

Selecting a Digital Camera for Telemedicine

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Abstract

The digital camera is an essential component of store-and-forward telemedicine (electronic consultation). There are numerous makes and models of digital cameras on the market, and selecting a suitable consumer-grade camera can be complicated. Evaluation of digital cameras includes investigating the features and analyzing image quality. Important features include the camera settings, ease of use, macro capabilities, method of image transfer, and power recharging. Consideration needs to be given to image quality, especially as it relates to color (skin tones) and detail. It is important to know the level of the photographer and the intended application. The goal is to match the characteristics of the camera with the telemedicine program requirements. In the end, selecting a digital camera is a combination of qualitative (subjective) and quantitative (objective) analysis. For the telemedicine program in Alaska in 2008, the camera evaluation and decision process resulted in a specific selection based on the criteria developed for our environment.

Key words: digital cameras, camera features, camera applications, camera image quality

Introduction

Digital cameras are the most utilized peripheral for store-and-forward telemedicine. While they are primarily used for skin imaging, they are also utilized for eye, oral cavity, wound, hair, x-ray, text, surgical, endoscopy, and pathology applications. The decision to purchase a digital camera is complicated by the difficulty to predict and lack of information on market availability, failure rates, and normal camera lifetime. For telemedicine programs that are presently using digital cameras, there is no consen-

sus as to when to upgrade digital cameras. Choosing a digital camera can be difficult because of the multitude of camera models and features. Amazon.com lists over 2,000 point-and-shoot digital cameras, and approximately one third are priced below \$200 (USD). Here we explore important aspects to consider when selecting a digital camera for telemedicine. We then explain how we used these principles to select a digital camera for our telemedicine program in Alaska.

Methodology of Selection

USER

How many people will be using the digital camera? What is the turnover rate? What is their skill level? How often will they use the camera?

It is important to know who and how many will be using the digital camera and what their camera skill level is. The camera choice can be different if there are multiple basic users versus one camera-savvy technician. With the dissemination of technology and changing workforce, it is difficult to know who is comfortable with a digital camera. One needs to assume that most users are beginners or intermediate and benefit from basic training and accompanying quick-start guides. Other persons can assimilate and retain higher-level training. Remember that retention of information is directly related to how often a piece of equipment is used. Based on this user population, you should be able to determine whether the camera will be primarily used in Auto or Manual mode, and you can take this into consideration when selecting the camera.

APPLICATION

What is the primary clinical application?

It is important to know what will be imaged and the workflow that is involved. Dermatology requires imaging of skin and associated lesions. Primary care requires imaging of skin, wound, burns, and x-ray imaging. Dental and ear-nose-throat require intra-oral imaging of moist mucous membranes and teeth. Surgery requires imaging of skin, blood, and moist anatomical landmarks such as vessels, nerves,

organs, etc. Pathology requires adaptation to a microscope and imaging of slides with specific color and lighting needs. While the purpose of the application is usually for diagnosis and treatment, there may be another purpose that guides your selection, such as quality assurance, legal documentation, education, and development of teaching files.

Image Quality

What is the image quality for skin and wound images under various lighting conditions? How does the image quality compare to images from other cameras? Does the image provide the needed details for diagnosis and treatment?

Image quality is determined by careful assessment of color and detail. Color quality is influenced by lighting, while image detail is related to resolution, compression, lighting, focus, clarity, and motion artifact. The overall image quality as determined by color and detail is a representation of the camera lens, charged couple device (CCD), and overall electronics.

Image quality may be the most important consideration and the hardest to determine. While it is necessary to know the camera specifications and the manufacturer reputation, these do not guarantee excellent image quality. A variety of reputable Web sites offer excellent reviews of digital cameras such as <http://www.imaging-resource.com/> and <http://www.neocamera.com> and <http://www.dpreview.com>. These resources have excellent information that includes feature and image quality reviews. However, there is more information to be obtained from actually shooting images with the cameras and comparing them side by side. Our office has conducted three formal image reviews in 8 years to evaluate digital cameras. These reviews have been key to determining image quality and revealed differences not readily apparent from reading reviews. For this review, the authors served as subject matter experts representing a knowledge base in the clinical and technical fields. All photographs were viewed in their original unaltered format. A representative photograph from each camera was displayed simultaneously so that images were compared side by side according to similar subject matter and camera settings. Photographic detail was examined by simultaneously zooming on specific edges and margins of the images.

To perform your own evaluation of images, it is recommended that you purchase your top choice of camera and compare it with a camera known to provide excellent clinical images. Set the cameras to similar settings regarding resolution, compression, white balance, etc. Take photographs of the skin using both cameras. Include normal and macro settings. Use lighting conditions similar to your clinical settings. Compare the images and make sure there are no surprises. Check especially for color that may be misleading to the clinician. For

example, does the skin appear washed out (cadaver-like)? Does the skin appear slightly reddish (inflamed)? Does the skin appear slightly yellow (jaundiced)? Compare images taken at similar resolution and compression settings. Zoom in similarly on these images to determine which retains the most detail.

IMAGE COLOR

Image color is probably the most important clinically significant aspect regarding camera selection. Factors that affect image color include room lighting, camera optics, camera CCD, and camera settings (white balance and color). Human skin is a difficult subject for which to accurately obtain the correct color. Different cameras in the same settings result in different skin tones. It is difficult to notice color variation unless you compare the images side by side. Some cameras get better skin tones with the flash on and others with the flash off (*Figs. 1 and 2*). The mini MacBeth color chart is helpful for full color tones, but has limited use in defining accurate colors of the skin and other lesions.

IMAGE SIZE

"Picture size" relates to mega pixel size, i.e., "8 MP," and this is the selling point for most digital cameras. In fact, larger pixel size does correlate with higher definition, especially for photographic prints. However, the "pixel explosion" has become somewhat of a marketing scheme and show for bragging rights. Realistically for reviewing images on a monitor, more pixels are not necessarily better. Clinical review of still images captured from a video source in 640 × 480 mode has proved sufficient. For digital cameras, it is expected that you are capturing at least 1–2 MP images, but it is unclear whether there is any clinical benefit to larger image size. Size is most important when the image needs to be zoomed in. For example, a clinician may want to zoom into the details of a burn or the edge of a mole.

IMAGE DETAIL

Image size is only one factor related to the detail of the image, or how clear and crisp the image is. In a clinical setting, it is much more important that the image be taken properly to maximize lighting, color, focus, and minimize motion artifact. If a photo appears grainy or blurred, it is more likely due to poor lighting, improper focus, or movement rather than a lack of pixels.

IMAGE COMPRESSION

Most midrange digital cameras store images in Joint Photographic Experts Group (JPEG) format, an agreed-upon standard compression method. Digital cameras offer various levels of compression and



Fig. 1. Figure 1 is shot with Kodak V1003 with flash and incandescent lighting. Resulting skin tone has a natural appearance.



Fig. 2. Figure 2 is shot with Kodak V1003 without flash under incandescent lighting. Resulting skin tone has an orange appearance.

generally speaking, the higher the compression, the lower the quality and the smaller the file size. Compression settings are usually listed in the camera menu as a “picture quality” setting. “Picture quality” is inversely related to compression and is often listed as “low,” “normal,” “fine,” and “high.” Lower-quality image resulting from overcompression may result in JPEG artifacts that have a blocky or

streaky appearance. It is necessary to retain appropriate image detail for clinical decision-making. For telemedicine, it is important to have a high-quality image compressed to a reasonable size so that it can be transmitted without inconvenience, delay, or system crashes.

Advanced Settings

What are the settings for the camera? What are the default settings? What settings can be retained when you turn the camera off and back on? How do the advanced settings affect image quality? What are the best settings for your clinical needs? Will you need to preprogram settings for a “program” or “manual” mode?

Cameras have a range of settings, some more advanced than others. Navigating the sea of optional settings can be a source of confusion. The good news is that for most clinical applications (i.e., dermatology and primary care), these advanced settings are set to “auto,” and you do not need to become an expert on these settings prior to camera selection. However, it is helpful to understand the settings and make sure they are set similarly when comparing images from different cameras. The following settings exist on most cameras and are important to understand: size (resolution), quality (compression), color mode, auto focus control, white balance, face detection capture, exposure metering, auto focus zone, anti-shake (image stabilization), ISO speed, sharpness, digital zoom, orientation sensor, and video size.

RETENTION OF SETTINGS

Cameras retain different setting functions. Some allow you to select which settings are retained; others do not. Some settings that are retained, only work in “auto” (Kodak), whereas other cameras (Sony W-200) only work in “manual mode.” This gets confusing in cameras when “best shot” or “scene” settings are used. For example, with the Kodak V1233, applying macro with the toggle retains the other settings that you have applied; but applying macro with “scene” mode changes some of the settings (sensitivity is +1, etc.).

EASE OF USE

Do the controls of the camera appear inviting or intimidating? How easy is this camera to use?

It is important to consider all aspects of the camera for usability. The following buttons and operations should be most intuitive: on/off, auto mode, video mode, macro setting, flash settings, settings menu, image review, and image delete. Generally speaking, other functions need to be accessible, but not as intuitive, such as zoom, setting the timer, LCD display options, attachment to a tripod, etc. The LCD should be at least 2.5 inches and have display options for

brightness and displaying information. A viewfinder is optional and for most clinical settings not necessary. Buttons, wheels, and toggles need to be large enough for a typical user's finger. The need for simplicity of functions depends on the level of users.

MACRO

Using macro (close-up), how close can you get to the subject/lesion? Can the camera easily be put in and out of the macro setting?

The macro setting has proven to be useful for clinical photography. It allows capture of important details at close range and reduces the need for higher-resolution images. When photographing skin lesions, most dermatologists recommend a full body or symmetric shot followed by a close-up shot, enabled by macro. In our experience, if you want clinicians to use macro, it needs to be an intuitive process. Therefore, it is important to select a camera that can easily be put in and out of macro mode. The most convenient access to macro is in

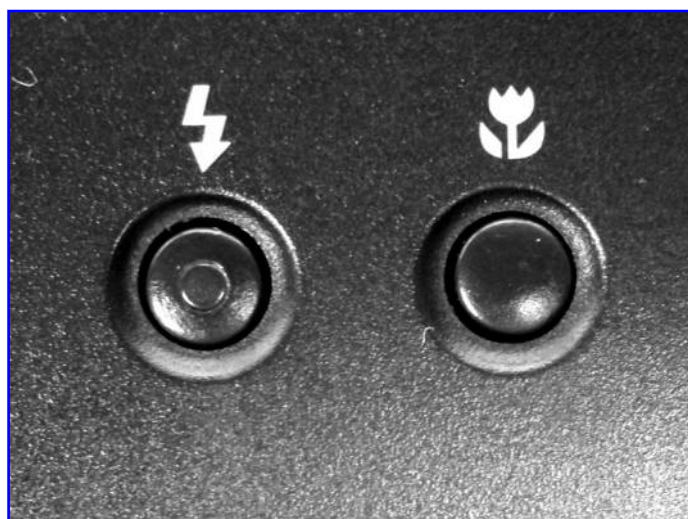


Fig. 3. Macro button (flower).

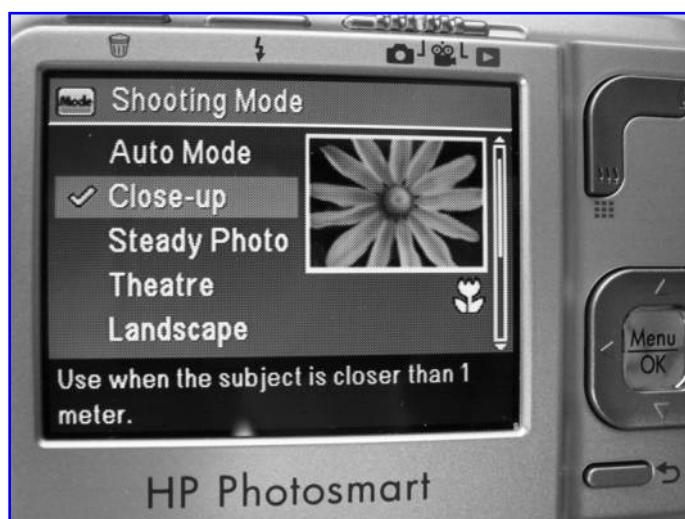


Fig. 5. Macro accessed from shooting mode.



Fig. 4. Macro toggle (flower).



Fig. 6. Macro accessed from scene mode.

the form of a physical button or toggle that turns macro on or off (Figs. 3 and 4). The macro indicator is traditionally a “flower” and should be easily seen on the display LCD screen. Other less intuitive pathways to macro include scene or best shot settings (Figs. 5 and 6) and dials.

Cameras vary with the macro setting as to how close you can get to the subject. The closer the photograph is taken to the subject, the more detail is included in the original image, and the reviewer has less of a need to zoom in on the final photograph. In addition, users are accustomed to taking a close-up photo of skin at a reasonable distance; that distance should accommodate the photographer to get approximately 4 inches or closer to the lesion. In our experience, macro settings that require focus at greater than 4 inches tend to confuse the user as they think they can get closer, and then the resulting image is blurry. So, if one is purchasing multiple cameras for multiple users, there are less likely to be user mistakes using macro if the camera can be in-focus at a reasonably close distance. Of course, each photographer has their preference as to how close to get to the lesion using macro. It is usually best (but not always) to turn off the flash when using macro to avoid “washout” of the colors. Cameras may automatically turn off the flash as part of the macro function; the user needs to be aware of this.

POWER

How is the camera powered? What type of battery is needed or desired? Rechargeable versus disposable? Standard or proprietary form factor (shape)? What is the battery technology: alkaline, LiMH, NiCad, or NiMH? How will the batteries be charged? How many photos can be obtained with a fully charged battery?

Most digital cameras are powered by batteries. Some have optional AC to DC adapters that allow the camera to be directly powered, and these are useful for certain applications such as when a digital camera is attached to an operating microscope. Digital camera batteries can be a standard form factor such as AA batteries (Fig. 7) that can be disposable alkaline or rechargeable Ni-MH. While alkaline AA batteries can be used, it is most common to utilize AA rechargeable NiMH batteries with at least 2,000 mAh because they last longer. AA rechargeable batteries are usually charged with a standard AA battery charger outside of the camera. A few cameras charge the AA batteries while placed in a docking station (camera cradle).

Alternatively, camera batteries can have a proprietary format, usually square or rectangular style (Fig. 8) that are often lithium ion. These batteries are space efficient, last long, and may be charged in the camera while placed in a docking station (camera cradle) or charged in a proprietary battery charger outside of the camera.

IMAGE TRANSFER

What method of image transfer is needed and desired? How will the workflow proceed?

Digital cameras are capable of storing some images on internal memory and many more on a memory card such as secure digital (SD) card, compact flash, memory stick, or extreme digital (xD) picture card. It is important to plan how you want the user to transfer images into the telemedicine software. Options include using the



Fig. 7. AA batteries: Ni-MH battery pack, Ni-MH singles and alkaline singles.



Fig. 8. Proprietary lithium ion batteries from the Casio EX-V8, Kodak V1233 and Sony DSC-W200.

removable media, USB transfer cable, camera docking station (camera cradle). When using removable media, one needs to make sure that the memory card can be removed from the camera and inserted into a memory reader with relative ease, and without damage to the card and camera. This can be a problem, for example, when the door to the memory card is opened and the AA batteries fall out of the camera. In addition, some cards are small and difficult to remove from the camera. When using a USB transfer cable, it needs to be obvious to the user where to plug the cable into the camera and computer; and the cable has a tendency to get lost. When using a camera docking station (cradle), one needs to make sure that the contacts to the docking station are not damaged by the camera during transition.

It is now possible for digital cameras to upload images to a PC directly through a wireless connection, by replacing the existing SD memory card with a “wireless SD memory card.” These special memory cards look exactly like a standard SD card, but include wireless technology that is powered by the camera battery to communicate with a PC over Wi-Fi technology (typically 802.11g, 802.11b and backwards-compatible 802.11n wireless networks).



Fig. 9. Camera and docking stations for the Kodak V1233 (top), Sony DSC-W200, and Casio EX-V8.

Using software provided by the card’s manufacturer, the card can then upload images directly into a folder on the PC as the images are taken. When the camera is out of range of the PC, the images are stored on the SD card and uploaded at the next available opportunity to the PC. This Wi-Fi approach raises concerns regarding configuration, network, security, and clinical workflow. For example, images may be uploaded to a PC, a Web site, or both. Users would need to check on security concerns when uploading to anything but a local PC, and to make sure that medical images do not traverse outside the secure hospital network.

CAMERA DOCKING STATION/CRADLE

Is a docking station needed and desired for battery charging and image transfer?

Depending on your application, you may desire a camera docking station. The advantages of a docking station include that the camera is always charged, there is no battery charger to get lost, image transfer is enabled, there is no USB transfer cable to get lost, and the camera has a specific location where it is to be returned. The disadvantages include the difficulty in cable management and mounting and cost of the docking station. With some docking stations it is not obvious which direction to place the camera, so it is important to train users appropriately. Make sure the camera fits properly into the docking station.

Most cameras do not have docking stations, so it is necessary to decide early on if a docking station is needed. Identifying digital cameras with docking stations is more difficult than it looks as sales persons are misinformed or Web site information is not accurate. Several types of cameras and docking stations are shown in *Figure 9*.

PRICE

What can your budget afford? Does this include memory card and accessories?

Digital cameras continue to come down in price. Presently, one can get a very good consumer-grade digital camera for skin imaging for under \$350. More expensive cameras are appropriate if a technician or clinician knows how to use them. More expensive cameras are sometimes used in specialty applications, such as when changing lenses or attaching to microscopes, etc.

Results

APPLYING THE CRITERIA FOR DIGITAL CAMERA SELECTION: DIGITAL CAMERA SELECTION 2008

In Alaska, new digital cameras were needed to replace existing digital cameras (Sony Mavica FD90 & FD200 and Fuji FinePix

E550) on the AFHCAN Telemedicine carts located at 300 sites across Alaska. A market survey and literature review revealed 20 makes and models as potential candidates for the new telemedicine deployment. The following digital cameras were included in our evaluation for 2008: Canon PowerShot A640, Casio EXILIM EX-V8, Casio EXILIM EX-Z1200, Fujifilm FinePix E900, Fujifilm FinePix F40, Fujifilm FinePix Z3, HP M547, Kodak V1003, Kodak V1233, Kodak Z812, Kodak Z885, Kodak Z1275, Nikon Coolpix 3100, Nikon L1, Nikon L5, Nikon S7c, Panasonic DMC-FX01, Pentax Optio M20, and Sony DSC-W200. Cameras were examined through June 2008 as they came to market and were available. Additional cameras were also considered and informally reviewed, but not listed here.

Table 1 lists all of the cameras and compares some important features to consider for use in healthcare. Table 2 describes why the Kodak V1233 was selected.

USERS AND CLINICAL APPLICATION

The camera list was generated from market reviews taking into consideration the user mix and clinical applications. Primary users of the digital camera are community health aides followed by physician assistants, nurse practitioners, audiologists, and physicians. Users range from beginners to advanced, although most fall into the beginner and intermediate group. The camera will be used for primary care, dermatology, and otolaryngology applications. From this perspective, it is most important that skin, face, and wound images are accurately captured. Much of the decision-making process considered whether the skill level of the user was compatible with the accessibility of the particular feature.

IMAGE QUALITY

Formal evaluation of image quality was conducted for all cameras using 27 standard images of the skin, wounds, and fixed

Table 1. Digital Cameras Evaluated and Important Feature Comparison

CAMERA	MAXIMUM RESOLUTION MPIXELS	CLINICAL IMAGE QUALITY	EASY MACRO	CLOSEST MACRO	BATTERY	IMAGE STORE	DOCKING STATION	PRICE	DIMENSIONS (MM)
Canon PowerShot A640	10.0		Yes	0.4 in	4 × AA	SD	No	\$292	109 × 66 × 49
Casio EXILIM EX-V8	8.1		No	3.9 in	Custom lithium	SD	Yes	\$238	96 × 60 × 25
Casio EXILIM EX-Z1200	12	Excellent	No	3.9 in	Custom lithium	SD	Yes	\$311	93 × 59 × 23
Fujifilm FinePix E900	9.0		Yes	3.0 in	2 × AA	xD	Yes	\$206	102 × 64 × 36
Fujifilm FinePix F40	8.3	Excellent	Yes	2.8 in	2 × AA	SD	No	\$210	97 × 59 × 23
Fujifilm FinePix Z3	5.1		Yes	3.1 in	Custom lithium	xD	Yes	\$191	90 × 55 × 20
HP M547	6.1		No	3.9 in	2 × AA	SD	Yes	\$97	96 × 63 × 37
Kodak V1003	10.1		Yes	2.0 in	Custom lithium	SD	Yes	\$164	103 × 55 × 25
Kodak V1233	12.1	Excellent	Yes	2.0 in	Custom lithium	SD	Yes	\$186	102 × 55 × 23
Kodak Z812	8.2		Yes	7.9 in	2 × AA ^a	SD	Yes	\$252	108 × 74 × 76
Kodak Z885	8.1	Excellent	No	7.9 in	2 × AA ^a	SD	Yes	\$181	90 × 65 × 32
Kodak Z1275	12.1	Excellent	No	7.9 in	2 × AA ^a	SD	Yes	\$182	90 × 65 × 32
Nikon L1	6.2		Yes	1.6 in	2 × AA	SD	No	\$139	90 × 61 × 47
Nikon L5	7.1		Yes	1.6 in	2 × AA	SD	No	\$208	97 × 61 × 45
Nikon S7c	7.1		Yes	1.6 in	Custom lithium	SD	Yes	\$319	101 × 60 × 21
Panasonic DMC-FX01	6.0		No	2.0 in	Custom lithium	SD	No	\$226	94 × 51 × 24
Pentax M20	7.0		Yes	2.0 in	2 × AA	SD	No	\$149	89 × 60 × 25
Sony DSC-W200	12.0		Yes	2.0 in	Custom lithium	Mem. stick	Yes	\$278	91 × 59 × 27

^a Or 1 × CR-V3 lithium.

Table 2. Why the Kodak V1233 Is Selected for Telemedicine**The Kodak V1233 offers:**

- Compact, yet reasonable size to hold: 4.0 × 2.1 × 0.9 in
- LCD size 2.5 inch
- High-quality clinical images using the Auto settings
- Intuitive controls
- Easily accessible macro; macro distance close as 2.0 inches
- Docking station for battery charging and image transfer
- Long battery life
- USB 2.0 high-speed connection
- Image storage on common media, SD card
- Still image capture options of 12.0, 10.7, 9.0, 6.0, 3.1, 2.2, 2.1, or 1.2 megapixels
- Efficient image compression; smaller image size compared to other cameras
- Video capture options of 1,280 × 720 HQ, 1,280 × 720, 640 × 480 HQ, and 320 × 240. Note the ability to capture high-definition video 1,280 × 720 at 30 fps
- Configuration setting to maintain: flash, white balance, ISO speed, color mode, sharpness, exposure metering, AF zone
- Digital image stabilization to reduce blur
- ISO 64–3200 and shutter 8 – 1/1200
- Excellent manuals: Get Started Guide and User Guide (PDF versions)

The Kodak V1233 has minor drawbacks:

- SCN (scene) button enables 23 scene modes, the default is Auto mode (other cameras typically use a dial that is clearly set to Auto); this may require explaining to the user
- Some minor reduction in image detail (JPEG artifact) with high image compression
- Slower speed in writing data to the memory card (@5–8 seconds)
- It is not a large camera, so some people find it difficult to hold

objects. Images were shot with and without flash under normal clinical lighting (fluorescent) conditions. The cameras that received highest marks for both color quality and detail included the Casio EX-Z1200, Fuji F40, Kodak Z885, Kodak Z1275, and Kodak V1233. Some generalizations can be made regarding the image quality for the following cameras: Canon A640 produced good images overall, but had extensive overexposure with flash despite change of settings. Fuji E990 produced good images overall, but not as crisp as the predecessor, Fuji E550. Panasonic DMC FX01 showed inconsistent image quality and had overexposure with flash. Sony DSC W200 performed poorly for color as the skin images had a reddish tone. *Figures 10* and *11* demonstrate differences in color capture for the Fuji F40 and Sony DSC W200. The HP M547 Had excellent color quality, but lower detail scores. Kodak V1003 had excellent detail, but lower color scores. All of the Kodak cameras utilize a

**Fig. 10.** Hand shot with Fuji F40 using flash demonstrates excellent (natural) skin color.**Fig. 11.** Hand shot with Sony DSC-W200 using flash demonstrates poor (yellowish) skin color.

compression algorithm that seems to do a very good job in reducing file size and retaining detail. Therefore, Kodak camera images are significantly smaller in file size. *Figures 12* and *13* demonstrates how a 12MP image from the Kodak V1233 has more detail than 6.1MP image from the HPM547, yet the images are the same file size (1.7 MB) due to Kodak's compression.



Fig. 12. Leg wound shot with Kodak V1233 at high resolution (4,000 × 3,000 pixels). Kodak compression reduces the file size to 1.73 MB while retaining image quality. This image has more detail than Figure 13.



Fig. 13. Leg wound shot with HP M547 at medium high resolution (2,848 × 2,136 pixels) produces file size of 1.71 MB. The image has good quality, but not the detail of Figure 12.

ADVANCED SETTINGS

As the camera selection was narrowed, the advanced settings were explored more carefully. The camera that was ultimately selected, Kodak V1233, required trial and error to maximize image quality and convenience for the user. For example, the Kodak V1233 provides the truest skin tones with the color set to “low” rather than “high” or “natural.” The advanced settings applied to Kodak V1233 are listed in *Table 3*.

EASE OF USE

The five cameras that provided high-quality images were assessed more closely and the following aspects regarding ergonomics are noted.

The Casio EX-Z1200 is relatively easy to use except for a few problems. Users were confused by the steps needed to put the camera into and out of auto and macro settings that require the best shot button

“BS.” Also, when one uses the menu screen and selects with the set button, the screen causes the menu to disappear, requiring the user to start over. The set buttons and toggles are a bit small to maneuver. In macro mode, the camera can approach 3.9 inches and then the on-screen frame goes from green to red when the distance is too close. The camera has a very nice docking station. If a user can be trained to use this camera consistently, it would be a fine choice for clinical imaging.

The Fuji F40 is probably the easiest of the five cameras to use. Buttons are obvious, functions are intuitive, and the controls fit the fingers. Unfortunately, there is no docking station for image transfer and charging. The battery needs to be removed from the camera and charged in a separate battery charger with 120-V AC power. Other than this, the Fuji F40 would be fine for clinical imaging.

The Kodak Z885 and Z1275 have similar designs and are generally easy to use. However, to enable macro, the user needs to dial the control knob to SCN (scene mode) and then select close-up for macro. This is a bit tedious and the infrequent user is likely to forget. In addition, the macro allows a distance no closer than 7.9 inches to the subject; users wanted to move the camera closer and kept getting close-up images that were out of focus. For these reasons, these cameras are not recommended.

The Kodak V1233 is a modern-looking digital camera with easily accessible functions. The SCN button allows the camera to be in auto or one of the other 22 scene modes. Macro can be accessed from the scene mode or directly using the toggle. The macro label below the toggle is a little difficult to see because it is shiny silver color. The review, delete, menu, and share buttons surround the toggle and this is a bit unusual, but an easily understandable concept. The camera is just large enough to allow the user to hold it steady with all four corners.

MACRO

Approximately half of the cameras are easily put into macro mode with a direct button or toggle: Canon A640, Fuji E900, Fuji F40, Fuji Z3, Kodak V1003, Kodak V1233, Kodak Z812, Nikon L1, Nikon L5, NikonS7c, Pentax M20, and the Sony DSC-W200. The other cameras

Table 3. Recommended Settings for Kodak V1233

FEATURE CHOICES	DEFAULT	WE RECOMMEND*	COMMENTS
Self-timer: 2 sec, 10 sec, Off, 2 shot	Off	Off	Used primarily for self-portraits
Burst: On, Off	Off	Off	Takes 3 shots when shutter is depressed
Picture size (MP): 12, 10.7, 9, 6, 3.1, 2.2, 2.1, 1.2	12 MP	6 MP	Large files are compressed automatically
Long time exposure (sec): 0.5, 1, 2, 4, 8	None	None	
Color mode: High Color, Natural Color, Low Color, Black & White, Sepia	Natural color	Low color	For more natural skin tones
AF control (still): Single AF, Continuous AF	Single AF	Single AF	
Date stamp: On, Off	Off	Off	
White balance: Auto, Daylight, Tungsten, Fluorescent, Open Shade	Auto	Auto	
Face detect capture: On, Off	On	Off	
Exposure metering: Multi-pattern, Center Weight, Center Spot	Multi-pattern	Center Spot	
AF zone: Multi-zone, Center-zone	Multi-zone	Center-zone	
ISO speed: Auto, 64, 100, 200, 400, 800, 1600, 3200	Auto	Auto	
Sharpness: High, Normal, Low	Normal	Normal	
Red eye preflash: On, Off	On	On	
Blur warning: On, Off	On	On	
Maintain settings: Flash, White Balance, ISO Speed, Color Mode, Sharpness, Exposure Metering, AF Zone	Flash On, all others Off	Flash Off, all others On	
LCD brightness: Power Save, High Power	High power	High power	
LCD dimmer (sec): 30, 20, 10, Off	10 seconds	Off	
Image storage: Auto, Internal Memory	Auto	Auto	
Set album: Off, [multiple]	Off	Off	
Orientation sensor (still): On, Off, On transfer	On	Off	When On, it rotates images that have no obvious "up"
Orientation sensor (video): On, Off, On transfer	Off	Off	
Camera sounds	Theme, etc.	Theme, etc.	
Sound volume: Off, Low, Medium, High	Medium	Medium	
Date & time: MDY, DMY, YMD	MDY	MDY	
Digital zoom: On, Off	On	Off	Discourage use in clinical photography
Auto power Off (min): 10, 5, 3, 1	3 minutes	10 minutes	
Video out: NTSC, PAL	NTSC	NTSC	N & S American standard
Photo frame: Display Interval, Transition, Source, Run Time, Loop	10 seconds, Off, Internal/card, 0.5 hours, Off	10 seconds, Off, Internal/card, 0.5 hours, Off	
Language	18 choices	English	English
Reset camera: Continue, Cancel	None	None	Returns settings to default
Format: Memory Card, Cancel, Int. Memory			
Feature demos: Exit, New Features, HD Video, Multimedia, Slide Show, Perfect Touch, Digital Image, Stabilization, High ISO	None	None	Choose from menu and press OK to view
Self timer: Off, 10 sec, 2 sec	Off	Off	
Video size: 1280 x 720 HQ, 1280 x 720, 640 x 480 HQ, 320 x 240	1280 x 720	640 x 480 HQ	
Control (video): Continuous AF, Single AF	Continuous	Continuous	
Image stabilizer: On, Off	On	On	

*Bold indicates change from default settings

require the user to go into a scene mode or dial that is less intuitive and will likely cause problems for the user.

Cameras vary in how close you can get to the subject, and it is desirable for beginner and intermediate users to be able to get within 4 inches for a macro shot of particular skin images and wounds. The closest distance attainable for macro settings is listed for each camera in *Table 1*.

POWER

The cameras use AA batteries or custom lithium ion batteries. In some cases the AA batteries can be replaced with a CR-V3 lithium. The Kodak V1233 utilizes a proprietary lithium KLIC-7004 that is rechargeable. Depending on the camera, batteries are charged in the camera using a docking station or charged separately by means of a battery charger.

IMAGE TRANSFER

Image transfer is enabled by removing the image storage media, using a USB transfer cable or using a docking station. Storage media for these 20 cameras is limited to SD card, xD Picture card, and Memory Stick. The xD cards are very small and difficult for a typical user to manipulate.

Some cameras have the battery and storage media located in the same compartment and when the door is opened, the batteries tend to fall out (i.e., Fuji E900, HP M547, and Pentax M20). While image transfer can be accomplished with a USB transfer cable, these tend to get lost in the clinical setting.

CAMERA DOCKING STATION/CRADLE

It has become evident from use in the field that a camera docking station is most useful in a clinical environment. The docking station retains the camera in one location, keeps the camera charged, and allows for easy transfer of images. It does not require the user to fuss with removing a media card or have them searching for a USB transfer cable. Although it was not an absolute requirement, it is very desirable to have a docking station for telemedicine carts in Alaska. Cameras with docking stations are listed in *Table 1*. Camera docking stations can add up to \$75 to the price of the camera.

PRICE

The price of digital cameras has fallen while the functionality has risen over the past 10 years. It is expected that you can get an excellent consumer-grade digital camera for under \$500. We searched

cameras with a maximum price of \$350. Prices are very different based on local or Internet-based retailer and volume pricing. Prices in *Table 1* were recently obtained from common Web sites and may be higher or lower, depending on the source. The Kodak V1233 has come down in price since our first purchase. Interestingly, because prices have stabilized in a reasonable range, this aspect has become the least important variable in selecting a digital camera.

Conclusion

Important considerations for digital camera selection include: (1) experience of the camera user, (2) specific clinical application, (3) performance of the camera in terms of image quality, (4) advanced settings that may be needed, (5) ease of use, (6) macro setting, (7) power source, (8) method of image transfer, (9) need for a docking station, and (10) price. These 10 considerations guided the recent selection of digital camera for telemedicine in Alaska. In our case, the Kodak V1233 was chosen as providing the best solution. The Fuji F40 would serve well if a docking station is not needed. The Casio EX-Z1200 is a good choice if the user can be trained to utilize the macro setting properly. A carefully designed selection process with criteria can assist in making the most appropriate choice for a digital camera that best meets one's needs for a given application in a specific telemedicine setting.

Additional Information

More information on this topic can be viewed as the webinar "Selecting the Right Digital Camera for Telehealth Applications" at the American Telemedicine Association Web site address: http://www.americantelemed.org/i4a/ams/amsstore/category.cfm?category_id=1

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