Infectious Diseases Resources for the iPhone

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Modern technology has revolutionized the clinician's ability to have vast information resources available literally at one's fingertips. The advent of the smartphone—an integration of the mobile phone with an ultraportable computer, web browser, multimedia player, and camera, has given clinicians the capability to merge their information and communication resources into one compact handheld instrument. Apple's iPhone, and its sister device, the iPod touch, with a combined customer base of more than 50 million users and more than 100,000 downloadable applications, are now the leading handheld platforms for medical personnel to access personal information, medical reference, clinical data, and medically oriented "apps" on the go. The purpose of this article is to provide an overview of some of the diverse infectious diseases-oriented resources available to the iPhone/iPod touch user.

The medical student's book-laden lab coat has been as much a part of the lore of medicine as the stethoscope or the Aesculapian staff. Generations of clinicians have long sought ways to have medical information accessible at arm's length. The internet brought vast information resources to a physician's desktop. With the acceptance of electronic media by the medical community came a desire to make these resources portable. The advent of the smartphone—an integration of the mobile phone with an ultraportable computer, web browser, multimedia player, and camera—has given clinicians the capability to merge their information and communication resources into one compact and versatile instrument.

Although the first primitive smartphone, the Simon, was released in 1992 [1], initial attempts to further develop the smartphone platform were hampered by impaired functionality, limited applications, and cost. By merging the Palm-based personal digital assistant (PDA) with a phone module in 2001, Handspring (later Palm) was the first developer to bring palm-based medical applications to a phone handset [2]. In 2002, the BlackBerry was released, which incorporated several medical-friendly wireless information services, including push e-mail, text messaging, and web browsing [3]. By 2006, Windows Mobile, Blackberry, Symbian, and Palm OS–based smartphones were all well-established. An overview of these platforms has been published previously [4].

The first-generation iPhone, introduced in 2007 [5], included enhanced features not previously found in existing smartphones, including ample flash memory (initially 8 gigabytes), full-size web page and PDF file support within its included Safari browser and a iPod media player. The native applications included with the initial handset, such as short messaging service (SMS) support. Google maps, and a YouTube viewer, were well integrated but of limited medical utility. Some clinically oriented applications could be accessed via its Wi-Fi and mobile network connections. However, early iPhone users found this application support cumbersome, since Wi-Fi availability could be limited in practice environments and its sole US carrier AT&T's Enhanced Data Rates for GSM Evolution (EDGE) network connections were often quite slow.

In response to user input, Apple announced support for a software developer's kit (SDK) [6], released in March 2008, and opened the iPhone and its sister device, the iPod touch, to downloadable add-on applications. Released almost simultaneously with its second-generation enhanced handset, the iPhone 3G [7], the application site opened in July 2008, with 500 applications, including a version of the popular drug reference, *Epocrates* (Figure 1). The "App store," [8] as it is called, became an instant success, in some ways even supplanting the original concept of the iPhone. The iPhone has become renowned not as much as a *smart phone* as an "app phone," a connected platform for multiple applications of the owner's choosing. The Wi-Fi enabled iPod touch, introduced in September 2007, which lacks the cel-

Figure 1. Drug reference apps for the iPhone/iPod touch: *A,* Epocrates mobile reference; *B,* Medscape suite; *C,* FDA Drugs; *D,* Skyscape's Rx Drugs.

lular network support, camera, and (for earlier models) microphone of its larger sibling, has also been utilized by clinicians who wish to access iPhone applications without the need for a mobile contract. As of early 2010, more than 100,000 applications were available on the App store, and more than 3 billion applications had been downloaded. Applications for the iPhone now have a potential combined customer base of more than 50 million iPhone/iPod touch users [9, 10]. A new device, the iPad, joined Apple's lineup of mobile devices in early 2010 and is compatible with most iPhone apps, though in a tablet-sized format.

With its growing adoption in the medical community, third-party developers of medical software have responded by making a number of paid and free applications available for medical iPhone users. Many of these applications are suited to infectious diseases clinicians. Other ID-oriented educational tools are also available that take advantage of the iPhone's multimedia capabilities. The purpose of this article is to provide an overview of some of the diverse infectious diseases–oriented resources available to the iPhone/iPod touch user.

MULTIMEDIA DOWNLOADS

A growing number of medical educational resources are now being made available via multimedia audio (MP3) and video (MP4) files. Whereas audio cassettes and VHS tapes were once the formats of choice for distributing board reviews, media reproductions of conference sessions, and continuing medical education (CME) programs, vendors have for several years begun to make their products accessible through an iPod, MP3 or other multimedia player. In many cases, educational providers (eg, Sound Images; http://www.siattend.com) have permitted their content to be accessible via downloads. Audible.com, one of the largest online audiobook and podcast distributors, also offers medically oriented podcast and au-

dible book titles available for download. Multimedia files can be played through the iPhone or iPod touch's built in iPod function.

YouTube (http://www.youtube.com), the online video sharing site now owned by Google, offers a growing collection of medical and infectious diseases–related content available via the iPhone's YouTube application. Streaming YouTube videos play best through a Wi-Fi connection, although mobile 3G connections are also possible.

Like YouTube, podcasts also permit the review of audio and video content via the video iPod function, but offer the advantage that they can be pre-downloaded to the device and then reviewed without an internet connection. Infectious disease–oriented podcast sites (eg, http://www.idpodcasts.net) permit content to be downloaded to a desktop computer for uploading to an iPod or iPhone or can be streamed directly through the device's Safari browser.

The iTunes Store is now the largest legal online media retailer in the world [11], having sold over 6 billion songs since its inception in 2004. With over 70% of the online market, compatibility with iTunes has even been sought by other smart-phone manufacturers (ie, the Palm Pre) [12] who recognize the importance of access to a user's iTunes library. The iTunes store's podcast site includes numerous medical, public health (eg, Johns Hopkins and the Centers for Disease Control and Prevention [CDC]), academic (eg, National Jewish Health), and scientifically oriented (eg, Lancet Infectious Diseases) podcasts.

In an attempt to improve access and to promote the exchange of educational podcast material, the iTunes Store established iTunes U in 2007 [13]. This service provides colleges or universities with a personal site in the iTunes store for distributing multimedia downloads, which may include course lectures, demonstrations, extracurricular activities, or campus infor-

mation. Although this format shows promise as a medium for distributing medically oriented content, few academic universities or public health institutions have yet to utilize it.

As diverse as these information resources are within the iPhone/iPod touch handset, it is the adoption of the online application service, or "App" store, by medical users, that has proven to be the most transforming as a pocket resource. Medical content providers have made accessible almost every major electronic reference and/or educational volume via the platform's touch-screen interface. Content has been provided through 1 of 3 models, via a free download, through a onetime purchase price, or as a periodic subscription (Table 1).

INFECTIOUS DISEASE APPLICATIONS FOR THE iPHONE

Applications useful to the ID clinician are available in the form of popular reference guides, review materials, drug information databases (Figure 1), medical news sources, and medical calculators. Reference guides (eg, The Merck Manual) [14] are available as stand-alone applications. Some popular titles are available through subscription with Skyscape (http://www.Skyscape.com), a large mobile medical reference provider. Applications for US Medical Licensing Examination (USMLE) microbiology review from Lange, Current, and PreTest are popular among students. Several drug information databases (eg, Epocrates) can be found in the App Store. Newsreader applications grab the top stories from medical news and healthcare sites and deliver content directly to one's iPhone or iPod touch. Medical calculators aid the ID physician in calculating pharmacokinetic data and other useful calculations necessary to their practice. Some applications integrate multiple features. Medscape from WebMD (Figure 2) includes a comprehensive drug reference and interaction checker, medical news, CME provider, and a health directory listing over 400,000 physicians [15]. The following is a brief discussion of a few applications in each of these categories that are useful to practicing clinicians.

REFERENCE APPLICATIONS

A free download of the Skyscape application [16] makes more than 350 medical resources in 35 specialties available to the iPhone user. Free resources include RxDrugs (Figure 1), a pharmacopeia; Outlines in Clinical Medicine, containing evidence-based clinical information on hundreds of diseases; Archimedes, a medical calculator; and MedAlert, an updated compendium of information regarding journal summaries and clinical trial results that can be tailored to one's specialty. Full-color images and the capability to cross reference other Skyscape resources take advantage of the iPhone's functionality. The following is a brief review of some of the ID-specific reference applications available through Skyscape on the iPhone/iPod touch.

The 5 Minute Infectious Diseases Consult. The popular quick reference serves as a resource to the clinical diagnosis, laboratory tests, and appropriate therapy of infectious diseases [17]. More than 500 topics are arranged alphabetically to provide key information for quick reference at the clinician's fingertips, though its content may be more basic for the ID clinician.

The Washington Manual Infectious Diseases Subspecialty Consult. This consult reference covers the whole spectrum of infectious diseases in a format similar to its print form [18]. The table of contents is organ-system based and includes other topics such as sexually transmitted diseases, bioterrorism and vaccines. Drug information and references are also available.

Antibiotic Essentials. A concise, practical guide to the treatment and prevention of adult infectious disease syndromes encountered in adults, the guide is a regularly updated reference to empiric antibiotic therapy, human immunodeficiency virus (HIV) infection, fungi, parasites, prophylaxis and immunizations [19]. It is available via Skyscape for subscription periods from 4 months to 3 years. Image and table indices simplify the search process. A unique feature of this product is suggested intravenous and oral equivalents.

INFECTIOUS DISEASE REVIEW MATERIAL APPLICATIONS

At least 2 microbiology review applications are available on the iPhone. These references come in a flash card format and are more geared toward the student for board review, but can serve as helpful reminders to the clinical physician.

Microbiology Wiz with Immunology. From Current Clinical Strategies, this application (Figure 2) offers 1800 flash cards featuring up to date USMLE microbiology and immunology topics [20]. Subjects include bacteriology and genetics, mycology, parasitology, and virology and can be customized into a study folder. Study questions focus on transmission, diagnosis, and treatment commonly tested on exams.

Lange Microbiology and Infectious Disease Flash Cards. At a greater cost, this application allows the user a more customizable experience, again in a flash card format [21]. Contents include more than 900 cards detailing 142 diseases that can be annotated and bookmarked to personalize one's review experience. Comprehensive information and classic clinical vignettes make this application a popular choice in its category.

DRUG INFORMATION DATABASES

Epocrates. One of the first applications initially released for the iPhone platform (Figure 1), the free version of Epocrates [22] provides constantly updated access to information on thousands of drugs including dosing, adverse reactions, formularies, pricing, and pill reproductions as well as a medical calculator and the latest medical news and information. For an

Table 1. Selected Infectious Diseases Resources for the iPhone

Name	Description	URL address	Comments
Multimedia content providers			
Audible.com	Audio books, magazines, and other content	http://www.audible.com	Now part of Amazon.com
IDPodcasts.net	Infectious disease presentations and other content	http://www.idpodcasts.net	Podcasts also available at the iTunes store (http://bit.ly/cNhzHW)
iTunes.com	World's largest digital media store	http://www.itunes.com/	Requires iTunes software (free)
Sound Images	Medical conference recordings	http://www.siattend.com/	Audio files are playable on mobile devices
Skyscape	One of the largest digital content providers for the iPhone	http://www.skyscape.com/	Free app needed to access courtesy and paid content (see below)
YouTube	Short video clips	http://www.youtube.com/	Built-in iPhone app; access through "channels" and search functions
Applications for infectious diseases resources			
Reference texts			
Merck Manual	Classic medical reference in iPhone format	http://bit.ly/3SrR1j	Self-contained, although it can receive automatic updates
Skyscape	Accesses multiple free and subscription applications available via Web site	http://bit.ly/3Sjz0Z	>350 medical reference titles available; pay apps require annual renewal
Drug references			
Epocrates	Popular free medical drug reference	http://www.epocrates.com	Medical Reference subscription suite also available
Johns Hopkins POC-IT ABX Guide	Skyscape-affiliated drug reference	http://hopkins-abxguide.org	Includes resistance tool for HIV genotype interpretation, interactive Q&A forums
FDA Drugs	Drug information database	http://bit.ly/50Fuvz	Includes labels and/or package inserts
Integrated apps			
Medscape	Free mobile version of the popular WebMD site	http://bit.ly/4OYDgl	Includes drug reference, interaction checker, medical news, CME
Clinical references			
5 Minute Infectious Diseases Consult		http://bit.ly/8IrbqJ	Comprehensive, quick reference through Skyscape platform
Washington Manual	Mobile version of text	http://bit.ly/2c38wD	Similar to print version (Skyscape)
Antibiotic Essentials	Concise, practical guide to the treatment and prevention of adult infectious diseases	http://bit.ly/n3Xui	Suggested intravenous/oral equivalents (Skyscape)
Review guides			
Microbiology Wiz with Immunology	Flash cards with microbiology and immunology topics	http://bit.ly/8V33qH	Study questions focus on transmission, diagnosis, and treatment
Lange Microbiology and Infectious Diseases Flash Cards	>900 cards detailing 142 diseases	http://bit.ly/89IPKC	Customizable format
Medical news and information			
Medical News Reader	Receives RSS feeds	http://bit.ly/5LFrZv	Customizable format
Blackbag	Receives RSS feeds	http://bit.ly/3Qqgvv	Industry sponsored
Calculators			
Antibiotic Dosage Calculator	Dosage adjustment of 66 antibiotic agents for renal failure	http://bit.ly/3AkvrN	Uses Cockcroft-Gault formula
DrugDoses.net	Vancomycin and gentamicin dosage calculators	http://bit.ly/7SCz8d and http://bit.ly/5HTHL9, respectively	Each calculator is available separately
Epidemiology			
Outbreaks Near Me	Comprehensive outbreak information tracker	http://bit.ly/NRrOB	Utilizes HealthMap database
H1N1 (Swine Flu) Update	Pandemic flu update tool	http://bit.ly/1Lx2Je	News feeds only

NOTE. Some URL addresses have been shortened due to length using the bit.ly notation. Some URL addresses require installation of the iTunes software and access to the App store. Most apps also function on the iPod touch/iPad devices. ABX, antibiotics; CME, continuing medical education; FDA, Food and Drug Administration; HIV, human immunodeficiency virus; POC-IT, point-of-care information technology; RSS, Really Simple Syndication.
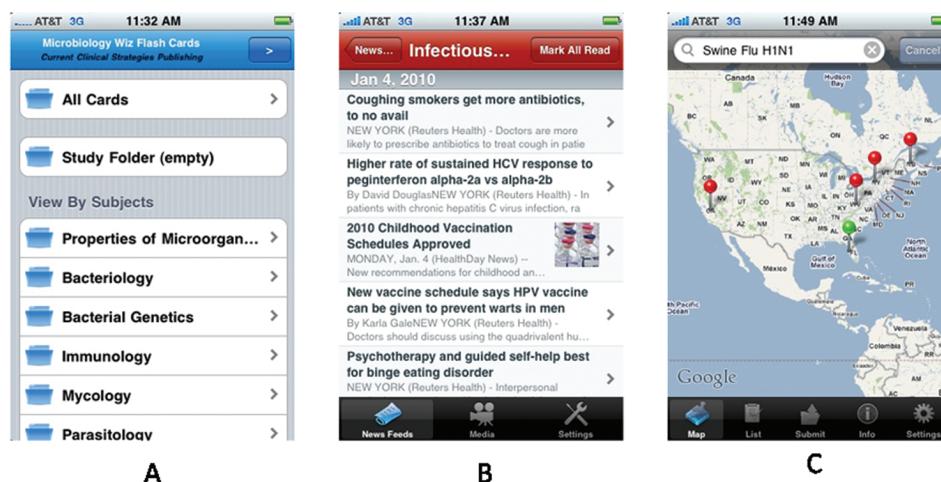
Figure 2. Medical applications for the iPhone/iPod touch: *A*, Microbiology Wiz Flash Cards; *B*, Blackbag application; *C*, Outbreaks Near Me.

additional fee, premium versions add disease information with images, lab test interpretation, information on herbal and over-the-counter medicines, and Epocrates ID. Epocrates ID provides treatment guidelines for dozens of infectious disease syndromes and the option to search by "bug" or drug class. Performance is noticeably improved on the later generation iPhone/iPod touch models.

Johns Hopkins POC-IT ABX and HIV Guide. These 2 programs offered through Skyscape include up-to-date information on the pathogens, diagnosis, treatment, and management of infectious diseases. Information on vaccines is also included and the applications include integrated CME material. The HIV Guide application also includes a resistance tool to help interpret genotypic resistance in viruses. A unique feature of this application for registered users is the interactive Q&A forums with clinical experts who promise to provide prompt e-mail responses to subscribers [23].

FDA Drugs. One of the newest drug information databases available to iPhone and iPod touch users is FDA Drugs (Figure 1) by Sigmaphone.com [24]. It is the only app to offer official labels or package inserts of prescription and over the counter drugs approved by the US Food and Drug Administration (FDA). Also unique about this application is the ability to search all drugs with a specific active ingredient and to search for therapeutically equivalent generic alternatives.

MEDICAL NEWS AND INFORMATION

Medical news and information is available in three broad general formats to iPhone/iPod touch users. Stand-alone applications offer RSS ("Really Simple Syndication") feeds to news in most subspecialties including infectious diseases. Examples of standalone medical news applications with RSS feeds include Medical News Reader [25] and Ortho-McNEil's Blackbag [26]

(Figure 2), both of which can be customized to the ID specialty. RSS feeds are also built into select applications including Epocrates and Medscape.

MEDICAL CALCULATORS

Several medical calculators are available for the iPhone and iPod touch, either built into other programs or as stand-alone applications and can contain hundreds of equations for the general physician or a few equations more commonly used by subspecialty physicians including infectious disease clinicians. Softforce's Antibiotic Dosage Calculator [27] calculates the dosage adjustment of 66 frequently used antibiotics used in the setting of renal failure based on the patient's glomerular filtration rate using the Cockroft-Gault formula. Programmers at DrugDoses.net have developed 2 applications to help guide the prescribing of vancomycin [28] and gentamicin [29], decreasing the likelihood of serious morbidity if they are improperly dosed.

EPIDEMIOLOGY/OUTBREAK

Another category of medical apps available for the iPhone/iPod touch targets epidemiology or current outbreak situations. Of international interest is the 2009–2010 pandemic H1N1 influenza outbreak, and several programs target healthcare providers' need for H1N1-related information.

Outbreaks Near Me (free download). This app [30] utilizes news media reports, medical e-mail list services, and alerts from official national and international organizations to monitor the occurrence and impact of global infectious diseases via the HealthMap database (http://www.healthmap.org) (Figure 2). The project, funded by Google, receives support from the CDC, the National Library of Medicine, and the Canadian Institutes of Health Research and utilizes alerts from several

Internet sources to compile information about international human and animal infection–related outbreaks. The infections are indexed (and can be searched) by disease state and displayed as push pins within the embedded Google Map to indicate disease locations and associated information. The app also includes a "list" tab (where outbreak information is listed regionally or by city), a "segment" tab where written information may be contributed to HealthMap, an "information" tab about HealthMap, and the ability to adjust app settings.

Swine Flu Tracker Map. This app (IntuApps [http://www.intuapps.com]; free) [31] provides information on the current level of H1N1 influenza activity, but sends the user to the HealthMap app to view and track H1N1 influenza. It does provide information about H1N1 influenza symptoms (from the CDC), but falls short in its contained map functions. The "alert" tab provides links to the World Health Organization, the CDC, and a HealthMap blog on a variety of infectious diseases worldwide.

H1N1 (Swine Flu) Update. Essentially a newsreader, it provides current news feeds from the CDC, the World Health Organization, and major news organizations (QxMD [http://www.qxmd.com]; free) [32]. Information is available from authoritative news sources (CNN, BBC, and Reuters), Twitter feeds, and other resources on the web including publications and educational materials from the New England Journal of Medicine, the Infectious Diseases Society of America, and UpToDate.

Many H1N1 influenza apps that require payment are similar in function. Worthy of mention are Swine Flu Upto-the-minute (Rogue Kiwi Party [http://www.swinefluiphone.com]; $0.99) [33], Swine Flu (H1N1 Virus) (JBMJBM [http://web.me.com/jbmjbm22/JBMJBM/JBMJBM.html]; $0.99) [34], and Swine Flu Guide (PTAJ Marketing [http://ptajmarketing.com]; $2.99) [35]—the latter app only relays CDC information.

FUTURE DIRECTIONS

It is anticipated that the iPhone may soon become available with other American mobile carriers, increasing its accessibility to a wider share of the US market. Successive hardware improvements in future iPhone and related devices will also likely extend the platform's capabilities. Increases in flash memory and processor speed will increase storage capacity and may permit multitasking of applications, a feature already found in other smartphones. When released in June, 2009, the iPhone 3GS, the most recent version, included a more powerful, autofocus-equipped still and VGA video camera, and a built-in compass. When combined with Multimedia Messaging Service (MMS) and live video streaming capability, many clinicians began to explore sending on the spot photos and video between iPhones, generating instant "remote consults" from colleagues. The built-in compass feature, innocuous by itself, when com-

bined with the camera and global positioning system, permits the development of "augmented reality apps," which could someday help navigate an ID clinician around a hospital, facilitate finding a text in the medical library, or guide a convention attendee to a symposium at a future meeting of the Infectious Diseases Society of America.

Several recent software developments may foreshadow the likely direction and growth of the iPhone platform. In late 2008, at the insistence of some in the medical community, Apple was successfully lobbied to create a separate medical classification for iPhone applications, its first spin-off category. In its first year, the medical category grew from 82 initial applications to more than 1200. In early 2009, the medical category became the third fastest growing App Store category, behind "Books" and "Travel" [36]. At the same time, the number of physicians using iPhones doubled between 2008 and 2009 [37]. Some hospitals have migrated their entire physician workforce to the iPhone, utilizing push e-mail, calendar, and contacts from Microsoft Exchange and promoting secure mobile access to the hospital electronic medical record [38]. More national medical care providers are integrating medical data access and electronic prescribing into iPhone applications, such as is seen with Quest Diagnostics' Care 360 program [39]. A Dragon Dictation application [40] became available in late 2009, opening the door to future medical dictation capability for the iPhone/iPod touch platform. With Apple's release of the latest iteration of its iPhone operating system (iPhone 3.0), the handset's software now permits it to synchronize with medical devices such as glucose monitors, obstetrical equipment and sphygmomanometers [41]. The FDA has been monitoring this development, and an FDA official has state that the iPhone may ultimately need to be regulated as a medical device [42]. With this, the smartphone will have seen a stunning transformation, from a "geek gadget" to an FDA-approved medical machine.

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