Utility of smartphone camera in patient management in urology

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Introduction: *To describe the utility of the smartphone camera in patient management in urology.*

Materials and methods: *Clinical scenarios were collected retrospectively in which photographs that were taken on smartphone and transmitted by multimedia messaging service (MMS) served an important role in making a diagnosis and/or helped in the self-monitoring of urologic issues by patients.*

Results: *Scenario 1 – a 39-year-old male that presented to the emergency room (ER) with scrotal pain, bruising, and swelling 1 day after bilateral vasectomy. The on call urologist requested that the ER physician send a photograph of the wound using his smartphone. After examining the photograph, the urologist concluded that the hematoma could be managed conservatively.*

Scenario 2 – a 40-year-old female who underwent transurethral resection of bladder tumor a month ago and had recurrence of gross hematuria. The surgeon asked the patient to monitor her urine color and to use her smartphone to periodically send a photograph of her urine until it turned clear.

Conclusions: *At our institution urology consults have been requested for postoperative patients owning to unfamiliarity with postoperative urology examination. By communicating with the on call urologist through MMS images of incisions or urine color, management of these patients has become more timely and efficient. Smartphone camera use can also decrease the in house time spent by on call residents, thus aiding in conforming to duty hours restrictions. Furthermore, this technology has potential for helping patients monitor their disease course, thus reducing hospital visits, anxiety, and healthcare costs.*

Key Words: smartphone, camera, teleconsultation, self-monitoring, self-management

Introduction

The smartphone in the current era is a ubiquitous handheld device that continues to have increasingly important roles in daily life. The ease of use and ever-faster Internet speeds have allowed for improved communication between individuals and for the rapid transmission of digital information. The myriad benefits offered by smartphones have further led to a nearly universal acceptance of their use in medicine. A 2010 market research report by EPG Health Media found that 81% of US physicians have adopted smartphone technology.[1] Of the remaining 19% of respondents that did not own a smartphone, nearly 70% stated that they might purchase one within 6 months. A more recent study by Manhattan Research reported that "75% of US physicians own some form of Apple device" and that the iPhone (Apple, Cupertino, CA, USA) is the top smartphone platform among US physicians.[2]

Continuous advancements in smartphone photocapturing and transferring technology have made it possible to take a high resolution photograph and digitally transfer it within a matter of a few seconds. A number of groups across several disciplines have studied and reported the advantages of using such smartphone capabilities in consultations and patient management.[3-7] Using images taken with a Nokia 6680 camera phone (Nokia Corp., Keilalahdentie, Espoo, Finland), Waran et al demonstrated that accurate diagnosis and meaningful decision-making in the long range consultation of acute neurosurgical problems is possible.[3] Such practices have also been put to use in India where ophthalmologists in Bangalore are using their Apple iPhones to review retinal images of patients in rural villages and then send their diagnosis

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and treatment recommendations.[8] An important goal of this outreach program is the potential for timely intervention of retinopathy of prematurity, a condition that may lead to irreversible blindness if left untreated.[9]

The smartphone, with its ability to send images with great ease and speed, has the potential to be used in combination with a patient history to allow for off-site consultation with on call residents and distant specialists.[4] Such uses of smartphones have proven advantageous in diverse settings and situations; however, the potential benefits of smartphone technology have not been reported in the practice of urology. We, hereby, describe the role of the smartphone in patient management in urology and its potential for reducing duty hours of urology residents.

Materials and methods

Clinical scenarios were collected retrospectively in which photographs that were taken on smartphone and transmitted by multimedia messaging service (MMS) served an important role in making a diagnosis and/or helped in the self-monitoring of urologic issues by patients. For the purposes of this study, a "smartphone" is defined as a handheld mobile phone with advanced computing capabilities that include web browsers, email, digital cameras, and software applications. Common examples of smartphones in our practice include Apple iPhone, BlackBerry (Research in Motion, Ltd., Waterloo, ON, Canada), and Android (Google, Mountain View, CA, USA) phones. Three relevant clinical scenarios are discussed below.

MEDLINE was searched for the articles discussing the utility of smartphone in the medicine. Articles specifically discussing the role of smartphone camera were selected and reviewed here.

Results

Scenario 1: Patient 1 is a 39-year-old male that presented to the emergency room (ER) with diffuse pain, bruising, and swelling of the scrotum 1 day after undergoing bilateral vasectomy. After obtaining the patient's history and physical, the ER physician called the on call urologist to assess the postoperative wound and scrotal hematoma.

Upon the urologist's request, the ER physician captured and text messaged a photograph of the wound to the on call urologist using a smartphone.

After receiving and examining the photograph, Figure 1, the urologist concluded that the scrotal hematoma was minor enough to be managed conservatively and would not require operative intervention in absence of increasing size. Patient 1 was reassured and discharged home.

Figure 1. Photograph captured with smartphone camera and demonstrating scrotal bruising 1 day after bilateral vasectomy.

Scenario 2: Patient 2 is a 40-year-old female who underwent transurethral resection of bladder tumor a month ago and had recurrence of gross hematuria.

Patient 2 became concerned about the blood in her urine and called her surgeon, who then asked the patient to capture and send a photograph of her urine to him using her smartphone. Upon review of the photograph taken of the urine, the surgeon advised the patient to continue monitoring the color of her urine.

Following the initial assessment, Patient 2 monitored her urine by capturing photographs of her urine for consecutive days until her urine turned clear, Figure 2. She sent those photographs periodically to her surgeon for his assessment.

Scenario 3: Patient 3 is a neonate who recently underwent cloacal exstrophy closure with a plan of delayed bladder closure. Several days after the operation, the registered nurse in the neonatal intensive care unit who was caring for Patient 3 became concerned about the appearance of bladder plates and contacted the on call urologist.

The nurse took a photograph using her smartphone camera and sent the image via MMS to the on call urologist familiar with the neonate's history and physical examination, Figure 3.

After reviewing the images, the on call urologist was able to confirm that the appearance of the bladder

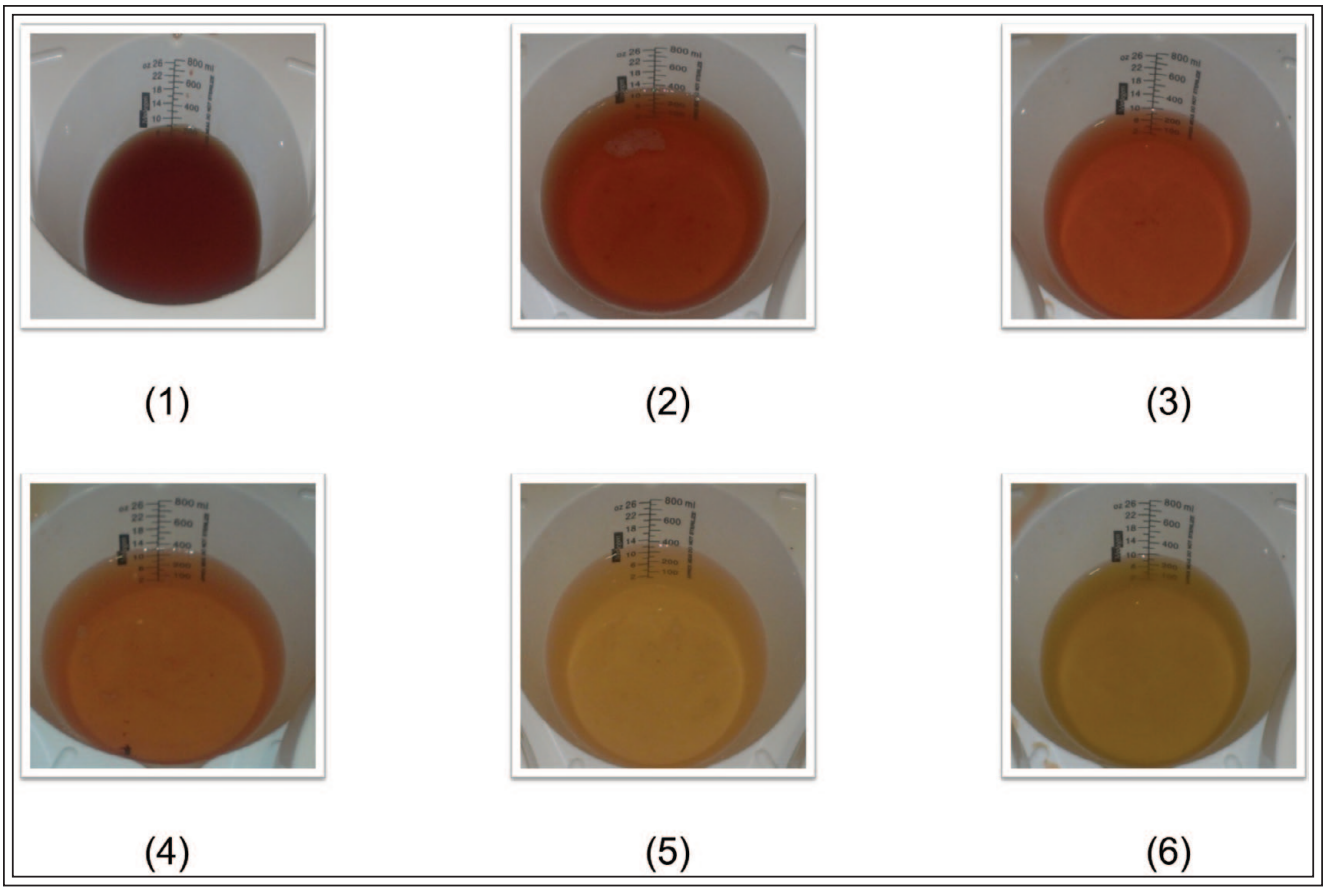

Figure 2. Photographs (1-6) captured with smartphone camera and demonstrating resolution of gross hematuria over consecutive urine collections.

plates had not changed since the examination he performed earlier that afternoon.

Discussion

The past decade has seen remarkable growth in handheld computing capabilities, including user interface, data speeds, software applications (apps), and multimedia sharing. Specifically related to the field of medicine, there are countless apps for smartphones that provide quick references for healthcare professionals or serve in educating patients about their disease process. In recent years, however, this technology has also experienced an expanding role in teleconsultation where medical images transmitted from a smartphone matched well with those viewed on a standard computer workstation.[7,10] For instance, in the remote management of extremity wounds, Tsai et al reported an 80% success rate in recognizing gangrenous extremity wounds in photos taken by a camera phone, with 85% sensitivity and 93% specificity.[6] In their study, teleconsultations occurred between consultant plastic surgeons and ER residents who examined and photographed extremity wounds that presented to the emergency department.

While traditionally assessed on workstation computers, teleophthalmology has also seen a rise in the practice of smartphone-based consultation.[11] In the assessment of diabetic retinopathy,[10] and colleagues reported images read on a smartphone had a greater than 85% sensitivity and specificity to detect retinopathy-related changes when compared to the gold standard of viewing images on a workstation computer. Similar practices can be adopted in the management of urologic patients in which on call urologists can provide consulting or patient management services by reviewing images sent to their smartphone. At our institution we have utilized smartphone technology for the management of non-urgent urologic issues. Traditionally, ER physicians and nurses caring for postoperative patients have requested urology consultations owning to unfamiliarity with postoperative urologic examination and management. By communicating with the on call

Figure 3. Photograph captured with smartphone camera and demonstrating bladder plates in an exstrophy patient.

resident and sending images of postoperative surgical wounds by MMS, such as our experiences in Scenario 1, management of these patients has become more timely and efficient. Importantly, the medical issue in the above scenario was non-urgent and involved consultation with a urologist familiar with the patient. Nevertheless, triaging such patients by smartphone consultation saves time and resources without undermining the quality of care delivered to patients.

Improvements in the quality of images, coupled with the ease of data transmission, have allowed for the use of newer generation smartphones in the management of skin diseases[12-14] and more recent developments in mobile teledermatology have led to a prototype that allows patients to self-monitor their skin lesions.[14] In this system, the patient captures a skin lesion photograph using their smartphone camera and transmits the image to the provider who can then manage the patient's progress over time. Similarly, our patient in Scenario 2 was able to self-manage her recovery process from home without impeding effective communication with her urologist or undermining the quality of care she received. By using her smartphone to transmit images of her urine color periodically, Patient 2 and the urologist caring for her were able to safely monitor her progress over time until full recovery. Such uses of smartphone technology in urology have the potential to permit regular analysis of any number of non-urgent clinical signs and symptoms. As highlighted by our experience in Scenario 2, this technology can aid patients in self-monitoring of their disease process by communicating effectively with physicians, thus reducing patient anxiety, hospital visits, and healthcare costs.

Smartphones have been used in many clinical applications in orthopedics,[15-17] including measuring spinal curve severity in the assessment of scoliosis[18] and hallux valgus deformity angles in the assessment of bunions.[17] In a similar fashion, smartphones have shown to be advantageous in the management of patients with Peyronie's disease.[19] In the past, physicians have asked patients to bring in hard copies of photographs taken of their erect penis to assist in diagnosis and assessment of curvature. Using their smartphone for this task, patients can transmit updated images to their urologist and save a digital record of old images, assisting in both non-invasive diagnosis and regular assessment of disease severity. Recently, University of Washingtion has developed a smartphone app called University of Washington Peyronie's Examination Network (UWPEN), in which patients are able to capture images of their erect penis and then measure the angle of penile curvature. Hsi et al reported that the UWPEN app provides accurate and reproducible measurements and has the potential to allow patients to self-monitor the status of their Peyronie's disease.[20] Such use of smartphones provides patients and urologists new opportunities for integrating technology into clinical management of disease.

Smartphones have been demonstrated to be useful tools in nearly all aspects of medical practice and their potential for further utility appears to be limitless. Apart from patient care, smartphones can aid in conforming to duty-hours restrictions by reducing the number of required trips to the hospital and the in house time spent by the on call resident. Furthermore, the transmission of images to an attending physician directly from the smartphone to obtain advice has been a great asset for resident training and education. Improved communication between providers is an additional benefit offered by smartphone technology.

For example, when residents are consulted about urine color, hospital staff often use nonspecific and vague descriptors such as "cherry red," "pink lemonade," or "tea-colored," which can be misinterpreted and lead to confusion. In such situations, it has been our experience that a photograph taken by smartphone lends better objective information and allows for better communication and patient management.

Our review drew from just a handful of the applications of smartphones reported in such diverse fields as neurosurgery, ophthalmology, dermatology, and orthopedics; however, to the best of our knowledge our report on the utility of smartphones in the daily practice of urology is among the first to be described in the literature. Our experience has shown that smartphones are an efficient and inexpensive method of achieving meaningful consultations between healthcare professionals and a significant tool for enabling patients to self-monitor their disease. Importantly, our scenarios involved minor decision-making in the non-urgent management of patients by a physician familiar with the patient history and plan.

Although a smartphone image may prove to be beneficial in patient management, it is important to note that it can only supplement and not replace a good patient history and physical. Furthermore, when taking an image by smartphone, it is best to use cameras with high resolution and to ensure that photographs are captured with adequate exposure and in proper lighting to depict an accurate representation of the image subject. Multiple photographs at different angles must be taken to provide the best representation of the pathology. Use of smartphones in urology offers many benefits, however, future studies are still needed to determine the extent of their utility and the impact their use has in the quality of care delivered. Particular focus should also be placed on protecting patients' privacy rights and encrypting information before digital transmission of images. □

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