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EMERGENCY RADIOLOGY SPECIAL FEATURE: COMMENTARY

Mobile devices and their prospective future role in emergency radiology

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ABSTRACT

Mobile devices, wireless networks and software have significantly evolved since the late 1990s and are now available with sufficient computing power, speed and complexity to allow real-time interpretation of radiology studies. Emergency radiology (ER)'s time-sensitive nature would seem to be an excellent match for study interpretation using mobile devices, allowing the radiologist to read studies anywhere, at any time. While suitable for use by the radiologist outside of the hospital, or clinicians and surgeons at the bedside or in the operating room, these devices do have limitations, and regulatory approval for in-hospital diagnostic use is limited. In the ER setting, we suggest that the best use of mobile devices is to be available to consult directly with patients about their imaging findings and to the clinical team during rounds and at handover. This will bring the radiologist to the clinician and patient, helping us to better understand the patient's presentation, educate both the physician and patient and increase the visibility and value of the radiologist as a member of the clinical care team.

The revolution in computers and networking technologies in the past 30 years has created mobile devices that seem “impossible” for many of us who remember computers as contraptions that were huge, slow and difficult to use. Our mobile devices are now millimetres thin, have ultra-high-resolution screens that are readable in almost all conditions, perform complex computational tasks in real time and have a secure, high-speed connection to almost everyone in the world. The future, as many of us envisioned it, is now.

And in radiology, where we use reading workstations that we think are “high end”, the future was about 10 years ago—this perception of us needing ultra-fast workstations is a relic of the past, when we taxed what were then high-end processors with displaying imaging studies. Today, in 2015, we now carry mobile devices in our pockets that are more than powerful enough for most radiology image viewing and manipulation tasks.

Emergency radiology (ER) is a unique subspecialty because of the highly time-sensitive nature of the work—delays in the ER department may lead to the worsening of a patient's condition or can lead to increased wait times for other patients waiting to be seen. Faced with the availability of mobile devices with computing power more than adequate to read imaging studies, what can we do to improve our

efficiency and improve patient care in what we do as emergency radiologists?

Can we use our new mobile devices to view ER imaging studies and somehow improve patient care? To answer this question, we need to look at whether this is even technically feasible, then analyse if there are ways to use these devices in our workflow.

The requirements for viewing CT studies on a mobile device are that the device can (a) receive the images quickly from the picture archiving and communication system (PACS), (b) display the images with appropriate fidelity, (c) allow the user to view and manipulate the images similarly to a workstation and (d) be appropriately managed to ensure stability and reproducibility of function. The first requirement depends on processor and network speed, the second depends on the screen and if digital imaging and communications in medicine (DICOM) conformance can be achieved and the third depends on the memory, processor and graphics processor. The fourth requirement depends on the care facility's information technology department, either supplying facility-owned and managed mobile devices or using management software on radiologist-owned devices to ensure adherence to technical requirements such as screen brightness and conformance with security standards.

Many tablet and smartphone devices now support the IEEE 802.3ac wireless networking standard, that with just a single channel can support network speeds up to 833 Mbps. Even with a real-world throughput of 1/10th of that, this could still transfer a 2000-image trauma CT in approximately 30 s, far faster than a human could read the study. Mobile device displays are now some of the most advanced displays available, equivalent to, or exceeding, the resolution of 3-megapixel diagnostic displays, and calibration tools are available to ensure conformance with the digital imaging and communications in medicine standard. Finally, high-end tablets all have multicore processors with 2 GB or more of random-access memory, support of at least 128 GB of storage and have impressive graphics processing units that can easily display the static images of an imaging study, in addition to allowing multiplanar-reformatted processing in real time.

While a proof of concept of using mobile devices for CT evaluation was published in 2000,¹ in 2003, a study evaluating the suitability of a mobile device for ER evaluation of CT of the head for haemorrhage concluded that a Palm Vx mobile device, with the now almost humorous specifications of a 160 × 160 pixel screen, 8 MB of random-access memory and a single-core processor running at 20 MHz, was adequate for the job.² So, with near supercomputing power now in our hands, what is stopping us from using today's technology to do the job?

It is not for a dearth of evidence. In 2012, the ER use of the original iPad for reading CT and MRI studies was evaluated, concluding that "emergency conditions commonly encountered on CT and MRI can be diagnosed using tablet computers with good agreement with dedicated PACS workstations".³ In 2013, the use of the iPad 2 to evaluate for brain haemorrhage on CT scans in a well-lit room in the emergency department was assessed and found excellent agreement between using the tablet for CT evaluation and using a radiology workstation,⁴ and a similar study in 2012 using the original iPad in the reading room environment had similar results.⁵ A systematic review looked at these and other studies, for CT, MRI and radiographic evaluation, finding that with some limitations, "the diagnostic accuracy of radiological interpretation is not compromised by using a tablet computer".⁶ A recent study even demonstrated that smartphone photographs of radiographs could be used to identify abnormalities with a high degree of confidence by a board-certified radiologist.⁷ And with a regulatory approval being perhaps the ultimate acid test, the United States Food and Drug Administration cleared its first mobile application for radiology study interpretation in 2011,⁸ with at least 10 other primary interpretation applications available, although while some are not approved for diagnostic use, others are approved for diagnosis "when a diagnostic workstation is not available".

With the availability of capable hardware and software, with regulatory approval for out-of-department use, and with evidence supporting the use of mobile devices in some radiology situations, is there anything holding back their use? In the current in-hospital scenarios for emergency radiologists, we often interpret images in our reading room, or perhaps at the bedside if performing an ultrasound, or at the CT scanner console for a trauma scan or an acute stroke case. Mobile

devices, owing to their small screen size, do not really have the potential to improve our experience or workflow in these situations. Certainly, the scenario of the on-call emergency radiologist out for dinner pulling up an urgent study on their tablet and calling the emergency physician with the critical finding is an obvious one, and is already in use today. And for several years, surgeons have been using tablets in the operating room for intra-operative review,⁹ and clinicians have been using them at the bedside to review images on rounds.¹⁰

But, another question is—should radiologists be encouraging their use? Today, when many clinicians are adept at interpreting radiology studies, and the adoption of PACS has been shown to minimize visits to the radiology department¹¹ and potentially limit relationships between radiologists and clinicians,¹² it is not too far fetched to believe that the availability of all imaging studies not just on computers at the nursing stations and in the clinic but rather in every clinician's pocket has the potential to continue to erode these relationships and further marginalize the radiologist. Like with many technologies, users will do what they want, and the market will create solutions if they are saleable; in this case, it is not as though we, as radiologists, have any choice in the matter.

Rather than clinicians using mobile devices to marginalize radiologists, is it time then that radiologists step out of the reading room (and into the light, literally) with mobile devices and start joining clinical teams to provide in-person expertise as the diagnostic physicians we are? Our wealth of knowledge about pathophysiology of disease, appropriateness criteria, image interpretation and the communication of results could be put to much better use with a radiologist as part of the clinical team. How many times has a clinician consulted you about a difficult case that they have already ordered every lab test for, and done a detailed clinical exam, and ordered some generic imaging studies to have you say, "well, it sounds like a case of (obscure condition). Why don't you get the patient a (specific imaging study) to confirm it?". Making radiologist attendance required at rounds and at patient handover during shift changes in the emergency department could significantly improve communication about patient care and contribute to patient management by having the radiologist review studies and findings with the clinical team on a mobile device.

There is much focus on value in radiology today.^{13,14} What could better reinforce our role as physicians and be more valuable than seeing patients? It is purely anecdotal, but, we have never met a patient who does not appreciate having his or her imaging reviewed in person by a radiologist, or a clinician who is uninterested in seeing the findings for himself or herself. We frequently complain about receiving poor histories from our clinicians that limits our interpretations. What better way to confirm or refine a study's findings than by reviewing the study with the patient, tablet in hand, showing them their images?

Mobile device technology is here to stay and will only continue to improve. It is certainly mature enough for use by radiologists in the on-call, out-of-hospital setting and by clinicians at the

bedside or in the operating room. The real value in this technology may lie in allowing the radiologist to bring images with them to the patient or clinician and improving patient care

through face-to-face interaction with teams and patients with us as diagnostic specialists. The future is now. How we use it to improve the care, and lives, of our patients is up to us.

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