

Smart phone apps every ophthalmologist should know about

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Abstract

• We are living in a mobile world, where the number of medical apps is surging in recent years. Over 320 000 healthcare apps are now available as shown in the latest research. The major function and potential of these apps vary, from assisting the learning and practice of clinicians as well as achieving better outcomes of patients to preventing eye diseases through the education of healthy individuals. However, based on the various features, ophthalmology apps nowadays contain a wide range of subjects and focus on different stakeholders in the ophthalmic practice, including but not limited to doctors, patients, and researchers. Here, we review special and advanced apps that ophthalmologists will find useful in their clinical practice.

• **KEYWORDS:** applications; healthcare; clinic; ophthalmology; ophthalmologist

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INTRODUCTION

Healthcare applications break the boundary of the doctors' physical clinics. They not only help doctors to extend medical services to patients but also provide opportunities for patients to reach the doctors and to seek basic information without going to the hospital in person. In other words, these apps help to transform healthcare delivery globally. In 2014, the first smartphone clinic app was launched by a mobile app

engine named "Borderless Clinic"^[1]. Since then, healthcare apps have kept surging.

The use of apps have been beneficial in number of specialties in medical practice, including but not limited to cardiology^[2], psychology^[3], sports medicine^[4], lung cancer^[5], and tuberculosis^[6]. Likewise, in a time of rising demand for ophthalmology services, new apps are surging and being updated. When searching for "mobile app" and "Ophthalmology"/ "Ophthalmologist"/ "eye"/ "ocular"/ "vision"/ "eye care"/ "eye test" on PubMed, MEDLINE, and Google Scholar, a few publications showed that smart phone apps have beneficial effect on ophthalmic practices, including visual acuity^[7-8], ocular alignment measurement^[9], dyschromatopsia screening^[10], retinoblastoma^[11], and dry eye^[12]. In 2013, Tahiri Joutei Hassani *et al*^[13] first identified 342 applications and sorted them into apps for ophthalmologists and patients, respectively. Subsequently, a review discussed the positive impact of teleophthalmology on patients with vitreoretinal diseases using smart phones^[14]. They concluded that teleophthalmology can largely reduce the diagnosis and examination costs for patients. Meanwhile, Rodin *et al*^[15] also analyzed mobile apps in the iTunes store, but they only focused on the ones in Canada. In 2020, Hogarty *et al*^[16] further divided the ophthalmic apps into 5 categories, including posterior segment, anterior segment, amblyopia, low vision and visual acuity. They concluded that more evidence is required to support these apps before their clinical use as issues including validation should be accounted for. Overall, these reviews summarized the existing ophthalmic apps but did not specifically recommend and evaluate the apps. Until now, to our knowledge, a review on the most practicable apps for ophthalmologist is still lacking.

Being an ophthalmologist is a continuous process in learning, updating the knowledge, working, sharing, and communicating with the peers around the world. However, nowadays ophthalmologists are working in busy clinical settings globally. They need to find the quickest ways to acquire the most updated information about the clinical guide, and practical tools to better serve the patients. Therefore, this review aims to discuss the professional apps till 2019 that ophthalmologists will be interested in for their clinical practice. The apps

mentioned in this review will be sub-categorized into education and networking, ophthalmic tool, visual aids, social media, and others.

METHOD OF LITERATURE SEARCH

In this review, keywords, or main concepts, including similar terms or phrases of the topic were identified before searching in both English and non-English literatures with peer-review processes. The content contains “mobile app”, “Ophthalmology”, “Ophthalmologist”, “eye”, “ocular”, “vision”, “eye care” and “eye test”, which are mainly used in searching PubMed, MEDLINE, and Google Scholar.

Meanwhile, search terms were combined using AND, OR, NOT. Truncation, wildcard, and parentheses were also used for efficient searching. Furthermore, the references cited in literatures were located and reviewed.

EDUCATIONAL AND NETWORKING OPHTHALMIC APPS

American Academy of Ophthalmology Related Apps

American Academy of Ophthalmology (AAO) is the world’s most influential professional medical association of ophthalmologists. It has developed several high-quality and useful apps. 1) AAO Ophthalmic Education App provides the latest news, lectures, cases diagnosis, and surgery videos in 11 filters: cataract/anterior segment; cornea/external disease; glaucoma; retina/vitreous; neuro-ophthalmology/orbit; ocular pathology/oncology; oculoplastic/orbit; comprehensive ophthalmology; refractive management/intervention; pediatric ophthalmology/strabismus and uveitis. Users can also search for specific information or participate in discussion with the global community of more than 30 000 doctors through the EyeWiki channel in this app. New contents are updated daily, enabling busy residents and ophthalmologists to improve their clinical practices. 2) AAO also publishes the journal *Ophthalmology*, available in the app called “Ophthalmology: Journal of The AAO”. Users can find the articles in press, the latest issue, most read, and even all issues in *Ophthalmology* using this app. 3) AAO ebook allows users to have convenient access to the continuously updated, reliable and essential Academy textbooks, including the book series: 2019-2020 Basic and Clinical Science Courses with contents covering from anatomy to ophthalmic diseases. Compared with other knowledge-based apps, the information in these AAO-operated apps is more representative.

Pros: As the largest association of ophthalmologists in the world, AAO helps engaged doctors informed with the latest changes in ophthalmic practice. By developing and updating these high quality apps, AAO also helps to ensure the highest quality eye care in the world^[17].

Cons: For “Ophthalmology: Journal of The AAO”, full length article needs to be subscribed^[17].

Google Play Score: 1) 4.0; 2) 4.1; 3) 3.3 (out of 5).

App Store Score: 1) 4.9; 2) 1; 3) 5 (out of 5).

Available: Apple, Android. Free.

Ophthalmology Guide Ophthalmology Guide is a well-organized and topic-oriented e-book app. Users are given the chance to select the topic they want and learn about the systematic details of the following contents: approach to the ophthalmologic patient; symptoms of ophthalmologic disorders; how to perform eye procedures; orbital disorders; eyelid and lacrimal disorders; corneal disorders; conjunctival and scleral disorders; glaucoma; uveitis and related disorders; cataract; retinal disorders; optic nerve disorders and ophthalmology instruments. Because of the clear categorization of the topic, it is very convenient for ophthalmologists to find the specific guidelines accurately and quickly during their busy time in the clinic and other occasions. The topics also are updated all the time.

Pros: This app replaces the heavy paper version of ophthalmology guide and keeps updating more topics. It is also well categorized, and ophthalmologists can find what they need in a very short time. Compared with other ophthalmology guide apps which just copy the content of the guidebook, this app filters and transforms the content of the guideline and keep revising them to make the information updated and current^[18].

Cons: It is for professionals only^[18].

Google Play Score: 4.7 (out of 5).

Available: Android. Free.

EyeTube Searching videos of ophthalmic surgery on YouTube or Google is a popular way to find the desired resources. However, due to the large and mixed content, one is likely to get astray from the topic. The app EyeTube is a global video pool which collects professional videos in ophthalmology, aiming at provision of ophthalmological educational and surgical videos with free access^[19]. It provides a wide range of ophthalmological surgeries, symposia and dialogues. Meanwhile, breaking news and cutting-edge videos of ophthalmology practice management are also being updated constantly.

Pros: This app not only helps ophthalmologist to easily find the desired videos from the professional ophthalmology video pool but also saves their time and energy when compared with searching on YouTube or Google^[19].

Cons: It is for professionals only^[19].

App Store Score: Not available.

Available: Apple, Free. For Android, YouTube also has plenty of ophthalmology videos.

American Journal of Ophthalmology To date, only two top-level ophthalmic journals are available on the app. Apart from the app of the journal *Ophthalmology*, *American Journal of Ophthalmology* is the other one, with open-access. American

Journal of Ophthalmology (AJO) has the latest clinical studies and features several contents, including but not limited to AudioSlides, Virtual Microscope, 3D Radiological Viewer, and 3D Neuroimaging Viewer. Users can get access to the full text and supplementary content including the figures *via* the IP of their institutions, watch the videos, take notes, highlight papers, and even share them through social media.

Pros: Latest ophthalmic literatures published in this refereed journal can be read by just one tap on the app, and users can get the information of literatures quickly with free access^[20].

Cons: This app can only get access to the publications on AJO. Google Play Score: 4.1 (out of 5).

App Store Score: Not available.

Available: Apple, Android. Free.

OPHTHALMIC TOOL APPS

Ophthalmic Instruments This is a practicable app with the biggest collection of nearly all ophthalmic instruments compared to other apps. For each instrument in the app, other names, methods of usage and description are shown clearly. Choices of instruments for nine classical ophthalmic surgeries, including cataract surgery, chalazion surgery, dacryocystorhinostomy surgery (DCR), enucleation, laser-assisted *in situ* keratomileusis (LASIK), lid surgery, pterygium surgery, strabismus surgery, and vitreoretinal surgery, are also provided in this app. Furthermore, users can take a test by switching to the examination mode.

Pros: It contains a large pool of ophthalmic instruments with detailed information and is easy to learn with a “Check yourself” section in the app to examine the learning outcome^[21].

Cons: No practical instruction videos of how to manipulate these instruments are available^[21].

Google Play Score: 4.8 (out of 5).

Available: Android. Free.

Eye Handbook Eye Handbook, the first mobile app in ophthalmology, provides comprehensive tips for diagnosis and treatment of eye diseases. In particular, this app facilitates various calculation of the intraocular lens (IOL) power, including the risk of developing glaucoma and lens power transposition. Currently, the app contains abundant features, including testing tools, videos, journal portals, and discussion board or forum, which allow the ophthalmologists to keep updated of the recent development in the field.

Pros: This is the most popular ophthalmic multi-functional app, which continuously updates knowledge and provides an interactive platform for communication^[22]. The powerful calculation function may replace the IOL calculator, which is well known to the ophthalmologists^[23].

Cons: a study showed this app running on iPhone 5 may overestimate the visual acuity measurement result when compared with the conventional method (near vision card)^[24].

Google Play Score: 4.6 (out of 5).

App Store Score: 4.7 (out of 5).

Available: Apple, Android. Free.

Ullman Indirect Standard fundus photography is not always available in some health service institutions around the world. For the underserved communities, retinal examination has much room to be improved. Ullman Indirect is the only user-friendly fundus camera app which fills the gap. The “Photo Burst” mode enables the users to obtain excellent retinal images by eliminating interferences from the users’ shaking hand or the movement of patients. Meanwhile, this app can export the “still photos” from the video recorded. The correct fundus orientation can also be achieved easily by rotating photos or videos (180 degrees). Only a single magnifying lens is needed during the examination. This app is supported by the grant from the Prevention of Blindness Society.

Pros: Fundus photography is indispensable in ophthalmic clinical practice. This is the only app in the world which can be used by ophthalmologist when the standard fundus photography equipment is not available^[25]. Also, the retinal examination results can be shared with others using the portable device^[25].

Cons: The overall function of the fundus photography in the app is not as good as the standard fundus photography equipment in routine clinical setting^[25].

Google Play Score: 4.1 (out of 5).

App Store Score: 5.0 (out of 5).

Available: Apple, Android. Free.

VISUAL AIDS APPS

Be My Eyes Not all the vision loss of patients is reversible. Patients who are incurably blind or with low vision may need both physical and mental assistance in their daily life. The app, Be My Eyes, is the only specialized app that connects the blind patients with sighted helpers, including volunteers and app officials. A live video call provides the blind with visual assistance, including reading expiry dates or error messages on the computer screen, identifying the clothes that need to be washed, checking the weather, and reading instructions. Up to Feb 26th of 2020, more than 3 568 182 volunteers joined this app, aiming to help the blind people around the world.

In 1800s, Dr. Edward Trudeau put forward the aphorism “To cure sometimes, to relieve often, to comfort always”. At this time, ophthalmologists may also turn their attention into promoting the quality of life for the patients. The ophthalmologists can recommend this app to the patients in need of assistance in their daily living, on top of the treatments and diagnosis that an ophthalmologist can offer.

Pros: With the highest grading score, this is the world’s most famous visual aids app. It not only enables people with vision problems to get the assistance easily by just a video call but

also makes them feel welcome, promoting their quality of life^[26].

Cons: a feature in which the volunteers can select the time that they will be available to receive the phone call is lacking^[26].

Available: Apple, Android. Free.

Google Play Score: 4.7 (out of 5).

App Store Score: 4.7 (out of 5).

SOCIAL MEDIA APPS FOR OPHTHALMOLOGY

Twitter In spite of the various functions of the ophthalmic apps, a common imperfection exists among them, *i.e.*, the lack of social networking function that delays the timely communication among the global ophthalmologists. Twitter is one of the most popular microblogging and social networking service in the world. Unlike other social networking apps, Twitter is an everyday news source, with far-ranging users including worldwide leaders, specialists, and organizations. It is easy to follow and interacts with the individuals globally. When searching “ophthalmology” on the user column of twitter, there are plenty of ophthalmic official accounts releasing the latest breaking news. Those include top journals of ophthalmology such as those from the AAO, world institutions of ophthalmology and international conferences. In addition to getting the information, Twitter enables users to interact with these accounts, forming a world ophthalmology community by just a tap on the screen.

Pros: This app is already exceedingly popular on social network, which provides a platform with a wide range of ophthalmic official accounts to deliver their latest information and has interactive platforms for communication among users^[27]. Users can easily reach the ophthalmologists or officials registered with the Twitter accounts^[27].

Cons: The detailed professional information may not be available in each ophthalmic official account and people may get overwhelmed by the sheer number of updates^[27].

Google Play Score: 4.5 (out of 5).

App Store Score: 4.7 (out of 5).

Available: Apple, Android. Free.

OTHERS

Eye Emergency Manual When eye emergency is inescapable, finding the right and systematic solution is an urgent need. After searching with the key word “emergency”, “eye”, “ophthalmology”, on Google Play and App Store, we found Eye Emergency, the only app that meets the sweeping need. Just like a small encyclopedia, this app provides information on topics like common eye traumas, classical treatments and instructions, acute red eye or eyelid related knowledge and treatment, eye assessment, acute visual disturbance, diagnostic tree, anatomy, and patient education.

Pros: When facing eye emergency, users can find the necessary information quickly through the comprehensive and

multifunctional app^[28].

Cons: It has basic and recognized information but without cutting edge diagnostic or treatment updates^[28].

Google Play Score: 4.3 (out of 5).

App Store Score: 5.0 (out of 5).

Available: Apple, Android. Free.

CONCLUSION

The current apps in ophthalmology can be used for acquiring the continuously updated information quickly and accurately, communicating with peers in the world at any time, solving problems in ophthalmic practice efficiently, and offering assistances to patients with irreversible vision loss. Unlike previous ophthalmology apps reviews^[13-16], this review selectively updated the single-function and non-mainstream apps with the multifunctional, widespread and popular ones, highlighting why the ophthalmologists will find them useful in the clinical practice.

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