Protocols, Instrument, Reliability Analyses for Content Analysis

Our sample consists of news stories that refer to scholarly publications on opioid-related disorders, published by *BBC, Breitbart, CBC, CNN, Fox News, Global News,* the *New York Times, Vice,* and the *Washington Post* between 2017 and 2019. The final dataset contained 223 mentions of 164 unique studies across 149 news stories.

Data collection

To identify research studies relevant to the prevention, harm reduction, and treatment of opioid-related disorders, we queried PubMed, a database for biomedical and life sciences research. PubMed indexes research studies according to Medical Subject Headings, or "MeSH terms," which provide a consistent way of cataloguing and searching the database when authors use different terms for the same concept or topic (e.g., opioid addiction and heroin addiction). For MeSH term "opioid-related disorders"[1], which includes abuse, addiction, and dependence and any kind of opioid or opiate (e.g., heroin, morphine, codeine), we selected the following subtopics as these align closest with prevention, harm reduction, and treatment efforts: *diagnosis, drug therapy, prevention and control, rehabilitation, therapy, epidemiology*. Besides, we also searched for the MeSH term "needle-exchange programs" as these were not covered by any of our previous search terms yet a critical part of harm reduction. This search yielded 12,166 relevant research papers.

Next, we searched the Altmetric Explorer for news stories mentioning or linking to any one of these scientific studies (May 20, 2019). The Altmetric Explorer is a tool built for exploring the Altmetric database, which tracks online activity and news mentions of scientific research outputs ("Altmetric.com," 2015). Since the Altmetric Explorer allows for PubMed queries, we were able to use the same search terms as above to find relevant news stories. We limited our query to the most widely used news sources—*BBC, Breitbart, CBC, CNN, Fox News, Global News,* the *New York Times, Vice,* and the *Washington Post*—and to news stories published between 2017 and 2019. The final dataset contained 223 mentions of 164 unique studies across 149 news stories.

To see how the number of news stories citing research compares to the overall volume of news coverage on the opioid crisis and opioid-related disorders during that time, we queried Media Cloud setting the search parameters to the same nine news sources and timeframe as before. We used the following search terms: "(opioid OR heroin OR morphine) AND (addiction OR abuse OR epidemic OR crisis OR dependence OR overdose OR overdoses)." We removed instances that were irrelevant to our search, such as videos, podcasts and radio shows, and tv news transcripts since we do not consider these to be online news stories.

[1] https://www.ncbi.nlm.nih.gov/mesh/?term=opioid-related+disorders

Coding

A coder used a detailed coding instrument (see the "Codebook for Content Analysis," page 3 of this Appendix) to record certain news story characteristics such as the broad thematic focus of the story (science communication or a different issue), whether the news story was an original or republished, and whether it included a link to the research study. Then we assessed how each news mention of scientific research in the sample was framed, first coding for the individual frame elements, then for the overarching frame. This strategy allowed us to uncover how individual news mentions were framed in the news coverage, as well as the distinct characteristics of each frame, enabling us to provide a more nuanced analysis than would be possible with an analysis of the overarching frames alone. Importantly, while the uncertain and controversial science frames could convey certain elements of the valid science frame (e.g., scientific credibility), the valid science frame could not include any uncertain or controversial aspects. As such, any mentions containing elements of the valid science frame as well as of either the uncertain and/or controversial science frames were coded as uncertain or controversial, not as valid.

Table 1 presents an overview of the observed frames and their related codes. Note that in the coding instrument itself, codes are not grouped by frame but instead organized into conceptual groups. This conceptual and physical proximity helped us to gain a clearer understanding of these closely related variables and to minimize uncertainties during the coding process.

Table 1 Frame definitions and code classification

	Valid Science	**Uncertain Science**	**Controversial Science**
Major Theme	Trust	Doubt	Conflict
Previous Research	Antilla (2005: 344) Ruhrmann et al. (2013: 10) Guenther et al. (2017: 11)	Zehr (2000: 92) Guenther et al. (2017: 11)	Zehr (2000: 90) Atilla (2005: 347) Ruhrmann (2013: 10) Guenther et al. (2017: 11)
Conceptual Definition	The valid science frame portrays scientific research as sound and trustworthy and omits any potential scientific uncertainties and controversies surrounding the research, such as poor methodological quality or contrasting research	The uncertain science frame portrays scientific results as tentative or pending additional research. It cautions against seeing research findings as trusted facts and may indicate flaws in the study, errors in the	The controversial science frame injects and/or emphasizes controversy and disagreement surrounding the reported research study. This is done by contrasting research findings or presenting conflicting viewpoints. This frame does not portray scientific

	findings. Instead, research findings are presented as trusted facts and certain, often without further discussing or evaluating them, or by implying broad scientific agreement regarding the results.	data, or replicability issues.	research as trusted or certain; neither does it just invoke doubt and uncertainty. Instead, it clearly highlights two diverging perspectives.
Relevant Codes	● Trusted facts ● Positive credibility	● Preliminary findings ● Questionable credibility	● Contrasting research findings ● Conflicting viewpoints

All coding was completed by a single coder. To minimize bias and ensure consistency in the coding, the research team also met continuously throughout the coding process to ensure the coder was on the right track and to discuss any questions that they raised. A 20% random draw of all mentions (n = 45) was independently coded by both our primary coder and a reliability coder to calculate coding reliability. The coding, and reliability check took just over two weeks to complete.

Codebook for Content Analysis

Directions:

1. Fill out each item below for each excerpt on the corresponding excel spreadsheet
    a. Each row is a “mention” (or observation): an excerpt from a news story referring to one particular research study;
    b. Each column is a variable corresponding to one of the codes in the coding scheme presented below;
    c. For news story characteristics, draw data from the news story, and enter data into corresponding columns (see var) based on coding scheme (e.g., 1 or 0). To access the news story, click on the link in Column C.
    d. For the news frames, draw data from the excerpt in Column A, and enter data into corresponding columns (see var) based on coding scheme (e.g., 1 or 0).
2. Please use the “notes” column to document any idiosyncratic findings that may be important to the researchers (anything that is unique or stands out to you).
3. If you have any questions, do not hesitate to ask Lisa (l.a.matthia@gmail.com). It is always better to be sure!

Universe: all online news stories published by *BBC, Breitbart, CBC, CNN, Fox News, Global News, New York Times, Vice, and the Washington Post between January 1, 2017 - December 31, 2018*, which mentioned or linked to research articles indexed under the following PubMed Medical Subject Headings (“MeSH terms”) relevant to opioid-related disorders: *diagnosis, drug therapy, prevention and control, rehabilitation, therapy, epidemiology,* and *needle-exchange programs*.

Unit of Analysis: News mention.

Method of Data Collection: Altmetric Explorer for Researchers, news transcripts from news source's website.

News story characteristics

Code:	**News focus**
Brief definition:	The thematic focus of the news story.
How to determine:	Use only the headline and the first paragraph. of the news story. Select "scicomm" if the primary focus of the news story is reporting on a scholarly publication. For example: ● new research findings; **OR** ● evidence-informed mitigation efforts; **OR** ● new prescription guidelines. Select "issue" if the primary focus of the news story is a larger issue, in which research was referenced, but not the main focus of the story. Instead, the main topic of the news story may be, for example: ● policy development; **OR** ● pharmaceutical companies; **OR** ● personal stories.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	SCICOMM: "Clinical Trial Examines Tramadol to Treat Opioid Withdrawal Researchers at Johns Hopkins University have found the drug tramadol, when combined with other therapies, may be effective for treating opioid withdrawal." → *The headline and the first paragraph of the news story highlight the scholarly publication.* ISSUE: "CVS Becomes First Retailer to Limit Opioid Prescriptions to 7 Days CVS announced it will limit all opioid prescriptions to a seven-day supply, becoming the first major retail chain to do so in the wake of the opioid epidemic." → *The headline and the first paragraph of the news story do not highlight any scholarly publications.*

Code:	**Original news story**
Brief definition:	If the news story was originally published by the news source named in Column B, "news_source."
When (not) to use:	Check the header and the footer of the news story to determine who published the news story.

	Type 1 if the news news story was first published by the news outlet listed in Column B. Type 0 if the news story was first published by a different source than the news outlet listed in Column B, and the news outlet in Column B is republishing/reposting it.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: News story on the Washington Post website states "By Keith Humphreys." → *This is classified as an original news story since the Washington Post is the original publisher as indicated by linking the author's name, "Keith Humphreys," to his Washington Post author profile.* TRUE: News story on the Fox News website states "By Greg Gutfeld, | Fox News." → *This is classified as an original news story since Fox News is the original publisher.* FALSE: News story on the Washington Post website reads "By Marilynn Marchione | AP." → *This is not classified as an original news story since the Washington Post only re-published a news story from the Associated Press (AP).* FALSE: News story on the Fox News website states "By Margie Skeer, Tufts University | LiveScience." → *This is not classified as an original news story since Fox News only re-published a news story from the LiveScience.*

Code:	**News link schol pub**
Brief definition:	If the news story contains a hyperlink to the scholarly publication.
When (not) to use:	Check the entire news story for a hyperlink to the scholarly publication. In some cases the link might only be listed at the very end of the news story Type 1 if the news story contains a hyperlink to the scholarly publication. Type 0 if the news story does not contain a hyperlink to the scholarly publication.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: The drug naloxone, which can reverse prescription opioid and heroin overdoses, **may not be effective against potent synthetics**. → *This news story contains a link to the scholarly publication.* FALSE: But abstinence does not in and of itself treat substance use disorder. And upon release, prisoners generally have a reduced tolerance for opioids; one study found that within two weeks of being released, former inmates overdose at rates nearly 130 times as high

	as the general population. → *This news story mentions a scholarly publication, but does not link to it.*

News frames

Concept: Confidence in research results

Code:	**Trusted facts**
Brief definition:	The research results are presented as trusted facts.
When (not) to use:	Type 1 if the news story: ● describes the research results as valid; **AND** ● omits any uncertainties; **OR** ● generalizes broad scientific agreement, indicating consensus around the research results (e.g., "research/science shows", "researchers agree", or reference to systematic reviews/meta analyses/surveys of scientific studies); **OR** ● only provides a link to the research study, but does not discuss the research further. (Note: using terms such as "might" or "may" does not in and of itself indicate uncertainty, as this is common practice when discussing research results - e.g. "Naloxone may save as many as 3 million lives a year") Otherwise type 0. Also type 0 if any of the following codes are present: preliminary findings, questionable scientific credibility, contrasting research findings, conflicting views.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: Today's opioid crisis is already the **deadliest drug epidemic** in American history. Opioid overdoses killed more than 45,000 people in the 12 months that ended in September, according to the Centers for Disease Control and Prevention. → *This is just a link with no indication that it leads to a research study.* TRUE: **A 2013 study of New York City businesses** found that 58% of store managers had seen drug use in their toilets. → *The results of the study are presented as certain ("found"), and are not questioned.* FALSE: The new study, published on Tuesday in *The Lancet*, was only the second to compare the drugs, and the first in the United States. → *The study "was only the second" of this kind. Hence, it's unclear how reliable the results are.* Close but FALSE: Few studies have measured the outcomes of jail-based methadone treatment. But a 2001 study at Rikers Island, which started one of the country's first jail-based methadone programs in 1987, found that participants were less likely to commit

	new crimes and more likely to continue treatment. And a 2014 **Australian study** found fewer overdose deaths after release. → *Read in isolation, the results of the Australian study are presented as trusted facts. Stating that there have only been a "few studies" on this topic, weakens the reliability.*

Code:	**Preliminary findings**
Brief definition:	The news story presents research results as uncertain.
When (not) to use:	Type 1 if the news story: ● uses the term "uncertain"; **OR** ● uses the term "preliminary"; **OR** ● uses the term "incomplete"; **OR** ● uses the term "trial stage" (or something synonymous) to describe the research results of the reported study; **OR** ● uses the phrase "only few studies". Otherwise type 0. Also type 0 if the news story only provides a link to the research study, but does not discuss the research further.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: The city said it does not keep track of the income or race of buprenorphine patients, and data on buprenorphine treatment demographics is sparse at the national level as well. **A study** published in 2016 in Drug and Alcohol Dependence, a scientific journal, found that buprenorphine and methadone access were correlated with income and ethnicity in New York City. Without broad government surveys, precision is difficult; the report lamented that no nationally representative data on ethnicity or income has been published since 2006, when a survey by the Substance Abuse and Mental Health Services Administration showed that 92 percent of buprenorphine patients were white. → *To be a* trusted fact*, more comprehensive data is needed. Until then the results are seen as preliminary.* FALSE: The drug naloxone, which can reverse prescription opioid and heroin overdoses, **may not be effective against potent synthetics**. → *This is just a link. The uncertain tone relates to the content of the sentence, but does not express uncertainty about the research study.* Close, but FALSE: But abstinence does not in and of itself treat substance use disorder. And upon release, prisoners generally have a reduced tolerance for opioids; **one study** found that within two weeks of being released, former inmates overdose at rates nearly 130 times as high as the general population. → *In this case, "one" does not highlight a lack of existing research, but that one study is used to support the journalist's claim that "abstinence does not in and of itself treat substance use disorder."*

Concept: Scientific credibility

Code:	**Positive scientific credibility**
Brief definition:	The research results are presented as scientifically credible.
When (not) to use:	Type 1 if the news story: ● includes supporting independent expert commentary; **OR** ● refers to the high methodological quality (e.g., large sample size) of the study; **OR** ● portrays the researcher(s) as competent; **OR** ● mentions the researchers' affiliation; **OR** ● mentions the researchers' funders; **OR** ● mentions the journal in which the study was published; **OR** ● states the study's findings have been applied or cited elsewhere; **OR** ● states the study's findings were approved by an authoritative organization (e.g., Food and Drug Administration); **OR** ● mentions that other studies have had similar results (although no clear consensus has been established); **OR** ● if the results deviate from other research, offers an explanation as to why this might be the case. Otherwise type 0. Also type 0 if the news story only provides a link to the research study, but does not discuss the research further.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: Gail D'Onofrio, a pioneer of the practice who leads the department of emergency medicine at Yale, published a study in 2015 showing that starting patients on Suboxone in the emergency room **works**: 78 percent were still in treatment a month later, twice as many as those who got only referrals to treatment. She said hospitals in fewer than 10 cities offer Suboxone in the emergency room. (In Philadelphia, only a few do). "But way more are in process," she said, adding that she gets calls from new places every week. → *Scientific credibility is conveyed by mentioning D'onofrio's leading job position and that the research findings are being implemented into practice.* TRUE: A substantial body of research has found that people who take buprenorphine **are less likely to die** and more likely to stay in treatment. → *"A substantial body of research" indicates that several studies have had similar results.* TRUE: But there's also less data out there on Vivitrol compared to methadone and buprenorphine. There have been just five trials for the drug's impact on opioid addiction—compared to hundreds on buprenorphine and methadone. Vivitrol was FDA approved for opioid treatment, based on a **single trial**, conducted in Russia, where other medications are illegal. → *This would be coded as*

	"positive scientific credibility" since the FDA, an authoritative organization approved the drug, AND "preliminary results" because there has only been "a single trial." FALSE: A study **from 2010** in Sydney, Australia, found a supervised injection facility led to fewer ambulance calls for treating overdoses. → *There isn't any information provided about the credibility of the study or the researchers.* Close but FALSE: Five industry-funded clinical trials have **found** Vivitrol to be effective in treating opioid problems—at least for those who choose to stick with it. → *Although this mention refers to multiple clinical trials, which could imply credibility, it also says these trials have been "industry-funded," and the trial stages remain unclear.*

Code:	**Questionable scientific credibility**
Brief definition:	The news story casts doubt on the credibility of the research results and/or the researchers.
When (not) to use:	Type 1 if the news story: • questions the scientific credibility of the research findings; **OR** • questions the scientific credibility of the researchers; **OR** • criticizes the methodology of the research study (e.g., small sample size); **OR** • highlights a conflict of interests. Otherwise type 0. Also type 0 if the news story only provides a link to the research study, but does not discuss the research further.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: Dr. Rotrosen and Dr. Joshua Lee, a co-author of the study and an associate professor at New York University School of Medicine, have both led or participated in previous studies for which Alkermes provided medication or funding. Two of the other authors also reported receiving research support and in one case, consulting fees from Alkermes. Indivior donated the Suboxone for the study. → *The researchers have received funding from Alkemeres, a major opioid producer, indicating a conflict of interest.* FALSE: A federally funded **study** last year found that naltrexone, a non-opioid medication that JourneyPure has offered to some patients since it opened in 2015, was just as effective as buprenorphine. → *"Federally funded" conveys credibility.*

Concept: Conflict

Code:	**Contrasting research findings**
Brief definition:	The news story suggests that the current study departs from previous research.
When (not) to use:	Type 1 if the news story: ● juxtaposes the results of two or more separate studies; **OR** ● emphasizes that the study discussed does not align with previous research findings; **AND** ● no explanation is offered as to why results differ from one another. Otherwise type 0. Also type 0 if the news story only provides a link to the research study, but does not discuss the research further.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: Zielinski found that for women in MMT, cannabis use was associated with falling off the wagon. Women who reported using recreational cannabis while in MMT were 82 percent more likely to also use illicit opioids, according to Zielinski's study, published last month in Biology of Sex Differences. But she told me it's not a clear cause-and-effect happening. (...) Other researchers **have found that cannabis use has no association** with how well someone manages to stay of opioids while receiving MMT. → *Two research studies on the same topic have produced different results.* FALSE: Gail D'Onofrio, a pioneer of the practice who leads the department of emergency medicine at Yale, published a study in 2015 showing that starting patients on Suboxone in the emergency room **works**: 78 percent were still in treatment a month later, twice as many as those who got only referrals to treatment. (...) A follow-up study showed that the gains were holding at two months, but not at six months or a year. Nevertheless, Jeffrey Hom, a policy adviser to Philadelphia's public health department, said the program was still valuable. "For many people this is a chronic disease," he said. "Relapses happen. You may have tried Suboxone and had some success and it may not be sustained, but you may come back to it at a later date." → *The follow-up study was able to replicate and extend the findings of the original study.* Close, but FALSE: Eli Lilly's trials of the drug for osteoarthritis pain were unsuccessful. At the time, the drug's use in treating other kinds of pain and lessening opioid dependence wasn't tested. But researchers opted to start testing it after they found it interacted with the body on a target known to be involved with pain relief. → *Conflicting findings are presented, but these concern two unrelated medical issues, and it is explained how researchers discovered the drug might be used for different purposes.*

Code:	**Conflicting viewpoints**

Brief definition:	The news story presents conflicting viewpoints on the research topic.
When (not) to use:	Type 1 if the news story includes statements that present a different interpretation of the research findings **OR** their implication from: ● other researchers; **OR** ● experts; **OR** ● other credible individuals; **OR** ● the journalist themselves. (Note: This can sometimes appear as the journalist maintaining objectivity and balancing opinions.) Otherwise type 0. Also type 0 if the news story only provides a link to the research study, but does not discuss the research further.
Examples (underlined = indicator for code; **blue, bold, underlined** = link to research; *italic* = explanation)	TRUE: "There is evidence on both sides," Elliot said during question period Monday. "We need to make sure that we review all of the evidence to understand what is happening. What is happening that is saving lives? What else can we do to save more lives? Are there other examples that we should be looking at besides supervised injection clinics?" Experts and advocates on the frontlines of the opioid epidemic, however, say there is already an overwhelming body of evidence to show that the overdose-prevention and safe injection sites save lives and help get people into treatment. (...) Studies on these facilities conducted in Canada and around the world have shown they are not only life saving but connect people with long-term addiction treatment, reduce the spread of HIV and hepatitis C, and ultimately save healthcare dollars. One study **published in 2011** examined overdose mortality in the two years before and after a supervised injection site opened in Vancouver in 2003 known as InSite. It found the fatal overdose rate in the area decreased by **35 per cent**. → *Elliot is questioning if safe injection sites have merit, the journalist then presents evidence that they have.* FALSE: History is filled with examples of scientifically sound guidance that was ignored or pilloried by those in power. In the late 1990s, for example, half a dozen major health agencies, including the Department of Health and Human Services, endorsed a **national needle exchange program** to curb the spread of H.I.V./AIDS. But President Bill Clinton rejected the advice, and the resulting H.I.V. infections cost the health care system as much as half a billion dollars. → *This is just a link.* Close, but FALSE: The drug courts often place offenders in treatment facilities or sober housing that allow only Vivitrol. "That's where we're handcuffed to Vivitrol," said Judge David Matia, who leads the drug court in Cuyahoga County, Ohio. Dr. Joshua Lee, the lead author of a **2016 study of Vivitrol**, said he questioned whether the drug had given criminal justice authorities "too easy of an out"

	not to make buprenorphine or methadone more widely available in their settings. → *The conflicting viewpoint does not relate to the study and the reference merely provides additional information about Dr. Lee but is not further elaborated.*

Reliability Coding

Two coders, using the same coding instrument (see this appendix, above), independently analyzed a random draw of approximately 20 percent of coded transcripts (n=45). We present several measures of agreement. We include percent agreement, which is intuitive but overestimates true intercoder agreement. We also present Krippendorff's alpha and Cohen's alpha, both of which are more flexible and can account for multiple coders. Scores that approach 1 are indicative of greater agreement between coders. In most fields, a threshold of .7 is seen as an acceptable score of reliability. The results in the table below show that we have met or exceeded that threshold for all measures.

Code	**% Agreement**	**Cohen's Kappa**	**Krippendorff's Alpha**
Trusted Facts	95	0.857	0.858
Preliminary Findings	97.5	0.844	0.845
Positive Credibility	85	0.699	0.703
Questionable Credibility	100	1	1
Contrasting Findings	100	1	1
Conflicting Viewpoints	95	0.722	0.726