Fundamentals of Enterprise Photodocumentation: Connecting the Clinical and Technical—a Review of Key Concepts

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Abstract

Photodocumentation is an invaluable tool in many specialties, including dermatology, facial plastic and reconstructive surgery, and wound management. As digital cameras and camera-enabled smartphones have become omnipresent in our society, they have brought photodocumentation to all corners of healthcare organizations including the emergency department as well as family medicine and pediatrics. Simultaneously, enterprise imaging programs have evolved enabling access to all medical images for all providers throughout these organizations. Through their unique perspective, enterprise imaging teams have an opportunity to guide development of high quality, ethical programs that are compliant with legal and regulatory requirements. Clinical and technical standards for photodocumentation are not fully evolved and thus establishing an enterprise photodocumentation program will require communication and education. Development of such a program requires an understanding of the clinical, ethical, and technical issues around photodocumentation. This article explores how photodocumentation is utilized, the patient's experience, current quality concerns, tools and technical issues around image acquisition, and the topics of informed consent, privacy, security, and lifecycle and health information management.

Keywords Enterprise imaging · Photodocumentation · Clinical photography · Visible light · Digital imaging

Introduction

As enterprise imaging programs are adopted across the nation and the scope of those programs expands the inclusion of visible light images in the form of surface anatomy photographs is an area of great opportunity. Photodocumentation has its foundation in the traditional professional medical photography department. These departments were established to provide high-quality photographic services. They are able to provide the optimal environment for reproducible high-quality photographs. These departments may serve an entire hospital or they may be dedicated to a single subspecialty department. Currently medical photography is one of the most widely distributed imaging acquisition modalities. Photographs may reside in sophisticated highly subspecialized archives in the dermatology department; they may be scanned into the document management system for long-term archiving or they may simply exist as individual photographs stored in a residual paper chart. Clinical photography has been a long standing valuable tool for facial and plastic surgeons, dermatologists, and wound care specialists. With the advent of camera-enabled smartphones, high-quality photographic image acquisition technology is now ubiquitous. With this new ease of acquisition, the value of this type of documentation is being realized by other specialists including traumatologists, emergency medicine specialists, family practitioners, and pediatricians.

As these advances in photo acquisition technology have evolved the role of enterprise image (EI) programs has also advanced. The goal of any EI program is to aggregate all medical images, including photographs, in to a single image library which that can then be integrated with the electronic health record (EHR) [1]. This integration is designed to ensure that all clinically relevant information is accessible in a comprehensive longitudinal medical record. The development of an advanced EI program is best built on a foundation of enterprise thinking which extends beyond traditional subspecialty boundaries. Disciplines such as dermatology and plastic surgery which have long relied on photographs for documentation have well-developed guidelines and standards for acquisition of photographs. Their use cases are well defined. As other disciplines engage in the process of photodocumentation

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they should develop appropriate use cases, guidelines, and standards. EI teams have a unique opportunity and obligation to support the development of these programs by sharing existing knowledge and by leading the effort to develop enterprise standards and guidelines. In the future, national consensus may influence these guidelines and standards.

As development of shared standards is in its infancy this paper seeks to report the issues that should be discussed and provide a review of guidelines established by subspecialties with more advanced photodocumentation experience. The purpose is to provide a solid foundation for an ethical program that meets regulatory and legal regulations and produces high quality photodocumentation.

Review and Discussion

Overview

The visual representation of a patient's condition has been integral to medicine throughout time. The original documenters were true artists depicting the human body through a number of different artistic media. As photographic techniques evolved, it was a natural progression to integrate this form of artistry into medical documentation. Photodocumentation, also known as clinical photography, is the representation of a patient's condition using photography rather than alphanumeric descriptors. Photodocumentation is perceived as less biased that the text record [2]. Providers engage in photodocumentation for a number of reasons all of which should share having a positive impact on patient care. In their study of photodocumentation in the emergency department management of soft tissue infection 65% of the participating physicians believed that photodocumentation improved their assessment of the patient and 64% stated that photodocumentation improved their confidence in their decisions regarding antibiotic therapy [3]. Seventy-five percent of the participating physicians felt that photocumentation was superior to alphanumeric documentation. However, studies have revealed a lack of knowledge by those in the emergency department on the factors critical to obtaining high quality images [4].

Evaluation of images published in clinical journals provides insights in to the quality of images currently being obtained. Theoretically, these images represent the best of what an author has to offer. These images serve as a learning tool for readers of the journal. Systematic review of images in both the orthopedic literature and the oral and maxillofacial literature indicate significant quality gaps [5, 6]. Features these authors have investigated include background, patient preparation and positioning, inclusion of anatomic landmarks, scale/perspective, sharpness/focus/detail, color, white balance, and lighting [5–7]. In Wu's investigation sharpness, white balance depth of field and light exposure received some of the lowest quality scores [6]. Color received the highest score. Features which lead to lower quality photographs included emergency situations and intra-operative scenarios as compared to pre and post-operative scenarios [6]. In Uzun et al.'s evaluation only 44.9% of images satisfactorily fulfilled all three of their established criteria (background, patient position, image technique) [5].

As stated by Lakdawala, "As digital imaging becomes more accepted as a diagnostic tool, much like routine labs or radiological studies, patients will come to expect a greater level of accuracy and reliability in these images" [8]. In their study, they found that inconsistencies in technique were factors that contributed to decreasing value of photodocumentation. This type of inconsistency is especially troubling in those use cases where comparison between images at different points in time is critical. Photographic misrepresentations can occur due to patient positioning, camera angle, lighting [9]. It is a well-recognized fact among those most experienced with photodocumentation that in order to best represent changes over time there must be consistent technical standards including camera distance, camera perspective/angle, background brightness and color, picture size, and lighting [3, 10–12]. These features are discussed in greater detail later in this manuscript.

Patient Experience Studies of patient's perception of clinical photography have shown that patients appreciate the value of photodocumentation [3, 13, 14]. Patients are interested in seeing their photos and it is believed that photodocumentation can be used to improved patient engagement in their disease process [13]. In a study by Wang et al., where the vast majority of the patient's wound were not directly visible to the patient, 81% of patients reported that following photographs of their wounds helped them understand the progress of their condition and 58% felt that photographs made them more involved with their care [15]. In the emergency department setting for the evaluation of soft tissue infections patients understood that photodocumentation contributed to their overall care by providing continuity between visits and between providers [3]. These patients were comfortable with the addition of these images to their medical record. Interestingly patients in the control group who were not photographed expressed a desire to have their infections imaged, even though they did not perceive any difference in the quality of care received.

The person who is taking the photograph can impact the patient's experience. In their study of dermatology inpatients in a French hospital, Hacard et al. reported that their dermatology population accepted imaging by a provider, a nurse or medical student [13]. However, in Leger et al.'s study of a heterogeneous patient population from 4 different outpatient dermatology departments in New York City 94% of patients were most comfortable when pictures were taken by a

physician [14]. For other provider types, comfort levels were 79.6% for medical students, 66.8% for medical photographers, and 43% for nurses and physicians assistants. Patients were also more comfortable when the person taking the photograph was of the same gender 90.3% versus 73.5% when the photographer was of the opposite gender [14]. Patient acceptance is varied by race and age with greatest acceptance by Caucasians and those over 60 years of age [14].

Patients have different reactions to how photographs are utilized beyond the immediate doctor-patient interaction. The vast majority of patients, ranging from 72 to 98% approved of their images being utilized for clinical documentation in the medical record, for communication among the care team and for viewing by physicians directly involved in their care [14, 16–18]. In these same studies acceptance rates trended lower for use in research (60–88%) and teaching (60–75%). Patients put restrictions on use for teaching and research if they could be identified on the images [14]. Patients were less accepting of using their photographs for publications or for use on medical websites [13, 14, 18].

Users of Photodocumentation Providers of all types and all specialties are now utilizing photodocumentation. In one study at multiple locations of the Mayo Clinic, any provider who had electronic health record access privileges was able to access their internally developed application [7]. During the course of their study, photographs were acquired in an encounter every 44 min with an average of 2.8 photos per encounter. The distribution by provider type for those using the application was 31% residents/fellows, 29% attending physicians, and 14% nurses. The distribution of photos added was 18%, 30%, and 28% respectively indicating that nurses added proportionally more images. Orthopedic, general surgery, and plastic surgery had the most users followed by dermatology and medicine. Dermatology however accounted for 54% of all photographs taken. Surgical specialties added 26% of the images and medicinal specialties add 4%. The leg was the most common site imaged accounting for 19% of all photos, followed by the face (12%) and the back (10%). The mobile photo upload service did not decrease utilization of their formal medical photographers' services. This observation indications that the mobile photo upload process is additive to professional photography services rather than competitive and it is being utilized for enhanced documentation and new use cases.

Tools Photography's role in medicine has continued to evolve and grow as new technologies have been introduced, most recently the introduction of digital photography followed by the marriage of digital cameras and smartphones. However, as smartphone technology has evolved, it has begun to rival the capabilities of the digital cameras utilized by these photographers. Smartphones are now ubiquitous. Smartphones are used by the vast majority of individuals in ACGME training programs with iPhone dominating, being utilized by 48% of respondents [19]. They provide the capability for on demand imaging in all healthcare environments.

Patients are sensitive to the type of device used to acquire their photographs and concerns have been raised about professionalism and the use of smartphones [17]. A study of patients in urban academic and private practice environments revealed that 97.7% of patients readily accepted being imaged with a hospital owned camera while only 27% accepted being photographed by a provider's digital camera or personal smartphone [17]. In another study, 75% of surveyed plastic surgery patients in the English National Health System preferred hospital owned cameras and dermatology inpatients in France also demonstrated a preference for a hospital owned camera over a personal cameras [13, 18]. Patients from 4 different outpatient clinics in New York City 91% preferred a clinic owned camera [14]. These investigators all found low acceptance rates for use of personal mobile phones and digital cameras ranging from 12 to 52.2%, with slightly higher acceptance rates for personal digital cameras compared to personal mobile phones [13, 14, 18]. Reasons cited by patients included concerns over confidentiality and privacy [13, 17].

The file format used for image storage also needs to be considered. The RAW file format is considered the best file format for photography. In the RAW format there is minimal manipulation of the data which means that the maximal pixel information is preserved [20]. The RAW format is preferred for forensic photography [21]. There are issues with the RAW format due to inconsistencies due to a lack of industry standards. If the images cannot be stored in the RAW format TIFF format is preferred over the JPEG format. In most enterprise imaging systems these files will then be dicomized for archiving. With the intersection between smartphones and clinical imaging the two industries are now intertwined. Changes in one industry will impact the other. With the introduction of iOS11 Apple changes its native image file format to HEIF (high efficiency image file format) [22]. Unfortunately, most viewers, including universal DICOM viewers will be unable to handle this format [23]. While work-arounds exist, such unanticipated changes will catch the medical imaging community off guard.

Challenges

The challenges faced during implementation of a photodocumentation program center around metadata, workflows, and associating images and text data within the EMR. The metadata issues are not insignificant. They range from association of the proper demographic information to inclusion of clinically relevant information such as the encounter diagnosis. Multiple scenarios have been described for associating demographic information ranging from

starting the series with an image with the data such as a copy of the patient's ID band, to including the information on every single image; manually entering the data during upload; or having some form of electronic transmission. The third option, electronic transmission is most desirable and multiple different options for this electronic transmission exist [24]. An ideal scenario would be to have the photo acquisition and upload software integrated with the EMR so that images can be acquired within the context of a specific patient's chart. Such workflows exist in some EMR mobile applications, although those workflows currently do not communicate with the image archive which is at the core of an enterprise imaging strategy.

The need for a photograph may not always be anticipated and with smartphones as the primary modality, a modality worklist is currently not feasible. Most photodocumentation programs will follow an encounters-based workflow [25]. An encounters-based workflow will create an unsolicited result in the EMR and will need to include the ability to generate a unique identifier for the study. The workflow should favor structured study descriptors over free text to identify the result. With structured study descriptors indexing for future searchability is optimized. If the study is stored in a DICOM format, there are challenges with the body part field which is currently not fully inclusive of terms specific to the surface anatomy which is the subject of most photographs.

The need to create a bidirectional relationship within the EMR connecting the images with the textual information describing the imaging findings has already been solved for radiology examinations. However, the challenge of creating this connection remains open for other imaging modalities including photodocumentation. While some organizations may have solved this need with custom programing, EMR vendors need to develop standard mechanisms for creating this connection. Having a connection between the imaging data and the context stored in the associated clinical note enhances the power of both types of information. An extensive discussion of mobile technology, workflows, and appropriate file formats can be found in the HIMSS-SIIM series of whitepapers on enterprise imaging [22–27].

Use Cases

As the use of smartphones as an image acquisition tool becomes more widespread the potential for inappropriate utilization grows. This concern is especially true among our younger physicians who have grown up with a smartphone as a feature of everyday life. Photodocumentation of every aspect of life is common place from photographs of interesting meal to the traditional pre-prom pictures. Medical photo documentation should not be based in such an unstructured approach. Use cases should be deliberately defined. The use cases define the purpose of the documentation and the purpose of the

documentation determines the essential features of the photograph.

Within EI different imaging types are categorized on the intent of imaging. Imaging content falls in to one of four categories: diagnostic imaging, procedural imaging; evidence imaging and image-based clinical reports [1]. The vast majority of medical photography falls in to the category of evidence based imaging—documenting current state. As the use of photography in the operating room becomes more widespread there will be a compensatory increase in the percentage of procedural imaging with photography. The underlying reasons for documenting current state are numerous. They include:

1. Medicolegal documentation
2. Documentation of current state with the intention of obtaining sequential images for follow up or surveillance
3. Facilitation of consultation
4. Teaching activities
5. Patient education
6. Pre and post operative documentation
7. Surgical planning (location, size, nature of lesion, relation to surrounding tissue)
8. Surgeon practice review and monitoring
9. Forensic evidence.

Each use case should have a specific driving indication. Development of the use cases also requires a consideration of the legal aspects of forever placing the information in the chart. The philosophy of whether photodocumentation should be used sparingly or be widespread will vary from institution to institution. Documentation for the purposes of medical record keeping is a common driver for photodocumentation. In this case, "a picture is worth a thousand words" and the use of photo documentation may ease the burden of putting into words information that is easily conveyed in a single photograph. For example, using a photograph to document the appearance or location of a lesion prior to excision. Photodocumentation is a valuable tool in the emergency room for documentation of injuries in vulnerable patients, such as those victimized by child abuse [10]. These authors believe that photographs of all injury may become the accepted standard. An importance use of photographs in dermatology is the identification of a biopsy site with the intention of preventing subsequent wrong site surgery [28]. Recording current state to aid follow up is the primary driving force behind many wound photodocumentation programs. Wound photography is essential to monitoring healing and determining appropriate therapy [29]. Total body photography is currently being explored as a technique for skin cancer screening [30]. This application also highlights the potential for combing artificial intelligence with photodocumentation to enhance clinical care. The list of published list of use cases is vast.

Informed Consent

Patient informed consent for photodocumentation is a critical step in establishing an ethical and compliant program [31, 32]. Respect for patient's autonomy is one of the four medical ethical principles and is at the heart of the informed consent process. Patients retain the right to control over their body including whether or not it is photographed for medical reasons. Their decision needs to be based on a discussion of the risks and benefits of photodocumentation. Patients have the right to refuse to be photographed without negative impact on their care. Beneficence, another of the four medical ethical principles, guides healthcare provider behavior. Beneficence requires that actions be motivated by doing good. In the case of photodocumentation, there needs to be an intent to do good the process of acquiring a clinical photograph. The intended benefit could be for the direct care of the patient being photographed or it may be for the benefit of future patients as providers learn from their experiences [32]. These benefits and the intended use of the photographs need to be explained to the patient. The primary risk associated with photodocumentation is unauthorized disclosure of the photograph [8]. Unlike a surgical or procedural associated risk which is finite this risk of disclosure persists for as long as the photograph exists. A discussion of how these risks will be mitigated needs to be part of the consent process. Patients need to be assured that their images will be treated with respect and with appropriate security.

The components of informed consent to photograph a patient include: how their photograph will be used and who will be viewing the images; methods for protecting their identity; how the images will be stored and what security methods are employed. Consent to photograph for the purposes of medical care is distinctly separate from the consent to publish photographs or to use photographs in teaching materials. Likewise, using patient's photographs for marketing materials requires additional consent. Many professional journals now recognize the need for permission to print and may require release from the patient when identifying landmarks are included on the image [32]. Failure to obtain consent can have disastrous consequences for a provider even when the image are not acquired for purposes of photodocumentation in the medical record. Consequences are heightened when the failure to consent is when coupled with inappropriate release of those images [33]. Providers and patients need to be aware that consent may be withdrawn at any time. However, if consent was given for publication and the images are now within the public domain, their use may be impossible to reverse [8]. Consenting a minor will follow typical processes as obtaining consent for other procedures and processes. An additional consideration exists with minor. When a minor reaches the legal age they may withdraw consent for use of their photographs.

Investigations have revealed that patients are very thoughtful about the consent that they are providing for photodocumentation. 78.8% of Hacard's patients in France believed that every potential use of the photograph should be outlined on the consent form and 44.9% desired to address consent or not for each type of use [13]. Forty-seven percent of patients in Lau's study felt that consent should be requested for each mode of distribution of the images [18]. Furthermore 41% of Lau's patients wanted to be notified each time their images were used and 55% wanted to be notified of specific journals or meetings where their photographs were to be utilized. When surveyed patients overwhelmingly preferred written consent to verbal consent. The division was 78.4 to 14.1% in Leger et al.'s study and 60% to 40% in Hsieh et al's study [14, 17]. Interestingly providers have a very different approach to informed consent. The vast majority of physicians surveyed utilized verbal consent and many felt that written consent was impractical (75–92%) [34, 35]. In many cases they noted a failure to document their verbal consent.

Each institution needs to determine their policy on how this consent is to be obtained. Consent may be included in the general consent to treat document, a separate written consent may be required or verbal consent with documentation may suffice. All of these methods have been reported in the literature and each institution will determine what is appropriate for them [8].

Acquisition

High-quality photographs are essential to provide accurate documentation [2]. Lower-quality images reduce interpretative ability of those who utilize the images for diagnosis, follow up, and even for legal evidence [2].

Standards for photodocumentation for esthetic surgery were established by Dibernardo in 1998 and those standards are maintained today with few modifications [11, 31]. These standards are reflected in the standards in many other specialty practices. Without an appreciation for the variation that different techniques can create images can be acquired that falsely create changes in appearance. For many of the subspecialty already utilizing photo documentation standard views have been implemented. To acquire photographs which can be used for follow up a single patient or for comparison among numerous patients' features such as positioning, lighting, camera, lens, and post processing should be consistent [36]. An overview of these various features is presented although a detailed discussion of photographic techniques is beyond the scope of this manuscript.

Background Setting the stage for photodocumentation can significantly impact the quality of the images and the information contained within. The use of a consistent background is therefore critical especially when comparing images

between patients or at different time points for a given patient. The background should be a solid color and a medium blue background is optimal for representing skin tones [11, 31, 37]. Other acceptable background colors include medium gray or the green of a surgical towel [5, 11].

Distractions should be removed from the environment and the person that is the subject of the photograph. Room distractions such as doorways, IV poles, pictures on the wall, other medical equipment should not be visible. Distractions on the body such as bloody bandages, surgical instruments, jewelry, hair and if excessive makeup, should be removed. Those distracting items which cannot be removed should be covered.

Patient Positioning The area of concern needs to be appropriately positioned for the photographs. The most basic concept for positioning a patient is to mimic the orientation of the body part as one would examine it clinical [37]. Incorrect positioning can lead to visual misinterpretation. Multiple examples of this type of visual error have been reported in the literature. Small changes in positioning of the head and neck have been shown to significantly alter pre- and post-operative assessment of facial plastic surgery patients [12]. Incorrect positioning has been shown to create the false appearance of rhinoplasty, or otoplasty [38]. Difference in depth of inspiration can produce an inaccurate representation of the effects of liposuction [11].

Plastic surgery has been the leader in establishing standard views for pre-surgical evaluation for a number of different surgeries and body parts [31, 37, 39]. This concept has been introduced into the emergency medicine literature by Bloemen et al. who reviewed the literature and published standard views for extremity photographs [10]. Standard position for orthopedic photographs has also been described in detail by Uzun et al. [5].

Spatial Relationship/Framing Not only does the body need to be appropriate positioned, the camera needs to be appropriately positioned relative to the body. When photodocumentation is being obtained to follow a lesion over time or for pre- and post-surgical evaluation the same anatomic landmark should be used as the focal point [38]. The camera should be parallel to the body part being photographed to prevent distortion [4]. An angulation of greater than 15° will create angular distortion that is visible on the image [4]. Lack of an orthogonal imaging plane is a key component of decreased forensic image quality for representation of bite marks [40]. The camera should also be centered on the area of interest [5, 11, 29]. The distance between the subject and the camera will add to variations in image quality. Ideally this distance between camera and patient should remain fixed for each body part and should not vary between images acquired at different points in time [11]. Uzun et al. presented a series of standard patient to camera distances for the extremities [5]. The area to be photographed should fill as much of the field of view as possible while still including appropriate anatomic landmarks or margins of the lesion [11, 31]. Spatial orientation of the body part should reflect the typical anatomic orientation of the body part similar to the orientation of the body part on standard radiographic images.

Ruler Whether or not a ruler or other representation of scale should be included is determined on of the intended purpose of the image [39]. There are those who advocate for use of some form of calibration tool for every photodocumentation series [10, 39]. A ruler may not be necessary for documentation of deformities. However, inclusion of some form of measurement is critical for conditions that will be followed over time, such as skin lesions and wounds [29]. A study by Eskiizmir et al. demonstrated that their metric view, a view with a ruler, showed no statistically significant difference when compared with the actual size of the lesion and outperformed any of the other views in the series [9].

How the ruler should be placed varies in the literature. It may be placed directly on the skin or held at a predetermined distance [4, 10]. The strongest recommendation is to have the ruler on the skin so as to reduce distortion in scale [20]. When placed on the skin one should take care to insure that the ruler does not impress on the skin creating additional distortion [20]. The ruler should be placed as close to the lesion as is reasonable without covering any portion of the region of interest. The important fact is consistency.

A number of different rulers and calibration tools are available. A ruler with a Matt finish reduces reflection and a rigid ruler avoids distortion of scale [4]. The inclusion of circles on the ruler enables one to judge the degree of angular distortion [20]. Coins can also be placed on the field to help prevent angular distortion although they may be a source of reflected light within the image [40]. The camera can be aligned to the circular object which is near the center of the field of view. Forensic rulers are based on the American Board of Forensic Odontology ABFO No. 2 standard reference scale [41]. These rulers are L-shaped with calibration lines along both limbs of the L. With use of this ruler a grid can be drawn across a lesion. Three circles are present to aid in establishing a perpendicular orientation between the camera and region of concern [41].

Series and Number of Images The number of images required will vary depending on the pathology being imaged and the upload technique. Similar to other imaging techniques photodocumentation can be broken down into different series. Two or three series should be sufficient to cover most scenarios. These series would include (1) Patient identification (if needed), (2) Large scale perspective images, and (3) Detail-zoomed image series [7, 9, 10].

Patient identification images are required in workflows where images are to be uploaded at a remote point in time. In these photodocumentation studies, the first image should be of a label with appropriate patient identifiers including patient name, date of birth, medical record number, or other unique patient identifiers. This image may or may not be uploaded to the image archive with the rest of the clinical images in the series. Its primary purpose is to identify the patient in the subsequent clinical images in the series preventing upload to the wrong patient's chart. It is necessary in a workflow where images are not immediately sent an archive and where multiple patients' images may be stored on the device, typically a digital camera. These workflows have a higher security risk should the device be lost or accessed by unauthorized persons. Date and time of acquisition are commonly included in the image metadata. Due to the disconnected nature of this workflow, patient metadata is not included. Ideally in mobile upload workflows, image acquisition occurs in the context of a patient's chart and such identifiers are not required.

Large scale perspective images are obtained to orient the viewer to the anatomic location of a lesion on the body. Anatomic landmarks such as the ear or nose or an adjacent joint put the lesion in context. For injuries or deformities, a number of images from different perspectives/orientations may be necessary. If the lesions have occurred along a curved surface, multiple different perspectives may be required to adequately document the pathology [20]. Typically three different positions are sufficient [20]. With each position, care must be taken to insure proper camera orientation relative to position of the ruler and to the body part. The detail-zoomed series provides the greatest detail about the lesion including color and boundaries. These zoomed images should be taken utilizing the optical zoom feature of the camera. With this technique, image resolution is maximized. The digital zoom feature should not be relied upon. An upload program that allows for editing of images would optimize documentation by allowing multiple images to be acquired and only the best selected for uploading to the archive. In the literature, the typical number of uploaded images is around 6 [7].

Lighting and Color Representation Lighting is a very influential feature of appropriate photography technique. Much has been published on the use of appropriate lighting for medical photography for well-established professional programs. Lighting is one of the features that is most difficult to control in the ad hoc environment in which smartphones are utilized [11, 40]. The flash of a smart phone does not provide the best lighting conditions. Simple variations in lighting and shadowing can significantly alter the representation of anatomy. Dickason et al. demonstrated the photographic blepharoplasty and apparent improvement in a burn scar created just by altering the position of the lighting [38]. Optimal lighting is achieved when daylight is eliminated and consistent artificial lighting is used [11]. The best conditions are achieved when two lighting sources are positioned at 45 degrees to each other and form slightly above the area to be imaged [11]. This orientation of the light sources helps eliminate shadowing. Many compensatory features are built into smartphones including red eye and blemish remover and lighting filters. These auto features should be disabled for clinical photography [22, 27].

Lightening also significantly impacts color in the photograph. The type of lighting used will affect the representation of color in the photograph. The white balance is used to correct differing color representations in the photograph which result from different types of lighting. Accurate color representation is a critical feature for diagnosis of multiple skin lesions including assessment of wound healing [42, 43]. Color charts are critical for accurate documentation of bruising [20]. Color calibration can be achieved in different ways and no standard technique is recognized. Color standards can be included in the image [4, 10]. A simple technique is to include a single white item in imaging field [44].

Identification of Laterality Identification of laterality is a must to complete the labelling of images. This site identification is of the utmost importance whenever more than one site is being photographed and is a necessity for extremity imaging. If images are used to document surgical site in pre-operative evaluations, this information is a critical component of surgical site identification. This information will be key during the time out and universal protocol to prevent wrong site surgeries. Laterality can be identified in several different ways. Laterality can be included in the study descriptor of the examination. Following principles from radiology the strongest way to identify laterality is through a maker that is placed in the field at the time of the image acquisition [45]. Post-acquisition annotation to identify laterality carries with it a potential for mislabeling. Orientation of the body part should not be relied upon to identify laterality. Many image viewers offer the potential to flip images. The images might be saved in this flipped orientation. For some body parts which are imaged through specialized devices, for example, the retina, a label placed on the field may not be feasible. It is thus imperative that a process be developed to insure consistent and accurate identification of laterality. Failure to adequately identify laterality can have ramifications should the images be required in court proceedings. Unequivocal identification of left/right is the right things to do for accuracy in documentation and patient safety and quality care.

Frequency For those conditions where photo documentation is being utilized to follow a process over time, there needs to be some sense of how rapidly conditions typically change. Imaging too frequently is likely to yield a series of images with little change between adjacent time points even when significant changes exist [3]. Of course, there are situations

where imaging may fall outside an expected frequency. If there is a worsening of the clinical condition that additional imaging is likely warranted [3]. This parameter needs to be defined for each use case.

Privacy and Sensitive Photos

All photographs, like all the rest of the information in the electronic health record, are subject to current privacy obligations as defined by HIPAA [46]. Providers are obligated to only access charts on the patients for whom they are caring for and additionally to only access those parts of the chart relevant to the care they are providing. These obligations should provide adequate protections for all photographs. However, there are photographs which do raise sensitivity issues for both patients and providers. Specifically, images which contain features which allow identification of a patient such as the face, birthmarks, and tattoos as well as images of a patient's genitalia or breasts often raise concerns. Complete de-identification may not be achievable [8]. Several issues need to be considered when dealing with these types of images.

First, in general clinical images should not include any patient identifying information directly within the photographs such as name, date of birth or any other information consider part of protected health information (PHI). According to HIPAA, full face photographic images and any comparable images (such as nevi, tattoos) are considered PHI. Images of the breast should be framed so as to not include the patient's face [32]. This practice will protect the patient should the images be inappropriately released. It is accepted in the esthetic surgery literature that in some cases evaluation of the patient may be best accomplished without any clothing. Disposable garments are available to cover genitalia. In other applications any part of the body not considered an area of interest should be covered [10]. However this practice will not prevent any provider or non-provider who has access to the chart from viewing this images.

A number of potential safeguards can be implemented. The photo descriptor that contains the anatomic site should indicate to anyone in the chart the content of the images and ethics would dictate that they only be viewed if clinically relevant. The addition of "sensitive" to the photo descriptor may provide an additional barrier. An awareness of the sensitive nature of these images is necessary as they may be viewed in non-secure locations. Software techniques that prevent access without appropriate authorization may be implemented [27]. However, this process could mean that a clinical provider who needs to access the image and who is not pre-authorized by the system may be prevented from viewing information which is clinically relevant. Break the glass systems can be used to overcome this problem. Regular audits of persons accessing these images can help ensure compliance with institutional policy.

Inclusion of identifying information within an image is an interesting conversation. In general, for purposes of security in photodocumentation the desire is to avoid any identifying information on the image. However, when the images are being acquired for purposes of forensic documentation the trend is to include as much identifying information in the image as possible [4, 10, 39]. Yet another reason why understanding the reason for documentation is critical to providing the highest value images.

Security

Security issues are a great concern for clinical photography. Part of this concern is reflected in patients' preference for hospital owned devices over personal devices. These concerns apply to both the acquisition device as well as the storage devices and the means of communication between the two. Acquisition devices are subject to loss, theft, malware, and other misfortunes. Communication via unsecured Wi-Fi, use of social media, portable storage devices all raise concerns. Whether or not the device is protected against these misfortunes is key to insuring that a patient's privacy is protected. Virtual private networks, encryption, two factor authentication are all strategies that can be utilized to mitigate these risks.

Kunde et al. discovered in their survey of dermatologists in Australia that 85% of the respondents stored patients images on their personal phones and only 23% had some form of security enabled on the phone [35]. In their survey of members of the Canadian Society of Plastic Surgeons, Chan et al. found that 89.1% of the respondents took patient photographs using their personal smartphones; 73% stored patient images in the same folder as personal images. While 21% deleted the images after transferring to another storage media, 57% left the images on their phones and 26% had accidentally shown a patient's photo to someone who should not have seen it [34].

In the medical software industry, new technologies are being implemented to help limit these security risks [22]. A search of the internet reveals a multitude of applications which have been developed for secure clinical photography. Features include password access, encryption, and the ability to acquire photographs without storage on the local camera roll and secure transmission to a HIPAA compliant form of storage. In the best workflow these images are sent directly to a vendor neutral archive which is accessible through the electronic health record.

Lifecycle

The lifecycle management of electronic health information is still an undefined space. Many vendors are just beginning to provide sophisticated lifecycle management tools in to their archives. Many institutions which have lifecycle management policies on paper have yet to act upon those policies.

Academic institutions in particular are loath to purge information which may become valuable in future research endeavors. For other institutions the research value is irrelevant and maintaining data is a pure expense. As elegantly stated by Koller in an interview "After regulatory requirements have been met, the value of the clinical information to the institution and its patients' needs to be weighed against the risk and cost of keeping it." [44]. There are few guidelines to help determine appropriate management of radiologic images and even less information is available to guide management of clinical photography. Regulations typically vary by state.

Health Information Management

If clinical photographs are retained they should be defined as part of the designated medical record and the potentially the legal medical record [47, 48]. As defined by HIPAA the designated record set includes: A group of records maintained by or for a covered entity that is: (i) The medical records and billing records about individuals maintained by or for a covered health care provider; (ii) The enrollment, payment, claims adjudication, and case or medical management record systems maintained by or for a health plan; or (iii) Used, in whole or in part, by or for the covered entity to make decisions about individuals. As part of the designated medical record set photographs must be released to patients who request copies of their medical records. The legal medical record serves as the official business record of the institution. Each institution needs to define their own legal medical record and clinical photographs may or may not be included [48]. Additional considerations should be given to whether or not photographs are considered part of a patient's legal medical record and under what conditions they are released to nonclinical third parties.

Summary

The development of digital photography and the integration of digital cameras with smartphones have provided the appropriate conditions for the use of photodocumentation by all providers throughout the enterprise. The exciting advances in enterprise imaging and the bringing together of all medical images in to a single archive with viewing through the electronic health record affords all caregivers the ability to view all medical images including clinical photographs. Bringing high quality photodocumentation to the enterprise level requires an understanding of the clinical challenges, education of those acquiring the images and selection of appropriate technology and techniques. Enterprise imaging teams with their focus across the organization can help facilitate these activities.

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