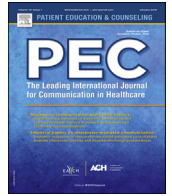




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## Review Article

# What we know about media communication on antibiotics and antimicrobial resistance: A systematic review of the scientific literature

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## ABSTRACT

**Objective:** Systematically review the literature regarding media communication about antibiotics and anti-microbial resistance (AMR) to synthesise its key characteristics and impact effectiveness, identifying gaps and areas for further research.

**Methods:** A comprehensive systematic review covering five international databases for articles published between 1<sup>st</sup> September 2008 and 1<sup>st</sup> September 2018 was performed using the registered protocol (PROSPERO: CRD42018116464). The search using terms related to media communication and antibiotics or AMR yielded 19 eligible studies, which were analysed and qualitatively synthesised.

**Results:** Research on media communication regarding antibiotics or AMR has rapidly increased in the last decade. 74% of studies used a media content analysis method, while the remaining studies collected data via surveys. Print media were examined in 53% ( $n = 10$ ), with 74% ( $n = 14$ ) focused on English language media. **Conclusion:** Currently, knowledge regarding media communication of antibiotics and AMR is very restricted to English-speaking print media. Further research is required to understand communication on this topic from other media (types and geographical regions) as well as how media effects attitude and behaviour change.

**Practice implications:** Better understanding of media communication regarding antibiotics and AMR may be crucial for policymakers and public health experts when planning strategies to tackle this issue.

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## 1. Introduction

Antibiotics have revolutionised our society and economy by turning previously lethal infections into uncomplicated diseases. However, this success is now at risk, mainly because of the overuse or inappropriate use of antimicrobials. Antimicrobial resistance (AMR) is a major challenge both for today and tomorrow's public health, and the preservation of antibiotics ability to cure has become a worldwide shared goal. AMR occurs when bacteria, viruses, fungi, and parasites adapt to antimicrobial drugs, resulting in drug inefficiency and persistent infections, with a subsequent increase in the risk of severe diseases and transmission [1]. One of the reasons is the inappropriately use of antibiotic treatment which is associated with higher all-cause mortality in patients with severe bacterial infections [2]. Proof of this was the high-level meeting of the United Nations General Assembly (UNGA) in 2016 where countries discussed how to fight AMR and cooperate to preserve global access to effective antimicrobials [3]. This was a significant landmark as UNGA had previously convened high-level meetings to discuss only three major health issues [4], specifically HIV, non-communicable diseases, and Ebola. In Europe for instance, AMR has been estimated to be responsible for 25,000 deaths annually [5], despite efforts of the European Centre for Disease Prevention and Control and of the WHO Regional Office for Europe. Data from the European Antimicrobial Resistance Surveillance Network (EARS-Net) show high and increasing resistance percentages for gram-negative bacteria in many parts of Europe [6]. Data from the European Surveillance of Antimicrobial Consumption Network (ESAC-Net) show that overall consumption of antibiotics in the community remained unchanged from 2011 to 2015 [6]. As a result, the high resistance to key antimicrobial groups reported by many countries is of great concern, representing a serious threat to patient safety in Europe since options for the treatment of infected patients are becoming more limited.

Strategies to reduce this problem have been largely communicated via public health campaigns [7], for example, by targeting health professionals reminding to avoid prescribing antibiotics for viral diseases, and patients to make an appropriate use of antibiotics. To ensure a significant impact and changes in practice, interventions to reduce AMR require multidisciplinary research, attention, action relating to education regarding antibiotic misuse, and the achievement of the general population's good understanding of antibiotic principles of use [8]. Indeed, the high prevalence of antibiotic resistance tends to correlate with low levels of public awareness about AMR [9]. Given the role of the media as the main source of information concerning health and science [5,10,11], understanding media conversations about antibiotics and AMR may be crucial for policymakers and public health experts when planning strategies to address this issue.

Although research in public communication in the field of AMR and antibiotics has notably increased in the last decade, no integration of the research conducted has been performed to date. In this context, our aim was to systematically review the literature that examined media communication on antibiotics and AMR to

synthesise its key characteristics and impact effectiveness, identifying gaps and areas for further research. This review focused on: (i) the published evidence on each type of communication media; (ii) geographical regions where the analyses has been conducted; and (iii) the study measures and outcomes.

## 2. Methods

A systematic literature review was conducted following PRISMA guidelines [12] to retrieve relevant articles. A protocol for the review was developed through consensus among the research team and it was registered in PROSPERO 2018: CRD42018116464.

### 2.1. Databases and literature search strategy

The literature search was conducted in October 2018 using the following five electronic databases for relevant studies: PubMed (including MEDLINE), Scopus, the International Bibliography of Social Sciences (IBSS), the Cumulative Index to Nursing and Allied Health (CINAHL) and the Latin American and Caribbean Health Sciences Literature (LILACS). These databases have been used in previous systematic reviews on media communication of health topics [11,13–15], and allow a strategic search covering both fields: health sciences and social sciences.

The literature search included papers in any language that were published during the last 10 years, from 1<sup>st</sup> September 2008 to 1<sup>st</sup> September 2018. The search strategies were constructed as a combination of domains and terms related to antibiotics, AMR, and media communication (see search strategy in Table 1). The search only considered papers published in the last decade to provide an up-to-date perspective as communication and media landscape have both gone through many changes [16] to accompany the strong development of digital media over that period.

### 2.2. Title and abstract screening

Regardless of their methodological quality, the studies had to meet the following inclusion criteria: (1) to consist in an experimental study or an observational study such as a content analysis of publications made in mass media; (2) to address media communication analyses of antibiotics or antimicrobial resistance; (3) to report on original qualitative or quantitative data examining media communication activities about antibiotics or antimicrobial resistance. These inclusion criteria will ensure that the final selection of studies are within the scope of the study objective. Reference lists of key articles were manually searched to identify further relevant studies. Systematic reviews, abstracts, dissertations, single-case reports, editorials, commentaries, conference abstracts, and non-research articles were excluded, as well as articles analysing advertisements on vaccines in the media. The PRISMA flow diagram represented in Fig. 1 outlines the screening processes applied to the articles identified by the literature

**Table 1**  
Search strategy in PubMed.

Search terms	Items found
#1 Search [Title] antibiotic* OR hospital-acquired OR resistan* OR antimicrobial OR anti-microbial OR antibacterial OR anti-bacterial OR nosocomial OR microbial OR bacterial OR "drug resistan*" OR AMR OR HCAI	547648
#2 Search [Title] television* OR TV OR radio OR newspaper* OR print OR press OR magazine OR news OR "mass media" OR "communications media" OR "social network*" OR "social media" OR Twitter OR Facebook OR LinkedIn OR Google+ OR Snapchat OR Tumblr OR Pinterest OR Flickr OR YouTube OR Instagram OR Vine OR WhatsApp	3853
#3 Search #1 AND #2 Filter: Publication date from 2008/09/01 to 2018/09/01	198

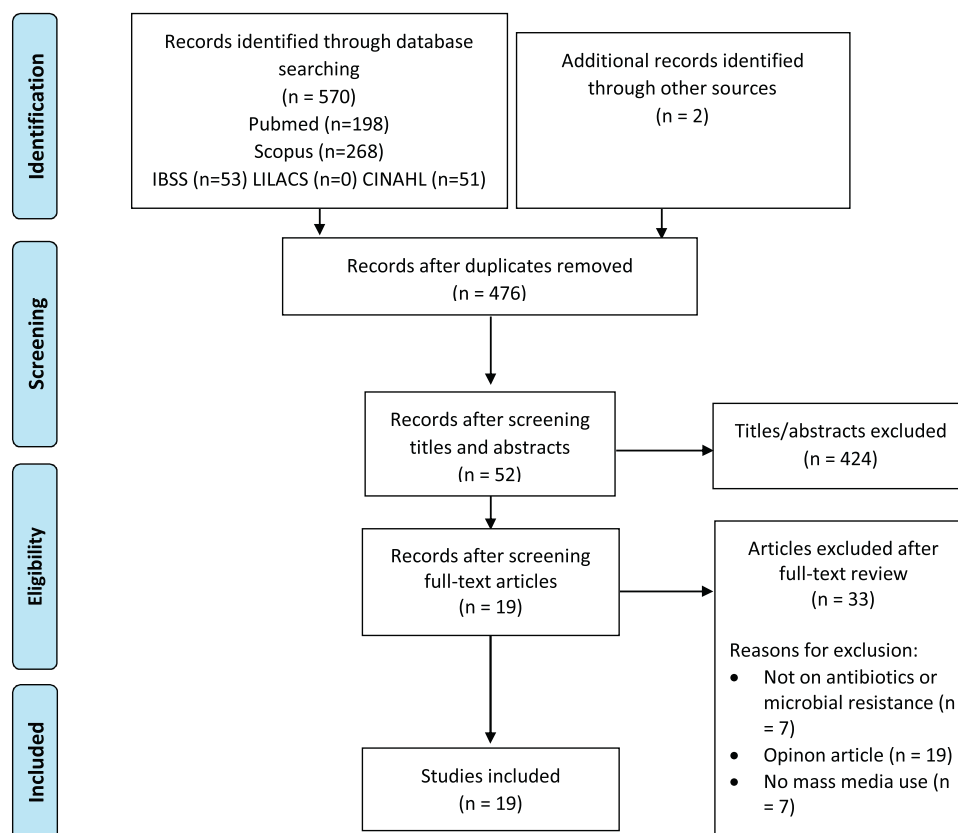


Fig. 1. Prisma flow diagram.

searches, which were subsequently screened for duplication and relevance through title and abstracts. Of those, articles that were considered relevant were assessed for eligibility by reviewing full texts.

### 2.3. Data extraction

Literature search results were uploaded to Zotero. Following the removal of duplicates, titles and/or abstracts of studies retrieved using the search strategy and those from additional sources were screened independently by two review authors to identify studies that potentially met the inclusion criteria previously outlined. The full text of these potentially eligible studies was retrieved and independently assessed for eligibility by two review team members. Any disagreement between them over the eligibility of particular studies was resolved through discussion with a third reviewer.

### 2.4. Synthesis, analysis and quality appraisal

A standardised, pre-piloted form was used to extract data from the included studies for assessment of study quality and evidence synthesis. Extracted information was grouped among the following variables: country; media type; theme; objectives; study measures; sample size; main outcomes; and main conclusions. When some data was missing, it was requested from study authors. We anticipate that there was not scope for meta-analysis because of the range of different outcomes measured across the small number of existing studies. Therefore we followed a qualitative research synthesis by grouping the data according to the previously identified variables. Qualitative research synthesis has shown to provide effective means of producing an actionable knowledge base in order to inform further policy and practice [17].

After data extraction and synthesis, the findings were recorded in Tables 2 and 3 and summarised as narrative answers to the research questions. Evidence of publication bias for eligible studies was assessed by conducting a quality appraisal through the *Joanna Briggs Institute Critical Appraisal Checklist for Qualitative Research* [18] which was conducted at study level.

## 3. Results

The database searches yielded 570 articles, which were checked for duplicates and matching of inclusion criteria. Finally, 476 articles were reviewed for title and abstract, and 52 were considered for full text review. Two additional relevant articles [19,20] were identified by manual search of reference lists of these full texts. Of those, 19 met the inclusion criteria and were included for further analysis. The reasons for exclusion of the other 33 remaining articles are detailed in the PRISMA flow diagram (Fig. 1). The characteristics of the 19 studies including the country, media type, theme and objectives are detailed in Table 2, the study measures, sample size, main outcomes and conclusions in Table 3, and quality assessment is in the Supplementary Table which is available in the online version of this paper. Overall, the aims, data collection methods, samples and outcomes were successfully described in the studies. However, 63% of study reports (n = 12) presented with at least one weakness, e.g. doubt about whether the influence of the researchers was addressed, inter-coder reliability analyses or consensus protocol among coders of the study samples were not included or mentioned in the papers. As the assessment was not done at outcome level and we did not conduct a quantitative synthesis of study results, we did not determine whether the assessment of risk of bias might affect cumulative evidence.

**Table 2**  
Characteristics of the selected studies.

Authors	Country	Media type	Theme	Objectives
Andersen et al. [21]	Worldwide	Twitter	Antibiotics and antimicrobial resistance	Understand user conversations revolving around antibiotics and AMR on Twitter.
Barthes [31]	US	TV	Antimicrobial resistance	Analyse the representation of <i>superbugs</i> through a corpus of 14 episodes from American primetime television series.
Bohlin and Höst [5]	Sweden	Newspaper	Antibiotics	Explore the information concerning bacterial resistance to antibiotics reported in Swedish newspapers and investigate the distinction between personal and societal efficacy in the reporting of antibiotic resistance.
Bohlin and Höst [26]	Sweden	Newspaper, Internet and biology textbooks	Antibiotics	Investigate the extent to which common sources of science information provide the Swedish general public and pupils with evolutionary explanations for antibiotic resistance.
Boyce et al. [19]	UK	Newspapers	MRSA	Explore the relationship and influence between the government, media and published medical research of UK media coverage for MRSA.
Chan et al. [28]	UK	Newspaper	MRSA	Investigate the reasons underlying the prominence of MRSA reporting in the general press, and in particular, to the explicit connection made to hospital cleanliness.
Collins et al. [10]	UK	Newspapers	Antimicrobial resistance	Examine the discussion of AMR as it appears in UK news publications (2010–2015) through transitivity analysis and SRT to determine what social actors are represented in the discussion and who (or what) is characterised as having agency, with a particular focus on the degree of agency attributed to ordinary members of the public.
Corroy and Roche [30]	France	Magazines	Antibiotics and antimicrobial resistance	Analyse media coverage and representations of antibiotics and the phenomenon of antibiotics resistance in French magazines.
Crawford et al. [29]	UK	Newspaper	MRSA	Examine similarities and differences in media discourses relating to MRSA at three important points in the development of the bacterium and its perception by the public over the last decade.
Crowson et al. [25]	US	Google	Antibiotics	Forecast national Medicaid prescription volumes for common ototopical antibiotics, and correlate prescription volumes with internet user search interest using GT.
Dyar et al. [22] Kahle et al. [32]	Worldwide US	Twitter Press release	Antibiotics MDR HIV	Explore events and individuals influencing the discourse about antibiotics on Twitter. Address the nature of the media coverage and the effect of the press release on awareness of HIV drug resistance, perception of the importance of media coverage, and intention to engage in HIV-related behaviors.
Mizuno et al. [27]	Japan	Newspaper	Nosocomial infection	We investigated how changes in the content and number of news reports over time affected the impressions in the minds of the newspaper readers regarding a nosocomial infection to elucidate the features of coverage regarding healthcare issues.
Morris et al. [46]	UK	Newspaper	Antibiotics	Investigate contestation and consensus surrounding the use of antibiotics in agriculture and their implications for AMR as mediated through mainstream news-media and farming print media in the UK.
Pisano et al. [33]	US	Twitter and Facebook	Antimicrobial resistance	Disseminate educational information and increase awareness of ASP tools available to providers, including infection-related clinical pathways and order sets. Because our CAP pathway was made available via an internal Web site for use the same month as the intervention began.
Scanfeld et al. [23]	Worldwide	Twitter	Antibiotics	Determine overarching categories and explore evidence of misunderstanding or misuse of antibiotics in Twitter.
Schnellinger et al. [20]	US	Videos and pamphlets	Antibiotics	Create an animated video to teach parents about the appropriate use of antibiotics and compare the knowledge of parents who were provided with the American Academy of Pediatrics pamphlet
Singh et al. [24]	US, UK, Canada, India, Australia	Newspaper	Antibiotics	Examine how the word <i>evolve</i> is used in the popular press.
Zucco et al. [35]	Italy	Internet and social media	Antibiotics	Establish the extent of Internet and Social Media use to search for antibiotic related information and the potential implications in health care among adult population in Italy.

Abbreviations: AMR: antimicrobial resistance; ASP: Antimicrobial stewardship program; CAP: Community-acquired pneumonia; GT: Google Trends; MDR HIV: Multidrug-resistant HIV; MRSA: Methicillin-resistant *Staphylococcus aureus* infections; SRT: Social representation theory; TV: Television; UK: United Kingdom; US: United States.

**RQ1.** What are the main characteristics of the studies analysing media communication about antibiotics or antimicrobial resistance?

Regarding the publication date, the majority of articles ( $n = 12$ ) were published since 2014, revealing an increase in such research in recent years. As a result of the full text review of the 19 selected studies, 14 (74%) followed both quantitative and qualitative content analysis methods, with the remaining studies using surveys for data collection. The majority of the studies were conducted in English speaking countries (74%  $n = 14$ : 6 in US, 6 in UK, 1 in Canada, and 1 in Australia), with the remaining analyses conducted in Sweden ( $n = 2$ ), France ( $n = 1$ ), Italy ( $n = 1$ ) and India ( $n = 1$ ). Most studies followed a national perspective, analysing the

media of one country; only four studies analysed media from more than one country [21–24].

Print media (53%,  $n = 10$ ) was the most frequent media type reported among the included studies. Overall, top national circulating daily and quality newspapers were the media most frequently selected for the research. Social networks including content analyses on Twitter or Facebook represented the second most frequent group among the studies (32%,  $n = 6$ ). One study analysed television coverage, one the media impact of a press release and another study compared the effect of a video campaign versus the use of pamphlets. Altogether, the 19 studies looked at 8486 newspaper articles, 54 magazine articles, 14 TV show episodes, 892,076 Twitter or Facebook posts, and 1377 survey participants.

**Table 3**  
Outcomes and conclusions of the selected studies.

Authors	Study measures	Sample size	Main outcomes	Main conclusions
Andersen et al. [21]	Corpus of tweets with "antibiotic" and "antimicrobial resistance", keyword tracks: how users have discussed antibiotics and AMR, highlights any spikes in activity during a particular time frame, and identifies potential instances of misinformation.	602100 tweets + 45,976 tweets	Discussions about antibiotics and AMR predominantly occur in the United States and the United Kingdom, with roughly equal gender participation. These conversations are influenced by news sources, health professionals, and governmental health organizations. Users will often defer to retweet and recirculate content posted from these official sources and link to external articles instead of posting their own musings on the subjects.	The findings are important benchmarks in understanding the prevalence and reach of potential misinformation about antibiotics and AMR on Twitter.
Barthes [31]	Genre (epidemiological, medical and police series), dates when episodes take place. Theme and discourse of the antibiotic resistance, type of bacteria mentioned, antibiotic names, types of solutions, causes for the infection.	14 episodes from TV series	The issue of AMR is dramatized in each episode, but discourses are highly diverse and scattered. Even though they do not quite correspond to reality, they foster public awareness of the issue, allow the viewer to acquire pieces of knowledge (including through metaphors created by the writers), and develop a better understanding of public health issues.	The TV series can be used to support the work of health promoters willing to enhance communication and education on antimicrobial resistance.
Bohlin and Höst [5]	Risk-magnitude descriptions, causes for the development and spread of antibiotic resistance, and possible risk-reduction measures	7 newspapers. 221 articles	The magnitude of the AMR problem is predominantly described qualitatively, stating for example that it "is a rising problem". Numerical descriptions of infections or their mortality are also present, but to a lesser degree. The majority of the articles provided some description or explanation related to magnitude, cause and/or societal efficacy measures. Less than a quarter of the articles (24%) reported personal efficacy measures. Societal efficacy measures are reported more frequently than personal efficacy.	The results motivate further research exploring conditions potentially associated with differences in the reporting of risk reduction measures for different diseases and other risks, as well as the consequences on readers' risk perception.
Bohlin and Höst [26]	Content coding categories: biotic potential, differential survival, individual variation, origin of variation, inherited variation and change in population. Accompanying visual structures (photographs, illustrations, flowcharts, diagrams, etc.).	7 general newspapers. 221 articles	Evolutionary mechanisms are seldom included in accounts of antibiotic resistance provided by these sources. None of the newspaper articles covered all six categories. A cluster of four concepts regarded as most important for understanding the evolution of resistance development was only included in one news article. Explanations were seldom supported visually and only two accompanying illustrations were found during the analysis.	A large proportion of the Swedish public might never encounter an explanation of antibiotic resistance in evolutionary terms. This could be problematic since increased public awareness and understanding is crucial to counter the issue of bacterial resistance.
Boyce et al. [19]	The articles on MRSA were examined to identify: (i) story leads; (ii) quoted sources; (iii) reported causes of the problem; and (iv) reported solutions.	12 newspapers. 2880 articles	The lead of most stories was not about science and data, but instead about victims or political statements about MRSA. Health professionals were absent from much of the coverage of MRSA. The most common sources were members of the public affected by MRSA, suggesting that the dominant discourse in stories about MRSA is not scientific, but rather a more general and accessible discourse. Cleaners and cleanliness was the leading reported cause and accounted for 102 (35.9%) of all causes discussed. Cleaning was the most reported solution.	Personal narratives and political statements demonstrates the difficulty for scientists or scientific research to have a significant impact on how MRSA is covered. Healthcare workers, experts and professional bodies have criticised the nature of media reporting, but have had little influence or involvement in the press. This may facilitate journalists, celebrities, the public and politicians to drive these stories unchecked and allow politics to address only the simplistic solutions generated.
Chan et al. [28]	Number of occurrences per year for each search term related to the accepted risk factors for MRSA and causes implicated.	All UK national newspapers. 2129 articles	Cleanliness was by far the most common factor alleged as a major cause of MRSA, and it was also the factor least likely to be unmentioned. The events around reporting of a National Audit Office publication in February 2000 appear to be particularly important in defining the cause of MRSA as dirty hospitals.	There is a strong bias in newspaper coverage of MRSA to link this infection with hospital cleanliness. The metaphor of 'the dirty hospital' was derived from, and was a distortion of, official reports from government departments. It had a certain evocative power, with public acceptance, and so became used by journalists, on the one side, and by politicians, government officials and ministers on the other, in a cycle of mutual reinforcement.

Table 3 (Continued)

Authors	Study measures	Sample size	Main outcomes	Main conclusions
Collins et al. [10]	All mentions of 'antibiotics' from the data and systematically assessed the clause construction to identify who and what were discussed in relation to 'antibiotics', as well as the process between them.	19 newspapers. 627 articles	Antibiotics and the infections they are designed to treat are instilled with agency, that there is a tension between allocating responsibility to either doctors-as-prescribers or patients-as-users and collectivisation of the general public as an unspecified 'we': Marginalising livestock farming and pharmaceutical industry responsibilities.	Bacteria, superbugs and infections are positioned as the enemy which needs to be beaten but there appeared to be little focus on solutions or on the tools that might be utilised in the fight against AMR.
Corroy et al. [30]	Discursive positions of media speeches.	3 magazines. 54 articles	The discourse that emerges from the weekly news magazines is a segmented one: they threaten with a war against bacteria which will "soon be lost" while ignoring its victims. In the family and parenting magazines, on the contrary, it is through the figure of the child that the media discourse about antibiotics resistance is embodied.	Even though these magazines endorse the discourse of the health insurance system, they fail to situate this public health issue in a more global perspective.
Crawford et al. [29]	Words commonly found in combination with the key terms, as well as visually searched by two of the researchers independently to code for metaphors where one domain was being explained in terms of another.	All British newspapers. 490 articles.	The study identifies a shifting media narrative that involves changes in dramatis personae over the decade. First, personified forces of nature, doctors and hospitals are engaged in a battle of evil against good, but also intelligence over stupidity. Second, we are presented with victims of personified bacterial forces and doctors and hospitals cast as perpetrators of crimes of omission by not cleaning hands or wards. Third, the malignant forces of politics try to exploit the evil forces of nature for their own ends while a mediator between the doctors and the potential victims of MRSA emerges and is given political and symbolic power: the modern matron.	The value of attending to metaphors in the stories of risk presented in the public sphere where MRSA is important. Rather than merely attenuating or amplifying risk, it is clear that a great deal of work is done in formulating it precisely, through choices of language, metaphor and historically familiar narratives such as those of the matron, Florence Nightingale or the idea of the microbe as a kind of intelligence
Crowson et al. [25]	Quarterly national Medicaid summary drug utilization data and weekly GT search engine data for CD, OF and CS ototopicals.	NA	Medicaid prescription volumes demonstrated sinusoidal seasonality for OF, CS, and CD with annual peaks in July, August, and September. In 2017, OF was forecasted to be the most widely prescribed ototopical, followed by CD. CS was the least prescribed, and volumes were forecasted to decrease 9.0% by 2017 from 2014. GT user search interest demonstrated analogous sinusoidal seasonality and significant correlations with Medicaid data prescriptions for CD, OF and CS.	We found that OF, CD, and CS ototopicals have sinusoidal seasonal variation with Medicaid prescription volume peaks occurring in the summer. After 2012, OF was the most commonly prescribed ototopical, and this trend was forecasted to continue. CS use was forecasted to decrease. Google user search interest in these ototopical agents demonstrated analogous seasonal variation. Analyses of GT for interest in ototopical antibiotics may be useful for health care providers and administrators as a complementary method for assessing healthcare utilization trends.
Dyar et al. [22]	Activity peaks (message frequency over three times that of baseline) were analysed to identify events leading to the increase.	243000 tweets	The greatest activity increases appeared after: (i) the UK CMO's declaration of antimicrobial resistance as a national risk; (ii) the release of the US CDC's report on antimicrobial resistance; and (iii) the US FDA announcement on azithromycin safety concerns (March 2013). The CMO report in March reached an estimated worldwide audience of 20 million users in a single day. However, the frequency of antibiotic Tweets returned to basal levels within 48 h of all four peaks in activity.	Institutional events can rapidly amplify antibiotic discussions on social media, but their short lifespan may hinder their public impact. Multipronged strategies may be required to prolong responses. Developing methods to refine social media monitoring to evaluate the impact and sustainability of societal engagement in the antimicrobial resistance agenda remains essential.
Kahle et al. [32]	What respondents remembered about the media report. Responses were coded against a list of 10 key messages predetermined by the investigators. Questions on HIV testing, current sexual behavior and methamphetamine referred to the 2 weeks before and the 2 weeks after the press release (30 days before the survey). Five-point Likert scales were used to measure intention to engage in these HIV-related behaviors in the next 30 days.	325 respondents	Among 325 participants, 57% heard or saw messages related to the press release. Of these, 87% remembered 1 or more key points, but only 5% remembered key prevention messages. Ninety-eight percent of participants thought it was important for the health department to get the message out about drug-resistant HIV.	The press release was found to be a useful and well-received method to inform the public about an HIV drug-resistant cluster. Low retention and non-prominent coverage of key prevention messages suggests that health departments using press releases as a prevention tool need to carefully consider placement and emphasis of those messages in a press statement.

Table 3 (Continued)

Authors	Study measures	Sample size	Main outcomes	Main conclusions
Mizuno et al. [27]	The total number of extracted articles, the total number of characters contained in the articles, the number of key words, and the trends of the time-lines. Errors in the contents of the articles were checked independently by two expert researchers.	5 newspapers. 188 articles	The trends in the total number of articles and total number of characters contained in the articles were congruent, with a peak on the day after the incident was disclosed and a rapid decrease thereafter. The numbers of articles and characters that appeared during the first 3 days corresponded to 45 and 51% of those that appeared during the entire study period. On day 9, it was published that <i>Serratia liquefaciens</i> propagated on medical instruments, and both the number of articles and the number of characters increased by approximately 40% in comparison to those published on the day after the initial report of the incident. The individual articles were deemed to be medically accurate; however, the main problem was that only part of the specific medical issue had been emphasized because of a poor balance in the number of news reports on this topic.	This study has provided valuable information on the structural reason why news reports on malpractice in newspapers cause discomfort among healthcare professionals. In order to provide accurate and high-quality medical information to the public, the media and the medical community must integrally work together.
Morris et al. [46]	Framing was developed under these categories: diagnostic framing (identification of problem and its cause/ attribution of blame), motivational framing (impetus for action), prognosis framing (presentation of solutions), system failure, maintenance of status quo and voluntary action.	4 newspapers and 1 magazine. 91 articles	A 'system failure' frame is the most frequently occurring and positions intensive livestock production systems as a key contributor to AMR-related crises in human health. A 'maintaining the status quo' frame argues that there is no evidence linking antibiotics in farming to AMR in humans and stresses the necessity of (some) antibiotic use for animal health. A third frame, which is only present in the farming media, highlights a need for voluntary, industry-led action on animal antibiotic use in terms of farmer self-interest.	Common to all frames is that the relationship between agricultural use of antibiotics and problems posed by AMR is mostly discussed in terms of the implications for human health as opposed to both human and animal health.
Pisano et al. [33]	The survey assessed IMR awareness of ASP initiatives, social media usage, and attitudes and beliefs surrounding antibiotic resistance. Over 6 months, IMRs received posts and Tweets of basic antibiotics/infectious diseases trivial while promoting use of educational tools and clinical pathways on the ASP Web site.	55 participants	Of the IMRs, 98% and 58% use Facebook and Twitter, respectively. To compare pre- and postintervention, median scores for antibiotic knowledge increased from 12 (interquartile range, 8–13) to 13 (interquartile range, 11–15; $P=0.048$ ); IMRs knowing how to access the ASP web site increased from 70% to 94%. More IMRs indicated that they used the clinical pathways 'sometimes, frequently, or always' after the intervention (33% vs 61%, $P=0.004$ ).	Social media is a valuable tool to reinforce ASP initiatives while encouraging the use of ASP resources to promote antimicrobial mindfulness.
Scanfeldt et al. [23]	To explore cases of potential misunderstanding or misuse, Twitter status updates were mined for co-occurrence of the following terms: 'cold 1 antibiotic(s)', 'extra 1 antibiotic(s)', 'flu 1 antibiotic(s)', 'leftover 1 antibiotic(s)', and 'share 1 antibiotic(s)' and reviewed to confirm evidence of misuse or misunderstanding.	1000 status updates in twitter	The status updates were categorized into 11 groups: general use (n 5289), advice/information (n 5157), side effects/negative reactions (n 5113), diagnosis (n 5102), resistance (n 592), misunderstanding and/or misuse (n 555), positive reactions (n 548), animals (n 546), other (n 542), wanting/ needing (n 519), and cost (n 58). Cases of misunderstanding or abuse were identified for the following combinations: 'flu 1 antibiotic(s)' (n 5345), 'cold 1 antibiotic(s)' (n 5302), 'leftover 1 antibiotic(s)' (n 523), 'share 1 antibiotic(s)' (n 510), and 'extra 1 antibiotic(s)' (n 57).	Social media sites offer means of health information sharing. Further study is warranted to explore how such networks may provide a venue to identify misuse or misunderstanding of antibiotics, promote positive behaviour change, disseminate valid information, and explore how such tools can be used to gather real-time health data.
Schnellinger et al. [20]	Proper antibiotic use survey to three groups: control, pamphlet and video.	84 participants.	Scores improved significantly in the pamphlet and video groups compared with baseline. The video group's follow-up scores were not significantly different from the postintervention-survey scores ( $P=0.32$ ). The pamphlet-group scores at follow-up were significantly lower than the postintervention-survey scores ( $P=0.002$ ). The control group's scores were similar at all 3 time periods. The pamphlet group had significantly better scores than the control group after the intervention ( $P<0.001$ ). The video-group scores exceeded the control-group scores at all 3 time periods.	An animated video is highly effective for educating parents about the appropriate use of antibiotics in the emergency department setting and results in long-term knowledge retention. The results of this study provide a foundation to further evaluate the use of animated video in additional populations.

Table 3 (Continued)

Authors	Study measures	Sample size	Main outcomes	Main conclusions
Singh et al. [24]	How many articles included the term “evolve” and analyzed how this varied with newspaper, country, and time.	30 newspapers. 1639 articles	An overall rate of 18% of article used the term “evolve” but with significant variation among countries. UK newspapers had the highest rate (24%), more than double of those in India (9%), the country with the lowest rate. These frequencies were lower than those found in scientific papers from both evolutionary journals and biomedical journals. There were no statistically significant changes in frequency and no trends when “evolve” usage was compared against variables such as newspaper circulation, liberal/conservative bias, time, and state evolution acceptance in US newspapers.	This study highlights the globally low usage of the word “evolve” in the popular press. Authors suggest this low usage may affect public understanding and acceptance of evolutionary concepts.
Zucco et al. [35]	The questionnaire included questions on knowledge, attitudes, and behaviour towards antibiotic use, and questions about Internet use to gather information about antibiotics.	913 parents	22.1% did not know when it was appropriate to use antibiotics. 32.3% of parents reported self-medication with antibiotics. 73.4% of respondents used the Internet to search for information about antibiotic use. Among social networks users, 46.5% reported the use of these media to get information about antibiotics and 45% of instant messaging app users share information about antibiotics. The results of the multiple logistic regression analysis showed that Internet use to search for antibiotic-related information was higher among females, younger subjects, with a higher level of education, in those who reported self-medication with antibiotics and in those who needed additional information on side effects of antibiotics from the GP compared with those who did not need any additional information.	Internet and social media are widely used for antibiotic-related information seeking in the Italian population. Health organizations must consider social media within their communication strategy to promote the appropriate Web use for antibiotic-related information seeking in the general population, although more evidence is needed regarding the optimal mix of communication interventions.

Abbreviations: AMR: antimicrobial resistance; ASP: Antimicrobial stewardship program; CD: ciprofloxacin-dexamethasone; CDC: Centers for Disease Control and Prevention; CMO: Chief Medical Officer; CS: Cortisporin; FDA: Food and Drug Administration; GP: General practitioner; GT: Google Trends; IMR: Internal medicine residents; MRSA: Methicillin-resistant *Staphylococcus aureus* infections; OF: ofloxacin; UK: United Kingdom; US: United States.

The majority of themes of the studies focused on antibiotics (47%,  $n=9$ ), antimicrobial resistance in general ( $n=3$ ), and two articles focused on both antibiotics and antimicrobial resistance. Three articles focused specifically on methicillin-resistant staphylococcus aureus infections (MRSA), one article studied nosocomial infections and one multidrug-resistant HIV. Regarding the objectives of the studies, there were three main categories: a) risk message and message framing analysis ( $n=11$ ), b) general content analysis ( $n=3$ ), and c) knowledge and behavioural effects analysis ( $n=5$ ).

**RQ2.** What are the main measures and outcomes of media communication of antibiotics and antimicrobial resistant?

In relation to the measures, they were diverse according to the study objectives. Studies analysing social networks measured mostly corpuses of posts with “antibiotic” and “antimicrobial resistance”. The studies conducting media content analyses measured the characteristics of the media coverage quantitatively such as the frequency of target contents, number of pages, word count, dates of publication, length, etc. In addition, the qualitative variables varied according to the aims of each study. Some common measures were the sources of information, genre, themes, tone, controversies, health outcomes, discourse completeness and use of evidence. The studies using surveys for data collection were mainly focused on message recalls, knowledge, attitude and behaviour towards antibiotic use.

According to the methodology that was followed in each of the studies, they were grouped as: ‘content analysis in social digital networks’; ‘content analysis in the traditional media’; ‘analysis of changes in knowledge, attitude or behaviour’. The main outcomes and conclusions were grouped according to these categories.

### 3.1. Content analysis in social digital networks

Social media was found to be a means of health information sharing about antibiotics and AMR. According to a study [23], Twitter users share misuse or misunderstanding of antibiotics, negative reactions, advice, diagnosis, resistance, positive reactions, among others. Another study [21] found that Twitter and AMR conversations were influenced by news sources, health professionals, and governmental health organisations, as users normally retweet content posted by these sources instead of posting their own. The use of Google Trends user search interest demonstrated significant correlations with data prescriptions for ototopical antibiotics [25]. Another study [22] in Twitter found that institutional events can rapidly amplify antibiotic discussions on social media, but their short lifespan may hinder their public impact as the frequency of antibiotic tweets returned to basal levels within 48 h of all peaks in activity.

### 3.2. Content analysis in the traditional media

In relation to the print press, Bohlin and Höst [5,26] found, in Sweden, that the AMR problem is predominantly described qualitatively, stating that the use of antibiotics and antimicrobial resistance “is a rising problem”. They also found that explanations were rarely supported visually such as with illustrations, and that evolutionary mechanisms were seldom included. Another study [24] showed a similar outcome with regards the poor use of the term “evolve” to describe antibiotics news. Both studies suggested that this poor usage of evolutionary explanations may limit public understanding of AMR and antibiotics. Therefore a large proportion of the public might never encounter an explanation of antibiotic



resistance in evolutionary terms in the media, arguing that this simplistic coverage could be problematic since increased public awareness and understanding is crucial to counter the issue of bacterial resistance. In addition, these studies conducted in Sweden [5,26] found that reporting on antibiotics are only effective against bacteria was only found in less than 5% of the articles about AMR, and less than 1% mentioned the importance of completing a course of antibiotics. This basic coverage is supported by other studies. For example, Collins et al. [10] provided some indications of emerging social representations of AMR in the way that bacteria, superbugs and infections are positioned as the enemy which needs to be beaten. Moreover, there is a tendency in allocating responsibility to external causes, such as to doctors, 'others' who overuse antibiotics and society as a whole, rather than one's own individual action [10]. Likewise, farming and the pharmaceutical industry responsibility are marginalised among these causes [10]. Furthermore, a study [19] revealed that health professionals and scientific data are absent from the media coverage of MRSA, being the most common source members of the public affected by MRSA, political statements and institutional events. A similar finding was found in other study [22], which revealed that institutional sources amplify antibiotic discussions. However, media coverage on AMR was mostly related to these events, with a peak on the day after an incident was disclosed and a rapid decrease thereafter in the media coverage [27]. Moreover, due to poor number of institutional reports, only part of the specific medical issue was emphasised. Cleaners and cleanliness were the leading reported cause and cleaning was the most reported solution by many studies [19,28,29] using the metaphor of "the dirty hospital". Prescribing antibiotics unnecessarily was also reported as a main cause [5]. Another study [10] found tensions allocating responsibility to either doctors-as-prescribers or patients-as-users, rarely to farming and the pharmaceutical industry. A study [30] found alarming messages addressing magazines' readers, discourse such as the war against bacteria will "soon be lost". The only study on television [31] which analysed series episodes found that the issue of AMR is dramatised, but discourses are highly diverse and scattered. Although these do not quite correspond to reality, they foster public awareness of the issue and develop a better understanding of the issue. Mobilising messages, solutions and measures that individuals can employ were poorly reported in the media.

### 3.3. Analysis of changes in knowledge, attitude or behaviour

A survey [32] about what respondents recalled about a press release on HIV multi-drug resistance showed that only 5% remembered key prevention messages although 57% of respondents had heard or saw messages related to the press release. Another study [33] that addressed how social media is a valuable tool to reinforce awareness among medical residents, showed more knowledge about antibiotics and more engagement in promoting antimicrobial mindfulness. A comparative study [34] between the effects of a pamphlet and a video to educate about the appropriate use of antibiotics showed that an animated video is highly effective for educating parents and the appropriate use of antibiotics and results in long-term knowledge retention. Another study [35] conducted a survey among 913 parents reported that 73% widely used the Internet and social media for antibiotic-related information seeking, 22% of parents did not know when it was appropriate to use antibiotics, and 32% reported self-medication with antibiotics.

## 4. Discussion and conclusion

### 4.1. Discussion

The present systematic review provides an overview of the research on communication about antibiotics and AMR. The

objective of this review was to identify the most recent reporting on the use of communication on antibiotics and AMR to determine key characteristics, effectiveness and identify gaps and opportunities for further research. Despite the observed methodological heterogeneity and variation in the analyses, there was an agreement among studies regarding the importance of communication as a key driving force to combat AMR. To our knowledge, this is the first systematic review of media communication analyses on AMR and antibiotics, composed of 19 studies published during the last 10 years (since 2008) covering any type of media source and from any geographical region. This review has revealed that research on communication of antibiotics and AMR is limited into English language media and newspaper coverage. Available data show that media can help public awareness about the appropriate use of antibiotics and that digital media are important for increasing visibility in the short term. In addition, media should provide more mobilising messages, background information as well as more scientific sources.

Some key insights emerged from this review. First, we identified that the studies tackled a broad array of method analyses, with most studies originating from English speaking countries, mainly from Europe or North America, with no studies located in South America or Africa. This finding supports a previous study [36] analysing authorship nationalities in the journal 'Health Communication' revealing that for 90.5% of studies, the first authors were from the US. In other regions of the world, such as in Spanish-speaking countries, the research field of Health Communication is now growing with significant development over the last decade [37,38]. Therefore, we expect there to be more diversity in terms of the countries whose media are analysed over the coming years. Another relevant point was that only one country, India, that is actually not classified as high-income economy according to the World Bank [39], has been analysed. For that reason, another research gap in the field is the lack of studies in countries with middle or low-income economies. The poor health-status that prevails in most of these countries could have considered AMR as a secondary problem [40]. However, AMR is one of the biggest challenges facing global public health as there are no borders for resistant microbial strains. For that reason, our findings suggest future research towards the differential role of media communication in informing the population in different geographical regions of the world as well as with a variety of cultural and economic conditions.

Regarding the methodological approach of the selected studies, this systematic review showed a preference for conducting media coverage analyses in print media, including both newspapers and magazines. Grouping these two media sources into one category might be too general, nonetheless, they were grouped for the purposes of synthesising this review, and because both types of media share the same format of 'print press', and are considered 'quality press'. This term has been previously defined referring to media with national distribution, never regionally, and which provide broad and in-depth news coverage, contextualising the information through proper background [41]. Surprisingly, although the 'quality press' is the most analysed media among the selected studies, an issue that has been highlighted is that the topic of antibiotic resistance is mostly covered superficially. For example, 'reporting on antibiotics are only effective against bacteria' was only found in less than 5% of the articles about AMR, and less than 1% mentioned 'the importance of completing a course of antibiotics'. In addition, there appeared to be little focus on solutions or on the tools that might be utilised in the fight against AMR. According to the literature, adopting a style labelled 'solutions journalism' or 'constructive journalism', an increasing popular journalistic approach, may improve readers' engagement towards the problem than when no solution was mentioned [42].

Another issue that has been highlighted is that newspapers were the media type that was most analysed by the studies. Newspapers have a significant influence on readers' behaviours concerning health risks [5]. However, a changing media landscape had given people increased access to online information. In this regard, our review identified that approximately one third of the articles analysing AMR related publications were in social networks or websites. Although these analyses represent a broad array of different media, other media communication formats should be considered in future studies such as radio, movies and television, which was only analysed in one study. These other media formats are also relevant in society, for example, US adults spend 12 h a day consuming media, of which, print media represents only 25 min, TV represents 4 h, and radio represents almost 1.5 h [43]. The only study [31] analysing TV revealed that TV series can be used to support the work of health promoters willing to enhance communication and education on antimicrobial resistance.

Another relevant issue in relation to the poor AMR media coverage is that healthcare workers, experts and professional bodies are not frequently used as sources which allows journalists, celebrities, the public and politicians to present AMR stories unchecked, addressing only basic assumptions [10]. In this regard, some studies found that there is a strong bias in newspaper coverage of MRSA to link this infection with hospital cleanliness [19,28,29] by using the metaphor of "the dirty hospital", which has been largely used as a distortion of official reports from government departments. This shows that there is an apparent disconnection among science, knowledge and patients which demands greater public understanding of AMR. The media is an important starting point for understanding the nature and structure of representations of AMR [10] and avoiding distorted descriptions of the issue is then needed.

Regarding the use of Internet and social networks, they play an important role in antibiotic-related information seeking, health information sharing, promoting positive behaviour change, disseminating valid information, and exploring how such tools can be used to gather real-time health data [23,35]. In this regard, Google searches has shown to be useful for healthcare providers and organisations [25]. In fact, Google Trends have been previously used by epidemiologists and healthcare policy makers in other settings, such as in seasonal influenza outbreaks [44], showing how Internet user behaviour can be used as an early warning system. In relation to social networks, when Twitter is used by an institution or expert organisation, the studies showed that social media is a valuable tool to reinforce initiatives to promote antimicrobial mindfulness [33]. Nonetheless, the studies revealed how social networks lead to high visibility in the short term but their short lifespan may hinder their public impact. In addition to this short lifespan, another issue that has been identified is the low and short term retention of AMR messages. So, social networks should be accompanied by other communication formats such as an animated video in order to improve message retention, although this should be validated in further experiments regarding the optimal mix of communication interventions.

Finally, as some studies have suggested [11,15,27], in order to provide accurate and high-quality medical information to the public, the media and the public health community must work together, developing a close collaboration to improve public communication. For example, it was already mentioned that healthcare professionals and scientific experts are poorly used as sources which can lead to a simplistic coverage on AMR [10]. With this in mind, we do not suggest that journalists should become public health practitioners aiming to engage individuals to use antibiotics properly, but rather, the media should serve as a source through which people become conscious of a concern, solutions to

address it, and possibly be motivated to take action. To achieve this, the present review provides a basis and might be of interest to those in the public health field as well as researchers and policy makers who are trying to communicate their messages about AMR or antibiotics to the public.

#### 4.2. Limitations

Although our review followed systematic review methods, some limitations need to be noted and any interpretation of the results must take into account these study restrictions. This review outcome does not cover all media. Among the media that were analysed, our review found a dominance of the print press, with only one study analysing television, none in radio, movies or other media types. Therefore, the results of the current review are predominantly based on newspapers. We are concerned that media consumption today is not the same as before when people waited for their morning papers, more and more readers, viewers, and listeners are going online for their news. Nevertheless, print news reporting continues to serve as the original source for much of what is reported later in other media, influencing a wider audience than just newspaper readers [45]. Despite these limitations, to our knowledge, this is the first systematic review to date that analyses media coverage on AMR and antibiotics. Given the increasing number of scientific articles during the last decade on public communication on AMR and antibiotics, and in view of the increasing public health challenge of antimicrobials, our study may provide a comprehensive synthesis for decision-making.

#### 4.3. Conclusions and practice implications

Regardless of the methodological heterogeneity of the reviewed studies, there was an agreement about the important role of media communication in public awareness on antibiotics in society. Considering the increasing public health challenge on AMR, more studies are needed to fill current research gaps. Based on the findings from this review, the following are possible topics for further research:

- a) Investigate AMR and antibiotics coverage in media of other geographical regions, specially in middle- and low-income countries as the present study showed that the majority of the studies have been conducted in English speaking and high-income countries.
- b) Analyse the public communication of AMR and antibiotics in a variety of media, such as radio, movies and television as most studies have only analysed newspapers and Twitter, thus there is a lack of information regarding what and how communication in other media is conducted.
- c) Analysis of the effects of public communication about AMR and antibiotics through the media is needed to further explore change of knowledge, attitudes and behaviour of the population. The majority of existing studies of media communication in AMR or antibiotics conducted content analyses only, thus we can only speculate on the characteristics of the messages covered and the information quality, but we cannot claim that the patterns have actually shaped public views or behaviours in relation to AMR or antibiotics.

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### Conflicts of interest

The authors declare that there are no conflicts of interest.

### Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.pec.2019.03.020>.

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