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# Perspective of Spanish medical students regarding undergraduate education in infectious diseases, bacterial resistance and antibiotic use☆

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ABSTRACT

*Introduction:* One of the main tools to optimise antibiotics use is education of prescribers. The aim of this article is to study undergraduate education in the field of infectious diseases, antimicrobial resistance and antibiotic stewardship from the perspective of Spanish medical students.
*Material and methods:* An anonymous online questionnaire was distributed among sixth grade students using different channels in Europe, within the ESGAP Student-Prepare survey. The questionnaire included 45 questions about knowledge, attitudes and perceptions about diagnosis, bacterial resistance, use of antibiotics and undergraduate training in infectious diseases. We present here the Spanish results.
*Results:* A total of 441 surveys were received from 21 medical schools. A total of 374 responses (84.8%) were obtained from the 8 most represented faculties, with a response rate of 28.9%. Most students felt adequately prepared to identify clinical signs of infection (418; 94.8%) and to accurately interpret laboratory tests (382; 86.6%). A total of 178 (40.4%) acknowledged being able to choose an antibiotic with confidence without consulting books or guidelines. Only 107 (24.3%) students considered that they had received sufficient training in judicious use of antibiotics. Regarding learning methods, the discussion of clinical cases, infectious disease unit rotatories and small group workshops were considered the most useful, being evaluated favourably in 76.9%, 76% and 68.8% of the cases.
*Conclusion:* Medical students feel more confident in the diagnosis of infectious diseases than in antibiotic treatment. They also feel the need to receive more training in antibiotics and judicious antibiotic use.



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# La formación de grado en enfermedades infecciosas, resistencia y uso de antibióticos desde la perspectiva de los estudiantes de Medicina

*Palabras clave:*
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Resistencia a los antibióticos

RESUMEN

*Introducción:* Una de las principales herramientas para optimizar el uso de los antibióticos es la formación de los prescriptores. El objetivo de este trabajo es conocer la opinión de los estudiantes de Medicina españoles sobre la formación en enfermedades infecciosas.
*Material y métodos:* Se distribuyó un cuestionario *on line* anonimizado entre estudiantes de sexto curso a través de distintos canales. El cuestionario incluyó 45 preguntas sobre conocimientos, actitudes y percepciones sobre el diagnóstico, resistencia antimicrobiana, uso de antibióticos y la formación de pregrado en enfermedades infecciosas.
*Resultados:* Se recibieron un total de 441 encuestas de 21 facultades. Se obtuvieron 374 respuestas (84,8%) de las 8 facultades más representadas, con una tasa de respuesta del 28,9%. La mayoría de los alumnos se sentían preparados para identificar los signos clínicos de infección (418; 94,8%) y para interpretar correctamente las pruebas de laboratorio (382; 86,6%). Reconocieron saber elegir un antibiótico con seguridad sin consultar libros ni guías (178; 40,4%). Solo 107 alumnos (24,3%) consideraron haber recibido suficiente formación en el uso prudente de los antimicrobianos. Respecto a los métodos de aprendizaje, se percibieron como más útiles la discusión de casos clínicos, los rotatorios en servicios o unidades de enfermedades infecciosas y los talleres de pequeños grupos: se evaluaron favorablemente en un 76,9; en un 76 y en un 68,8% de los casos, respectivamente.
*Conclusión:* Los estudiantes de Medicina se encuentran más seguros en el diagnóstico de enfermedades infecciosas que en el tratamiento antibiótico. Asimismo, sienten la necesidad de recibir mayor formación en antibioterapia y uso prudente en antibióticos.


## Introduction

Bacterial resistance to antibiotics is, according to various healthcare institutions (WHO, CDC, ECDC), one of the most significant challenges faced by healthcare systems. Antibiotic use is associated with the selection and emergence of resistance, which makes optimising usage essential. However, again and again, when antibiotic use is evaluated, 30–50% of cases present opportunities for improvement.[1–4] Educating and training prescribers are important in order to optimise usage. Looking into the way in which medical students acquire this knowledge could provide information of great importance in the assessment of the problem.

Various studies have evaluated the training medical students receive in infectious diseases, antimicrobial resistance and prudent antibiotic use.[5–11] These studies primarily comprise surveys aimed at final-year medical students to evaluate their knowledge and perceptions about different aspects of the discipline, in some cases exploring the usefulness of different methods of learning in antibiotic therapy, such as placements in infectious diseases departments and units[11] and several methods of active in-person and online learning.[12–14] To date, no studies have evaluated how Spanish medical students behave in this regard.

Our aim was to study the knowledge, attitudes and perceptions of Spanish students, as well as the teaching methods employed.

## Material and methods

### *Context*

This work formed part of the European Student-PREPARE project, sponsored by the European Society of Clinical Microbiology and Infectious Diseases Study Group for Antimicrobial Stewardship (ESCMID: ESGAP),[15] which consisted of designing, distributing and analysing a survey among medical students from over 20 European countries. The results from the surveys conducted at Spanish institutions are analysed herein.

### *Questionnaire*

The medical students' knowledge, perceptions and attitudes were recorded in an English questionnaire containing 45 questions divided into three blocks. The first block included the participants' demographic variables. The second block included 27 questions about their perceptions on their preparedness for the different skills needed for adequate diagnosis and treatment of infections (indication and selection of empirical and targeted antibiotic treatment and duration). Questions were multiple choice, on a scale from 1 ("I feel not at all prepared") to 7 ("I feel very well prepared"). The third block included 12 questions on the pedagogical methodology used to teach about infectious diseases, antimicrobial resistance and antibiotic use, as well as the students' opinion on the usefulness of the different teaching methods used (available as additional material).

### *Survey distribution*

Spain's study coordinators contacted Professors of Medicine from eight Spanish medical schools (University of Navarra, University of Seville, University of Zaragoza, University of Elche, Complutense University of Madrid, University of Córdoba, University of Málaga and University of Cantabria), who were tasked with distributing the online questionnaire (www.surveymonkey.com) by email. The survey was also shared on Twitter via the corporate accounts @PROA_HULP and @PROA_HCUZ. The first invitation to participate in the survey was sent in November 2015 and there were two subsequent reminders. The number of students enrolled in the final year of Medicine at the eight schools targeted that year was provided by the professors.

### *Data analysis*

The percentages and means of the responses given in each category were calculated in order to carry out a descriptive study (response range from 1 to 7). The comparative analysis of the mean responses was done using the Wilcoxon test.

**Table 1**
Participating universities: number of students enrolled, participation level and percentage provided to the study sample.

| University | Final-year students enrolled | Responses received ($n = 441$) $n$ (%) | Proportion of responses in relation to the total in % |
|---|---|---|---|
| University of Navarra | 175 | (120) 68.6 | 27.2 |
| University of Seville | 174 | (58) 33.3 | 13.2 |
| University of Zaragoza | 294 | (43) 14.6 | 9.8 |
| University of Elche | 120 | (40) 33.3 | 9.1 |
| Complutense University of Madrid (12 October) | 120 | (37) 30.8 | 8.4 |
| University of Córdoba | 153 | (28) 18.3 | 6.3 |
| University of Málaga | 159 | (25) 15.7 | 5.7 |
| University of Cantabria | 98 | (23) 23.5 | 5.2 |
| Others | 5600 | (67) 1.2 | 15.1 |

Others: we estimated the number of students who were not enrolled at the eight participating universities.

As regards the learning methods used, the results were presented as percentages, excluding students who stated that they had not used specific methods, in order to evaluate their level of satisfaction in a second analysis. Analysis was performed using the SPSS® statistical package, version 15.0.

## Results

*Demographic characteristics of the participants and response rate*

441 surveys were received in total, of which 285 (65%) corresponded to female participants. Spain was the country of origin of 98% of the respondents. The eight medical schools in which the full professors disseminated the survey accounted for 85% of the responses (Table 1), with a participation rate of 28.9%. Taking into account the total population of final-year medical students in Spain, the participation rate was 6%.

*Students' perceptions regarding their skills for diagnosing infectious diseases and prescribing antibiotics*

Most students felt prepared to recognise the signs of infection (418; 94.8%); assess the severity of infection (358; 81.2%); interpret markers of inflammation (382; 86.6%); take microbiological samples correctly (345; 78.2%) and interpret the results of basic microbiological tests (344; 78.1%). However, 149 (33.8%) did not feel prepared to use rapid diagnostic tests at the patient's point of care.

Moreover, most students also felt prepared to decide when antibiotic use is indicated (Fig. 1), but less so when it came to choosing the most adequate treatment without using guidelines or books (40.4%), knowing the urgency of administration (48.2%), choosing combination therapies (38.7%), assessing allergies (46.2%) or prescribing according to guidelines (43.6%).

The percentages of students who felt prepared to assess treatment response, de-escalate based on microbiological tests and evolution, switch to oral therapy or decide upon a shorter regimen were 55.1%; 55.5%; 50.3% and 34.7%, respectively. The majority (79.8%) felt prepared to explain to a patient why antibiotic treatment is not needed.

The students' perceived preparedness regarding the assessment and diagnosis of patients with infectious diseases (Fig. 1, questions 1 and 2) was compared to their perceived preparedness for treating and managing infections (Fig. 1, questions 3 and 4). This was higher ($p < 0.01$) for diagnosis and assessment than for treatment (mean 4.79 versus 3.52).

While the students mostly indicated that they felt prepared to use their knowledge on resistance mechanisms (63%), the principles of resistant microorganism transmission (84.4%) and the negative consequences of antibiotic treatments (84.1%), few saw themselves as capable of applying their knowledge on the epidemiology of antibiotic resistance to local or regional circumstances (44%) or interpreting antibiotic usage data (39.6%). (The percentages for each response option can be found in the additional material).

*Learning methods*

The respondents were asked which were the most widely used teaching methods at their schools and how useful they felt each one was. The most used were lectures (93%) and discussions of clinical cases (92%), while the least used were role-plays (42.2%) and teaching in groups of fewer than 15 people (59%). Those deemed most useful were discussions of clinical cases and infectious diseases clinical placements, while those considered least useful were e-learning (40.7%) and microbiology clinical placements (49.2%) (Table 2).

*"Overall, do you feel you have received sufficient teaching at medical school in antibiotic use for your future practice as a junior doctor?"*

In total, 107 students (24.3%) answered "yes". Conversely, 116 (26.3%) felt they had enough teaching on general antibiotic treatment, but needed more on prudent antibiotic use, while 179 (40.6%) felt they needed more training on both concepts.

## Discussion

This work shows that the vast majority of final-year students at Spanish medical schools feel that their training in the field of infectious diseases and antibiotic use and resistance is insufficient. While they feel sufficiently prepared regarding the assessment and diagnosis of infectious diseases and interpreting additional tests, they did not feel the same about aspects related to treatment. These findings, which constitute one of the first approaches to the problem regarding training on infectious diseases and antibiotic use among medical students in Spain, are consistent with those reported recently by Dyar et al.,[6] concerning a sample of students from seven European countries, and by Abbo[11] on US students. While in Dyar's work 74% of the respondents requested more training on these aspects, Abbo and her team found that this rate reached 90% in their study. Although university teaching ought to not only be evaluated by means of students' perceptions, this is without a doubt a dimension that should be taken into account.

Since the training and education of future prescribers is one of the primary interventions for improving antibiotic use, this work highlights that there is room for improvement. Perfecting teaching in this field is a complex undertaking and depends on various factors. Firstly, that undergraduate education, and primarily teaching on clinical aspects, is structured into modules that are organised by organs and systems. Thus, students receive training on infectious diseases and antibiotic use across various modules which are imparted by a vast number of lecturers from different specialities. The inclusion of clinical modules with specific content on optimising antibiotic use could prove useful in mitigating the problem. The development and delivery of said specific content on optimising antibiotic use should occur as a result of multidisciplinary collaboration, as occurs in the management of infectious diseases in clinical practice.[16] In this regard, however, the departmental structure of Spanish universities and study programmes will probably not facilitate this multidisciplinary approach.

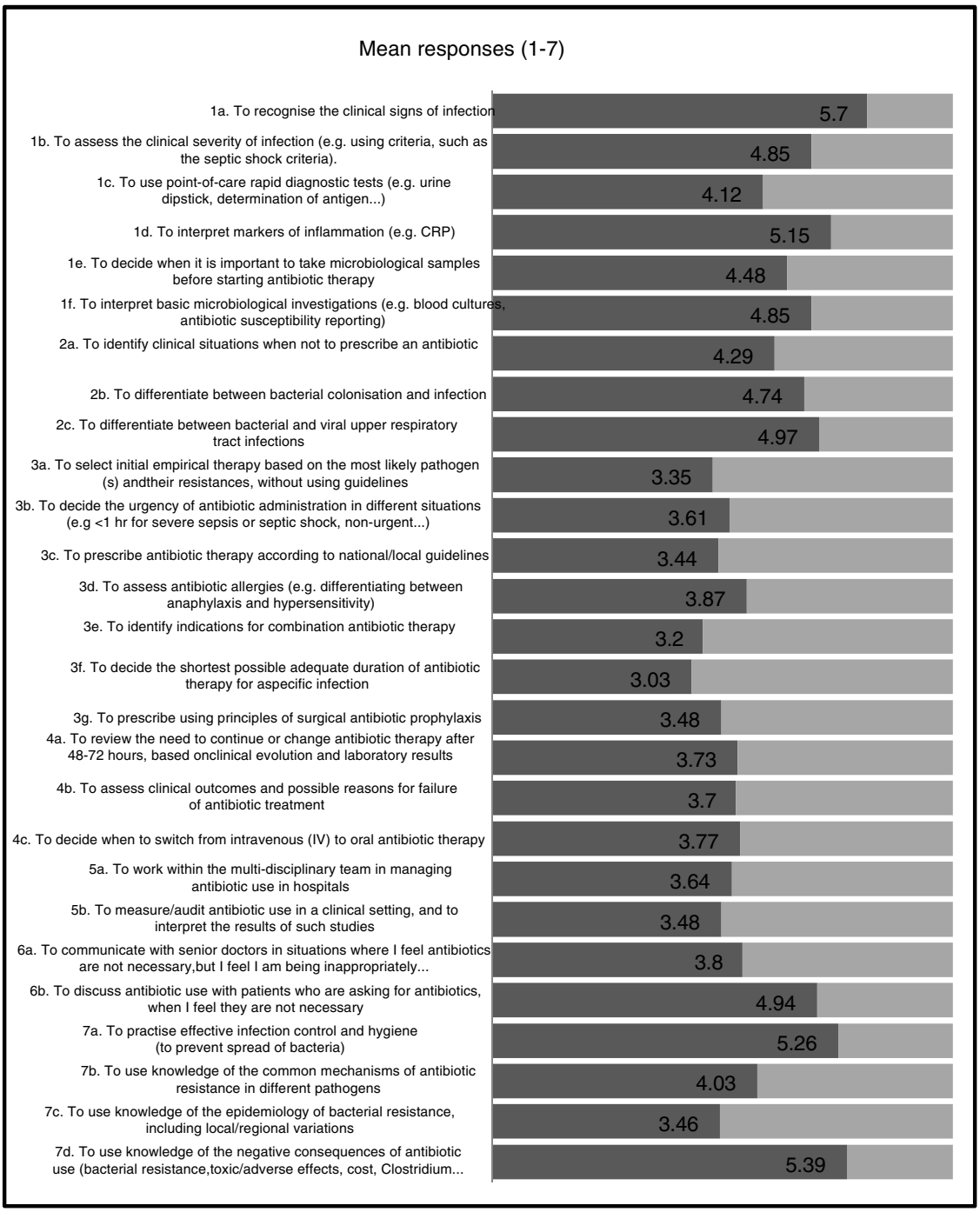


**Fig. 1.** Perception of final-year students regarding their preparedness for the skills required for the adequate diagnosis and treatment of infectious diseases. The value represented is the mean response received for each question on a scale from 1 ("I feel not at all prepared") to 7 ("I feel very well prepared").

Nevertheless, it may prove of great use to incorporate undergraduate training in the curriculum on the principles of optimising antibiotic use, which are currently dispersed among different modules, thus hindering the students' consolidation thereof. Designing this new curriculum should begin with the definition of the various learning objectives pursued, alongside the corresponding skills that students must acquire.[16] The fact that some Spanish universities already include specific subjects on optimising antibiotic use, as highlighted by Gutiérrez et al., is a positive.[17] Moreover, the existence of a National Plan against Antibiotic Resistance (*Plan Nacional contra la Resistencia a los Antibióticos, PNRAN*), in which training is a strategic line, with the participation of dozens of medical schools, may serve as a catalyst in this much-needed reform.[18]

Undoubtedly, improving undergraduate training on antibiotic use involves using the most effective teaching method. In this sense, it is striking that despite lectures not being among the most effective knowledge transfer methods, they are the most commonly used teaching resource employed in Spanish medical schools and, curiously, are widely accepted by students.[16] Problem-based learning, such as the discussion of clinical cases or workshops, is among the most valued activities; however, others such as role-play and e-learning are much less used and the level of satisfaction shown

**Table 2**
Percentage of use of the learning methods and percentage of students who, having used them, found them useful or very useful.

| Learning method | Percentage of use | Percentage of students who, having used them, saw them as useful/very useful |
|---|---|---|
| Lectures (with >15 people) | 93 | 59.4 |
| Small group teaching (with <15 people) | 59 | 68.8 |
| Discussions of clinical cases | 91.2 | 76.9 |
| Active learning | 71.7 | 62.9 |
| E-learning | 65.1 | 40.7 |
| Role-play | 42.2 | 52.1 |
| Infectious diseases clinical placement | 79.4 | 76 |
| Microbiology clinical placement | 76 | 49.2 |
| Peer teaching | 67.3 | 62.3 |

by the students is far lower. The degree of implementation and acceptance of lectures is probably related to students' most immediate expectation—passing the module—and the need for factual and primarily rote learning in order to access specialised medical training through the Spanish MIR exam (to become a resident medical intern). As long as rote learning constitutes the most direct route to good academic results, lectures and note-taking will continue to be among the methods preferred by students. The introduction of more effective teaching methods for skill acquisition is very likely, requiring substantial changes to the student assessment model so that it no longer focuses on knowledge alone. Another way to change the pedagogical model, prioritising the processes of reasoning and skill acquisition over factual and rote learning, is swapping lectures for the flipped classroom approach, which is being increasingly adopted in US medical schools and consists of providing students with teaching materials, usually in digital format, to be studied and processed outside of the classroom.[19]

The implementation of the flipped classroom method would be made all the more difficult by Spanish students' low acceptance of e-learning as a teaching method, in particular, while in other countries it has proven an effective tool for subjects as complex as pharmacokinetics. This is the case in the study by Mehvar et al., who showed that students could master pharmacokinetic parameters and PK/PD calculations in antibiotic therapy through active leaning and online platforms.[12] Moreover, MacDougal et al. proved that students' knowledge could be improved following an antibiotic prescription training programme using workshop teaching and e-learning.[14] The fact that two-thirds of the respondents note the use of e-learning, but that this is the least valued method, should prompt us to stop and think about whether our schools are using the most effective resources and tools when resorting to this method.

With regard to teaching methods, the disparity between the percentage of students who find infectious diseases placements useful compared to microbiology placements (76% versus 49.2%) should be highlighted, which may be due to the fact that the former have more of a clinical focus, or that in the latter there are fewer opportunities to discuss clinical cases, a technique deemed useful by the students in our survey.

This work has some limitations to be taken into account. Firstly, the fact that the questionnaire was circulated in English may have limited participation to students with a higher command of the language, leading to selection bias and a potential overrepresentation of students of a higher academic standard. Secondly, the sample represents approximately 6% of the population of final-year students enrolled at Spanish medical schools. However, this figure totals almost 30% in relation to the students registered at the eight targeted schools, which is similar to that obtained in other surveys of this nature. Taking into account that these types of surveys are widely distributed across Spain, we believe that the overall representativeness of the study is not significantly affected on this basis. Among the targeted schools, the response rate is variable. Although this could be explained by the different strategies used by professors to disseminate the survey and encourage participation, it could also reflect the existence of selection bias. Either way, another form of selection bias can be found in this regard, since the reasons some schools achieved a greater response rate than others could be linked to the attitudes of students and teachers. Moreover, it should be noted that this survey must be contextualised within the Medical Degree's competence framework, since some of the skills explored (e.g. interpreting data on antibiotic use) go beyond those that should be acquired during this period.[16] Finally, we must not forget that this study evaluates training solely from the students' perspective, analysing their perceptions and not their knowledge.

Ultimately, this work highlights that there are opportunities for improvement as regards training on infectious diseases and antibiotic use and resistance, as noted by Spanish medical students, which should prompt us to think about what and how we can improve upon this essential tool for optimising antibiotic use.

## Conflicts of interest

The authors declare that they have no conflicts of interest.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.eimce.2018.10.003.

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