Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Radiology in the News: A Content Analysis of Radiology-Related Information Retrieved From Google Alerts

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A B S T R A C T

Introduction: Radiology topics receive substantial online media attention, with prior studies focusing on social media platform coverage. We used Google Alerts, a content change detection and notification service, to prospectively analyze new radiology-related content appearing on the internet.
Materials and Methods: An automated notification was created on Google Alerts for the search term "radiology," sending the user emails with up to 3 new links daily. All links from November 2019 through April 2020 were assessed by 2 of 3 independent raters using a coding system to classify the content source and primary topic of discussion. The top 5 primary topics were retrospectively evaluated to identify prevalent subcategories. Content viewing restrictions were documented.
Results: 526 links were accessed. The majority (68%) of links were created by non-radiology lay press, followed by radiology-related lay press (28%), university-based publications (2%), and professional society websites (2%). The primary topic of these links most frequently related to market trends (28%), promotional material (20%), COVID-19 (13%), artificial intelligence (8%), and new technology or equipment (5%). 15% of links discussed a topic sourced from another article, such as a peer-reviewed journal, though only 2 linked directly to the journal itself. 8% of links had content viewing restrictions.
Conclusion: New radiology content was largely disseminated via non-radiology news sources; radiologists should therefore ensure their research and viewpoints are presented in these outlets. Google Alerts may be a useful tool to stay abreast of the most current public radiology subject matters, especially during these times of social isolation and rapidly evolving clinical practice.

Introduction

Medicine has consistently been the subject of substantial media attention.[1-7] This also applies to the field of radiology, for example in the areas of radiation safety,[8] teleradiology,[9] mammography,[10] and artificial intelligence.[11] Modern analytic tools have recently been employed to analyze content trends in radiology-related online media searches[12] and the effects of media coverage on promoting research findings.[7] Furthermore, a prior study has demonstrated an association between media coverage and scientific citations of peer-reviewed journal articles, irrespective of article quality.[3]

Recent months have seen rapidly evolving practice and clinical guidelines due to the novel coronavirus SARS-CoV-2 (COVID-19) pandemic[13,14] and there has been a strong emphasis on staying up-to-date. Google Alerts is one way to do so, especially during times of social isolation; it is a content change and notification service launched in 2003 which notifies users of new results (e.g. web pages, news media, and scientific research) matching a particular user-specified search query.[15,16] This service leverages Google Search, the most popular search engine[17] and website in the world[18] with over 1 trillion searches per year.[19] Google Alerts has previously been utilized to study new media content in the fields of primary care,[20] infectious disease,[21,22] and midwifery.[23]

Google Alerts has not previously been utilized in the field of radiology nor, to our knowledge, has there been any detailed and comprehensive content analysis of new radiology-related media on the internet. In order to fill this knowledge gap, we used Google Alerts to prospectively analyze new radiology-related media content on the internet.

Materials and Methods

This study was deemed exempt by our local Institutional Review Board.

On Google Alerts (Google, Mountain View, CA), a user can detail a search query utilizing standard search engine language, with or without Boolean operators (e.g. AND, OR) and may further specify the frequency ("as-it-happens," "at most once a day," or "at most once a week"), media source (automatic or specific [news, blog, web, video, books, discussions, and/or finance]), language, geographic region (country), and number of results ("all results" or "only the best results") (Fig 1A). When enabled, this query generates an automated email to the user matching the specified search parameters (Fig 1B).

For this prospective study, an email alert was created on the Primary Investigator's (VP) Google Alerts account prior to November 1, 2019 for the search term "radiology," with daily frequency, from

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0363-0188/

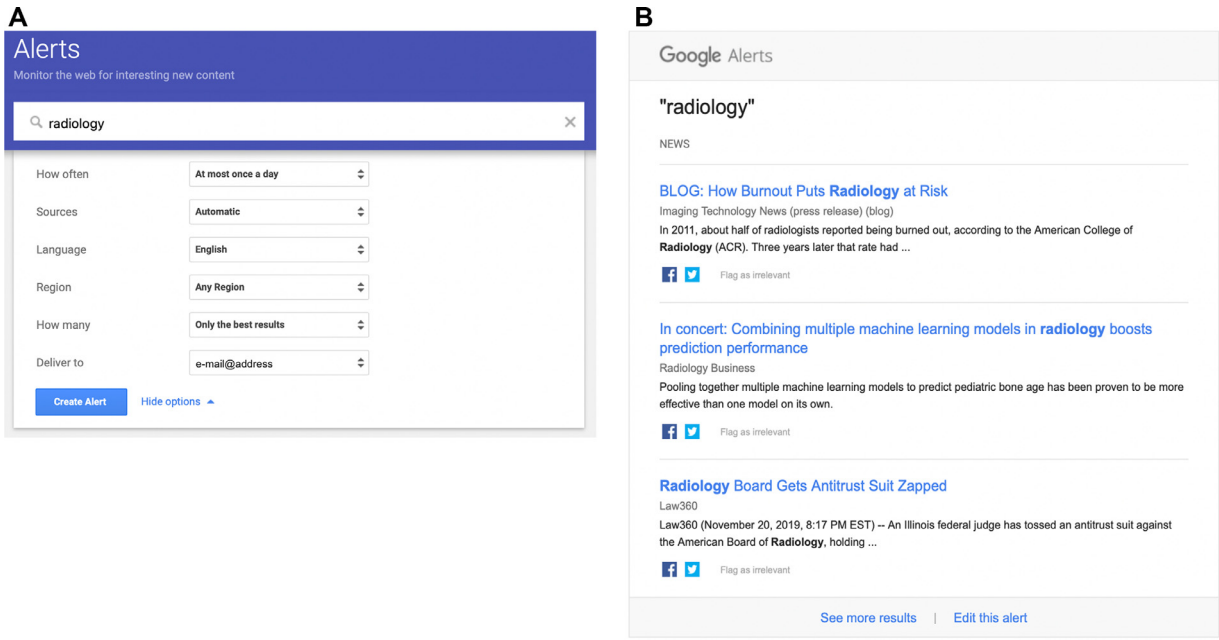

FIG 1. (A) Using Google Alerts to create a search term. (B) Example of a daily e-mail with results matching desired query of "radiology."

"automatic" sources, in English language, from any geographic region, and including "only the best results." This generated daily emails directly to the user containing up to three results per day and was run consecutively for the 6-month period of November 2019 through April 2020.

All links for the 6-month period were retrieved and accessed. The links were categorized by two of three raters (VP, KM, and MDS, with eight, one, and one year(s) of online media research experience, respectively) using an iteratively developed coding system to classify the content source and primary topic of discussion. Additionally, content viewing restrictions, including "paywalls" (i.e. requiring payment to view content), requirement for account creation, and requests to deactivate ad blockers before viewing content, were documented. For the purpose of ad blocker deactivation determination, the free, publicly available ad blocker AdBlock (www.getadblock.com) was added to the web browser on which the link was loaded. When articles were unavailable (nonworking link or subscription-requiring service) an attempt was made to categorize the article based on the title or any available viewable content. The top five primary topics of discussion were then retrospectively evaluated to identify prevalent themes or subcategories. Note was also made of whether links were pertaining to the 2019 Radiological Society of North America (RSNA) Annual Meeting, which occurred on December 1-6, 2019. All discrepancies were re-reviewed until consensus was achieved.

The data were evaluated using standard summary statistics, computed in Google Sheets (Google, Mountain View, CA).

Results

A total of 526 unique links were accessed. Four links were nonfunctioning during the coding process and unable to be categorized based on the title or available content. Of the remaining 522 links, a majority of the content was created by non-radiology lay press ($n = 355$, 68%), followed

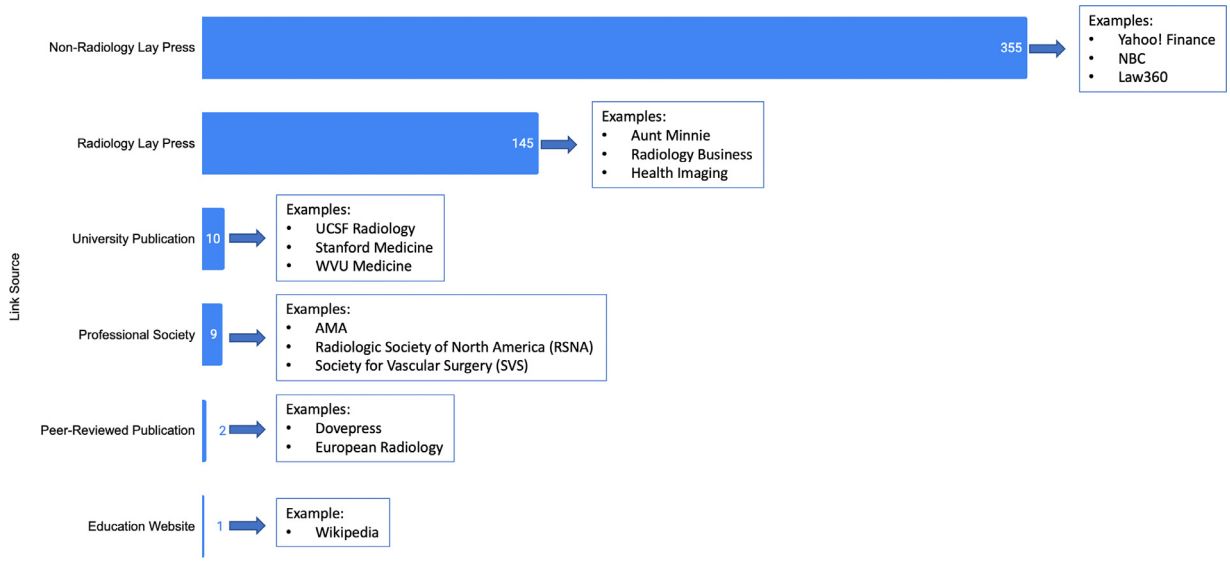

FIG 2. Sources of links provided by Google Alerts. Links were most frequently to articles by non-radiology news outlets.

TABLE 1
Coding system used to categorize links sent by the Google Alerts algorithm from November 2019 through April 2020 using the search criteria "radiology", with representative examples.

Primary Topic	Description	Example
Market Trends	Current and future market trends in radiology.	• *Industry News Releases*: Global Radiology Treatment Equipment Market Insights Report 2019-2025 • *Yahoo! Finance*: United States Pediatric Radiology Market Prospects, Trends Analysis, Market Size and Forecasts Report 2019-2024
Promotional	Career accomplishments (e.g. new hiring, promotion, or award), new business partnerships, and meeting advertisements	• *Radiology Business*: American College of Radiology names its 2020 Gold Medalists, honorary fellows • *MDLinx*: Duke Radiology in the Islands 2020 • *BioSpace*: US Radiology Enters Arizona through Partnership with Radiology Ltd.
COVID-19	Clinical and imaging guidelines, operational issues and deaths related to COVID-19	• *Radiology Business:* Radiology practices should expect volume decreases as high as 70% for months, experts say • *Aunt Minnie:* How is global radiology bearing up in COVID-19 pandemic? • *NY Post:* Tunisian engineers develop online coronavirus scanning tool
Artificial Intelligence	Artificial intelligence software, perceptions, regulation, and issues with implementation	• *Aunt Minnie*: Medical students, radiologists may view AI differently • *Radiology Business*: In concert: Combining multiple machine learning models in radiology boosts prediction performance
New Technology or Equipment	Trends in or new radiology equipment (e.g. new MRI machine) or technology (new software)	• *Scoop*: New equipment brings improved imaging to radiology • *BioSPACE*: Samsung Unveils its Latest Radiology Innovations at RSNA 2019 • *Nevada Business*: Desert Radiology Continues Commitment to Patient Care With Addition of Advanced CT Scanner
Legal Matters	Malpractice and other lawsuits and legislative changes.	• *Law360: Radiology Board Gets Antitrust Suit Zapped* • *CBS*: 'I was scared, and now I'm mad,' says woman suing Raleigh Radiology
Wellness and Burnout	Wellness and burnout risks, research, and solutions	• *Imaging Technology News*: How Burnout Puts Radiology at Risk • *Health Care Business News*: Burnout is real: Addressing quality of life in radiology
Educational	Increasing public awareness of radiology	• *NBC*: Health Matters: What is Interventional Radiology? • *Health Imaging*: Special report: Radiology's efforts will be 'crucial' for understanding vaping-related lung injury
Future of Radiology	Evolution of radiology	• *Radiology Business*: Dwindling number of generalists in radiology could have 'far-reaching implications' • *Aunt Minnie*: Human connection is key to progress in radiology
Celebratory	Events, year-end topics, and international days of recognition	• *Express Healthcare*: IRIA to take part in Eighth Annual International Day of Radiology • *Radiology Business*: Radiology-related companies score high marks for LGBTQ corporate equality
Radiology Training	Graduate medical education topics	• *Radiology Business*: Hospital finds success deploying radiology residents as imaging consultants • *Health Imaging*: Global radiology training is on the rise, new study finds
Informatics	Imaging informatics, including cybersecurity and informatics research	• *Radiology Business*: Radiology hacking experts offer 3 steps for physicians to cybersecure their practices • *Health Imaging*: RSNA announces effort to strengthen image sharing across radiology

by radiology-related lay press ($n = 145$, 28%), university-based publications ($n = 10$, 2%) and professional society websites ($n = 9$, 2%) (Fig 2).

The details of the coding system used to evaluate the content of each link is provided in Table 1. The primary topic of the linked content was most frequently related to market trends (28%), promotional (20%), COVID-19 (13%), artificial intelligence (8%), new technology or equipment (5%), celebratory (5%), and legal matters (4%) (Fig 3). COVID-19 first appeared in links on February 20, 2020, after which it represented the primary topic in 43% of posts, exceeding that of any other topic. COVID-19 represented 40% (64/163) of links in the months of March and April.

Results of our subcategorization of the top 5 primary discussion topics are displayed in Table 2. Links relating to market trends most frequently discussed growth trends in information technology (48%), interventional radiology (21%) and radiology equipment (11%), and a minority discussed reimbursements (7%). Promotional links most frequently discussed new business partnerships (38%), career advancements (38%), and advertisements (24%). Links relating to COVID-19 most frequently discussed operational issues and guidelines (65%), COVID-19 related deaths (15%), imaging findings and guidelines (7%) and experimental research (6%). Links relating to artificial intelligence most frequently discussed perception (27%), implementation (20%), new software (18%), and new research (11%); only 9% ($n = 4$) discussed limitations of artificial intelligence.

A total of 15% (78/526) of all links discussed a topic sourced from another article, such as a peer-reviewed medical journal, however only two links directly sent the user to a primary peer-reviewed journal article. Seventeen links covered topics directly related to the 2019 RSNA Annual Meeting, all of which were posted on or after December 2, 2019.

A total of 43 links (8%) had one or more content viewing restrictions, most commonly requiring deactivation of ad-blockers ($n = 19$) or account creation ($n = 15$) and less frequently paywalls ($n = 9$).

Discussion

Radiology continues to be a rapidly advancing field as clinical guidelines evolve and subspecialties continue to produce new guidelines. This has been further accelerated in recent months due to the COVID-19 pandemic and staying current with daily updates is as important as ever. This is the first study to prospectively assess new online searchable media in radiology, utilizing a tool that leverages the most popular search engine in the world. We identified a diverse set of topics present in online media and found that most links were directly to non-radiology lay press. The most common topics related to market trends, promotional content, COVID-19, and artificial intelligence.

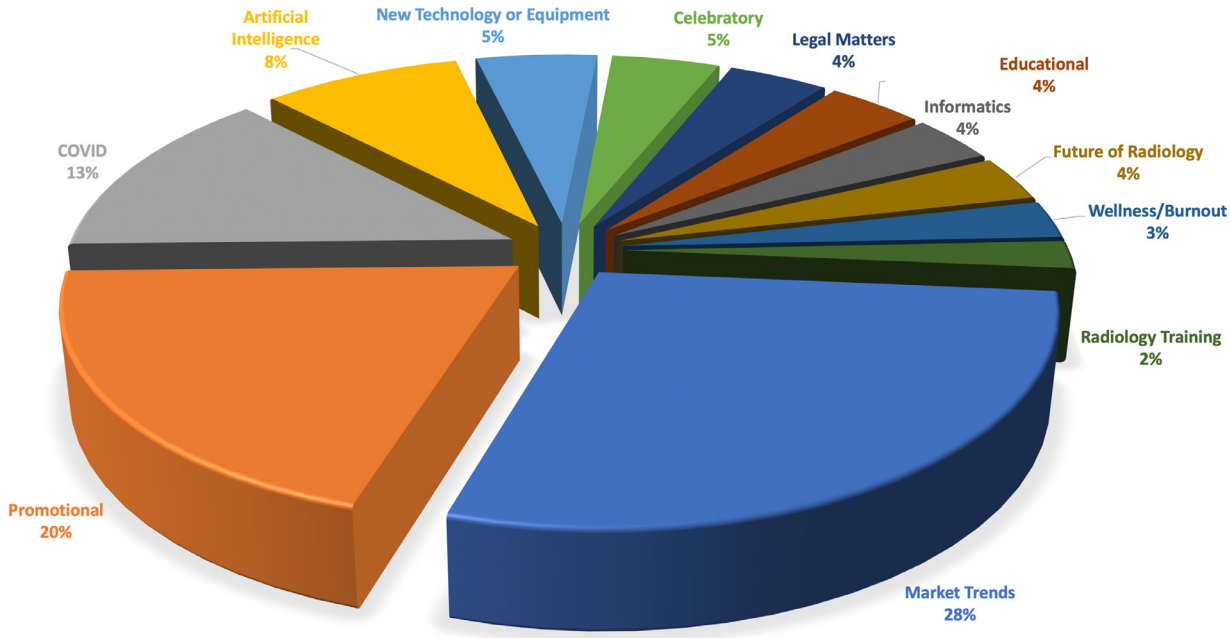

FIG 3. Content of articles from Google Alerts. Google alerts content most frequently related to market trends, promotional material, or COVID-19.

We identified a diverse set of sources providing new searchable radiology-related content. Links most frequently came from non-radiology lay press (68%), followed by radiology-related lay press (28%), with a much smaller fraction coming from university publications (2%), and professional medical societies (2%). In addition to the lay press predominance, only two links (<1%) over the 6-month period sent the user directly to a primary peer-reviewed medical journal article. These findings highlight the importance of staying well-informed of medical coverage by traditional non-radiology lay press outlets and/or making active attempts to publicize research or viewpoints in these forums. These mediums can be the primary guiding source for public perception of medical topics, rather than primary peer-reviewed literature that is most frequently viewed by physicians. This is especially important as prior work has shown that media articles can be sensationalized[24,25] and may omit basic facts, which have the potential to mislead the public.[2,26]

TABLE 2
Sub-categorization of the five most frequent primary topics of discussion pertaining to links sent by Google Alerts from November 2019 through April 2020 using the search criteria "radiology".

Primary Topic	Subcategory Frequency (Percentage)	
Market Trends (n = 148)	Information Technology	71 (48%)
	Interventional Radiology	31 (21%)
	Radiology Equipment	16 (11%)
	Reimbursements	10 (7%)
	Dental Radiology	9 (6%)
	Pediatric Radiology	7 (5%)
	Veterinary Radiology	3 (2%)
	Bankruptcy	1 (1%)
Promotional (n = 104)	New Partnership	40 (39%)
	Career Advancement	39 (38%)
	Business Advertisement	17 (16%)
	Meeting Advertisement	8 (8%)
COVID-19 (n = 69)	Operational Issues	45 (65%)
	COVID-19 Related Death	10 (15%)
	Imaging Findings/Guidelines	5 (7%)
	Experimental Research	4 (6%)
	Recognition/Philanthropy	3 (4%)
	Effects on Education	1 (1%)
	Epidemiology	1 (1%)
Artificial Intelligence (n = 44)	Perception	12 (27%)
	Implementation	9 (20%)
	Software	8 (18%)
	Journal/Research	5 (11%)
	Regulation	4 (9%)
	Limitations	4 (9%)
	Funding	1 (2%)
	Workshops	1 (2%)
New Technology or Equipment (n = 27)	Imaging Equipment	15 (56%)
	Imaging Software	6 (22%)
	Virtual/Augmented Reality	3 (11%)
	AI Software	2 (7%)
	Software Competition	1 (4%)

Some links (15%) were secondary descriptions of primary peer-reviewed journal articles. Of these, 30% were from non-radiology lay press. In addition, of the 17 articles covering topics directly related to the 2019 RSNA Annual Meeting, the majority (65%) were from non-radiology lay press. This implies that non-medical lay press outlets are paying significant attention to radiology literature and large national meetings as topics worthy of coverage.

Our study also highlighted that radiology-related online content encompasses a wide variety of topics. The most common of these were market trends (28%). Market trends have consistently been a topic of discussion in radiology literature, including topics such as market shares, the job market, and growth trends.[27-30] For example, the 2019 Medicare Physician Fee Schedule proposed by the Centers for Medicare and Medicaid Services has been a topic of much discussion within the radiology community in recent months.[31,32] To our surprise, however, we found that only 7% ($n = 10$) of all links discussed the topic of radiology reimbursements, which is popular in peer-reviewed literature.[31,33] Rather, links related to market trends most frequently discussed recent and future market growth trends in the areas of information technology, interventional radiology, and radiology equipment.

The first link related to the COVID-19 pandemic was sent by Google Alerts on February 20, 2020, a full nine days before the first reported COVID-19 related death in the United States.[34] After this, 43% of links were related to coverage of the COVID-19 pandemic. Recent months have seen rapidly evolving practice and clinical guidelines,[13,14] and our findings highlight the potential role that Google Alerts can play in assisting radiologists stay up-to-date during times of rapid change. Google Alerts provided links that covered a broad

range of COVID-19 related topics. Most frequently, links offered insights into operational issues, such as ways to prepare imaging suites, protect staff, maintain practice volumes, and impending financial burdens. Several links brought awareness to COVID-19 related deaths of radiologists and radiographers. Surprisingly, only one link discussed the effects of the pandemic on radiology trainees, a topic that has received much interest in recent literature.[35-37]

We also found a large proportion (20%) of promotional material via Google Alerts. These links often discussed new business partnerships, career accomplishments (such as a new hiring, promotion, or award), and advertised businesses and society meetings. Prior research has suggested that radiologists and radiology departments could utilize social media to promote their departments.[38-40] The results of our study demonstrate the additional role that non-social internet media plays in the promotion of departments and radiologists in order to increase visibility.

The fourth most common topic covered was artificial intelligence (8%). This is no surprise, as artificial intelligence is one of the hottest topics in the radiology peer-reviewed literature, with over 8000 articles published worldwide in the past two decades, a number which is rapidly rising.[41] The links we found via Google Alerts covered a broad range of topics, including perceptions, issues with implementation, new software, and new research. However, only a small percentage (9%) of links discussed the potential limitations of artificial intelligence. This is concerning, as the prospect of artificial intelligence is often cited as a point of concern for medical students considering radiology as a career choice and radiologists concerned about their job prospects,[42] despite well-documented limitations.[43,44] This suggests that there should be more participation by radiologists to disseminate well-rounded information on artificial intelligence into the lay press.

Lastly, a small proportion (8%) of links had one or more content viewing restrictions, including requirement for account creation, deactivation of ad-blockers, and paywalls. This is helpful information to know, as widespread public access to health-related information is advantageous for the purposes of the expansion of scientific knowledge of the community, although there are obvious financial downsides for those providing this information for free. Our results parallel not only the rapid global expansion of access to the internet, which provides an enormous amount of information at no cost, but also the recent open access movement in the scientific community, calling for expanded access of journal articles,[45] with many diagnostic and interventional radiology journals following suit.[46]

There are several limitations of our study. We evaluated links over a 6-month period, so these results may not be generalizable to the entire calendar year. Second, we used a blanket search term of 'radiology' and users may desire to choose their own search term relevant to subspecialty or imaging modality. Lastly, there is uncertainty regarding the details of Google's (and thereby Google Alerts') automated search algorithm, which may prioritize results based on its own preferences, a user's search history, and/or its advertisers, as it does in its standard publicly-available search engine.[47] It is also unclear if the links provided by Google Alerts correlate with changes in search result prioritization on Google itself.

Conclusion

New radiology-related media obtained from a popular search engine were largely provided by traditional non-medical news sources and infrequently described peer-reviewed literature. Google Alerts may be a useful tool that radiologists can use to design unique searches relevant to their practice area and stay abreast of the most current public radiology or subspecialty subject matters, especially during these times of social isolation and rapidly evolving clinical practice.

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