The Benefit of the Smartphone in Oral and Maxillofacial Surgery: Smartphone Use Among Maxillofacial Surgery Trainees and iPhone Apps for the Maxillofacial Surgeon

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Abstract The use of smartphones has soared among healthcare professionals in recent years, with estimated figures reporting that the majority of clinicians own and use smartphones in the workplace. Smartphones allow the clinician to carry textbooks in their pocket, write documents on the move and use email and internet to enhance productivity and clinical decision making. These advances in smartphone technology have enabled access to healthcare information for the clinician and transfer of data between team members, giving rise to the phenomenon of telemedicine. With the ability to instantly transfer clinical data to the off-site surgeon, combined with purpose-built medical apps, the smartphone is rapidly becoming an invaluable tool for the modern surgeon. Many studies have linked the benefits of smartphones and apps in other surgical specialities, but no article to date has highlighted the merits and full scope of this technology to the Oral and Maxillofacial Surgeon. We report that 94 % of British maxillofacial surgery trainees own a smartphone, with 61 % owning an iPhone. 89 % of trainees questioned had downloaded medical apps and used them regularly during clinical activities. We discuss the clinical application of the smartphone in the field of oral and maxillofacial surgery and review a list of useful and relevant apps for the modern maxillofacial surgeon using the iPhone as an example platform.

Keywords Smartphone · iPhone · Application · App · Oral and maxillofacial surgery · OMFS

Introduction

A smartphone is a category of mobile device that provides advanced capabilities beyond a typical mobile phone. Smartphones have a complete operating software system that provides a standardised interface and platform for application developers. They allow users to carry a mobile phone, games console, music player, camera, calendar and internet browser all in one small handheld device, with their limitations governed only by the types of applications (apps) downloaded onto them. The smartphone is now omnipresent among the general public and has rapidly permeated into healthcare, with recent studies estimating that over 80 % of doctors own a smartphone [1]. Evidence is growing to support the use of smartphones in the clinical setting, with benefits demonstrated as an electronic educational resource, in clinical decision making support and in the prevention of medication errors [2]. As an enhanced communication tool, studies have reported that smartphones were strongly preferred over any other form of hospital colleague–colleague communication. Improvements were seen in efficiency, ease of communication and overall satisfaction judged by hospital staff [3].

The combination of text, photography, email and live video function has created the novel ability for immediate remote medical consultation, which for many hospital specialties is proving very valuable. General surgery trainees have reported the numerous advantages of the multifunctional smartphone for on-the-move decision-making and communication with colleagues. Dala-Ali et al. [4] discussed the benefits, for surgeons, of carrying a portable calendar, a full contact list, having instant access to hospital emails and the ability to make telephone calls. By their own admission, surgeons are “notoriously difficult to

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contact”, thus using a smartphone to combine many useful functions on one device has proven especially useful.

Medical and surgical specialties alike are finding numerous uses for the advanced capabilities of smartphone technology, and their popularity continues to increase. As a direct consequence there has been an overwhelming increase in third party apps available for download, irrespective of the brand of smartphone platform used. Previous literature has discussed the use of smartphones and apps in many surgical specialties [4–6]. To date, no article has highlighted the merits or full scope of this technology within oral and maxillofacial surgery (OMFS).

The aims of this paper are to investigate current patterns of smartphone and medical app use among British OMFS trainees, and inform the readership of the benefit of the smartphone within OMFS. We use the iPhone as an example platform to review a (non-exhaustive) collection of useful apps for the modern maxillofacial surgeon, discussing the specific clinical merits of the smartphone within OMFS.

Methods

Using an online survey tool (www.surveymonkey.com) we contacted British OMFS trainees via email, registered with the ‘Fellows in Training’ (registrar/specialty level trainees) and ‘Junior Trainee Group’ (open to OMFS senior house officers and interested medical and dental students) of the British Association of Oral and Maxillofacial Surgeons online forums. The survey [Appendix 1] was sent out twice, with a one-month window between each distribution. No honorarium was offered. The short questionnaire asked basic questions relating to smartphone and medical related app ownership, utilisation of the smartphone during clinical activities and which specific apps trainees found most useful. Questions were derived from previous literature [5, 7] and the personal experience of the authors. The survey was constructed by the two first authors, and reviewed by the remaining authors, with minor changes being made at this stage.

Using both the data derived from the *suggested useful apps* section of our trainee survey, and from the authors collective personal experience, we explored useful and relevant apps using the Apple iPhone. In addition, the ‘power search’ function within the App Store was utilized, using keywords to search in different combinations such as ‘maxillofacial’, ‘maxfax’, ‘facial surgery’, ‘head and neck surgery’ among many others. Relevant apps were purchased and presented for the reader with their retail price, App Store star rating and target audience. We later review the apps by category based on content and function.

Results

We received responses from 51 Junior Trainees and 38 Specialty Trainees. At the time of distribution, 120 Specialty Trainees were registered with the Fellows in Training forum and 109 Junior Trainees were registered on the Junior Trainees Group forum. This equated to a response rate of 31.7 and 46.8 % respectively, comparable to other studies of a similar nature [5, 7].

Overall similar patterns of smartphone and app usage were displayed between the junior and senior trainee groups; as such data is grouped and presented together. In total 94.4 % ($n = 84/89$) of trainees owned a smartphone (92.2 % of Junior Trainees and 97.4 % of Specialty Trainees), with 60.7 % ($n = 54/89$) using the iPhone. Of those owning a smartphone, 89.3 % ($n = 75/84$) had downloaded medical related apps, with the majority owning between 1 and 5 medical apps, and very few owning more than 10 (Fig. 1). Frequency of use of medical apps during clinical activities is shown in Fig. 2.

iPhone Apps for the Maxillofacial Surgeon

To provide an educational resource for the readership we have constructed a list of reviewed iPhone apps relevant to the oral and maxillofacial surgeon. This list is derived from suggested useful apps from our trainee survey data and personal experience. We divide apps into one of six categories, based upon content and function (Table 1).

Drug Dosing and Formulary Apps

The *British National Formulary* (BNF) app and the *BNF for Children* app, both offer secure and uninterrupted information on prescribing, dispensing and administering medications. These apps are user friendly and well presented, however the main drawback is the requirement to

Fig. 1 Number of medical related apps owned by maxillofacial surgery trainees already owning a smartphone

Fig. 2 Frequency of use of medical related apps by maxillofacial surgery trainees during clinical activities

pay the full app fee for every BNF update (information is updated biannually and annually respectively).

Paeds ED is a paediatric medication dose calculator with the ability to select drug dose based on age or weight. This is a low cost, quick and simple-use app, which includes all medications relevant to paediatric maxillofacial surgery.

As an alternative to the costly BNF app, *Epocrates* is a free app that is useful for all surgeons. It contains an

excellent drug formulary, together with additional features such as an ‘interaction checker’ and clinical calculators.

Logbook Apps

The *eLogbook* app has the useful feature of syncing directly with the Royal College of Surgeons of England eLogbook website (Fig. 3c). The app itself mimics the web based version but does require an annual subscription fee for website syncing capability. The use of the online Intercollegiate Surgical Curriculum Programme has been mandatory for surgical trainees on the new curriculum [8]. This is used as part of the Annual Review of Competence Progression where trainees have to demonstrate an up-to-date and contemporaneous logbook [9]. The data is housed by the Royal College of Surgeons of Edinburgh, so that no patient identifiable data is kept on the smartphone. This application was co-written by a maxillofacial trainee and is increasingly used by all surgical trainees.

iDoctor gives the surgeon a handheld logbook to record procedures, log patients seen, hours worked,

Table 1 iPhone apps listed within function based categories with cost, app store star rating and training grade target audience information displayed

Category	App name	Cost	App store star rating	Training grade target audience
Drug doses and formulary apps	BNF	£29.99/\$42.99/€33.99	No rating	All grades
	BNF children	£39.99/\$59.99/€44.99	No rating	All grades
	Paeds ED lite	Free (Paeds ED £1.49)	4/5	All grades
	Epocrates	Free (website registration required)	2.5/5	All grades
Logbook apps	Mobile elogbook	Free (annual subscription fee £4.99)	4/5	All grades
Clinical and educational apps	iDoctor	£6.99/\$9.99/€7.99	4.5/5	All grades
	iResus	Free	4/5	Junior-middle grade trainees
	Snellen	Free	3/5	All grades
	AO surgery reference	Free	5/5	Junior-middle grade trainees
	Netters advanced head and neck flash cards	£27.99/\$39.99/€31.99	2.5/5	Junior trainees
	Oxford handbook of ENT and head and neck surgery	£34.99/€39.99	No rating	Junior trainees
	Maxfax SHO	Free	4/5	Junior trainees
Image viewing apps	Mobile MIM	Free (\$1 per patients set of images)	3/5	Middle-senior grades
	OsiriX HD	£20.99/\$29.99/€23.99	No rating	Middle-senior grades
Literature search and journal apps	PubSearch	Free	3/5	All grades
	NEJM this week	Free	3.5/5	All grades
National OMFS association apps	BAOMS	Free	3/5	All grades
	AAOMS	Free	3/5	All grades

Fig. 3 Clockwise **a–d**—screenshots of reviewed apps. **a** Maxfax SHO app, **b** mobile MIM app, **c** mobile eLogbook app and **d** AO surgery reference app

education attended and consults given in a secure interface. The selling point for this app is its comprehensive scope of all working activities compared to other similar apps.

Clinical and Educational Apps

iResus offers up-to-date guidance from the Resuscitation Council (UK) for management of emergencies in and out

of hospital. It is a free app that contains essential information for all physicians and surgeons alike. The real-time updates, algorithm approach, and clearly displayed drug doses make this a fantastic app.

A simple yet useful app, *iSnellen* provides accurate bedside visual acuity recordings for quick and easy documentation. An invaluable tool for the OMFS surgeon to aid medico-legal documentation of orbital and zygomatic insults.

AO Surgery Reference is a comprehensive resource of craniofacial and dentoalveolar surgery (Fig. 3d). It provides technical guidance on approaches, detailed procedures, quick-reference guides and literature search. It has an easy to navigate system which is laid out in a logical manner. Users can choose which area of the craniofacial skeleton they wish to review (skull base and cranial vault, midface, mandible and dentoalveolar trauma). They are then directed into teaching on common fracture patterns, how to manage them, surgical approaches and definitive management, with appropriate aftercare information.

For the panicked trainee pre-theatre or for education and illustration to patients, *Netters Advanced Head and Neck Flash Cards* is a colourful informative app. It provides good content on embryology, development, head and neck anatomy and useful annotated CT imaging for the maxillofacial trainee and beyond.

The *Oxford Handbook of ENT and Head and Neck Surgery* is a useful app for junior trainees. This resource offers some useful cross specialty topics on anatomy, examination and management options of ENT emergencies, parotid, salivary gland and sinus disease as well as head and neck cancer surgery.

Maxfax SHO is a recently released free app useful for junior trainees new to OMFS (Fig. 3a). Currently the only OMFS-specific app in the market, with useful information on emergency and ward based management of all major scenarios, it also houses a useful contacts page for bleep numbers and hospital extensions.

Image Viewing Apps

OsiriX HD is an interactive visualisation programme designed for the display and analysis of medical images. It is compatible with any DICOM-compatible software including PACS servers. It comes at a cost, but is free to operate once synced with the computer or server.

As an alternative to the above app, *Mobile MIM* is a free app, but charges \$1 per patient's set of images (Fig. 3b). Users upload images to a 'cloud' service (a web-based file storage service), which can then be accessed remotely on the iPhone or iPad. It has the benefit of being fully FDA approved to view diagnostic images, with accredited security features. These apps have the greatest potential for the enhancement of telemedicine via the virtual exchange

of medical images aiding learning and offsite management of patients.

Literature Search and Journal Apps

PubSearch is a simple search tool for all medical professionals enabling access to research articles indexed by PubMed (Medline) without the need for a PC. This serves as an excellent tool for all grades and specialties. Access to the free version requires an Institution or Library password, avoided by purchasing the *PubSearch Plus* version (£1.99).

Although not specific to OMFS, the *NEJM This Week* app is the only medical journal of its kind available for iPhone. It offers the latest medical research findings, review articles and editorial opinion from *The New England Journal of Medicine*.

OMFS Association Apps

The *BAOMS* app is the official British association app. Currently this app only provides information on up and coming conferences and events which have BAOMS involvement. The potential scope for expansion, to access the members site and vote in BOAMS council elections via this route will no doubt be explored in the future. Also available is the American Association of Oral and Maxillofacial Surgeons App; this provides a news feed, events listing, and a product guide.

Discussion

We provide evidence that the great majority of British maxillofacial surgery trainees own smartphones and regularly use apps to aid their clinical activities. Furthermore, these high levels of smartphone and app use within the British OMFS trainee community appears to correlate with similar trends in other surgical subspecialties [4] and among medical trainees [7]. Maxillofacial trainees are using smartphones to improve access to health information, notably clinical management or drug guidelines, with little use of more complex apps. This endorsement of new technology within OMFS is both encouraging and vital to our growth as a specialty.

The remainder of this article will discuss the merits of the smartphone, its relevant clinical application and benefits specifically within OMFS. Above we have illustrated many examples of useful downloadable apps, which in themselves make the smartphone a beneficial device for a maxillofacial surgeon. Additional educational opportunities also exist through smartphone downloads such as scholarly podcasts and iTunes U. Below we discuss other

clinical uses of the smartphone's enhanced functionality software.

Access to Health Information

Smartphones have the ability to allow the clinician rapid access to healthcare information, either by utilising a downloaded medical app, opening a stored PDF or e-book within their personal library, or by searching the internet. Most smartphones also have the facility to create text documents for note taking, and having this information to hand when under pressure and on the move cannot be underestimated.

A recent systematic review highlighted the valuable impact of smartphone use in patient care by providing 'point of care' assistance and allowing the clinician to consult the most recent clinical management guidelines 'on-the-go' [2]. A study by Lindquist et al. [10] also advocated the smartphone's capability for immediate access to medical information, which is especially pertinent in time pressurised acute care scenarios. For the maxillofacial surgeon, corollaries can easily be drawn when managing patients with facial trauma and those acutely unwell with oro-facial sepsis, usually seen in the emergency department. One can instantly realise the benefits to the maxillofacial junior of having rapid access to drug dosages in combination with the use of the calculator function to compute drug values. Having immediate access to OMFS and emergency medicine e-books would also benefit juniors when dealing with new scenarios and procedures.

Teleradiology

Teleradiology is a simple but exciting concept very applicable to OMFS, which describes the ability to access radiographs remotely. Studies within cardiology [11] and stroke medicine [12] have provided excellent evidence of diagnostic accuracy when viewing radiographic images remotely on a handheld device. Common to both disciplines above and to OMFS are the problems of time-constrained management decisions combined with off-site seniors at night and on weekends. This ability to remotely visualise X-rays and CTs may be particularly pertinent to OMFS during emergency trauma scenarios.

Photodocumentation

For a maxillofacial surgeon, the ability to clearly record injuries is crucial. Several papers have described novel uses of the smartphone camera feature [4, 13, 14]. A word of caution however for UK-based surgeons, please research and be mindful of local policy regarding clinical photography. In addition, one should always ensure to gain full

informed consent for any such procedure. Many hospital trusts already have in place strict policies to prevent the use of personal photography including mobile phones in the hospital and it is important to refer to these.

Telecommunication

As previously discussed, telephone and email contact are invaluable to on-call specialties, particularly for specialties where the surgeon may be covering more than one site. Plastic surgeons have reported the valuable diagnostic use of the smartphone within their specialty as a tool for remote management of the extremity wound. A pilot study conducted by 3 plastic surgeons, reported success rates of 66–88 % in identifying gangrene, necrosis, erythema, and cellulitis using camera phone images. They were subsequently able to make remote treatment recommendations regarding whether to use antibiotics or to perform debridement from these photographs [13]. Armstrong et al. [15] describe the use of the iPhone *FaceTime* app during consultations and intra-operatively. This video-calling app was utilised by the authors to conduct real-time telemedicine clinic consultations and during surgery to seek advice from a colleague. In a similar article, in an OMFS setting, smartphone telemedicine has been described for "remote specialist consultation", utilising the ability to rapidly send digital images between surgeons [15, 16].

While enhanced telecommunication functions such as Facetime or Skype may prove useful, we advise adhering to local policy regarding video use in a clinical setting.

Obstacles to Smartphone Use and Integration

As with all technological advances, concerns relating to clinical smartphone use have been raised [17]. The surgeon with a smartphone may encounter issues relating to professionalism, security and confidentiality. It opens the user up to indictments about being distracted at work, breaching data security, and even infection control issues of the device itself [18]. Worse still comes the potential problems associated with misplaced devices containing confidential patient details [17]. Technology is changing at such a rate that it is impossible to anticipate the future risks this technology may bring with regard to security. For many hospitals, the technological advances of the smartphone have come ahead of the security regulation that may govern its future use.

Conclusion

The smartphone has the ability to greatly influence the clinical activities of the modern oral and maxillofacial

surgeon and further enhance patient care and safety [2]. However, our review of iPhone apps reveals only a small number currently available specific to OMFS. Nevertheless, the scope for growth and development is vast. Given the ease with which data on smartphones can be carried we should remain mindful of the ethical and legal manifestations of being mobile with such data and maintain our professions guidance on this matter [19].

With the exciting and evolving world of information technology merging with that of medicine, the clinician can use the smartphone to stay abreast of this modernising clinical environment. Medical apps are one example of this technological evolution, which is available to both clinicians and patients. As such, smartphones provide a promising new method of delivering and improving access to health information for maxillofacial surgeons.

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Appendix 1

1. Do you own an iPhone or other smartphone? Please tick that which applies (if no please scroll to the bottom and click 'complete survey')

- a. iPhone
- b. Google android
- c. Blackberry
- d. Nokia
- e. Other
- f. Does not own a smartphone

2. If yes, do you own medical related apps on your smartphone?

- a. No
- b. Yes 1–5
- c. Yes 6–10
- d. Yes 11–15
- e. Yes 16–20
- f. Yes 20+

3. If yes, during clinical activities how often do you refer to the above apps?

- a. Never
- b. Rarely
- c. Sometimes
- d. Often
- e. Always

4. Please list specific apps that you find most useful: (free text entry box for data entry)

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