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Review Article

Translating technology into patient care: Smartphone applications in pediatric health care

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ABSTRACT

The latest generations of smartphones are increasingly viewed as handheld computers rather than as phones and the applications on these phones are becoming increasingly popular among the medical professionals. A large number of health care applications are available across various smartphone platforms. At times it may be difficult to identify most appropriate and reliable application for use at the point of care. In this review, we have tried to identify the applications relevant to Pediatrics and Childcare which when used at the point of care might be helpful in improving patient care.

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Introduction

Interactive mobile media devices, such as smartphones and tablet computers, are quickly becoming popular clinical tools within the field of medicine.^{1–6} As health care professionals, our most important task is to effectively treat the patient, educate the caretaker of the patient about the disease, and provide education to other health care professionals. And currently one of the barriers to improved pedagogy and health care delivery is that clinicians usually teach the way they were taught.^{1,7}

In 2008, medical applications (referred to as apps) became available for use on an iPhone as a new way to access medical information at the point of patient care.⁶ Before the advent of apps mobile interventions included a website component which contributes to data transfer and viewing. In contrast, apps are downloadable programs designed to run on the smartphone operating system. In terms of medical usage, health care apps offer instant access to multimedia

information, including medical references, calculators, medication databases and relevant news updates.⁸ The shift toward mobile apps and Internet as a preferred way to access medical information was identified in a survey of internal medicine house staff.¹ And more recently, a study found that the hospitals that use UpToDate, a desktop clinical knowledge system also available as an app, had shorter length of stay, lower risk-adjusted 30-day mortality rates and better quality performance than hospitals without this system.⁹ This reinforces that using computerized tools at the point of care could be helpful in improving patient care.

The estimated total number of health care apps is more than 12,000 and is increasing rapidly. Hence, it may be difficult and time consuming to identify relevant apps. There is a need for the medical community to better understand which apps are available to them for assistance in their areas of interest and how these might facilitate patient management. In view of the aforementioned, we have conducted a review of apps relating to the discipline of pediatrics and childcare.

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Methods

The search was conducted in August 2012 on the official application stores for the five major smartphones: iPhone (App Store), Android (Android Market), Blackberry (App World), Nokia/Symbian (Ovi), and Windows Mobile (Marketplace). The health/lifestyle and medical categories, when present were searched. In addition, search terms including “pediatrics”, “paediatrics”, “childcare”, “neonate”, “newborn”, “life support”, “asthma”, “phototherapy”, “journal”, “coma”, “breast feeding”, and “heart sound” were employed to identify any remaining relevant applications. Apps that were written in languages other than English were excluded. The final selection represents more than 20 applications. Table 1 provides a summary of the apps grouped into the following categories: reference and education, medical calculators, drug information, epidemiology and news. Salient features of selected apps have been highlighted below.

Reference and education

Medscape

Medscape ranked as the number one downloaded free medical app in 2010. The app provides information on more than 8000 drugs, 4000 diseases and clinical references, 2500 clinical images and procedure videos, a drug interaction tool checker, and free continuing medical education. The diseases section carries an overview of the disease followed by clinical presentation, differential diagnosis, workup, treatment and management, drug therapy, and references. The news feature allows the user to tag field of interest so that updates on new articles from various journals may be viewed. An Internet connection is not required once the information has been downloaded.

Skyscape, iPharmacist and Drug Reference+ are other apps with similar features.

UpToDate

This is an evidence based, peer reviewed reference app offering information on >9500 conditions/states. The topics are written by physicians and are updated continuously. An Internet connection is required for accessing the information. UpToDate offers three types of subscriptions: individual clinician subscription, individual trainee subscription, and site subscription.

Journal RSS

This is a free app which links to RSS feeds for scientific and medical journals. It allows for viewing article titles from various leading journals including Science and Nature. The journals that offer link to PDF files can be downloaded for offline reading. MP3 and video podcasts where available can also be downloaded. It also allows for PubMed search.

In addition to Journal RSS, most of the leading journals offer their own apps. These include Pediatrics, Archives of Diseases in Childhood (ADC), New England Journal of Medicine and various other journals.

PubMed on tap lite

This app searches PubMed to find reference information. The results may be emailed as formatted text or as research

information system tagged record, ready to be imported into reference management applications such as EndNote. An Internet connection is required for this app.

Pediatrics central

This app, published by unbound medicine, gives an option of subscription to three products viz Pediatrics Central Dx, John Hopkins ABX guide, and treatment guidelines. When all resources are downloaded, this app provides a quick reference to the commonly seen pediatric conditions, the treatment in brief, and comprehensive guides to antibiotic use for infectious diseases. Also included is an option to access Medline journals, for an added reference. The application shell is available for free, but each of the individual resources requires subscription.

ICD9 consult 2012

This application is the electronic form of the ICD9-CM 2012, with searchable and browsable codes, as per the traditional category. A particular code can be searched by entering either a short form for the condition (MI for myocardial infarction), which is expanded into possible full forms, enlisted in the order of likelihood; or by using a longer descriptive term of the condition. This app provides a convenient and rapid mode of ICD search.

Redi reader

This is a reader app, used to access designated medical references and guidelines. The interface provides all the guidelines a user has downloaded on the welcome screen. In the options section, there is an integrated browser with preferred links to popular societies, for example Infectious Diseases Society of America, American diabetes association etc. The guidelines, once downloaded, can be grouped into folders, and are available at one place for offline use.

Atlas of congenital heart diseases

This app provides users a brief bedside description of different congenital cardiac diseases, with easy to understand graphical description. This app is easy to comprehend, but due to the brevity of content, requires background knowledge of a particular condition, and hence is best used as a reference guide or a quick refresher. This app is available free of cost for use but requires a working Internet connection for accessing data.

Essentials of pediatric radiology

This is a companion app to the similarly titled book, and provides a concise view of the different images in disease conditions. The images are displayed on one half of the screen with discussion/trivia about the condition on the other. Other similar apps available include PediatricXR, Elsevier case reviews etc.

Asthma

This is an app that helps in classifying severity of asthma in children and adults and provides treatment recommendations. The data is entered in stepwise fashion based on symptoms, signs and spirometry/peak expiratory flow rate measurements and the app then classifies asthma and provides guidelines for treatment.

Table 1 – Description of medical apps.

Category and name	Cost	General description
Reference and education		
• Medscape ^{1,2,3,4}	• Free	• Drug and disease reference, images, drug interaction tool checker, free CME
• Skyscape ^{1,2,3}	• Free	• Reference for drugs and diseases and common medical calculations
• UpToDate ^{1,2,3}	• Subscription fee	• Evidence based, peer reviewed literature resource offering detailed answers to clinical questions
• Journal RSS ³	• Free	• RSS feeds from all popular journals with links to PDF files for some of the articles and links to podcasts
• PubMed on Tap Lite ^{1,3}	• Free	• Searches PubMed for references
• Pediatrics Central ³	• Subscription fee	• Covers Pediatrics Central Dx, Johns Hopkins ABX guide, and treatment guidelines
• ICD 9 consult ^{1,2,3}	• Free	• Electronic form of ICD9 with searchable and browsable codes
• Redi reader ³	• Free	• Reader app to access medical references and guidelines
• Atlas of Congenital Heart diseases ³	• Free	• Reference guide for congenital cardiac disorders
• Essentials of Pediatric Radiology ³	• Free	• Concise radiological view of different conditions
• Asthma ³	• Free and paid version	• For classifying children with asthma and deciding the management protocol
• Blausen Human Atlas Lite ^{1,2,3}	• Free	• Three dimensional rotating body to view human anatomy
• Johns Hopkins Abx guide ^{1,3}	• Subscription fee	• Evidence based information on treatment of infections
• Journal with apps ^{1,3}	• Free	• Free apps available for all leading journals including Pediatrics, Archives of Diseases in Childhood, New England Journal of Medicine etc
• Heart murmur pro ³	• Free and paid version	• Heart sound learning tool, with simulation of heart sounds in different heart diseases, tips on examination
• ECG guide ^{1,2,3}	• Paid	• An ECG companion, for bedside reference of ECGs
• iResus ³	• Paid	• Resuscitation guidelines of Resuscitation council (UK)
• ICD 10 ^{1,2,3}	• Free and paid version	• Electronic form of 10th revision of International Classification of Diseases 2011
• ACLS Rhythm ^{1,3}	• Paid	• ACLS resuscitation guidelines and ECG advisor
• PFT Eval ^{1,3}	• Free	• Educates about approach to pulmonary function tests
• Autism ihelp-Play ^{1,3}	• Free	• A speech/language learning tool for children with autism
• Pediatric airway ³	• Free	• Guide to drug dosage for emergency pediatric airway management
• CoagGuide ³	• Free	• Coagulation disorder diagnostic tool/lab value analyzer for coagulation disorders
• Podcasts ^{1,2,3,4}	• Free	• Available for various societies guidelines and journals; downloadable for subsequent listening/viewing
• SoundBuilder ^{1,2,3,4}	• Free	• Allows to listen to common murmurs and heart sounds with graphics to understand underlying pathophysiology
• Breastfeed ³	• Free	• Helps to determine medical info regarding breast feeding and otherwise
• NeoTube ^{1,3}	• Free	• Provides trainees with a visual and instructional resource to facilitate learning neonatal intubation procedures
Drug information		
• Epocrates Rx ^{1,2,3}	• Free	• Drug information/interaction and medical calculators provided with this app
• Micromedex drug information ^{1,3}	• Free	• Detailed drug information including off-label indications
• Lexi Drugs ³	• Subscription fee	• Comprehensive drug database
• Sanford guide to antimicrobial therapy ^{1,3}	• Subscription fee	• Critical information on treatment of infectious diseases
• MIMS ^{1,2,3}	• Paid	• Monthly Index of Medical Specialties, electronic form of the popular drug reference guide
Calculators		
• MedCalc ³	• Paid	• Medical calculator with an extensive list of 200 formulas
• Qx calculate ^{1,2,3}	• Free	• 150 unique calculators and decision-support tools with interactive questions
• PICU calculator ³	• Free and paid version	• Information about normal reference ranges for vital parameters, drug dosages for different age/weight

Table 1 – (continued)

Category and name	Cost	General description
• Phototherapy calculator ^{1,3}	• Paid	• Based on neonatal age, risk factors, serum bilirubin it plots graph and advises about phototherapy requirement
• Children's Coma scale ³	• Paid	• Interactive app to assess child's GCS
• Stat Growth Charts ³	• Free and paid version	• Allows to plot height and weight of child to assess growth
• BMI calculator app ^{1,2,3,4}	• Free	• Tool for Body Mass Index calculation
• ABG ^{1,2,3}	• Free	• Tool for interpretation of arterial blood gas values
Epidemiology		
• iScrub Lite ³	• Free	• Records hand hygiene observations
• Learn Stats ³	• Free and paid version	• Helps to perform basic biostatistics
News		
• MedPage ^{1,3}	• Free	• University of Pennsylvania School of Medicine office of Continuing Medical Education sponsors breaking medical news alerts

Note: • The superscripts refer to the platforms on which these apps are available. 1 = Android; 2 = Blackberry; 3 = iOS; 4 = Symbian.
 • The web was searched for the specific names of these applications. In certain scenarios there may be functionally similar apps on different platforms, Stat Growth for growth monitoring is available on iOS but similar growth monitoring apps are available on other platforms.
 • While utmost care has been taken to deliver up-to-date information on these apps, due to extremely dynamic nature of these devices and apps, it may be possible that certain information may undergo change over time.

Podcasts

These are audio summaries offered by various journals and societies available for downloading and subsequent listening. Most of the international journals including Nature, Science, Pediatrics and ADC offer free podcasts.

Medical calculators

MedCalc

A medical calculator developed by two physicians with an extensive list of >200 formulas including Acute Physiology and Chronic Health Evaluation II (APACHE II) and Simplified Acute Physiology Score II (SAPS II) severity scores; Systemic Inflammatory Response Syndrome (SIRS) criteria; calculation of corrected and chronological age of premature neonates; sample size and need-to-treat calculations; and likelihood ratios. A reference is provided for each formula, and the app is updated several times a year. Internet connectivity is not required. However, therapeutic drug monitoring formulas are not included.

Qx

This app, developed by physicians, provides 150 unique calculators and decision-support tools. In addition, it provides the estimated 30-day mortality and suggested triage to intensive care unit (ICU) or non-ICU beds. Internet connectivity is not required. It is updated every 8 weeks. Therapeutic drug monitoring formulas are not included.

PICU calculator

This is available in two versions. The Lite version is free but lacks most of the features that the PICU Calculator paid version has. This requires the user to enter basic patient data including age, gender and weight and then it displays the normal physiological limits for all the vital parameters of child (including heart rate, respiratory rate, blood pressures with percentiles), minimum urine output and tidal volume. It also gives guidance for various airway, fluids and pharmacotherapy related issues in pediatric intensive care setting.

Phototherapy calculator

This calculator aids a clinician to assess a neonate's need for phototherapy using the American Academy of Pediatrics guidelines. It requires the clinician to enter the neonatal age, risk factors for jaundice, and serum bilirubin levels, which the app then plots on graph and provides a clear "yes" or "no" answer as to whether phototherapy is required.

Drug information

Epocrates Rx

This is one of the most downloaded app reference resources used by health care providers at the point of care. It provides clinical information, updated weekly, written by physicians and pharmacists on prescription drugs and over-the-counter drug products. The drug interaction checker can assess up to 30 drugs at a time. Dosing calculators are available in addition to up-to-dates on medical news.

Micromedex drug information

This is a useful resource to access basic information on >4500 drugs. Without an Internet connection, one can browse by drug name or class. Both US Food and Drug Administration (FDA)-labeled and non-FDA labeled indications are listed, and dosing, dosage adjustments, mechanisms of action, pharmacokinetics, drug monitoring, how the drug is supplied, and clinical teaching points are provided. This is a fast way to search for specific drug information that is differentiated as FDA-labeled and non-FDA labeled indications. The ongoing evidence based reviews are written by physicians, pharmacists, and nurses, and are updated as needed.

Lexi-drugs

This is a comprehensive drug database with monographs that cover adverse reactions, contraindications, dosing, drug safety issues, pharmacodynamics and pharmacokinetics, special alerts and international brand names from more than

100 countries. Updates written by a multidisciplinary in-house clinical staff are posted multiple times/week. An Internet connection is required.

The sanford guide to antimicrobial therapy

This app features infectious diseases and clinical conditions, anti-infective drug information, comparative spectra of activity, therapeutic adjuncts, and expanded coverage of topics compared with the print edition. Conditions are organized by four types: bacterial, fungal, mycobacterial, and viral. It provides recommendations for surgical prophylaxis as well as drug information covering pharmacology, adverse effects, drug–drug interactions, and dosage adjustments, all supported by editorial commentary and references. Internet connectivity is only required for the download and updates.

Epidemiology

iScrub lite

This app from the University of Iowa is meant for health care professionals who want to use a mobile device to record hand hygiene compliance. Observations are documented without Internet connection, but Internet connection is required when data are to be transferred by email.

LearnStat

This is a simple biostatistics tool that helps in conducting basic statistical tests. It also allows for importing datasets from Microsoft Excel for data analysis.

News

MedPage

The University of Pennsylvania School of Medicine Office of Continuing Medical Education and MedPage Today sponsor this breaking medical news coverage. Each article provides a summary with actionable information enabling the clinician to better understand the implications. News items are reviewed daily, and can be restricted to one's field of interest. An Internet connection is required for the breaking news, and the user must be registered with MedPage Today.

Besides most of other apps like Epocrates Rx, Medscape also offer medical news.

Discussion

The first cellular phone call was placed by a general manager at Motorola on April 3, 1973.¹⁰ Ever since, mobile communication has drastically changed the way we live and the way we work. The biggest thrust in this area was provided by the launch of smartphones, and the most resounding impact of smartphones has been witnessed in the field of medicine. One market research in United States estimates that 72% of US physicians use a smartphone and this figure is only expected to rise.¹¹ While we do not have similar data for India, but definitely, the newer generation of graduates and post-graduates are more comfortable with the use of technology and the smartphones.

Herein, we have given a pithy summary and identified the spheres where the smartphones can be used in pediatric practice. We have also enlisted numerous apps, which can aid in providing optimal therapy at the point of care. Since use of these gadgets bypasses the recall and memory related errors, they may correlate with better patient outcomes. A study in 2010 claimed that over 60% physicians surveyed felt that Epocrates (Epocrates Inc, San Mateo, Ca, USA) helped to reduce medical errors.¹² Epocrates claims that this app can save 20 min of time each day for many of their users but this has not been supported by the evidence base.^{12,13} While the data on medical apps use are currently scarce, but most of the anecdotal reports suggest that the use of apps is advantageous in patient care.

Apart from the physician and student reference, these apps are diversifying into several domains. They are being used to monitor immunizations, and the newer devices with better processors have compatible ultrasound and ECHO probes for an extended clinical examination. Another discipline, which is on verge of metamorphoses with smartphones, is teleconferencing. Especially in armed forces, where a specialist may be located in a remote area, a smartphone with Internet connectivity can enable him/her to send photographs/patient data for opinion of colleagues.

Although there are numerous benefits of integrating smartphones into the practice of medicine and one's personal life, there are noteworthy limitations. We would like to emphasize the ramifications of patients self-diagnosing, and self treating, using apps that are not regulated.¹² Though an FDA regulation on apps is expected, but as of now these are unregulated and easily available for anyone to download. Furthermore, older physicians and others less inclined to use or intimidated by new technologies may be at a disadvantage if the use of smartphones becomes more requisite within medicine. Nonetheless, it is imperative that older faculty is in line with the current trend of optimally using these devices and promoting their appropriate use by their students. And finally, as we become more dependent on technology, we become more dependent on it working flawlessly, with catastrophic implications when it fails.

Conclusion

Mobile technology on smartphones and tablets allows health care providers access to clinical information at the point of care. This not only helps in enhancing the knowledge of professionals but also assists them in providing best possible evidence based care to the patient. There is also a flip side to the use of these devices. There are reports that these devices while definitely helping in patient care can act as a source of distraction and intrusion and at times compromise the asepsis in the intensive care settings.^{2,14} Future research may shed further light on the impact, benefit or disappointment this content may have on the patient and the health care provider. In addition, with the surge of these apps, there is requirement of a regulated environment that can balance the evidence based clinical content without obstructing the progress these apps provide.

Conflicts of interest

All authors have none to declare.

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