American Journal of Infection Control 47 (2019) 864–868

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Physicians' attitude and knowledge regarding antibiotic use and resistance in ambulatory settings

Amanda Harris [a], Suganya Chandramohan MD [a], Reda A. Awali MD, MPH [a,*], Mehr Grewal [a], Glenn Tillotson PhD, FIDSA [b], Teena Chopra MD, MPH [a]

[a] Division of Infectious Diseases, Wayne State University and Detroit Medical Center, Detroit, MI
[b] GST Micro LLC, Durham, NC

Key Words:
Antibiotic resistance
Physicians' knowledge
Ambulatory

Background: The aim of this survey was to assess the attitudes of physicians toward antibiotic prescribing and explore their knowledge about antimicrobial resistance (AMR) in ambulatory care settings.
Methods: We conducted a cross-sectional survey that was administered to physicians who work primarily in ambulatory care settings in the United States. The survey was self-administered, voluntary, and anonymous, and was delivered through electronic mail and online forums using a 35-item questionnaire.
Results: The survey was completed by 323 physicians. Ninety-nine percent of respondents agreed that AMR is a national problem, but only 63% agreed that AMR is a local problem within their own facilities. Ninety-four percent of the respondents reported that each antibiotic prescription can impact AMR; however, 23% still believed that aggressive prescribing is necessary to avoid clinical failures. Factor perceived to have a low to moderate impact on the physicians' choice of antibiotic was the presence of prescription guidelines (54%). Top measures reported to be effective in reducing the emergence of AMR were institution specific guidelines (94%), institution specific antibiogram (92%), educating health care providers (87%), and regular audits and feedback on antibiotic prescribing (86%).
Conclusions: AMR awareness campaigns and antibiotic stewardships incorporating interactive education and feedback, along with input of local experts, are critically needed to address the problem of AMR in both inpatient and ambulatory settings.

Introduction of antibiotics for treatment of human infections have advanced the practice of medicine and allowed for a remarkable increase in life expectancies.[1] However, the alarming rise of antimicrobial resistance (AMR) threatens to impede this advancement and pose significant risks to public health safety globally.[1] A report by the Centers for Disease Control and Prevention estimated that >2 million people in the United States are infected with antibiotic-resistant organisms every year, resulting in nearly 23,000 deaths.[1] The economic burden imposed by infections due to antimicrobial resistant organisms on the US health system is also substantial, and estimated to be at $20 billion in excess medical spending annually.[2]

Studies showed that approximately 60% of adult and pediatric patients receive antimicrobial drugs during their hospitalizations,[3] with nearly 50% of the antimicrobials used being inappropriate or unnecessary.[4] Over prescribing and inappropriate use of antibiotics, particularly for upper respiratory tract infections, are even more pronounced in the ambulatory care and outpatient settings.[5-7] Studies showed that >60% of adult patients treated for rhinosinusitis or pharyngitis in outpatient settings were given antibiotics, with only 10% of these cases being bacterial in origin.[8-10] Similarly, despite data showing that the prevalence of bacterial upper respiratory tract infections among children was <30%,[11] a recent report demonstrated that the rate of antibiotic prescriptions in outpatient settings among children <2 years old was estimated to be 1,287 prescriptions per 1,000 children annually.[12] Important factors that were associated with inappropriate use of antibiotics among prescribers included patient expectations, unawareness of the problem of AMR, as well as underestimation of the grave effects of AMR.[13] Enhancing the prudent use of antibiotics and attaining substantial improvements in antibiotic use require a full understanding of health care professionals' attitudes toward antibiotic prescribing, and assessing their knowledge about the growing problem of AMR.[14] Therefore, we conducted this survey study to assess the attitude of physicians toward antibiotic

* Address correspondence to Reda A. Awali, MD, MPH, Division of Infectious Diseases, Harper University Hospital, 5 Hudson, 3990 John R, Detroit, MI 48201.
E-mail address: redaawali.ra@gmail.com (R.A. Awali).
Conflicts of interest: None to report.

https://doi.org/10.1016/j.ajic.2019.02.009

prescribing, and explore their knowledge about AMR in ambulatory care settings. We decided to focus on the ambulatory setting because of the high volume of unguided antibiotic prescribing at the discretion of the physicians.

METHODS

Study design and participants

We conducted a cross-sectional survey using a self-administered questionnaire to eligible physicians in the United States between May 2018 and August 2018. The questionnaire was voluntary and anonymous, and it was delivered through electronic mail and online forums such as Facebook. Eligible physicians were attending, resident, and fellow physicians (physicians in training) who work primarily in ambulatory care settings. Ambulatory care settings commonly reported by our study respondents included hospital-based outpatient clinics and emergency departments, nonhospital-based clinics and physician offices, urgent care centers, ambulatory surgical centers, oncology clinics, mental health clinics, and hospice. The study was approved by the institution review board at Wayne State University.

Study instrument

The questionnaire required 10-15 minutes to complete and was composed of 34 questions: 8 questions to collect information on demographics; 8 questions to assess physicians' general knowledge about AMR and their awareness on antibiotic use and resistance at their own facilities; 9 questions to evaluate physicians' familiarity with and confidence in treating multidrug resistant organisms (MDRO); 7 questions to assess physicians' attitudes toward prescription practices; 1 question to investigate the factors affecting physicians' antibiotic selection practices; and 1 question to explore participants' attitudes on current measures and interventions designed to address the problem of AMR.

Most questions were multiple choice, with some questions using a 5-point Likert scale ranging from either "strongly agree" to "strongly disagree," "very important" to "unimportant," "very confident" to "not confident at all," or "definitely effective" to "definitely ineffective." If the respondent did not know the answer to a question, they could answer, "I don't know" or skip the question. To evaluate factors affecting their antibiotic selection practices, physicians were asked to rank the impact of multiple factors on their antibiotic choice of treatment from 1-10, with 1 being low impact and 10 being significant impact. Physicians were also given the chance to identify and rate other factors that were not among the listed options.

Statistical analysis

A descriptive univariate analysis was conducted using the Statistical Product and Service Solutions (SPSS) software version 23 (IBM Corporation, Armonk, NY). Owing to small sample size, the results from questions using the Likert scale were collapsed to result in 3 final categories: disagree (strongly disagree, disagree), neutral, and agree (strongly agree, agree) or important (very important, important), unimportant, and neutral/don't know or effective (definitely effective, probably effective), unsure, and ineffective (probably ineffective, definitely ineffective). Also, the results from the question evaluating the factors affecting physicians' antibiotic selection practices were grouped into 3 categories: 1-4 as low impact; 5-6 as moderate impact; and 7-10 as high impact.

RESULTS

Three hundred twenty-three physicians completed the survey; 271 (84%) were attending physicians, the remaining were residents or fellows. Of all the respondents, 318 (99%) had a mean age between 26 and 60 years; 290 (90%) were women; and 297 (92%) practiced for at least 1 year. Of the respondents, 197 (62%) were primary care physicians including 45 (14%) family medicine, 85 (27%) internal medicine and 67 (21%) pediatrics. Of the responding participants, 118 (37%) were in the academic setting, 94 (29%) were in private practice, 24 (8%) worked in a city or county public hospital, and 49 (15%) worked in an outpatient facility.

General knowledge about AMR

Most respondents (99%) agreed that AMR is a national problem. Two-hundred sixty-nine (94%) responding physicians agreed that colonization is the growth of an organism without clinical symptoms, and 267 (93%) agreed that infection is isolation of the organism accompanied by clinical signs of illness.

Of all respondents, 283 (99%) reported that overprescribing of antibiotics and the use of antibiotics for self-limited nonbacterial infections are important causes of AMR (Table 1). Other factors perceived to have an important impact on AMR included: antibiotic use for self-limited bacterial infections (71%), use of antibiotics broader than the necessary spectrum (94%), use of antibiotics for shorter than standard duration (62.5%), use of antibiotics longer than standard duration (57%), suboptimal use of antibiotics (66%), access to local current antibiograms (67%), availability of prescription guidelines (69%), and patients' expectations (78.5%) (Table 1).

Table 1
Perceptions of importance of potential causes of antimicrobial resistance among the study respondents

Causes of AMR	Very important/important [n (%)]	Unimportant [n (%)]	I don't know [n (%)]
Overprescribing of antibiotic in general	283 (99)	1 (0)	3 (1)
Use of antibiotics for self-limited nonbacterial infections	285 (99)	0 (0)	2 (1)
Use of antibiotics for self-limited bacterial infections	202 (71)	10 (4)	74 (26)
Use of antibiotic broader than necessary spectrum	267 (94)	1 (0)	17 (6)
Use of antibiotic for shorter than standard duration	178 (63)	31 (11)	76 (27)
Use of antibiotic for longer than standard duration	163 (57)	27 (10)	95 (33)
Suboptimal dose of antibiotic	214 (75)	8 (3)	63 (22)
Poor access to local current antibiogram	215 (75)	12 (4)	59 (21)
Lack of prescription guidelines	194 (69)	15 (5)	73 (26)
Patient expectations	223 (79)	21 (7)	40 (14)

AMR, antimicrobial resistance.

Prevalence of AMR in corresponding facilities

One-hundred eighty-two (63%) participants agreed that AMR was a common problem within their own facilities. Moreover, 121 (42.5%) respondents claimed that their initial empiric choice of antibiotics is regularly affected by the prevalence of AMR in their facilities. Seventy-two (25%) participants reported that >20% of their facility patients fail empiric therapy or require longer treatment duration or additional therapy.

Familiarity with MDROs

All responding physicians (100%) reported caring for at least 1 patient infected with methicillin-resistant *Staphylococcus aureus*; 10 (4%) of them being not confident about caring for patients with methicillin-resistant *S aureus*. All respondents (100%) cared for at least 1 patient with vancomycin-resistant *Enterococcus*; however, 47 (22%) of them being not confident when caring for patients with vancomycin-resistant *Enterococcus*. Of the 209 (77%) responding physicians who took care of patients with extended-spectrum β-lactamase (ESBL) bacteria, 33 (16%) were not confident about caring for patients with ESBL. Only 107 (41%) participants reported taking care of patients infected with *Klebsiella pneumoniae* carbapenemase- (KPC) producing bacteria, 23 (21.5%) of whom were not confident about caring for KPC patients. Moreover, 4% of the respondents never heard about KPC or ESBL before this survey (Fig 1).

Prescription practices

Of all respondents, 44 (16%) admitted to prescribing antibiotics more often than they should. Two-hundred fifty-five (94%) agreed that each antibiotic prescription can impact AMR, and 201 (74%) of them believed that the development of new and effective drugs is not expected to keep pace with the growing rate of AMR. Although 257 (95%) responding physicians agreed that, to avoid development of AMR, newer antibiotics should be reserved for more resistant bacteria, only 61 (22.5%) agreed that they should skip to new or broad-spectrum antibiotics when bacteria begin to show resistance. Also, 63 (23%) thought that aggressive prescribing is necessary to avoid both clinical and economical failures.

Antibiotic selection

Factors perceived to have a moderate to high impact on the physician's choice of antibiotic included the patient compliance (85%), cost of antibiotic (80%), concern for AMR (74%), patient comorbidities (72%), familiarity with dosing and outcome (71%), access to antibiotic samples (62%), patient allergy (61%), severity of illness (54%) and pharmaceutical representative (52%). However, the presence of prescription guidelines was perceived to have a low to moderate impact on the physician's choice of antibiotic (54%).

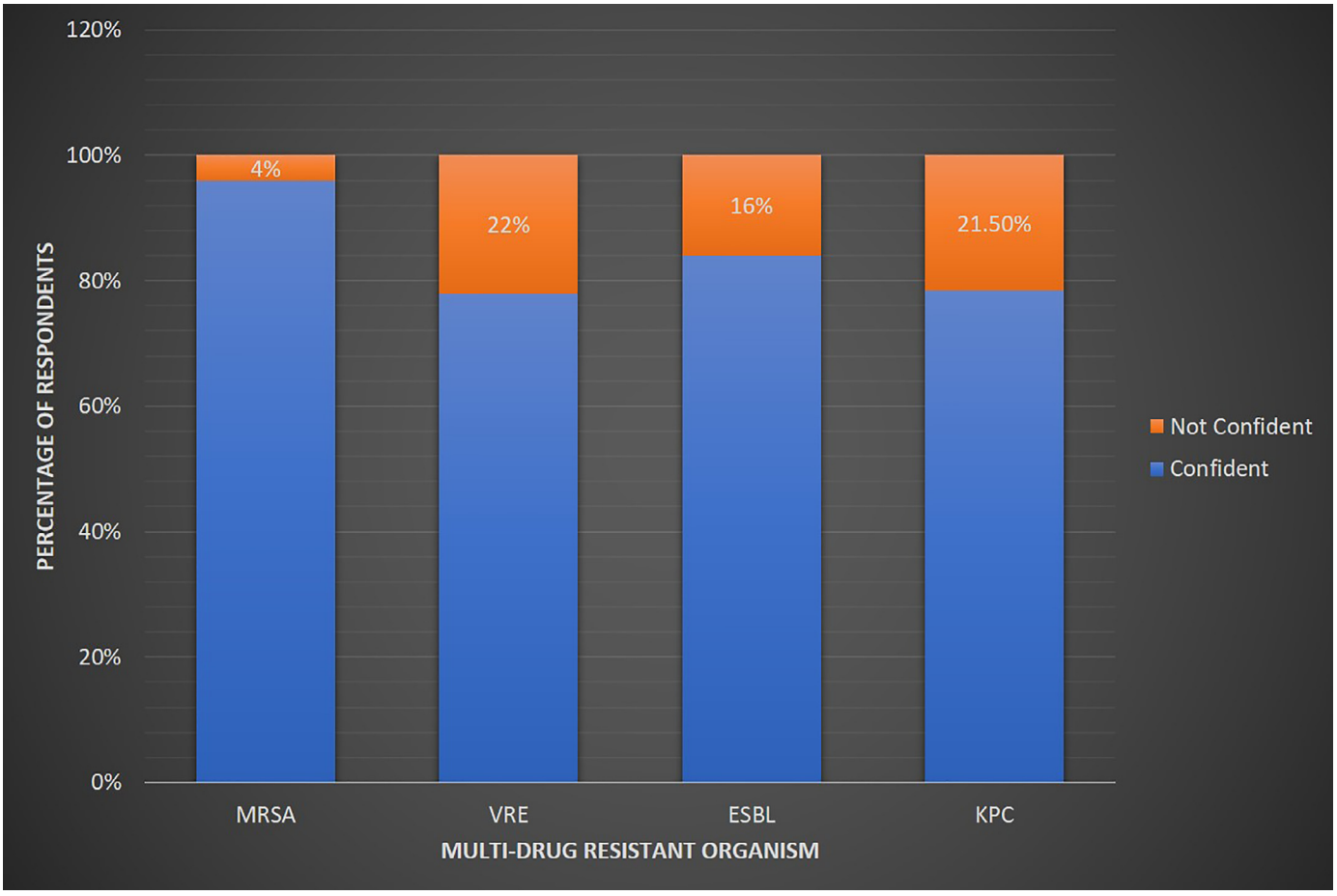

Fig 1. Confidence in treating common multidrug resistant organisms among responding physicians. *MRSA*, methicillin-resistant *Staphylococcus aureus*; *VRE*, vancomycin-resistant *Enterococcus*; *ESBL*, extended-spectrum β-lactamase; *KPC*, *Klebsiella pneumoniae* carbapenemase.

Interventions to reduce the emergence of AMR

Measures reported to be effective in reducing the emergence of AMR included institution specific guidelines for antibiotic use (94%), institution specific antibiogram (92%), educating health care providers on antibiotic use (87%), regular audits and feedback on antibiotic prescribing (86%), infectious disease (ID) approval for restricted antibiotics (77%), presence of antimicrobial management team (74%), and immediate consultation from ID physician, pharmacist, or infection control team (69%). However, 58% were either unsure about the effectiveness of an antibiotic order form or reported that requiring an antibiotic order form was ineffective in limiting the development of AMR.

DISCUSSION

Our survey demonstrated that physicians are aware of the evolving problem of AMR in the ambulatory health care setting. However, it uncovered significant knowledge gaps about the important causes and potential mechanisms of AMR with tendency for aggressive prescribing among our surveyed physicians. Despite 99% of the respondents agreed on AMR as a national problem, only 63% of them believed that AMR was a common problem within their own facilities. This contradictory finding is consistent with the findings of other studies[15,16] and suggests that many respondents still perceive the risk of AMR as theoretical rather than concrete.[15] It is fundamental to the fight against AMR that physicians be fully aware of the prevalence of AMR in their own facilities so that they can adjust their prescription behaviors accordingly.

In our study, 99% of respondents were aware that overprescribing of antibiotics in general and the use of antibiotics for self-limited nonbacterial infections are important causes of AMR. However, at least 25% of them lacked the knowledge regarding the effect of antibiotic use for self-limited bacterial infections, antibiotic use for shorter and longer than standard duration, and use of suboptimal dose of antibiotics on AMR, or perceived them as unimportant causes of AMR. This suggests that many physicians are unaware of the mechanisms of AMR, in which giving antibiotics shorter than standard duration or giving suboptimal doses of antibiotics would urge bacteria to develop resistance to antimicrobials and giving antibiotics longer than standard duration would select for resistant bacteria over time. Surprisingly, 94% of the respondents acknowledged the importance of avoiding the use of antibiotics broader than the necessary spectrum, owing to their negative impact on AMR. This is contradicting with previous studies in which broad-spectrum antibiotics were perceived to be more successful for curing an infection compared with narrow-spectrum antibiotics.[17,18] Unfortunately, more than two-thirds of the respondents perceived patients' expectations as an important cause of AMR. Cultural beliefs of patients were found to be an important host factor influencing the prescribing behavior of primary-care physicians.[19]

A large proportion of responding physicians who reported taking care of patients infected with MDRO were not confident in managing these patients. Lack of confidence while treating patients with MDRO infections affect the physician's choice of antibiotic and his or her infection control practices. Therefore, it might delay the prompt implementation of transmission precautions, thus leading to wide transmission of MDROs among patients and health care workers.[20]

Although 94% of respondents agreed that each antibiotic prescription can impact AMR, 16% reported prescribing antibiotics more often than they should, and 23% thought that aggressive prescribing is necessary to avoid clinical and economical failures. This again indicates that many respondents perceive the risk of AMR as not real, the factor that might impede the process of behavioral change. Another apparent contradiction was that 95% of responding physicians reported that newer antibiotics should be reserved for more resistant bacteria; however, only 22.5% believed that they should skip to new or broad-spectrum antibiotics when bacteria begin to show resistance. This finding cannot be fully explained and might be because of lack of knowledge regarding the mechanisms of resistance or might be related to misunderstanding the survey questions. Patients' demands were reported to be an important driver for overprescribing among the study respondents. Patients' demands for antimicrobials was acknowledged as an important stimulus of overprescribing, especially in the outpatient settings.[21]

Our study demonstrated that the presence of prescription guidelines at the facility has a low to moderate impact on the physician's choice of antibiotic. This could be partly because of lack of knowledge regarding the effect of prescription guidelines on AMR as documented in Table 1. This may also be because health care providers often do not adhere to established clinical practice guidelines for the management of common infections,[17] or they don't want to follow rules that compel their compliance and limit their autonomy,[15] and therefore, do not see guidelines as an effective measure of control over antibiotic prescribing and AMR.

Interestingly, immediate consultation from ID physician, pharmacist, or infection control team, ID approval for restricted antibiotics, and regular audits and feedback on antibiotic prescribing were perceived as effective measures in reducing the problem of AMR. This suggests that medical hierarchy with tendency to follow the orders set by expert opinions plays an important role in influencing the prescribing behavior among our study participants.[22,23] This also reflects our participants' desire for feedback through an interactive education rather than didactic sessions.[24,25] However, requiring an antibiotic order form was perceived as ineffective in limiting the development of AMR, perhaps because our participants preferred less paper work and less complication of antibiotic ordering.[15]

The findings of our current study should be interpreted in the context of some limitations. First, the survey was distributed via e-mail and a Facebook moms' group, which resulted in 90% of the respondents being women. Therefore, we cannot generalize our study findings to the physician population. Second, study participants were more likely to be motivated physicians who had some interest in and knowledge about AMR; this may have resulted in sampling bias. Moreover, because of the way the survey was distributed, a response rate could not be calculated. Third, our study may have lacked some internal validity as some of the respondents might have provided socially desirable questions that don't reflect true practices.

CONCLUSIONS

Our survey demonstrated that physicians in ambulatory health care settings are aware of AMR as an evolving national problem. However, there was a significant underestimation of the problem of AMR in the physicians' own facilities. Also, there have been significant knowledge gaps and ambivalence about mechanisms of resistance and the factors causing AMR. This underscores the need for further research to better understand the antimicrobial prescribing behavior and address the knowledge gaps among physicians in ambulatory care settings. Global and national AMR awareness campaigns and antibiotic stewardships that incorporate interactive education and feedback, along with input of local experts are critically needed to successfully address the mounting problem of AMR in both inpatient and ambulatory settings.

References

1. Centers for Disease Control and Prevention. Antibiotic Resistance Threats in the United States, 2013. Available from: http://www.cdc.gov/drugresistance/threat-report-2013. Accessed April 20, 2019.

2. Naylor NR, Atun R, Zhu N, Kulasabanathan K, Silva S, Chatterjee A, et al. Estimating the burden of antimicrobial resistance: a systematic literature review. Antimicrob Resist Infect Control 2018;7:58.
3. Pakyz AL, MacDougall C, Oinonen M, Polk RE. Trends in antibacterial use in US academic health centers: 2002 to 2006. Arch Intern Med 2008;168:2254-60.
4. Dellit TH, Owens RC, McGowan JE Jr., Gerding DN, Weinstein RA, Burke JP, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. Clin Infect Dis 2007;44:159-77.
5. Llor C, Bjerrum L. Antimicrobial resistance: risk associated with antibiotic overuse and initiatives to reduce the problem. Ther Adv Drug Saf 2014;5:229-41.
6. Aabenhus R, Hansen MP, Saust LT, Bjerrum L. Characterisation of antibiotic prescriptions for acute respiratory tract infections in Danish general practice: a retrospective registry based cohort study. NPJ Prim Care Respir Med 2017;27:37.
7. Dyar OJ, Beovic B, Vlahovic-Palcevski V, Verheij T, Pulcini C, on behalf of ESGAP (the ESCMID [European Society of Clinical Microbiology and Infectious Diseases] Study Group for Antibiotic Policies). How can we improve antibiotic prescribing in primary care? Expert Rev Anti Infect Ther 2016;14:403-13.
8. Fairlie T, Shapiro DJ, Hersh AL, Hicks LA. National trends in visit rates and antibiotic prescribing for adults with acute sinusitis. Arch Intern Med 2012;172:1513-4.
9. Smith SS, Kern RC, Chandra RK, Tan BK, Evans CT. Variations in antibiotic prescribing of acute rhinosinusitis in United States ambulatory settings. Otolaryngol Head Neck Surg 2013;148:852-9.
10. Barnett ML, Linder JA. Antibiotic prescribing to adults with sore throat in the United States, 1997-2010. JAMA Intern Med 2014;174:138-40.
11. Kronman MP, Zhou C, Mangione-Smith R. Bacterial prevalence and antimicrobial prescribing trends for acute respiratory tract infections. Pediatrics 2014;134: e956-65.
12. Fleming-Dutra KE, Hersh AL, Shapiro DJ, Bartoces M, Enns EA, File TM Jr., et al. Prevalence of inappropriate antibiotic prescriptions among US ambulatory care visits, 2010-2011. JAMA 2016;315:1864-73.
13. Costelloe C, Metcalfe C, Lovering A, Mant D, Hay AD. Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: systematic review and meta-analysis. BMJ 2010;340:c2096.
14. Charani E, Edwards R, Sevdalis N, Alexandrou B, Sibley E, Mullett D, et al. Behavior change strategies to influence antimicrobial prescribing in acute care: a systematic review. Clin Infect Dis 2011;53:651-62.
15. Wester CW, Durairaj L, Evans AT, Schwartz DN, Husain S, Martinez E. Antibiotic resistance: a survey of physician perceptions. Arch Intern Med 2002;162: 2210-6.
16. Paluck E, Katzenstein D, Frankish CJ, Herbert CP, Milner R, Speert D, et al. Prescribing practices and attitudes toward giving children antibiotics. Can Fam Physician 2001;47:521-7.
17. Sanchez GV, Roberts RM, Albert AP, Johnson DD, Hicks LA. Effects of knowledge, attitudes, and practices of primary care providers on antibiotic selection, United States. Emerg Infect Dis 2014;20:2041-7.
18. Shapiro DJ, Hicks LA, Pavia AT, Hersh AL. Antibiotic prescribing for adults in ambulatory care in the USA, 2007-09. J Antimicrob Chemother 2014;69:234-40.
19. Cribb A, Barber N. Prescribers, patients and policy: the limits of technique. Health Care Anal 1997;5:292-8.
20. Siegel JD, Rhinehart E, Jackson M, Chiarello L, Health Care Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in health care settings. Am J Infect Control 2007;35(10 Suppl 2):65-164.
21. Evans CT, Rogers TJ, Weaver FM, Burns SP. Providers' beliefs and behaviors regarding antibiotic prescribing and antibiotic resistance in persons with spinal cord injury or disorder. J Spinal Cord Med 2011;34:16-21.
22. Armstrong D, Ogden J. The role of etiquette and experimentation in explaining how doctors change behaviour: a qualitative study. Sociol Health Illn 2006;28:951-68.
23. Lewis PJ, Tully MP. Uncomfortable prescribing decisions in hospitals: the impact of teamwork. J R Soc Med 2009;102:481-8.
24. Guerra CM, Pereira CA, Neves Neto AR, Cardo DM, Correa L. Physicians' perceptions, beliefs, attitudes, and knowledge concerning antimicrobial resistance in a Brazilian teaching hospital. Infect Control Hosp Epidemiol 2007;28:1411-4.
25. Pulcini C, Williams F, Molinari N, Davey P, Nathwani D. Junior doctors' knowledge and perceptions of antibiotic resistance and prescribing: a survey in France and Scotland. Clin Microbiol Infect 2011;17:80-7.