AMERICAN TELEMEDICINE ASSOCIATION'S PRACTICE GUIDELINE FOR TELEDERMATOLOGY

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The American Telemedicine Association (ATA), with more than 2,500 members, is the principal organization of telemedicine practitioners in the United States. The ATA is a nonprofit society that seeks to bring together diverse groups from traditional medicine, nursing, allied health professionals, academic medical centers, technology and telecommunications companies, e-health, medical societies, government and others to overcome barriers to the advancement of telemedicine through the professional, ethical and equitable improvement in health care delivery. The ATA has strong ties and strategic relationships with host organizations with other international telemedicine societies. The ATA will occasionally define new practice guidelines and technical standards for telehealth practice to help advance the science of telehealth and to improve the quality of service to patients. Existing practice guidelines and technical standards will be reviewed for revision or renewal periodically.

The practice guidelines and technical standards generated by ATA have undergone a thorough consensus and rigorous review, with final approval by the ATA Board of Directors. The practice guidelines and technical standards recognize that safe and effective telehealth practices require specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by entities that do not provide these services is not authorized.

Preamble

These guidelines are designed to serve as both a consensus operational best practice reference based on clinical empirical experience and an educational tool to aid practitioners in providing appropriate telehealth care for patients. The practice of medicine is an integration of both the science and art of preventing, diagnosing, and treating diseases. It should be recognized that compliance with these guidelines will not guarantee accurate diagnoses or successful outcomes. The purpose of these guidelines is to assist practitioners in pursuing a sound course of action to provide effective and safe medical care that is founded on current information, available resources, and patient needs. The guidelines are not meant to be unbending requirements of practice and they are not designed to, nor should they be used, to establish a legal standard of care. The American Telemedicine Association advises against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The primary care practitioner is responsible for the decision about the appropriateness of a specific procedure or course of action, considering all presenting circumstances. An approach that differs from the ATA guidelines does not necessarily imply that the approach varied from the standard of care. If circumstances warrant, a practitioner may responsibly pursue a course of action different from these guidelines when, in the reasonable judgment of the practitioner, such action is indicated by the condition of the patient, restrictions or limits on available resources, or advances in information or technology subsequent to publication of the guidelines. Nonetheless, a practitioner who uses an approach that is significantly different from these guidelines is strongly advised to document in the patient record information adequate to explain the approach pursued.

Introduction

Teledermatology is one of the most active applications of telemedicine rendered in the United States. Dermatology is particularly suited to the use of advanced communication technologies and the Internet for delivery of care. [1-38] By using advanced communication technologies, dermatologists may be able to widen their reach to patients in a cost-effective manner, ameliorating the maldistribution of specialty care. The following Guidelines were designed to aid in the development and practice of coherent, effective, safe and sustainable teledermatology practices. Establishing Guidelines for teledermatology may improve clinical outcomes and promote informed and reasonable patient expectations.

The Practice Guideline for Teledermatology covers two major areas, reflecting the basic component processes associated with most teledermatology consultations: technical and clinical Administrative aspects of clinical teleconsultations in general are covered in the American Telemedicine Association's TeleHealth Standards document. [39] In teledermatology, store-and-forward (S&F) communication typically refers to the sending or forwarding of digital images and associated patient data to the specialist for storage and consultation. For real-time video teleconferencing (VTC), providers and patients interact via live videoconferencing. The recommendations apply to S&F, VTC and hybrid (utilizing both S&F and VTC) modes for teledermatology.

The Guidelines contain Standards for the practice of teledermatology that are required whenever feasible and practical as determined by the referring clinician practicing under local conditions. These Standards are presented first in the document and are identifiable in the text when "***shall***" is used (indicated by bold italics). In the following section, the Guidelines contain recommendations for Best Practices that are indicated in the text by "***should***" to indicate an optimal recommended action, one that is particularly suitable, without mentioning or excluding others. The third section contains optional or permissible action indicated by "***may/attempt to***" to indicate additional points that may be considered to further optimize the teledermatology consult process.

A glossary of important terms, references to literature, and informative web sites are included at the end of the document for further consideration. An Appendix is included with information about the Digital Imaging & Communications in Medicine (DICOM) standard that is likely to impact the practice of teledermatology in the very near future.

I. STANDARDS FOR THE PRACTICE OF TELEDERMATOLOGY

a. Technical Specifications

i. Organizations ***shall*** ensure the technical readiness of the telehealth equipment and the clinical environment. [40]

ii. Organizations providing telehealth services ***shall*** have processes in place to ensure the safety and effectiveness of equipment through on-going support and maintenance. [40-41]

iii. Organizations providing telehealth services ***shall*** have policies and procedures in place to ensure the physical security of telehealth equipment and the electronic security of data. [42]

1. Image Acquisition

a. *Spatial Resolution:* Spatial resolution is the ability of an imaging system (e.g., digital camera) to permit two adjacent structures to be perceived as being separate, or as the distinctness or sharpness of an edge. [43-45] Spatial resolution is the property of the actual image once displayed (either on a digital monitor or printed out) and is typically defined as number of pixels per inch (ppi).

i. For a digital device, a minimum of 75 ppi (pixels per inch) ***shall*** be used. [44-46]

ii. For VTC, spatial resolution ***shall*** be a minimum of full Common Intermediate Format (CIF) [352 x 240 NTSC; 352 x 288 PAL] with a preferred minimum of 2 CIF [704 x 240 NTSC; 704 x 288 PAL].

b. *Metadata Labeling/Tagging*: All images and patient data associated with an exam ***shall*** have an accurate correspondence to a patient and exam record that includes at a minimum patient name, exam date and facility at which the exam took place. If VTC video is stored it ***shall*** be

labeled and marked with the appropriate acquisition date and time to insure easy retrieval.

2. **Image Storage, Retrieval & Transmission**
    a. *Security:* United States Health Insurance Portability & Accountability Act (HIPAA) [42] and state privacy requirements ***shall*** be followed at all times to protect patient privacy. Network and software security protocols to protect privacy and confidentiality ***shall*** be provided as well as appropriate user accessibility and authentication protocols. Measures to safeguard data against intentional and unintentional corruption ***shall*** be in place during both storage and transmission.
        i. *Encryption:* HIPAA requires that encryption (128 bit) of Electronic Protected Health Information ***shall*** be used. [47] Consistent with HIPAA and good practice, video sessions ***shall*** be secured to the greatest practical extent.
    b. *Personal Computer/Network Storage/Picture Archiving & Communications System (PACS):* Storage ***shall*** comply with all facility, state and federal regulations that pertain to medical record retention. Images stored at both the transmitting and receiving sites ***shall*** meet the jurisdictional requirements of those sites.
    c. *Retrieval and transmission*: Retrieval and transmission of images (and audio for VTC) ***shall*** be done over a secure network and a secure protocol should provide reliable exchange of medical information. Transmission of information over public or non-secured networks ***shall*** be encrypted.
3. **Image Display**
    a. *Resolution*: The resolution of the display monitor should match as closely as possible the resolution of the acquired image being displayed, or the originally acquired image resolution should be accessible using zoom and pan functions. A monitor with a minimum of 0.19-dot pitch ***shall*** be used.
    b. *Luminance*: Luminance specifies the perceived brightness of a display. It is typically measured in Candelas per Square Meter (cd/m^2). The maximum to minimum luminance ratio ***shall*** be at least 250 and manufacturers provide this value typically as the brightness of the monitor. The minimum luminance of the display should not be smaller than the ambient (i.e., room) luminance. A minimum of 0.5 cd/m^2 is recommended. Precise luminance measurements can be made using a photometer or many

off-the-shelf calibration programs come with the required photometer (often called a puck). [48-49]

c. *Contrast*: The contrast ratio (CR) is the ratio of the luminance between the brightest white and the darkest black that a display can produce. The higher the CR, the sharper the image is perceived to be. CRs of 1:500 or higher ***shall*** be used. The CR is greatly affected by ambient light conditions, being reduced significantly with higher room illumination levels.

b. Clinical Specifications

i. The telemedicine operation and its health professionals ***shall*** be satisfied that the standard of care delivered via telemedicine is at least equivalent to any other type of care that can be delivered to the patient/client, considering the specific context, location and timing, and relative availability of traditional care.

ii. Health professionals ***shall*** be responsible for maintaining professional discipline clinical practice guidelines to guide the delivery of care in the telemedicine setting, recognizing that certain modifications may need to be made to accommodate specific circumstances.

iii. Any modifications to specialty specific clinical practice standards for the telemedicine setting ***shall*** ensure that clinical requirements specific to the discipline are maintained.

iv. Health professionals providing telemedicine services ***shall*** have the necessary education, training/orientation, and ongoing continuing education/professional development to insure they possess the necessary competencies for the safe provision of quality health services.

v. When guidelines, position statements or standards exist from a professional organization or society such as the American Academy of Dermatology (AAD) [50-51] they ***shall*** be reviewed and incorporated into practice whenever safe and feasible. The specifications listed below are not meant to supercede those of existing guidelines, position statements or standards exist from a professional organization or society.

1. Practice Specifications

a. *VTC*: All persons in the exam room at both sites ***shall*** be identified to all participants prior to the consultation.

b. *Exam inclusion criteria/scope*: All aspects of dermatological care are suitable for teledermatology care: skin, hair, nails and mucosas, including genitalia, unless specified in the exclusion criteria. Teledermatology encompasses pediatric and adult patients, all ethnicities, and both genders. The inclusion of cases for a teledermatology consult is ultimately at the discretion of the referring and consulting clinicians.

c. *Special Considerations*: The exclusion of certain types of cases from a teledermatology consult is ultimately the

discretion of the referring and consulting clinician. There are certain types of exams/cases that may require special consideration.

i. *Full body exam*: A full body skin exam using VTC and S&F is possible, but it may not show all skin surfaces sufficiently. Enhanced lighting may be helpful.
ii. *Hair-bearing skin*: It is important to approach scalp lesions (and those in other areas with lots of hair) carefully. Special lighting may enhance viewing conditions.
iii. *Pigmented lesions*: Pigmented lesions may present a diagnostic challenge and may require a higher index of suspicion when interpreting. Peripheral devices such as dermatoscopes may be incorporated into teledermatology consultations.
iv. *Mucosal lesions*: Mucosal lesions and orifices, including genitalia, should be carefully assessed.
v. *Skin color*: Lighting and background conditions may influence the recorded appearance of different colors compared to how they appear in person.

d. *Consult request data*: As with any consultation, information needs to be shared about the patient between the referring and consulting clinicians.
   i. *Patient demographics*: Age, gender, race ***shall*** be included.
   ii. *Clinical history/results*: This section ***shall*** include the chief complaint, symptoms, duration, previous treatment for the presenting condition and its response, medications, allergies, personal and family history of any skin cancers, and prior and existing medical/skin conditions.
   iii. *Reports*: As with any consultation, there ***shall*** be a traceable record of the teleconsultation at both the referring and consulting sites, containing at a minimum the information in i-ii above and the consult report. The consultant's opinion and any services that were ordered or performed ***shall*** also be documented in the patient's medical record and communicated by written report to the requesting physician or other appropriate source (e.g., physician assistant, nurse practitioner, doctor of chiropractic, physical therapist, occupational therapist, speech-language therapist, psychologist, social worker, lawyer, insurance company). Recommended language for the consultant includes

"Based on the images and history provided, my impression is as follows."

1. *VTC*: The reports can be done verbally, but a written record of the interaction ***shall*** be kept at least at one side (referring and/or consulting). Reports may be faxed, mailed or electronically sent after the interaction has ended and should be done using secure methods.
2. *S&F*: Electronic, faxed, mailed or e-mailed notes ***shall*** be part of the patient's medical record and sent to the referring provider. If the consulting clinician annotates the images in any way, these annotated images may be sent back to the referring clinician and included in the record as well.
3. *Consultant Report*: This report ***shall*** include at a minimum the diagnosis, a summary of the findings, and recommended management.

II. RECOMMENDATIONS FOR BEST PRACTICES

a. Technical Specifications

i. Organizations ***should*** have appropriate redundant systems and appropriate recovery procedures in place that ensure availability of the network for critical connectivity.

ii. Organizations ***should*** insure compliance with all relevant safety laws, regulations, and codes for technology and technical safety. [40-41]

iii. Organizations ***should*** have infection control policies and procedures in place for the use of telehealth equipment and patient peripherals.

1. **Image Acquisition:** Image quality is an essential component in assuring the optimal communication of patient image data to the dermatologist for teleconsultations. The following parameters of image acquisition and display can be accounted for and optimized as indicated to help insure the best possible diagnostic interpretation environment. [43-44]
    a. *Device* (e.g. digital camera): Digital cameras ***should*** be used for image capture. They have better color acquisition, white point adjustment and focus than cell phones, PDAs (Personal Digital Assistant) or other dual-task devices with cameras.
        i. *VTC*: A dedicated patient exam camera ***should*** be used for close-up views, while the general VTC camera can be used for overviews. It is important to keep the patient exam camera as steady as possible during imaging/viewing to avoid motion artifacts. If

necessary a camera stand can be used to minimize motion. Freeze frame can be used to capture still images during a video sequence.

b. *Macro:* The macro mode should be used to acquire close-up images. The macro mode uses a special lens designed specifically for close-up photography that adjusts the focus to properly capture near objects.
c. *Color Bit-depth*: The acquisition device ***should*** allow for at least 24 bits of color.
d. *Compression:* If the acquisition device automatically applies compression (e.g., JPEG) the type and amount of compression ***should*** be known. [44,46]
e. *Room Lighting:* The room in which the photography is done ***should*** be well lit, preferably using light sources as close to white light as possible (i.e., fluorescent day-light or full spectrum bulbs rather than incandescent).
f. *White balance*: Some digital cameras come with a white balance function that can be adjusted, while others come with auto-mode white balance. [44,52-54] White balance ***should*** be adjusted if possible since it can contribute to the overall color accuracy of the image.
    i. *White balance for VTC*: Each camera used for VTC ***should*** be white balanced separately, i.e., both the "main" (pan-tilt-zoom) camera and the "peripheral" video microscopes/examination cameras. It ***should*** be done for every session.
g. *Backdrop:* A non-reflective surface ***should*** be used as a backdrop behind the region of interest whenever possible. The background should be clean and plain in color (no patterns or lines; neutral gray or dark blue – blue is preferred for VTC) and neither too shiny or too dark. Ideally the backdrop should be outside the focal plane so as not to distract during image viewing.
h. *Viewpoint:* In general, all images ***should*** be taken perpendicular to the plane of the lesion. Include oblique views if the lesion is subtle and difficult to evaluate in height.
i. *Clothing, jewelry & makeup:* Clothing, jewelry & makeup ***should*** be removed to obtain adequate viewing if necessary.

2. Image Storage, Retrieval & Transmission

a. *Storage medium in device* (memory stick, secure digital, compact flash, etc): All acquisition devices ***should*** have a method for storing the acquired image data at its original acquired resolution (whether or not compression is automatically applied). The device should have a method

for warning the user if image data are going to be deleted so the image data can be transferred to a secure archive. Both fixed and transportable media are acceptable for backup and archive purposes. Proper security measures should be taken with portable devices since they contain identifiable patient data.

3. **Image Display:** There are many types of digital (i.e., computer) displays available. Most displays contain a list of the most relevant display property specifications. These specifications ***should*** be considered when purchasing a display device.
    a. *QA/QC*: Initial quality assessment (QA) ***should*** take place when the monitor is purchased. Although manufacturers calibrate monitors before shipping, changes can take place because of movement etc. during shipping. Drifts in the calibrated settings can occur as well simply as a function of time. Quality Control (QC) should take place on a periodic basis looking minimally at luminance levels (maximum and minimum), gamma and white point. Older displays may require more frequent QC.
    b. *Warm-up time*: Displays ***should*** warm-up about 30 minutes before being used to interpret images.
    c. *Tools*: Image processing and manipulation tools ***should*** be available when viewing images. Brightness, contrast, zoom, pan and rotate (to access the originally acquired spatial resolution) are a minimum set of tools available for the specialist. To increase viewing speeds, presets may be considered. Rotating and flipping are also useful since many images do not appear in the proper orientation. Tools for calculating linear distances and/or areas are useful.
        i. *VTC*: Either the referring or consulting site ***should*** have the ability to control the zoom and pan (up, down, right, left) of the general room camera. When capturing images for diagnosis, the camera ***should*** be as still as possible to avoid motion artifacts. If necessary a camera stand or tripod may be used.
    d. *Ambient room light levels*: Some ambient room light is required for optimal viewing. Approximately 25-40 lux ***should*** be used. [55] Higher levels contribute to glare while lower levels affect the visual system's dark adaptation.
    e. *Ergonomic considerations*: The comfort of the dermatologist interpreting the images ***should*** be considered to prevent fatigue, computer vision syndrome problems and repetitive stress injuries common with increased computer interactions. [56]

b. Clinical Specifications

i. *Imaging protocols:* Basic imaging protocols ***should*** be used whenever possible. [57-59]

1. *Identify anatomical units based on location(s) of skin involvement*: If more than one area is involved, all regions involved ***should*** be included.
    a. *Anatomic Standard Views*: A standard set of images for each anatomic location ***should*** be used.
        i. Head/Neck
        ii. Trunk
        iii. Arms
        iv. Legs
        v. Buttocks/Groins
        vi. Hands
        vii. Feet
2. *Close-up*: Detailed views designed to show the surface texture, topography, color and architecture of the lesion ***should*** be used. Clearly identify, focus and center the lesion in the close-up view.

ii. *Complementary views:* Complementary views ***should*** be included. For example, if the hands are involved it is useful to include the feet and perhaps evaluate and document the elbows and knees as well. [57 provides a complete table of complementary image sets]

iii. *Lesion identification*: Lesions ***should*** be localized especially if there is more than one lesion in a field of view or if it is difficult to see. The placement of the identification marker should be close enough to the lesion to clearly mark it without covering any portion of it.

1. *On the skin*: Lesions can be identified using sticky labels, surgical tape, washable markers and other easily placed and removed tools.
2. *In the image*: Before sending the image, many programs will allow the user to add a digital circle, box or arrow to the image as well as digitally added numbers.

iv. *Measurement*: A ruler ***should*** be included in each image (general and close-up) in close proximity to the lesion so that size/extent can be determined from the image. [43]

v. *Chaperone or guardians*: A chaperone or legal guardian **should** be used as required.

vi. *QA/QC:* Images ***should*** be reviewed during the acquisition process to insure acceptable quality.

vi. *Peripheral devices:* Peripheral devices such as dermatoscopes ***may*** be incorporated into teledermatology consultations.

III. OPTIONAL STEPS TOWARDS OPTIMIZING TELEDERMATOLOGY PRACTICES

a. Technical Specifications

i. **Image Acquisition**

1. *Color:* Digital cameras capture only shades of gray. Filters that are sensitive to certain wavelengths (blue, green & red) filter certain wavelengths to the sensor pixels creating, by various wavelength combinations, color. The sensors and filters of each manufacturer's camera typically differ so color rendition is typically different for each camera model. Cameras ***may*** be characterized before capturing images for diagnostic purposes. [44,60] Video cameras come in two general types.1-chip cameras use a single computer chip to process all the colors, while the 3-chip cameras uses one chip each for red, blue and green. The 3-chip cameras are generally more expensive but the color rendition is typically better.
    a. *Implementation strategy:* One method to accomplish this is to attach a color calibration label (e.g., GreTag Macbeth Color Chart) to at least one image (preferably all) in a patient/case image set. [52,60-61] The same color label is then shown on the display being used to interpret the images and the user gauges visually how well the display device renders the color label (i.e., how well they match). If the colors do not match, the monitor should be adjusted using the display settings function in the computer control or using color calibration software tools. [48-49,52,60-65] In some cases a perfect match may not be possible.
2. *Compression:* Most digital cameras come with automatic settings for high, medium and low compression of images, typically using the JPEG compression scheme. Higher compression means that the final image size is smaller and thus will transmit more quickly, but at the expense of a potential loss in image quality. Lower compression levels give larger file sizes, but the images tend to be of a higher quality. In general, medium and low compression are recommended (nothing greater than 20:1). Some cameras use the high, medium and low to indicate the quality of the image rather than the compression levels. The manufacturers specify what these settings mean and generally provide the exact compression levels associated with each setting.
3. *Flash:* The digital camera ***may*** have flash capability. If it does, it is recommended that the flash output be adjusted to avoid washout of close-up images. [43,52]
4. *White balance*: White balance ***may*** be adjusted and can contribute to the overall color accuracy of the image so that the captured image faithfully reproduces the live scene.
    a. *Implementation strategy*: If the camera being used to acquire cutaneous digital images is not being operated in an automatic mode and does have a white balance function it can be calibrated if the camera offers such capability. To calibrate the white balance of a camera, aim the camera at a white field using the ambient room light levels to be used

when capturing images. Fill the view with the white scene and press the white balance tool on the camera (separate button or in the menu). Some cameras have several pre-set white balance adjustments (e.g., fluorescent lights, outdoors) that can be used and matched for a given lighting condition.

5. *Auto-focus*: Some cameras come with an auto-focus option that generally does a good job of properly focusing the subject properly at the appropriate depth. Limitations occur when ambient lighting or contrast conditions are low and if there are not enough linear edges in the field, leading to blurry images. The auto-focus option can generally be turned off if necessary to obtain sharp pictures using manual focus. [43]
6. *Audio synchronization:* If using real-time VTC, audio synchronization, good vocal tone and punctuation are important to avoid overlapping conversations during live sessions due to normal delays in transmission times. Speakers and microphone should be placed nearby for adequate capture and transmission of sound without being in the way. Echo canceling should be used.

ii. Image Storage, Retrieval & Transmission

1. *Security with watermarking*: Watermarking techniques are an option to insure that if images are modified or manipulated without permission, the changes are detectable. Editing of watermarked images is typically allowed to only specific individuals with permission.
2. *Security with VTC*: Security (to comply with HIPAA) ***may*** be accomplished via one or more of the following methods.
    a. *Video encryption*: Using the inherent real-time video encryption in contemporary CODECs.
    b. *Virtual private networks (VPNs)*: Hardware and/or software based systems that "tunnel" secure network sockets over public networks can be used.
    c. *Isolated (private) networks*: This may involve either private VTC circuits or separate packet-based networks that do not physically or logically interconnect with public networks.
    d. *Firewalls*: It should be noted that firewalls only offer protection behind the firewall. VTC sessions with sites beyond the firewall's protection are not necessarily protected.

iii. Image Display

1. *Color:* A simple method for color calibration is to obtain a copy of the Gretag Macbeth ColorChecker Chart (a printed chart of 24 colored squares [66]) and visually adjust the display to match as closely as possible the chart colors. [48-49,52,60-66] For more precise calibration when feasible, it is recommended that a color temperature setting of 6500 deg K (D65, or sRGB are also

notations used) be used for most picture viewing (most new monitors come at this setting). The gamma level should be set at 2.2 to allow maximum display of color range (most new monitors come at this setting). Set the bit depth to a minimum of 24 using the Display function in the Settings option of the monitor. Color settings can be adjusted via the monitor itself or through software. The DICOM (Digital Imaging & Communications in Medicine) Grayscale Standard Display Function (GSDF) can also be used to calibrate a display. [67-69]

   a. Off-the-shelf devices such as the Spyder from ColorVision can be used easily to calibrate color displays. These devices come with a "puck" that records the luminance levels of a display in association with software that uses these measurement to calibrate the display to a selected setting.

2. *Ambient room light levels*: Ambient light can be measured using a photometer or some digital cameras that have flash meters can measure the ambient illumination level. If neither method is feasible, display a typical clinical image on the monitor being used and adjust the room lights until they appear to be about the same level as the display. If the lights are not adjustable, it is better to turn the ambient lights off rather than have them on. Diffuse backlighting (behind the display) is preferred to direct overhead lighting to avoid glare and reflections. Fluorescent (day-light or full spectrum bulbs) are preferred to incandescent lights.

3. *Ergonomic considerations*: The following factors ***may be*** considered.
   a. Computer workstations require adequate airflow, optimal room temperature and humidity controls.
   b. If more than one workstation is in an area, consider shielding them from each other to reduce noise (especially if electronic dictation methods are being used).
   c. Proper chairs with sufficient lumbar support can help avoid well-known back, shoulder and neck injuries.
   d. The workstation table and keyboard height can be adjusted and the location of the keyboard and mouse should be optimized for comfort and efficiency.
   e. Easy access to dictation and other necessary tools (e.g., reference tools, access to the Internet) while at the workstation improves workflow.

GLOSSARY

1. **bit depth**: The number of pieces of digital data (bits) used to store information about each pixel. With 8 bits there are 256 colors available and with 24 bits there are 16,777,216 colors available.
2. **CODEC:** A device or program capable of performing encoding and decoding on digital data streams or signals.
3. **compression:** A method to reduce the volume of data using encoding to reduce image processing, transmission times, bandwidth requirements, and storage space requirements. Some compression techniques result in the loss of some information, which may or may not be clinically important.
4. **dot pitch:** Specification for computer displays that describes the distance between LCD cells of the same color within the display screen (or phosphor dots in a CRT). It is measured in mm and the smaller the number the sharper the image (more dots per given area).
5. **metadata**: Information that describes a central set of data. In teledermatology, the captured image is the data and metadata associated with that image can consist of items such as patient name, date, time and so on.
6. **ppi:** pixels per inch or pixel density referring to the resolution of a computer display or printed document.
7. **Resolution***:* Spatial resolution is the ability of an imaging system (e.g., digital camera) to permit two adjacent structures to be perceived as being separate.
8. **white balance:** The process of removing unwanted color casts in images so that white objects appear white. White balancing takes into account the color temperature (i.e., the spectrum of light radiated) of the light source in the scene and adjusts white levels in reference to the scene color temperature.

Appendix A

Existing Digital Imaging Standards

This is not meant to be a comprehensive list of all existing standards, but rather provides a description of the standards most relevant to the practice of teledermatology.

a. ***ISO/TC42/WG18 12233***: This standard was developed (by the International Standards Organization ISO [70]) for photography/electronic still picture imaging. Section 12233 includes a resolution test chart and three measurement methods, including a computerized method of measuring the spatial frequency response.

b. ***ITU-T****:* The International Telecommunications Union has established a series of standards (H.300) for VTC. It includes such sections as the H.320 series for circuit-switched, n x 64 (i.e., ITU-T); the H.323series: packet-switched/network, Internet Protocol; and the H.324: Plain Old Telephone Service (POTS).

c. ***Session Initiation Protocol (SIP****):* The Internet Engineering Task Force RFC 3261 also applies to VTC. SIP is a text-based protocol for initiating interactive communication sessions between users, including voice, video, chat, and virtual reality.

d. ***DICOM*****:** The Digital Imaging & Communications in Medicine standard has a number of sections dealing with medical image handling, transmission, archiving, and display. Originally developed for Picture Archiving and Communications Systems (PACS) in radiology, many components of this standard are being adapted for use in other medical imaging applications. [67] DICOM currently has a visible light supplement that makes the DICOM standard relevant to teledermatology. Appendix A provides additional details on the rationale for migrating teledermatology to DICOM. Currently DICOM standards have two components:

ii. Information object definition: Assigns attributes to the information contained to be identified such as file name, patient name, medical record number, demographics, date, time etc.
iii. Services: Sends, stores and retrieves the object.

e. ***JPEG/TIF/WAV***: Some of the most common compression methods used for still images include the following. The method used depends on the achievable compression ratio and the number and types of artifacts created during compression. *Lossless compression* allows for the reconstruction of the exact original data prior to compression without any loss of information. *Lossy compression* refers to methods that lose data once the image has been compressed and uncompressed. The level of compression and method used affect the amount of data loss and whether or not it is visually perceptible. The type and level of compression may vary depending on the type of exam. Different compression algorithms will achieve different compression ratios with varying degrees of artifacts. The choice of compression method and level should be reviewed periodically for each image and exam type, to insure that artifacts are not perceptible. It should be noted that lossy compression can affect the colors in an image.

1) *JPEG (2000):* JPEG 2000 uses wavelet technology that allows an image to be retained without any distortion or loss. [71] File extensions for JPEG 2000 are either .jp2 or .j2c (traditional JPEG is either .jpg or .jpeg).

2) *TIF*: Tagged Image File Format used for formatting and compressing images. It can be lossy or lossless. The file extension TIF is .tiff or .tif.

3) *WAV*: A method of compression using wavelets transforms (mathematical functions that divide data based on frequency components). There are a variety of file extensions depending on the wavelet method used. It can be lossy or lossless.

f. ***HL7***: Health Level Seven is one of several American National Standards Institute (ANSI) Standards Developing Organizations (SDOs) operating in the healthcare arena. Health Level Seven's domain is clinical and administrative data. [72]

g. ***IHE***: Integrating the Healthcare Enterprise is an initiative to improve how computer systems in healthcare share information. It promotes coordinated use of established standards such as DICOM and HL7 to address specific clinical needs to support optimal patient care. [73]

h. ***US HIPAA***: The United Sates Health Insurance Portability & Accountability Act of 1996 (Public Law 104-191)calls for improved efficiency in healthcare delivery by standardizing electronic data interchange, and the protection of confidentiality and security of health data through setting and enforcing standards. [42,47] It has rules for:

1) Standardization of electronic patient health, administrative and financial data
2) Unique health identifiers for individuals, employers, health plans and health care providers
1) Security standards protecting the confidentiality and integrity of "individually identifiable health information," past, present or future.

i. ***JCAHO***: The Joint Commission evaluates and accredits nearly 15,000 health care organizations and programs in the United States. An independent, not-for-profit organization, The Joint Commission is the nation's predominant standards-setting and accrediting body in health care. Since 1951, The Joint Commission has maintained state-of-the-art standards that focus on improving the quality and safety of care provided by health care organizations. The Joint Commission's comprehensive accreditation process evaluates an organization's compliance with these standards and other accreditation requirements. Joint Commission accreditation is recognized nationwide as a symbol of quality that reflects an organization's commitment to meeting certain performance standards. To earn and maintain The Joint Commission's Gold Seal of Approval™, an organization must undergo an on-site survey by a Joint Commission survey team at least every three years. (Laboratories must be surveyed every two years.) [40]

Appendix B

DICOM for Teledermatology

Migrating Teledermatology to DICOM: There are two reasons for using DICOM for the creation of an image object. First, it is desirable to create standard formatted dermatology image objects that contain a predefined set of metadata elements like the patient name and identifier. Second, it is advantageous to be consistent with the rest of the digital medical imaging community in order to take advantage of existing interoperability opportunities (e.g., Integrating the Healthcare Enterprise).

A DICOM image object is composed of a set of metadata elements followed by the image, and is processed (that is, created, transmitted, stored, reviewed, archived, etc.) as a single entity. The metadata consist of a specific set of data elements that are defined in the DICOM Standard for a clinical discipline and an acquisition technology. DICOM was originally developed for radiology and has been very successful there. It is now being used in other clinical specialties like cardiology, dentistry, ophthalmology, endoscopy, and pathology.

Teledermatology provides an opportunity for DICOM to be used in the "low tech, low cost" clinical settings, where there may be no healthcare system infrastructure at all. Teledermatology is generally practiced by acquiring images with a digital camera, downloading them to a personal computer (PC) or telemedicine workstation, attaching them to an email message, and sending them to the dermatology consultant. DICOM can be used to standardize the image acquisition process, the store and forward process, and the reading review process, and to do so at a low cost.

Acquisition Software

A DICOM image acquisition software package needs to be loaded onto the PC that is going to be used to obtain patient and study identification information, receive the images from the digital camera, create DICOM objects from the metadata and the raw images, and send them to the consulting service.

The DICOM metadata contained in every image object includes patient and study identification information as well as clinical data. This is usually obtained by the DICOM software at the beginning of the image acquisition session, although some image specific information (for example, body site or laterality), acquisition parameters (for example, type of camera and setting), and comments (for example, "Patient not cooperative") may be input during the imaging process.

Table 1 shows the set of data elements representative of the types of data that can be acquired prior to the imaging process.

Data Element	Tag (group, element)
Institution Name	(0008,0080)
Institution Address	(0008,0081)
Referring Physician's Name	(0008,0090)
Referring Physician's Address	(0008,0092)
Referring Physician's Telephone Numbers	(0008,0094)
Patient Name	(0010,0010)

Data Element	Tag (group, element)
Patient ID	(0010,0020)
Issuer of Patient ID	(0010,0021)
Patient's Birth Date	(0010,0030)
Patient's Sex	(0010,0040)
Other Patient IDs	(0010,1000)
Patient's Weight	(0010,1030)
Patient's Address	(0010,1040)
Patient's Telephone Numbers	(0010,2154)
Additional Patient History	(0010,21B0)
Reason for Study (64 characters only)	(0032,1030)
Requested Procedure Description	(0032,1060)
Study Comments	(0032,4000)

Table 1: The set of data elements representative of the types of data that can be acquired prior to the imaging process.

Values for some of these data elements, like the institution and referring physician information, can be set via site-configurable options. Other data elements, like the patient and study information, need to be acquired on a study-by-study basis. There are two ways to do this. If the clinic has an order entry application as part of an Electronic Health Record (HER), it may be possible to electronically transfer this information to the image acquisition system using the DICOM Modality Worklist service. In the absence of such facilities, the data needs to be entered manually.

Once this information is obtained by the DICOM software image acquisition can be performed. As each image is acquired, additional information about the body site may need to be entered. After the images are acquired, they are joined with their corresponding metadata and are formed into DICOM objects. These DICOM objects are then sent to the consulting service.

Transferring the DICOM Objects

There are three different ways to send DICOM objects, depending upon the technical capabilities of the consulting service.

If Internet connectivity does not exit, the DICOM objects can be written onto CD or DVD and sent to the consultant via physical mail. The IHE Portable Data for Imaging (PDI) integration profile specifies the implementation details for this. [73,74] The DICOM objects are written to media along with an additional file named DICOMDIR containing the manifest and indexing information. The IHE PDI requires that a diagnostic quality DICOM viewer be provided on the media to display the DICOM images. It also recommends that the DICOM images be provided on the media in web-enabled viewing format (typically JPEG).

If adequate Internet connectivity exists the DICOM objects can be sent via email. In this case, the sender places the DICOM objects in a folder along with the DICOMDIR file, similarly to what is done in the IHE PDI. The whole folder is then ZIPed, encrypted, attached to an email message as DICOM.ZIP, and sent to the consulting service.

If the consulting service is DICOM enabled and there is a reliable permanent network connection to it, the images can be transferred using the DICOM Storage Service Class communications

message exchange protocol. This is the method that would most likely be used in a secure technically well-developed enterprise.

Reading Site

If the consulting service did not support DICOM at all, it should be able to handle the IHE PDI portable media.

In order to handle the DICOM.ZIP email attachment, the consulting service would minimally need to have a DICOM viewing application that would display the contents of the DICOM.ZIP attachment. These are available from many sources free of charge. [75]

It the consulting service had a DICOM EHR/PACS and wanted to import the study from the portable media or the email, then the IHE Import Reconciliation Workflow integration profile can be used. [38] This allows the study to be directly imported into a DICOM EHR/PACS.

Implementation

If there is an order entry application available on an EHR system, then the image acquisition workstation can use the DICOM Modality Worklist service to download the ordering information. If the order entry application does not exist, then the same information needs to be entered manually on the image acquisition workstation.

The images are acquired from the camera using whatever means are necessary to transfer them (USB, removable memory device, TWAIN, etc.). The metadata for the study is incorporated in the headers when these images are converted to DICOM. The images would use the DICOM Visible Light Image SOP Class until a DICOM Dermatology SOP Class is defined. It is assumed that the images would be lossy JPEG compressed approximately 25:1. (This is only a convenience for the telecommunications.) The transfer syntax would be either for JPEG Process 1, JPEG Process 14, or JPEG 2000 lossy. The annotations would be conveyed using the Grayscale or Color Softcopy Presentation State SOP Classes.

The DICOM objects would be placed into a folder and treated as a virtual DICOM file set following the IHE Radiology Portable Data for Imaging (PDI) integration profile. The file set would zipped and encrypted following the DICOM Standard (PS 3.11-2007 Annex L (Normative) – ZIP File over Email Interchange Profiles). The display of the images by the consultant is also defined by the IHE Radiology Portable Data for Imaging integration profile. Should the consultant wish to import the study into their PACS, the IHE Radiology Import Reconciliation Workflow integration profile would be used.

A minor issue that needs to be resolved is that while the IHE PDI specification handles only uncompressed images, the dermatology consult images are lossy compressed.

The results would be formatted as an HL7 CDA XML-encoded document, with a style sheet (XSLT). This would enable them to be easily display by the referring provider and would allow the further utilization of the discrete data.

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