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Nursing home nurses' opinions on the potential evolution of their role in antibiotic stewardship: A French national cross-sectional survey

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1 **Nursing home nurses' opinions on the potential evolution of their role in antibiotic**
2 **stewardship: A French national cross-sectional survey**

3
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20 **Credit Author Statement**

21 Céline Bridey: Conceptualization, Investigation, Data curation, Formal analysis, Software, Project
22 administration, Original draft preparation.

23 Aurélie Bocquier: Conceptualization, Investigation, Supervision, Writing - review & editing.

24 Stéphanie Bonnay: Investigation, Project administration, Writing - review & editing.

25 Céline Pulcini: Conceptualization, Writing - review & editing.

26 Nathalie Thilly: Conceptualization, Methodology, Supervision, Validation, Writing - review &
27 editing.

28

29 **Conflict of interest**

30 None to declare for all authors.

31

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39 questionnaire and nursing home nurses who agreed to test it. We are grateful to the Regional
40 infection prevention and control and antibiotic stewardship Centers for disseminating the survey to
41 nursing homes by email and for their support.

42

43

44 **Abstract**

45

46 **Aims:** To assess French nursing home nurses' opinions on the potential evolution of their antibiotic
47 stewardship role, facilitators and barriers, and nurses' characteristics associated with their opinion
48 towards new roles regarding antibiotic prescribing.

49 **Design:** We conducted a cross-sectional study in French nursing homes with ≥ 20 beds and for
50 which an e-mail address was available in a national database managed by the French government
51 between May and June 2022.

52 **Methods:** A self-administered internet-based questionnaire of 43 closed-ended Likert items was
53 sent to directors of eligible nursing homes by e-mail asking them to forward the link to the
54 questionnaire to the nurses and head nurses of their institution. Data analysis included descriptive
55 statistics and χ^2 tests.

56 **Results:** 7,215 nursing homes were sent the online questionnaire; 1,090 participants completed it
57 partially or totally and 923 fully filled in the questionnaire. A majority of nurses supported
58 strengthening and expanding their antibiotic stewardship role. Regarding new roles, over 70%
59 agreed that nurses could collect urine samples to perform a urine culture on their own initiative,
60 prescribe microbiological laboratory tests, and change the drug formulation or the administration
61 route of the antibiotic prescribed by the general practitioner.

62 One third declared that they could initiate antibiotics for some infections and/or change the
63 empirical antibiotic treatment prescribed by the general practitioner. Nurses from public nursing
64 homes with connection to a hospital (27.5% vs $> 35\%$ for other status) and with recent experience
65 in nursing homes (31% for < 5 years of practice vs 41% for 10 years or more) were less likely to
66 agree to prescribe antibiotics.

67 **Conclusions:** This quantitative questionnaire survey identified potential new nurses' roles in
68 antibiotic stewardship that seem to be acceptable and feasible for participants. These new nurses'
69 roles need to be explored in future experimentations before considering implementation.

70

71 **Keywords:** Nursing homes, Nurses' roles, Antibiotic resistance, Antibiotic stewardship, Cross-
72 sectional survey

73

74 **Implications for the profession and/or patient care**

75 Consider the evolution of the role of nurses in antibiotic stewardship in nursing homes, improve
76 the care of residents by limiting antibiotic consumption.

77

78 **Impact**

79 What problem did the study address?

80 Nurses could play a greater role in antibiotic stewardship but it is necessary to define and quantify
81 this. Nursing home nurses' opinions towards the potential evolution of their role in antibiotic
82 stewardship are poorly investigated, especially views of a large national sample of nursing home
83 nurses are unknown.

84 What were the main findings?

85 Nursing home nurses have positive attitudes towards strengthening and expanding their antibiotic
86 stewardship role. Future potential antibiotic stewardship roles for nurses have been identified and
87 need to be evaluated before implementation is considered: collect urine samples to perform a urine
88 culture on their own initiative, prescribe microbiological laboratory tests, and change the drug
89 formulation or the administration route of the antibiotic prescribed by the general practitioner.

90 Facilitators (i.e. better multidisciplinary teamwork, training and access to antibiotic stewardship

91 tools) and barriers (i.e. lack of human resources, lack of time, and frequent interruptions in the
92 workflow) to expanding the nursing home nurses' roles in antibiotic stewardship must be taken
93 into account.

94 Where and on whom will the research have an impact?

95 This study offers perspectives on the potential evolution of the role of nursing home nurses in
96 antibiotic stewardship in France and abroad. This research may have an impact on the care of
97 residents and provide guidance for limiting antibiotic use in nursing homes.

98 **Reporting Method:** The study adhered to relevant EQUATOR guidelines and followed the
99 STROBE reporting guidelines

100
101 **Patient or Public Contribution:** A self-administered internet-based questionnaire was sent to
102 directors of eligible nursing homes by e-mail asking them to forward the link to the questionnaire
103 to the nurses and head nurses of their institution. Nurses and head nurses who were interested and
104 willing could complete the questionnaire online partially or fully.

105
106 **What does this paper contribute to the wider global clinical community?**

107 - Identify new roles for nurses in antibiotic stewardship in nursing homes that could be
108 implemented in various countries.

109 - Propose ways to improve the care of nursing home residents in the context of infection through
110 the evolution of the role of nurses, which could be applicable in various countries.

111 - Consider involving nurses more widely in the use of antibiotics in nursing homes and to fight
112 against antibiotic resistance and to share the avenues of evolution that could also be deployed in
113 other countries

114

115 **Trial and protocol registration**

116 This study is not a clinical trial and is not eligible for trial registration. We used another suitable
117 study registration site, the Center for Open Science.

118

119

Accepted Version

120 **Introduction**

121 ***Background***

122 Antibiotics have revolutionized modern medicine.¹ However, overuse and misuse of
123 antibiotics reduce their effectiveness by driving antibiotic resistance which can lead to antibiotic
124 treatment failure and even therapeutic impasses, with negative effects on morbidity, mortality, and
125 health costs.² In 2019 in Europe, 133,000 deaths were attributable to multidrug-resistant bacterial
126 infections.³ In France, multidrug-resistant bacterial infections cause 12,500 deaths per year.⁴ The
127 World Health Organization considers antibiotic resistance to be one of the three most important
128 public health threats of the 21st century.¹

129 Antibiotic use is of particular concern in nursing homes, where infections are common due to the
130 residents' characteristics (e.g., old age, comorbidities) and community lifestyle favoring cross-
131 infections^{5,6}. Antibiotic prescriptions in nursing homes are frequent and often inappropriate.⁶
132 Pooling data from 78 studies from 39 countries, Raban et al. estimated the prevalence of antibiotic
133 use in nursing homes at 5.2% over one day (95% CI: 3.3–7.9) and 62.0% over one year (54.0–
134 69.3); the estimated proportion of appropriate antibiotic prescriptions, which assessed whether an
135 antibiotic treatment was warranted based on the presence of infectious symptoms (McGeer
136 criteria), was 28.5% (10.3–58.0).⁷ In France, where antibiotic use is one of the highest in Europe,⁸
137 most antibiotics are prescribed in the community or in nursing homes,⁹ and there is considerable
138 room for improvement in nursing homes.¹⁰ Consequently, elderly people in nursing homes have a
139 higher risk of infection with antibiotic-resistant bacteria than their community-dwelling peers,
140 estimated to be, for example, 40% higher for *Enterobacteriaceae* cultured from urine samples.¹¹
141 Furthermore, diagnosing an infection can be difficult in the elderly individuals, who often present
142 atypical symptoms, making it difficult to prevent serious complications.¹²

143 Thus, antibiotic stewardship, defined as the effort to measure and improve how antibiotics
144 are prescribed by physicians and used by patients, is essential in nursing homes,¹³ through effective
145 infection surveillance, prevention and control programs. Among the antibiotic stewardship
146 practices identified in French nursing homes, we found the establishment of policies and
147 organizations to improve antibiotic use, provision of therapeutic guidelines for antibiotic
148 prescribing for common infections, written protocols to guide sampling or therapeutic
149 management, evaluation of the appropriateness of empirical or targeted antibiotic therapies, access
150 to antibiotic consumption and bacteriological data, regular feedback on antibiotic use and
151 resistance to prescribing physicians and nursing staff, and education and training sessions on
152 infection management and/or antibiotic prescribing.¹⁴ However, those practices whose impact on
153 antibiotic use and/or resistance have been evaluated in the nursing home setting are rare.¹⁵ A few
154 antibiotic stewardship interventions (mostly from North America, the United Kingdom, the
155 Netherlands, and Sweden mostly) have been evaluated in nursing homes and have shown promising
156 results in improving antibiotic use, but further high-quality research is needed to identify effective
157 and sustainable antibiotic stewardship strategies.^{13,15} In France, the recent 2022-2025 national
158 strategy for preventing infections and antibiotic resistance aims to define core antibiotic
159 stewardship elements in nursing homes, and calls for strengthened antibiotic stewardship actions
160 in nursing homes. The strategy encourages the exploration of potential new strategies, based on an
161 interprofessional perspective and a collaborative and multidisciplinary approach.⁹ Additionally, as
162 antibiotic stewardship programs are insufficient in most nursing homes, it is essential to identify
163 strategies that will accelerate the implementation of antibiotic stewardship interventions in nursing
164 homes.¹⁶

165 The central role of nursing home nurses in antibiotic stewardship has been described in the
166 literature as follows:^{6,17} they are primarily responsible for detecting infections, assessing patients,

167 taking microbiology samples and communicating information to physicians. Nursing home nurses
168 are also responsible for monitoring patients and the effectiveness and safety of antibiotics; they
169 provide residents and families with education about medications and their appropriate use and are
170 the main source of information among the various health professionals involved in residents' care
171 (e.g., general practitioners, nurse assistants, pharmacists, biologists).¹³ Expanding the role of nurses
172 in antibiotic stewardship in a multidisciplinary approach has shown promise in improving
173 antibiotic use in nursing homes and other settings and it is necessary to consider achieving the full
174 potential of nurses' contributions.¹⁸⁻²⁰ Nurses could develop new antibiotic stewardship roles, but
175 it is necessary to define and quantify these roles.^{20,21} In a previous qualitative study, we found that
176 French nursing home nurses had overall positive views toward the development of their skills and
177 role in antibiotic stewardship, despite mixed views regarding some potential new roles they
178 identified, such as the prescription of antibiotics.⁹ Participants also made concrete proposals to
179 strengthen and develop their antibiotic stewardship roles. They suggested strengthening some of
180 their current authorized antibiotic stewardship tasks, such as performing urine dipstick screening
181 tests of their own initiative, monitoring the resident during the treatment, discussing antibiotic
182 prescriptions with the general practitioner, and participating in the choice of drug formulation.
183 They also proposed new antibiotic stewardship roles, such as ordering microbiological laboratory
184 tests, evaluating the appropriateness of empirical antibiotic therapy, and monitoring antibiotic
185 consumption.⁹ However, data on nursing home nurses' opinions toward the potential evolution of
186 their role in antibiotic stewardship are scarce,²² and the views of a large national sample of nursing
187 home nurses are unavailable, to the best of our knowledge.

188

189

190 *French context regarding the antibiotic prescribing process and antibiotic stewardship in*
191 *nursing homes*

192 Nursing homes provide 24/7 functional support and the necessary medical care to medically
193 stable elderly people who have lost their physical and/or mental autonomy in daily life. In France,
194 approximately 7,500 nursing homes accommodate 728,000 residents, of whom three quarters are
195 women, one-third are older than 90 years and half are severely or totally dependent.⁹ In 2016, the
196 estimated point prevalence of infections in French nursing homes was 3% on a given day; the most
197 frequent infections were urinary tract infections (37%) and lower respiratory tract infections
198 (24%).⁹ Standard nursing homes' paramedical staff includes a head nurse (responsible for nursing
199 care organization), several nurses (nursing care) and assistant nurses (hygiene and comfort care).
200 In France, nurses currently have the following four main roles: patient monitoring, administration
201 of drugs, disease prevention and education.⁹ After two additional training years, nurses can obtain
202 advanced practice registered nurse status. This status, introduced in France by a French law in
203 2018, allows nurses to expand their skills in clinical assessment and therapeutic care (e.g.,
204 independent ordering of blood or urinary biological tests, microbiological analyses and medical
205 imaging exams and renewal/adaptation of existing drug prescriptions). Advanced practice
206 registered nurses are progressively integrating into nursing homes.

207 Nursing homes must have a coordinating physician in charge of the organization of care
208 who does not provide direct medical care to residents except in emergencies or epidemic contexts.
209 Residents are usually managed by their own general practitioner who has a private practice and
210 comes to the nursing home for regular visits or on nurses' request. Thus, nursing home nurses are
211 in contact with a multiplicity of general practitioners, sometimes as many as there are residents.
212 Paramedical understaffing, especially during the night, and high turnover are frequent in French
213 nursing homes. On average, there were 6 nursing home nurses per day per 100-bed nursing homes

214 and 20 assistant nurses in 2015.²³ However, there are great disparities between nursing homes in
215 terms of nursing staff and public nursing homes have more nursing staff compared to private ones.²³
216 Public nursing homes with connections to a hospital (approximately around 20% of all French
217 nursing homes) can benefit from infection prevention and control and antibiotic stewardship team
218 expertise and access to the hospital pharmacy and laboratory. National requirements regarding
219 antibiotic stewardship activities are currently not in place for the other types of nursing homes,
220 even though they are planned in the 2022-2025 national strategy mentioned above.

221

222 ***Objectives***

223 In this context, we conducted a national cross-sectional questionnaire survey to assess
224 nursing home nurses' opinions on the potential evolution of their antibiotic stewardship role,
225 distinguishing the reinforcement of current roles and the development of potential new roles, and
226 to identify facilitators and barriers to these potential new roles. As a secondary objective, we
227 evaluated associations between nursing home nurses' demographic and professional characteristics
228 and opinions toward new roles regarding antibiotic prescribing.

229

230 **Methods**

231 ***Survey design and distribution***

232 We conducted a national cross-sectional exploratory survey from May 2 to July 10, 2022
233 among French nursing home nurses. A self-administered and internet-based questionnaire hosted
234 on the free LimeSurvey® software was used.

235 The survey questionnaire was developed by a multidisciplinary team composed of one
236 nurse and PhD student in public health (CB), one public health specialist (NT), one epidemiologist

237 (AB) and a health care project manager (SB) based on the results of our previous qualitative study
238 on nursing home nurses' perceptions of the potential evolution of their role in antibiotic
239 stewardship.⁹

240 To the best of our knowledge, this previous qualitative study is the only study published on
241 this topic and its objective was to encourage the emergence of ideas about tasks to be strengthened
242 and potential new roles in antibiotic stewardship from a sample of 20 nursing home nurses. We
243 paid attention to select nurses from nursing homes of different sizes, statuses (public or private)
244 and locations (urban, suburban or rural areas) and to reach data saturation⁹.

245 The survey questionnaire was then reviewed by an expert committee composed of one
246 infectious disease physician, one general practitioner practicing in nursing homes, two pharmacists,
247 one nursing home head nurse and one infection prevention and control nurse. The questionnaire
248 was then pilot-tested for length, clarity and suitability by three nursing home nurses from one
249 nursing home located in northeastern France.

250 To distribute the survey, we first used a national exhaustive database managed by the
251 French government (available at: <https://www.data.gouv.fr>) to identify French nursing homes
252 (public and private) with at least twenty beds and an available e-mail address (7,215/7,485; 96%
253 met these criteria). Then, we contacted the directors of the nursing homes by e-mail to present the
254 survey, asking them to forward the link to the online questionnaire to the nurses and head nurses
255 of their nursing home. Up to four reminders were sent to nursing homes' directors by e-mail: one
256 by the Regional Infection Prevention and Control Center and the Regional Antibiotic Stewardship
257 Center one week after the first e-mail and three others by the research team two, three, and four
258 weeks later. Finally, we contacted by phone the nurses of a random sample of 144 nonresponding
259 nursing homes by phone between June 21 and July 1, 2022. Randomization was stratified by
260 nursing home geographic area, status and size. We asked the nurses whether they had received the

261 e-mail invitation, encouraged them to participate in the survey, and sent the link to the
262 questionnaire again if needed.

263 Participation was voluntary and not compensated. The survey was completely anonymous
264 (at the respondent and nursing home levels), so French data protection authority (CNIL:
265 Commission National de l'Informatique et des Libertés) approval was not needed. This study was
266 granted approval by the ethics committee of the University Hospital of Nancy.

267

268 **Survey questionnaire**

269 The 43-item questionnaire included four parts (Document S1): (1) opinions on the potential
270 reinforcement of the current antibiotic stewardship role of nursing home nurses (i.e., roles that are
271 currently possible but could be carried out more frequently/systematically); (2) opinions on the
272 potential development of new antibiotic stewardship roles (3) facilitators of and barriers to these
273 potential new antibiotic stewardship roles; and (4) demographic and professional characteristics
274 (sex, age group, diploma, professional experience, and nursing home status and urban, suburban or
275 rural location).

276 In the first three parts, participants reported their level of agreement with each item on a 5-
277 point Likert scale (from *strongly disagree* to *strongly agree*, including *do not know/no response*).
278 In the third part, participants could also propose facilitators and barriers other than those mentioned
279 using open-ended questions. At the beginning of the first two parts, we instructed participants to
280 answer questions by assuming a situation characterized by (1) a good collaboration between
281 nursing home professionals, (2) training adapted to the proposed roles, and (3) a legislative
282 framework that would allow the nurses to perform the related activities.

283

284

285 **Statistical analysis**

286 Participants' demographic and professional characteristics, as well as answers to each item
287 of the questionnaire, are presented as numbers and percentages.

288 To identify characteristics associated with opinions toward new roles regarding the choice
289 of the antibiotic molecule to be prescribed by the nursing home nurses (before or after receiving
290 the antibiotic susceptibility testing results), we created a dichotomous variable "Opinion toward
291 new roles regarding antibiotic prescribing" (*agree/disagree*) combining answers to the two
292 following items: "Could the nursing home nurses initiate antibiotics for some infections [...]?" and
293 "Could the nursing home nurses change the empirical antibiotic treatment prescribed by the general
294 practitioner [...]?". The "Agree" category included participants who agreed or strongly agreed with
295 both proposals. The "Disagree" category included all other participants. Comparisons of nursing
296 home nurses' characteristics according to their opinions on a potential new role regarding antibiotic
297 prescribing were performed by using χ^2 tests. Characteristics considered were participants' age (*18-*
298 *34, 35-54, 55 years or more*), diploma (*nurse, head nurse, specialist nurse, i.e., advanced practice*
299 *registered nurse, IPC nurse or anesthetist nurse*), number of years of practice as a nurse in nursing
300 homes (*<5, 5-9, 10 years or more*) status of nursing home of practice (*public with connection to a*
301 *hospital, public without connection to a hospital, associated/private nonprofit, private for-profit*)
302 and location (*urban, suburban, rural*). All statistical analyses were performed using RStudio
303 (RStudio V 4.2.1, Boston, USA) with $p < 0.05$ considered statistically significant.

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309 **Results**

310 **Study sample (Table 1)**

311 The online questionnaire was sent to 7,215 nursing homes. A total of 1,856 participants
312 opened the link and finally, 1,090 nursing home nurses partially or totally completed the
313 questionnaire and were thus included in the analyses; 923 (85%) fully completed the questionnaire
314 (Figure 1). Approximately 30% of the respondents had been practicing in nursing homes for five
315 to nine years, and 40% had been practicing for at least 10 years; 44% were head nurses. More than
316 half were practicing in a public nursing home, 29% in a private nonprofit nursing home and 16%
317 in a for-profit nursing home.

318
319 **Nursing home nurses' opinions on the potential reinforcement of their current antibiotic**
320 **stewardship role (Table 2)**

321 A great majority of nursing home nurses agreed to reinforce their role in residents' clinical
322 assessment and performing additional tests, especially urine dipstick screening tests on their own
323 initiative (93% agreed or strongly agreed).

324 In the case of an antibiotic prescription, approximately 70% of participants agreed that
325 nursing home nurses should have more discussion with general practitioners about the relevance
326 of the decision to prescribe an antibiotic. Almost all participants agreed that discussion about the
327 relevant drug formulation should be encouraged, whereas opinions regarding the discussion about
328 the molecule, dose or duration were more mixed. In addition, approximately 90% of nursing home
329 nurses agreed to enhance their role in monitoring the effectiveness of the antibiotic treatment and
330 its potential adverse effects, as well as in treatment assessment at 48-72 hours, by contacting the
331 general practitioner.

332 There was also a strong agreement among participants on the reinforcement of their
333 educational/preventive antibiotic stewardship role regarding the education of residents and their
334 relatives, and the training of assistant nurses.

335
336 **Nursing home nurses' opinions on the potential development of new antibiotic stewardship**
337 **roles (Table 3)**

338 Regarding the clinical assessment and the performance of additional tests, a great majority
339 of participants agreed that nursing home nurses could collect urine samples to perform a urine
340 culture on their own initiative and could even order microbiological laboratory tests.

341 Less than half agreed that nursing home nurses could prescribe antibiotics (either initiate
342 an antibiotic or change an empirical antibiotic treatment prescribed by the general practitioner).
343 However, approximately three-quarters agreed that nursing home nurses could modify the drug
344 formulation or the administration route prescribed by the general practitioner. Most participants
345 also agreed with the prescription of nonpharmacological therapies by nursing home nurses
346 (complementary infection prevention and control precautions: 93%; respiratory physiotherapy:
347 61%).

348 Regarding their preventive antibiotic stewardship role, 63% of participants declared that
349 nursing home nurses could contribute to the production of an annual statistical report on infections
350 and antibiotic use in the nursing home.

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355 **Facilitators and barriers to nursing home nurses' of potential new antibiotic stewardship**
356 **roles (see Figures S1a and S1b in the Supplemental Material)**

357 Regarding facilitators of potential new antibiotic stewardship roles, there was strong
358 agreement among participants on all items included in the questionnaire (e.g., better
359 communication and collaboration between different health professionals, antibiotic stewardship
360 training, access to antibiotic stewardship tools, legal developments, introduction of advanced
361 practice registered nurses; Figure 1a). The open-ended responses also highlighted increased
362 paramedical staffing (24%), especially nurses (17%), and better salaries (9%) as facilitators, as the
363 new antibiotic stewardship activities would entail new responsibilities for nurses.

364 Approximately 90% of the participants agreed that the lack of human resources or lack of
365 time and frequent interruptions in the workflow were barriers to the development of new antibiotic
366 stewardship roles (Figure 1b); a lack of knowledge/skills and general practitioners' disapproval
367 were also barriers for approximately 70% of the participants. In contrast, disapproval from
368 residents/their relatives or from nursing home administrators was perceived as a barrier by only
369 one-third of participants. The open-ended responses also underscored the fear of new
370 responsibilities (10%), insufficient salaries (8%), lack of physicians (7%), and nursing home
371 nurses' workload (4%) as potential barriers.

372
373 **Nursing home nurses' characteristics associated with opinion toward new roles regarding**
374 **antibiotic prescribing (Table 4)**

375 Thirty-six percent of participants reported that nursing home nurses could initiate
376 antibiotics for some infections and change the empirical antibiotic treatment prescribed by the
377 general practitioner after receiving the antibiotic susceptibility testing results.

378 Nursing home status was strongly associated with agreement to prescribe antibiotics
379 ($p=0.004$), with the highest agreement in associated or private nonprofit nursing homes (42.8%)
380 and the lowest agreement in public nursing homes with connections to a hospital (27.5%). The
381 higher the number of years of practice in nursing homes, the higher the agreement to prescribe
382 antibiotics (31% for less than 5 years of practice vs. 41% for 10 years or more, $p=0.018$). Specialist
383 nurses tended to be less likely to agree to prescribe antibiotics than other nurses, but the difference
384 did not reach statistical significance.

385

386 **Discussion**

387 In this large cross-sectional nationwide questionnaire survey among French nursing home
388 nurses, the majority of participants agreed to strengthen their current antibiotic stewardship role,
389 especially by reinforcing their role in residents' clinical assessment and by performing additional
390 tests (especially urine dipstick screening tests on their own initiative). Regarding potential new
391 roles, taking into account the main facilitators and barriers identified, over 70% of participants
392 agreed that nursing home nurses could collect urine samples to perform a urine culture on their
393 own initiative, order microbiological laboratory tests, and change the drug formulation or the
394 administration route of the antibiotic prescribed by the general practitioner. One-third agreed that
395 they could initiate antibiotics for some infections and change the empirical antibiotic treatment
396 prescribed by the general practitioner.

397 The positive attitudes of nursing home nurses toward strengthening and expanding their
398 antibiotic stewardship role are consistent with those in a previous United States study conducted
399 by Scales et al.²² Expanding nursing home nurses' participation in antibiotic stewardship could
400 help reduce antibiotic resistance, as suggested by Manning et al.,² and is in line with the 2017 US
401 Centers for Medicare & Medicaid Services requirement that gave more social responsibility and

402 autonomy to nurses in antibiotic stewardship.²⁴ Indeed, practising in nursing home settings requires
403 special clinical skills and autonomy due to the specificities of the residents' care and because
404 general practitioners are rarely present on site in France.²⁵ One of the main facilitators of new
405 antibiotic stewardship roles highlighted in our study was training. This is consistent with the
406 findings of several other international studies that showed insufficient nurses' knowledge of
407 antibiotic stewardship and the need for additional training on all main aspects of infection
408 management (e.g., clinical infectious signs, indications for microbiological investigations,
409 antibiotic management) and on the appropriate use of antibiotics.²²

410 We also found that better multidisciplinary teamwork was perceived as an important
411 facilitator of nursing home nurses' new antibiotic stewardship new activities. As reported by
412 Monsees et al., the nursing antibiotic stewardship role may make tangible contributions to
413 residents' care and strengthening interprofessional collaboration within antibiotic stewardship is
414 essential to optimize antibiotic use.²⁶

415 Conversely, we found that lack of human resources and lack of time were the main reported
416 barriers to new antibiotic stewardship activities. Indeed, French nursing homes currently face
417 frequent shortages of nurses and substantial staff turnover, increasing workload and consequently
418 leading to a lack of nursing time.⁹ Therefore, as reported in an Australian study by Hall et al,
419 implementing antibiotic stewardship strategies to optimize antibiotic use in nursing homes requires
420 taking into account all tasks (visible and nonvisible) and the additional workload they generate
421 (e.g. negotiation, administrative tasks) to allocate resources efficiently, optimize the organization
422 of the work and find acceptance by nursing home nurses.²⁷

423 One particular field in which nursing home nurses would like to develop their antibiotic
424 stewardship role was the management of urinary tract infections in which, as in the United States,
425 they already play an active role, notably in autonomous evaluation.²⁸ We found that they wanted

426 to be autonomous in performing urine dipstick screening tests and ordering / collecting urine
427 samples. This could facilitate residents' management, especially in the context of the absence of
428 general practitioners on site, but should be considered with caution for several reasons. First, urine
429 dipsticks are not indicated for nursing home residents to guide the diagnostic process when a
430 urinary tract infection is suspected due to the high prevalence of false-positive results.²⁹ Second,
431 nursing home nurses' pressure to order urine cultures and then their expectation for antibiotic
432 prescriptions in case of a positive culture is the first contributor to unnecessary antibiotic use due
433 to the high prevalence of asymptomatic bacteriuria in nursing home residents³⁰. Third, the
434 interpretation of urine samples, especially from catheterized or incontinent residents, is a challenge
435 in nursing home settings; because of many factors that often make it difficult to establish a definite
436 diagnosis in nursing home residents, even experienced physicians can be unsure about the need for
437 an antibiotic prescription.³¹ In addition, a recent United States study showed that professionals'
438 difficulty in distinguishing symptomatic bacteriuria from a urinary infection led to unnecessary
439 antibiotic treatment.²⁸

440 The evolution of nursing home nurses' antibiotic stewardship role requires a demonstration
441 of its added value within a multiprofessional collaborative perspective, in addition to assessing its
442 impact on the quality and safety of care. In case a positive impact is demonstrated, training and
443 guidelines must be available, for example to improve asymptomatic bacteriuria management,³² and
444 reduce overtesting of residents for urine samples.³³ A Danish study suggested that a combination
445 of educational activities and support tools can help nursing home nurses implement more evidence-
446 based practices regarding antibiotics for urinary tract infections in nursing homes.³⁴

447 Establishing a dedicated antibiotic stewardship nurse position could facilitate the
448 implementation of a multifaceted and multiprofessional collaborative antibiotic stewardship
449 program in nursing homes.²⁴

450 Regarding their role in antibiotic prescribing, we found that most nursing home nurses
451 agreed to discuss more with general practitioners about the relevance of prescribing an antibiotic.
452 This result is similar to that reported in a French study conducted by Chaaban et al. which showed
453 that nurses were motivated to take part in an educational training program on antibiotic therapy to
454 improve their knowledge and to be able to discuss antibiotic prescriptions with the general
455 practitioner.³⁵ Even if the responsibility for prescribing antibiotics is clearly assigned to physicians,
456 nursing home nurses could participate in the resident's management by providing useful
457 information or suggesting to delay the prescription and wait a few days to reconsider the need for
458 an antibiotic in case of diagnostic uncertainty, provided that severity criteria are absent.³¹ Using a
459 structured approach to provide data on residents' clinical assessments to general practitioners can
460 help nurses communicate accurately and help the general practitioners make diagnoses.³⁶ They
461 could support general practitioners in their infection management and development of an optimal
462 antibiotic treatment plan³⁵ when communication between off-site physicians and on-site nurses is
463 harmonious.³² In our study, most nursing home nurses agreed to have the possibility of adapting
464 the antibiotic drug formulation to each resident based on their knowledge of the residents' clinical
465 situation. However, nursing home nurses were less prone to discuss other criteria of the prescription
466 (e.g. molecule, dose and duration) with general practitioners, perhaps because of their lack of
467 experience and in-depth knowledge on this topic.³⁵

468 In addition, two-thirds of French nursing home nurses declared that they preferred not to
469 have an antibiotic prescribing role (i.e. initiate antibiotics for some infections and change the
470 empirical antibiotic treatment prescribed by the general practitioner). As described by Maddox et
471 al. in a study among English nurses, nursing home nurses may do not want to take responsibility
472 for prescribing medicines for which the risk is perceived as high (e.g., patients at high risk of drug-

473 related morbidity), especially if they feel they have insufficient knowledge and skills.³⁷ Antibiotics
474 may be perceived by nursing home nurses as high-risk medications because they can lead to
475 therapeutic failure and the occurrence of adverse events, particularly in elderly patients who often
476 have comorbidities and multiple medications.³⁸ The most experienced nursing home nurses were
477 more prone to have an antibiotic prescribing role than others. Their experience and their in-depth
478 knowledge of nursing home patients may give them confidence in their clinical skills.³¹ In contrast,
479 nursing home nurses working in nursing homes connected to a hospital or specialist nurses were
480 less likely to agree to prescribe antibiotics, possibly because they have more frequent contact with
481 and easier access to infection specialists and because they are more aware than other nurses of the
482 complexity of the diagnostic and therapeutic management of patients suspected of having an
483 infection.²⁶

484 Finally, due to their extended skills, advanced practice registered nurses could provide
485 antibiotic stewardship support for nursing staff in nursing homes³⁹ (e.g., ordering and interpreting
486 certain microbiological laboratory tests, monitoring of antibiotic prescriptions and educating
487 patients on antibiotic use)⁹, particularly in urinary tract infections. The United States has gone even
488 further by authorizing advanced practice nurses to prescribe treatment for infections in nursing
489 homes.²⁸ In France, this needs further investigation within a concerted collaboration with general
490 practitioners.

491

492 ***Strengths and limitations***

493 This original nationwide survey in a sample of 1,090 French nursing home nurses has several
494 strengths. This is the first quantitative study to provide a broad view of nursing home nurses'
495 perceptions about their antibiotic stewardship role and its potential evolution; this study generated
496 concrete suggestions that might be explored. The anonymous self-administered survey may have

497 limited social desirability bias but increased the risk of misunderstanding without face-to-face
498 explanation by an interviewer.⁴⁰ The online access allowed nursing home nurses to answer at their
499 convenience and complete the survey at their own pace, which should have encouraged
500 participation. However, this study also has some limitations. First, the participation rate in the
501 survey was low, with only 1,090 responses from 7,215 nursing homes. Thus, the directors who
502 agreed to forward the questionnaire to their nursing staff and the nursing home nurses who
503 participated in the survey were probably more interested in antibiotic stewardship and more
504 favorable to the evolution of nursing home nurses' role in this field than nonparticipants. This
505 selection bias may have led to an optimistic perspective regarding antibiotic stewardship, which
506 may affect the generalizability of the findings and limit their transferability to a broader population
507 of nursing home nurses. To try to limit this bias, a reminder strategy was implemented, including
508 up to four reminders by e-mail (one of which was sent by regional organizations that regularly
509 work with nursing homes) and a phone call to a random sample of nonresponding nursing homes
510 (144 nursing homes contacted, response rate of 63%). Second, to respect the anonymity of this
511 study, little information on participants and their nursing homes was collected, preventing us from
512 quantifying the number of participating nursing homes or studying in-depth characteristics
513 associated with opinion toward new roles regarding antibiotic prescribing.

514

515 **Conclusions**

516 This nationwide questionnaire survey showed that nursing home nurses had overall positive
517 attitudes toward strengthening and expanding their antibiotic stewardship role when certain
518 facilitators and barriers were taken into account. These suggestions need to be evaluated by well-
519 designed interventional studies to assess their impact on antibiotic use, patient care and safety and

520 their implementation in nursing homes. This study offers perspectives on the potential evolution of
521 the role of nursing home nurses in antibiotic stewardship in France and abroad.

Accepted Version

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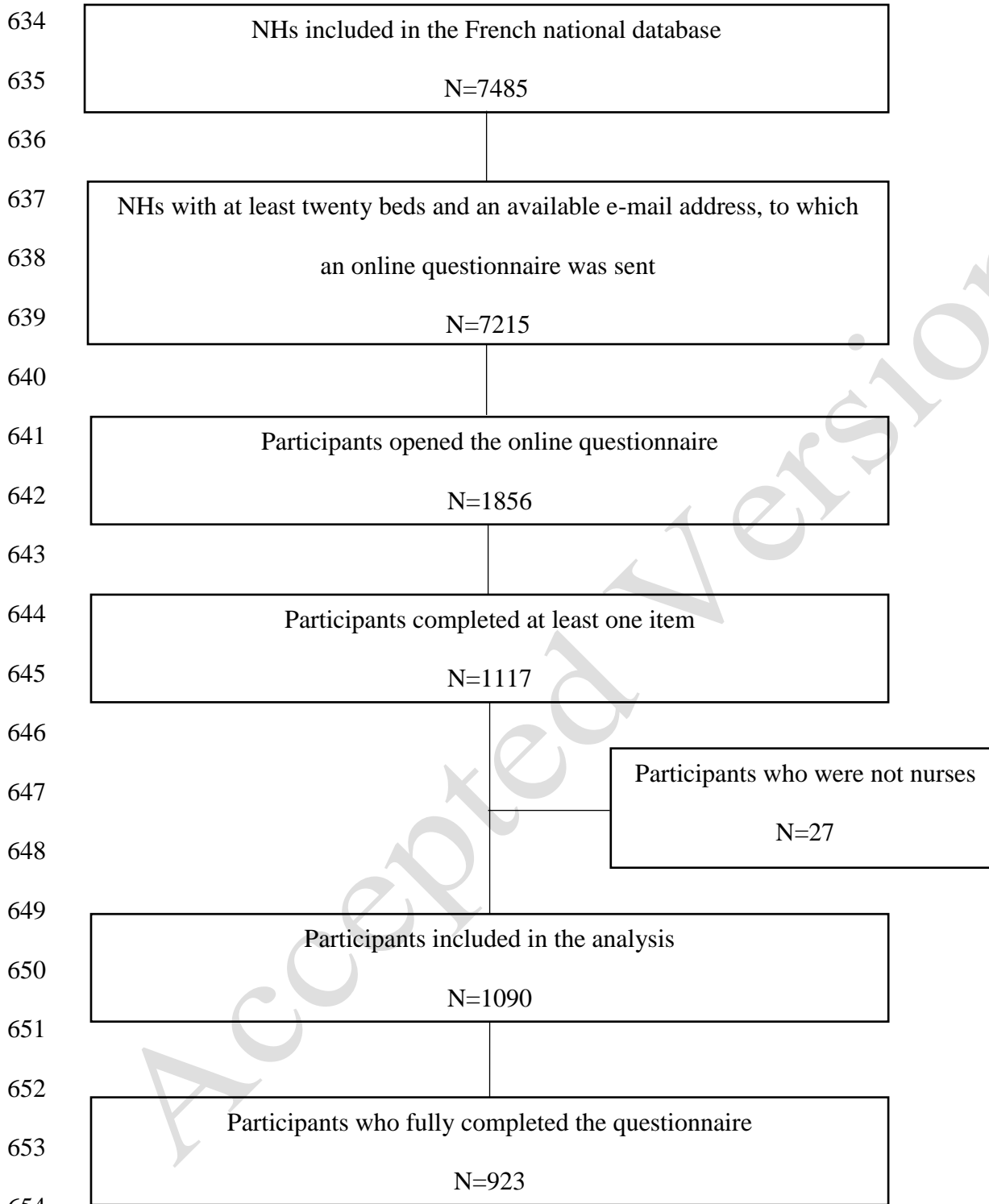
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655 Figure 1: Flowchart of the survey sample

656 NH: nursing home

Table 1 Participants' demographic and professional characteristics

Characteristics	n/N ^a	%
<i>Demographic characteristics</i>		
Sex		
Female	839/929	90.3
Male	90/929	9.7
Age (years)		
[18-24]	26/930	2.8
[25-34]	220/930	23.7
[35-44]	278/930	29.9
[45-54]	276/930	29.6
[55-62]	122/930	13.1
≥ 63	8/930	0.9
<i>Professional characteristics</i>		
Number of years of practice as nurse (years)		
< 5	112/926	12.1
[5-9]	176/926	19.0
[10-19]	328/926	35.4
≥ 20	310/926	33.5
Number of years of practice as nurse in NHs (years)		
< 5	283/925	30.6
[5-9]	259/925	28.0
[10-19]	303/925	32.8
≥ 20	80/925	8.6
Diploma		
Nurse	498/925	53.8
Head nurse	407/925	44.0
Advanced practice nurse	6/925	0.7
Other ^b	14/925	1.5
<i>Characteristics of the NH</i>		
Status		
Public with connection to a hospital	240/923	26.1

Public without connection to a hospital	267/923	28.9
Associated or private nonprofit	271/923	29.3
Private for-profit	145/923	15.7
Location		
Urban	180/924	19.5
Suburban	369/924	40.0
Rural	375/924	40.5

NH: nursing home.

^a Number/total respondents to the item.

^b Infection prevention and control nurse (n=13), anesthetist nurse (n=1).

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Table 2 Nursing home nurses' opinions on the potential reinforcement of their current antibiotic stewardship role

Items	N ^a	Strongly disagree	Rather Disagree	Rather Agree	Strongly agree	Do not know/no response
<i>Regarding the clinical assessment of residents and performance of additional tests, could these roles be reinforced?</i>						
Perform a urine dipstick screening test on her or his own initiative	1,090	3.8%	2.2%	11.1%	81.5%	1.4%
Manage the follow-up ^b of the biological analyses (blood tests, urine tests, etc.)	1,089	4.6%	5.4%	16.6%	72.0%	1.4%
<i>When the GP prescribes an antibiotic, should the NHN be enabled to discuss more with him or her about...?</i>						
The relevance of the decision to prescribe an antibiotic	1,089	8.7%	15.9%	34.5%	37.1%	3.8%
The relevance of the molecule choice	1,086	18.4%	33.8%	25.8%	15.3%	6.7%
The relevance of the drug formulation (orodispersible form, tablet, IV...)	1,086	2.1%	1.8%	19.1%	76.3%	0.7%
The relevance of other elements of the prescription (e.g., dose and duration)	1,086	17.5%	32.9%	24.0%	18.8%	6.8%
<i>In the case of prescription of an antibiotic and its monitoring, could these roles be reinforced?</i>						
Monitor antibiotic effectiveness	1,080	2.0%	3.1%	25.3%	68.2%	1.4%
Monitor adverse events	1,080	2.0%	2.2%	16.8%	78.0%	1.0%
After 48-72 hours, contact the GP to reassess the initial antibiotic treatment with the results of additional tests including the antibiotic susceptibility testing	1,078	4.9%	6.0%	22.7%	63.4%	3.0%
<i>Regarding the prevention and education of antibiotic use, could these roles be reinforced?</i>						
Educate residents and their relatives on the appropriate use of antibiotics and/or infection prevention and control	1,077	3.7%	8.4%	35.4%	48.7%	3.8%
Train assistant nurses on the appropriate use of antibiotics and/or infection prevention and control	1,075	5.3%	9.1%	36.1%	46.5%	3.0%

Train animator staff on infection prevention and control	1,076	13.9%	19.9%	30.3%	29.0%	6.9%
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ABS: antibiotic stewardship, GP: general practitioner, IV: intravenous, NHN: nursing home nurse.

^a Total respondents to the question.

^b Collect results and contact the GP in case of abnormal results.

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Table 3 Nursing home nurses' opinions on the potential development of new antibiotic stewardship roles

Items	N ^a	Strongly disagree	Rather Disagree	Rather Agree	Strongly agree	Do not know/no response
<i>Regarding the clinical assessment of residents and performance of additional tests, could the NHN perform these new roles?</i>						
Perform pulmonary clinical examination	1,024	22.4%	31.2%	24.6%	17.0%	4.8%
Collect a urine sample, according to preestablished criteria, to perform a urine culture in case of suspected urinary tract infection. This test would be performed by the nurse on their own initiative, without an initial medical prescription ^b	1,024	2.8%	2.9%	20.8%	72.3%	1.2%
Order biological and microbiological laboratory tests (urine tests, blood tests) on their own, according to preestablished criteria, in case of suspected infection	1,024	7.9%	11.2%	25.6%	52.7%	2.6%
<i>Regarding the prescription of antibiotics/specific procedures, could the NHN perform these new roles?</i>						
Initiate antibiotics for some infections (urinary tract, pulmonary and skin infections) after receiving the antibiotic susceptibility testing results	1,022	24.3%	31.3%	23.9%	17.8%	2.7%
Change the empirical antibiotic treatment prescribed by the GP after receiving the antibiotic susceptibility testing results	1,021	26.0%	31.0%	23.7%	16.9%	2.4%
Change the drug formulation (orodispersible form, tablet, IV...)	1,020	10.1%	13.1%	33.2%	41.8%	1.8%
Change the administration route (e.g., switch from IV to oral)	1,020	11.4%	13.7%	33.8%	39.2%	1.9%
Prescribe respiratory physiotherapy	1,018	14.0%	21.8%	30.1%	30.8%	3.3%
Prescribe infection prevention and control measures (e.g., additional precautions)	1,020	3.1%	2.3%	28.8%	63.9%	1.9%
<i>Regarding the surveillance of antibiotic use and resistance, could the NHN perform this new role?</i>						

Contribute to the production of an annual surveillance report on infections and the use/resistance of antibiotics in the NH	1,019	15.6%	15.7%	35.3%	27.3%	6.1%
---	-------	-------	-------	-------	-------	------

ABS: antibiotic stewardship, GP: general practitioner, IV: intravenous, NH: nursing home, NHN: nursing home nurse.

^a Total respondents to the question.

^b The GP would order the urine culture *a posteriori* to regularize the situation with the laboratory.

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Table 4 Associations between nursing home nurses' opinions toward new roles regarding antibiotic prescribing and their demographic and professional characteristics (results from bivariate analyses, line %)

Characteristics	N	Agree to initiate antibiotics and to change the empirical antibiotic treatment ^a		P value ^b
		% [95% CI]		
Age (years)				0.789
[18-34]	246	34.1	[28.3;40.5]	
[35-54]	554	36.6	[32.6;40.8]	
55 or more	130	35.4	[27.3;44.3]	
Diploma				0.080
Nurse	498	33.1	[29.1;37.5]	
Head nurse	407	39.6	[34.8;44.5]	
Specialist nurse ^c	20	25.0	[9.6;49.4]	
Number of years of practice as a nurse in NHs (years)				0.018
<5	283	31.1	[25.8;36.9]	
[5-9]	259	33.2	[27.6;39.4]	
10 or more	383	41.0	[36.1;46.1]	
NH status				0.004
Public with connection to a hospital	240	27.5	[22.0;33.7]	
Public without connection to a hospital	267	36.3	[30.6;42.5]	
Associated or private nonprofit	271	42.8	[36.9;48.9]	
Private for-profit	145	35.9	[28.2;44.3]	
Location				0.447
Urban	180	38.8	[31.8;46.4]	
Suburban	369	33.6	[28.8;38.7]	
Rural	375	36.5	[31.7;41.7]	

APRN: advanced practice registered nurse, CI: confidence interval, NH: nursing home, NHN: nursing home nurse.

^a Agree to initiate antibiotics for some infections (urinary tract, pulmonary and skin infections), after receiving the antibiotic susceptibility testing results AND to change the empirical antibiotic treatment prescribed by the general practitioner after receiving the antibiotic susceptibility testing results.

^b χ^2 tests.

^c Specialist nurses are advanced practice registered nurses, IPC nurses and anesthetist nurses.

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Document S1. Nursing home nurses' interview guide (individual interviews)

Mail

Dear Madam or Sir,

The APEMAC Research Unit ("Adaptation, Measurement and Evaluation in Health. Interdisciplinary Approaches") of the University of Lorraine has been conducting projects on antibiotic stewardship and the fight against antibiotic resistance for several years.

One of our projects aims to explore the potential evolutions in the antibiotic stewardship role of the nursing profession in nursing homes. Nurses occupy a central place in the resident's care and contribute to antibiotic stewardship with the general practitioner. In addition, the recent creation of the status of advanced registered practice nurse allows us to explore perspectives for the nursing profession.

In a first phase, we conducted a qualitative study with nurses in the Grand Est region. This enabled us to identify their current role in antibiotic stewardship and the potential evolutions of their roles in nursing homes.

We would now like to submit these suggestions to all nursing staff working in nursing homes in France. This is why we are asking you to give your opinion on possible evolutions in the nurse's antibiotic stewardship role in nursing homes by means of the following questionnaire. It takes about 15 minutes to complete. You will be able to save your answers and fill it in over several days. We assure you that the data collected will be treated anonymously. Neither your name or the name of your practice is requested.

We would like to thank you in advance for your contribution, which might allow the national authorities to reflect on the evolution of the nursing profession's antibiotic stewardship role.

Prof. Nathalie Thilly and Céline Bridey

PART 1. CURRENT ABS ROLE THAT COULD BE REINFORCED

Thank you for agreeing to participate in this survey.

In this first part, we are asking your opinion on the antibiotic stewardship role of the nursing profession in nursing home that could be reinforced (i.e. roles that are currently possible but that could be carried out more frequently or more systematically).

We ask you to answer the following questions by assuming a situation characterized by good collaboration between professionals in the nursing home, by a training of nurses adapted to the proposed roles and by a legislative framework that would allow nurses to perform the roles.

Regarding the clinical assessment of residents and performance of additional tests, could these roles be reinforced?

Perform a urine dipstick screening test on her or his own initiative Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Manage the follow-up^b of the biological analyses (blood tests, urine tests, etc...)

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

When the general practitioner prescribes an antibiotic, should the nursing home nurse be enabled to discuss more with him/her about...?

The relevance of the decision to prescribe an antibiotic

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

The relevance of the molecule choice

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

The relevance of the drug formulation (orodispersible form, tablet, IV...)

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

The relevance of other elements of the prescription (e.g., dose and duration)

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

In the case of prescription of an antibiotic and its monitoring, could these roles be reinforced?

Monitor antibiotic effectiveness Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Monitor adverse events Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

After 48-72 hours, contact the GP to reassessing the initial antibiotic treatment with the results of additional tests including the antibiotic susceptibility testing Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Regarding the prevention and education of antibiotic use, could these activities be reinforced?

Educate residents and their relatives on the appropriate use of antibiotics and/or infection prevention and control Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Train assistant nurses on the appropriate use of antibiotics and/or Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

infection prevention and
control

Train animator staff on infection prevention and control Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

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PART 2. NEW ABS ROLES THAT COULD BE DEVELOPED

In this second part, we ask for your opinion on potential new antibiotic stewardship roles that could be developed by nurses in nursing homes.

As before, we ask you to answer the following questions by assuming a situation characterized by good collaboration between professionals in the nursing home, by nurses training adapted to the proposed roles and by a legislative framework that would allow nurses to carry out these activities.

Regarding the clinical assessment of residents and performance of additional tests, could the nursing home nurse perform these new roles?

Perform pulmonary clinical examination Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Collect a urine sample, according to pre-established criteria, to perform a urine culture in case of suspected urinary tract infection. This test would be performed by the nurse on their own initiative, without an initial medical prescription Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Order biological and microbiological Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

laboratory tests (urine tests, blood tests) on their own, according to pre-established criteria, in case of suspected infection

Regarding the prescription of antibiotics/specific procedures, could the nursing home nurse perform these new roles?

Initiate antibiotics for some infections (urinary tract, pulmonary and skin infections), after receiving the antibiotic susceptibility testing results

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Change the empirical antibiotic treatment prescribed by the GP, after receiving the antibiotic susceptibility testing results

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Change the drug formulation

Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

(orodispersible form,
tablet, IV...)

Change the administration route (e.g., switch from IV to oral) Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Prescribe respiratory physiotherapy Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Prescribe infection prevention and control measures (e.g., isolation) Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

Regarding the surveillance of antibiotic use and resistance, could the nursing home nurses perform this new role?

Contribute to the production of an annual surveillance report on infections and the use/resistance of antibiotics in the nursing home Strongly disagree Rather disagree Rather agree Strongly agree Do not know/no response

PART 3. FACILITATORS AND BARRIERS TO THE EVOLUTION OF NURSING HOME
NURSES' POTENTIAL NEW ANTIBIOTIC STEWARDSHIP ROLES

Finally, we would like to have your opinion on what could facilitate or, on the contrary, slow down the implementation of the new roles mentioned in the previous section.

In your opinion, what are the facilitators to the evolution of nursing home nurses' potential new antibiotic stewardship roles?

Training on infectious diseases, antibiotics' pharmacology and recommendation on the appropriate use / prescription of antibiotics, particularly in the elderly	<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
The revision of the nursing roles in the law	<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
Optimization of work organization	<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
Provision of and/or access to information/decision support tools (antibiotic guidelines, protocols, computerized care records, telemedicine)	<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
Better communication and collaboration between different health professionals (general practitioner, pharmacist,	<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response

infection prevention and
control nurse, assistant
nurse)

Introduction of advanced practice registered nurses in nursing home

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Other, please specify

In your opinion, what are the barriers to the evolution of nursing home nurses' potential new antibiotic stewardship roles?

Lack of knowledge / information about antibiotics and infections

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Lack of time to perform new antibiotic stewardship roles

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Lack of nursing staff resources

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Frequent interruptions in the nurses' workflow

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

General practitioners' unfavourable opinion

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Residents or their relatives' unfavourable opinion

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Nursing home administrators' unfavourable opinion

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Lack of interest about antibiotics

<input type="checkbox"/> Strongly disagree	<input type="checkbox"/> Rather disagree	<input type="checkbox"/> Rather agree	<input type="checkbox"/> Strongly agree	<input type="checkbox"/> Do not know/no response
--	--	---------------------------------------	---	--

Other, please specify :

PART 4. PERSONAL AND PROFESSIONAL CHARACTERISTICS
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To complete this questionnaire, please fill in the general information questions below:

1. Sex:

- Female
- Male

2. Age:

- | | |
|--|--|
| <input type="checkbox"/> 18-24 years old | <input type="checkbox"/> 25-34 years old |
| <input type="checkbox"/> 35-44 years old | <input type="checkbox"/> 45-54 years old |
| <input type="checkbox"/> 54-62 years old | <input type="checkbox"/> 62 years old and more |

3. Number of years of practice:

<5 5-9 10-19 >20 and more

4. Number of years of practice in nursing homes:

<5 5-9 10-19 >20 and more

5. What is your occupation?

- Nurse
- Coordinating nurse
- Nurse manager
- Senior nurse manager
- Advanced practice nurse

6. What is the nursing home's status where you practice?

- Public status with attachment to a hospital
- Public status without attachment to a hospital
- Associative or private non-profit status
- Private for-profit status

7. Where is this nursing home located?

- City > 50 000 inhabitants
- City from 5000 to 50 000 inhabitants
- City < 5000 inhabitants

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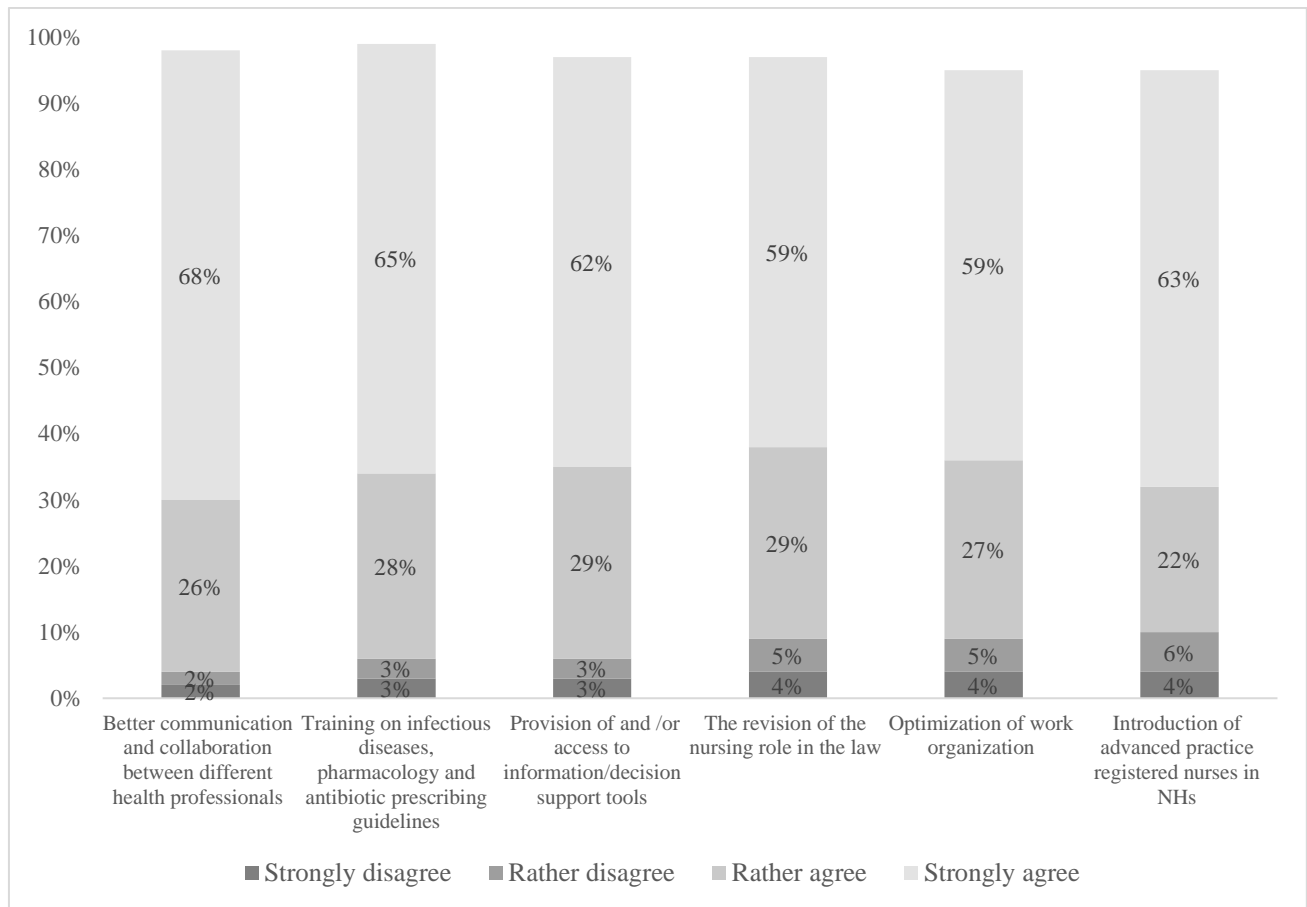


Figure S1a: Facilitators to the evolution of NHNs' potential new ABS roles (N=979 to 980)^a
^a The 'no opinion' category is not displayed here; it ranged from 1.3 to 4.8% depending on the item
 ABS-antibiotic stewardship, NH-nursing home, NHN-nursing home nurse.

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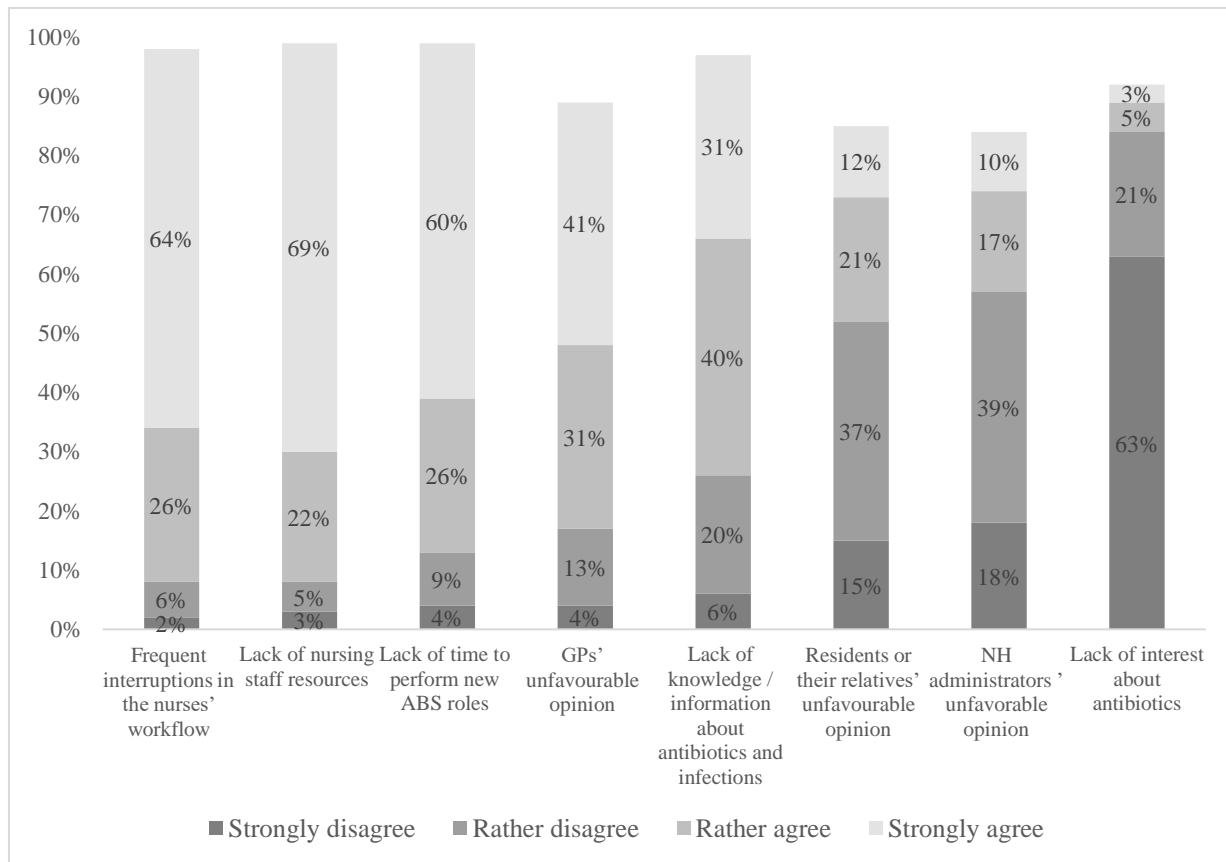


Figure S1b. Barriers to the evolution of NHNs' potential new ABS roles (N=976)

^a The 'no opinion' category is not displayed here; it ranged from 1.3 to 15.9% depending on the item

ABS-antibiotic stewardship, GP-general practitioner, NH-nursing home, NHN-nursing home nurse.

NH administrators include directors, head nurses and coordinating physicians.