

## Polish Physicians' Attitudes Towards Antibiotic Prescription and Antimicrobial Resistance

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### Abstract

Antimicrobial resistance has been one of the biggest global current issues in medicine and public health. Overuse and imprudent use of antimicrobial agents are recognized as one of the leading causes of antibiotic resistance. The aim of this study was to analyze the attitudes of Polish physicians practicing at the community level towards antibiotics and antimicrobial resistance. The majority of physicians taking part in the survey believed that Polish people overuse antibiotics (98%). Most physicians (91%) considered that antimicrobial resistance is a major problem at present. The majority of physicians indicated the reasons for prescribing the antibiotic are related to health factors, such as optimal recovery (best effectiveness, least side effects) (80%), latest therapeutic guidelines (70%) and microbiological/epidemiological factors (63%). Knowledge of the *National Recommendations for the management of Community-Acquired Respiratory Tract Infections 2010* (NR-CA-RTI) developed within National Programme for Protection of Antibiotics was declared by 84% of respondents. Among those who are aware of the NR-CA-RTI, the majority follow them in their daily practice (91%). Among physicians, 62% are not familiar with the Centor/McIsaac scores used to differentiate bacterial and viral infections in patients presenting with a sore throat. Among physicians familiar with the scores, 90% use them in their daily practice. Rapid microbiological detection methods for Group A beta-hemolytic streptococcal pharyngitis are used only by 20% of respondents. Almost all of physicians declared readiness to use these tests. Main sources of information on antibiotics prescribing originate from Polish medical journals, scientific conferences organized by medical societies, pharmaceutical companies.

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**Key words:** physicians attitudes, antibiotics, antimicrobial resistance, respiratory tract infections

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### Introduction

Antibiotic resistance has become one of the most important challenges for medicine and public health. The recent World Health Organization (WHO) report makes a clear case that resistance of common bacteria has reached alarming levels in many parts of the world (WHO, 2014). It was shown in many studies that antibiotic resistance is higher in countries with high consumption of this group of drugs (Bronzwaer *et al.*, 2002). Poland is one of the few European Union countries where consumption of antibiotics has an increasing trend (ECDC, ESAC-Net, 2016).

In December of 2009 the first National Recommendations for the Management of Community-Acquired Respiratory Tract Infections – NR-CA-RTI (Hryniewicz *et al.*, 2009) were published. They were based on Polish epidemiological data and susceptibility profile of the most common etiological agents and international literature reviewed by a panel of various specialists and broadly consulted by medical community in Poland. They were publicized and made available free of charge

on the website of the National Programme on Antibiotic Protection ([www.antybiotyki.edu.pl](http://www.antybiotyki.edu.pl)). They were updated in 2016.

In Poland more than 95% of antibiotics are prescribed by physicians practicing in the outpatient sector especially for respiratory tract infection which in majority of cases are of viral etiology ([www.antybiotyki.edu.pl](http://www.antybiotyki.edu.pl)). This is why the aim of this study was to analyze the attitudes of Polish physicians practicing at the community level towards antibiotics and antimicrobial resistance. In addition the compliance of physicians antibiotic prescription with the National Recommendations on the NR-CA-RTI was evaluated.

### Experimental

#### Materials and Methods

**The questionnaire.** The research instrument used in the study was a self-designed questionnaire to be completed by the respondents. The questionnaire differed in a section on the use of antibiotic therapy in

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particular indications, based on the medical specialty of the respondent. The questionnaire consisted of closed questions, semi-open questions, additional multiple choice single and multiple answer questions, and demographic items.

The areas covered in the questionnaire included:

1. Attitudes towards antibiotics.
2. Familiarity with the European Antibiotic Awareness Day campaign (EAAD).
3. Indications for antibiotic therapy.
4. Familiarity with and complying with current National Recommendations of the Management of Community-Acquired Respiratory Tract Infections.
5. Compliance of antibiotic prescriptions with the NR-CA-RTI
6. Source of knowledge on antibiotics and antimicrobial resistance.
7. Demographic and education data (medical practice setting, year of graduation and name of medical school).

**Study design.** The research was carried out between March 2011 and March 2012, during the medical conferences for 3 groups of physicians:

- paediatricians, 8th conference “Akademia po Dyplomie – Pediatria” [Postgraduate Academy – Paediatrics] in Warszawa on March 11–12, 2011;
- paediatric ENT, 18th Symposium “Paediatric Otolaryngology Days” in Mikołajki, on June 9–11, 2011;
- general practitioners (GPs), Top Medical Trends congress in Poznań on March 23–25, 2012.

The questionnaire was handed to be completed during above mentioned events to 3450 physicians (1500 paediatricians, 450 paediatric ENT physicians and 1500 GPs). The completed survey was returned by 18% of paediatricians, 32% of paediatric ENT physicians and 10.5% of GPs.

The participation was voluntary and anonymous. The organisers of the three conferences mentioned above consented to the questionnaire-based research to be carried out during the events.

**Ethics.** The study was approved by the Ethics Committee of Warsaw Medical University (Registration number: AKBE/45/13).

**Data analysis.** All analyses were carried out using the IBM SPSS Statistics for Windows 19.0 software package. Collected data was expressed as frequencies and percentages.

Some variables were recoded to chosen categories including binary coding to be used in logistic regression. To identify the sociodemographic factors related to attitudes and knowledge about the effectiveness and use of antibiotics and diagnostics tools multiple logistic regression was used. The reference groups were set as a medical specialties, medical practice, year of graduation and knowledge of the NR-CA-RTI. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated. For all test p-values of 0.05 or less were considered to be statistically significant.

## Results

**Study group characteristics.** The study group consisted of 579 physicians representing three medical specialties: paediatrics (276), paediatric ENT (145) and GP (158). Five hundred sixty five responding physicians disclosed the year of graduation. In this cohort, 121 (21.4%) graduated from medical school before 1979, 213 (37.7%) graduated in 1980–1989, 231 (40.9%) graduated in 1990 and later. The majority of the respondents reported medical practice in an outpatient setting (N = 357; 61.7%), 222 respondents (38.3%) reported mixed setting inpatient-outpatient practice. The highest proportion of GPs and paediatricians reported outpatient practice only: 72.8% and 63.4%, respectively. The characteristics of the study group are summarized in Table I.

**Attitudes towards antibiotics.** The vast majority of respondents (98%) stated that antibiotics are overused in the Polish population. The opinions of physicians on the knowledge of antibiotics in the general public and the medical community differed significantly by medical specialty and practice setting (Table II). Most (67.9%) respondents claimed the physicians do not have sufficient knowledge regarding the use of antibiotics.

Ninety percent of respondents consider antimicrobial resistance to be a significant problem, as compared

Table I  
Socio-demographic and professional characteristics of the study participants.

		Study participants n (%)	GPs n (%)	Paediatrics n (%)	Paediatric ENT physicians n (%)
<b>Medical practice</b>	outpatient only	357 (61.7)	115 (72.8)	175 (63.4)	67 (46.2)
	both outpatient and inpatient	222 (38.3)	43 (27.2)	101 (36.6)	78 (53.8)
<b>Year of graduation</b>	before 1979	121 (21.4)	30 (19.6)	70 (25.5)	21 (15.3)
	1980–1989	213 (37.7)	48 (31.4)	107 (38.9)	58 (42.3)
	1990 and later	231 (40.9)	75 (49.0)	98 (35.6)	58 (42.3)

Table II  
Physician opinions regarding the knowledge of antibiotics by the public and the medical community.

There is a commonly held belief of inadequate knowledge of antibiotic use. It is legitimate for and applicable to:						
	n	The entire community without medical background (%)	A part of the community without medical background (%)	A part of the medical community (%)	Definitely NOT the medical community (%)	There is another group it is legitimate for and applicable to (%)
<b>Total</b>	579	24.0	61.3.	67.9	3.1	1.2
<b>Medical specialties</b>						
paediatrics	276	23.6	63.8	70.7	4.7	1.4
GPs	158	30.4	57.6	62.0	0.6	1.9
paediatric ENT physicians	145	17.9	60.7	69.0	2.8	0.0
sig.*		<b>0.039</b>	0.439	0.171	0.06	0.281
<b>Medical practice</b>						
outpatient only	357	25.2	61.1	65.5	4.5	1.1
both outpatient and inpatient	222	22.1	61.7	71.6	0.9	1.4
sig.*		0.390	0.876	0.128	<b>0.016</b>	0.805

\*sig. – statistically significant (in bold), significance obtained using Chi<sup>2</sup>-test

to 0.7% not considering it to be a problem and 8.7% stating it will become a problem in the future. Significant differences were seen in the expressed opinions on antimicrobial resistance and medical specialty represented ( $p=0.025$ ). The opinion that antimicrobial resistance was a significant problem nowadays was expressed by 94.9% of the GPs cohort, 90.4% of the paediatricians and 86.1% of the paediatric ENT cohort. Paediatric ENT physicians tended to express an opinion that antimicrobial resistance would be a problem of the future more often (12.5%) than paediatricians (9.6%) or the GPs (3.8%). The opinion that antimicrobial resistance was not a significant problem nowadays was expressed by 1.3% of the GPs cohort, 1.4% of the paediatric ENT cohort and none of the paediatricians.

**Physician familiarity with the European Antibiotic Awareness Day campaign.** Overall, 38% of physicians confirmed recent familiarity of the EAAD information campaign. The paediatricians (44.9%) tended to be more familiar with the EAAD as compared to the GPs (35.0%) and the paediatric ENT physicians (31.0%)  $p=0.011$ .

Among the respondents who had recently heard of or participated in the EAAD campaign, 64.7% considered it to be necessary, 32.4% considered it to be beneficial, whereas 2.0%, considered it to be irrelevant for the knowledge of general public. Among 246 respondents, who admitted using EAAD promotional materials, 46.3% declared multiple use of the resources, 18.7% declared one time use whereas 35.0% were unable to state how many times they used them.

**Indications for antibiotic therapy.** The vast majority of the respondents pointed to health-related factors,

that is optimum treatment of infection, ensuring highest efficacy and minimum adverse effects (79.6%), as the key to prescribing antibiotics, followed by the most current therapeutic guidelines (69.9%) and microbial/epidemiologic factors (62.9%). Almost 9% of respondents take patient expectations into account when prescribing antibiotic therapy. Differences in including various factors when prescribing antibiotic therapy were observed depending on medical specialty and the year of graduation (Table III).

The GPs tend to consider economic factors when prescribing antibiotics more often (29.7%) than the two other specialties, whereas paediatricians tend to consider current therapeutic guidelines the most often (75.0%). Patient expectations were considered when prescribing antibiotics by 11.4% of GPs, 9.1% of paediatricians and 4.8% of paediatric ENT physicians.

More graduates from 1980–1989 or 1990 and later declared considering microbial/epidemiologic factors and therapeutic guidelines when prescribing antibiotics, as compared to the pre 1979 graduates (Table III).

**Familiarity with and complying with the National Recommendations on the Management of Community-Acquired Respiratory Tract Infections '2010.** Overall, 569 respondents (84.4%) declared familiarity with the NR-CA-RTI. Significant differences were observed in the declared familiarity with the Recommendations by different medical specialties and medical practice settings (Table IV). This was definitely the highest among paediatricians (97.0%), followed by paediatric ENT physicians (81.8%) and GPs (64.7%). Almost 90.0% of physicians reporting mixed setting

Table III  
Factors considered when prescribing antibiotics.

	N	Health-related (%)	Economic (%)	Epidemiologic/microbiological (%)	Therapeutic guidelines (%)	Patient expectations (%)
<b>Total</b>	579	79.6	18.1	62.9	69.9	8.6
<b>Medical specialties</b>						
paediatrics	276	77.9	13.4	67.0	75.0	9.1
GPs	158	80.4	29.7	65.2	65.8	11.4
paediatric ENT physicians	145	82.1	14.5	52.4	64.8	4.8
<b>sig.*</b>		0.578	<b>&lt;0.001</b>	<b>0.010</b>	<b>0.040</b>	0.119
<b>Medical practice</b>						
outpatient only	357	79.0	19.3	61.6	66.1	9.5
both outpatient and inpatient	222	80.6	16.2	64.9	76.1	7.2
<b>sig.*</b>		0.634	0.345	0.433	<b>0.011</b>	0.335
<b>Year of graduation</b>						
before 1979	121	79.3	19.0	55.4	56.2	5.8
1980–1989	213	83.1	15.5	64.3	68.5	7.0
1990 and later	231	76.6	19.5	66.7	78.4	11.7
<b>sig.*</b>		0.238	0.513	0.105	<b>&lt;0.001</b>	0.098
Familiar with the National Recommendations on the Management of Community – Acquired Respiratory Tract Infections						
Yes	480	80.2	17.7	65.2	72.9	9.2
No	89	77.5	21.3	50.6	57.3	5.6
<b>sig.*</b>		0.563	0.414	<b>0.009</b>	<b>0.003</b>	0.273

\* sig. – statistically significant (in bold), significance obtained using Chi<sup>2</sup>-test

Table IV  
Familiarity with the NR-CA-RTI.

	n	I know the National Recommendations on the NR-CA-RTI YES (%)	Adjusted ORs (95% CI)	sig.*	n	I know and follow the National Recommendations on the NR-CA-RTI YES (%)	Adjusted ORs (95% CI)	sig.*
<b>Total</b>	569	84.4	–	–	479	91.0	–	–
<b>Medical specialties</b>								
GPs	156	64.7	1	–	101	94.1	1	–
paediatrics	270	97.0	17.02 (7.67–37.76)	<b>&lt;0.001</b>	262	91.9	0.53 (0.19–1.48)	0.227
paediatric ENT physicians	143	81.8	2.16 (1.19–3.92)	<b>0.011</b>	116	87.9	0.39 (0.13–1.16)	0.092
<b>Medical practice</b>								
outpatient only	348	80.2	1	–	279	92.1	1	–
both outpatient and inpatient	221	91.0	2.88 (1.55–5.36)	<b>0.001</b>	200	89.5	0.80 (0.41–1.56)	0.511
<b>Year of graduation</b>								
1990 and later	231	81.0	1	–	186	90.3	1	–
before 1979	118	85.6	1.24 (0.63–2.47)	0.531	101	89.1	0.83 (0.37–1.87)	0.652
1980–1989	206	88.8	1.85 (1.02–3.37)	<b>0.044</b>	183	92.9	1.37 (0.64–2.91)	0.416

\* sig. – statistically significant (in bold)

practice declared familiarity with Recommendations, as compared to 80.2% of those reporting outpatient practice only (OR = 2.88, 95% CI = 1.55–5.36).

Among respondents declaring familiarity with the recommendations (n = 479), the vast majority (91.0%) follow them in their everyday practice: 94.1% of GPs,

91.9% of paediatricians and 87.9% of paediatric ENT physicians. At the same time 12.1%, 8.8% and 5.9% of paediatric ENT physicians, paediatricians and GPs, respectively, declared they were familiar with yet did not follow the NR-CA-RTI. In the latter group (N=43), the most frequently reported reasons for this attitude included following other recommendations (48.8%) and other reasons (44.2%), such as the need for further diagnostic testing, lack of access to the literature and own clinical experience.

**Familiarity with and use of Centor/McIsaac score.** Overall, 38.1% of respondents stated familiarity with the Centor/McIsaac score used for differentiation between bacterial and viral pharyngitis (Table V). This was declared by 40.5% of GPs, 37.2% of paediatricians and 37.1% of paediatric ENT physicians.

Among those familiar with the Centor/McIsaac score, the majority graduated from medical school in 1990 or later (45.4%), followed by the 1980–1989 graduates (34.3%, OR=0.61, 95% CI=0.41–0.92) and the pre-1979 graduates (31.0%, OR=0.56, 95% CI=0.35–0.92). Familiarity with the Centor/McIsaac score was declared by 39.8% of physicians reporting familiarity the NR-CA-RTI and 29.8% of those unfamiliar with these recommendations (OR=1.97, 95% CI=1.11–3.51). Almost 90% of physicians reporting familiarity with the Centor/McIsaac score use it in their everyday practice (Table V). Great majority (91.1%) of physicians using the Centor/McIsaac score declared familiarity with the NR-CA-RTI.

**Using rapid diagnostic tests to detect Group A streptococcal (GAS) pharyngitis.** Twenty percent of 569 respondents reported using rapid diagnostic tests to detect Group A streptococcal (GAS) pharyngitis. Differences in using it were observed between the three medical specialties (Table V). The rapid tests were used by the GPs more often (26.4%) than by other two specialties. The main reported barriers to use it were their inaccessibility and lack of reimbursement. At the same time, the majority of the respondents (95.3%) declared their willingness to use the test if it is reimbursed by the National Health Fund.

**Compliance of antibiotic prescriptions with the NR-CA-RTI.** Figure 1 shows the physician views (N=434) on prescribing antibiotics in the following clinical cases:

- acute bronchiolitis in a 12-month infant with no additional risk factors,
- common cold in a 3-year-old,
- flu and flu-like symptoms in a 5-year-old,
- otitis media in a 2.5-year old, within the first 2 days since symptoms onset,
- rhinosinusitis without fever, facial pain or sore throat,
- I don't prescribe antibiotics in any of the above cases

Differences in prescribing decisions were observed depending on medical specialty and year of graduation. Almost 60% of GPs as compared to 46.7% of paediatricians stated they do not prescribe an antibiotic for

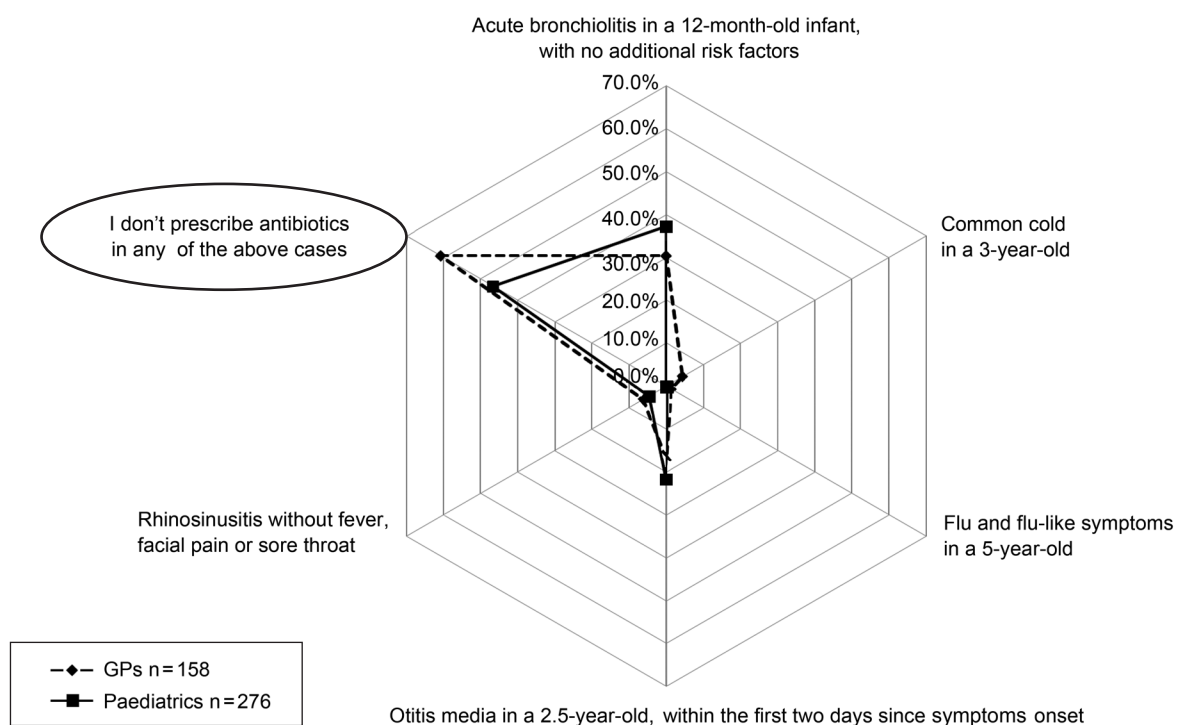


Fig. 1. Paediatricians and GPs views on prescribing antibiotics for certain indications. Choice of therapeutic option in line with the NR-CA-RTI was circled in black. Base: GPs and paediatricians (N=434).



Table V  
Familiarity of surveyed physicians with the Centor/McIsaac score and use of rapid diagnostic tests to detect Group A Streptococcal (GAS) pharyngitis.

	n	I know the Centor/McIsaac score YES (%)	Adjusted ORs (95% CI)	sign.*	n	I use the Centor/McIsaac score – physicians reporting familiarity with the score YES (%)	Adjusted ORs (95% CI)	sign.*	n	I use rapid diagnostic tests to detect Group A Streptococcal (GAS) pharyngitis (caused by <i>S. pyogenes</i> ) (%) YES	Adjusted ORs (95% CI)	sign.*
<b>Total</b>	557	38.1	–	–	205	89.3	–	–	569	20.0	–	–
<b>Medical specialties</b>												
GPs	148	40.5	1	–	59	88.1	1	–	148	26.4	1	–
paediatrics	266	37.2	0.74 (0.46–1.18)	0.205	96	93.8	1.17 (0.32–4.25)	0.813	276	21.4	0.60 (0.35–1.03)	0.062
paediatric ENT physicians	143	37.1	0.76 (0.45–1.27)	0.294	50	82.0	0.43 (0.13–1.41)	0.162	145	11.0	0.28 (0.14–0.56)	<0.001
<b>Medical practice</b>												
outpatient only	338	36.7	1	–	121	90.1	1	–	347	17.9	1	–
both outpatient and inpatient	219	40.2	1.08 (0.74–1.57)	0.698	84	88.1	0.92 (0.35–2.42)	0.862	222	23.4	1.56 (0.99–2.45)	0.054
<b>Year of graduation</b>												
1990 and later	227	45.4	1	–	100	86.0	1	–	230	18.7	1	–
before 1979	113	31.0	0.56 (0.35–0.92)	<b>0.021</b>	35	94.3	2.49 (0.51–12.16)	0.261	118	21.2	1.22 (0.68–2.17)	0.502
1980–1989	204	34.3	0.61 (0.41–0.92)	<b>0.017</b>	66	90.9	1.36 (0.46–3.95)	0.577	208	21.2	1.27 (0.77–2.08)	0.347
<b>Familiar with the National Recommendations on the Management of Community-Acquired Respiratory Tract Infections</b>												
I know the National Recommendations MCA-RTI	465	39.8	1	–	169	91.1	1	–	474	20.9	1	–
I don't know the National Recommendations MCA-RTI	84	29.8	1.97 (1.11–3.51)	<b>0.020</b>	10	76.0	3.28 (0.99–10.90)	0.052	85	14.1	1.87 (0.89–3.92)	0.098

\* sig. – statistically significant (in bold)

any of the above indications ( $p=0.033$ ,  $OR=0.60$ , 95%  $CI=0.37-0.96$ ), which is in line with the NR-CA-RTI.

Those who graduated in 1980–1989 (54.8%) and in 1990 or later (54.3%) more frequently stated they do not prescribe an antibiotic for any of the above indications, as compared to 43.0% of pre-1979 graduates. Then this follow in everyday practice (51.8%) National Recommendations for the Management of Community-Acquired Respiratory Tract Infections more frequently gave the correct answer, than this who do not use the Recommendations (27.6%,  $p=0.012$ ).

Figure 2 shows the first choice empirical antibiotic therapy declared by 143 GPs for the community-acquired pneumonia in a 40-year-old. More than 31% of GPs chose 1,000 mg of amoxicillin every 8 h for 7 days, which is in line with the NR-CA-RTI. Almost 40% of respondents suggested 1,000 mg of amoxicillin with clavulanic acid every 12 h for 7 days, 18.9% – 1,000 mg of amoxicillin every 12 h for 7 days, 6.3% – 500 mg of azithromycin once daily for 3 days and 2.8% – 625 mg of amoxicillin + clavulanic acid every 8 h for 7 days.

Overall, 81.5% of respondents declared the immediate use of an antibiotic for otitis media in infants below 6 months of age, which is in line with the NR-CA-RTI and which was confirmed by 91.7% of paediatricians, 85.5% of paediatric ENT and 60.1% of GPs ( $p<0.001$ ).

**Sources of knowledge of antibiotics and antimicrobial resistance.** The main sources of knowledge of antibiotics mentioned by our respondents inclu-

ded national medical journals (88.4%), conferences organised by medical societies (76.3%), conferences organised by pharmaceutical companies (54.2%) and the Internet (36.6%). International medical journals (15.2%) were less accessed sources of information on antibiotics (Table VI).

Differences were observed in utilizing different sources of knowledge, depending on medical specialty and year of graduation of respondents. National medical journals were identified as the main source of knowledge by 95.3% of paediatricians, 84.2% of GPs and 80.0% of paediatric ENT physicians ( $p<0.001$ ).

Conferences organised by medical societies were identified as the main source of knowledge on antibiotics by 87.6% of paediatric ENT physicians, 81.9% of paediatricians and 56.3% of GPs ( $p<0.001$ ). In all three specialties, more physicians pointed to conferences organised by medical societies rather than to ones organised by pharmaceutical companies as their main source of knowledge. Internet was mostly mentioned as the source of knowledge of antibiotics by those who graduated in 1990 or later (41.4%), followed by the 1980–1989 graduates (37.6%) and only by 27.3% of pre-1979 graduates ( $p=0.036$ ).

The conferences provided by pharmaceutical sector were selected by the majority of the 1980–1989 graduates (59.6%), followed by the pre-1979 graduates (58.7%), and to a significantly lower extent by those who graduated in 1990 or later (48.5%)  $p=0.040$ .

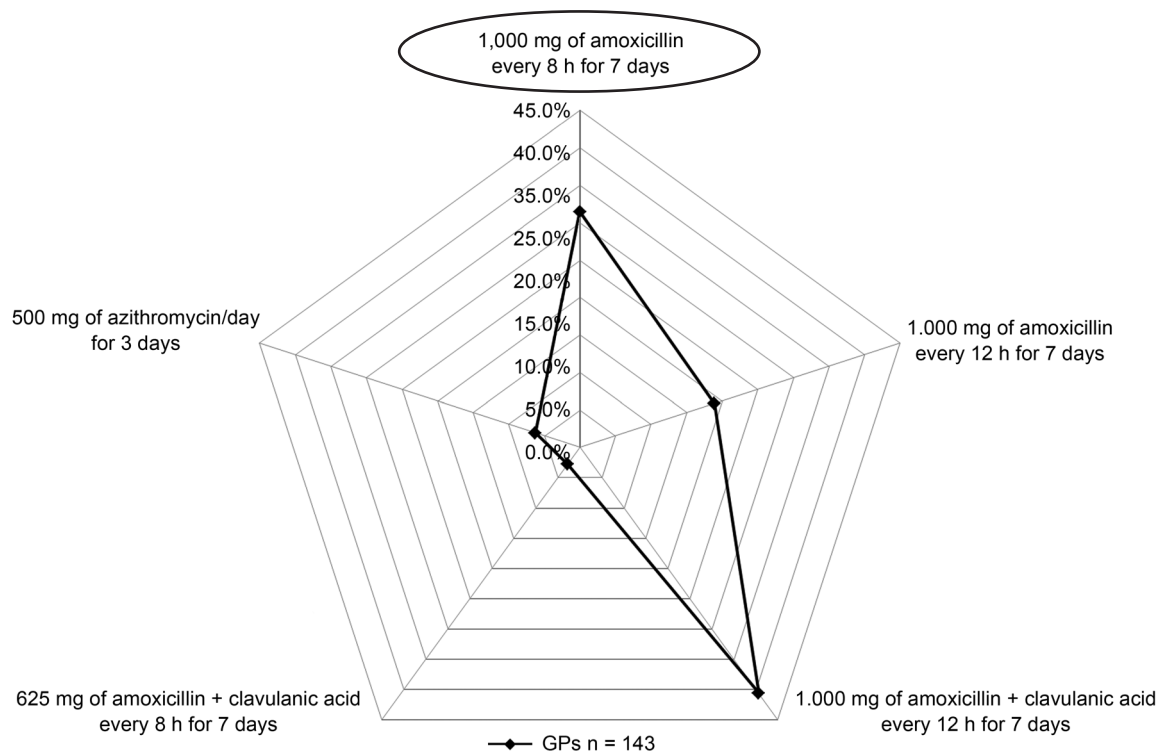


Fig. 2. Therapeutic decisions of GPs in the first episode of community-acquired pneumonia in a 40-year-old. Choice of therapeutic option in line with the NR-CA-RTI was circled in black. Base: GPs (N = 143).

Table VI  
Sources of current knowledge of antibiotics.

	n	National medical journals (%)	International medical journals (%)	Conferences organised by medical societies (%)	Conferences organised by pharmaceutical sector (%)	Internet (%)
<b>Total</b>	579	88.4	15.2	76.3	54.2	36.6
<b>Medical specialties</b>						
paediatrics	276	95.3	14.1	81.9	58.3	34.1
GPs	158	84.2	14.6	56.3	52.4	38.0
paediatric ENT physicians	145	80.0	17.9	87.6	59.3	40.0
sig.*		<b>&lt;0.001</b>	0.567	<b>&lt;0.001</b>	<b>0.002</b>	0.445
<b>Medical practice</b>						
outpatient only	357	87.1	9.5	75.4	55.2	31.4
both outpatient and inpatient	222	90.5	24.3	77.9	52.7	45.0
sig.*		0.210	<b>&lt;0.001</b>	0.478	0.560	<b>0.001</b>
<b>Year of graduation</b>						
before 1979	121	86.8	15.7	77.7	58.7	27.3
1980–1989	213	88.7	14.1	76.5	59.6	37.6
1990 and later	231	89.6	15.6	76.2	48.5	41.4
sig.*		0.728	0.884	0.950	<b>0.040</b>	<b>0.036</b>

\* sig. – statistically significant (in bold), significance obtained using Chi<sup>2</sup>-test

The vast majority of the respondents (N = 578; 97.9%) indicated a willingness to increase their knowledge of antibiotic use. Among our respondents, 3.3% of paediatricians stated no reason to broaden their knowledge of antibiotic use. The majority of those willing to increase their understanding of antibiotics graduated in 1990 or later (99.6%) and in 1980–1989 (98.1%), followed by slightly lower percentage of pre-1979 graduates (94.2%)  $p = 0.004$ . The highest proportion of respondents who stated no reason to broaden their knowledge of antibiotics consisted of pre-1979 graduates (5.8%).

The most popular future training topics indicated were: antimicrobial resistance of pathogens causing respiratory tract infections (72.7%), general principles of rational antibiotic use (69.8%) as well as microbiological diagnostics (68.6%).

Differences in participation in training on antibiotics therapy between the represented medical specialties were observed ( $p < 0.001$ ). Paediatricians (45.3%) and paediatric ENT physicians (38.9%) reported participating in training on antibiotics therapy twice a year, whereas GPs (33.5%) reported receiving such training once a year. At the same time 21.3% of all respondents participate in training on antibiotics less often than once every year, with 7.0% stating that they have never participated in such training.

The main motivation for participating in training on antibiotic therapy was the need to update knowledge (80.8%) and broaden it (67.4%), followed by the need to get educational points (12.6%), wishing to meet

one's friends (8.6%) and having uncertainty concerning prescribing antibiotics/treatment (6.4%).

The need to update knowledge was mentioned as a motivation to participate in training on antibiotics by 87.0% of paediatricians, 80.7% of paediatric ENT physicians and less often by GPs (70.3%)  $p < 0.001$ . Depending on practice setting, this need was expressed by 81.5% of outpatient practitioners, and 79.7% of mixed setting practitioners. The need to broaden the knowledge was definitely reported the most frequently among GPs (75.9%), followed by paediatricians (68.5%) and paediatric ENT physicians (55.9%)  $p = 0.001$ . Ten percent of GPs, 6.2% of paediatricians and only 2.8% of paediatric ENT physicians reported having uncertainty concerning prescribing antibiotics/treatment  $p = 0.032$ .

## Discussion

Many reports from all over the world, as well as the results of the study described in this paper, suggest that physicians play the most important role in providing the public with information about the proper use of antibiotics (Napolitano *et al.*, 2013; TNS Opinion and Social, 2016). They decide whether to prescribe antibiotics or not. Thus physicians have a significant impact not only on antibiotic consumption, but also on their rational use. Family physicians play an especially important role in this process, with up to 90% of all



antibiotics prescribed by primary care doctors (particularly by family physicians).

The data presented in this paper have revealed the attitude of Polish physicians towards antibiotic use and antimicrobial resistance. They indicated their high awareness of the threat of antimicrobial resistance. A similar attitude among physicians was shown in several studies from Europe and the USA as well as among medical students from various European countries (Bjorkman *et al.*, 2013; Dyar *et al.*, 2013; 2014). Data from England revealed that the awareness of antimicrobial resistance threat is higher among physicians practicing in hospitals and long term care than in an outpatient setting (Simpson *et al.*, 2007). Our study, which tackled Polish physicians practicing in the ambulatory setting, indicated that they encounter the problem of antimicrobial resistance on a daily basis while doctors from the USA, France and Scotland regard this problem on a global level but not in their everyday practice (Wester *et al.*, 2002; Giblin *et al.*, 2004; Pulcini *et al.*, 2011). Several studies which presented the opinions of both physicians and medical students noted that the main reason for the emergence and rapid spread of resistant bacteria is the overuse and improper use of antibiotics (Dyar *et al.*, 2014).

When prescribing an antibiotic, several factors should be considered to help with the choice of a specific drug. Our study demonstrated that these factors included general health of a patient, therapeutic recommendations, and epidemiological situation. Similar answers were given by physicians from Iceland, Great Britain and Sweden who underlined the value of therapeutic recommendations and information on local epidemiology with regard to resistance (Petursson, 2005; Milos *et al.*, 2014). Other studies indicate additional factors to be taken into consideration by physicians when prescribing an antibiotic (Stranberg *et al.*, 2013; Ashworth *et al.*, 2016; Strumiło *et al.*, 2016). They can be divided into two groups. First, from a physician point of view, such as uncertainty of diagnosis, fear of patient's health deterioration and resulting claim for poor management, previous negative experience of post infectious complications, need to keep good relationship with patients in order not to lose them, and physician's personality. The second group of factors included patients' perspective and satisfaction (Shapiro, 2002; Ong *et al.*, 2007). Interestingly, in our study patients' expectations accounted only for 10% of decision making.

It has been shown in many studies that additional diagnostic tools available at the physician's office may facilitate differentiation between virus and bacterial etiology and limit unnecessary antibiotic prescription (Fine *et al.*, 2012; Palla *et al.*, 2012). The best illustration is acute pharyngitis, in which an antibiotic prescription by family physician is the most common. The rapid test

detecting antigen of *Streptococcus pyogenes*, a leading bacterial etiology of acute pharyngitis, allows in many cases to avoid giving antibiotic for viral infections. The test is strongly recommended by various scientific societies including IDSA.

The most spectacular promotion of rapid streptococcal test at the physician office started in 2002 in France. The National Insurance Company advised its use in patients above 3 years of life suspected of bacterial pharyngitis and was made available free of charge to every physician practicing in an outpatient setting. In 2012 more than 60% of French physicians declared to use the test in every day practice in children between 3 and 16 years of age. An antibiotic is only given when the *S. pyogenes* test is positive (Michel-Lepage *et al.*, 2014).

The Polish NR-CA-RTI advice both usage of Centor/McIsaac scale and rapid Strep-test (Hryniewicz *et al.*, 2009) and almost 80% of physicians participating in the study are acquainted with the NR-CA-RTI although only one fourth of Polish physicians regularly has access to the test in their office. However, all of them would be happy to use the test in every day work provided it is reimbursed by health service payer as is the case in other countries. Additional help can be obtained in differentiation between viral and bacterial pharyngitis by using the so-called Centor/McIsaac score, which is based on clinical signs and symptoms. Good correlation was shown between positive streptococcal test, culture and high score (Stefaniuk *et al.*, 2017). Fewer than half of the Polish physicians participating in our study were not acquainted with this score however they claimed to know the Recommendation.

As it was already mentioned almost 80% of questioned Polish physicians know the NR-CA-RTI. However, only about 50% complies with them in regard to antibiotic prescription for acute bronchiolitis, common cold, flu, otitis media, facial pain and sore throat, and community-acquired pneumonia. The best compliance with the NR-CA-RTI was noticed in the case of acute otitis media in children younger than 6 months, whom immediate antibiotic usage is indicated. The high doses of amoxicillin recommended in NR-CA-RTI are justified because Polish study on community respiratory isolates indicate high percentage of *S. pneumoniae* non-susceptible to penicillin ([www.koroun.edu.pl](http://www.koroun.edu.pl)).

Several strategies were described limiting antibiotic usage. One of them is the so-called delayed prescription practiced in many countries. However, it is rarely practiced in Poland again because of difficulties in access to a physician. It is mostly used in the case of acute otitis media in children and called a watchful waiting strategy, which is also included in the Polish National Recommendations but unfortunately rarely practiced because of difficulties with accesses to physician for additional visit.

Many international studies targeting physicians and medical students have shown that the most efficacious way to improve antibiotic prescription is direct education (Figueiras *et al.*, 2001; McGettigan *et al.*, 2001). They also demonstrated their great willingness to broaden knowledge on antibiotic therapy and antibiotic resistance, which should be included in the medical curriculum and continuous education programs (Minen *et al.*, 2010; Dyar *et al.*, 2014). The same was observed in our study in which the great majority of participating physicians declared interest in updating knowledge on antibiotics and their use in therapy in the time of growing resistance.

The ease of internet access and consultation with “dr Google” may impact physician-patient interactions. Wrongly interpreted medical information by a not medically educated patient can lead to unreasonable health concerns and influence expectations from a physician concerning therapeutic decisions.

Several studies pointed at the role of pharmaceutical companies in increased antibiotic consumption due to often aggressive promotion and additional benefits for prescribers. This view was supported by the results of a study in Spain performed among family physicians and the conclusions presented stated that there is a need to limit the contribution/participation of companies in educational events if a drop in needless prescription is to be expected (Caamano *et al.*, 2002). Physicians should have access to objective evidence-based information in order to achieve proper antibiotic prescription. Our own data indicated that half of Polish physicians get updates on antibiotics and their proper use during meetings organized by pharmaceutical companies. This mostly refers to those who completed their medical studies before 1989. They also more often use not current therapeutic recommendations. On the other hand, some papers underline the value of educational initiatives undertaken by pharmaceutical companies not only in countries with low resources. The majority of British general practitioners declared in 2001 that pharma people are their major source of current therapeutic recommendations (McGettigan *et al.*, 2001). The great popularity of pharma sponsored educational meetings is also due to the fact of free access to them.

The threat created by rapidly growing resistance has promoted several educational campaigns on the European level organized by ECDC and global level managed by WHO (Huttner *et al.*, 2010; Earnshaw *et al.*, 2014; Chaintarli *et al.*, 2016). Poland joined the European initiative immediately when the European Antibiotics Awareness Day was established in 2008. Our data revealed that almost 40% of Polish physicians participating in this study come across EAAD and more than 60% declared that it is beneficial for building awareness to antibiotic resistance.

The results of this study revealed several gaps in knowledge of physicians concerning proper use of antibiotics. Further more focused educational activities of medical community need to be performed under umbrella of the National Programme for Protection of Antibiotics and according to the results of our study.

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