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**CONTRIBUTORS:**

Michael R. Migden, MD  
Assistant Professor  
Departments of Dermatology and  
Plastic Surgery  
The University of Texas  
M.D. Anderson Cancer Center  
Houston

**Dennis L. Fowler, MD**

Vice President and Medical  
Director, Perioperative Services  
U.S. Surgical Professor of  
Clinical Surgery  
Chief, Division of General Surgery  
Leon C. Hirsch Professor of  
Clinical Surgery  
NewYork-Presbyterian Hospital  
New York City

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**GENERAL SURGERY NEWS**

# Special REPORT

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## The Use of High-Definition Video Technology in the Surgical Setting

### Introduction

In 1995, a group of German researchers reviewed the results of 54 invasive endoscopic procedures performed with imaging systems using "improved resolution" technology and predicted that high-definition (HD) technology "may well become an essential part" of the surgeon's armamentarium. The authors noted that "both endoscopically inexperienced and experienced surgeons [could] benefit from the use of a[n imaging] system with improved resolution."<sup>1</sup> Now, in 2007, their prediction has become reality. Today, several large hospital centers incorporate HD technology into their surgical suites and medical-school classrooms, both for use as an educational tool and clinical/diagnostic aid.

### HD: From Home to Hospital

A world leader in high-definition technology, Sony Electronics introduced its first branded HD medical product for use in the surgical suite and the medical/surgical classroom in the fall of 2006. The Sony HD technologies currently on the market are designed to address a range of medical applications. Sony's IPELA<sup>®</sup> HD videoconferencing system, for example, is enabling increasing numbers of students and physicians to "observe" surgical procedures with excellent video quality, without actually needing to be in the OR. The technology also provides teachers, students, doctors, and surgeons with images of the highest resolution and detail for discussion. During surgeries ranging from minimally invasive to endoscopic



**FIGURE 1. A SIMULATED IMAGE OF THE VIEW FROM SONY'S LMD-2450MD HIGH-DEFINITION MEDICAL MONITOR.**

exams and screening procedures, Sony HD cameras, displays and recorders offer enhanced views of a patient's anatomy and pathology. In this article, 2 medical centers illustrate how each application of Sony technology has benefited their work.

Sony HD technology is running inside and alongside some of the most advanced surgical equipment in the industry (Figure 1). From conferencing systems and monitors to cameras, printers, and storage systems, Sony HD products and components have been integrated into original equipment manufacturer (OEM) systems developed by medical equipment manufacturers and distribution partners such as Olympus, Smith & Nephew, Linvatec, Karl Storz, and Stryker, among others.<sup>2</sup>

**Our HD system allows us to demonstrate this to students and surgical residents in precise detail—details that they might not be able to see otherwise, even in the OR, because the fine detail of skin and subcutaneous structures include subtleties less apparent to the unaided eye.**

Sony first entered the medical market in 1985 with the development of a specially designed 3/4-inch tape recorder to capture high-line black and white video images, a technology that was utilized by several leading radiology imaging companies. As minimally invasive surgical procedures began to create the need for greater image visualization, the company met this demand through a growing line of high-quality medical grade printers, monitors, video recorders, and cameras. Today, Sony's medical product line supports important advances in healthcare, enhanced through the use of digital technologies.<sup>2</sup>

The resolution of standard definition (SD) digital video is 480 lines, compared to 1080 lines for HD.<sup>3</sup> In a study published earlier this year, Hagiike et al observed 54 laparoscopic surgeons as they performed a series of typical procedures using either an HD monitor or an SD monitor. All of the participants subjectively evaluated HD as "superior to SD in the laboratory setting and during actual surgery," and the technology was also found to positively impact performance. In the study, knot-tying times were significantly reduced when guided with HD systems (mean, 173 +/- 84 sec vs 214 +/- 107 sec;  $P=0.003$ ). In addition, participants with less skill (more documented time required in the basic module on a surgical simulator) improved significantly in the knot-tying task with the HD system.<sup>4</sup>

## M.D. ANDERSON: THE HOSPITAL GOES HOLLYWOOD

*By Michael R. Migden, MD*

*Assistant Professor*

*Departments of Dermatology and Plastic Surgery*

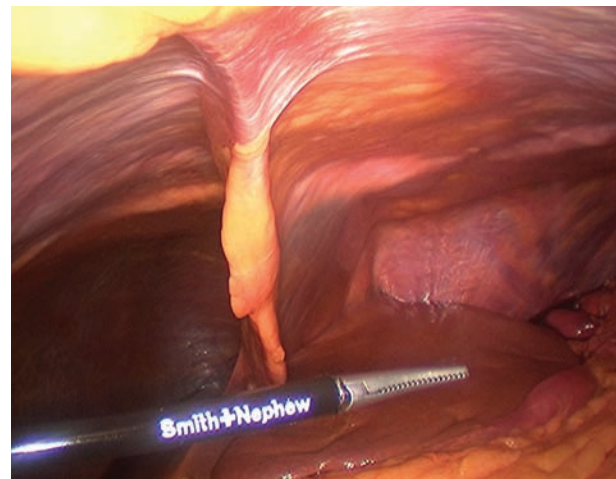
*The University of Texas M.D. Anderson Cancer Center  
Houston*

At the University of Texas M.D. Anderson Cancer Center, we have been heavily involved in the development of HD media technology for education and training in the surgical setting, particularly for use in Mohs micrographic surgery, a method for treating skin cancers frequently involving the head and neck. The procedure involves taking a tissue layer from the affected area, precisely mapping the location of the cancerous cells, and treating just those locations. Because of the precision involved in the Mohs procedure and subsequent reconstruction, only digital video captured at the highest resolution conveys dynamic content with the finest possible detail, which is essential for optimal education and training (Figure 2).

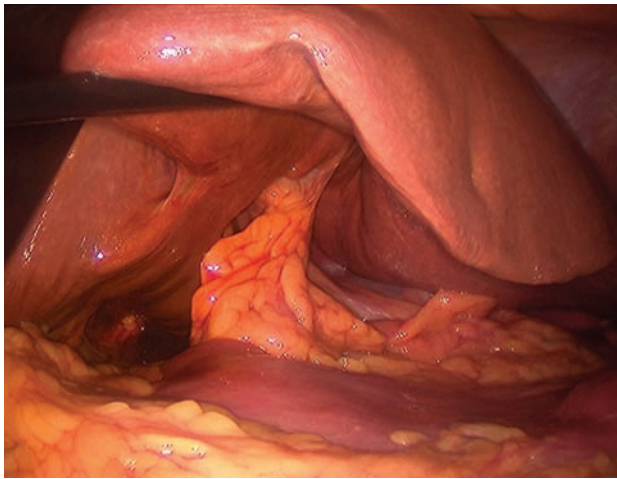
In Mohs surgery, the surgeon essentially functions as both surgeon and pathologist. As we remove tissue from the affected area—often close to or involving vital structures of the face—we color and mark it to accurately map its margins in correct location and orientation. By sequentially excising and mapping layers verified to have microscopically controlled margins, we clear the tumor, sparing as much normal tissue as possible.

Our HD system allows us to demonstrate this to students and surgical residents in precise detail—details that they might not be able to see otherwise, even in the OR, because the fine detail of skin and subcutaneous structures include subtleties less apparent to the unaided eye. Tight camera shots obtained with HD imaging provide sufficient magnification so that the viewer can more clearly appreciate, for example, the interface between the epidermis and the dermis and the dermis and subcutaneous fat. They can also get an extremely detailed view of suturing techniques used in reconstruction.

As a result, I have designed a method to bring our Sony HDC-X310 camera and PDW-70MD optical recorder into any of the surgical suites in our Mohs surgery unit. This articulated device positions the camera high above the patient and out of the way of the surgeon. By doing so, it decreases the



**FIGURE 2. A MONITOR DISPLAYING HIGH-DEFINITION IMAGE OF A SURGICAL PROCEDURE. ONLY DIGITAL VIDEO CAPTURED AT THE HIGHEST RESOLUTION CONVEYS DYNAMIC CONTENT WITH THE FINEST POSSIBLE DETAIL, WHICH IS ESSENTIAL FOR OPTIMAL EDUCATION AND TRAINING.**



**FIGURE 3. HIGH-DEFINITION IMAGE OF A BOWEL FOLLOWING LAPAROSCOPIC RESECTION. A HIGHER-RESOLUTION PICTURE PROVIDES SURGEONS WITH IMPROVED VISUAL/GUIDANCE CAPABILITIES IN THE OR.**

limitations of often encountered viewing obstacles: heads and backs of hands. While we are capturing the HD footage, our residents and fellows gravitate away from watching the surgeon's hands and toward the Sony LMD-2450MD 24"HD monitor.

We have become so confident of our ability to obtain an extraordinarily high quality of the video using HD technology that residents, fellows, and staff often review complex surgical content in preparation for more challenging cases. It is just this level of image quality that has led us to create a set of procedures organized as modules accessible from our LAN (local area network) using ordinary file servers. The same modules can be authored and packaged as physical media for publication. These can be used as teaching tools, or as resources for practicing surgeons. As we add to our list of Mohs and reconstructive procedures, our hope is that practicing surgeons with access to the content can easily navigate to and view content relevant to their upcoming cases.

**Our plan is to have 5 of our operating rooms outfitted with HD cameras and screens by the end of 2007, and add another 5 systems next year. A number of our surgical teams will use the technology, coupled in some cases with robotics, to perform surgical procedures such as laparoscopic cholecystectomy, laparoscopic partial nephrectomy, and laparoscopic gastric bypass, among others.**

Based on our initial success using HD technology, we were the first to present a 1080p HD-projected video of surgery or microscopic pathology. We used a Grass Valley Viper Film-Stream™ camera, designed by Thomson for digital moviemaking, to provide footage of surgical tumor removal and several microscope pathology cases including malignant melanoma. This was the same camera type used by noted film director Michael Mann on his movie "Collateral." We presented our digital "film" at the 63rd annual meeting of the American Academy of Dermatology (AAD) in New Orleans in 2005, and the results were projected in uncompromised progressive HD video.

For the AAD presentation, both the surgery and the microscopic pathology were shot using the Viper camera and recorded

onto an S2 disk recorder. The content was also edited and compressed into Microsoft Windows Media HD 1080p. Both compressed and original versions were shown to delegates on a 16-foot by 12-foot screen using a digital cinema projector from Christie Digital Systems. In the future, this 1080p content will be used in M.D. Anderson's Mohs Surgery education program to train other physicians in the technique. Canon USA, Carl Zeiss, Telemetrics, and Century Optics, a division of Schneider Optics, also provided support for this presentation.

In addition to further developing our library of Mohs and reconstructive surgery, our future plans include collaborating with Sony and other manufacturers in the application of next-generation HD technology. We've already provided feedback on Sony's new camera technology, and speak to a number of manufacturers about their products during the National Association of Broadcasters meetings, which I attend regularly.

We also hope to apply this technology to patient education. If a patient has been scheduled to undergo a surgical procedure, they can review relevant information explained by their surgeon or an equivalent colleague via an HD screen—the exam room's workstations monitor. This includes HD discussion of the basic information contained in a portion of the informed consent process. We can also use the technology to demonstrate postoperative wound care.

In general, we feel strongly that incorporating HD technology for viewing our surgical process has improved the overall quality of our teaching capabilities, which ultimately lead to improved patient outcomes. We see extraordinary potential for use of this technology in surgical education as well as patient education. We will be publishing an article on some of our findings in *Seminars in Cutaneous Medicine and Surgery* in early 2008.

## NEWYORK-PRESBYTERIAN HOSPITAL: IMPROVING THE IMAGE OF ENDOSCOPIC PROCEDURES

By Dennis L. Fowler, MD  
Vice President and Medical Director, Perioperative Services  
U.S. Surgical Professor of Clinical Surgery  
Chief, Division of General Surgery  
Leon C. Hirsch Professor of Clinical Surgery  
NewYork-Presbyterian Hospital  
New York City

We have only been using HD in our operating theater on a trial basis; however, we've already seen some impressive results and believe HD has the potential to replace 3-dimensional imaging in laparoscopic surgery.

The use of 2-dimensional imaging to guide laparoscopic procedures completely changed the paradigm; it proved that minimal-access surgery was an improvement over traditional methods, but there were still limitations. With 3-D imaging, we learned that by improving the image we provided our surgeons we could improve precision. Just from seeing its application in the consumer marketplace, we already know that HD technology reproduces the wide field of vision human beings have naturally, which could be an enhancement over 3-D systems. Indeed, you have improved depth perception with HD; as the surgeon, it gives you a real sense of where you are during a procedure.

We have 5 of our operating rooms outfitted with HD cameras and screens, and plan to add another 5 systems by the end of this year. A number of our surgical teams will use the technology, coupled in some cases with robotics, to perform surgical

procedures such as laparoscopic cholecystectomy, laparoscopic partial nephrectomy, and laparoscopic gastric bypass, among others (Figure 3).

We are working with manufacturers such as Sony in developing best practices for the recording, editing, presentation, and storage of HD data. We have already equipped many of our training areas with HD displays, and found that our surgical residents have really benefited from the added detail. Surgeons at NewYork-Presbyterian Hospital are using HD technology as part of “surgical simulators” developed for training purposes.

The benefits of HD are obvious. A higher-resolution picture provides surgeons with improved visual/guidance capabilities in the OR. When you look at the image, you know it is dramatically crisper—just as you can easily tell the difference between HD and SD televisions at Circuit City. There is no doubt that HD quality ranks as superior. These features enhance the capability to perform any operation laparoscopically—appendectomy, cholecystectomy, splenectomy, hernia repair, and colon resection. Literally any operation carried out in the abdomen, chest, or pelvis stands to benefit from HD technology. If you can view internal structures with greater precision, you can achieve more detail on the specific tissues and potentially produce better outcomes in the OR.

## Conclusion

Having already firmly established itself as the standard in the consumer products market, HD technology is quickly becoming more commonplace in the medical/surgical arena as well. Its benefits with regard to guidance in endoscopic procedures are unquestioned. As noted by von Orelli et al,<sup>5</sup> surgeons performing endoscopic procedures can benefit from the precision offered by HD technology. Surgeons at Rush University Medical Center in Chicago recently announced

that they have begun performing living-donor kidney transplants using an HD robotic surgery system offering shorter recovery and smaller incisions for donor patients. And, thoracic surgeons at Penn Presbyterian Medical Center in Philadelphia have incorporated HD technology into their surgical suite.

As noted in a 2006 editorial in *Surgical Endoscopy*, “In the operating theater environment, evidence is growing that advanced minimally invasive surgery is facilitated by the integration of the theater equipment, the video endoscopic system, and surgical devices... [HD]’s potential to improve the precision of surgery and protect against errors inevitably will put growing pressure on hospitals to replace their current equipment with new HDTV equipment.”<sup>6</sup> It’s only a matter of time, then, before HD technology is routinely used in surgery and medical education.

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