
Effect of Remote Orthopedic Consultation on Hospital Referrals in a Community-Based Urgent Care Facility

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Abstract

Objectives: To describe the contribution of a remote messaging and x-ray viewing tool integrated into the Emergency Medical Records of a chain of privately-run urgent-care clinics in order to facilitate orthopedic consultation and decrease orthopedic referrals to hospital emergency departments.

Methods: Non-orthopedic physicians were trained in simple splinting and casting techniques and given access to a remote telecommunications tool. Hospital referral rates for orthopedic traumatic injury were compared between 3-month periods before and after implementation of the technology and, after its implementation, between times with and without physician access to remote orthopedic consultation.

Results: The referral rate for fractures decreased from 24% to 14% after introduction of the technology ($p < .0001$). During the 14 months of the tool's implementation, the mean referral rate was 4.3% when it was available and 6.3% when it was not ($p < .0001$). Survey of the physicians involved yielded 100% satisfaction with the ability to obtain virtual orthopedic consultations.

Conclusions. Remote orthopedic consultation is a highly effective tool for managing many fractures on-site in an urgent care environment, thereby sparing patients and health systems the cost and inconvenience of hospital referral.

MeSH Words: Information technology, orthopedics, urgent care, free standing emergency facilities

Introduction

In the Israeli health system, patients who seek hospital emergency care must be referred by their family or other physicians. During off hours, the health funds encourage patients who need emergency services to attend urgent care centers [1,2,3,4]. Self-referral to emergency departments (ED) entails payment on the part of the patient, except for certain conditions, such as new-onset fracture. However, patients who go directly to the ED for a suspected fracture who then prove not to have one are liable for the full cost of the emergency room visit. Therefore, physicians in urgent care centers encounter many

cases of suspected fracture. At our center in Jerusalem, in 2006, fractures were among the 5 most frequent diagnoses in the 10-20-year old and over-70-year-old age groups. Nevertheless, most of the urgent care centers in Israel do not provide specialized orthopedic services. Although, as shown in a previous study by our group, certain fractures can be successfully managed by non-orthopedic physicians [5], there continue to be many referrals to hospital EDs for orthopedic consultation.

Studies have shown that in cases of orthopedic trauma, providing physicians with access to teleradiology improves diagnostic accuracy and

patient disposition in emergency departments and outlying hospitals [6]. However, in a trial conducted in Thailand, Chandhanayingyong et al. [7] attempted to expand physician accessibility to teleradiology by multimedia messaging of digital photographs taken on mobile phones to orthopedists. The overall misdiagnosis rate was 40%: overdiagnosis 12% and underdiagnosis 27%. The consequences of misdiagnosis would have resulted in mismanagement in up to 48% of cases, making this technique not clinically viable [7].

Most hospitals and all health fund clinics in Israel have some components of electronic medical records (EMR) [8]. Recently, many of the health fund computer programs were enhanced to allow for remote viewing of digital x-rays. The present work was based on the rationale that newly developed information technology (IT), tools can be applied to reduce the need for orthopedic referrals from urgent care centers. In 2006, a major urgent care clinic in Jerusalem introduced a technology that made it possible for physicians to remotely consult with an orthopedic hospital-based specialist using text messaging and web-based viewing of orthopedic x-rays. The aim of this study was to determine the effect of this technology on referral rates for fractures over a 3-month time period compared to the same time frame in the previous year, prior to its implementation. We also compared hospital referral rates after implementation of the technology between times when it was or was not accessible. Finally, the ability of a senior orthopedist to read the web-based images on a mobile phone screen was evaluated.

Material and Methods

Setting

The study was conducted in a privately-owned system of free-standing emergent care clinics in and around Jerusalem, Israel. The central clinic is open 24 hours per day 365 days per year. The remaining clinics are open in afternoon/evenings and on weekends and holidays. An orthopedist is on site in the central clinic for approximately 5 hours daily. The remaining clinics do not have an on-site orthopedist at any time.

Electronic Medical Records

The TEREM clinics use a proprietary EMR system to register, clinically manage, and administer all visits, laboratory tests and radiological studies. Most essential clinical data

(primary complaint, tests performed, discharge diagnosis and disposition, x-rays and their reports, bacteriological culture reports, follow-up instructions and more) are digitally recorded into the EMR. Any other materials, such as handwritten doctor's notes and printed lab results, are scanned into the system and attached to the patient's record. This provides a complete digital version of each patient visit.

The combined data from all the clinics are housed in a unified "data warehouse". A set of web-based forms were developed to allow for the review of individual charts as well as the extraction of summary statistics. For example, a reviewer can request a list of visits by patients of a certain age with a specified diagnosis. Statistics can be generated based on combinations of query criteria. In this manner, we extracted for analysis all patients with a trauma-related chief complaint and/or diagnosis of fracture from the time the consultation tool was implemented. We further extracted the rate at which patients with a diagnosis of fracture were referred to hospital EDs in June, July and August 2006 (before implementation of the technology) and in June, July and August 2007 (after its implementation). We started the study in July, 3 months from the time the tool became functional, to account for the learning curve among the physicians, most of whom work within the system only part time.

Digital Radiology

Since June 2006, all 5 clinics have provided their physicians with digital, on-site, computerized radiology (Agfa®) during all operating hours. Digital radiological images are stored for the short term in DICOM format, in 2 picture archiving and communication systems (PACS), one manufactured by Real Time Imaging (RTI®) and the other by MyFreePACS (open source). X-ray images are also stored long-term as compressed jpegs in an online, secured, web-accessible archive.

Casting Clinic

The clinic system currently employs 68 physicians from a wide range of clinical backgrounds. Because many did not have previous hands-on orthopedic experience, we require that within the first year of their employment in the system, all physicians must complete a specialized course, developed in-house, on a broad range of topics in urgent and emergent care. The course includes lectures on assessment of trauma patients, indications for

bone x-rays, interpretation of these x-rays, and casting/splinting techniques, in addition to a hands-on session for practicing the actual application of cast splints. Until they complete the course, the physicians always work with another physician who is already skilled in cast application.

Continuing Quality Improvement

All x-rays performed in the clinic system are digitally recorded and then reviewed by a senior radiologist within 24 hours via a centralized and remotely accessible RTI teleradiology system. In the event that the treating physician missed a finding, the radiologist indicates this within the EMR. This action notifies a senior staff physician who then calls the patient back for definitive treatment. In addition, the treating physician is sent an email requesting his/her review of the film. This feedback includes a web-based link to a digital copy of the x-ray film.

Communication with Orthopedists

The RTI PACS system includes a module for remote viewing of films in any of the system clinics, regardless of where they were initially performed. Prior to the intervention, consults were available from remote clinics by telephone, with the orthopedist being able to view the same film as the physician with the question. However, the treating physicians in the remote clinics found it very time-consuming to call the central clinic, locate the orthopedist and request a consult. To deal with this issue, the current system delivers instant messages between the orthopedist and consulting physician within the same EMR application that each physician uses for patient treatment.

Since March 2007, treating physicians have been able to request an orthopedic consultation by typing a question into an EMR-integrated "consulting" messaging window. A computer server utility copies the appropriate local clinic's DICOM images from the MyFreePACS server, across the TEREM-wide area network (WAN) that connects all 5 clinics, directly to the hard drive of the orthopedist's computer in the central branch. Upon completion of the copy process, the EMR station on the orthopedist's computer opens a dedicated window showing the following: (a) the x-rays (displayed in a DICOM viewer); (b) the question of the treating physician along with other clinical data about the patient

from the EMR; and (c) a text area within which the orthopedist types a response to the treating physician. After the orthopedist digitally signs the consultation, the treating physician receives an SMS indicating that the consultation is ready.

Study Procedure

Instant Messaging Consults

For each of the TEREM clinics, we calculated the proportion of all trauma-related visits in which the remote orthopedic consultation tool was used. The dispositions of all patients with fractures treated between June 1 and August 31 2007 were compared with those of patients treated during the same time frame in 2006. To rule out the presence of confounders, the findings were analyzed against the management of head trauma during the same time periods. In addition, during the 14 months of the tool's implementation (March 2007 - April 2008), we compared the referral rates between the times physicians had access to a remote orthopedist and the times they did not.

Comparisons of groups were done by chi-square analysis with significance set at $p < .05$.

Hand-held viewers

To account for scenarios in which a mobile orthopedic consultant is not in proximity to a station of the EMR, we loaded 41 of the jpeg-compressed x-ray images from the web-based archive onto a Nokia E-61 3G mobile phone. The images were presented to a senior orthopedist who had not previously seen them. The interpretation of the orthopedist was compared to the official reading of the radiologists.

Physician satisfaction

The frequency of use of the consultation tool by individual physicians was extracted from the data warehouse. To determine satisfaction with the tool, each of the 68 non-orthopedist physicians employed by the system of clinics was contacted by telephone and asked if he or she was pleased with the availability of the consult service.

Results

Instant Messaging Consults

Since the inception of this new service, 2165 consults were sent digitally out of a total of 7568 trauma-related visits during which x-rays were

performed, for an overall consultation rate of 28.6%. The time from the physician's posting of a request to his/her receipt of a response from an orthopedist was less than 15 minutes in >91% of the cases and less than 30 minutes in >95% of cases. The hospital referral rate for all fractures decreased from 24% (139 referrals out of a total of 587 diagnosed fractures) in June-August 2006 to 14% (93 of 683 diagnosed fractures) in June-August 2007 (Pearson's chi-square = 21.2; $p < .0001$). The types of fractures were similar in both time frames. Furthermore, for all cases in which the site of fracture could be identified from the data warehouse (92% in 2006, 98% in 2007), there was no difference in the percentage of upper- vs lower-limb fractures (27% vs 63% in 2006 and 28% vs 66% in 2007). For comparison, analysis of the head trauma referral rate during the same time periods yielded values of 14.8% in 2006 and 16.8% in 2007 ($p = \text{NS}$). In the 14 months since inception of the tool, the hospital referral rate was 4.3% (333 out of a total of 7325 fractures) during hours in which an orthopedist was available compared to 6.3% (1273 out of 4081 fractures) during hours in which an orthopedist was not available (Pearson's chi-square=21.4; $p < .0001$).

Hand-Held Viewers

When shown 41 images on the Nokia phone, the study orthopedist identified all of the findings, subtle and gross, noted by the reporting radiologist.

Physician Satisfaction

The consultation tool was used at least once by every physician in TEREM. All physicians interviewed voiced satisfaction with the availability of the service.

Discussion

Our study shows that the addition of a remote digital orthopedic consultation service to existing teleradiology technology in a chain of community-based free-standing urgent-care centers was associated with a statistically significant reduction in hospital referrals. The finding that the referral rate for another type of trauma (head) was not similarly reduced indicates that our results were not simply a reflection of more experience among physicians or changes in company policy. The attribution of the reduction to the IT tool is further supported

by the lower rates of hospital referral during the hours in which an orthopedist was available for consultation than in the hours in which one was not.

This type of technology can be used in any location where direct physical access to an orthopedist is limited. Non-orthopedists can be trained to identify common fractures and then to apply a cast splint, which suffices in the vast majority of cases, especially in children. In the event that orthopedic consultation is necessary, the original x-ray can be digitized and the images transmitted to a remotely located orthopedist. Earlier trials with transmission of digital photographs for purposes of specialist consultations have not been successful [7]. However, we found that although original DICOM images are many megabytes large, the compressed jpeg versions of the same x-rays take up only a few hundred kilobytes, so that they could even be emailed with standard web-based email programs or clearly displayed on the screen of a mobile phone. This versatility further enhances the applicability of remote consultation, anytime and anywhere.

This approach is potentially amenable to medical specialties other than orthopedics and different medical set-ups in which local expertise is wanting. The speedy feedback on film interpretation as well as patient management holds promise for improving the professional qualification and independence of local medical personnel over time. The present anecdotal experience with non-orthopedic physicians in our clinics requires further confirmation with wider implementation of this tool in Israel and other countries. Its use may ultimately lead to a significant decrease in hospital referrals, sparing patients much inconvenience and saving costs to the medical system as a whole.

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