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A Content Analysis of Antibiotic use in Livestock in National U.S. Newspapers

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Abstract

The discovery of the antibiotic Aureomycin as a growth promotor for the livestock industry was viewed as revolutionary in 1950. The use of antibiotics as growth promoters in livestock, however, has been questioned by health professionals concerned with the role this use might play in the development of antibiotic resistant bacteria. As a public health issue, newspapers have covered this topic since its discovery. Media, such as newspapers, have used frames to discuss the topic over time as new discoveries have occurred, policy changes have been implemented, and food animal production has changed. The purpose of this study was to determine the frames and sources used by national U.S. newspapers when discussing the topic of antibiotic use in livestock and antibiotic resistance. A quantitative content analysis was conducted on three national U.S. newspapers from 1996 – 2017 and found three primary frames were used when discussing antibiotic use in livestock and antibiotic resistance. The content analysis also indicated that over 90% of the news articles contained a scientific source when communicating about this scientific topic. Based on the frames identified some readers are being ill-informed about this topic and could be using this information in their decision making without having all of the facts. Science communicators should prioritize the inclusion of scientific sources in their writing as they communicate about complex, controversial topics.

Keywords

Content Analysis, Livestock, Antibiotic, Newspaper, Framing

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Introduction

"'Wonder Drug' Aureomycin Found to Spur Growth 50%" was the headline that appeared in *The New York Times* in April 1950 after the discovery that the antibiotic could increase growth in livestock when added to animal feed (McKenna, 2017). Antibiotics were found to play a role in promoting growth in livestock by increasing the animal's ability to put on more lean muscle without the need for additional feedstuffs (McKenna, 2017). Announced at the annual meeting of the American Chemical Society, the use of aureomycin as a growth promotor for livestock was viewed as a game-changer for livestock producers. The article in *The New York Times* read: "The discovery of the new role for aureomycin, described in the announcement as 'spectacular,' is believed to 'hold enormous long-range significance for the survival of the human race in a world of dwindling resources and expanding populations,'" (McKenna, 2017, p. 43).

Although the discovery that antibiotics could be used to increase the growth of livestock without additional feed was an exciting and revolutionary discovery, it raised several questions and concerns among public health professionals regarding the impact of continued use of these antibiotics and the future effectiveness of such antibiotics in human medicine (McKenna, 2017). Because of this discovery in 1950, public health researchers began studying outbreaks of antibiotic resistant bacteria and any linkage of these outbreaks to the use of antibiotics at sub-therapeutic levels for growth promotion in livestock (McKenna, 2017). As bacterial resistance to antibiotics increases, the effectiveness of antibiotics to treat life-threatening illnesses can be hindered (McEachran, et al., 2015). Both misuse and overuse of antibiotics play a critical role in the development of antibiotic resistant bacteria (McEachran, et al., 2015).

In 1971, an antibiotic resistant salmonella outbreak spurred legislative action that banned the use of antibiotics for growth promotion in the United Kingdom, making it the first country in the world to implement this type of ban (McKenna, 2017). Although the United States made no legislative action at this time, continued research regarding the role of antibiotic use in livestock and the development of antibiotic resistant bacteria continued as cases popped up across the country (McKenna, 2017). Today, this research continues as human and animal health researchers discover new manners in which antibiotic resistance can proliferate (McEchran et al., 2015).

In April 1977, Donald Kennedy, the new commissioner of the FDA, proposed a ban of growth promoting antibiotics in animal agriculture (McKenna, 2017). This ban would include the use of penicillin and tetracyclines, both antibiotics considered medically important in human medicine, and would further ban the use of antibiotics for disease prevention once researchers identified compounds livestock producers could use instead (McKenna, 2017).

Kennedy's plan was met with harsh criticism and was blocked by the chair of the House Appropriations Subcommittee on Agriculture and Rural Development (McKenna, 2017). The chair threatened to hold the budget hostage from the FDA if Kennedy proceeded with the legislation (McKenna, 2017). By putting the legislation on hold, the subcommittee allotted extra funding to complete more research regarding the impact of antibiotic use in livestock for both growth promotion and disease prevention. This funding allowed the National Academy of Sciences to study the public health impact of growth promotors in livestock (McKenna, 2017). In the absence of legislation, campaigns that encourage the prudent use of antibiotics have been developed in the United States and abroad to help combat the development of antibiotic resistant bacteria (Landers, Cohen, Wittum, & Larson, 2012).

Since 1977, public health researchers, animal scientists, agricultural economists, and others have studied the impact of antibiotics as growth promotors (McKenna, 2017). On October 9, 1996, President Clinton signed the Animal Drug Availability Act (ADAA), which regulated new animal drugs and medicated feeds (FDA, 2016). The intention of the law was to increase the number of approved new drugs on the market for animal use and was supported by the FDA's Center for Veterinary Medicine as well as several animal industry groups, veterinarians, livestock producers, and manufacturers of animal health products (FDA, 2016). The idea behind the passing of this legislation was to benefit the nation's animals and the animal health industry without compromising public health (FDA, 2016).

The next major U.S. step in public health protection came in June 2016 with the passing of the Veterinary Feed Directive (VFD) (FDA, 2016). One component of this legislation was a new category of drugs called "Veterinary Feed Directive Drugs" (FDA, 2016). These drugs are intended for use in animal feeds but are only permitted for use under the professional supervision of a licensed veterinarian and are not labeled for the use of growth promotion (FDA, 2017a).

The primary purpose of this research was to identify how print media, specifically newspapers, have framed the topic from the signing of the ADAA in 1996 to the passing of the final rule of the VFD and to better understand the use of scientific sources in reporting the issue.

Review of Literature

Previous research has examined media coverage of controversial topics related to agriculture and natural resources. Holliman (2002) found communicators play a key role in increasing dialogue between scientists and society with the goal of reducing perceived tension. Marques, Critchley, and Walshe (2015) found as media coverage of genetically modified organisms (GMOs) increased over time, public support for GMOs decreased among Australians.

Framing

Although limited, previous research of media coverage regarding antibiotic use and antibiotic resistance in livestock has found national newspapers in the U.K. had contradictory and opposing frames (Morris, Helliwell, & Raman, 2016). Frames are the manner in which information is presented to an audience and influences the choices people make about how they process that information (Entman, 1993). Through a qualitative content analysis, Morris et al. (2016) found a disagreement between four national newspapers from 1998 to 2014 regarding how antibiotic use and antimicrobial resistance was framed. In their study, three major frames were identified. The first frame was the "system failure" frame. This frame indicated that "antibiotic use in farming was diagnosed as a significant factor that contributes to and exacerbates problems with antimicrobial resistance," (Morris et al., 2016, p. 47). The second frame was the "maintain the status quo" frame. This frame indicted that "most media is riddled with misconceptions, misinformation, or based on inconclusive science about the contribution of intensive agriculture to the problem of antimicrobial resistance," (Morris et al., 2016, p. 49). The final frame was the "voluntary action" frame. "This frame does not directly contest the "system failure" frame, but instead presents an alternative interpretation of the issue. It illuminates alternative solutions and motivations regarding how to deal with antibiotic resistance" (Morris et al., 2016, p. 50).

Although the frames Morris et al. (2016) identified serve as a foundational understanding about how antibiotics are discussed in newspapers, scholars have identified threats to reliability and validity this type of frame analysis (Matthes & Kohring, 2008). In a quantitative content analysis of the framing of biotechnology in *The New York Times*, Matthes and Kohring (2008)

used hierarchical cluster analysis of frame elements to derive the frames of the stories rather than determining frames *a priori* or as they emerged through qualitative content analysis. This method combined the advantages of manual coding with the advantages found in computerized analysis (Matthes & Kohring, 2008). Matthes and Kohring found that over time, frames discussing biotechnology changed from three frames between 1992–1996 to six frames from 1997–2001. The "Agri-Food" frame did not occur until the analysis of articles from 1997–2001 (Matthes & Kohring, 2008). This frame was controversial in that it primarily discussed the advantages and disadvantages of using biotechnology in food production.

Computer assisted content analysis is an additional manner in which newspapers have been analyzed to understand the frames newspapers use to discuss biotechnology related to food production. Crawley (2007) analyzed the framing of agricultural biotechnology among community newspapers in two regions of the United States using computer assisted content analysis. Findings indicated subtle, yet unique differences between the way local newspapers frame information regarding agricultural biotechnology in northern California and Missouri (Crawley, 2007). Newspapers in Missouri framed the topic in terms of the economic importance to the state of Missouri. Northern California newspapers also framed the topic in terms of the economic importance to the region while also framing the topic in terms of the controversial nature of the topic for the region (Crawley, 2007). These findings indicate the same topic can be framed differently based on priorities and regional dependency (Crawley, 2007).

Sources

When covering scientific issues, journalists use experts for background information and clarification (Conrad, 1999). In a study of source expertise in newspapers, researchers and scientists were the dominant experts quoted in articles related to scientific topics (Conrad, 1999). The presentation of scientific news can influence the reader's understanding of the science and the media plays an important part in setting how the science is communicated to the public. The use of quotes can add an important balance to how the topic is reported and can introduce neglected viewpoints into the public discourse (Conrad, 1999).

The way a journalist understands and views a topic is ultimately how the topic will be presented to the public in writing. Thus, analyzing traditional print media regarding the topic of antibiotic use in livestock through methods such as content analysis can lead to a better understanding of how this scientific information is communicated to the public (Conrad, 1999; Reisner & Walter, 1994; Marks, Kalaitzandonakes, Wilkins, & Zakharova, 2007).

Theoretical Framework

Framing served as the theoretical lens for this study. Entman (1993) explained framing as the selection of some aspects of perceived reality and making them more salient in a communication text. By doing this, the writer encourages a specific way of defining a problem, causal interpretation of the problem, moral evaluation, and/or recommendation for how to treat the problem (Entman, 1993). Framing has been used in several disciplines and recently has been used in analyzing agriculture and food policy issues particularly as these issues relate to food security (Mooney and Hunt, 2009; Kirwan and Maye, 2013). Some evidence has shown news media are more ambivalent about agricultural biotechnology and more positive toward reporting medical applications of technology (Marks et al., 2007). Thus, public attitudes regarding agricultural and medical biotechnology generally mirrors the stance of news media (Marks et. al., 2007).

Frame analysis allows researchers to better understand how an issue is communicated in the media, thus resulting in a better understanding as to how the public might view the issue (Scheufele & Tewksbury, 2007). Since it was introduced in the 1970s, framing has been found useful in aiding in the better understanding of factors that influence both online and traditional media coverage (Entman, 1993; Goffman, 1974). Framing theory proposes that media play a central role in establishing certain public issues as more salient than others in addition to providing a particular angle to describe the events in the story (Entman, 1993, 2004).

The way a story is framed highlights selected pieces of important information within the story through inclusion of particular text or frame elements and claims, their placement, and recurrence (Entman, 1993). Some scholars have identified issues regarding reliability and validity of the content analysis of media frames (Gandy, 2001; Scheufele, 1999). These issues center on the idea that a frame is a more abstract variable that can be challenging to identify and difficult to code in content analysis (Van Gorp, 2005). Thus, Matthes and Kohring (2008) offered an alternative measurement procedure in which the content analysis of media frames can be determined. This measurement is based on the idea that frames are clusters of frame elements (Matthes & Kohring, 2008; Miller, Andsager, & Riechert, 1998). These frame elements are not necessarily specific words, but rather previously defined components of a message (Matthes & Kohring, 2008). Thus, a frame is made up of specific elements of the message that when combined together make up the frame (Matthes & Kohring, 2008). Instead of directly coding entire frames, the more manifest frame elements are coded and the frames are determined though cluster analysis of the frame elements with the most closely clustered frame elements making up the frame (Kohring & Matthes, 2002; Matthes & Kohring, 2008).

In a public opinion study regarding nuclear power, Gamson and Modigliani (1989) found facts alone have little to no intrinsic meaning, but rather become meaningful once they are embedded within the frame or the story line. Additionally, previous research has indicated that with regard to genetically modified (GM) food, even subtle manipulations of the information, done by the framing of the statement, can change consumer's willingness to accept GM food (Heiman & Zilberman, 2011). In the case of antibiotic use and antibiotic resistance in livestock, the media can choose to focus on the dangers of overusing, misusing, and sub-therapeutic use of antibiotics for growth promotion as opposed to the animal health and welfare benefits associated with antibiotics.

Purpose and Research Questions

From the 1996 passing of the Animal Drug Availability Act to the June 2015 final rule of the Veterinary Feed Directive (VFD), little research has indicated how scientific information regarding the topic of antibiotic use in livestock has been disseminated to the public through mass media and what role this has played in shifting public opinion. Thus, the following research questions (RQ) were proposed:

RQ1: What scientific sources were used by national U.S. newspapers to discuss antibiotic use and resistance in livestock from 1996–2017?

RQ2: What frame elements were present regarding antibiotic use and resistance in livestock in national U.S. newspapers?

RQ3: How did national U.S. newspapers frame articles related to antibiotic use and resistance in livestock?

Methods

When identifying media frames, it is essential to understand and describe the content as well as the message (McQuail, 2000), thus this study followed the concepts established for analyzing and identifying frames in news stories using quantitative content analysis. One of the great strengths of quantitative content analysis is the ability to quantify meaning of text, discover terminology, and determine the frequency of occurrences (Riffe, Lacy, & Fico, 2014).

Passed in 1996, the Animal Drug Availability Act limited and dictated how and when drugs were to be used in animals including livestock. Thus, 1996 was chosen as the starting year for the content analysis of news media's coverage of the use of antibiotics and antibiotic resistance in livestock. The last year of the analysis was 2017. Published in June 2015, the final rule of the Veterinary Feed Directive (VFD) was put into place. This rule required the use of antibiotics approved for both humans and animals to be discontinued for the use of growth promotion. This final rule officially went into effect in January 2017 (FDA, 2017b). News coverage regarding the implementation of the VFD was collected through eight months of this implementation until August 31, 2017. This study used quantitative content analysis, as it sought to explain the interplay of framing that occurred from 1996–2017 by measuring frequency of frame elements in text.

Study Units

The study employed a census in conducting the content analysis. It examined the framing of the use of antibiotics and antibiotic resistance in livestock from 1996-2017 as reported in three national U.S. newspapers. A 2017 Pew Research Center study found television, online, radio, and print newspapers were the top four methods Americans used to get their news (Bialik & Matsa, 2017). Although print newspapers ranked fourth, there is an increasing use of major newspaper websites with the news on such websites is essentially the same as that in the print newspaper (Lacey, Riffe, & Varaouhakis, 2007). Further, several studies have indicated that newspapers remain an important source for setting inter-media agendas thus playing a strong role in placing topics on the public's agenda (Lee, 2004; Reese & Danielian, 1989).

Following the suggestions of Johnson, Stamm, Lisosky, and James (1995) and Riffe et. al. (2014), the following national newspapers (print and online) were chosen for analysis: *New York Times, Washington Post,* and *USA Today*. News, feature, opinion, and editorial stories regarding antibiotic use and resistance in livestock reported in the *New York Times, Washington Post,* and *USA Today* were collected from the Lexis Nexis database. Search terms used were: "antibiotic," "resistant," "resistance," "livestock," and "food animals." Stories returned from the Lexis Nexis database search were included for subsequent analysis if they primarily discussed the use of antibiotics in livestock or the development of antibiotic resistance through the use of antibiotics in livestock. A total of 270 newspaper articles were collected and analyzed using a researcher-developed codebook (Appendix C). Of the 270 articles collected and analyzed, 99 were identified as being opinion/editorial pieces. The *New York Times* produced 135 articles, the *Washington Post* produced 100 articles, and *USA Today* produced 35 articles for analysis.

Units of Analysis

The unit of analysis was the newspaper story. Following the methods of Trumbo (1996), story-level analysis was chosen for this study as a story can be more clearly defined than an individual paragraph. Variables measured in this study were the following:

Title: The title of each news article was recorded.

News Source: The news outlet that produced the piece was recorded (*New York Times*, *Washington Post,* or *USA Today*).

Date of News Story: The year the news story was originally published was recorded.

Frame Elements: Frame elements were determined via a pilot study of newspaper articles from the *Chicago Tribune* and *Los Angeles Times* and a review of technical reports of information regarding the use of antibiotics in livestock and antibiotic resistance from the Food and Drug Administration. These frame elements are used to describe antibiotic resistance issues and support the frame of the story. Frame elements are not words, but rather previously determined components of the frames (Matthes & Kohring, 2008). A cluster analysis of the frame elements should reveal the frames used based on the frame elements that most commonly occur together (Matthes & Kohring, 2008).

Defines Antibiotics: The article defined what an antibiotic is.

Defines Antibiotic Resistance: The article defined what antibiotic resistance is.
References the VFD: The article referenced the Veterinary Feed Directive.

References the 80% FDA Figure: Coders determined if the article referenced the flawed figure that states 80% of all antibiotics used in the United States are used in livestock. The FDA stated the figure is flawed and should not be used for direct comparison between use in humans and animals (FDA, 2017c). This frame element was coded as present if the figure was reported as true.

Medically Important Antibiotics: The article discussed that some antibiotics are medically important in human medicine.

Human Misuse: The article discussed the contribution of human misuse of antibiotics to the development of antibiotic resistance.

Sickness: The article mentioned an instance where an individual became sick with an antibiotic resistant bacterial infection.

Antibiotic Residue: The article mentioned an instance of antibiotic residue being found in meat or milk.

Withdrawal Periods: The article mentioned the use of withdrawal periods (the amount of time between when an animal is administered an antibiotic and when it is harvested) to prevent the contamination of meat and milk with antibiotic residue.

Growth Promotion: Coders determined if the article mentioned the use of antibiotics for growth promotion.

Animal Welfare: The article discussed the use of antibiotics to combat poor animal welfare practices on farms and ranches.

Threat to Human Health: The article mentioned that the use of antibiotics in livestock was a threat to human health.

Policy Change: The article mentioned an institutional or governmental policy change.

Scientific Source: Coders used the attribution of direct quotes from scientific sources to determine the presence of scientific sources. Scientists were identified as reputable sources regarding this topic as their knowledge and experiences with the topic should be rooted in training and experience. Additionally, previous literature (Conrad, 1999) has indicated that researchers and scientists were the dominant experts quoted in traditional print media. If no scientific sources were used in the development of the article, the article was coded as having no scientific source. Opinion/editorial pieces traditionally do not contain sources and were therefore coded as not having a source (Fink, 2004).

University Scientist: Professors or researchers affiliated with a college or university
Industry Scientist: Researchers or scientists who work for a private company or corporation (e.g. pharmaceutical company scientist)

Governmental Scientist: Researchers or scientists who work for or represent a governmental body such as the FDA or United States Department of Agriculture (USDA)

Human or Animal Medical Doctor: Individuals who hold a doctor of medicine or doctor of veterinary medicine

Other Scientist: Researchers or scientists who do not fall into one of the other categories. Direct quotes from research documents (e.g. journal article) were included in this category if the author's scientific credentials were not provided.

Reliability

Reliability in content analysis is defined as an agreement regarding how content is categorized among the coders (Riffe, et al., 2014). Coder training took place on November 14, 2017, using articles from outside the time period under investigation in this study. As Wimmer and Dominick (2003) suggested, a content analysis of 10% (n = 27) of the total content was analyzed in order to determine intercoder reliability. These stories were retrieved from the Lexis Nexis database if they primarily discussed the use of antibiotics in livestock and the development of antibiotic resistance in livestock. Each story was then given an identifying number. Krippendorff's alpha was chosen as the appropriate measurement to determine intercoder reliability. Krippendorff's alpha should be used with multiple coders and the samples size is small (Riffe et al., 2014). The acceptable level of reliability with using Krippendorff's alpha is generally about .8, but alphas as low as .667 have been reported (Riffe et al., 2014). After unsuccessfully reaching an acceptable level of intercoder reliability in the first effort to establish intercoder reliability, a second round of coder training was conducted with an additional 10% of the articles.

At this point, acceptable levels of intercoder reliability were attained. Krippendorff's alpha levels for each frame element and source ranged from .72 to 1.0.

Validity

Because this study is a content analysis, validity is a main concern. Face validity is important to address because by assuring face validity of the coding scheme, the researcher can ensure the concepts being measured make sense on its face (Riffe, et al., 2014). To address face validity, the frame elements and source categories in the study were developed from Food and Drug Administration technical reports and a pilot study of articles from the *Chicago Tribune* and the *Los Angeles Times*.

Data Analysis

To answer the research questions, descriptive statistics were calculated. Additionally, guided by Matthes and Kohring (2008), a hierarchical cluster analysis using the Ward Method was used to determine the frames based on the pre-determined frame elements. Every frame element was computed as a binary variable. If the frame element was found in the article, the variable was coded as 1 (*yes*); if it was not present, it was coded as 0 (*no*).

Results

RQ1: What scientific sources were used by national U.S. newspapers to discuss antibiotic use and resistance in livestock from 1996-2017?

Scientific sources were used in 156 (57.8%) of the articles analyzed from 1996-2017; 114 (42.2%) articles did not contain any direct scientific source in reporting or discussing information regarding the use of antibiotics in livestock and the development of antibiotic resistance. However, of the 114 articles that did not contain a scientific source, 99 (86.8%) of the articles were opinion/editorial pieces, which as noted earlier were automatically coded as having no source (Fink, 2004). Thus, 156 (91.8%) of the 171 non-op-ed articles were found to contain a scientific source. Of the non-op-ed articles from *The New York Times*, 91.2% contained a scientific source, 89.7% of non-op-ed articles from the *Washington Post* contained a scientific source, and 95.8% of non-op-ed articles from *USA Today* contained a scientific source. Table 1 outlines the total number of op-ed and non-op-ed articles by newspaper and the use of scientific sources in each.

Table 1
Frequencies and Percentages of Op-Ed and Non-Op-Ed Articles and use of Scientific Sources

Newspaper	Op-Ed	Non-Op-Ed	Use of Scientific Sources
New York Times	56	79	73 (91.2%)
Washington Post	32	68	61 (89.7%)
USA Today	11	24	23 (95.8%)

Governmental scientists were a source in 43.3% (n = 74) of non-op-ed articles, human or animal medical doctors in 30.4% (n = 52), university scientists in 29.8% (n = 51), industry scientists in 20.5% (n = 35), and other scientists in 13.5% of non-op-ed articles (n = 23). Direct quotes from scientific journals primarily made up the greatest percentage of other scientists but were coded as other due to the inability to determine the type of scientists who conducted and

reported the findings. Frequencies and percentages for each scientific source are outlined in Table 2.

Table 2
Frequencies and Percentages of Scientific Sources in National U.S. Newspaper Articles Regarding the Use of Antibiotics in Livestock and Antibiotic Resistance (N = 156)

Scientific Source	Total	%
Governmental Scientist	74	27.4
Human or Animal Medical Doctor	52	19.3
University Scientist	51	18.9
Industry Scientist	35	13
Other Scientist	23	8.5

Note: The total does not equal 100% as multiple sources could be cited in each story.

RQ2: What frame elements were present regarding antibiotic use and resistance in livestock in national U.S. newspapers?

Thirteen frame elements were identified *a priori* and were coded in each of the 270 articles. The only two (0.7%) articles defined antibiotics, a reference to the VFD was found in three (1.1%), a report of antibiotic residue in meat or milk was found in three (1.1%), and a reference to the use of withdrawal periods to prevent antibiotic residue in meat and milk was found in six (2.2%) of articles. Because each of these frame elements were found in less than 5% of the articles, based on the recommendations of Matthes and Kohring (2008) they were excluded from the cluster analysis. The remaining frame elements were included in the cluster analysis.

Frame elements included in the cluster analysis were describing antibiotic use in livestock as a threat to human health in 74.8% (n = 202); referencing antibiotic use for growth promotion in 54.1% (n = 146); referencing a policy change in 44.8% (n = 121); a reference of sickness from antibiotic resistant bacteria in 33.7% (n = 91); referencing human misuse in 29.6% (n = 80); referencing antibiotic use to combat poor animal welfare in 27.4% (n = 74); referencing the 80% FDA figure in 24.1% (n = 65); referencing medically important antibiotics in 15.2% (n = 41); and the defining of antibiotic resistance in 13.3% (n = 36) of articles. Although instances of referencing withdrawal periods, the VFD, antibiotic residue, and defining antibiotics were found, those frame elements were omitted from the cluster analysis as their frequencies was too low (Matthes & Kohring, 2008). Frequencies and percentages for the occurrence of all frame elements found in the articles are outlined in Table 3.

Table 3
Frequencies and Percentages of Frame Elements in National U.S. Newspaper Articles Regarding the Use of Antibiotics in Livestock and Antibiotic Resistance (N = 270)

Frame Element	Total	%
Threat to Human Health	202	75.80
Growth Promotion	146	54.10
Policy Change	121	44.80
Sickness	91	33.70
Human Misuse	80	29.60
Animal Welfare	74	27.40

References the 80% FDA Figure	65	24.10
Medically Important Antibiotics	41	15.20
Defines Antibiotic Resistance	36	13.30
Withdrawal Periods	6	2.20
References the VFD	3	1.10
Antibiotic Residue	3	1.10
Defines Antibiotics	2	0.70

Note: The total does not equal 100% as multiple frame elements could be used in each story.

RQ3: How did national U.S. newspapers frame articles related to antibiotic use and resistance in livestock?

In order to answer RQ3, a hierarchical cluster analysis using the Ward method was performed to determine the frames national U.S. newspapers used based on the co-occurrence of the frame elements. The Ward method is a good technique for determining cluster solutions for binary variables (Matthes & Kohring, 2008). The cluster analysis revealed three frames. The dendogram in Figure 1 is a visual representation as to how the frame elements were linked by distance using the hierarchical cluster analysis. In a dendogram, distance between clusters is measured on a scale of 0 to 25, with shorter distances indicating a closer linkage (Norusis, 2011).

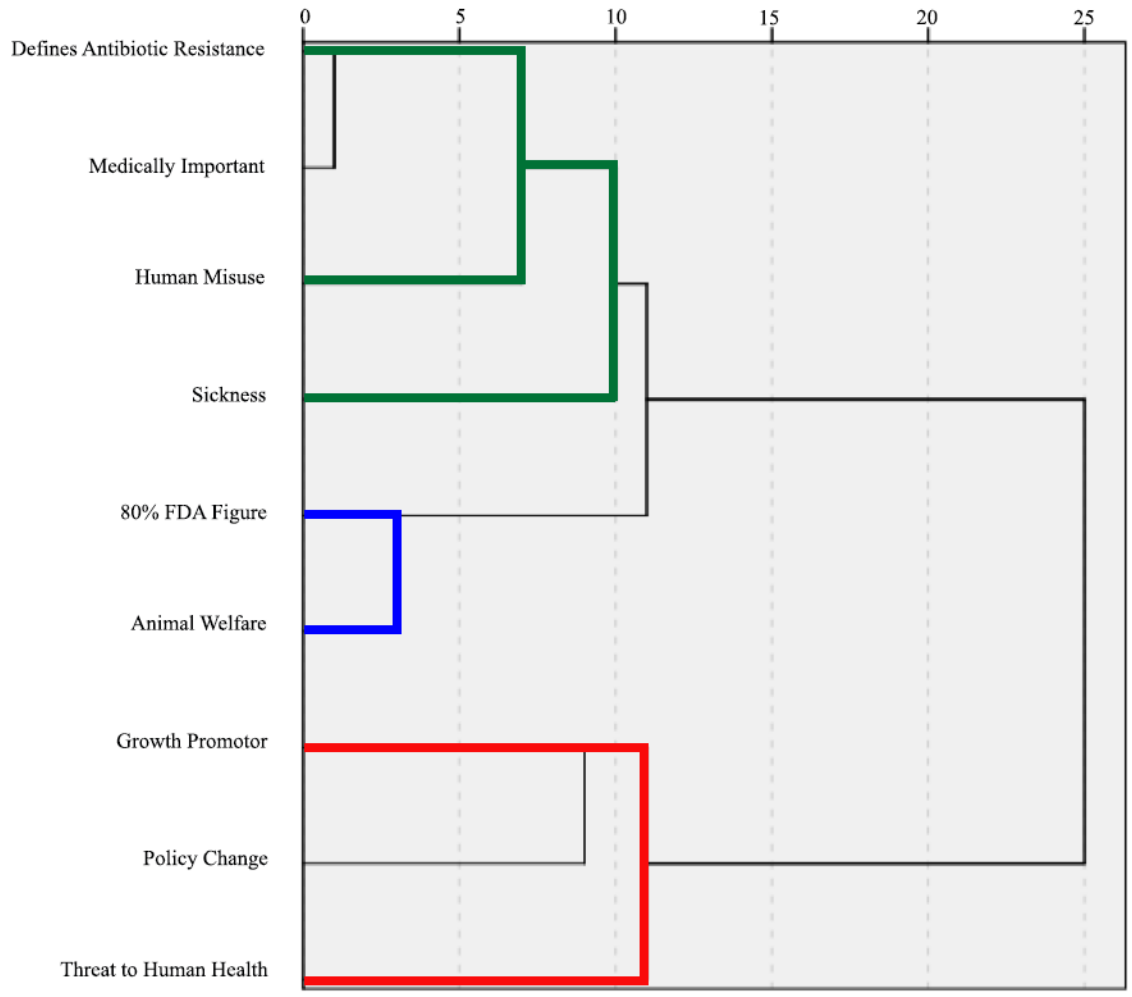

Figure 1. Dendogram of Clustering of Frame Elements

The first frame identified with the closest linkage was the blame frame, represented by the blue lines in the dendogram, and included 108 articles. The blame frame had the frame elements of using the flawed 80% figure and the use of antibiotics to combat poor animal welfare practices in food animal production.

The second frame was identified as the human impact frame, represented by the green lines, and included 85 articles. The human impact frame included the frame elements of defining antibiotic resistance, discussing specific antibiotics as medically important, describing the role human misuse of antibiotics plays in the development of antibiotic resistance, and highlighting a case of human sickness with a bacterial infection resistant to antibiotics.

The final frame identified was the change frame, represented by the red lines in the dendogram, in 77 articles. The change frame had the frame elements of describing the use of antibiotics for growth promotion, discussing the use of antibiotic in livestock as a threat to human health, and discussing a policy change regarding how antibiotics are used. The frames and frame elements are provided in Table 4.

Table 4
Frames used in National U.S. Newspaper Articles Regarding the Use of Antibiotics in Livestock and Antibiotic Resistance

Frame	Frame Elements
Change	Growth Promotion
	Threat to Human Health
	Policy Change
Blame	References the 80% FDA Figure
	Animal Welfare
Human Impact	Defines Antibiotic Resistance
	Medically Important Antibiotics
	Human Misuse
	Sickness

From 1996-2017, *The New York Times* published 135 articles related to antibiotic use in livestock. The frames identified in each of the newspapers are displayed in Table 5. Of the 135 articles from *The New York Times*, 39 were within the human impact frame, 60 were within the blame frame, and 36 were within the change frame. One hundred articles were published in the *Washington Post* with 33 within the human impact frame, 35 in the blame frame, and 32 in the change frame. Finally, 35 articles were published in the *USA Today*. Thirteen of these articles were human impact framed, 13 were blame frame articles, and 9 were change frame articles. A Chi-Square test was conducted and determined there was no significant difference in frames used among the three newspapers X^2 (4, N = 270) = 2.76, p = .25.

Table 5
Frames National U.S. Newspapers Used to Report on Antibiotic Use and Antibiotic Resistance in Livestock

Newspaper	Human Impact Frame		Blame Frame		Change Frame		Totals
	N	%	N	%	N	%	
New York Times	39	28.8	60	44.4	36	26.7	135
Washington Post	33	33.0	35	35.0	32	32.0	100
USA Today	13	37.1	13	37.1	9	25.7	35
	85		108		77		270

The inclusion and exclusion of scientific sources in non-op-ed articles in each of the three identified frames was also evaluated with 88.3% of human impact framed articles containing a scientific source, 90.4% of blame frame articles containing a scientific source, and 97.9% of change frame articles containing a scientific source.

Conclusions and Implications

Since the discovery of antibiotics, researchers and health professionals have had concerns regarding their continued effectiveness (McKenna, 2017). Once scientists recognized the role giving sub-therapeutic levels of antibiotics to livestock plays in growth promotion, researchers began working to better understand how this use of antibiotics might lead to less effective antibiotics over time (FDA, 2016). This information has been communicated to the public via mass media outlets such as newspapers since this discovery (McKenna, 2016).

RQ1 found 91.8% of non-op-ed articles analyzed used a scientific source when communicating information about the topic of antibiotic use in livestock to the readership of the newspapers. This finding aligns with those of Conrad (1999) that found researchers and scientists were the dominant experts quoted in articles. Of the scientific sources used in the articles, 43.3% were governmental scientists who primarily worked for the FDA or USDA. With the role politics played in the blocking of Kennedy's plan in 1977 (McKenna, 2017), governmental scientists as sources of information could play a role in how the science of antibiotic use is framed to the public via mass media coverage.

The results for RQ2 found the frame elements of growth promotion, threat to human health, and policy change were the most commonly used frame elements when reporting on antibiotic use in livestock. These frame elements also most commonly occurred together in the cluster analysis resulting in the identification of the change frame in RQ3. Research has indicated that providing antibiotics to livestock at sub-therapeutic levels for growth promotion does contribute to the development of antibiotic resistance (FDA, 2016). Further research has indicated that as antibiotic resistance increases, the usefulness of some antibiotics has been depleted resulting in an increased threat to human health (FDA, 2016). These findings contributed to the legislation that lead to the passing of both the Animal Drug Availability Act and the Veterinary Feed Directive (FDA, 2016).

The 80% FDA figure was used in almost a quarter of all articles (n = 65, 24.1%) and the animal welfare frame element was used in about the same amount (n = 74, 27.4%). These frame elements most commonly occurred together resulting in the blame frame identified in RQ3. This frame demonstrated that almost a quarter of the articles across these three major U.S. newspapers used false or biased information to depict the role that antibiotic use in livestock plays in the development of antibiotic resistance. Entman (1993) defined a frame as an active social construct developed by groups that are purposely and intentionally seeking to convince others of their

understanding of an issue and the specific modes of action necessary to address it. By using these two frame elements together, authors of these articles may be trying to convince readers that farmers and ranchers are using the vast majority of the antibiotics consumed in the United States each year in an effort to combat poor animal welfare practices. Personal agendas, biases, and viewpoints of journalists have been found to play a key role in how journalists communicate information to the public (Erikson & Tedin, 2015). This frame could additionally demonstrate that. By including some information and not including other information, the authors are filtering what information readers have to make informed decisions. If this information is flawed, the resulting attitude formation and behavioral choices are flawed.

The final frame elements the hierarchical cluster analysis found to co-occur together were labeled as the human impact frame. These frame elements were most commonly factual in nature and identified the role both humans play in contributing to the development of antibiotic resistant bacteria and how humans are impacted by the use of antibiotics in livestock. This frame most closely aligns with the "voluntary action" frame Morris et al. (2016) identified. Both frames highlight the role both human and animal medicine play in the development of antibiotic resistance and the need for human and animal medicine to act to combat the further development of this issue.

Finally, RQ3 additionally sought to describe how national U.S. newspapers framed the topic of antibiotic use in livestock. The Chi-Square test indicated there was no significant difference in frames used among the three newspapers regarding the topic of antibiotic use in livestock and the development of antibiotic resistant bacteria. However, it is concerning that all three newspapers used the blame frame more often than either the Human Impact or Change frames. Because this frame uses flawed information (FDA, 2017c) the readership of these newspapers may be influenced by this false information.

Recommendations

Findings from this study indicated readers of *The New York Times, Washington Post,* and *USA Today* may be receiving more information that blames the development of antibiotic resistant bacteria on livestock production. This is concerning since one of the primary frame elements of this frame communicated inaccurate science (FDA, 2017c) to the readers. Because readers are being ill-informed about this topic, they could be using this information in their decision making without having all of the facts. A qualitative content analysis of the accuracy of articles within the blame frame could provide for a better understanding of the level to which readers may be receiving inaccurate information. Further, an agenda setting study could additionally allow for a better understanding as to what role, if any, these newspapers may play in influencing public opinion regarding antibiotic use in livestock and the development of antibiotic resistant bacteria.

A framing effects study to examine the role frame elements play in public opinion of antibiotic use in livestock and the development of antibiotic resistance could allow for a better understanding as to how these newspaper articles influence public opinion. Further, by studying public opinion using the co-occurrence of these frame elements built within a frame, agricultural communicators can develop and improve current campaigns to educate consumers about these topics and prepare farmers and ranchers to better communicate about antibiotic use.

This study only evaluated the inclusion of quotes from scientific sources and did not evaluate quotes from special interest groups or organizations. Since these groups and organizations are promoting a certain outcome for this debate, the inclusion of their quotes should be evaluated in future research. Additionally, as more research is conducted and issues with antibiotic resistance arises, how this topic is framed in the media should be analyzed, thus it is suggested that a

longitudinal framing study be conducted to determine how the frames used to discuss the topic may change over time.

Science communicators should prioritize the inclusion of scientific sources in their writing. The presentation of news influences a reader's understanding of a topic and thus by providing quotes from scientific sources, science communicators can better balance how the information is reported and allow for greater understanding and trust in the news itself (Conrad, 1999).

Finally, the field of agricultural communications should increase its use of cluster analysis, specifically when studying controversial agricultural issues such as this. By determining frame elements within the content and allowing for a computerized determination of frames, researchers may be able to get a more robust understanding of how a controversial topic is communicated to the public.

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