Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: http://www.elsevier.com/locate/rpor

Review

Smartphones and tablets: Reshaping radiation oncologists' lives

Alfonso Gomez-Iturriaga[a,*], *Pedro Bilbao*[a], *Francisco Casquero*[a], *Jon Cacicedo*[a,b], *Juanita Crook*[b]

[a] *Department of Radiation Oncology, Hospital Universitario de Cruces, Barakaldo, Vizcaya, Spain*
[b] *Department of Radiation Oncology, British Columbia Cancer Agency, Center for the Southern Interior, Kelowna, BC, Canada*

ARTICLE INFO

Article history:
Received 12 December 2011
Received in revised form
15 July 2012
Accepted 1 August 2012

Keywords:
Technology
Smartphones
Tablets
Radiotherapy
Cancer

ABSTRACT

Background: Smartphones and tablets are new handheld devices always connected to an information source and capable of providing instant updates, they allow doctors to access the most updated information and provide decision support at the point of care.
Aim: The practice of radiation oncology has always been a discipline that relies on advanced technology. Smartphones provide substantial processing power, incorporating innovative user interfaces and applications.
Materials and methods: The most popular smartphone and tablet app stores were searched for "radiation oncology" and "oncology" related apps. A web search was also performed searching for smartphones, tablets, oncology, radiology and radiation oncology.
Results: Smartphones and tablets allow rapid access to information in the form of podcasts, apps, protocols, reference texts, recent research and more.
Conclusion: With the rapidly changing advances in radiation oncology, the trend toward accessing resources via smartphones and tablets will only increase, future will show if this technology will improve clinical care.

1. Background

Smartphones and tablets are handheld devices that offer not only the standard facilities such as voice and text communication, but also advanced computing and communication capability, including, for example, Internet access and geo-positioning systems. Most of the newer generations incorporate other features such as on-board personal management tools, high quality cameras and recording devices. They run on a specific operating system and can download applications (apps) that run on the operating system.[1,2]

These portable systems enable users to accomplish tasks anywhere, anytime, are significantly cheaper than personal computers and can be easily carried wherever a medical professional is working.

The subject of new technologies and medicine is the connection of two fast-evolving systems: health and technology. This connection is a dynamic one in which communications advance both consumers' and providers' engagement with

* *Corresponding author at*: Department of Radiation Oncology, Hospital Universitario de Cruces, Plaza Cruces-Gurutzeta, 12, 48903 Barakaldo, Vizcaya Spain. Tel.: +34 946006232; fax: +34946006627.
E-mail address: alfonso.gomezdeiturriaga@osakidetza.net (A. Gomez-Iturriaga).
1507-1367/$ – see front matter © 2012 Greater Poland Cancer Centre. Published by Elsevier Urban & Partner Sp. z o.o. All rights reserved.
http://dx.doi.org/10.1016/j.rpor.2012.08.001

Table 1 – Functions and topics of the apps presented in the manuscript.

Topic	Name	Functions
Radiology	*Mobile MIM*	Evaluation of images from CT, MRI and PET scans
General oncology	*NCCN guidelines*	Access to the guidelines and updates
	CTCAE v. 4.0	Access to the latest approved version of the National Cancer Institute's Common Terminology Criteria Adverse Events standard.
Radiation Oncology	*BED calculatoreLQRadiation Oncologist tool*	Use the linear-quadratic (LQ) model to calculate the biologically effective dose (BED) in various radiotherapy protocols involving different numbers of dose fractions.
	Varian medical systems	Series of interactive Educational Videos, for both patients and physicians on the latest advances including IMRT and IGRT for professionals
General medicine	*Up to dateMedscape*	Access to the interactive encyclopaedia of medical knowledge
	Draw MD	Allow anyone to sketch, stamp, or type directly on detailed anatomic images. Providing the ability for doctors to communicate and explain treatment plans, including surgical procedures, as well as document these plans for patient records

health information technology. It is here that the ubiquity of these small, interconnected computers plays a very appealing role, meaning that every physician will soon have access to a wide collection of software and hardware to help them perform their daily work, and it will happen sooner than we probably think.

2. Radiation oncology and technology

The practice of radiation oncology has always been a discipline that relies on advanced technology and the key clinical, technical and administrative support roles it plays are now firmly established.

In recent times, radiation oncology clinical practice has become increasingly dependent on images and servers that can be accessed in real-time from decentralized locations. The rapid development of Internet web sites in combination with portable technology has opened a new and growing communications pathway to ensure that these workflow needs can be met successfully.

Students, trainees and early adopters among us have embraced the notion that smartphones and tablets improve clinical care because of rapid access to most updated information in the form of podcasts, apps, protocols, reference texts, recent research and more. It is not necessary to carry tons of books or subscribe to dozens of hard copy journals anymore.

3. Apps

Today's smartphones provide substantial processing power, incorporating innovative user interfaces and applications ("apps").[3] Based on growth trends, by August 2012 there will be more than 13,000 iPhone health apps available for consumers.[4]

Apps have become so prolific and comprehensive that the federal Food and Drug Administration (FDA) felt the need to craft a review and approval process for medical apps, which is about to be enforced for the most vital ones out there. The first will be those that transform smartphones or tablets into medical devices, such as glucose meters or blood pressure monitors, and which control existing FDA-approved gear like insulin pumps.[5]

Those apps such us medical calculators simplify the bedside use of medical equations, scores, stratification, and risk prediction and prevention models. These devices can assist with physical examinations using applications to check hearing, eyesight, and color recognition; evaluate mental status; or photograph or video document physical findings (Table 1).

They are no longer restricted to numeric or text data and allow viewing of "digital information and communication in medicine" (DICOM) formatted 3-dimensional imaging data from "radiology information" or "picture archiving and communication systems" (RIS/PACS) in conventional radiology, ultrasonography, computed tomography and magnetic resonance imaging, or endoscopy.[6] The first application for diagnostic image review on the iPad, iPhone, or iPod touch was approved by the FDA in February. The application – the Mobile MIM from Cleveland-based MIM Software™ [7] – can be used to view results of CT, MR imaging and PET exams on mobile devices and use those images to make diagnoses. This application opens a new scenario that could be of great interest for radiation oncologists. In the near future, we are likely to be able to contour structures, design target volumes and evaluate dosimetric plans, check the cone-beam images, perform DRRs fusion, etc.

For example, in iTunes App Store there are currently around 150 apps accessible by searching for "oncology", although not all of them are relevant for oncologists, there are a few that may well be of interest.

The National Comprehensive Cancer Network (NCCN; Fort Washington, PA, USA) Clinical Practice Guidelines in Oncology are free mobile apps developed for the iPhone and Android systems. These are free to download and support access to all NCCN guidelines, and their updates.[8]

Another attractive free app available in the iTunes App Store is CTCAE v4.0. This app uses the latest approved version of the National Cancer Institute's Common Terminology Criteria Adverse Events standard. Members of a research team now have the access to more than 190 pages of the original document in a portable, highly intuitive, hierarchical interface.[9]

The old-fashioned medical encyclopaedias and popular journals, now have entered the Medicine 2.0 era with an interactivity and search functions galore. A good example is UpToDate. A huge interactive encyclopaedia of medical knowledge which has half a million subscribers, and is now sporting an iOS app. There is a free alternative, Medscape by webMD,

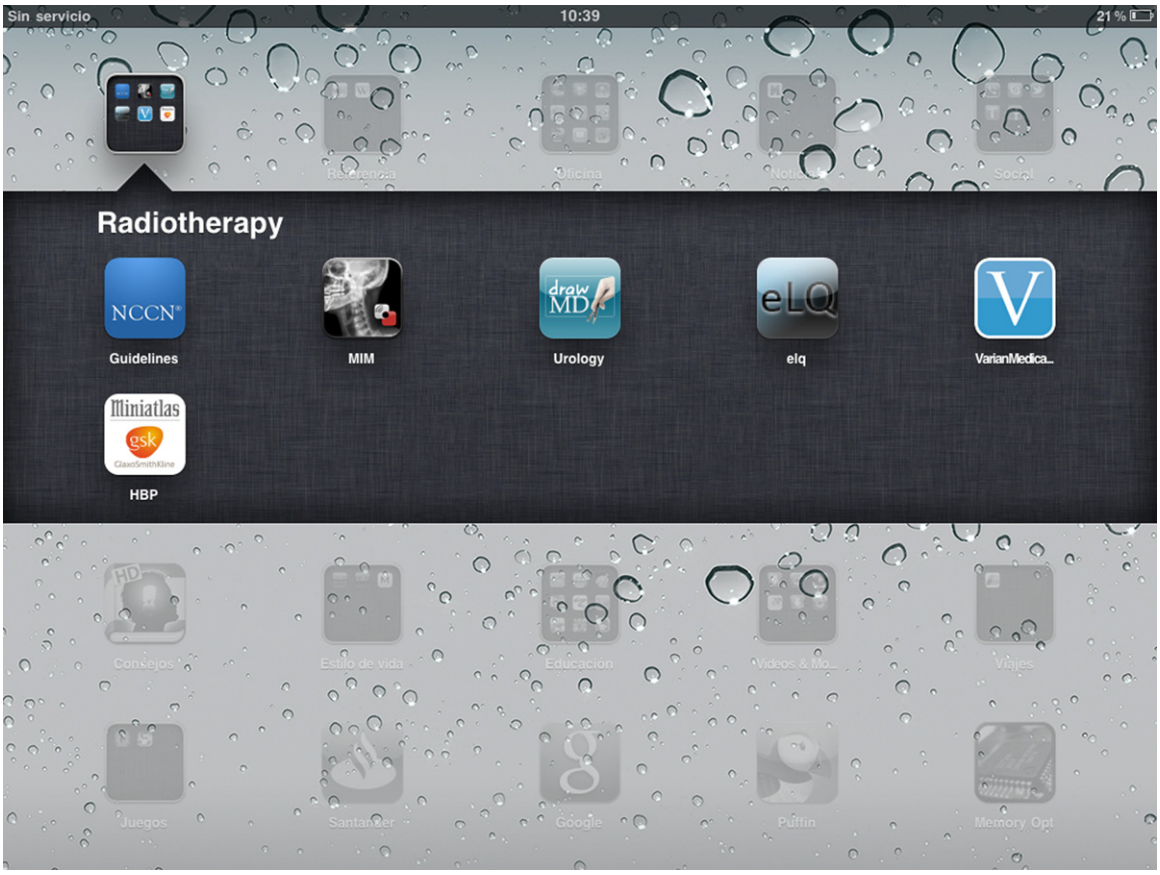

Fig. 1 – Radiation oncology apps in an iPad 2.

which has both iOS and Android versions, and its database is similarly mind-boggling with 3500 disease clinical references, twice as much drug references, 2500 + clinical images and procedure videos, a drug interaction tool, and so on.[10]

There are also a few specific apps for radiation oncology. Most of them are calculators that use the linear-quadratic (LQ) model to calculate the biologically effective dose (BED) in various radiotherapy protocols involving different numbers of dose fractions. This applications calculate BED for a given alpha/beta ratio as a function of dose per fraction and the number of fractions based on the equation suggested by Dr. Jack Fowler[11–13] (BED calculator, eLQ, Radiation Oncologist tool).

Varian Medical Systems Inc., the world's leading manufacturer of medical devices and software for radiation treatments, has not lagged behind and has developed an app with a series of interactive Educational Videos, for both patients and physicians. Each downloadable video provides important step-by-step information in an easy-to-understand interactive presentation for patients, and focuses on the latest advances including IMRT and IGRT for professionals.[14]

Although not specific for Radiation Oncologists, there are different anatomic atlases that can be used in our daily work. For example, drawMD is an app designed to improve patient understanding of medical problems. drawMD utilizes the iPadïs interface to allow anyone to sketch, stamp, or type directly on detailed anatomic images. The included images are tailored to each specialty and provide the ability for doctors to communicate and explain treatment plans, including surgical procedures, as well as document these plans for patient records.[15]

4. Books, protocols and guidelines

Another interesting fact is the way tablets are replacing books in the most famous medical schools, and how mobile apps are changing the curricula. Yale University, for example, will be giving all of its 520 first year students an iPad 2 with a keyboard, while Harvard is actually creating its own medical apps (see Fig. 1).[16]

In addition, it has recently been announced to students at Manchester Medical School that those currently in year 4 (out of 5) will be offered Apple iPad 2s in order to assist them with their studies. In its announcement, the School points at three key objectives – to reduce its carbon footprint, effectively manage/access bidirectional feedback, and access e-resources from anywhere.[17]

Smartphones and tablets allow doctors to access the most updated information in the form of podcasts, apps, and more. They do not need to carry tons of books or subscribe to dozens of hard copy journals. These handheld devices can provide both information and decision support at the point of care by accessing traditional medical textbooks, professional society

guidelines, drug references, and institution-specific therapy standards.

In the oncology world, protocols, interventions, and research change at a rapid pace, causing day-to-day variations in the ways that patients are treated. It is very important for an oncologist to have the most up-to-date information as soon as it is available, including clinical guidelines and articles from numerous medical journals. Smartphones and tablets are always connected to an information source and are capable of providing instant updates.

These devices are not a magic potion but, in the hands of a skilled physician user, can provide instantaneous access to synthesized evidence in point-of-care tools, such as the Cochrane Library, DynaMed and UpToDate, guidelines or e-books related to our area of expertise.

5. Security

A different utility being investigated about these devices is the role they could play in terms of security. The Department of Radiation Oncology at Rhode Island Hospital/Brown Alpert Medical School has designed a project called: Implementing Smartphone Technology for Radiation Oncology for Error Prevention. The goal of this project is to develop and implement an innovative approach to minimize the incidence of radiotherapy adverse events that could potentially have negative impacts on patient safety by using smartphone technology.[18]

6. Pros and cons of multitasking and "always on" status

Smartphones and tablets enable users to accomplish tasks anywhere, anytime and allow performing multiple tasks during the same period of time. Multitasking has been introduced to make computers more productive, operating systems perform multiple tasks by scheduling processes that use different strategies, which may or may not have profitable effects.

There are of course pros and cons to multi-tasking and this has been profoundly discussed in the last years. It allows us to approach more projects with a hint of variety. However, on the other hand, multi-tasking can make us feel overwhelmed and may result in a poor quality of work.

Some "pros" are: it keeps you connected along work, it makes it possible to collect information from multiple sites simultaneously, it saves time by making its users capable of working on multiple programs at the same time, and it keeps you updated by letting you get information from multiple resources.

The biggest cost is to the productivity, a consequence of splitting the attention in multiple activities but rarely fully engaged in any one of them. In part, because when switching away from a primary task to do something else, the time taken to finish that task is increased by an average of 25%.[19]

As more doctors employ smartphones and tablets and drop work-only pagers, the potential for distractions is rising. Physicians are interrupted nearly five times an hour by phone calls, emails and face-to-face interactions.[20]

Facing the above mentioned problems, experts have suggested some tips to use the multitasking more effectively and avoid interruptions and distractions from the "always on" status, such us implementing security protections for mobile devices that enable work-related and consumer functions to be isolated from each other, allowing only employer-supplied mobile devices to be used in patient care, building reminders into computerized order entry systems, implementing rules or guidelines for optimal safe use of mobile devices, or ensuring that routine personal interruptions do not affect the delivery of quality care by silencing or minimizing nonclinical communications.[21]

7. Conclusions

The arrival of smartphones and tablets in our lives is a step forward from the days of PDAs and, further back, hard copy books and journals. With the rapidly changing clinical advances in radiation oncology, the trend toward accessing resources via smartphones and tablets will only increase.

It is not far away the time for us to be able to carry out our contouring in a tablet, check dosimetry plans in a smartphone and for a physicist from the physics department to perform brachytherapy real time planning with a responsible physician being in the operating room.

Technology will change forever the way we obtain and process medical information and the way we practice medicine.

Conflict of interest

None declared.

REFERENCES

1. Smartphone definition. http://www.smartphoneappspedia.com/ [accessed October, 2011].
2. Definition: tablet PC. http://searchmobilecomputing.techtarget.com/definition/tablet-PC [accessed October, 2011].
3. Shih G, Lakhani P, Nagy P. Is android or iPhone the platform for innovation in imaging informatics. *J Digit Imaging* 2010;**23**:2–7.
4. Consumer health apps for Apple's iPhone. http://mobihealthnews.com/research/consumer-health-apps-for-apples-iphone/ [accessed October, 2011].
5. Smartphones and tablets as medical devices. http://www.phonearena.com/news/Smartphones-and-tablets-as-medical-devices_id21791 [accessed November, 2011].
6. Baumgart DC. Smartphones in clinical practice, medical education and research. *Arch Intern Med* 2011;**171**: 1294–6.
7. Mobile MIM for the iPad & iPhone. http://www.mimsoftware.com/products/mobilemim [accessed October, 2011].
8. NCCN guidelines apps for iphone and android. http://www.nccn.org/mobile/default.asp [accessed September, 2011].
9. CTCAE by global clinical solutions. http://itunes.apple.com/us/app/ctcae/id436917453?mt=8 [accessed October, 2011].
10. Review of the much anticipated UpToDate iPhone app, arguably the most read medical reference tool. http://www.

imedicalapps.com/2011/08/the-much-anticipated-uptodate-iphone-app-is-finally-here-app-review/ [accessed October, 2011].
11. BED calculator: radiation dose http://itunes.apple.com/br/app/bed-calculator-radiation-dose/id397088240?mt=8 [accessed October, 2011].
12. eLQ By SFjRO http://itunes.apple.com/us/app/elq/id398906906?mt=8 [accessed November, 2011].
13. Radiation oncologist tool. http://itunes.apple.com/us/app/radiation-oncologist-tool/id440336064?mt=8&ls=1 [accessed November, 2011].
14. Varian medical systems. http://itunes.apple.com/br/app/varian-medical-systems/id439615305?mt=8 [accessed November, 2011].
15. Draw md. http://www.drawmd.com/ [accessed October, 2011].
16. Med school gives students iPads. http://www.yaledailynews.com/news/2011/aug/26/med-school-gives-students-ipads/ [accessed September, 2011].
17. First UK medical school trials the Apple iPad, Manchester Medical School. http://www.imedicalapps.com/2011/09/uk-medical-school-apple-ipad-manchester-medical-school/ [accessed September, 2011].
18. Implementing smartphone technology for radiation oncology error prevention; 2011.
19. Pros and cons of multitasking in information technology jobs. http://www.1stwebdesigner.com/design/pros-cons-multitasking-it-jobs/; 2011 [accessed July, 2012].
20. Wu R, Rossos P, Quan S, et al. An evaluation of the use of smartphones to communicate between clinicians: a mixed-methods study. *J Med Internet Res* 2011; **13**:e59.
21. Halamka. Order interrupted by text: multitasking mishap. Morbidity and mortality rounds on the web; 2011.