide was built after bibliographical research and addressed the following subjects: practitioner's role in antimicrobial prescribing; prescription process and the different factors influencing it; perceived needs to optimize antimicrobial prescribing; implementation of the proposed measures.

The interview guide was reviewed and validated by infectious disease's physicians, geriatric physicians familiar with NHs and qualitative and implementation science researchers. The interview guide was then piloted during two preliminary interviews with prescribing NHs physicians in order to evaluate its relevance and understanding. It was slightly modified according to feedback. The final interview guide was composed of 16 questions (Table S1. Appendix). We did not need to adapt the interview guide during the data collection prosses.

Data collection
Following quantitative data were collected: age, gender, role, number of years working in a NH, number of residents followed by the physician and number of NH in which the physician worked. We also collected data on the characteristics of the facility where the physician worked: location (urban/rural), funding (for-profit or not-for-profit), number of residents, number of working physicians, partnerships (laboratory, pharmacy) and presence of a 24-hour nurse. When practitioners worked in more than one facility, we collected the location and funding of facilities, the total number of residents followed by the participant and whether they usually had partnerships (laboratory or pharmacy) and access to a

24-hour nurse, without going into detail about each nursing home where they worked.

Individual interviews were conducted and recorded by the first author (MH) either face-to-face at the NH, by telephone or videoconference. No repeated interviews were conducted. MH is a female medical doctor who was a Master of Public Health student at the time of the study. She had no preliminary experience as an interviewer. She was academically trained in qualitative studies and under the supervision of co-authors of the study who had an extensive experience in qualitative research. The purpose of the study was outlined to participants. They were aware of MH's credential and occupation, but not of her personal motivations. MH collected field notes during and after the interviews. Interview recordings were anonymized before being transcribed verbatim. Non-verbal communication was also transcribed. Once the transcripts were checked for accuracy, the audio recordings were destroyed. The transcripts and findings were not returned to participants.

Data analysis

Quantitative data were described by median and interquartile range for quantitative variables and by number and percentage for qualitative variables.

An inductive thematic content analysis [34] was conducted using NVivo13 to code, organize and analyze the interview transcripts.

After checking and reviewing transcript records in detail to identify major themes and categories, two coders (MH and CD) independently coded a third of the transcripts. They applied codes to broad themes and further decomposed it into sub-themes. Code definitions and compiled illustrative examples were iteratively reviewed with a larger research team (MH, CD, NPS, ARS). Then, the primary coder (MH) finished structurally coding all transcripts. A third coder (NPS) reviewed all the transcripts. There were frequent discussions and reviews of coding results. After coding, sub-themes and themes were categorized and classified independently using theoretical domains framework [35]. A theme tree was developed and reviewed with the larger research team before interpretative data analysis. The process of data analysis was iterative and parallel to the conduct of the interviews. The recruitment of physicians and the conduct of interviews continued until the themes were saturated.

Ethics

According to French law for qualitative study, the study protocol was approved by the Ethics Committee of *Gérond'if, gérontopole d'Ile de France.* The protocol was classified as MR-004 on the 03/16/2022. The acceptance number is 12,022.

Results

We conducted thirteen interviews between February and June 2022. The interviews ranged from 35 to 85 min. Participants were mostly women ($n=9/13$), aged 48 years, with a median of 3 years of experience in NHs. Six participants worked as medical coordinators only, three as general practitioners only and two as salaried doctors only. Five participants worked in multiple NHs. Two of them worked both as part-time medical coordinators (two days a week) in one of the NHs in which they worked and as general practitioners in the others. Four of the medical coordinators worked full time, three half time and two part time. Most participants worked in a private NH ($n=11/13$), located in an urban area ($n=11/13$). On average, participants were in charge of 60 residents. Seven physicians worked in at least one NH with access to nurse during the night. Most physicians worked in at least one NH with a partnership with a pharmacy ($n=12/13$) and a laboratory ($n=12/13$). Details are provided in Table 1.

General information about antimicrobial prescribing

While some of the participants prescribed antimicrobials at least once a week, others reported prescribing it every six months or depending on the season. All agreed that the most common infections were urinary tract infections, respiratory tract infections and skin infections. Participants stated that they felt quite comfortable with antimicrobial prescribing. Some agreed that "complex infections" required hospitalization and therefore were not managed in NHs.

Prescribers sought help for antimicrobial prescribing in different situations. First, when they did not know or were unsure of therapeutic modalities. Second, when they needed help in case of treatment failure. Finally,

Table 1 Demographic information about participants

Demographic information	
Participant	**n = 13**
Age, *median (IQR)*	48 (34;61)
Female, *n (%)*	9 (69)
Years working in a nursing home, *median (IQR)*	3 (1;10)
Medical coordinator, *n (%)*	9 (69)
Employed in two or more nursing homes, *n (%)*	5 (39)
Employed in a for profit nursing home, *n (%)*	9 (69)
Work in an urban area, *n (%)*	11 (85)
Number of residents monitored by the participant, *median (IQR)*	60 (22;90)
Work in at least one NH with a partnership with a laboratory, *n (%)*	12 (92)
Work in at least one NH with a partnership with a pharmacy, *n (%)*	12 (92)
Work in at least one NH with access to a nurse during the night, *n (%)*	7 (54)

some of them needed support in deciding where to manage the infection (NH or hospital).

Determinants of antimicrobial prescribing

Figure 1 summarizes the major determinants of antimicrobial prescribing.

Resident characteristics

Residents' age, condition and history influenced prescribing. Participants particularly considered kidney function and swallowing disorders when choosing which antimicrobial to prescribe and its route of administration. The infection's symptoms and severity also had a great influence on antimicrobial initiation. The only microbiological results reported as having an impact on prescribing were urine samples.

Most participants did not believe that the residents' opinions influenced their prescribing decisions due to their frequent cognitive impairment. When residents

were capable of understanding they usually didn't discuss the medical decision nor did residents' relatives.

Environmental context and resources

Microbiological samples other than urinalysis were generally not performed because they depended on the equipment, time, skills and habits of the nursing staff. Lack of access and delay obtaining diagnostic tests encouraged empiric antimicrobial prescribing which was often not reassessed because of the lack of microbiological testing or the delay in obtaining results. Added to this is the fact that certain antibiotics cannot be retroceded in French NHs.

Most physicians did not have access to local guidelines and consulted national guidelines published by scientific societies. A lot of them used an electronic decision support system (Antibioclic® for eight of them) or called a specialized doctor. Antibioclic® is a French free academic
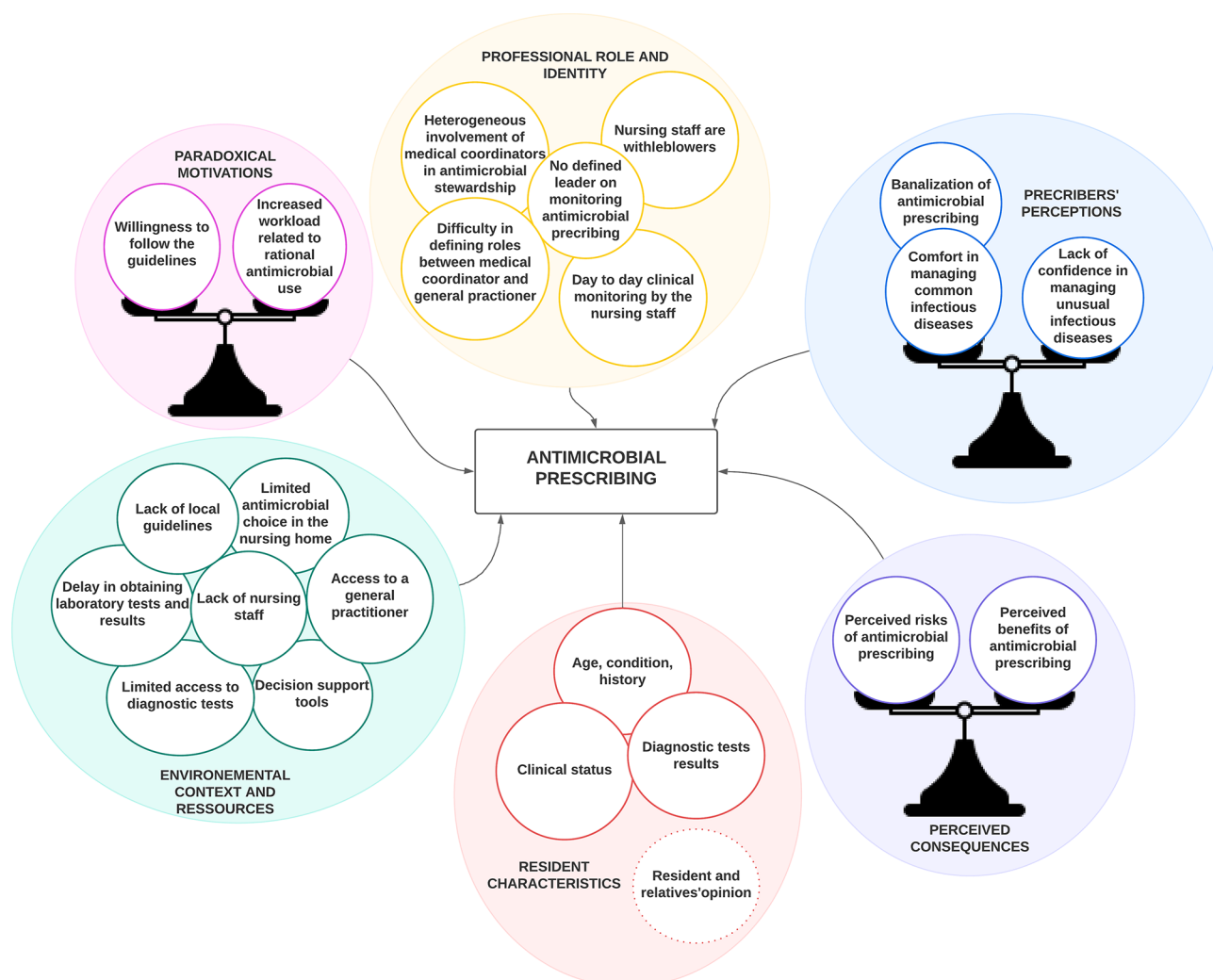

Fig. 1 Determinants of antimicrobial prescribing in nursing homes

digital Clinical Decision Support System (CDSS) widely used by GPs in France for antimicrobial prescribing [36].

Professional role and identity

Nursing staff played a central role in the decision process. Unlike most physicians, they were present at the NH every day and knew the residents best. They observed and notified day to day clinical changes. Many participants relied on them for administration, monitoring and reassessment of antimicrobials. Participants thus declared that a lack of nursing staff, high turnover or bad communication could have a negative impact on antimicrobial prescribing. Physicians who involved nurses in the decision-making process did so to tailor the prescription to the resident's clinical condition. Most of participants did not feel pressured by the nursing staff to prescribe.

Due to the difficulty of access to a GP and the urgent nature of an infection, the medical coordinator was often the one initiating antimicrobials even out-of-hours. The patients' GP then usually took over and was free to choose whether to continue, change or stop the antimicrobial therapy initiated by the medical coordinator. Discussions on antimicrobial therapy between the medical coordinator and resident's GP depended on the quality of their relationship, their availability and sometimes on the sense of legitimacy of the medical coordinator. However, according to participants, such discussions rarely occurred. Participants who feel alone or left out in the NH tend to discuss more about antibiotic therapy with other physicians. Most of the participants agreed that the medical coordinator should monitor and promote a rational use of antimicrobials in NHs. However, this mission was not clearly defined and the original prescriber was often the only one responsible for the prescription.

Perceived consequences

The benefit-risk balance of antimicrobial prescribing leaned most of the time towards prescribing. Prescribers knew the risks of bacterial resistance and adverse effects of antimicrobial therapy. It could influence the choice and duration of antimicrobial therapy but not the decision and act of prescribing. Most physicians prescribed antimicrobials to improve the patient's comfort (even more in palliative care situations) but also to prevent subsequent complications (deterioration, super-infection) and, for some of them, to avoid hospitalization and its consequences.

Prescribers perceptions & paradoxical motivation

Although participants reported having only basic training on antimicrobial prescribing and a lack of specific knowledge on this topic, they believed that this training was enough to correctly treat infections they describe as basic (e.g. urinary tract infections, pneumonia,

erysipelas). In those situations, they usually do not seek for help. Some didn't think that these infections could be the source of prescribing errors, or at least that these errors were not so serious. Despite a general desire to adhere to the guidelines, they often relied on prescribing habits as rational use of antimicrobials required more effort. Many were critical of their colleagues' prescription habits. Some pointed out generational differences in the attitudes towards antimicrobial prescribing.

Interventions to improve antimicrobial prescribing

Actions to improve antimicrobials 'use

Most of the participants proposed actions to improve antimicrobial prescribing including guidelines tailored to NHs' context and decision support tools. Most of them already used a digital CDSS called Antibioclic. For the majority of participants, incorporating recommendations tailored to NH's context and to the geriatric population in this decision support tool could constitute a great improvement.

Expertise

Participants also recommended developing or reinforcing dialog with an infectious disease specialist by building a partnership with a hospital-based infectious disease department. This specialist could help them when needed and could be easily reached through a dedicated telephone line operating day and night. Some participants suggested facilitating access to antimicrobials that are restricted to hospital use, including intravenous therapies in order to avoid unnecessary hospitalizations.

Monitoring and reporting

Numerous physicians suggested audit and feedback interventions to help them step back from their prescriptions and thus improve their practice. This information could be used as an indicator of AMS with personalized feedback and global reports on antimicrobial use.

Accountability & education

Participants proposed to train all members of NHs' staff including nurses on different subjects related to AMS and stressed the role of the medical coordinator in the organization of these trainings. They assumed that those training sessions could contribute in reinforcing the role of nurses in the follow-up of patients treated with antibiotics.

When focusing the discussion on the potential role of local administrative institutional leaders in AMS activities, some participants preferred them not to interfere. They justified that response by the idea they should not be involved in medical decision making. Other participants believed that change in antimicrobial prescribing

could be supported by institutional leaders but it depended on the authorities' willingness.

Relevant quotes on determinants of antimicrobial prescribing are gathered in Table 2. Links between antimicrobial prescribing determinants and AMS interventions suggested by interviewed physicians are summarized in Fig. 2.

Implementation strategies for AMS interventions

First of all, participants pointed out possible barriers to the implementation of AMS strategies. The major barrier was that antimicrobial prescribing was not the top priority issue in NHs. Physicians declared more concern about nutrition, behavioral disorders and end of life. Especially since, as mentioned before, they felt quite comfortable with antimicrobials. Another important barrier was the acceptability of AMS interventions. They explained that it can be difficult to break prescribing behaviors and therefore that some physicians may feel reluctant to change their prescribing routine. However, according to some participants, a national-scale AMS intervention could gain more credibility, leading to higher potential adoption and acceptability. For example, when discussing a CDSS, a standardized tool used universally would

be more widely recognized. This can serve as a neutral reference for discussions on antimicrobial prescribing, thereby enhancing shared decision-making and minimizing potential friction between physicians.

One of the broad areas of implementation strategies that seemed most relevant to participants was the development of stakeholder relationships. The main idea was to recruit, identify or inform local opinion leaders, mainly identified as the medical coordinator and eventually involving executive boards. They would be in charge of promoting the implementation of the AMS strategy. The implementation strategy could be defined during local consensus discussions between the medical and nursing team.

They also identified training and educating all kind of NHs' stakeholders as an effective implementation strategy. It could be through educational meetings organized by actors from outside the NHs (geriatric hospital team for example) or using the train-the-trainer strategy.

Some declared that supporting clinicians by developing reminder systems designed to help clinicians remember information and/or encourage them to use clinical innovation could help implementing AMS. They suggested a poster pinned up in the care station or an alert integrated

Table 2 Relevant quotes on general information and determinants of antimicrobial prescribing

| Theme	Sub-themes	Relevant quotes
General information about antimicrobial prescribing		P11: *"If the infection is more complicated to manage, it will be managed in the emergency room. That's why I'm telling you that it's not very complicated to manage an infection in nursing homes"*
		P10: *"Situations in which we need help? It's a clinical situation that doesn't get better, a bronchitis for example that doesn't get better despite the start of ceftriaxone."*
Determinants of antimicrobial prescribing	Resident characteristics	P2: *"The question is whether the resident will be able to swallow or not. That's the big question."*
		P3: *"What I've learned in palliative care is that if it's [the infection] well tolerated and there's no fever, there's no point in giving antibiotics."*
		P3: *"Residents aren't able to express an opinion about antimicrobial prescribing because the majority suffer cognitive impairment."*
	Environmental context and resources	P3: *"There's one thing we never do that we should do: blood cultures. We tried but it's too complicated. Often, we don't have the equipment. One person [nurse] who has to take care of 100 people makes it already difficult to manage emergencies."*
		P2: *"I feel like I'm in prehistoric times. To get a biological check-up in emergency is complicated. So, there are times when I start a treatment before I've had the results".*
		P8: *"Sometimes it's 24 h to get a medication. We don't get the antimicrobial susceptibility testing that quickly. So, sometimes, we're already at 5 days of treatment, there's only 2 left, so if the micro-organism is susceptible, I don't change."*
		P5: *"I think that the patients in nursing homes are very subject to the current problems of nursing homes and that antibiotic therapy is one of them. The lack of equipment, the fact that we have to do more and more with less and less staff and equipment."*
	Professional role and identity	P4: *"As a medical coordinator, I believe that my role is to keep an eye on prescriptions. I shouldn't control or censor, but if I see things that don't conform to good practice, I should review it with the prescribing physician. I think it's defined in a very theoretical way but not at all in a practical way. I would say that is only at my initiative."*
	Prescribers beliefs /Paradoxical motivations	P4: *"I'm not saying that we do things well, but even the fact that we don't do it very well doesn't create too many problems for us."*
		P11: *"Prescribing is easy because it's simple stuff which is easy to manage."*
		P13: *"I feel that the younger generation is really trained, now we know that we shouldn't prescribe too much."*
	Perceived consequences	P11: *"I can't imagine leaving someone with an infection even if they are almost at the end of their life, leaving them in uncomfortable conditions when a simple antibiotic could improve the situation."*
		P4: *"It is always in our interest to avoid a trip to the emergency room. And from time to time, we say to ourselves, ok, we prefer an empiric antibiotic therapy."*
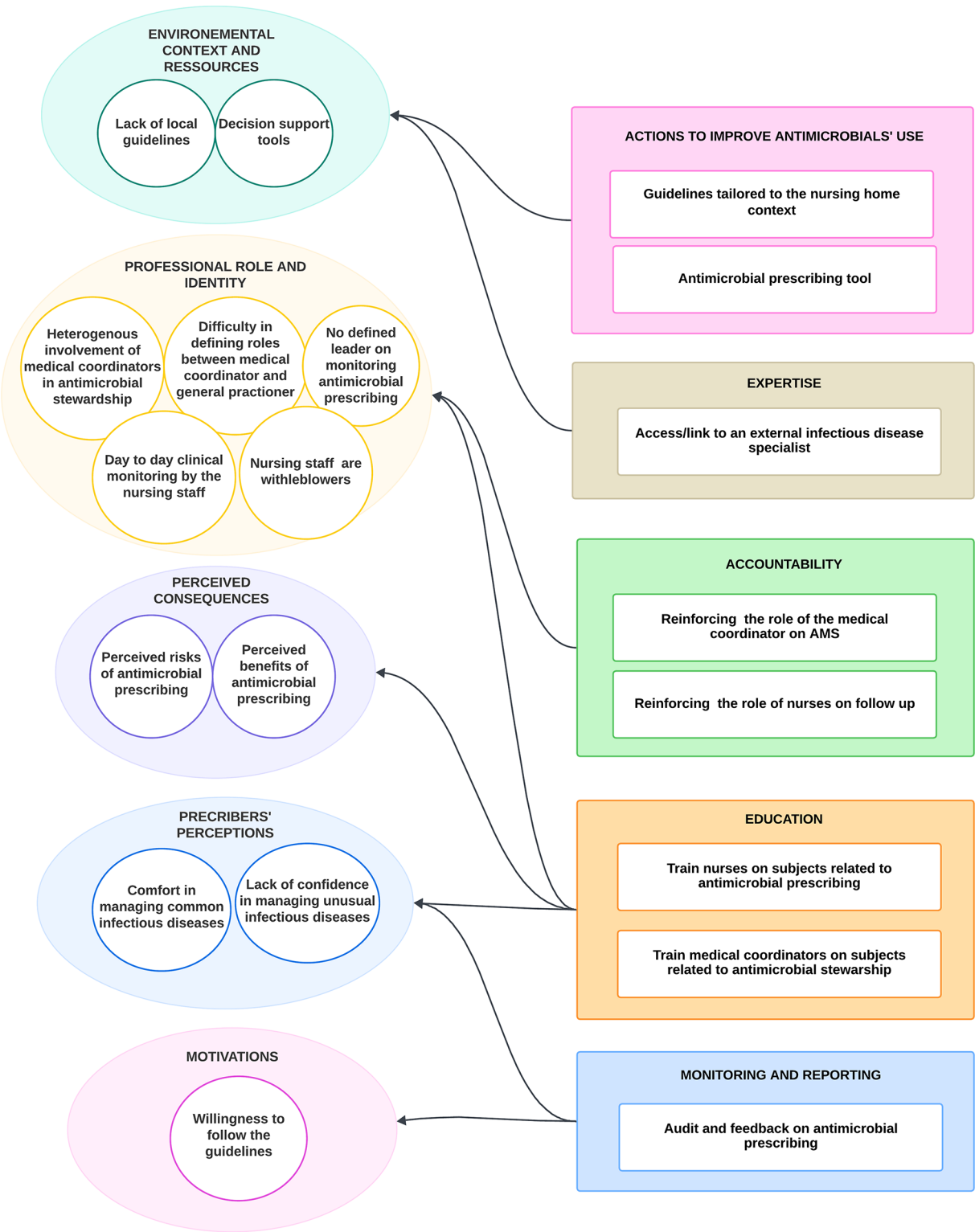
Fig. 2 Links between antimicrobial prescribing determinants and antimicrobial stewardship interventions suggested by interviewed physicians

into the prescription software. This reminder could, for example, prompt participation in a training session or provide a contact number for accessing an expert. The intent is to maintain ongoing awareness and engagement with the AMS initiative, ensuring that healthcare professionals have easy access to support and are consistently reminded of the AMS intervention implemented in the facility.

One of the participants related her positive personal experience in implementing AMS strategies in NHs. First, regarding AMS strategies, she embraced her role in managing and monitoring antimicrobial prescribing as a medical coordinator has been well identified and accepted by the GPs with who she works. She also established standard protocols based on guidelines from scientific societies and health authorities, ensured access to external infectious disease expertise and theoretical training sessions on antimicrobial prescribing. These AMS strategies were implemented via identifying and training leaders and formalizing the adoption of these strategies in consensus discussions.

Discussion

Antimicrobial prescribing is a decision-making process involving different factors and actors in NHs. Our results confirm what has already been described in the literature, despite geographical differences.

Resident characteristics (age, condition and history) was mentioned by all the participants. They placed particular emphasis on swallowing disorders which, to our knowledge, have not been described in the literature. However, it influences antimicrobial selection, which may then differ from the guidelines. Recent studies suggest that advanced age and comorbidities (e.g. history of infection and indwelling urinary catheters), potential signs of infection, or limited life expectancy tend to increase overall prescribing rate and inappropriate antimicrobial prescribing [3, 20, 22, 37]. Indeed, as interviewed physicians pointed out, perceived risk of infectious complications and discomfort among frail NH residents probably encourages antimicrobial prescribing.

AMS interventions targeting diagnoses process could help physicians to perform the right tests on the right patients and thus help them to make an accurate diagnosis and prescribing in particular clinical situations [38]. However, the fact that most of the interviewed physicians do not perceive difficulty in diagnosing and treating common infectious situation is a major barrier to the acceptability of these interventions.

Contrary to what has been described in the literature, few physicians in our sample felt pressure from nursing staff, families, or residents to prescribe antimicrobials [24, 39–43]. In our study, the lack of patient participation in decision-making seemed to be associated with the high prevalence of cognitive impairment in this population, but it could also be related to the lack of medical knowledge and high acceptability of care by these patients [43].

Participants also emphasized the influence of the environmental context and resources on antimicrobial prescribing. Indeed, the difficulty in obtaining microbiological samples, the lack of available GP, the lack of paramedical staff to monitor follow-up, the lack of guidelines tailored to the NH's context and the limited access to some antimicrobials (notably those exclusively delivered at hospital) were perceived as hindering improvement in the management of infectious diseases in NHs. Those constraints accentuated situations of doubt and increased the perceived benefits of antimicrobial prescribing compared to its risks.

Participants considered that local and general guidelines tailored to NHs' context and to the characteristics of institutionalized people could help improving proper antimicrobial use. International published guidelines on the management of infectious diseases in NHs are scarce [44–47] and often focus on one type of infection. The physicians never mentioned French guidelines for NHs as a reference [48], suggesting it might not be adapted to their needs or not well spread. It could thus be interesting to create a single document gathering the guidelines for the most frequent infections physicians encountered in NHs. These guidelines should consider the context of NHs where limited diagnostic tests and antimicrobials are available. It should also include antimicrobial prescribing in palliative care situations. Physicians also insisted on the utility of a CDSS like Antibioclic. Once appropriate guidelines available, it would be a good way to promote proper antimicrobial use since it seems to be well implemented, already highly used by physicians in NHs and have proven its effectiveness in literature [17].

The professional role of nurses and medical coordinators where identified as a key determinant of antimicrobial prescribing by participants. Nurses are the ones who alert physicians, monitor and follow up residents. They play a key role even if they don't take the decision or the responsibility for antimicrobial prescribing. Therefore, AMS interventions focusing on accountability by straightening the roles of nurses seemed relevant to this study and to the literature attesting the central role of nursing staff in AMS [49–51]. Interventions could reinforce their current role (e.g. clinical assessment, performing tests) or enhance their skills (e.g. prescribing microbiological samples, adapt antimicrobial therapy). Recent studies suggest that nurses feel able to take on such responsibilities, particularly when they are experienced nursing home nurses [52, 53]. One way of improving these AMS interventions would be, as participants suggested, to offer training sessions on the various aspects antimicrobial prescribing in order to ensure quality and safety of their new role. Nurses are already enthusiastic about taking part in training sessions [49]. It could also tend to bring doctors and nurses up to the same level of knowledge and thus improve the shared medical decision, as long as there is good inter-professional communication. However, the lack of nursing staff added to work-overload and high turnover could limit the implementation of that kind of intervention.

The medical coordinators definitively have a role to play in AMS. However, this role was often neglected according to participants and did not appear among medical coordinators' top priorities. It is essential to effectively train them to take the lead on AMS. Then, they could promote AMS interventions and develop and formalize interprofessional relationship on the territory. Besides, the presence of a coordinating physician shoed positive effects on reducing overall antimicrobial prescribing [54].

Some studies focused on aspects of human resources, management or organizational characteristics of NH, and revealed significant links with antimicrobial prescribing [20]. For some of these contextual factors, there is little room for action, particularly as they depend on public authorities and the economic context in which they exist. As a matter of fact, in France, 15% of the NHs don't employ a medical coordinator and 37.7% reported difficulties in finding human resources, resulting in frequent understaffing [33] and once again limiting the AMS interventions.

Other antimicrobial prescribing determinants emerged from this study. Perceived consequences of antimicrobial prescribing, motivations and prescribers 'perceptions also influence antimicrobial prescribing. Perceived risk of infection complications (e.g. discomfort, deterioration, hospitalization), the fear of not treating an infection when diagnosis is unclear and complementary examinations are not available often prompted physicians to prescribe antimicrobials "just in case" despite the will to follow guidelines. Physicians stated that proper antimicrobial prescribing in NHs required a major effort but was not judged a priority as compared to other medical issues. Added to that is the fact that physicians feel comfortable in dealing with what they consider as common infection (even if the diagnosis and treatment of those conditions can be challenging) probably doesn't prompt them to reconsider their prescribing habits and behaviors. Yet, prescribing habits are associated to overall prescribing rates and inappropriate antimicrobial prescribing [23].

In addition to actions to improve antimicrobials use, expertise and education, another important intervention suggested by the physician was audit and feedback. It could help physician step back and realize the impact of inappropriate antibiotic prescribing and motivate them changing their practice. Thus, encouraging results have been reported in French interventions based on the development on a list of quantitative and proxy indicators of appropriate antimicrobial prescribing in NHs [55–57]. These results are in line with recent systematic reviews that reported positive outcomes of AMS interventions in NHs in terms of overall antimicrobial use, appropriateness of antimicrobials and AMR rates [17–19]. Feedback is particularly efficient when: include an injunctive norm;

compare prescribing to the lowest prescribers; targeted high prescribers; the source is a supervisor or colleague; it is given more than once; it is delivered both verbally and in writing; and when it includes objectives and action plan [58, 59].

Overall, many AMS intervention already exist and most effective seem to be multimodal. To date, the only intervention that has shown effects one year after intervention has combined clinician education, CDSS and feedback [28]. This could be explained by the fact that it acted on different determinants levels of antimicrobial prescribing. The implementation of those different AMS strategies, according to the interviewed physicians, relied on developing stakeholders' relationships among NHs, training and education. They all agreed that the medical coordinator should have a central role in the process.

Some primary research articles on AMS interventions in NHs give us information on how AMS strategies were implemented. However, only a few give details on implementation strategies and on effectiveness for both implementation and clinical outcomes [60–63]. They all mention multimodal implementation strategies among which training and educating stakeholders and developing stakeholders' relationships that were also cited by the interviewed physicians in our study. According to those studies, other efficient strategies where using evaluative and iterative strategies and providing infrastructure assistance. Raban et al. (2020) reviewed on AMS strategies which included a section on process evaluations of AMS interventions, briefly describing implementation facilitators, barriers, and outcomes from included studies [17]. The main barriers to AMS strategies implementations were similar to those pointed out by physicians in our study. It included a lack of motivation of the physicians to improve prescribing, difficulties in getting physicians to change practices and ensuring adequate training of new staff. They also noted the high baseline level of appropriate prescribing which was difficult to further improve, high physician turnover in the facilities, a lack of buy-in from nurses and family expectations of antimicrobials. There are several options to explore, including adaption to the context which seems to be a major element to consider in the choice of AMS and implementation strategies [30]. Instead of using the same strategies for all, it may be relevant to propose a tool box of those strategies where each medical coordinator could pick up elements that will fit to each specific context.

Because selection of participants was voluntary, the opinions expressed may be skewed toward those who are concerned about these issues. Results of this study are limited by sample size, type of physician, period of time and restricted geographic area. Moreover, when physicians worked in more than one NH, the inquiry did not delve into specific details about each individual nursing

home they worked at. This approach may limit the granularity of the information as the conditions and resources in each nursing home could vary. Therefore, our results may not be representative and generalizable to all NHs, especially since we found that environment and professional role influence antimicrobial prescribing. We did not include other populations that are known to influence antimicrobial prescribing such as the nursing staff or the residents and their families.

Despite the limitations mentioned, the strength of this study is that it explored in depth the views of the prescribing physicians in NHs in the aim of proposing AMS interventions tailored to their needs and therefore more easily adopted because of its perceived interest. To ensure transferability and so that readers can judge whether they can apply our findings to their own settings, we have provided detailed descriptions of our research context, participant demographics, and the methods used. By offering this contextual information, readers can better assess the applicability of our results to their specific circumstances. Additionally, the consistency of our findings with existing literature further supports their potential transferability. We are confident that physicians will find valuable insights to improve antibiotic prescribing in nursing homes. It also allows us a deeper understanding of the NH's particular context in order to propose the most appropriate AMS interventions and thus facilitate their implementation. These are essential steps to maximize the chances of promoting proper antimicrobial prescribing in these facilities.

Conclusion

Antimicrobial prescribing in NHs depends on the residents' characteristics, environmental context, available human and technical resources, and the shared responsibilities between healthcare professionals. The perceived benefits versus risks balance of antimicrobials in NHs often leads to "just in case" prescriptions. Nonetheless, physicians felt quite comfortable with prescribing antibiotics in everyday situations and did not consider improving it as a top priority. Developing guidelines tailored to the NHs' context, providing audit and feedback on antimicrobial prescribing and straightening multidisciplinary relationships between city and hospital professionals appear to be promising interventions to improve antimicrobial prescribing in NHs. The medical coordinator should have a central role in the process.

Abbreviations

AMS	Antimicrobial stewardship
AMR	Antimicrobial resistance
CDSS	Clinical decision support system
GP	General practitioner
NHs	Nursing homes

Declarations

Author details

[1]Department of Geriatrics, APHP Bichat Hospital, University Paris Cité, Paris, France
[2]Infectious Diseases Department, APHP Bichat Hospital, University Paris Cité, Paris, France
[3]IAME, Inserm, UMR 1137, Université Paris Cite, Paris, France
[4]Service de Maladies Infectieuses et Tropicales, Hôpital Bichat, 46 Rue Henri Huchard, Paris 75018, France

References

1. Ricchizzi E, Latour K, Kärki T, et al. Antimicrobial use in European long-term care facilities: results from the third point prevalence survey of healthcare-associated infections and antimicrobial use, 2016 to 2017. Euro Surveill Bull Eur Sur Mal Transm Eur Commun Dis Bull. 2018;23(46):1800394. https://doi.org/10.2807/1560-7917.ES.2018.23.46.1800394.

2. Raban MZ, Gates PJ, Gasparini C, Westbrook JI. Temporal and regional trends of antibiotic use in long-term aged care facilities across 39 countries, 1985–2019: systematic review and meta-analysis. PLoS ONE. 2021;16(8):e0256501. https://doi.org/10.1371/journal.pone.0256501.

3. Appaneal HJ, Shireman TI, Lopes VV, et al. Poor clinical outcomes associated with suboptimal antibiotic treatment among older long-term care facility residents with urinary tract infection: a retrospective cohort study. BMC Geriatr. 2021;21(1):436. https://doi.org/10.1186/s12877-021-02378-5.

4. Azzini AM, Be G, Naso L, et al. Risk factors for colonization with multidrug-resistant Gram-negative bacteria and Clostridioides difficile in Long Term Care facilities (LTCFs) residents: the evidence from 27 facilities in a high endemic setting. Front Cell Infect Microbiol. 2023;13:1155320. https://doi.org/10.3389/fcimb.2023.1155320.

5. Cassone M, Mody L. Colonization with Multi-drug resistant organisms in nursing homes: Scope, Importance, and management. Curr Geriatr Rep. 2015;4(1):87–95. https://doi.org/10.1007/s13670-015-0120-2.

6. World Health Organization (WHO) Global Antimicrobial Resistance and use surveillance system (GLASS) Report 2022. Accessed July 31. 2024. https://iris.who.int/bitstream/handle/10665/364996/9789240062702-eng.pdf?sequence=1

7. Moro ML, Gagliotti C. Antimicrobial resistance and stewardship in long-term care settings. Future Microbiol. 2013;8(8):1011–25. https://doi.org/10.2217/fmb.13.75.

8. Rosello A, Hayward AC, Hopkins S, et al. Impact of long-term care facility residence on the antibiotic resistance of urinary tract Escherichia coli and Klebsiella. J Antimicrob Chemother. 2017;72(4):1184–92. https://doi.org/10.1093/jac/dkw555.

9. Pulcini C, Clerc-Urmes I, Attinsounon CA, Fougnot S, Thilly N. Antibiotic resistance of Enterobacteriaceae causing urinary tract infections in elderly patients living in the community and in the nursing home: a retrospective observational study. J Antimicrob Chemother. 2019;74(3):775–81. https://doi.org/10.1093/jac/dky488.

10. Surveillance de la résistance bactérienne aux antibiotiques en soins de ville et en établissements pour personnes âgées dépendantes. Mission Primo: résultats 2020. Saint-Maurice: Santé publique France. 2022. p88. 2022. www.santepubliquefrance.fr

11. Davey P, Marwick CA, Scott CL, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. Cochrane Database Syst Rev. 2017;2(2):CD003543. https://doi.org/10.1002/14651858.CD003543.pub4.

12. Baur D, Gladstone BP, Burkert F, et al. Effect of antibiotic stewardship on the incidence of infection and colonisation with antibiotic-resistant bacteria and Clostridium difficile infection: a systematic review and meta-analysis. Lancet Infect Dis. 2017;17(9):990–1001. https://doi.org/10.1016/S1473-3099(17)30325-0.

13. CDC. The Core Elements of Antibiotic Stewardship for Nursing Homes. 2015. https://www.cdc.gov/antibiotic-use/core-elements/pdfs/core-elements-antibiotic-stewardship-H.pdf

14. British Society for Antimicrobial Chemotherapy. ANTIMICROBIAL STEWARDSHIP: FROM PRINCIPLES TO PRACTICE. 2018. https://bsac.org.uk/antimicrobial-stewardship-from-principles-to-practice-e-book/

15. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Antimicrobial stewardship essentials in long-term care. 2018. https://www.publichealthontario.ca/-/media/documents/p/2018/primer-antimicrobial-stewardship-ltc.pdf?la=en

16. Aliyu S, Travers JL, Heimlich SL, Ifill J, Smaldone A. Antimicrobial stewardship interventions to optimize treatment of infections in nursing home residents: a systematic review and Meta-analysis. J Appl Gerontol off J South Gerontol Soc. 2022;41(3):892–901. https://doi.org/10.1177/07334648211018299.

17. Raban MZ, Gasparini C, Li L, Baysari MT, Westbrook JI. Effectiveness of interventions targeting antibiotic use in long-term aged care facilities: a systematic review and meta-analysis. BMJ Open. 2020;10(1):e028494. https://doi.org/10.1136/bmjopen-2018-028494.

18. Crespo-Rivas JC, Guisado-Gil AB, Peñalva G, et al. Are antimicrobial stewardship interventions effective and safe in long-term care facilities? A systematic review and meta-analysis. Clin Microbiol Infect off Publ Eur Soc Clin Microbiol Infect Dis. 2021;27(10):1431–8. https://doi.org/10.1016/j.cmi.2021.06.003.

19. Tandan M, Thapa P, Maharjan P, Bhandari B. Impact of antimicrobial stewardship program on antimicrobial-resistance and prescribing in nursing homes: a systematic review and meta-analysis. J Glob Antimicrob Resist. 2022;29:74–87. https://doi.org/10.1016/j.jgar.2022.02.002.

20. Bocquier A, Erkilic B, Babinet M, Pulcini C, Agrinier N, ORANEAT Study Group. Resident-, prescriber-, and facility-level factors associated with antibiotic use in long-term care facilities: a systematic review of quantitative studies. Antimicrob Resist Infect Control. 2024;13(1):29. https://doi.org/10.1186/s13756-024-01385-6.

21. Dyar OJ, Pagani L, Pulcini C. Strategies and challenges of antimicrobial stewardship in long-term care facilities. Clin Microbiol Infect off Publ Eur Soc Clin Microbiol Infect Dis. 2015;21(1):10–9. https://doi.org/10.1016/j.cmi.2014.09.005.

22. Appaneal HJ, Caffrey AR, Lopes V, Dosa D, LaPlante KL. Antibiotic prescribing in outpatient settings: rural patients are more likely to receive fluoroquinolones and longer antibiotic courses. Antibiot Basel Switz. 2023;12(2):224. https://doi.org/10.3390/antibiotics12020224.

23. Daneman N, Campitelli MA, Giannakeas V, et al. Influences on the start, selection and duration of treatment with antibiotics in long-term care facilities. CMAJ Can Med Assoc J J Assoc Medicale Can. 2017;189(25):E851–60. https://doi.org/10.1503/cmaj.161437.

24. Fleming A, Bradley C, Cullinan S, Byrne S. Antibiotic prescribing in long-term care facilities: a qualitative, multidisciplinary investigation. BMJ Open. 2014;4(11):e006442. https://doi.org/10.1136/bmjopen-2014-006442.

25. Charani E, Holmes A. Antibiotic stewardship-twenty years in the making. Antibiot Basel Switz. 2019;8(1):7. https://doi.org/10.3390/antibiotics8010007.

26. Broom A, Broom J, Kirby E. Cultures of resistance? A bourdieusian analysis of doctors' antibiotic prescribing. Soc Sci Med 1982. 2014;110:81–8. https://doi.org/10.1016/j.socscimed.2014.03.030.

27. Durand M, Forestier E, Gras Aygon C, et al. Determinants of doctors' antibiotic prescriptions for patients over 75 years old in the terminal stage of palliative care. Infect Dis Now. 2021;51(4):340–5. https://doi.org/10.1016/j.medmal.2020.10.013.

28. Buehrle DJ, Shively NR, Wagener MM, Clancy CJ, Decker BK. Sustained reductions in overall and unnecessary antibiotic prescribing at primary care clinics in a Veterans affairs Healthcare System following a multifaceted stewardship intervention. Clin Infect Dis off Publ Infect Dis Soc Am. 2020;71(8):e316–22. https://doi.org/10.1093/cid/ciz1180.

29. Moore GF, Audrey S, Barker M, et al. Process evaluation of complex interventions: Medical Research Council guidance. BMJ. 2015;350:h1258. https://doi.org/10.1136/bmj.h1258.

30. Conlin M, Hamard M, Agrinier N, Birgand G. ORANEAT co-investigators. Assessment of implementation strategies adopted for antimicrobial stewardship interventions in long-term care facilities: a systematic review. Clin Microbiol Infect off Publ Eur Soc Clin Microbiol Infect Dis. 2024;30(4):431–44. https://doi.org/10.1016/j.cmi.2023.12.020.

31. Singh S, Degeling C, Drury P, Montgomery A, Caputi P, Deane FP. What influences antibiotic initiation? Developing a scale to measure nursing behaviour in residential aged-care facilities. Nurs Open. 2024;11(5):e2184. https://doi.org/10.1002/nop2.2184.

32. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care. 2007;19(6):349–57. https://doi.org/10.1093/intqhc/mzm042.

33. L'enquête auprès des établissements d'hébergement pour personnes âgées (EHPA). https://drees.solidarites-sante.gouv.fr/sources-outils-et-enquetes/07-lenquete-aupres-des-etablissements-dhebergement-pour-personnes-agees

34. Thomas D. A General Inductive Approach for analyzing qualitative evaluation data. Am J Eval. 2006;27:237–46. https://doi.org/10.1177/1098214005283748.

35. Francis JJ, O'Connor D, Curran J. Theories of behaviour change synthesised into a set of theoretical groupings: introducing a thematic series on the theoretical domains framework. Implement Sci IS. 2012;7:35. https://doi.org/10.1186/1748-5908-7-35.

36. Delory T, Jeanmougin P, Lariven S, et al. A computerized decision support system (CDSS) for antibiotic prescription in primary care-Antibioclic: implementation, adoption and sustainable use in the era of extended antimicrobial resistance. J Antimicrob Chemother. 2020;75(8):2353–62. https://doi.org/10.1093/jac/dkaa167.

37. Bennett N, Imam N, James R, et al. Prevalence of infections and antimicrobial prescribing in Australian aged care facilities: evaluation of modifiable and nonmodifiable determinants. Am J Infect Control. 2018;46(10):1148–53. https://doi.org/10.1016/j.ajic.2018.03.027.

38. Dyar OJ, Moran-Gilad J, Greub G, Pulcini C, ESGMD Executive Committee and the ESGAP Executive Committee. Diagnostic stewardship: are we using the right term? Clin Microbiol Infect off Publ Eur Soc Clin Microbiol Infect Dis. 2019;25(3):272–3. https://doi.org/10.1016/j.cmi.2018.12.011.

39. Langford BJ, Quirk J, Carey S, Daneman N, Garber GE. Influencing duration of antibiotic therapy: a behavior change analysis in long-term care. Am J Infect Control. 2019;47(12):1409–14. https://doi.org/10.1016/j.ajic.2019.05.020.

40. Laur C, Sribaskaran T, Simeoni M, et al. Improving antibiotic initiation and duration prescribing among nursing home physicians using an audit and feedback intervention: a theory-informed qualitative analysis. BMJ Open Qual. 2021;10(1):e001088. https://doi.org/10.1136/bmjoq-2020-001088.

41. Lim CJ, Kwong MW, Stuart RL, et al. Antibiotic prescribing practice in residential aged care facilities — health care providers' perspectives. Med J Aust. 2014;201(10):574–574. https://doi.org/10.5694/mja13.00102.

42. van Buul LW, van der Steen JT, Doncker SM, et al. Factors influencing antibiotic prescribing in long-term care facilities: a qualitative in-depth study. BMC Geriatr. 2014;14(1):136. https://doi.org/10.1186/1471-2318-14-136.

43. Hartman EAR, Groen WG, Heltveit-Olsen SR, et al. Decisions on antibiotic prescribing for suspected urinary tract infections in frail older adults: a qualitative study in four European countries. Age Ageing. 2022;51(6):afac134. https://doi.org/10.1093/ageing/afac134.

44. Jump RLP, Crnich CJ, Mody L, Bradley SF, Nicolle LE, Yoshikawa TT. Infectious diseases in older adults of Long-Term Care facilities: Update on Approach to diagnosis and management. J Am Geriatr Soc. 2018;66(4):789–803. https://doi.org/10.1111/jgs.15248.

45. High KP, Bradley SF, Gravenstein S, et al. Clinical practice guideline for the evaluation of fever and infection in older adult residents of long-term care facilities: 2008 update by the Infectious Diseases Society of America. J Am Geriatr Soc. 2009;57(3):375–94. https://doi.org/10.1111/j.1532-5415.2009.02175.x.

46. Loeb M, Bentley DW, Bradley S, et al. Development of minimum criteria for the initiation of antibiotics in residents of long-term-care facilities: results of a consensus conference. Infect Control Hosp Epidemiol. 2001;22(2):120–4. https://doi.org/10.1086/501875.

47. Stone ND, Ashraf MS, Calder J, et al. Surveillance definitions of infections in long-term care facilities: revisiting the McGeer criteria. Infect Control Hosp Epidemiol. 2012;33(10):965–77. https://doi.org/10.1086/667743.

48. Guide des recommandations de prise en charge des infections aigues en EHPAD. Observatoire des Médicaments, des Dispositifs Médicaux et de l'Innovation Thérapeutique (OMEDIT) d'Ile-de-France. 2018. 2018. https://www.omedit-idf.fr/wp-content/uploads/2018/07/guide-antibios-V2018_VD.pdf

49. Chaaban T, Ahouah M, Lombrail P et al. Decisional Issues in Antibiotic Prescribing in French Nursing Homes: An Ethnographic Study. *J Public Health Res*. 2019;8(2):jphr.2019.1533. https://doi.org/10.4081/jphr.2019.1533

50. Dowson L, Friedman ND, Marshall C, et al. The role of nurses in antimicrobial stewardship near the end of life in aged-care homes: a qualitative study. Int J Nurs Stud. 2020;104:103502. https://doi.org/10.1016/j.ijnurstu.2019.103502.

51. Katz MJ, Gurses AP, Tamma PD, Cosgrove SE, Miller MA, Jump RLP. Implementing Antimicrobial Stewardship in Long-Term Care settings: an integrative review using a human factors Approach. Clin Infect Dis off Publ Infect Dis Soc Am. 2017;65(11):1943–51. https://doi.org/10.1093/cid/cix566.

52. Bridey C, Bocquier A, Bonnay S, Pulcini C, Thilly N. Nursing home nurses' opinions on the potential evolution of their role in antibiotic stewardship: a French national cross-sectional survey. J Clin Nurs. 2024;33(5):1849–61. https://doi.org/10.1111/jocn.16957.

53. Scales K, Zimmerman S, Reed D, et al. Nurse and medical provider perspectives on antibiotic stewardship in nursing homes. J Am Geriatr Soc. 2017;65(1):165–71. https://doi.org/10.1111/jgs.14504.

54. Tandan M, Burns K, Murphy H, Hennessy S, Cormican M, Vellinga A. Antimicrobial prescribing and infections in long-term care facilities (LTCF): a multilevel analysis of the HALT 2016 study, Ireland, 2017. Euro Surveill Bull Eur Sur Mal Transm Eur Commun Dis Bull. 2018;23(46):1800278. https://doi.org/10.2807/1560-7917.ES.2018.23.46.1800278.

55. Indicateurs nationaux de. bon usage antibiotiques en EHPAD: résultats d'un consensus formalisé d'experts.http://antibioresistance.fr/ressources/prevention_RATB/Indicateurs_BUA_EHPAD_VFF.pdf. 2021.

56. Collineau L, Godebert E, Thibaut S, et al. Evaluation of the French surveillance system for epidemiological surveillance of antimicrobial resistance in the community and nursing homes. JAC-Antimicrob Resist. 2022;4(4):dlac078. https://doi.org/10.1093/jacamr/dlac078.

57. Simon M, Pereira O, Hulscher MEJL, Schouten J, Thilly N, Pulcini C. Quantity Metrics and Proxy indicators to Estimate the volume and appropriateness of Antibiotics prescribed in French nursing homes: a cross-sectional observational study based on 2018 reimbursement data. Clin Infect Dis off Publ Infect Dis Soc Am. 2021;72(10):e493–500. https://doi.org/10.1093/cid/ciaa1221.

58. Raban MZ, Gonzalez G, Nguyen AD, et al. Nudge interventions to reduce unnecessary antibiotic prescribing in primary care: a systematic review. BMJ Open. 2023;13(1):e062688. https://doi.org/10.1136/bmjopen-2022-062688.

59. Ivers NM, Sales A, Colquhoun H, et al. No more business as usual with audit and feedback interventions: towards an agenda for a reinvigorated intervention. Implement Sci IS. 2014;9:14. https://doi.org/10.1186/1748-5908-9-14.

60. Boere TM, van Buul LW, Hopstaken RM, et al. Effect of C reactive protein point-of-care testing on antibiotic prescribing for lower respiratory tract infections in nursing home residents: cluster randomised controlled trial. BMJ. 2021;374:2198. https://doi.org/10.1136/bmj.n2198.

61. Boere TM, Hopstaken RM, van Tulder MW et al. Implementation and Use of Point-of-Care C-Reactive Protein Testing in Nursing Homes. *J Am Med Dir Assoc*. Published online 2021:S1525-8610(21)00830-6. https://doi.org/10.1016/j.jamda.2021.09.010

62. Cooper DL, Titler M, Struble L, Redman R. A multifaceted, evidence-based program to reduce inappropriate antibiotic treatment of suspected urinary tract infections. Ann Long-Term Care. 2017;25(2):36–43.

63. Cooper D, McFarland M, Petrilli F, Shells C. Reducing Inappropriate antibiotics for urinary tract infections in long-term care: a replication study. J Nurs Care Qual. 2019;34(1):16–21. https://doi.org/10.1097/NCQ.0000000000000343.

Publisher's note