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The World Wide Web and Robotic Heart Surgery

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ABSTRACT

Purpose: The primary goal of this study was to (1) determine patients' access to and use of the Internet for health-related information before and after endoscopic atraumatic coronary artery bypass (Endo-ACAB) surgery, (2) investigate patients' methods of searching for such information, and (3) suggest future improvements for Internet-based patient education. The secondary goal of this study was to determine (1) patients' health-related quality of life and (2) degree of satisfaction following the Endo-ACAB procedure.

Methods: A follow-up study was conducted of 50 consecutive patients who had undergone Endo-ACAB procedures at the Center for Less Invasive Cardiac Surgery and Robotic Heart Surgery in Buffalo, New York. Study surveys were designed cooperatively by a communication scientist specializing in Internet studies and cardiac surgeons. Patients completed surveys over a period of 18 months, from January 2001 to June 2002.

Results: All 50 patients (100%) in the targeted study group completed the survey. Forty-four (88%) of these respondents reported having Internet access. The Web was cited as the most popular source of initial information on Endo-ACAB, with 36% of patients (18) first learning about the procedure through an Internet search. All 44 patients with Internet access used the Web as an additional source of information before surgery, but only 20% (7/35) did so after surgery. Most patients (91%, 40/44) felt that their surgeon should develop a Web site to detail the Endo-ACAB procedure. An investigation of patient quality of life showed that 96% of patients were not experiencing any symptoms related to their surgery. All 50 patients reported high degrees of satisfaction with the Endo-ACAB procedure, and 98% (49) said that they would recommend the surgery to someone else.

Conclusion: A vast majority of patients are realizing the benefits of the Internet as a tool to educate themselves, both before and after surgery. The request by an overwhelming majority of patients that surgeons develop Web sites, however, shows that patients may not be completely satisfied with the current form or content of health sites on the Internet. Surgeons will see the benefits of Web-based education only when they ensure that their patients have access to adequate and credible health-related information. The early results of robotic surgery suggest a promising future and the need to investigate the role of the Internet in its growth.

INTRODUCTION

The astounding growth of Internet access and use has become an unmistakable trend over the past 7 years. An estimated 544.2 million people worldwide, including 164.14 million in the United States, have stepped onto the information superhighway to access more than 3 billion online documents [Nua 2002, Powell 2002]. The increasingly significant role that the Internet has played in the lives of Americans has drawn focus to the World Wide Web as a tool for health seekers. In their most recent report, the Pew Internet & American Life project found that 73 million adult Americans went online for health information, reflecting an increase of 21 million users since November 2000 [Pew Research Center 2002]. These Internet-savvy health consumers have found a home on the World Wide Web, where at least 2% of all sites are health related [Kiley 1999].

The Internet offers users the advantages of confidentiality, convenience, and availability in searching for online information. Health seekers in particular might view the Internet as a source of medical advice offering potential health benefits or even as a support network fostering communication between patients with similar conditions. Yet the finding that a substantial majority of those seeking health information online fail to follow verification procedures, including identifying site sponsors and ensuring that posted material is factual, implies a lack of awareness of the potential dangers of "surfing the Net." The fact that 44% of these health seekers have made a medical decision based on information found online raises concern

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regarding the increasingly significant influence of the Internet in patient education [Pew Research Center 2002].

In the field of cardiac surgery, an important distinction has been made between actual medical patients who seek health information online and health seekers who may be simple browsers. Surgical patients can directly affect the doctor-patient relationship by using medical information to empower themselves in their health care decision making. Ensuring access to adequate medical information is thus a necessary means to educate patients before and after surgical procedures [D'Ancona 2001]. A recent survey at our Center for Less Invasive Cardiac Surgery and Robotic Heart Surgery in Buffalo, New York, found that more than half of our patients having Internet access had used the Web to retrieve medical information before or after coronary artery bypass grafting (CABG) surgery. The participants of the study underwent operations by means of the minimally invasive surgical technique known as off-pump coronary artery bypass (OPCAB) grafting, which consists of constructing coronary anastomoses on the beating heart and avoiding the use of the heart-lung machine [Murero 2001].

As the largest surgical discipline that still employs a highly invasive approach, cardiac surgery is at the forefront of such advances in minimally invasive and, more recently, robotic techniques [Tang 2001]. Although a great deal of research has focused on making surgeons aware of these new approaches, little has been done to determine how patients inform themselves of innovative cardiac surgical procedures. The Internet may have a very significant role to play in providing patients with medical information on new surgical methods. A search for the term *robotic heart surgery* using the popular search engines Yahoo! and America Online retrieved 7410 and 6779 Web documents, respectively, on July 10, 2002. The potential impact of this volume of information on a relatively new approach to CABG is worth serious consideration. Endoscopic atraumatic coronary artery bypass grafting (Endo-ACAB) has drawn the attention of the medical community, including possible surgical patients, as the latest development in robotic technology permitting less invasive cardiac surgery.

Patients may be ready to collaborate with their cardiac surgeons to seek improved outcomes through methods such as Endo-ACAB. In an effort to better understand the role of the Internet in developing this relationship, the primary goal of this study was to determine the extent to which Endo-ACAB patients consult the Internet for health-related information before and after surgery and how they would improve the information they have retrieved. The secondary goal of our study was to assess the level of patient satisfaction and health-related quality of life following the Endo-ACAB surgical procedure.

Endo-ACAB Review

The conventional CABG procedure consists of full sternotomy and total exposure of the heart with the use of cardiopulmonary bypass (CPB) support to create a bloodless, motionless surgical field [Tang 2001]. This highly invasive method of "cracking the sternum" combined with the reliance on CPB has led the conventional CABG procedures to be associated with postoperative complications, including stroke and cognitive dysfunction. In 1997, the Society of Thoracic Surgeons National Database reported that 35.7% of patients experienced complications after primary CABG [Duhaylongsod 2000]. In addition to the morbidity rates, the costly medical and rehabilitative services associated with CABG have provided the motive behind the development of techniques to reduce the length of hospital stay and to decrease costs.

To achieve these clinical goals, investigators have explored minimally invasive CABG with 4 technical objectives: (1) achieving an effective coronary anastomosis; (2) achieving complete revascularization; (3) avoiding the use of CPB; and (4) avoiding the morbidity of sternotomy. The OPCAB approach meets the objective of avoiding major complications and costs by eliminating the use of CPB, but it still involves sternotomy. Another alternative to conventional CABG, the port-access method, avoids sternotomy by employing a limited left anterior thoracotomy incision and directly visualizing the dissection of the left internal thoracic artery bypass graft and its anastomosis to the target coronary artery [Duhaylongsod 2000]. Until recently, however, minimally invasive approaches have failed to achieve their proposed advantages over conventional CABG because of the limits of endosurgical instrumentation. The newest advances in surgical equipment have sought to overcome issues of poor optical quality and technical challenges in surgical movement through the use of robot-assisted instruments.

The Automated Endoscopic System for Optimal Positioning (AESOP) (Computer Motion, Goleta, CA, USA) has become the backbone of the movement toward totally endoscopic cardiac surgery. This robotic arm possesses 7 degrees of freedom and allows the surgeon to position the endoscope with verbal commands, thus creating a stable operative view. AESOP is the key to the latest minimally invasive approach to coronary artery bypass surgery, Endo-ACAB [Computer Motion 2002]. In this procedure, the surgeon is able to harvest the full length of the left internal mammary artery (LIMA) with the aid of 3 5-mm ports and to identify the left anterior descending (LAD) artery with the aid of robotic visualization. The minimally invasive direct coronary bypass (MIDCAB) is then performed under direct vision with an incision less than 2 inches long that overlies the LAD. In addition to improving optical quality for the surgeon, Endo-ACAB offers patients the benefits of good cosmetic results, quick rehabilitation, and excellent long-term recovery prospects. To date, more than 1500 successful Endo-ACAB procedures have been performed around the world [Computer Motion 2002].

STUDY METHODS

Fifty patients who underwent Endo-ACAB procedures at the Center for Less Invasive Cardiac Surgery and Robotic Heart Surgery in Buffalo, New York, participated in the study. All Endo-ACAB operations were performed consecutively between January 2001 and June 2002 with the assistance of the AESOP 3000 robot. The study took place over an 18-month

period and coincided with the period when the surgical procedures were performed. Patients were asked to complete a short survey before seeing the physician for their second follow-up clinic visit, between 3 and 6 months after surgery.

The study was conducted by an interdisciplinary team that included a communications scientist specializing in Internet studies and cardiac surgeons. All study surveys were anonymous and did not require any personal or biographical information that identified the patient. The 20-item, self-completed surveys were primarily multiple choice with the exception of 3 free-response sections. The average time from patient surgery to the completion of the questionnaire was 4.8 months.

The questionnaire was formulated into 2 main parts and subdivided into 5 brief sections. The first section in Part I of the survey determined how patients initially retrieved information about the Endo-ACAB procedure. Survey respondents were also asked whether they had access to the Internet. Patients who did not have Internet access skipped to the final part of the questionnaire. If the patient did have Internet access, the respondent proceeded to the next set of questions in Part I, which focused on Internet activity. In this section of the survey, respondents were asked how often, if ever, they used the Internet to search for information about their health-related problems. Those patients who did use the Internet for such searches were then asked whether the Internet was an additional source of information both before and after their Endo-ACAB procedure. The third section in Part I of the survey was designed for respondents who noted using the Internet to search for information on their surgery. This section of the survey had the purpose of investigating (1) the search engines used by the patient, (2) the search terms used, and (3) the types of sites visited. The Internet portion (Part I) of the survey culminated with a few questions that allowed respondents to offer suggestions to make the Internet a more proficient resource for educating prospective Endo-ACAB patients.

Part II of the survey consisted of 2 sections and was designed for completion by all study participants. Patients first answered follow-up questions to determine their health-related quality of life following the procedure and whether they experienced any cardiac-related complications since their surgery. The survey ended with a final set of questions evaluating the respondent's degree of satisfaction with the Endo-ACAB procedure.

Potential sources of error included blanks as well as incorrect responses due to misinterpretation of survey questions. In an effort to minimize errors, surveys were administered with outlined instructions for completion.

Data Analysis

Data were stored in an Excel (Microsoft, Redmond, WA, USA) database sheet and analyzed. Results were expressed as the percentage and the mean for responses to each question. Blanks were not included in the percentages of each response. For questions allowing multiple responses, percentage values were calculated from the fixed number of patients responding to the question. Therefore, the total response rate to survey questions exceeded 100% in some cases.

RESULTS

All patients in the targeted study group completed the survey (50/50, 100%). Of the 50 respondents, 28% (14) were women and 72% (36) were men. The mean age of the patients was 58.5 years (range, 48-82 years).

Sources of Information on Endo-ACAB

An overwhelming majority of patients (88%, 44/50) reported having access to the Internet, and the most frequently cited source of initial information on the Endo-ACAB procedure was online material (36%, 18/50). Figure 1 shows the additional sources that provided patients with initial information about the surgery. An equivalent plurality of patients (36%, 18/50) first learned about robotic surgery from their cardiologist. Television followed as the second most frequently reported source, with 14% of patients (7/50) first hearing of the surgery on documentaries featuring general robotic applications. Friends and family members provided an alternate means of learning about Endo-ACAB. Ten percent of patients (5/50) reported family members who had heard or read about the procedure as an initial source of information. Only 1 patient (2%), however, indicated first learning about the surgery from a friend or family member who actually had undergone the procedure. Primary care physicians were the least likely initial providers of material on Endo-ACAB. Only 1 patient (2%) cited the family doctor as the first source of information.

Internet Use for Endo-ACAB–Related Information

Figure 2 shows how often the patients relied on the Internet to obtain information that addressed their health problems. A vast majority of these patients (80%, 35/44) looked online at least once a week for material dealing with their health problems. Eighteen percent of patients (8/44) used the Internet every month for medical information. All patients having Internet access (88%, 44/50) used the Internet at least once every 6 months to search for health-related information. Only 1 patient (2%) reported using the Internet as little as once every 6 months for health-related searches.

Table 1 summarizes patient use of the Internet for Endo-ACAB–related searching. Before their Endo-ACAB procedure, all online health seekers (88%, 44/50) used the Internet as an additional source of information. Of the 70% of patients (35/50) who later participated in cardiac rehabilitation, however, only 20% (7/35) cited the Internet as a source of "additional helpful information" on their therapy.

Endo-ACAB Internet Search Techniques/Feedback

The search methods of patients looking for information on their surgery are reported in Table 2. The most popular search engines were America Online (30%, 13/44) and Yahoo! (22%, 10/44). Fourteen percent of respondents (6/44) used the HotBot engine, and another 11% (5/44) reportedly accessed the Google site. Only 9% of patients (4/44) used Infoseek/Lycos, and 14% (6/44) relied on other search engines. Half of all patients (22/44) accessing the Internet for Endo-ACAB–related information used the search term *robotic*

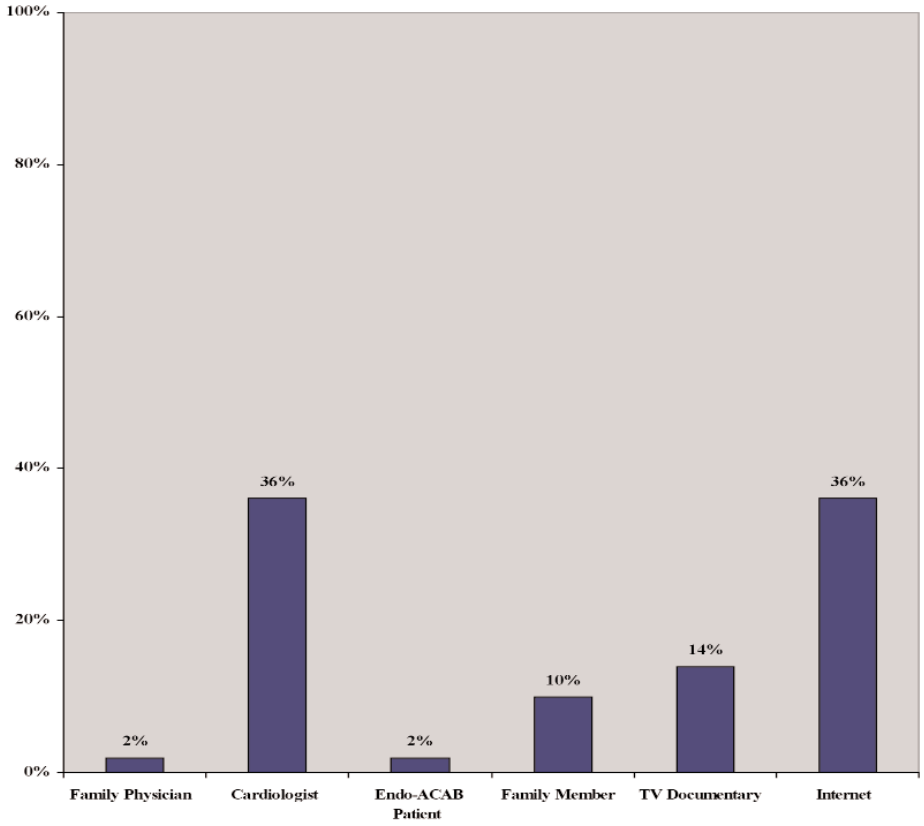

Figure 1. Initial sources of information for 50 patients undergoing endoscopic atraumatic coronary artery bypass (Endo-ACAB) surgery.

heart surgery. Only 7% of respondents (3/44) reported using *MIDCAB* to begin searches, and 32% (14/44) entered *endoscopic CABG* when looking for information. Eleven percent of the patients (5/44) could not recall the term they used to retrieve online information related to their surgery. Most patients (64%, 28/44) reported visiting Web sites that featured online "scientific articles" on the Endo-ACAB procedure. Other respondents accessed hospital Web sites (20%, 9/44) and robotic company sites (16%, 7/44) for information on their surgery or rehabilitation.

In a set of open-ended questions, 50% of responding patients (12/24) commented that the number of sites dedicated to robotic heart surgery is "overwhelming." The excessive number of commercial pages on the procedure was noted by 25% of these patients (6/24). In addition, 25% of respondents (6/24) also observed that actual anatomical information was lacking from many sites.

A significant percentage of patients (91%, 40/44) felt that their surgeon should develop a Web site to detail the Endo-ACAB procedure. These patients decided that there were a number of features that such sites should have, the most popular of these features being animation (68% of patients, 30/44). Although 41% of patients (18/44) wanted their surgeon to include pictures of the robot, only 11% (5/44) wanted to see a video clip of the procedure. Twenty-three percent of patients (10/44) believed their surgeon's site should have before and after images showing the healed incision of an Endo-ACAB patient.

Health-Related Quality of Life after Endo-ACAB

The vast majority of Endo-ACAB patients (96%, 48/50) were not experiencing any medical problems related to undergoing the procedure. In fact, only 2 patients (4%) reported having disabling symptoms that were possibly caused by their surgery. More specifically, 1 patient (2%) noted experiencing rib pain/tenderness, and another patient (2%) reported having numbness along the incision site. There were no patients (0%, 0/50) who experienced a lung hernia or any other disabling symptoms. Seven patients (14%) had cardiac reintervention for a planned hybrid procedure following their Endo-ACAB surgery. No patients, however, had percutaneous intervention, either for new lesions or for the same bypassed vessel. In fact, 96% of Endo-ACAB patients (48/50) had not been readmitted to the hospital since their procedure. The 2 reported cases (4%) of readmission involved atrial fibrillation and pleural effusion.

Satisfaction with Endo-ACAB

Figure 3 shows the degree of satisfaction with the Endo-ACAB procedure as mentioned by the patients. All 50 Endo-ACAB patients reported a high level of satisfaction with their procedures. An overwhelming 95% (47/50) chose the highest

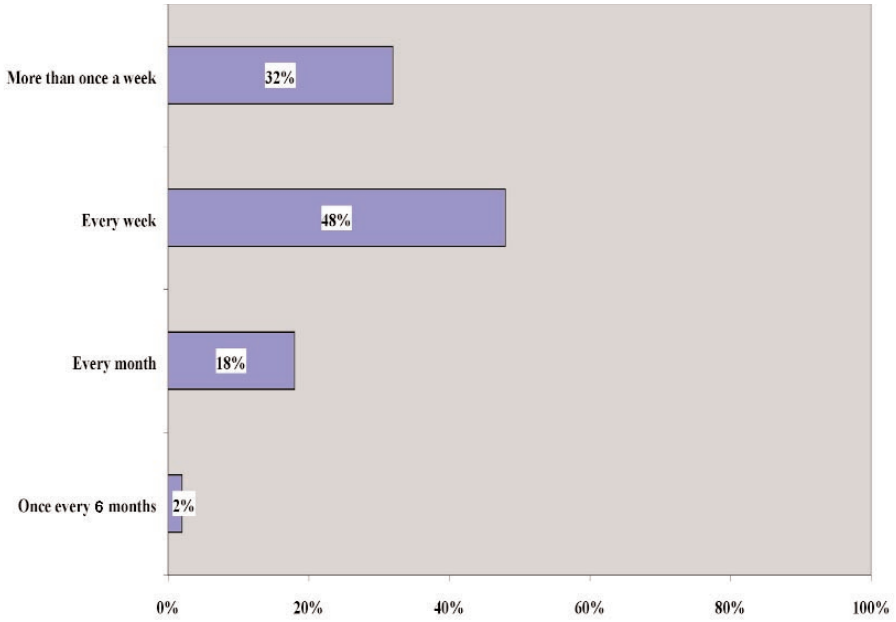

Figure 2. The frequency of Internet use for health-related information by 50 patients with Internet access who underwent endoscopic atraumatic coronary artery bypass.

rating of "extremely satisfied" to describe their degree of content with the surgery. Two patients (3%) were "highly satisfied" after the procedure, and 1 patient (2%) was "satisfied." There were no respondents who indicated that they were "not satisfied" with their surgery. The patient-perceived success of Endo-ACAB is further reflected in the 98% of respondents (49/50) who stated that they would recommend the procedure to another person. In addition, when patients compared their recovery time with that of a patient who had undergone conventional CABG with full sternotomy, 88% of Endo-ACAB patients (44/50) found their own recovery to be moving along at a faster rate. Five patients (10%) found that conventional CABG patients had recovered just as well as they had, and only 1 patient (2%) noticed no apparent differences between the two healing processes.

DISCUSSION

Surgeons continuously seek to eliminate technical challenges in the operating room by familiarizing themselves with the latest surgical techniques. Motivated by their desire to reduce costs and, more importantly, improve patient outcomes, surgeons are adapting to new developments in minimally invasive approaches. In the field of cardiac surgery, the movement toward totally endoscopic procedures has recently given rise to Endo-ACAB. Although the benefits to the surgeon of improved optical quality have provided the motivation behind the development of robotic surgery, it is Endo-ACAB's advantages to the patient that have caught the attention of many health seekers. Surgical patients are using the Internet to explore the latest in surgical options and ultimately take an active role in their health care. The World Wide Web offers a medium through which these patients may collaborate with their cardiac surgeons to seek improved outcomes through methods such as Endo-ACAB.

In a previous study conducted at the Center for Less Invasive Cardiac Surgery and Robotic Heart Surgery, we found that more than half of our patients having Internet access used the Web for health-related information on their OPCAB procedure [Murero 2001]. The findings of this study further illustrate that patients are recognizing the Internet as an empowering tool to educate themselves before and after cardiac surgeries. Most patients first found out about Endo-ACAB through an Internet search, and all patients with Internet access used the Web as a source of additional information on the procedure. Data from both of our studies point to a trend of patients using the Internet frequently when preparing for or rehabilitating from relatively new cardiac procedures such as minimally invasive OPCAB and Endo-ACAB. Because surgical patients are frequently using the Internet to retrieve information on minimally invasive surgery, the quality of related online material should be ensured. The fact that most of our Endo-ACAB patients turned to the Web as an initial source of information further emphasizes the need for such regulation. Given that the role of robotics in the operating

Table 1. Patient Internet Access and Use*

	Internet Access (n = 50)	Internet Use for Information before Endo-ACAB (n = 50)	Internet Use for Information on Cardiac Rehabilitation (n = 35)
Yes	44 (88%)	44 (88%)	7 (20%)
No	6 (12%)	6 (12%)	28 (80%)

*Endo-ACAB indicates endoscopic atraumatic coronary artery bypass.

Table 2. Patient Search Methods (n = 44)*

Search engine, n	
Yahoo!	10 (22%)
America Online	13 (30%)
HotBot	6 (14%)
Google	5 (11%)
Infoseek/Lycos	4 (9%)
Other	6 (14%)
Search term, n	
Robotic heart surgery	22 (50%)
Endoscopic CABG	14 (32%)
MIDCAB	3 (7%)
Don't remember	5 (11%)
Web site, n	
Robotic company site	7 (16%)
Hospital Web site	9 (20%)
Scientific articles posted online	28 (64%)

*CABG indicates coronary artery bypass grafting; MIDCAB, minimally invasive direct coronary artery bypass.

room is still being heavily researched, patients must be cautious when relying on the Internet as a source of robotics-related health information [Sigouin 2002]. Although many cardiac surgeons are new to robotic surgery, they must take the initiative in directing patients toward reliable and useful medical documents on the Web.

Surgeons might pay particular attention to the lack of "helpful" online material focusing on therapy following Endo-ACAB. Of the 70% of our patients (35/50) participating in cardiac rehabilitation, only 20% (7/35) found that the Internet was a useful source of information during their therapy. After undergoing minimally invasive cardiac surgery, patients are encouraged to follow rehabilitation plans and make lifestyle changes that can prolong the effectiveness of the procedure as well as their overall health [HeartCenterOnline 2002]. The demonstrated frequency with which patients access the Internet prior to Endo-ACAB strongly suggests the usefulness of adequate online material focusing on therapy after the procedure.

Aside from ensuring that a sufficient quantity of health information is available to patients searching the Internet, surgeons should determine the quality of these online documents. A crucial primary step in making this determination is to consider the search methods of patients using the Internet for medical research. The finding that 80% of our respondents used the Internet once a week or more to look for health-related information suggests capability in their search techniques. In comparison, the Pew Internet & American Life national study revealed that most health seekers are only occasional visitors to health and medical sites, with 58% using the Internet to look for health-related information every few months or less [Pew Research Center 2002]. Although Endo-ACAB patients conduct health-related searches more frequently than most Internet health seekers, this higher frequency alone does not make them efficient navigators.

In a recent observational study, a detailed analysis of how participants use the Internet for health information revealed "suboptimal" techniques similar to those found in our study [Eysenbach 2002]. All patients in our study group used general search engines to retrieve information on their surgical procedure. These engines offer health seekers the least amount of screening when it comes to finding health-related documents. America Online and Yahoo! were reported as some of the most popular means of accessing health material, and none of the patients used search engines specifically designed to find medical information. Previous studies have similarly noted that patients and those searching on behalf of patients demonstrate a lack of awareness of Web sites geared toward retrieving health-related documents [Pew Research Center 2002, Eysenbach 2002, Sigouin 2002, Semere 2003]. Resources such as the Cochrane Collaboration and MEDLINE use the

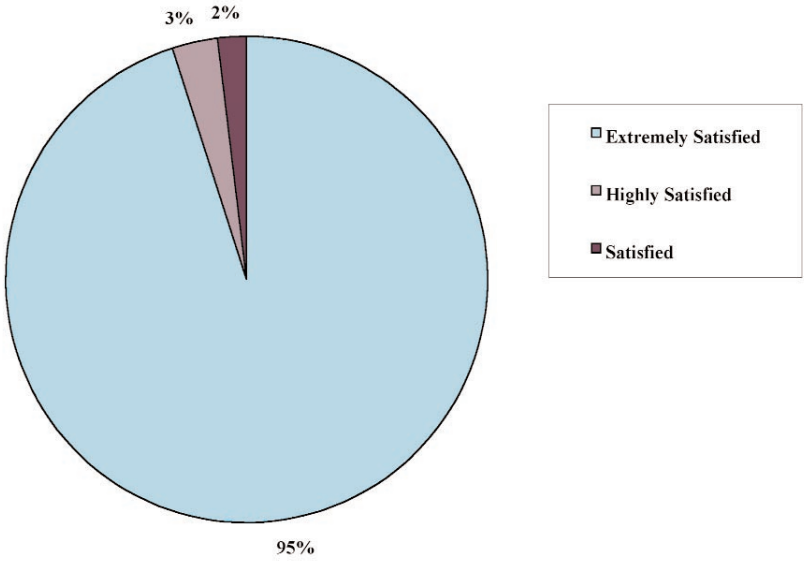

Figure 3. The degree of satisfaction following surgery of 50 patients who underwent endoscopic atraumatic coronary artery bypass.

Internet to promote evidence-based decision making (EBDM). The EBDM initiative seeks to facilitate the judicious, systematic, explicit, and conscientious consideration of the current best evidence from research to guide patients in health-related decisions [Sigouin 2002]. By not using the sites of medical societies and libraries as a starting point, patients expose their searches to a vast amount of unfiltered results.

When trying to reduce the amount of irrelevant or inaccurate "hits," patients must carefully consider their inputted search terms. The most popular search term for patients seeking Endo-ACAB–related online material was *robotic heart surgery*. As a result of not using specific medical terminology to describe their procedure, half of the patients found that the number of retrieved sites was overwhelming. Our own searches on Yahoo! and America Online supported this finding; inputting the general phrase *robotic heart surgery* yielded thousands of Web links. Although a substantial 39% of respondents used specific search terms such as *endoscopic CABG* and *MIDCAB*, a worrying 11% of patients could not recall the words that led to the health information they found.

To increase the effectiveness of their searches, patients might consider, when applicable, the use of explicit Boolean operators such as *and* to ensure that retrieved sites are related to all words in the search term. In addition, using phrase searches—words enclosed in quotation marks to search for documents where they appear together—can also be helpful in eliminating unrelated hits. Limiting searches to include only relevant material has demonstrated importance, considering the studies showing that health seekers typically choose one of the first results displayed by the search engine and visit few sites [Eysenbach 2002, Pew Research Center 2002].

Despite the somewhat ineffective search techniques revealed in our findings, patients seemed to locate reliable sources of information on Endo-ACAB. An astounding 64% of patients relied on "scientific articles" available online for additional material on their surgery. Because patients did not use medical portals in their searches, however, they had limited access to medical publications and as a result may have encountered misleading or incomplete articles. Those patients who did not rely on Internet articles visited either robotic company or hospital Web sites. Although both sources offered seemingly reliable data, some patients found that the sites lacked actual anatomical information. Patients also expressed concern about the excessive amount of commercial pages dedicated to the topic of robotic surgery.

Realizing the inherent flaws of Internet searching, an overwhelming majority of patients felt that their surgeons should develop Web sites to detail the Endo-ACAB procedure. Most patients expressed a desire for basic and comprehensible information related to their surgery. They wanted this material in the form of inviting sites with attractive features including animation, pictures, and video clips. Patients seeking Endo-ACAB information online are looking for a central location where they can access reliable and pertinent material on their procedure in a user-friendly manner.

The concerns of our patients are echoed by the 82% of American adults who also say that they worry about getting online health information from an unreliable source [Ferguson 2000]. Some researchers have described the Internet as the enabling force behind the transition of passive patients into active end users who are taking control of their health care [Ferguson 2002]. These "medical end users" are inviting their physicians and surgeons to explore the opportunities in patient education that are available through Web-based interactions. In our study, a vast majority of patients placed emphasis on the surgeon's role in ensuring the quality of health-related Internet information. Although surgeons must take responsibility in helping their patients locate adequate and accurate learning material both before and after surgery, measures must be taken to ensure the large-scale quality of health information on the Internet.

This online health material includes everything from personal accounts of illnesses and patient discussion groups to peer-reviewed journal articles and clinical decision support tools. Regulating such a diverse set of information has presented Internet researchers with a challenge. In addition, developing a single quality standard might not work in the same way to reassure both patients, who are possibly looking for simple explanations, and health care professionals, who are likely seeking data from clinical trials [Purcell 2002]. Self-applied codes of conduct, defined as sets of quality criteria that provide a list of recommendations for the development and content of Web sites, are the products of the first attempts to regulate health information on the Internet. The Health On the Net Foundation (http://www.hon.ch) produces one of the most popular quality labels adhering to criteria established by organizations such as the eHealth Code of Ethics of the Internet Health Coalition (http://www.ihealthcoalition.org/ethics/ethics.html). These quality labels are in the form of a logo or symbol and are seen on sites for which the owner has submitted a formal application acknowledging a commitment to the principles of the represented code. More advanced forms of the code of conduct incorporate the approval of a third party awarding the label to sites providing information that meets current standards for content and form. User guidance systems provide an alternate form of regulation that enables users to check if a site complies with set standards via the access of a series of questions from a displayed logo. Sites including DISCERN (http://www. discern.org.uk) for adults and QUICK (http://www.quick.org.uk), which is geared toward children, help users assess health-related information on the Internet through brief questionnaires or step-by-step guides. The more recent development of filters offers an effective shortcut to searches using general or nonspecific search engines. These tools accept or reject entire sites on the basis of preset criteria specific to a particular group of consumers. Resources such as OMNI use filters that are geared toward students, researchers, academics, and practitioners in the health field [Wilson 2002].

Despite the benefits that the rating tools and the quality standards appear to easily offer, these systems depend on the user's ability and interest in their use. Exhausted by the sheer amount of quality initiatives, some investigators have suggested that educating producers and users of health information on using the Internet is the better approach [Delamothe 2000, Purcell 2002]. If regulation approaches are to take the form of

education, then surgeons must be prepared to assist their patients in seeking the most reliable online sources of medical information. To keep up with a growing number of Internet-savvy patients, cardiac surgeons must use the Web as a tool to help their patients find the best treatment opportunities.

For the vast majority of our patients, Endo-ACAB has been their most rewarding surgical option. All of our patients were satisfied with the procedure; in fact, 95% assessed their satisfaction with the surgery at the highest rating of "extremely satisfied." It was therefore not a surprise that 98% of our patients said that they would recommend Endo-ACAB to someone else. Results from our questionnaire show that most Endo-ACAB patients experienced symptom-free postoperative recovery. The 2 patients who did claim to have disabling symptoms related to their procedure cited rib pain or tenderness and numbness along the incision. These specific symptoms, if not related to other cardiac complications, might still improve over a longer recovery period.

Overall, Endo-ACAB patients demonstrate positive long-term recovery results. Findings from our study showed that of the 50 patients studied, only 2 were readmitted to the hospital for cardiac-related events. The causes of readmission were postoperative atrial fibrillation and pleural effusion, which are common complications that often lead to increased morbidity and prolonged hospitalization following on-pump CABG surgery. At Washington Hospital Center, MIDCAB was associated with a lower incidence of atrial fibrillation, but it still accounted for the prolonged hospital stay of 21% of patients who underwent off-pump CABG [Stamou 2000]. The finding that only 2 of our patients experienced postoperative atrial fibrillation or pleural effusion suggests the possibility of an even lower incidence with the Endo-ACAB procedure. Furthermore, the only cardiac reinterventions that occurred after Endo-ACAB were the planned hybrid procedures of 7 patients. The recent advent of MIDCAB combined with percutaneous transluminal coronary angioplasty (PTCA) in a hybrid approach has the benefits of lower morbidity for both the PTCA and the minimal incision, as well as a high rate of patency for the LIMA-to-LAD anastomosis [Sim 2000]. Similar to the results we have seen with Endo-ACAB, hybrid procedures demonstrate the advantages of reducing the likelihood of reoperation in younger patients and avoiding the potential harm of CPB in older patients.

Beyond considering their own rehabilitation process, Endo-ACAB patients were asked to compare their recovery with that of patients they knew who had undergone conventional CABG. A vast majority of our patients found that they experienced a faster rate of recovery than those who had undergone the traditional surgery. The successes of Endo-ACAB are seen in the high levels of patient satisfaction that are attributed to positive results both inside and outside of the operating room.

In an effort to build on these early results, advances such as the development of the virtual cardiac surgical planning platform (VCSP) have been made. The VCSP allows surgeons to plan the surgical procedure in advance with preoperative 3-dimensional images of the thorax, complete with virtual manipulation of the simulated thoracic ports, to choose the optimal access for the endoscopic tools [Czibik 2002]. Further developments in robotic surgery have the potential to reveal innovative surgical approaches that will significantly reduce patient morbidity and lead to completely endoscopic cardiac procedures. Robotic technology promises to have a striking impact on the relationship between cardiac surgeons and their patients, inside as well as outside of the operating room.

In addition to the technology of robot-assisted instruments, the World Wide Web has emerged as the enabling technology behind robotic surgery and has the potential to improve patient education to allow better communication between surgeons and their patients.

REFERENCES

Computer Motion. 2002. A surgical evolution: the Endo ACAB™ program. Available at: http://www.computermotion.com/endo-acab/index.html. Accessed July 10, 2002.

Czibik G, D'Ancona G, Donias HW, Karamanoukian HL. 2002. Robotic cardiac surgery: present and future applications. J Cardiothorac Vasc Anesth 16:495-501.

D'Ancona G, Murero M, Bergsland J, Karamanoukian H. 2001. Is the Internet a useful tool to educate cardiac surgery patients? Heart Surg Forum 5:e13-4. Available at: http://www.hsforum.com/vol5/issue2/2001-4444.html. Accessed July 22, 2003.

Delamothe T. 2000. Quality of websites: kitemarking the west wind. BMJ 321:843-4.

Duhaylongsod FG. 2000. Minimally invasive cardiac surgery defined. Arch Surg 135:296-301.

Eysenbach G, Köhler C. 2002. How do consumers search for and appraise health information on the world wide web? Qualitative study using focus groups, usability tests, and in-depth interviews. BMJ 324:573-7.

Ferguson T. 2000. Online patient-helpers and physicians working together: a new partnership for high quality health care. BMJ 321:1129-32.

Ferguson T. 2002. From patients to end users. BMJ 324:555-6.

HeartCenterOnline. 2002. Minimally invasive bypass surgery. Available at: http://www.heartcenteronline.com/myheartdr/common. Accessed July 24, 2002.

Kiley R. 1999. Internet statistics. Health Information on the Internet 10:e1-2. Available at http://www.rsm.uk/hii/issue10.pdf. Accessed July 22, 2003.

Murero M, D'Ancona G, Karamanoukian H. 2001. Use of the Internet by patients before and after cardiac surgery: telephone survey. J Med Internet Res 3:e27. Available at: http://www.jmir.org/2001/3/e27. Accessed July 22, 2003.

Nua. 2002. How many online? Available at: http://www.nua.org/surveys/how_many_online. Accessed July 17, 2002.

Pew Research Center. 2002. Vital decisions: how Internet users decide what information to trust when they or their loved ones are sick [Pew Internet & American Life Web site]. Available at: http://www.pewinternet.org/reports/toc.asp?Report = 59. Accessed July 22, 2003.

Powell J, Clarke A. 2002. The WWW of the World Wide Web: who, what, and why? J Med Internet Res 4:e4. Available at: http://www.jmir.org/2002/1/e4. Accessed July 22, 2003.

Purcell G, Wilson P, Delamothe T. 2002. The quality of health information on the internet: as for any other medium it varies widely; regulation is not the answer. BMJ 324:557-8.

Semere W, Karamanoukian HL, Levitt M, et al. 2003. A pediatric surgery study: parent usage of the Internet for medical information. J Pediatr Surg 38:560-4.

Sigouin C, Jadad AR. 2002. Awareness of sources of peer-reviewed research evidence on the Internet. JAMA 287:2867-9.

Sim EKW, Grignani RT, Cheng A, Lim TT, Lim YT, Saw HS. 2000. Hybrid cardiac revascularisation surgery. Singapore Med J 41:36-8.

Stamou SC, Dangas G, Hill PC, et al. 2000. Atrial fibrillation after beating heart surgery. Am J Cardiol 86:64-7.

Tang WT, D'Ancona G, Bergsland J, Kawaguchi A, Karamanoukian HL. 2001. Robotically assisted video-enhanced-endoscopic coronary artery bypass graft surgery. Angiology 52:99-102.

Wilson P. 2002. How to find the good and avoid the bad or ugly: a short guide to tools for rating quality of health information on the Internet. BMJ 324:598-600.

REVIEW AND COMMENTARY

1. Editorial Board Member AN153 writes:

a) The acronym ACAB has become standard for awake CAB, so an alternate acronym would be better.

b) How is the term *atraumatic* being used? With reference to incisions or avoiding CPB.

Authors' Response by Wagahta G. Semere, MD:

a) The complete acronym is Endo-ACAB and has been described by the cited references much earlier than the terminology used for awake CAB. It is more appropriate to use the term Endo-ACAB for this procedure and not ACAB.

b) The word *atraumatic* refers to the lack of rib spreading for access to the LAD and performance of the coronary anastomosis. This "atraumatic" aspect makes this operation distinctly different from MIDCAB, in which surgeons use rib spreading to harvest the LIMA and also on occasion to remove a rib for this purpose or for construction of the anastomosis. Endoscopic harvesting of the LIMA obviates rib spreading. Therefore, *atraumatic* is a word of minimally invasive terminology. It can also be used with or without CPB, but the vast majority of reported cases in the literature for the endoscopic harvesting of the LIMA and the manual construction of the LIMA-to-LAD anastomosis (the Endo ACAB procedure) has used the off-pump technique.