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Preparing for Antibiotic Resistance Campaigns: A Person-centered Approach to Audience Segmentation

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Abstract

Antibiotic resistance is growing threat to public health threat that calls for urgent attention. However, creating campaigns to slow the emergence and spread of drug-resistant pathogens is challenging because the goal—antibiotic stewardship—encompasses multiple behaviors. This study provided a novel approach to audience segmentation for a multifaceted goal, by using a person-centered approach to identify profiles of US adults based on shared stewardship intentions. The latent class analysis identified three groups: Stewards, Stockers, and Demanders. The findings suggest campaigns with goals aimed at encouraging Stewards to follow through on their intentions, encouraging Stockers to dispose of their leftover antibiotics, and convincing Demanders to accept provider's evidence-based judgment when a prescription for antibiotics is not indicated. Covariate analysis showed that people who held more inaccurate beliefs about what antibiotics can treat had higher odds of being Demanders and Stockers instead of Stewards. People with stronger health mavenism also had higher odds of being Stockers instead of Stewards. The covariate analysis provided theoretical insight into the strategies to pursue in campaigns targeting these three groups.

Keywords

antibiotic resistance; audience segmentation; latent class analysis; misattributions; health mavenism

On September 18, 2014 President Obama brought national attention to the challenge of antibiotic resistance, when he issued an executive order and a national strategy (Obama,

2014). While antibiotic-resistant genes have always been present in the population of bacteria (D'Costa, McGrann, Hughes, & Wright, 2006; Smith, M'ikanatha, & Read, 2014), the dramatic increase in production and use of antibiotics in clinical settings and in animal husbandry has exacerbated the emergence and spread of these genes. These factors create a perfect storm for public health, in which more than 2 million people in the U.S. are infected annually with antibiotic resistant bacteria and 23,000 die each year from antibiotic resistant infections (CDC, 2013). The CDC (2013) estimates that in the US, direct health care associated with antibiotic-resistant infections are as high as \$20 billion dollars as much as \$35 billion due to lost productivity related to those illnesses. The U.S. is not alone in its concern about antibiotic resistance and its far-reaching consequences; other countries and organizations such as the World Health Organization have galvanized attention toward what is considered a serious threat to global public health (WHO, 2014).

Two primary strategies to reduce the emergence and spread of antibiotic resistant bacteria are to reduce the number of infections and to maximize antibiotic stewardship. Physicians and the public can both practice these strategies, thereby addressing the U.S.'s National Strategy for Combating Antibiotic Resistance goal #1 (http://www.whitehouse.gov/sites/default/files/docs/carb_national_strategy.pdf). Through infection control measures (e.g., proper hand hygiene practice) the transmission of infectious agents can be minimized, thus limiting the number of potential patients exposed to antibiotics. Antibiotic use exacerbates the spread of resistance in patients and in populations; the fewer bacteria that are exposed to antibiotics, the slower the evolution of resistance. Ideally, antibiotics should be administered at the optimal dose and duration and minimal toxicity to cure an infection while limiting selective pressure for resistance in non-target organisms (e.g., the other bacteria that live in and on us that are not causing disease, Fishman, 2006).

The general public can play an important role in slowing antibiotic resistance by engaging in behaviors to prevent infections, such as receiving recommended vaccines and practicing proper personal hygiene in their daily lives. The public can also reduce their unnecessary exposure to antibiotics by accepting evidence-based medicine when healthcare providers indicate drugs are unnecessary for their illnesses, for example for acute viral infections.

To develop effective interventions to promote antibiotic stewardship, scholars (Slater, 1996; Slater, Kelly, & Thackeray, 2006; Maibach, Leiserowitz, Roser-Renouf, & Mertz, 2011; Maibach, Maxfield, Ladin, & Slater, 1996) argue that research is needed to understand the current intentions of the general public and to identify relevant audience segments. This can be pursued by probing people's intentions to engage in stewardship-related actions. The current study takes a person-centered approach to audience segmentation by using latent class analysis (LCA) to identify profiles of US adults based on shared stewardship intentions. While the LCA allows for informed decisions about with whom to intervene, supporting theory is needed to understand how to do so effectively (Slater, 1996; Slater et al., 2006; Maibach et al., 1996; Maibach et al., 2011). To that end, we include a covariate analysis of theoretically relevant predictors to anticipate strategic communication efforts. Beliefs relevant to health behaviors include perceptions of risk and efficacy; thus, the risk perception attitude (RPA) framework (Rimal & Real, 2003) is used to frame this study. In addition, we pay attention to identifying which behavioral patterns are more likely to occur

in people with the attributes of opinion leadership, specifically health mavens and demanders (Boster et al., 2011). For public health campaign planning, it is important to identify whether potential opinion leaders are engaging in recommended actions, making them possible agents of change (Rogers, 2003; Rogers & Singhal, 2003), or in problematic behaviors, making them particularly important segments to target.

Antibiotic Resistance

Most recent reports and publications on antibiotic resistance paint a grim picture (see Smith et al., 2014 for a review). Globally, the World Health Organization (2014) estimates that over 50% of tested infections for *E. coli*, *K. pneumoniae*, and *S. aureus* showed resistance to commonly used antibiotics. Furthermore, these statistics likely underestimate the problem, because antibiotic-resistant infections can be difficult to detect in clinical settings (CDC, 2013; WHO, 2014), and the complicating effects of antibiotic-resistant infections on other conditions from which people die may not be captured in the reported data (CDC, 2013).

The useful lifetime of an antibiotic depends on many factors, including human behavior (Smith et al., 2014). Relevant behaviors that exacerbate the appearance and spread of antibiotic resistant infections include antibiotic use, hygiene and sanitation, and vaccination (see Smith et al., 2014 for an explanation of the biological mechanism). While the drivers are complex, in brief, every dose of antibiotic drugs places a selective pressure for resistance on the targeted bacteria and on other non-targeted bacteria in one's system. Both targeted and non-targeted bacteria that possess genes for drug resistance are capable of sharing these genes vertically and laterally: they may replicate progeny with the genes or share the genes to other types of bacteria. To mitigate this inherent problem of antibiotic resistance, one can remember: "The first rule of resistance management is to take antibiotics only when absolutely necessary" (Smith et al., 2014, p. 4).

Physician prescription habits contribute to antibiotic resistance. A study of oral antibiotic prescriptions dispensed in 2010 estimates that 258 million courses of antibiotics were dispensed (833 prescriptions per 1000 people; Hicks & Taylor, 2013); however, it is estimated that 50% of antibiotics prescriptions are unnecessary (CDC, 2013). Despite the facts that antibiotics are ineffective against viruses and that acute bronchitis is generally caused by a virus, nearly 75% of U.S. adults seeking treatment for acute bronchitis receive antibiotics (Fauci & Marston, 2014). Health providers have reported prescribing antibiotics to patients who seem to expect them or who ask for them (Harrington et al., 2007; Stivers, 2002). A report by Baucher et al. (1999) showed that 30% of physician respondents have prescribed antibiotics for children (who make up one of the largest consumers of antibiotics) "occasionally" or "frequently" when pressured by parents. Patients' requests and persuasion behaviors, then, could be a critical target for campaigns. A subset of patients who may warrant particular attention are physicians self-prescribing antibiotics for themselves or their children (Gendel et al., 2012).

In addition, patients do not always complete their entire prescription of prescribed antibiotics (Kardas et al., 2005). A meta-analysis of patients' non-compliance showed that worldwide, on average, 62% of patients took all of their prescribed antibiotics; in North

America, 57% were compliant. It is unclear what patients do with their remaining drugs. If they keep them in order to use them for a future infection, this presents another opportunity for unnecessary or inappropriate exposure of bacteria to antibiotics. Indeed, the meta-analysis of antibiotic use (Kardas et al., 2005) showed that, globally, 29% of patient used their leftover antibiotics. These behaviors have received little research.

In addition to modifying prescription behaviors (requests and consumption), it is also critical to reduce the transmission of infectious agents to slow antibiotic resistance. By preventing new infections, we can reduce the number of people who may be prescribed antibiotics (Smith et al., 2014). Getting recommended vaccines throughout one's life and sanitizing one's environment are both efficacious ways to prevent infections (CDC, 2013).

Audience Segmentation

Audience segmentation provides critical information for planning effective campaigns that use resources strategically (Maibach et al., 2011). Antibiotic stewardship involves multiple behaviors, which presents a challenge for campaign development. One option is to target one behavior at a time, but the question is which to target. For a multiple-behavior objective, like antibiotic stewardship, it may be useful to segment audiences into homogeneous sub-groups based on shared behaviors. Recent developments in person-centered methods provide a rigorous, quantitative method to identify classes for audience segmentation. This study uses LCA (Collins & Lanza, 2010), which is similar to other latent variable models such as factor models, in that it attempts to capture latent constructs from measurable variables. LCA is used when the latent construct is categorical (Collins & Lanza, 2010), as with audience segments. The procedure provides two parameters: (a) the likelihood of membership in a latent class, and (b) the likelihood of a providing a particular response conditional on the set of classes. Goodness-of-fit indicators for models are used to select the best number of classes. LCA also allows one to test whether covariates predict the odds of membership in one class relative to another (i.e., reference class), such as theoretical variables relevant for campaign design.

Research Question 1: Is there a latent class structure that adequately represents the heterogeneity in U.S. adults' intentions to engage in stewardship-related actions?

Predictors of Stewardship Intentions

The RPA (Rimal & Real, 2003) explains how people's perceptions of health risks and their perceptions about the efficacy of particular responses predict their actions. Stronger perceptions of risks, such as severity, motivate people to act. In this study, severity was captured as people's perception of how severe it is to have an antibiotic resistant infection. As people feel that such infections are more serious, painful, or fatal, they are more likely to act. Efficacy perceptions determine whether people's risk-induced motivation to act results in engaging in the recommended actions. People tend to engage in actions that they believe will work; this perception is referred to as response efficacy (Rimal & Real, 2003). It is possible that sometimes people perceptions of a response's efficacy are wrong. In this study, we investigated misattributions of antibiotic's response efficacy, that is, the inaccurate perceptions of what antibiotics are able to treat. Antibiotics are designed to treat bacteria.

Studies show, however, that people may also believe that antibiotics can treat viruses, or treat symptoms such as fevers, and pain (e.g., sore throats, Pechère, 2001). Antibiotic stewardship behaviors, then, may be predicted by stronger perceptions of the severity of antibiotic resistant infections and fewer misattributions of antibiotics' treatment capacities.

In addition to using theory to anticipate campaign message design, it may also be important to identify the behaviors of people with the attributes of opinion leaders. Some people serve as opinion leaders for others in their social networks. Boster and colleagues (2011) described three different personality traits of opinion leaders: mavenism, persuasiveness, and connectivity. This study focuses on health mavens. Health mavens actively maintain expertise in a variety of areas, share their knowledge, and are likely to be resources for others (Boster et al., 2010). Boster and colleagues (2010) argue that identifying people with these qualities may be useful to efforts to diffuse health information via opinion leadership. They also may be the source of counter-messages in the community.

Research Question 2: Do perceived severity of antibiotic resistant infections, misattributions of antibiotic efficacy, and health mavenism predict membership in antibiotic stewardship- latent classes?

Method

Participants

Participants ($N = 193$; 39% female) were adults who were recruited through Amazon's Mechanical Turk. Participants on average were 32 years old ($SD = 9.36$, $Median = 30$, $Minimum = 18$, $Maximum = 67$; skewness and kurtosis $< |1|$). Participants identified themselves as Caucasian (77%), Asian (10%), African American (2%), and Native Hawaiian or Pacific Islander (1%). Five percent identified their ethnicity as Hispanic. Thirty-four percent of participants reported being married and 37% reported having children. Participants self-reported their occupation as full time student (15%), employee in a company they did not own (62%), self-employed (29%), and unemployed (17%). Participants varied in their highest levels of formal education: 5% attended high school, 47% graduated from high school, 42% graduated with an undergraduate degree, and 6% completed graduate education. Participants resided in multiple states in the US: 38 different states were represented.

Design and Procedures

The study used a cross-sectional design. An institutional review board approved the study before data were collected. This study was conducted through Amazon's Mechanical Turk (see Mason & Suri, 2011 for guidance on how to use this system). Briefly, adults willing to complete tasks, such as participating in research studies, register with Amazon and create an Amazon payment account to receive compensation for their efforts. Researchers post opportunities for research (referred to as HITs) and list criteria for inclusion. This research opportunity was restricted to US citizens and compensation was \$4.00. The average time per survey was 30 minutes. In this study, compensation was provided when participants reported a code found at the end of the survey. Participants were compensated even if they did not answer every question in the survey. The survey included items about their intentions to

engage in behaviors related to antibiotic stewardship, psychological scales, and demographics.

Latent Class Indicators

Seven items were used to assess participants' intentions to engage in behaviors related to appropriate and inappropriate antibiotic stewardship. The seven items appear in the Appendix. The response options for the seven items were *no*, *yes*, and *unsure*. These three options were collapsed into two categories for the latent class analysis. For the five problematic behaviors, *no* was separated from *yes* or *unsure*. This coding emphasizes that even the potential for engaging in these actions is problematic. For the two recommended behaviors (vaccinations and sanitation), *no* and *unsure* was separated from *yes*. This coding emphasizes the goal of persuading people to intend to engage in the recommended actions; those who uncertain would be targeted to move toward intending to engage in the recommended behavior. Table 1 shows the codes assigned to responses for each item.

Covariates

A confirmatory factor analysis of scales—perceived severity, antibiotic efficacy misattributions, and health mavenism—was estimated with maximum likelihood; all factors were allowed to covary, but error terms were not. The model showed reasonable goodness of fit: $RMSEA = .07$ [90% CI, .05, .08], $SRMR = .06$, with $X^2 (df = 51, N = 193) = 114.38, p < .001$ (Holbert & Stephenson, 2002).

Perceived severity—Four items (adapted from Witte, Meyer, & Martell, 2001) assessed the perceived severity of antibiotic resistant infections (e.g., *An antibiotic resistant infection is a severe medical condition.*). Responses, marked on five-point scales (later coded as 1 = *strongly disagree* to 5 = *strongly agree*), were averaged into one score ($\alpha = .88$), with higher scores indicating stronger perceived severity.

Antibiotic efficacy misattributions—Four items were used to assess the perceived response efficacy of antibiotics to treat *viral infections*, *pain*, *swelling*, and *fevers*, which antibiotics can not treat. Responses, marked on five-point scales (later coded as 1 = *not effective at all* to 5 = *completely effective*), were averaged into one score ($\alpha = .82$); higher scores indicate stronger efficacy misattributions.

Health mavenism—Four items (adapted from Boster et al., 2010) were used to assess identification as a health maven (e.g., *I like to be aware of the most up-to-date healthy lifestyle information so I can help others by sharing it*). Responses, marked on five-point scales (later coded as 1 = *strongly disagree* to 5 = *strongly agree*), were averaged into one score ($\alpha = .86$); higher scores indicate stronger mavenism.

Results

Descriptive Statistics

As seen in Table 1, over one third of participants intended to ask their providers for antibiotics when they are sick or were unsure whether they would ask for antibiotics. About

20% intended to try or might try to persuade their health providers to change their minds and prescribe an antibiotic if their providers were initially reluctant to write a prescription. Over a third of participants intended to or might store antibiotics for future illnesses, and 40% intended to or indicated that they may take antibiotics with them when they travel out of the US. Almost 15% of participants intended to or indicated that they may share leftover antibiotics with others. These findings reflect similar results of previous studies, in which nearly a quarter of participants were noncompliant through storage of “leftover” antibiotics (Kardas et. al, 2005). This suggests that there is a nontrivial portion of the public that intends to or may be inclined to engage in problematic behaviors that may exacerbate the appearance and spread of antibiotic resistance.

Close to 80% of the participants reported intentions to engage in prevention: getting recommended vaccinations and sanitizing their environment. Twenty percent, then, need to be encouraged to engage in prevention behaviors related to antibiotic resistance.

Eighty-four percent of participants had heard of the term antibiotic resistance. Interestingly, awareness varied by gender: 95% of women, but only 79% of men had heard of antibiotic resistance, $X^2(1, 193) = 10.09, p < .01, \Phi = .23$. Fewer participants (24%) reported personally knowing someone who has been diagnosed with an antibiotic-resistant infection, which also varied by gender, $X^2(1, 193) = 4.14, p < .05, \Phi = .15$. Thirty-two percent of women and 19% of men personally knew someone diagnosed with an antibiotic-resistant infection.

Latent Class Analysis

To address RQ1, PROC LCA (Lanza et al., 2007) was used to calculate the fit indices for two- to seven-class models (see Table 2). Each test was run using 200 random starting values. The lowest Akaike information criterion (AIC) and Bayesian information criteria (BIC) estimates were used to identify the best fitting model (Collins & Lanza, 2010). The AIC and BIC estimates both converged at a minimum value on the three-class model. These findings suggested that there are three latent classes of people based on their antibiotic stewardship behaviors.

Table 3 shows the item-response probabilities for the three-class model and the likelihood of reporting a behavior (i.e., the responses that were coded as 2 in Table 1) within a class. The largest group (65%), labeled *Stewards*, had low likelihoods of intending to engage in problematic behaviors related to antibiotics and high intentions of getting vaccinated and sanitizing their environments. The other two classes also had some likelihood of reporting these prevention behaviors (vaccination and sanitation); they differed in their pattern of problematic antibiotic behaviors. Another group (14%), labeled *Stockers*, had high likelihoods of intending to store antibiotics and to take them as they traveled. The last group (21%), labeled *Demanders*, had high likelihoods of intending to ask for antibiotics when sick and to persuade providers to prescribe them antibiotics when the providers did not do it. Demanders also were somewhat likely to intend to store and to take antibiotics with them. Importantly, intending to share leftovers antibiotics with others was not very likely in any of the classes. Put differently, while 15% of participants intended to share leftover antibiotics, this intention did not characterize a particular class.

Covariate Analysis

RQ2 explored whether perceived severity of antibiotic-resistant infections, misattributions of antibiotic efficacy, and health mavenism predicted membership in latent classes of antibiotic stewardship. The covariate analysis was tested with Stewards as the reference class. We also ran a second covariate analysis with two demographics: parenthood and gender. Table 4 shows the results of this analysis. Perceived severity, antibiotic efficacy misattributions, and health mavenism were all statistically significant covariates of class membership. In comparison to Stewards, participants who perceived antibiotic resistant infections as more serious health conditions had slightly higher odds of being Stockers and much lower odds of being Demanders. Participants with stronger misattributions of antibiotics' efficacy to treat multiple conditions had higher odds of being Demanders or Stockers, in comparison to Stewards. Finally, people with stronger health mavenism had higher odds of being Stockers, in comparison to Stewards; mavenism did not differentiate between Demanders and Stewards.

Demographically, males had higher odds of being Demanders or Stockers than Stewards. While the analysis showed that parents had lower odds of being Demanders and slightly higher odds of being Stockers, in comparison to Stewards, these differences were not statistically significant.

Discussion

The threat of antibiotic resistance has been elevated as a public health priority in multiple countries. With increased attention through such actions as the executive order by President Obama (Obama, 2014) and Prime Minister Cameron in the UK (Department of Health, 2014), the need for thoughtful planning for communication campaigns has become urgent. Creating campaigns to slow the incidence and spread of antibiotic resistance is challenging because the goal—antibiotic stewardship—encompasses multiple behaviors. This study provided a novel approach to audience segmentation for a multifaceted goal, by using the person-centered approach of latent class analysis.

Person-Centered Audience Segmentation

The basic descriptive statistics showed that a non-trivial number of participants intended to engage in problematic antibiotic-related behaviors and did not intend to engage in recommended prevention behaviors (e.g., personal hygiene and vaccination). The LCA identified three groups based on their antibiotic stewardship behaviors, labeled as Stewards, Stockers, and Demanders. These results alone, provide a more refined way to segment audiences based on their pattern of responses, and suggest three different types of campaign goals: to encourage Stewards to follow through on their intentions, to encourage Stockers to dispose of their antibiotics, and to influence Demanders to accept medical advice when an antibiotic is not indicated and to dispose of their leftover antibiotics.

The presence of Demanders resonates with other communication studies of how parents present their children's problems to providers (Stivers, 2002) and the questions they ask during medical visits (Harrington et al., 2007). These studies provide useful insight on how

to improve doctor-patient conversations around antibiotics. That said, more research is needed to understand and identify patients' intentions when they visit providers (e.g., are they seeking care with the goal of being prescribed an antibiotic?) and how and why patients gain compliance (e.g., how do patients persuade providers to prescribe them unneeded antibiotics?) (Harrington et al., 2007; Stivers, 2002).

The Demanders class provides an important conundrum for campaign designers, because of their problematic communication and storing behaviors. Theoretical guidance is needed to inform which behavior to prioritize for intervention. Biologically, we might ask which will slow down resistance or limit exposure the most. Theoretically, we may also consider which is the most movable. Hornick and colleagues (Hornik & Woolf, 1999; Parvanta et al., 2013) provides compelling ideas on identifying the pay-off of particular beliefs. Theoretical attention is needed around the movability of a given behavior or belief based on qualities such as how far it needs to change and how well we can sustain changes.

We also need to consider potential outcomes of changed behavior. For example, people are exposed to antibiotics when they take a prescription antibiotic, but exposure also happens through other means, such as through water, food, and toiletries. Antibiotics are present in the water supply throughout the U.S. (Venkatesan & Halden, 2014). While it is impossible to prevent all drugs entering the water supply (the body can only metabolize so much of a drug and the rest is excreted), one way that antibiotics get into water supplies is by people disposing of them in toilets (Mispagel & Gray, 2005). If an intervention is introduced, it must include provisions to ensure proper disposal of the antibiotics, such as, a pill "take-back" program through pharmacies. We would need to ensure that the systems are in place to provide a means by which to dispose of antibiotics.

Anticipating Targeted Campaigns

The covariate analysis provided theoretical insight into the strategies to pursue in campaigns targeting these three groups. People who perceived contracting antibiotic resistant infections as less serious health conditions, believed antibiotics could treat more conditions than they actually can, and were male, had higher odds of being Demanders instead of Stewards. Demanders, then, could be targeted with messages to increase perceived severity of antibiotic resistant infections and correcting their beliefs in antibiotics' efficacy. We have much guidance on the messages to increase perceived severity. While we have guidance on how to increase efficacy, there has been less attention paid to constructing messages that correct inaccurate perceptions of response efficacy. This theoretical guidance is needed to design campaigns for Demanders.

People with stronger health mavenism and misattributions of antibiotics' efficacy had higher odds of being Stockers instead of Stewards. This finding has serious implications for campaign design. This opinion leader trait describes people who like to be sources for health expertise and advice (Boster et al., 2010), but these results in this study suggest that they may also be holding onto health resources, like left-over antibiotics. As sources of advice, it may be critical to target health mavens first in order to prevent them spreading misinformation and allow them to spread accurate messages about the efficacy of antibiotics.

Limitations

While the participants were diverse in many respects, our sample is small in comparison to the U.S. population. Population-level studies should be done in order to assess how well these results generalize to the U.S. population. In addition, while self-reported intentions are useful for formative research and planning, there is not a perfect relationship between intentions and self-reported behavior (e.g., Sheppard, Hartwick, & Warshaw, 1988) or observed behavior. It would be useful to compare these findings, such as by observing interactions between patients and providers and using unobtrusive methods to measure left-over antibiotics.

While we have discussed ways to consider campaigns aimed at the public from our results, this is not to suggest that providers and community systems are not important for slowing antibiotic resistance. Limiting exposure to unnecessary antibiotics in the US is not trivial, and is affected by decisions at the personal, agricultural, clinical, and national levels. In the 70 years since the introduction of antibiotics, millions of metric tons of antibiotics have been produced, distributed worldwide, and used for a variety of purposes (Davies & Davies, 2010). Indeed, while we have focused on humans, the systemic saturation of water and other ecosystem features with antibiotics affects species, such as insects, birds, and animals (see Allen et al., 2010 for more on this topic). Antibiotics use in animal husbandry accounts for almost 75% of the antibiotic market in the US (Fauci & Marston, 2014). Antibiotics are included in toiletries and household cleaning products (Davies & Davies, 2010). Multiple behaviors performed by completely different actors are needed to reduce people's exposure to antibiotics.

Conclusion

Some life scientists have warned that without concerted efforts we may be approaching a post-antibiotic era (Davies & Davies, 2010; Smith et al., 2014). As Nobel Laureate Dr. Joshua Lederberg wrote "The future of humanity and microbes likely will unfold as episodes of a suspense thriller that could be titled *Our Wits Versus Their Genes*" (p. 290). The growing threat of antimicrobial resistance is fueled by multiple, complex factors that include biological, behavioral and societal aspects. Transdisciplinary collaborations, involving biological, communication, and behavioral sciences as well as medicine and public health, are needed to address the growing health burdens imposed by drug resistant infections (Smith et al., 2014). A large component of the problem is caused by human behavior, so that behavioral change is needed to alleviate it. Notably, Edgar and colleagues (Edgar, 2012; Edgar, Boyd, & Palamé, 2009) have tried to educate life scientists and clinical scholars on how to use social marketing concepts (e.g., communication) to change human behaviors and their antecedents (e.g., beliefs). However, more efforts to apply communication scholarship to the problem of antibiotic resistance are needed. This study provides an important step in that direction, by identifying audience segments based on shared patterns and using theoretical and pragmatic covariates of segment membership in order to guide campaign decisions and designs.

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Appendix

	No	Yes	Don't know/ Unsure
I intend to ask health providers to prescribe me an antibiotic when I am sick.			
I intend to try to persuade my health providers to change their minds and prescribe me an antibiotic, if my health providers do not want to prescribe me an antibiotic.			
I intend to store antibiotics at my house for a potential, future illness.			
I intend to take antibiotics with me when I travel out of the country.			
I intend to share my leftover antibiotics with someone else who is sick.			
I intend to get vaccinated as recommended by my health care providers.			
I intend to sanitize things (e.g., door handles) that are touched on a regular basis.			

Table 1Future Intentions: Indicators for Latent Class Analysis ($N = 193$)

Indicators	Code	Label	<i>n</i>	%
Ask for antibiotic when sick	1	No	122	63.2
	2	Yes or Unsure	71	36.8
Persuade providers for prescription	1	No	153	79.3
	2	Yes or Unsure	40	20.7
Store antibiotics for future illness.	1	No	132	68.4
	2	Yes or Unsure	61	31.6
Take antibiotics when traveling abroad	1	No	115	59.6
	2	Yes or Unsure	78	40.4
Share leftover antibiotics with others	1	No	165	85.5
	2	Yes or Unsure	28	14.5
Get recommended vaccinations	1	No or Unsure	42	21.8
	2	Yes	151	78.2
Sanitize environment	1	No or Unsure	31	16.1
	2	Yes	162	83.9

Table 2

Model Fit Information for Comparison of Latent Class Models

Number of classes	G ²	AIC	BIC	df
2	114.11	144.11	223.05	112
3	87.86	133.86	208.91	104
4	74.29	136.29	237.43	96
5	60.05	138.05	265.30	88
6	48.57	142.57	295.91	80
7	39.45	149.45	328.90	72

Note. Boldface type indicates the selected model. AIC=Akaike's Information Criterion; BIC=Bayesian Information Criterion; *df*=degrees of freedom.

Table 3

Item-Response Probabilities for Three-Class Model Given Latent Class Membership

	Demanders	Stewards	Stockers
	21%	65%	14%
Ask for antibiotic when sick	.88	.19	.44
Persuade providers for prescription	1.00	.00	.00
Store antibiotics for future illness	.68	.05	1.00
Take antibiotics when traveling abroad	.73	.18	.93
Share leftover antibiotics with others	.43	.01	.36
Get recommended vaccinations	.68	.81	.82
Sanitize environment	.78	.87	.79

Note. Percentages reflect the number of participants likely to be in each profile. Cells contain the likelihood of agreeing with the concept. Likelihoods over 50% appear in bold.

Table 4

Covariate Analysis with Stewards as the Referent Class

	Demanders		Stockers		LL ²
	OR	B	OR	B	
Perceived severity	0.36	-1.03	1.14	0.13	13.98*
Antibiotic efficacy misattributions	3.04	1.11	1.51	0.41	25.91*
Health mavenism	0.99	-0.01	2.01	0.70	6.86*
Male	4.65	1.54	2.07	0.73	6.82*
Parents	0.27	-1.31	1.19	0.17	3.57

Note. OR = Odds ratio; B = beta estimate.

* $p<.05$