

Antibio'Malin: an e-health resource to raise awareness of antibiotic stewardship and resistance in France

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Objectives: To develop a nationwide French website with reliable, practical and public-oriented information on antibiotic stewardship and resistance.

Methods: The design and evaluation were based on the following process: (i) development of a pilot website by a multidisciplinary group; (ii) evaluation phase, using mixed methods and involving health professionals (GPs and community pharmacists) and the general population; and (iii) launch of a final version of the website with 6 month follow-up usage statistics.

Results: The Antibio'Malin website (<https://sante.fr/antibiomaline>), supported by the French Ministry of Health, contains practical information for the general population on antibiotics marketed in the outpatient setting and on the most common infections, with an antibiotic stewardship perspective. A 'For further information' section provides details on various concepts, such as antibiotic resistance. As part of the evaluation, 8 general practitioners and 5 community pharmacists were individually interviewed, 46 health system users replied to an online questionnaire and 5 focus groups were conducted (17 participants). In addition, more than 100 people (professionals and general population) provided feedback directly on the website. The website was well received by health professionals, particularly general practitioners, and described as a reference site for patients and a communication tool. The general population also found the site useful. Several comments helped improve the website before the launch of the final version on 18 November 2019. At 6 month follow-up, more than 25 000 persons had visited the website.

Conclusions: The Antibio'Malin information website was developed and tested. Post-launch data suggest a useful addition to the multifaceted French national antibiotic stewardship strategy.

Introduction

Antibiotic resistance is a public health emergency. In Europe, in 2015, an estimated 33 000 patients died of multiresistant bacterial infections.¹ As antibiotic resistance is accelerated by the use of antibiotics, antibiotic stewardship programmes are essential to tackle antibiotic resistance. Antibiotic use in France is high as compared with other European countries;² 80% of antibiotics are prescribed by primary care providers.³ Information and communication to the general population on antibiotics and antibiotic resistance is essential.^{3,4} In the 2018 French Eurobarometer study, 35% of people declared that antibiotics are effective against viruses, 16% reported that antibiotics should be stopped when

they feel better and only 45% remembering getting information in the previous year about how unnecessary use of antibiotics reduces their effectiveness.⁵ Internet has become one of the leading sources of information on health topics, along with health professionals (HPs).^{6,7} Indeed, 59% of Americans surveyed in The Pew Internet & American Project's study^{7,8} in 2013 and 51% of French people in the Ad-Santé-Net survey in 2012⁷ declared they had searched for health-related information on the internet in the past year and at least once a week, respectively. In 2016, 68% of French people were looking for health information on the internet and almost half discussed it with their general practitioners (GPs).⁹⁻¹¹ However, to the best of our knowledge, no website or smartphone application with reliable, practical and

public-oriented information on antibiotics, infections, antibiotic stewardship and resistance is available in French or in English.

Our objective was to develop such a nationwide French website, supported by health authorities, based on the following stepwise process: (i) development of a pilot website by a multidisciplinary group; (ii) evaluation phase, using a mixed-method and involving HPs and the general population; and (iii) launch of a final version of the website with 6 month follow-up usage statistics.

Methods

Design of the website

A multidisciplinary working group was set up in April 2018, including four GPs, seven infectious diseases specialists, four pharmacists, one paediatrician, two dentists, one midwife, one nurse, one microbiologist, one infection prevention and control practitioner, one sociologist, three public health specialists, two patients' representatives, three programmers and five Health Insurance representatives from the Grand Est region. This group was tasked with defining: (i) the objectives; (ii) the target population; and (iii) the content of the website, as well as producing the content and reviewing it based on the evaluation.

The project was coordinated by the public health research unit of Lorraine University, in northeastern France, in collaboration with the Ministry of Health (MoH), the Health Insurance (both national and regional), the regional Health Agency and the regional antibiotic stewardship network (AntibioEst). No specific funding was received to develop the website. The design of the pilot website and its editing was done by the MoH's staff under the supervision of the working group. A pilot version of the website was available in May 2019.

Evaluation of the pilot website

Once a pilot website was available, it was assessed in two ways: (i) evaluation in northeastern France using mixed methods; and (ii) large pilot-testing at national and regional levels, with feedback sent by users directly through the website.

1. Evaluation in northeastern France

This evaluation was based on: (i) semi-directed individual interviews conducted between 31 July and 30 August 2019 with HPs [GPs and community pharmacists (CPs)]; (ii) an online survey conducted among users coming from the general population in August; and (iii) focus groups involving users between 14 and 18 September. The interview guides and the survey were first drafted by G.L.-D. (epistemologist), A.E. (PhD candidate) and S.R. (infectious diseases trainee), and then reviewed by J.K. (senior sociologist), N.T. (public health specialist) and C.P. (infectious diseases specialist).

a. Health professionals GPs were recruited through the professional network of the multidisciplinary working group. CPs were recruited through professional and social networks and by directly approaching CPs on site. The interviews aimed at assessing their opinion and perceptions regarding the relevance and the quality of the website as a source of information for the general population, and as a possible communication tool with patients. They were also asked about modifications, improvements, and additions they felt were necessary or useful to make. The interviews were conducted until data saturation was reached.

b. Health system users (HSUs) Participants were recruited through various methods: (i) through two associations (France Assoc'Santé, Office Nancéien des Personnes Agées); (ii) through the networks of the evaluation team (J.K., A.E., S.R., G.L.-D.); and (iii) through the public mailing list of

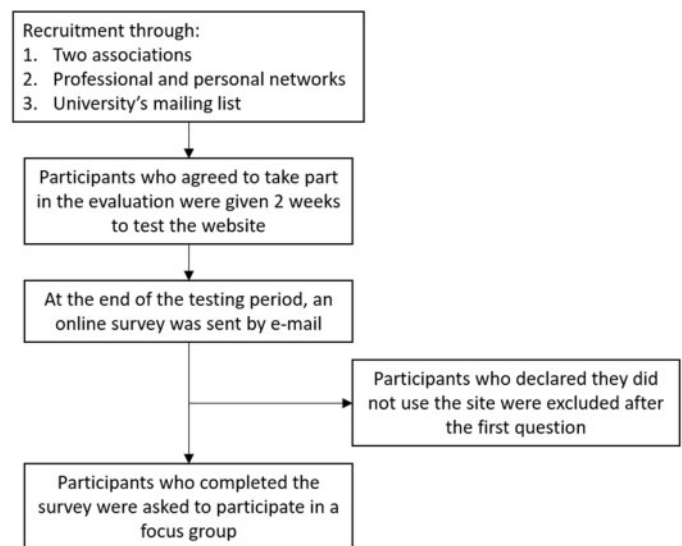


Figure 1. Online survey participation process.

Lorraine University. The HSUs who agreed to participate were asked to test the website during a 2 week period and complete an online survey (Figure 1). The survey was hosted on SurveyMonkey© (see Appendix S1, available as [Supplementary data](#) at JAC-AMR Online). Focus groups were then conducted, until data saturation, by G.L.-D. and A.E. to further explore the attractiveness, usability and quality of information of the website and to assess the users' understanding of antibiotic resistance. Focus group participants were recruited from the survey and through the personal and professional networks of the evaluation team. Participants of the survey and focus groups were recruited according to their family situation and/or their age: only elderly people (over 65 years old) and parents of children under 18 years old were included, children and elderly people being the two populations that use antibiotics the most in France.¹²

2. Large-scale pilot testing at national and regional levels, with feedback received by users directly through the website

Each page on the website allowed for collection of anonymous feedback from users, with data available in an Excel© spreadsheet.

During a 2 month period (July and August 2019), a large group of HPs, patients and general population was asked to test the website and provide feedback, as well as to ask up to 10 of their relatives, peers or patients to do the same. We sent this request to the multidisciplinary working group of the project as well as to the Antibiotic Resistance National Action Plan stakeholders' group, coordinated by the MoH.

Data analysis

For qualitative studies (individual interviews and focus groups), all interviews were recorded after an oral informed consent from participants. Complete transcripts of the interviews were made. A comprehensive thematic analysis allowing an inductive approach was performed by A.E. and G.L.-D. An analytical grid was elaborated by G.L.-D. to highlight the ideas most often put forward by the participants.

Regarding the online survey and the feedback collected directly from the website, descriptive statistics were performed for closed questions and open-ended responses were analysed using an analysis grid to assess the most frequently recurring ideas.

Ethical statement

The evaluation was anonymous at all stages thus no ethical approval was required in accordance with French law.

Launch with 6 month follow-up usage statistics

In September and October 2019, the pilot website was amended according to the results of the evaluation. The final version of the website was officially launched on 18 November 2019 by the MoH. Usage statistics were collected during a 6 month follow-up period.

Results

Design of the website

To design the pilot website, three meetings of the project multidisciplinary working group were held (in addition to regular e-mail exchanges) and the website content was revised four times.

The objectives, target audience and content outline of the website were defined by the multidisciplinary working group. Two objectives, each with a specific target population, were identified: (i) providing practical information regarding common infections, antibiotics and antibiotic resistance to the general population, on a website that anyone could access on their own; and (ii) providing support to HPs to facilitate their communication with their patients. The content outline was developed bearing in mind the following principles: (i) the content would address situations commonly met in primary care; (ii) the content would be short and practical (addressing questions commonly raised by patients), with an antibiotic stewardship perspective; and (iii) weblinks pointing towards reliable sources of information (e.g. health authorities) would be listed in case the user wants further information on a specific topic.

The website was organized around three sections: 'Antibiotics', 'Common infections' and 'For further information' (Tables 1, 2 and 3). All systemic antibiotics available in primary care in France were listed.¹³ The most common viral and bacterial infections were included.¹⁴⁻¹⁶ The 'For further information' section was presented as frequently asked questions (FAQs), detailing questions commonly asked by patients to HPs.

The name of the website was discussed during the working group meetings. It was finally decided to use the name 'Antibio'Malin', with 'antibio' being a familiar short name for 'antibiotic' and 'malin' meaning 'smart'.

Antibio'Malin was included as a specific thematic resource in the MoH website, called Santé.fr (santé meaning health). The Santé.fr website (also available as an app) was launched by the MoH in early 2019 and intends to become the reference health website for all French people. It provides and aggregates all types of health information, but only includes reliable, high-quality and validated information. Users can send anonymized feedback on all webpages to help improve the content. Antibio'Malin is available in French at the following URL: <https://sante.fr/antibiomalin>.

Evaluation

The evaluation was conducted using both a mixed-methods study in northeastern France among HPs and HSUs and large-scale pilot testing at national and regional levels using feedback sent by users directly through the website.

Table 1. List of antibiotics presented on the Antibio'Malin website

Antibiotics (N = 42)

Amoxicillin
 Amoxicillin/clavulanate
 Azithromycin
 Benzathine benzylpenicillin
 Cefaclor
 Cefadroxil
 Cefalexin
 Cefixime
 Cefotiam
 Cefpodoxime
 Ceftriaxone
 Cefuroxime
 Ciprofloxacin
 Clarithromycin
 Clindamycin
 Cloxacillin
 Doxycycline
 Erythromycin
 Fosfomycin tromethamine
 Fusidic acid
 Josamycin
 Levofloxacin
 Lomefloxacin
 Metronidazole
 Minocycline
 Moxifloxacin
 Nitrofurantoin
 Norfloxacin
 Ofloxacin
 Ornidazole
 Phenoxymethylpenicillin
 Pivmecillinam
 Pristinamycin
 Roxithromycin
 Spiramycin
 Spiramycin/metronidazole
 Sulfadiazine
 Sulfamethoxazole/trimethoprim
 Telithromycin
 Tetracycline/metronidazole/bismuth
 Tetracycline
 Trimethoprim

For each of them, there is information on the antibiotic class, the risk of resistance [medium or high, according to the National Drug Agency (ANSM) categorization],³² the main infections for which it is recommended (according to national guidelines), how the antibiotic should be taken by the patient and its potential impact on daily life (e.g. exercise, alcohol). Antibiotics were listed under their international non-proprietary names (INN), as part of the usual policy of government websites.

The northeastern evaluation included: (i) semi-directed interviews of HPs; (ii) an online survey; and (iii) focus groups, the latter two conducted among HSUs. Thirteen individual interviews of HPs (eight GPs and five pharmacists) were conducted, with interviews lasting between 25 and 45 min. Out of a total of 63 people who

Table 2. List of infections presented on the Antibio'Malin website

Infections (N = 20)
Bronchitis
Bronchiolitis
Chickenpox
Dental abscess
Dental caries
Erysipelas
Gastroenteritis
Herpes
Impetigo
Influenza
Laryngitis
Mycosis
Otitis
Pneumonia
Sinusitis
Common cold
Tonsillitis
Urethritis
Urinary tract infection in women
Urinary tract infection in men

For each of them, information on the type of infection (viral or bacterial), how one becomes infected, the duration of symptoms, the treatments that might be useful and how to prevent the infection is specified.

agreed to evaluate the site, 46 responded they used the site for 2 weeks (Figure 1 and Appendices S2 and S3), with 42/46 questionnaires totally completed (Table 4). Five focus groups were performed, with a total of 17 participants (Table 5).

Regarding the large-scale pilot testing at national and regional levels, with feedback received by users directly on the website, more than 100 different persons sent at least one comment. The results presented here focus on the most common comments.

The site was perceived by all as being of high quality and complete, with the most common infections for which antibiotics are used (appropriately or not) being listed. Antibio'Malin was considered to be of public interest and useful in daily life. The site, especially the introduction on the homepage, reminded almost all participants, HSUs and HPs, of the nationwide awareness campaign 'antibiotics are not automatic' that took place in the early 2000s. This campaign was viewed as a good campaign with a clear and useful message. Antibio'Malin was thus perceived favourably as a follow-up of this campaign, raising awareness on antibiotic resistance, and providing more precise information on the infections that may or may not require an antibiotic. During the interviews, all participants expressed a very general acceptance of the government action to inform, communicate and provide guidance on antibiotics and antibiotic resistance.

HPs considered Antibio'Malin as a good communication tool to initiate a discussion with their patients, especially to those requesting an explanation and/or pressing them to prescribe antibiotics. Some of the GPs compared the use they might have of Antibio'Malin to the use they have of the non-prescription pad promoted by the National Health Insurance.¹⁷ HPs, particularly GPs, declared they no longer feel threatened by online health

Table 3. List of 'for further information' questions of the Antibio'Malin website

For further information (N = 24)
What is inflammation?
What is an infection?
What is a microbe?
What is a virus?
What are bacteria?
What is <i>S. aureus</i> ?
What is <i>E. coli</i> ?
What is an antibiotic?
What are the adverse effects of taking antibiotics?
What is the microbiota?
What is antibiotic resistance?
What is the rapid diagnostic test for tonsillitis?
How to reduce the risk of being infected?
How to cough?
How to properly use my antibiotics?
Where can I find the INN on my antibiotic package?
What to do if the name on my prescription is not matching the one on the antibiotic package?
How to reconstitute my medication?
What to do if I forget to take my antibiotic?
What to do if I vomit after taking my antibiotic?
What to do if my child is asking questions?
Where I can find patients' stories?
What is the drug effectiveness?
What is a recommendation?

The 'For further information' section includes 24 FAQs on terminology (e.g. virus, bacteria, inflammation, recommendation), antibiotic resistance, general health advice, where to find the INN and answers to common questions about antibiotic use.

information sites. On the contrary, they said that they appreciate this access to information for their patients as it contributes to make their consultations easier and more efficient. They enjoyed the benefits of a well-informed patient. HPs appreciated that Antibio'Malin was hosted on an official website like the one of the MoH. Many pointed out the need to stress this issue more among the general population so they could realize the seriousness of antibiotic resistance and develop a more responsible attitude towards antibiotics. Although it was not the purpose of Antibio'Malin, some professionals viewed it as a site they could use themselves directly for information or updates. Some of the professionals criticized the site for its information being too specialized.

Among the HSUs, Antibio'Malin was perceived to be user-friendly with an understandable language. The access to direct weblinks to the 'For further information' section on the 'Antibiotics' or 'Common infections' pages was highly appreciated. Participants were surprised to discover some adverse effects of antibiotics (e.g. contraindication to exercise or sun exposure). They were particularly curious about the impact of antibiotics on the microbiota, a topic highly publicized in different media in France. Most of them discovered the threat of antibiotic resistance for modern medicine.

Asked about the impact of such an information website on the relationship they have with their GPs, users did not express any

Table 4. Survey questionnaire respondents' characteristics (N = 46)

Characteristic	n
Sex	
female	33
male	13
Age (years)	
18–29	10
30–39	14
40–49	7
50–59	6
60–69	4
≥70	5
Level of education	
A level and under	11
bachelor	14
master	9
PhD	11
Marital status	
married	19
single	18
divorced/widowed	5
Work situation	
unemployed	4
retired	8
student	6
employed	24
Medical background	14
Estimated health status	
very good	12
good	27
poor	3
very poor	0
Has children	10

questioning of the GPs' authority. The website did not tempt them to self-medicate, but rather provided them information on antibiotics to discuss the prescription with their GPs. They viewed Antibio'Malin as a tool to increase their knowledge and take better care of themselves.

We list here the most common suggestions for improvement, made by both the HSUs and HPs. They repeatedly expressed criticism of the form or structure of the site. The navigation was felt as being difficult and there was a poor understanding of the antibiotic resistance risk scale. The introduction was found to be too long, the risk of antibiotic resistance was not sufficiently highlighted and explained, and the urgency of the antibiotic resistance threat should be more detailed. The use of international non-proprietary names (INN) was found impractical to look for a specific antibiotic, since brand names are widely used in French practice.

Improvements made before the official launch

The main changes made prior to the launch concerned the homepage, the content of the introduction, information on antibiotic resistance and the navigation. The homepage was redesigned

with each section introduced with a short description of the information included in this section. More information on antibiotics and antibiotic resistance was provided in the relevant sections.

Launch with 6 month follow-up usage statistics

Antibio'Malin was launched by the MoH on 18 November 2019, during the World Antibiotic Awareness Week (18–24 November 2019) and the European Antibiotic Awareness Day (18 November 2019). The MoH, in collaboration with all its partners (e.g. national and regional health agencies, professional organizations, patients' associations), promoted (and continues to do so) the website through different channels, in particular social media, press releases, conferences, flyers, videos and existing antimicrobial resistance related websites.¹⁸

From 18 November 2019 to 25 May 2020, 27 741 people from more than 26 countries (Table 6 and Figure 2) visited the website and the average time spent on the site was 2 min.

Discussion

Summary of the main findings

A website, Antibio'Malin, was created to support patients and healthcare professionals with common infections, the role of antibiotics and the impact of antibiotic resistance. Antibio'Malin was positively perceived by HPs and the users. GPs reported that the use of such a website would facilitate their consultations and their communication with patients. The HSUs saw in Antibio'Malin the opportunity to be engaged in the decision of care and to initiate a discussion with their GPs.

Comparison to the existing literature

Presented in the early 2000s as a threat to GPs' authority, online information websites have emerged as a new tool to improve quality of care for both GPs and patients.¹⁹ GPs considered Antibio'Malin as a support to their consultation to facilitate discussion especially when they did not wish to prescribe antibiotics. As found in the literature, they were favourable to patient information including through the internet.²⁰ In addition, the use of information documents for patients is also one of the strategies recommended to decrease antibiotic use.²¹ HSUs did not see Antibio'Malin as an opportunity to contradict their GPs, but rather as a way to better communicate with them. Most of them said they trusted their GPs and had no desire to challenge them, which is consistent with the literature.^{22,23} Being informed is not questioning medical authority, but, according to several studies, it is being able to have richer exchanges with one's GP and being more active in the process of diagnosis, prevention and care.²⁴ Users appeared to want to be more involved in their own health, which is in line with health democracy and patient empowerment.⁹ Antibio'Malin did not seem to tempt people into self-medication. HSUs interest in the microbiota is also consistent with the idea that taking care of your microbiota is taking care of your health.²⁵

Strengths and limitations of Antibio'Malin

The main strength of Antibio'Malin is the access to verified information, hosted on an official government site. The information

Table 5. Focus group characteristics (N = 17)

Participants	Age (years)	Sex	Level of education	Medical background
Group 1. Retirees				
P1	66	female	master	yes
P2	67	female	master	no
P3	67	male	master	no
P4	67	male	PhD	no
Group 2. Parents and retirees				
P1	61	female	master	no
P2	51	female	master	no
Group 3. Parents				
P1	31	female	bachelor	no
P2	33	female	youth training	no
P3	36	female	bachelor	no
Group 4. Retirees				
P1	82	male	A level	no
P2	72	female	master	yes
P3	67	female	master	yes
Group 5. Retirees				
P1	67	female	A level	no
P2	74	female	none	no
P3	69	female	Diploma of Higher Education	yes
P4	74	male	Diploma of Higher Education	no

Table 6. List of countries from which users visited the Antibio'Malin website over the 6 month follow-up period

Countries	Number of visits
France	15 893
United States	168
Belgium	154
Morocco	132
Tunisia	104
Algeria	90
Cameroon	48
Canada	41
United Kingdom	38
Switzerland	28
Senegal	27
Burkina Faso	24
Côte d'Ivoire	23
Gabon	23
Portugal	21
Spain	19
Germany	18
Madagascar	18
Brazil	14
Israel	13
Luxembourg	13
Haiti	12
Netherlands	11
India	10
Mali	10
Turkey	10

thus appears as trustworthy and reliable. The website was co-constructed with a multidisciplinary working group and evaluated by a panel of professionals and HSUs, including GPs and CPs, using a mixed-methods approach. Furthermore, Antibio'Malin responds to most of the recommendations published by the Wellcome Trust on how to communicate effectively about antibiotic resistance.²⁶ Antibio'Malin provides simple and straightforward information on antibiotic resistance and what actions the general population can perform to tackle it.

One limitation of the evaluation of Antibio'Malin is the profile of participants. Participation in the evaluation requires personal time (using the site and answering the survey or participating in the interviews) without any compensation. HPs who agreed to participate are therefore likely to be HPs interested in antibiotic stewardship. Similarly, users are most likely to be aware of health problems in general, and antibiotics in particular. Moreover, 14 out of 46 respondents to the survey had a 'medical background'. Thus, there is probably a selection bias. Furthermore, Antibio'Malin is hosted by the Santé.fr website of the MoH as a thematic section. Not being a website on its own, Antibio'Malin is so far not referenced as such in search engines. If a search is made on antibiotics, Antibio'Malin currently does not appear among the first results. It will probably then only be consulted by those who are aware of its existence or who regularly consult Santé.fr. An ongoing communication effort is required to make Antibio'Malin known to professionals and the general population. HPs, in particular GPs and pharmacists, in which patients place their trust, have a major role to play to promote the website, using for example the flyer that has been produced (https://solidarites-sante.gouv.fr/IMG/pdf/flyers_antibio_malin_format_a5-final.pdf). Finally, the launch of Antibio'Malin was quite recent, so it is not yet possible to assess the long-term

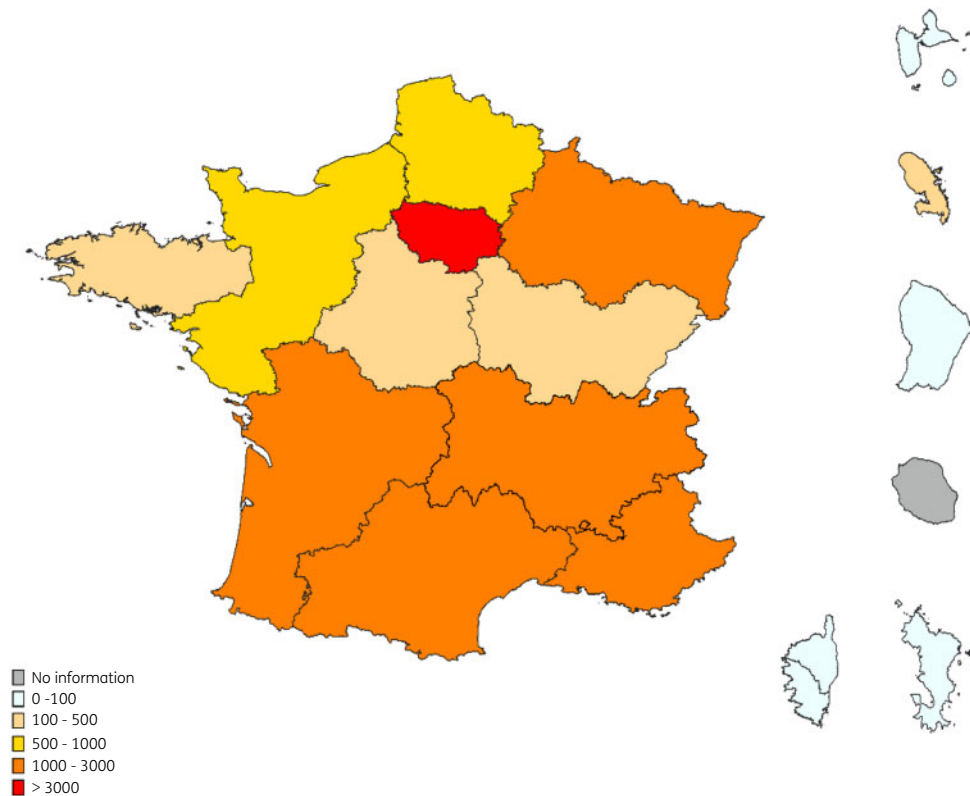


Figure 2. Geographical distribution of the number of French visits to the Antibio'Malin website.

uptake of this resource. Moreover, it will be difficult to assess its impact on antibiotic use, since several antibiotic stewardship interventions are being implemented at the same time in France.²⁷

Implications

Antibio'Malin provides expert knowledge to patients and HPs to better inform their antibiotic stewardship and antibiotic resistance understanding. In France, demand from patients is a driver of antibiotic use.²⁸ This is exacerbated by the anticipation of this demand by prescribers who go beyond their patients' perceived expectations of prescription.²⁹ Antibiotics are often perceived by patients as the only remedy to be cured fast, even in case of viral infections.^{30,31} As a result, improving patient knowledge can lead to improved diagnosis, therapeutic choices and economic gains.^{20,24} Antibio'Malin could improve antibiotic appropriateness, and consequently impact: (i) the prescriptions made to 'please the patient' even if prescribers know they are unnecessary; (ii) the prescribers' misreading of patients' expectations regarding prescriptions; and (iii) the patient' awareness of the risks of antibiotics (adverse effects, including the impact on the microbiota and antibiotic resistance). Although the literature shows that information acquired through the internet does not eliminate the need to consult a healthcare professional,²⁴ the knowledge of the duration of symptoms could also prevent patients from reconsulting too quickly and trying to obtain the antibiotic they were not prescribed the first time.

Antibio'Malin meets the first objective of the WHO's global action plan to improve awareness and understanding of antimicrobial resistance through effective communication, education,

and training.⁴ Our results might be useful for other countries that are considering implementing a similar intervention.

Future plans

Since its launch, Antibio'Malin's update was entrusted to the Grand Est regional antibiotic stewardship network, AntibioEst, which participated in its development. Continuous feedback from users is collected and will be used to improve the website further; at the end of each page, users are able to assess the usefulness of the information and enter comments. Usage statistics are also automatically collected and made available to AntibioEst and the MoH.

Conclusions

Antibio'Malin was developed to raise awareness and provide information on antibiotics, infections and antibiotic resistance to everyone, as well as serving as a communication tool for HPs. A post-launch study would be useful to explore the website's impact on the HSUs' perceptions, attitudes and knowledge. Nevertheless, it should be associated with other communication and awareness-raising interventions, and ongoing promotion of Antibio'Malin by all stakeholders is needed to increase its uptake.

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Transparency declarations

None to declare.

Author contributions

C.P. conceived the project. S.R., A.E. and F.P. drafted the content of the website, which was first reviewed by C.P. and then by the whole project working group. A.E. and G.L.-D. conducted the mixed-methods evaluation part, under the supervision of J.K., N.T. and C.P. S.R., A.E. and G.L.-D. drafted the first version of the manuscript, which was reviewed by all authors.

Supplementary data

Appendices S1 to S3 are available as [Supplementary data](#) at JAC-AMR Online.

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