

# Knowledge regarding antibiotic use among medical students, Medellin, Colombia: A cross-sectional study

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## Research article

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## Abstract

Background The objective of this study was to describe the knowledge regarding antibiotic therapy of students of three medical schools of Medellín, Colombia. Methods The study population was made up of medical students enrolled in three universities. The instrument contained questions about their current academic term, the university the perceived quality of the education received on antibiotic therapy and bacterial resistance and specific questions on upper respiratory tract infections, pneumonia, urinary tract infections and skin and soft tissue infections. The information was analysed by calculating frequencies and measures of dispersion and central tendency. Knowledge about the treatment of each type of infection was compared with the Mann–Whitney U test and the Kruskal–Wallis H test. Results We included 536 medical students, 43.5% consider that the university did not train them enough to interpret antibiograms, 29.6% consider that the quality of information received on the subject at their university ranges from regular to poor. The mean score for knowledge regarding antibiotic therapy for upper respiratory tract infections was  $44.2 \pm 9.9$  on a scale from 0 to 100. In the treatment of pneumonias, the median score was  $52.9 \pm 14.7$ , in urinary tract infection was  $58.7 \pm 14.8$  and skin and soft tissue infections was  $63.1 \pm 19.4$ . The knowledge regarding antibiotic therapy for upper respiratory tract infections, pneumonias and urinary tract infection does not improve with academic term, the university, or perception of the education received Conclusion A large proportion of medical students perceive that the training received from the university is deficient regarding antibiotics and bacterial resistance, which coincides with the limited knowledge reflected in the selection of antibiotic treatment for respiratory, urinary tract, skin and soft tissue infections. Overall, the situation is the same among all universities and it does not significantly increase with academic term.

## Background

Antibiotics are fundamental drugs in modern medicine as they have significantly decreased mortality due to infectious diseases, improved survival, and have been essential prevented or treated infections that can occur in patients who are receiving chemotherapy treatments; who have chronic diseases; or who have had complex surgeries such as organ transplants, joint replacements, or cardiac surgery. [1, 2].

The antibiotic resistance crisis has been attributed to several aspects, among which is the special attention the overuse and misuse of these medications, aspects that have led to an antibiotic resistance crisis, and to a serious problem of public health that constitutes a threat to all advances achieved by modern medicine. Infections by resistant bacteria do not respond to standard antibiotic treatment and result in an enlarged number of morbidity and mortality cases, and excess health care cost. Their easy dissemination between countries, due to international travel, compromises global public health [3, 4].

It is estimated that resistant bacteria cause approximately 25,000 deaths in Europe and at least 2 million infections in the United States each year. There are few reliable estimates for developing countries. However, there may be a greater impact of antimicrobial resistance due to the increase in infectious diseases and restricted access to new antibiotics [5]. In addition, the emergence of new resistance

mechanisms which complicate the treatment of common infectious diseases such as pneumonia, tuberculosis, septicaemia or sexually transmitted diseases, such as gonorrhoea, is common [3].

Nonetheless, many medical consider bacterial resistance is still infrequently encountered in the everyday practice and some question the evidence linking their prescribing to resistance and worse outcomes for their patients [6]. One of the consequences of considering the problem as not very serious, or of little relevance for routine clinical practice, is the lack of interest in making prudent use of antibiotics. For instance, regarding this last item, one study revealed that 23% of antibiotic prescriptions in the United States are inappropriate [7]. In Saudi Arabia, more than 46% of prescriptions are written for clinical conditions in which antibiotics are not indicated [8] and, in Colombia, a study revealed that between 29.2% and 67.4% of the doctors surveyed have incorrect knowledge regarding the prescription of antibiotics [9].

In this context, the World Health Organization advocates to implement strategies that allow the next generation of doctors to be better prepared to use antibiotics properly and combat bacterial resistance. In line with the foregoing, the objective of this study is to describe the knowledge regarding antibiotic therapy of students of three medical schools of Medellín, Colombia. The evaluation of this dimension will make it possible to know the level of knowledge of these students and to guide future interventions.

## Methods

Type of study: Cross-sectional descriptive

Subjects of study: the study population was made up of medical students enrolled in 2018 in three universities in the city of Medellin. The sample was taken at convenience, taking into account the inclusion of students of all semesters, both sexes and all ages. Students who rejected voluntary participation in the study and if there is more than 10% missing value were excluded.

Information-gathering instrument. An instrument designed by an infectious disease physician, a doctor in molecular epidemiology with experience in bacterial resistance research, and a microbiologist with a master's degree in education, was used to collect information. The instrument was divided into five sections: The first one contained questions about their current academic term (Semester 1 to 5: Basic, Semester 6 to 10: Clinics, Semester 11 to 12: Internship), the university and the perceived quality of the education received on antibiotic therapy and bacterial resistance. The other sections include specific questions on upper respiratory tract infections (8 questions), pneumonia (4 questions), urinary tract infections (7 questions), and skin and soft tissue infections (3 questions). The answers were generated taking into account if the participant agrees or disagrees with the question and they were transformed to a scale from 0 to 100 to account for the knowledge about treating each type of infection with the formula =

$$\frac{\text{Score obtained} - \text{minimum score possible}}{\text{Maximum minimum}} \times 100$$

The interpretation is made taking into account that the higher the score the better the knowledge.

Procedure: For the collection of information, educational institutions were contacted, and the project was presented to the students who endorsed their voluntary participation in the study and completed an anonymous survey. Interviewer, instrument and respondent biases were controlled during the collection of information. The interviewer conducted a training that included a protocol with operational definitions of the variables and guidelines on the fieldwork. A pilot test and validity of appearance was applied to the instrument. Respondents were guaranteed confidentiality and anonymity.

Analysis of the information: The information was analysed by calculating absolute and relative frequencies for the qualitative variables and measures of position, dispersion and central tendency for the quantitative variables. Knowledge about the treatment of each type of infection, according to the perception of the quality of education received, was compared with the Mann–Whitney U test and the Kruskal–Wallis H test, after verifying non-fulfilment of the assumption of normality evaluated with the Kolgomorov–Smirnov test with Lilliefords correction. Three conditions were used to evaluate potential confounding factors: i) the factor was not an intermediate step in the causal event horizon; ii) the variable might reveal an association with the study group or illness; iii) the variable might reveal an association with one type of infections. Therefore, the quantification of confounding factors was performed with multiple linear regression models. All analyses were performed in SPSS, version 25, and p-values less than 0.05 were considered significant.

Ethical aspects: The project has the approval of the ethics committee according to item number 023-2018, through record N0.001.

## Results

We included 536 medical students, most of them women (60.4%), ranging from 16 to 49 years of age and from the first semester through internship. When enquiring about the perceived quality of the education they receive on antibiotics and bacterial resistance, 43.5% consider that the university did not train them enough to interpret antibiograms. Furthermore, 46% of students consider that they receive insufficient training on switching from intravenous to oral antibiotics, and 21.4% consider themselves not to be adequately trained to find reliable sources of information. In general, 29.6% consider that the quality of information received on the subject at their university ranges from regular to poor (Table 1). Not missing data were identified.

### Upper respiratory infections

Regarding the use of antibiotics for the treatment of upper respiratory tract infections, it was found that 46.3% ( $n = 242$ ) of medical students consider that every otitis media in children should be treated with antibiotics and 29.1 % ( $n = 150$ ) state that the treatment of choice for these infections should be

azithromycin (Figure 1). The mean score for knowledge regarding antibiotic therapy for this type of infections was  $44.2 \pm 9.9$  on a scale from 0 to 100 (Table 2) and bivariate analysis shows that the knowledge does not improve with the academic term, the university or perception of the education received (Table 3).

## Pneumonia

In the treatment of pneumonias, it was found that 68.5% ( $n = 351$ ) state that all patients with acute pneumonia should receive antibiotics, whereas 74.8% ( $n = 377$ ) indicate that they must be prescribed whenever there is pneumonia due to *Mycoplasma* spp (Figure 2). The median score for these types of infections was  $52.9 \pm 14.7$  (Table 2) and knowledge does not improve with academic term, the university, or perception of the education received (Table 3).

## Urinary tract infections (UTI)

In cases of urinary tract infection, it should be noted that 42.8% ( $n = 216$ ) of the students stated that every asymptomatic bacteriuria in diabetic women should be treated. Also, that the follow up urine culture in patients undergoing treatment for urinary tract infection should be performed after finishing antimicrobials, 55.8% ( $n = 281$ ) and 26% ( $n = 130$ ) stated that the first choice of treatment for UTI should be Ampicillin/Sulbactam (Figure 3). The average score for this index was  $58.7 \pm 14.8$  (Table 2) and knowledge improves slightly with academic term and university (Table 4). In the multivariable analysis, only University and Switching from IV to oral antibiotics were associated.

## Skin and soft tissues

In reference to skin and soft tissue infections, 25.2% ( $n = 126$ ) found that all skin and soft tissue infections requiring hospital management should receive vancomycin and 55.4% ( $n = 276$ ) state that in necrotising skin infections treatment should be vancomycin in combination with linezolid (Figure 4). The score for this index was the highest of all the ones evaluated  $63.1 \pm 19.4$  (Table 2) and it improves significantly with academic term and university (Table 4). In the multivariable analysis, only Academic term were associated.

## **Discussion**

This study revealed that medical students have poor knowledge about the use of antibiotics to the extent that the ratios were between  $44.2 \pm 9.9$  and  $63.1 \pm 19.4$  points. In general, students perceive that training received from the university regarding the topic is insufficient. In this regard, it is important to remember that the World Health Organization has highlighted the importance of improving the training of undergraduate students in the use of antibiotics as one of the main strategies to preserve their effectiveness [910]. Despite this, the results of this research, plus that reported for students from the

United States [11], Spain [12] and seven other European countries [13] reflect that education on this topic is still deficient.

The interpretation of antibiograms is highlight among the topics in which the students consider that they receive insufficient training by the university, standing out with 43.5%. This finding is similar to an investigation in Chinese students where the frequency of dissatisfaction with the education received to interpret antibiograms was 71.7% [14]. The interpretation of antibiograms is a fundamental competence for trainee doctors because it guides the detection of new mechanisms of resistance, the knowledge of epidemiology in a defined geographical area and the choice of antimicrobial treatment. However, the interpreted reading of an antibiogram is a complex exercise that involves knowing, for instance, that there are antibiotics that are only slightly affected by the resistance mechanisms, so that they are reported as sensitive in inhibitory tests in cases when they are resistant. A classic example is the false sensitivity of *Salmonella* spp to ciprofloxacin and levofloxacin if these isolates are resistant to nalidixic acid. In the same vein, the false sensitivity to amikacin and tobramycin in *S. aureus* when it is resistant to gentamicin [15]. Failure to recognise these particularities has consequences in the choice of therapy - it leads to therapeutic failure, omits the reporting of new resistance mechanisms and increases costs by requiring specialised diagnostic tests. Therefore, teaching in this field constitutes a challenge for the city medical schools. Nevertheless, it's necessary to complement these actions by encourage their mission as promoters of health education, especially so that patients follow medical recommendations and adhere to therapies

Regarding knowledge about the treatment of specific infections, it was found to be low for respiratory infections due to a tendency toward the indiscriminate use of azithromycin, the selection of otitis treatment in children and the use of antibiotics in cases of acute pneumonias. This finding coincides with previous studies in practising physicians which found that 45% [16] to 64.2% of antibiotic prescriptions for patients seen for respiratory tract infections are inadequate [17]. Specifically, in medical students it has been shown that 18.1% consider that antibiotics are useful for the treatment of viral respiratory infections [18]. These findings evidence that it is necessary to improve the knowledge of the treatment of respiratory infections in trainee physicians because these infections are among the ten main causes of morbidity and mortality in the general population. They are within the first three in the paediatric population [19], and cases of pneumonia are the leading cause of death due to infectious diseases [20]. Not improving said knowledge has two implications. On the one hand, the prescription of antibiotics for cases in which they are not indicated contributes to the selection pressure for resistant microorganisms. On the other, adequate treatment is delayed, contributing to morbidity and mortality due to this cause.

With regards to UTIs, it was found that the average for this ratio was  $58.7 \pm 14.8$  with a high proportion of students stating that all asymptomatic urinary infections in diabetic women must be treated and that the first choice of treating a UTI must be Ampicillin/Sulbactam. This finding coincides with another investigation carried out in which 47.3% of students do not identify the appropriate UTI therapy [14]. In addition to mistakes regarding the correct therapy, research carried out on practising physicians found that only 41% of antibiotic prescriptions for these types of infections are written according to

recommended dosing, intervals and duration [21]. It has been described that in up to 96% of cases antibiotics are prescribed for UTIs in pregnant women without them being indicated [22]. Errors in the prescription of antibiotics for these types of infections is an important topic given that UTIs are one of the most common causes of doctor visits at the primary care level, affecting nearly 150 million people per year worldwide [23]. In the USA these cases are to blame for 0.7% of all outpatient visits. It is estimated that 7 million women per year seek medical care due to UTIs [24] and 15% of all antibiotics prescribed in outpatient clinics are directed toward treating these infections [25]. Furthermore, in the case of pregnant women, these medicines can present deleterious effects on the foetus [22].

Knowledge regarding the treatment of skin and soft tissue infections showed an average score of  $63.1 \pm 19.4$ , with a tendency for the use of vancomycin in hospital cases and in necrotising infections. The frequencies of these infections have presented a dramatic increase between 2000 and 2004, with values reaching 29% of total hospitalisation cases. Moreover, they are blamed for 6.3 million visits to the doctor per year. An important proportion of this frequency is linked to the appearance of community acquired infections by methicillin-resistant *Staphylococcus aureus* (MRSA) [26]. With the appearance of MRSA, the use of vancomycin has become popular, which could explain the students' tendency to prescribe this antibiotic. However, the use, and particularly the abuse that has been made of it has derived in cases of vancomycin-resistant *Staphylococcus aureus*. Although resistance to vancomycin has been less critical than predicted because the strains found are not pan-resistant and respond well to commonly used antibiotics such as trimethoprim-sulfamethoxazole or linezolid, it is of utmost importance to insist on prudent use of these antimicrobials starting at their early stages of formation[27].

Interventions directed to the improvement of antibiotic use have been traditionally focused on clinicians and pharmacists [28,29] or have been restricted to evaluating the effects of programmes to control infections associated with healthcare [30]. In medical students, interventions are meagre despite the fact that it is in them that they can have greater effects since they have not yet developed erroneous prescription habits [31]. Some interventions of this kind can be found at universities in the United States [11,32 ,33]. They could make up the basis on which to focus micro and macro curricular academic changes for local universities.

Possible limitations to this study include failure to take into account the study plans of medical schools regarding the use of antibiotics and bacterial resistance. The information gathered was based on self-reporting and three out of six universities in the city were included then external validity is compromised.

## Conclusions

Despite its limitations the study allows to reach the conclusion that a large proportion of medical students perceive that the training received from the university is deficient regarding antibiotics and bacterial resistance, which coincides with the limited knowledge reflected in the selection of antibiotic treatment for respiratory, urinary tract, skin and soft tissue infections. Overall, the situation is the same among all universities and it does not significantly increase with academic term. In this situation it's

necessary to act in different sectors, but it is clear that education in adequate prescription, as well as in control and prevention of infections is the basis for solving the problem.

## Abbreviations

**U:** University

**IV:** Intravenous

**UTI:** Urinary tract infections

## Declarations

### Ethics approval and consent to participate

The project has the approval of the ethics committee of Universidad Cooperativa de Colombia according to item number 023-2018, through record N0.001. The principles of the Declaration of Helsinki and Resolution 8430 of 1993 of the Colombian Ministry of Health were applied.

### Consent for publication

Students consented to the use of the information for investigative purposes and the analyses are based on data that do not contain information which could lead to the identification of the student. In Colombia, the scientific, technical and administrative standards for health research are found in resolution 8430 of 1993. In it, research is classified as research without risk, with minimal risk and with risk greater than the minimum. In Article 11 of that resolution, the research we carry out is classified as a risk-free investigation because it is a study that uses documentary research techniques and methods and in which no intervention or intentional modification of the biological, physiological, psychological or social variables of the individuals participating in the study. In article 16, first paragraph of the same resolution, it is stated that in investigations without risk the investigator can be dispensed from obtaining informed consent; however, informed consent verbal was obtained.

### Availability of data and material

Not applicable

### Competing interests

The authors declare that they have no competing interests.

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## Authors' contributions

LFH: helped design and conduct the study, collection and analyze the data and write the manuscript; VMG, JMA and LG contributed to the collection, analysis of data and write the manuscript; GER participated in design the study and the critical review of the manuscript; JNJ contributed to design and conduct the study and write the manuscript. All authors read and approved the final manuscript.

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## Tables

**Table 1.** Perceived quality of education they have received about antibiotic therapy

		N	%
Academic term	Basic (Semester 1 to 5)	218	40.7
	Clinical areas (Semester 6 to 10)	152	28.4
	Internship (Semester 11 to 12)	166	31.0
University	U1	215	40.0
	U2	170	31.6
	U3	153	28.4
The university prepares you well enough to...	... know when to start antibiotic treatment	473	89.9
	... select the antibiotics for each infection	423	80.4
	... understand the basic mechanisms of resistance	440	83.7
	... interpret antibiograms	296	56.5
	... find reliable sources of information	412	78.6
	... switch from IV to oral antibiotics	282	54.0
Evaluation of information received on the subject	Not received	32	6.0
	Average/Poor	157	29.6
	Good	258	48.7
	Excellent	83	15.7
Has experience in research or education regarding antibiotics and/or bacterial resistance		296	55.0

**Table 2** Knowledge profile regarding antibiotic therapy according to the type of infection

	<b>X ± DS</b>	<b>Me (RIQ)</b>	<b>Minimum</b>	<b>Maximum</b>
Treatment for upper respiratory tract infection	44.2 ± 9.9	42.9 (39.3-50.0)	14.3	71.4
Treatment for pneumonia	52.9 ± 14.7	50.0(41.7-66.7)	0.0	91.7
Treatment for urinary tract infection	58.7 ± 14.8	61.9(52.4-66.7)	9.5	95.2
Treatment for skin and soft tissue infection	63.1 ± 19.4	66.7(55.6-77.8)	0.0	100.0

**Table 3** Comparison of knowledge about antibiotic therapy for upper respiratory tract infections and pneumonias according to the perceived quality of education.

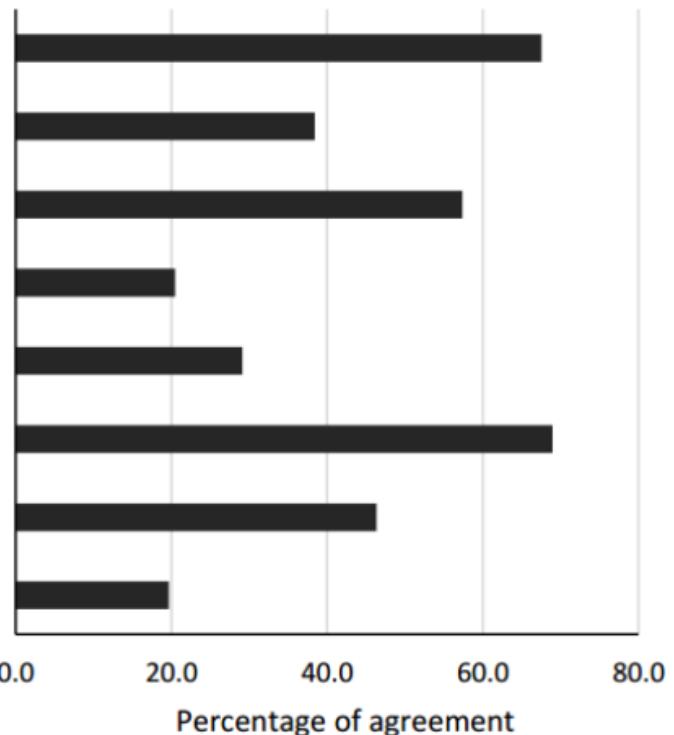
		<b>Upper respiratory Me(RIQ)</b>	<b>Pneumonia Me(RIQ)</b>
Academic term	Basic	46.4(35.7-50.0)	50.0(41.7-58.3)
	Clinics	42.9(35.7-50.0)	50.0(41.7-66.7)
	Internship	46.4(39.3-53.6)	50.0(50.0-66.7)
	<b>P value</b>	0.549	0.051
University	U1	42.9 (35.7-50.0)	50.0(41.7-58.3)
	U2	42.9(35.7-50.0)	50.0(50.0-66.7)
	U3	46.4(39.3-53.6)	50.0(50.0-66.7)
	<b>P value</b>	0.115	0.100
Knowing when to start antibiotic treatment	No	46.4(39.3-50.0)	58.3(50.0-66.7)
	Yes	42.9(35.7-50.0)	50.0(41.7-66.7)
	<b>P value</b>	0.535	0.323
Selecting the antibiotics for each infection	No	46.4(39.3-50.0)	50.0(41.7-66.7)
	Yes	42.9(35.7-50.0)	50.0(41.7-66.7)
	<b>P value</b>	0.574	0.456
Understanding the basic mechanisms of resistance	No	46.4(39.4-53.6)	58.3(50.0-66.7)
	Yes	42.9(35.7-50.0)	50.0 (41.7-66.7)
	<b>P value</b>	0.107	0.028*
Interpreting antibiograms	No	46.4(39.3-50.0)	50.0 (41.7-66.7)
	Yes	42.9(35.7-53.6)	50.0 (41.7-58.3)
	<b>P value</b>	0.909	0.107
Finding reliable sources of information	No	46.4(39.3-50.0)	50.0(41.7-66.7)
	Yes	42.9(39.3-50.0)	50.0(41.7-66.7)
	<b>P value</b>	0.384	0.515
Switching from IV to oral antibiotics	No	42.9(39.3-50.0)	50.0(50.0-66.7)
	Yes	42.9(35.7-50.0)	50.0(41.7-58.3)
	<b>P value</b>	0.329	0.131
Research or education	No	46.4(39.3-53.6)	50.0(41.7-66.7)
	Yes	42.9(35.7-50.0)	50.0(41.7-66.7)
	<b>P value</b>	0.400	0.697

**Table 4** Comparison of knowledge on antibiotic therapy for upper respiratory tract infections and pneumonias according to the perceived quality of education.

		UTI Me(RIQ)	Skin Me(RIQ)
Academic term	Basic	57.1 (42.9-66.7)	55.6 (44.4-77.8)
	Clinics	61.9(52.4-71.4)	66.7 (44.4-77.8)
	Internship	61.9 (52.4-71.4)	66.7 (55.6-77.8)
	<b>P value</b>	0.001**	0.002**
University	U1	57.1(42.9-66.7)	55.6(44.4-77.8)
	U2	61.9(52.4-66.7)	66.7 (55.6-77.8)
	U3	61.9(52.4-71.4)	66.7 (44.4-77.8)
	<b>P value</b>	0.000**	0.002**
Knowing when to start antibiotic treatment	No	61.9(52.4-71.4)	55.6 (44.4-77.8)
	Yes	61.9(52.4-66.7)	66.7 (55.6-77.8)
	<b>P value</b>	0.481	0.109
Selecting the antibiotics for each infection	No	61.9(52.4-71.4)	55.6 (44.4-77.8)
	Yes	61.9(52.4-66.7)	66.7 (55.6-77.8)
	<b>P value</b>	0.693	0.234
Understanding the basic mechanisms of resistance	No	61.9(57.1-71.4)	55.6 (44.4-77.8)
	Yes	57.1(47.6-66.7)	66.7 (55.6-77.8)
	<b>P value</b>	0.041*	0.804
Interpreting antibiograms	No	61.9(52.4-71.4)	66.7 (55.6-77.8)
	Yes	57.1(47.6-66.7)	55.6 (44.4-77.8)
	<b>P value</b>	0.055	0.002**
Finding reliable sources of information	No	61.9(52.4-66.7)	55.6 (44.4-77.8)
	Yes	61.9(47.6-66.7)	66.7 (44.4-77.8)
	<b>P value</b>	0.393	0.691
Switching from IV to oral antibiotics	No	61.9(52.4-71.4)	66.7(44.4-77.8)
	Yes	57.1(47.6-66.7)	55.6 (44.4-77.8)
	<b>P value</b>	0.002**	0.664
Research or education	No	61.9(52.4-66.7)	66.7(55.6-77.8)
	Yes	57.1(47.6-66.7)	66.7(44.4-77.8)
	<b>P value</b>	0.259	0.869

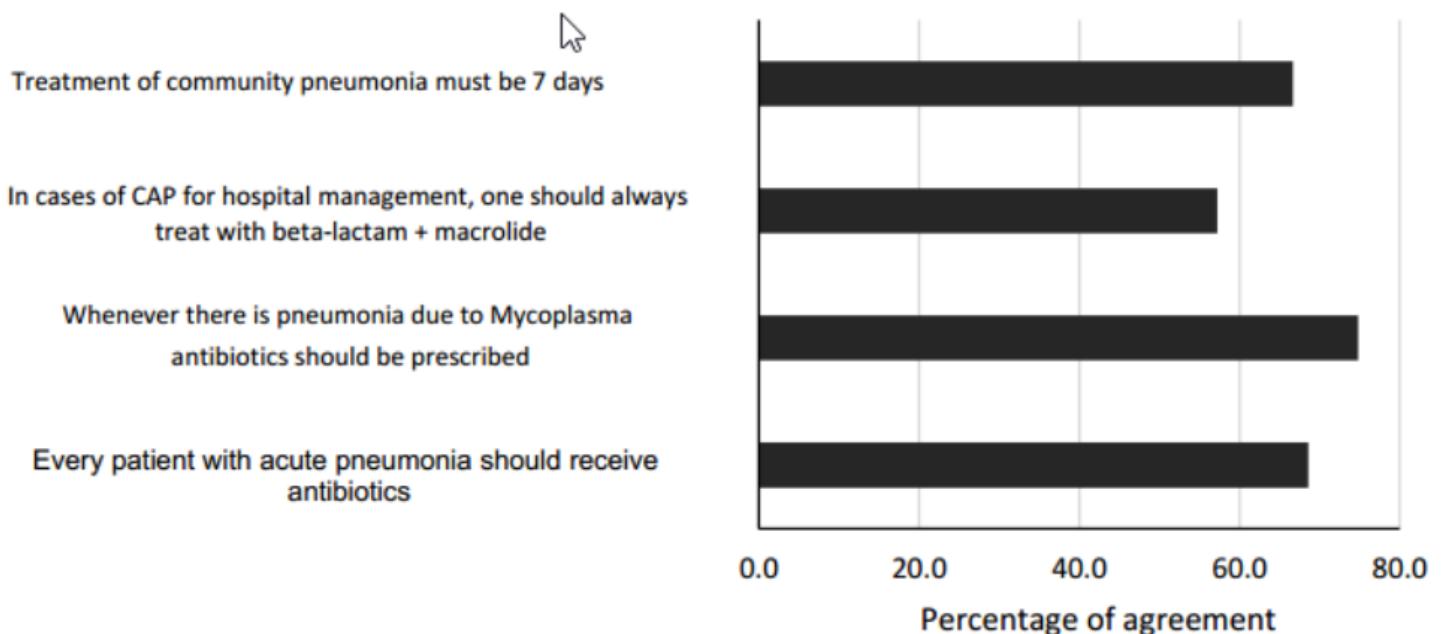
## Figures

- For resistance in pneumococcal and H influenza infection, amoxicillin clavulanate is better than amoxicillin.
- The treatment of choice for upper respiratory infections is amoxicillin clavulanate.
- The treatment of the choice of upper respiratory infections is amoxicillin.
- The treatment of choice for upper respiratory infections is quinolone.
- The treatment of the choice of upper respiratory infections is azithromycin.
- All tonsillopharyngitis in adults with purulent discharge should be treated with antibiotics.
- All otitis media in children should receive antibiotics.
- Always that acute sinusitis exists antibiotics must be commenced



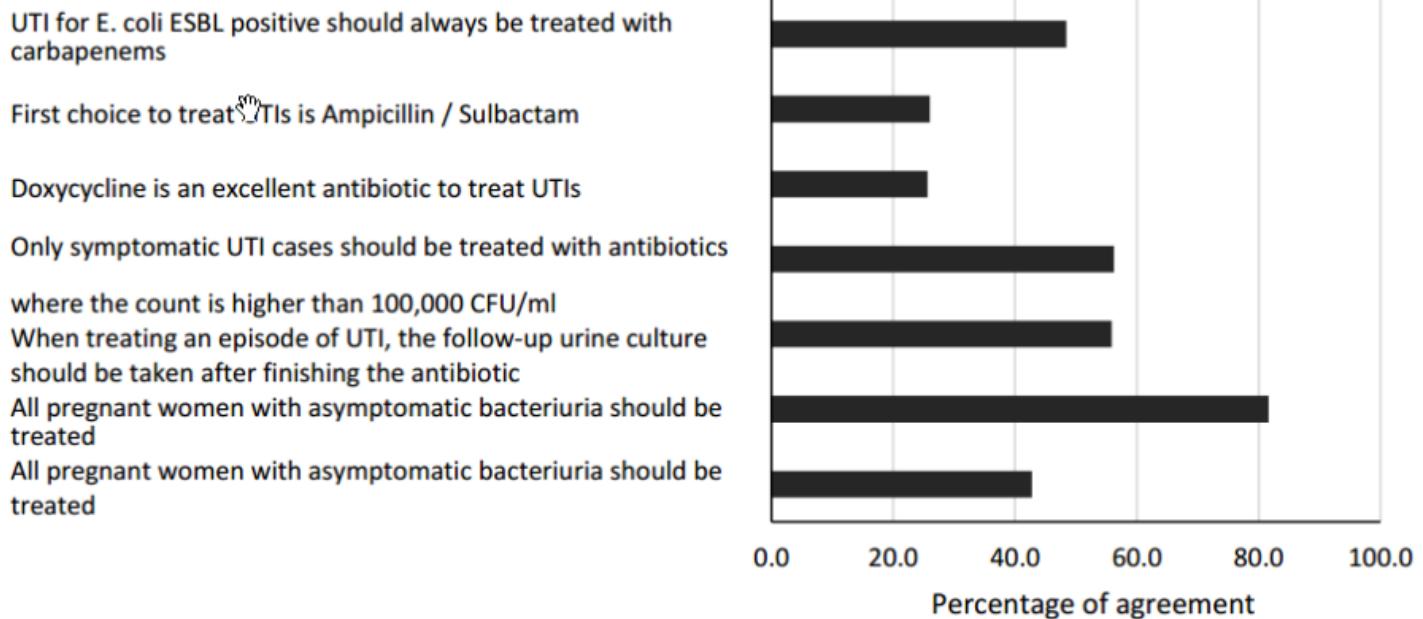
**Figure 1**

Relative frequency of responses for upper respiratory infections



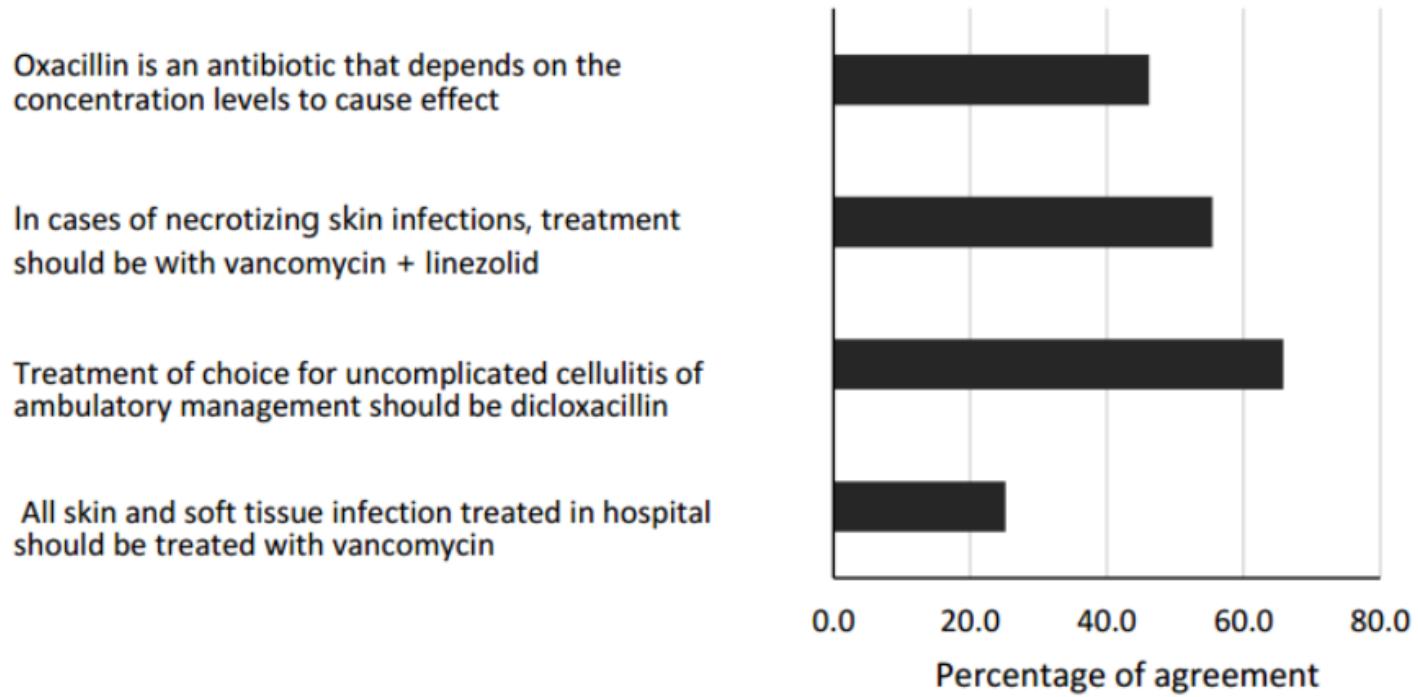
**Figure 2**

Relative frequency of responses for pneumonias



**Figure 3**

Relative frequency of answers for urinary tract infections



**Figure 4**

Relative frequency of answers for skin and soft tissue infections

## Supplementary Files

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- [supplement1.doc](#)