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## Volume 13 - Issue 2, 2013 - Cover Story: Social Media

### Social Media in Radiology

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Social media have now become familiar companions to everyday life, thanks to the widespread diffusion and ongoing technological evolution of highly portable mobile devices wirelessly connected to the Internet. In parallel, an increasingly large number of applications of social media have been designed to aid the radiologists' work. Some technical factors have contributed to driving this evolution, including:

A dramatic increase in the degree of component miniaturisation, leading to the development of ultra-mobile devices (such as smartphones and tablets) with an excellent power-to-weight ratio and long battery life

The availability of faster wireless internet connections with greater data capacity, enabling transfer of larger amounts of data within reasonable time compared to just a few years ago;

The development of cloud-based and stand-alone software tools (either as ultra-mobile versions of desktop or laptop applications, or new apps natively conceived for ultra-mobile platforms) for the medical community.

In the following sections the main radiologists will be reviewed, and some for the radiological community will be briefly illustrated.

#### Social Media for Education

Medical education is one of the fields in which social media may offer a very valuable support to radiologists and to physicians in general. Several online resources are available for continuing self-education of healthcare professionals, as well as for teaching and training of medical students and residents.

The main resources are represented by educational websites, which typically provide news, clinical and/or radiological cases, and review articles distributed for free or at a relatively low cost. Some of them are also optimised for usage on smartphones or tablets for maximum portability. Two excellent educational websites (both offering online CME tests) are Auntminnie ([http:// www.auntminnie.com](http://www.auntminnie.com)) and Medscape (<http://www.medscape.com>), the first focused on radiology,

with special attention to technical advancements and industry products, the other providing articles and news covering all medical specialties.

Major radiological societies give access to education and training resources, such as the European Society of Radiology (ESR, <http://www.myesr.org>), the Radiological Society of North America (RSNA, <http://www.rsna.org>) and the American Roentgen Ray Society (ARRS, <http://www.arrs.org>). Registered members can contact other members and share information, ideas or comments on virtually any topic of interest posted on website forums. To this purpose, radiological societies have a Facebook and/or a Twitter account, dramatically expanding the potential for interaction among radiologists and between them and other specialists. Members can also gain online access to official society journals and apply for participation in congresses and enrolment in stages, seminars or exchange programs for fellowships.

Other portals exist, such as Radiopolis (<http://www.radiopolis.com>), offering collaboration and educational resources for radiologists including forums, community blogs, and interactive teaching files. More dedicated resources are also available for use in radiologists' daily practice, such as calculators (e.g. glomerular filtration rate, pneumothorax size, TNM-based tumor classification) or statistical analysis tools.

Another important website is Radiopaedia.org (<http://radiopaedia.org>), an open-edit educational radiology resource which has been primarily compiled by radiology residents, registrars, fellows, and consultants from across the world. Users can even share their own cases or post articles on the site through a process of collaborative publication. All these portals have links to the major social networks (i.e. Facebook or Twitter), favouring dissemination among non-members and further expanding potential collaboration among radiologists.

### Mobile Apps

The evolution and increasing diffusion of ultra-mobile devices has spurred the development of lightweight, user-friendly, and exhaustive apps providing schematics, diagnostic flow charts, calculators of physiological parameters, and anatomoradiological atlases. Those apps, many of which are freely available online, usually require only modest processing power and can run natively on smartphones or tablets, easing on-the-go consultation by radiologists during their working sessions. Two examples are Radiology Assistant (<http://www.radiologyassistant.nl>) and IMAIOS e-Anatomy (<http://www.imaio.com/en/e-Anatomy>), the former providing schematic, but rigorous information on the main diagnostic topics throughout the entire body, and the latter detailed atlases of cross-sectional anatomy based on images obtained from several imaging techniques (such as CT, MRI, or conventional radiography).

### Social Media for Consulting and Image Sharing

Another important role of social media in radiology is to enhance communication among radiologists, and between themselves and non-radiology specialists. A typical scenario is the solution of a difficult case by a working radiologist that cannot be easily and/or quickly solved by searching across several websites or radiology treatises (which, in turn, usually refer to more specialised and hard-to-find books or articles). Likewise, social media can be essential to get information about particular conditions that occur rarely and are hard to find in conventional textbooks, monographs, or reviews. For instance, while these latter resources are usually adequate for working out many 'typical' cases, it is not rare in a radiologist's everyday working life to see patients with several comorbidities and/or distorted anatomy (e.g. due to surgical interventions or radiation therapy), where it can be really troublesome to formulate a diagnosis. Under these conditions, it can be very effective to describe the case in detail to a colleague on a post or via chat, ensuring that the consultant have access to all needed information. In addition, such a collaboration model has a great potential for reducing overall reporting times and interpretation errors, especially in complicated cases for which the advice of a colleague with specialised skills in a particular field can be extremely helpful. To this purpose, tablet versions of VoIP (Voice over Internet Protocol), videochat, and instant messaging services (such as Skype or Apple Facetime®) can be useful. Online services are also available that allow sharing of medical images with colleagues or patients using an authenticated account, such as Image32 (<https://www.image32.com>). Images from any imaging modality can be uploaded in DICOM format and compressed with the option to remove protected healthcare information (PHI) layers for secure data transfer and storage. Common types of web browsers are supported and ultra-mobile versions of the service are available for use on Apple® (iPhone®, iPad®) or Android devices.

### Social Networks

Increasingly popular social networks to connect physicians and other professionals from different countries and specialties are LinkedIn (<http://www.linkedin.com>) and ResearchGate (<http://www.researchgate.net>). ResearchGate is more academic-oriented, and allows subscribers to publicly keep track of and share their own publications, with the option to upload PDF versions of their published full-text articles for consultation by other users. Vice versa, users may follow the research activity of other subscribers, request full-text papers, ask questions, and endorse registered colleagues with experience in specific topics.

### Cloud-Based Tools

Other, more general-purpose tools for sharing images and all types of data are cloud-based data storage services,

such as Dropbox (<http://www.dropbox.com>), Google Drive (<https://drive.google.com>) or SugarSync (<https://www.sugarsync.com/>), which provide online disk storage for free or upon payment of a fee (depending on the purchased total disk size or amount of exchanged data). Files can be organised in folders as on a regular physical disk, shared with other users chosen by the subscriber, and are transferred and stored on redundant servers using advanced encryption algorithms to maximise data protection and integrity. However, it is the user's responsibility to ensure that no confidential information is unduly delivered over the Internet, and specifically radiologists must take extreme care to avoid breaching patients' confidentiality when sharing medical images with colleagues through the web.

A more advanced level of collaboration can be achieved if real-time remote interaction with a consultant can be integrated with image viewers, potentially allowing for a more complete exchange of information among users. A nice example of such a fully integrated collaboration service is the iChat Theatre feature built in OsiriX (<http://www.osirix-viewer.com>), enabling users to video-chat with colleagues while showing them radiological cases from the OsiriX environment. In this setting, the recent availability of tablets with very high screen resolution allows radiologists to see or show images on hand-held devices connected to the hospital PACS infrastructure, without the need for costly and bulky dedicated stand-alone workstations (see Figure 1). However, it should be considered that, while some tablets and image viewing apps have gained FDA and/or CE approval as medical devices, they do not have the ergonomics, flexibility, and processing power of conventional workstations (though this latter limitation can partly be overcome by thin-client solutions, by which all operations are performed remotely on a server) (John et al. 2012). Keeping in mind those limitations, tablets have been shown to be effective for preliminary 2D reading of medical images in an emergency setting, such as head CT (McLaughlin et al. 2012), CT pulmonary angiography (Johnson et al. 2012), or spinal MRI studies (McNulty et al. 2012), with the potential of saving time and improving patient care (see Figure 2). Surgery is another area that may benefit from the evolution of ultramobile technologies (Dala-Ali BM et al.) with some surgeons already using tablets in the operating room to assist

interventions (a nice example is World 1st iPad Surgery: OsiriX 3D navigation, can be seen at <http://youtu.be/n5nbNlpqdAY>).

## **Conclusions**

Social media and ultra-mobile devices have dramatically evolved over the last five years and, despite their youth, they can offer radiologists a wide set of tools that can be very useful for their scientific and professional activity. In particular, today radiologists may rely on a wealth of educational resources and collaboration tools that can be accessed virtually everywhere a wireless internet connection is available, without the need for dedicated workstations, printed atlases or textbooks, or physical vicinity of consultants. Radiologists should be aware of the great potential of these resources as well as of their current limitations and risks (with particular reference to mobile image viewing solutions and data confidentiality issues), in order to get the maximum benefit from them.

Published on : Thu, 19 Sep 2013