A Brief Overview of Selected Aspects of Colonoscopy: Past, Present and Future

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1. Introduction

All the organs of the body were having a meeting, trying to decide who should be the one in charge. "I should be in charge," said the brain, "Because I run all the body's systems, so without me nothing would happen." "I should be in charge," said the blood, "Because I circulate oxygen all over so without me you'd all waste away." "I should be in charge," said the stomach," Because I process food and give all of you energy." "We should be in charge," said the legs, "because we carry the body wherever it needs to go." "We should be in charge," said the eyes, "Because we allow the body to see where it goes." "We should be in charge," said the colon and rectum, "Because we're responsible for waste removal." All the other body parts laughed at the colon and rectum and insulted them, so in a huff, they shut down tight. Within a few days, the brain had a terrible headache, the stomach was bloated, the legs got wobbly, the eyes got watery, and the blood became toxic. They all decided that the colon and rectum should

be the boss. The moral of the story? ***The importance of the colon and rectum to patient well-being has been affirmed and colonoscopy has come of age!***

As editor of this book it is my intent in this brief introductory book chapter to provide a sampling of some of the varied topics related to the discipline of colonoscopy. By whetting the reader's appetite for this subject one will better enjoy the many superb multi-authored chapters written with an international perspective that follow.

2. The historical development of colonoscopy

In the last half century the field of gastroenterology has recruited ever increasing numbers of well-motivated and capable physician trainees. During the period 1950–70, investigations of the colon were largely restricted to barium radiographic studies, stool examinations, and the performance of rigid sigmoidoscopy. [Old habits such as performing diagnostic contrast enema studies of the colon die hard, however (Matsukawa et al., 2007).] In contrast, the modern-day gastroenterologist undergoes advanced training in gastroenterology and hepatology, unlike his predecessors has a wide armamentarium of services to offer and medications to use in clinical care, and is expected to develop a high level of skill in performing endoscopic procedures including colonoscopy and interpreting diagnostic studies such as CT enterography, magnetic resonance cholangiopancreatography, and capsule endoscopy. Because of patient demand and the financial considerations inherent in maintaining a clinical practice, the average practicing gastroenterologist however, may find that he has his plate full of endoscopic procedures, particularly screening colonoscopy to the possible detriment of teaching, research and perhaps other aspects of clinical care (Ganz, 2004).

The development that irreversibly altered the field of gastroenterology forever, by allowing the widespread use of endoscopes to peer into gastrointestinal orifices (and later, body cavities), occurred in the 1950s and 1960s when Drs. Basil Hirschowitz. William Wolff, Hiromi Shinya, Bergein Overholt and others used the principles of fiberoptics to develop and apply to gastroenterology the 'fiberscope' (Modlin, 2000, Wolf, 1989). Fiberoptic colonoscopes arrived on the scene in the 1970's (Achord, 2005). At first, the procedure was thought to be technically difficult in a way similar to the simultaneously developed biliary and pancreatic procedure endoscopic retrograde cholangiopancreatography (ERCP). Due to a lack of complete understanding of the intraluminal colonic anatomy, early attempts at using colonoscopy often required the aid of fluoroscopy. Because of this, the widespread acceptance of colonoscopy as a diagnostic and later therapeutic procedure was delayed despite the introduction of colonoscopic polypectomy (Dr. Hiromi Shinya in New York City using a home-made wire threaded through a thin plastic catheter with an assistant hand-holding the connection between the active cord of an electrosurgical unit and a hemostat clamped on the wire after the polyp was ensnared) and the demonstration of superior diagnostic results for colonoscopy when compared to barium enema studies and rigid sigmoidoscopy (Wolff & Shinya, 1971). Developments in colonoscopy have continued at a rapid pace with one major one occurring in 1983 when Welch Allyn® Inc. inserted

an image sensor or charge-coupled device into the distal tip of an endoscope (Sivak & Fleischer, 1984). Light was still transmitted down the endoscope through a fiberoptic bundle but the light falling on the charge-coupled device is converted into an array of electrical charges that are reconstructed on a video monitor. As electronic solid-state sensors had only previously been able to produce black and white images, modifications were required to reproduce the image in color. This was achieved by two techniques: either the rapid sequential use of the primary colors, red, green and blue, at the light source or by the use of color-chip imaging where the solid-state sensor has colored microfilters fixed to its surface. By the 1990's, videocolonoscopy, through developments at Olympus®, Pentax® and Fujinon®, had largely replaced fiberoptic colonoscopy with the video image projected onto monitors and thus facilitating teaching and allowing the findings to be shared "live" with endoscopy staff and other physicians. It was not long before the findings of the procedure were able to be "captured" by video recording devices and entered into the electronic health record. From an international perspective the development of gastrointestinal endoscopy over the last four decades in Malaysia has recently been chronicled (Goh, 2011).

As we will see, the future of (particularly therapeutic) colonoscopy seems assured, with new developments on the horizon.

3. Credentialing of colonoscopists

The provision of high-quality colonoscopy by well trained colonoscopists should be the goal of any institution whether it be an academic university medical center, hospital, ambulatory endoscopy center, physician's office, subspecialty society, government regulatory agency, or health insurance provider (ASGE, 1998, Parry & Williams, 1991, Marshall, 1995, Chak et al., 1996, ASGE, 1999, Wexner et al., 2001). Issues include uniformity of standards, training and determination of competence, the learning of new procedures, monitoring of colonoscopic performance and the need for continuing education (Cohen, 2011). This area has come under increased scrutiny in both training programs (Sedlack, 2010) and for application and re-application for hospital colonoscopy privileges (Wexner et al., 2002, Obstein et al., 2011). Polypectomy rate has been proposed as a useful quality measure with a high degree of correlation with the rate of detection of colorectal adenomas (Williams et al., 2011). Gastrointestinal procedure oriented meetings and sponsored courses (American Society of Gastrointestinal Endoscopy meeting held during the annual Digestive Disease Week and the annual course held in New York City sponsored by the New York Society for Gastrointestinal Endoscopy to name two of many available in the United States) are well attended and produce enduring materials that are circulated well beyond the population of the course attendees. Advanced DVD and Internet courses are becoming increasingly popular among those performing colonoscopies.

4. Indications for colonoscopy

Colonoscopy has made gains in popularity as a medical diagnostic procedure. It has been popularized by the publication of a patient-oriented paperback guide book,

Colonoscopy for Dummies, (Dobie & Burke, 2011) and in a television media public service announcement campaign to make people aware of the importance of screening for colorectal cancer in the United States, launched by the Columbia Broadcasting System's CBS Cares® Program (http://www.cbs.com/cbs cares/topics/?sec=colorectal cancer, http://www.cbs.com/cbs cares/video/?cid=822059380)). A colonoscopy has even become the prize of a popular sweepstakes (http://promotions.mardenkane.com /cbs/cbscares/rules.cfm). Nevertheless, it is prudent to keep in mind the proven utility of the procedure.

Colonoscopy is most useful in diagnosing and treating patients with neoplasms, strictures or colonic mucosal disease previously diagnosed on radiological imaging. Other uses include the evaluation of patients with gastrointestinal hemorrhage (hematochezia and occult bleeding) (Davila et al., 2005, Miskovitz & Steinberg, 1982, Miskovitz et al., 1987, Khalid et al., 2011, Kistler et al., 2011), unexplained iron deficiency anemia (Goddard et al., 2011), screening and surveillance for colonic neoplasms (Davila et al., 2006, Denberg et al., 2005, Wilschut et al., 2011, Lasser et al., 2011)), diagnosis and surveillance of inflammatory bowel disease (Leighton et al., 2006, Basseri et al., 2011), evaluation of chronic diarrhea (with or without stool microbiology sampling, intubation of the terminal ileum for Crohn's disease and multiple mucosal biopsies to diagnose microscopic colitis) (Eisen et al., 2001, Miskovitz & Rochwarger, 1993, Jaskiewicz et al., 2006, Misra et al., 2010), constipation (Qureshi et al., 2005), foreign body removal (Safioleas et al., 2009), decompression of megacolon and sigmoid volvulus (Eisen et al., 2002), and the treatment of anorectal disorders (Eisen et al., 2001). "Open access colonoscopy", a program designed to make colorectal cancer screening more convenient and available has been the subject of some debate (Rex, 2010-2011, Feld, 2010-2011). In this situation, patients without significant gastrointestinal symptoms have a screening colonoscopy without the inconvenience or cost of a preliminary office visit. Its purpose is to provide colonoscopy for screening purposes to a wider audience with less waiting time.

World-wide, colorectal cancer is the third most commonly diagnosed cancer in males and the second in females, with more than 1.2 million new cases and more than 600,000 deaths estimated to have occurred from colorectal cancer in 2008 (Jemal et al., 2011). Despite more than three decades of experience with using colonoscopy for colorectal cancer screening controversies about the procedure do exist (Smith, 2011a, Helwick, 2011a, Helwick, 2011b, Smith, 2011b). The field of colorectal cancer screening and prevention in women has recently been reviewed (Krishnan & Wolf, 2011) as has the overuse of screening colonoscopy in the Medicare (federal government subsidized health insurance for older people) population in the United States (Goodwin et al., 2011). The upper age limit for colorectal cancer screening by colonoscopy has recently drawn attention (Habbema et al., 2011, Naravadi et al., 2011). Recently proposed cascade colorectal screening guidelines from the World Gastroenterology Organization (Winawer et al., 2011) advocate that each country,

region or healthcare setting needs to determine whether colorectal cancer screening is a legitimate consideration based upon other healthcare priorities. This group endorses enhanced colorectal screening worldwide, especially in developing countries where the colorectal cancer incidence and mortality is rising.

As chapters in this book will illustrate, the indications for colonoscopy are expanding with advancements in technology.

5. Contraindications to and risks of colonoscopy

Contraindications to performing colonoscopy must take into account that this procedure represents a somewhat stressful physiological experience for the patient. Hypotension, cardiac dysrhythmias (including bradyarrhythmias from increased vagal stimulation), abdominal distention with compromise of diaphragmatic function, and oxygen desaturation, are a few among the many complications that may occur during the procedure. For this reason, patient selection for the procedure should take into account any bleeding diathesis the patient may have, the cardiovascular (recent myocardial infarction or recent evaluation of the patient's cardiac status) and pulmonary status of the patient along with concomitant conditions such as infection (contraindicated in acute diverticulitis), severe ulcerative, ischemic, infective or Crohn's colitis (contraindicated). It has become customary to use the American Society of Anesthesiologists 1963 derived and subsequently amended preoperative physical status classification system (ASA I→ASA VI) (American Society of Anesthesiologists http://www.asahq.org/clinical/physicalstatus.htm) in classifying patients undergoing the procedure. The clinician must also exercise judgment in deciding to convert a planned colonoscopy into a flexible fiberoptic sigmoidoscopy if findings in the rectosigmoid suggest that the planned procedure be terminated.

Colonoscopy is not without its risks (Miskovitz & Gibofsky, 1995). Perforation is perhaps the most dreaded, occurring more frequently in therapeutic colonoscopy than in diagnostic colonoscopy. Statistics from the last two decades of the last century reveal a perforation rate of approximately 1 in 2,500 procedures (Sieg et al., 2001) and a mortality rate of 1 in 15,000 procedures (Waye et al., 1996), deaths often being related to the management of perforations. Immediate laparoscopic surgery is the best treatment although there may be a role for conservative therapy with surgical observation, intravenous fluids and the use of antibiotics in select cases (Kavin et al., 1992). Hemorrhage, related to biopsy, polypectomy or balloon dilatation is another risk of the procedure occurring on up to 1.5% of cases (often with a delay up to four weeks). The risk of hemorrhage can be lessened by the sole use of coagulation current (as opposed to "cutting" current), slow transection of the polyp stalk, the submucosal injection of saline and or epinephrine at the polyp site, the use of endoscopically placed clips and loops, and the treatment of bleeding sites with biopolar electrocautery. A recent outpatient colonoscopy study proposes that the use of a 14-day time period for reporting would capture all perforations and the

majority (96%) of post-procedure hemorrhages that required hospital admission (Rabeneck et al., 2011).

As with many decisions in clinical medicine, the decision to perform colonoscopy on a patient is a balance between the risks and benefits of the procedure, made easier by a careful medical history, physical examination and a review of available laboratory data. These same factors are utilized in obtaining informed consent for the procedure from the patient and/or the patient's family.

6. Informed consent for colonoscopy

The concept of informed consent (and its corollary, informed refusal) for colonoscopy involves an assessment of the competence of the patient, disclosure of, in an understandable way, the information necessary to allow the patient to make an informed decision regarding the role of colonoscopy in his care, and the documentation of these proceedings in the medical record (Stunkel et al., 2010). It is an intrinsic part of the doctor-patient relationship and an ethical obligation on the part of the physician in the practice of medicine. In the United States, the doctrine of medical informed consent is often traced to a 1914 New York court decision centered about the observation that since most surgical operations involve some use of force, there must be consent. Because the nature of surgery is outside the experience of most patients, the consent must be granted only after the patient is properly informed. The most famous description of informed consent is a quote from Justice Benjamin Cardozo who, in 1914, stated that: "*Every human being of adult years and sound mind has a right to determine what shall be done with his own body; and a surgeon who performs an operation without his patient's consent commits an assault for which he is liable in damages*" (*Schloendorff v Society of New York Hospital*, 1914).

Without going into detail regarding the subsequent legal history of the development of the doctrine of informed consent and its applications, nor the legal consequences of not obtaining proper informed consent for colonoscopy, recent international reviews have concluded there is room for improvement in this area (Banic et al., 2008, Bai et al., 2007). Novel approaches to facilitating the obtaining of informed consent have even included the use of video presentations (Agre, 1994) and more recently by referring patients to peer-reviewed Internet educational websites for information about colonoscopy, preparation and procedure-associated risk prior to the patient's arrival in the unit. As colonoscopy is often performed under intravenous ("conscious") sedation, the issue of withdrawal of informed consent by a patient experiencing pain has recently drawn attention (Ward et al., 1999). Of interest is that patient recall post-procedure of having given informed consent for colonoscopy appears to be similar whether the consent is obtained immediately or several days before the procedure. (Elfant et al., 1995).

7. Bowel preparation for colonoscopy

Proper and safe patient bowel preparation for colonoscopy is essential (Beck, 2010). It is generally accepted that inadequate bowel preparation for colonoscopy can result in

missed lesions, cancelled procedures, increased procedural time, and a potential increase in complication rates. Bowel preparation itself may also be associated with complications (Korkis et al., 1992). An evidence based medicine summary of bowel preparations for colonoscopy has recently been published by the United States Department of Health and Human Services, Agency for Healthcare and Quality, National Guideline Clearinghouse and is accessible through the Internet (Wexner et al., 2006, http://asge.org/ PublicationsProductsIndex.aspx?id=352). Consideration is given to the elderly, those with documented or suspected underlying inflammatory bowel disease, those with diabetes mellitus, the pediatric population and the admittedly rare pregnant patient who requires colonoscopy. A new trend is to look at the timing of the bowel preparation with regard to its efficacy (Gurudu et al., 2010, Eun et al., 2011). Others have recommended a split-dose bowel preparation as effective and better accepted by patients in terms of tolerance (Huffman et al., 2010). Suffice to say that "one size does not fit all" in this matter.

8. Antibiotic prophylaxis for selected patients undergoing colonoscopy

The value of antibiotic prophylaxis for patients undergoing colonoscopy has been the subject of much debate. In the past, the rationale for antibiotic prophylaxis was to prevent patients with high-risk cardiac conditions from developing infective endocarditis and from those with prosthetic devices in place (vascular grafts, ventriculo-peritoneal shunts, prosthetic joints, etc.) from developing infected hardware. Recently, the practice of antibiotic prophylaxis for colonoscopy has substantially changed due in part to the low incidence of infective endocarditis following this procedure and the lack of evidence based medicine data supporting the benefit of antibiotic prophylaxis. It is also recognized that the widespread use of antibiotics can be associated with the development of resistant organisms, *Clostridium difficile* colitis, added expense, and the risk of drug toxicity. Recent guidelines for the use of antibiotic

Heart Association and the American Society for Gastrointestinal Endoscopy, respectively (Wilson et al., 2007, ASGE Standards of Practice Committee, 2008). Although the recommendation in these published guidelines are largely consistent with one another, they substantially differ from prior guidelines, the largest change being that both sets of guidelines no longer consider and gastrointestinal procedure high risk for bacterial endocarditis, thus lifting the recommended routine use of antibiotics for bacterial endocarditis including for those patients with high risk cardiac conditions such as prosthetic heart values and prior history of bacterial endocarditis). Although antibiotics are not recommended for patients receiving peritoneal dialysis who are undergoing colonoscopy with or without polypectomy, it may be reasonable to drain the peritoneum before performing the colonoscopy to minimize the risk of developing bacterial peritonitis.

9. Antithrombotic agents in patients undergoing colonoscopy

P4atients requiring colonoscopy with or without biopsy and/or polypectomy are often taking antithrombotic agents including anticoagulants such as warfarin, heparin, and

low molecular weight heparin, and antiplatelet agents such as aspirin, non-steroidal anti-inflammatory drugs, thienopyridines such as clopidrogel and ticlopidine, and glycoprotein IIb/IIIa receptor inhibitors. Indications for the use of these medications include atrial fibrillation, acute coronary syndrome, deep venous thrombosis hypercoagulable states and endoprotheses such as coronary artery stents. When bleeding does occur in patients taking these agents it is most commonly from the gastrointestinal tract (Choudari et al., 1994). Risk stratification for these patients can be relegated to two categories. Low risk procedures include diagnostic colonoscopy including mucosal biopsy (Sieg et al., 2001, Parra-Blanco et al., 2000)) and high-risk procedures include colonoscopy with polypectomy and the dilatation of colonic benign or malignant strictures (guidelines extrapolated in part from experience reported in the upper gastrointestinal endoscopy literature) (Singh et al., 2005, Solt et al., 2003, DiSario et al., 1994). A comprehensive review of the types of antithrombotic therapies, their implications for patients undergoing colonoscopy, and recommendations and a management algorithm for such patients using these agents has recently been published (ASGE Standards of Practice Committee, 2009). Newer anticoagulants, for which current guidelines regarding their being held for endoscopic procedures are lacking, are reaching the market at an increasing rate. These include danaparoid, a low molecular weight heparinoid consisting of a mixture of heparan sulfate, dermatan sulfate, and chondroitin sulfate (Danhof et al., 1992, Nurmohamed, et al., 1991) which was recently removed from the US market due to shortages; the direct thrombin inhibitors recombinant hirudin (lepirudin), argatroban, desirudin and bivalirudin (Greinacher & Warkentin, 2008, Clarke, et al., 1991, Warkentin, et al., 2008); the recently available orally active direct thrombin inhibitor dabigatran etexlate (Schulman, et al., 2009); and the factor XA inhibitors idraparinux, rivaroxaban, and apixaban (Turpie, 2008).

10. Sedation for colonoscopy

The use of sedation for colonoscopy is undergoing changes both in the United States and worldwide (Heuss et al., 2005, Aisenberg et al., 2005, Aisenberg & Cohen, 2006, Cohen et al., 2006). Driven in part by insurance reimbursement, the desire to improve efficiency in the procedure facility, the availability of anesthesiologists to sedate and properly monitor patients for endoscopic procedures and the development of new, short acting anesthetics, the days of either unsedated colonoscopy and/or endoscopist administered benzodiazepine and opioid cocktail may well be numbered (Luginbühl et al., 2009). This topic has been nicely reviewed in a recent Internet-based international study of endoscopic sedation practices (Benson et al., 2008). The authors conclude that although benzodiazepine with an opioid is used 56% of the time for colonoscopy sedation by the 84 endoscopists from 46 countries who participated in the study, propofol was use 18% of the time (as opposed to an unsedated colonoscopy rate of 10%). A comparison of sedation practices worldwide showed that sedation is used for most colonoscopies and sedation practices did not differ significantly between developing and developed countries. Computer-assisted personalized sedation holds

the promise of delivering safe and effective minimal to moderate propofol sedation to ASA class I and II patients undergoing colonoscopy with the medication provided by health care professionals who are not anesthesiologists (ASGE Technology Committee, 2011, Pambianco, et al., 2011). The effect that the untimely death of superstar Michael Jackson due to an off-label use of propofol by a non-anesthesiologist has had and will continue to have on the acceptance of the use of propofol outside of the operating room (and by those other than credentialed anesthesiologists) by insurance companies and regulatory agencies has been recently addressed (http://blogs.wsj.com/health/2009/08/06/ the-other-propofol-issue-when-insurance-should-pay-for-it/, http://thehappyhospitalist.blogspot.com/2009_08_01_archive.html, Coté, 2011)). As a counterpoint, the need for conscious sedation in routine adult cases has recently been challenged (Khalid et al., 2011).

The means for sedation of pediatric patients undergoing colonoscopy has also received attention (Fredette & Lightdale, 2008). Two general types of sedation are available for children undergoing colonoscopy: general anesthesia which entails increased costs and the need for hospital resources and intravenous sedation runs the risk of agitation (Thakkar et al., 2007). Increasingly, propofol, which can be given alone or in combination with other sedatives, administered by a dedicated anesthesiologist, is being used (Elisur et al., 2000). Wider concerns exist about the long-term effects of the use of anesthetics in infants and children (Rappaport et al., 2011, Blum, 2011))

11. Patient monitoring during colonoscopy

It is difficult to talk about sedation for colonoscopy without considering issues regarding patient monitoring during colonoscopy. Since the first colonoscopies were performed in the hospital setting, it has long been recognized that patients ("consciously") sedated for colonoscopy required proper peri-procedure monitoring (Bell et al., 1991). The availability of resuscitation equipment, airway suctioning equipment, EKG cardiac monitoring, and parenterally administered medications (including sedative reversal agents) in the procedure and recovery areas, having staff who were properly credentialed in state-of-the-art resuscitation methods, the presence of a qualified registered nurse to monitor the patient during the procedure, the obtaining and documenting of a preoperative history and performance and documenting of a preoperative physical examination, adequately maintained intravenous access, the use of oxygen enriched air by nasal cannula or face mask monitored by pulse oximetry, and more recently capnography monitoring of respiratory depression (Cacho et al., 2010), and the recording of vital signs from the procedure and in the recovery room became commonplace and the norm. As colonoscopy moved to the outpatient setting including ambulatory endoscopy facilities and doctors' offices, and the duration of the procedure lengthened due to therapeutic maneuvers, these standards became more formalized, often involving input from the anesthesiology community (particularly in situations where moderate or deep sedation were employed) with debate and at times even controversy as to the best method of sedation patients (from minimal sedation or

anxiolysis through general anesthesia). Much of the impetus for this came from the simultaneously evolving practice of using anesthesiology services outside of the operating room such as in the emergency department, the intensive care unit, the bronchoscopy suite, doctors' and dentists' offices and the radiology suite.

Today, many feel that propofol is the agent of choice for sedation for colonoscopy (Luginbühl et al., 2009). The increasing demand for sedating and properly monitoring patients may not be met by anesthesiology departments because of staffing reductions, reimbursement issues which drive up health care costs, and challenges by health insurance companies (Aisenberg & Cohen, 2006). Currently, the use of propofol in this setting by non-anesthesiologists (gastroenterologist-directed propofol use) is controversial (Faigel et al., 2002), monitoring-intensive because of the level of sedation, and may violate the package insert for the use this drug in some locales. The answer to this dilemma in the future may be computer-assisted sedation systems that are currently under development and investigation (Hickle, 2001, Pambianco, 2008, Caruso et al., 2009, ASGE Technology Committee, 2011).

12. The electronic endoscopic record and colonoscopy

Electronic endoscopic medical record systems with report generating capabilities and patient flow management modules are increasingly becoming an integral part of the daily operation of many office, hospital and ambulatory endoscopy center endoscopy units (Savides et al., 2004, Petersen, 2006). Using pull-down template menus designed for standardization, data retrieval, and coding for billing purposes, rather than "old-fashioned" free-text entry, the costs for such programs vary significantly between vendors and may range between $5,000 and $45,000 (US) per room for software implementation with an additional requirement for an annual maintenance contract and telephone support. Besides providing a standardized procedure report these systems provide for ease of information retrieval particularly when generating endoscopy unit statistics and maintaining research-related databases (Groenen et al., 2006, Faigel et al., 2006). They are also of value in providing a means for patient recall to improve adherence to follow up recommendations after colonoscopic examinations (Leffler et al., 2011). Issues confronting the colonoscopist contemplating the implementation of such systems include the multitude of competing systems available to choose from (some of which are Internet based and others of which require a Virtual Private Network to access) and the necessity to integrate these systems with pre-existing electronic health records already in place in doctors' offices and hospitals. Although features of these systems may improve patient care and enhance endoscopy unit efficiency and productivity, further studies to document this are necessary (ASGE Technology Committee, 2008).

13. The future of colonoscopy

"Perhaps the best thing about the future is that it comes one day at a time"-U.S. Secretary of State Dean Acheson (1893-971)

"Prediction is extremely difficult, especially about the future"—Danish physicist Niels Bohr (1885-1962)

"640 K should be enough for anybody"-CEO of Microsoft® Corporation Bill Gates, 1981

The future of colonoscopy has been the subject of much speculation (Sawhney, 2011, Marshall, 2011). Before reviewing the future of colonoscopy it would be prudent to review where we are today. Currently, colonoscopy is useful for diagnosis, polypectomy and biopsy, hemostasis, endoscopic mucosa resection, endoscopic submucosal dissection, decompression of the colon, treatment of radiation proctitis, stenting for malignancy, stenting for benign strictures, the occasional treatment of hemorrhoids and rarely cecostomy placement. Sometimes advances in colonoscopy technique are subtle in nature such as the increasingly accepted use of carbon dioxide over air for colonic insufflation (Church & Delaney, 2002, Uraoka et al., 2009, Yamano et al., 2010). Other advances are more profound. Future developments in colonoscopy will likely center about five areas: new methods of imaging, new colonoscopes, new colonoscopy assisting devices, new therapeutic tools, and new territories to explore.

New imaging techniques to enhance our vision are already upon us and undergoing refinement. Chromoscopy providing morphological enhancement (Brown & Baraza, 2010, Kahi et al., 2010, Pohl et al., 2011), magnifying endoscopy (Filip et al., 2011), high definition endoscopy (Singh et al., 2010, Buchner et al., 2010), confocal laser endomicroscopy (Gheona et al., 2011), endocytoscopy (Singh et al., 2010), narrow band imaging with enhancement of mucosal fine structure and vasculature (Cash, 2010, Van den Broek et al., 2011, Chiu et al., 2011, Oka et al., 2011, Wada et al., 2011), multiband imaging (Fedeli et al., 2011), computed virtual chromoendoscopy (Chung et al., 2010), optical coherence tomography (Roy et al., 2009, Adler et al., 2009, Consolo et al., 2008), spectroscopy and fluorescence (Ortner et al., 2010), autofluorescence imaging (ASGE Technology Committee, 2011a) and molecular endoscopy (Buchner et al., 2010) are but some of the new imaging techniques being unfurled. Using these techniques the colonoscopist is deepening the depths of colonic mucosal interrogation to the level of the submucosa with image resolution approaching that of conventional pathology in essence becoming an *in vivo* pathologist! This is not unlike our current use of visualization over histology for diagnosing duodenal ulceration, gastrointestinal stromal neoplasms, lipomas and pancreatic rests.

New colonoscopes are under development (Rösch et al., 2007) including the Aer-O-Scope™ which is a pneumatic, skill-independent, self-propelling, self-navigating colonoscope providing an omni-directional view through a conic lens and mirror system (Pfeffer et al., 2006). The Third Eye® Retroscope® (Waye, 2010, Rex, 2009, Leufkens et al., 2010) provides a continuous retrograde (backward) view side-by-side with the usual forward view of the colonoscope. This is particularly useful in locating polyps hidden behind folds. A novel computer-assisted colonoscope (NeoGuide Endoscopy System) (Eickhoff et al., 2007) delivers a real-time, three-dimensional map

of the tip position and insertion tube shape in addition to the video image of the colon lumen. Three-dimensional map images generated by the NeoGuide endoscopy system provide accurate information regarding tip position, insertion tube position, and colonic looping. The Invendoscope™ SC20 (http://www.invendo-medical.com/index eng.html, Rösch et al., 2008) has several features that are new to the field of colonoscopy. It is a single-use colonoscope with a working channel that is not pushed or pulled, but driven in and out of the colon. All endoscopic functions are performed using a handheld device and most importantly, it reduces potential forces on the colon wall to enable a gentle colonoscopy lessening the need for patient sedation. A recent study reports that for patients with a previously incomplete conventional optical colonoscopy, balloon colonoscopy performed by using the single-balloon enteroscope with an overtube was superior to a repeat attempt with a standard colonoscope in completing the examination (Keswani, 2011).

It is likely that current videocolonoscopes with only minor modifications will be widely used for the next 5-10 years with the ideal colonoscope of the future being a multi-modal instrument capable of switching from white light colonoscopy to magnification colonoscopy, multiband imaging and even endoscopic ultrasound. It is also quite likely that patient preference for capsule colonoscopy over conventional colonoscopy will drive the development of this modality (Sacher-Huvelin et al., 2010, Kuramoto et al., 2011).

One of the therapeutic tools that will undergo increased availability and usage in the future is stenting. This area, shared by both colonoscopists and interventional radiologists (Katsanos et al., 2010, Bonin & Baron, 2010), uses a minimally invasive procedure for palliation of inoperable malignant disease and for temporary bowel decompression, often as a bridge to surgery. Recent technological advances have been supported by an increasing number of publications detailing clinical experience with these devices (Farrell, 2007, Farrell & Sack, 2008).

Another therapeutic tool that will undergo refinements and increased availability is endoscopic mucosal resection, the technique of injecting fluid (saline or hydroxypropylmethylcellulose [HPMC]) into the submucosal space to create a submucosal cushion followed by resection of the lesion (De Melo et al., 2011, Moss et al., 2011). Wider acceptance of this technique will parallel outcomes research data and complications rates. Colonoscopic closure of colonic perforation with band ligation after enoclip failure (not for the faint at heart) has recently been reported (Han et al, 2011)!

Despite the lack of Medicare (government subsidized insurance for the elderly in the United States) coverage for the procedure and questions about its sensitivity and specificity, the use of CT colonography for colorectal cancer screening in United States hospitals appears to be on the rise, particularly in medical facilities that do not offer optical colonoscopy and may not be prepared to provide adequate follow up for

patients with failed CT colonography (McHugh et al., 2011). This trend, if sustained, will undoubtedly impact upon the future of conventional colonoscopy.

The use dogs for colorectal cancer screening not withstanding (Sonoda et al., 2011), along with avoiding performing the procedure late in the day (Lee et al., 2011), although others would argue that time-dependent factors such as colonoscopist fatigue and decreased colon cleanliness can be addressed (Freedman et al., 2011), the future of colonoscopy seems secure and bright.

14. References

Achord, J.L. (2005) The history of gastrointestinal endoscopy, In: *Clinical Gastrointestinal Endoscopy*, Ginsberg, G.G., Kochman, M.L., Norton, I., Gostout, C.J., (Eds.), pp. 3-12, Elsevier Inc. ISBN 10: 0-7216-0282-7, London

Adler, D.C., Zhou, C., Tsai, T.H. Schmitt, J., Huang, Q., Mahimo, H., Fujimoto, J.G. (2009) Three-dimensional endomicroscopy of the human colon using optical coherence tomography. *Opt Express.* Vol.17, No.2, (January 2009) pp. 784-96. ISSN 1094-4087

Agre, P., Kurtz, R.C., Krauss, B.J., (1994) A randomized trial using videotape to present consent information for colonoscopy. *Gastrointest Endosc.* Vol.40, No.3, (May-June 1994) pp. 271-6. ISSN 0016-5107

Aisenberg, J., Brill, J.V., Ladabaum, U., Cohen, L.B. (2005) Sedation for gastrointestinal endoscopy: new practices, new economics. *Am J Gastroenterol.* Vol.100, No.5, (May 2005) pp. 996-1000. ISSN 0002-9270

Aisenberg, J., Cohen, L.B. (2006) Sedation in endoscopic practice. *Gastrointest Endosc Clin N Am.* Vol.16, No.4, (October 2006) pp. 695-708. ISSN 1052-5157

American Society of Anesthesiologists. "ASA Physical Status Classification System," Accessed 1/5/2011. Available from: http://www.asahq.org/clinical/physicalstatus.htm.

ASGE [No authors listed]. (1998) Guidelines for credentialing and granting privileges for gastrointestinal endoscopy. American Society for Gastrointestinal Endoscopy. *Gastrointest Endosc.* Vol.48, No.6, (December 1998) pp. 679-82. ISSN 0016-5107

ASGE [No authors listed]. (1999) Principles of training in gastrointestinal endoscopy. From the ASGE. American Society for Gastrointestinal Endoscopy. *Gastrointest Endosc*. Vol.49, No.6. (June 1999) pp. 845-53. ISSN 0016-5107

ASGE Standards of Practice Committee, Anderson, M.A., Ben-Menachem, T., Gan, S.I., Appalaneni, V., Banerjee, S., Cash, B.D., Fisher, L., Harrison, M.E., Fanelli, R.D., Fukami, N., Ikenberry, S.O., Jain, R., Khan, K., Krinsky, M.L., Lichtenstein, D.R., Maple, J.T., Shen, B., Strohmeyer, L., Baron, T., Dominitz, J.A. (2009) Management of antithrombotic agents for endoscopoic procedures. *Gastrointest Endosc.* Vol.70, No.6, (December 2009) pp. 1060-70. ISSN 0016-5107

ASGE Standards of Practice Committee, Banerjee, S., Shen, B., Baron, T.H., Nelson, D.B., Anderson, M.A., Cash, B.D., Dominitz, J.A., Gan, S.I., Harrison, M.E., Ikenberry, S.O., Jagannath, S.B., Lichtenstein, D., Fanelli, R.D., Lee, K., van Guilder, T., Stewart, L.E. (2008) Antibiotic prophylaxis for GI endoscopy. *Gastrointest Endosc.* Vol.67, No.6, (May 2008) pp. 701-8. ISSN 0016-5107

ASGE Technology Committee, Banerjee, S., Desilets, D., Diehl, D.L., Farraye, F.A., Kaul, V., Kethu, S.R., Kwon, R.S., Mamula, P., Pedrosa, M.C., Rodriguez, S.A., Wong Kee Song, L.M., Tierney, W.M. (2011) Computer-assisted personalized sedation. *Gastrointest Endosc.* Vol.73, No.3, (March 2011) pp. 423-427. ISSN 0016-5107

ASGE Technology Committee, Wong Kee Song, L.M., Banerjee, S., Desilets, D., Diehl, D.L., Farraye, F.A., Kaul, V., Kethu, S.R., Kwon, R.S., Mamula, P., Pedrosa, M.C., Rodriguez, S.A., Tierney, W.M. (2011a) Autofluorescence imaging. *Gastrointest Endosc.* Vol.73, No.4, (April 2011) pp. 647-50. ISSN 0016-5107

ASGE Technology Committee, Conway, J.D., Adler, D.G., Diehl, D.L., Farraye, F.A., Kantsevoy, S.V., Kwon, R., Mamula, P., Rodriguez, B. Shah, R.J. Song, L.M., Tierney, W.M. (2008) Endoscopic electronic medical records systems. *Gastrointest Endosc.* Vol.67, No.4, (April 2008) pp. 590-4. ISSN 0016-5107

Bai, Y., Gao, j., Yang, Y., Long, F., Jin, H., Li, C., Zou, D.W., Li, Z.S. (2007) A multicenter prospective survey on informed consent for gastrointestinal endoscopy in China. *Digestion.* Vol.76, No.3-4, (December 2007) pp. 203-6. ISSN 0012-2823

Banic, M., Kardum, D., Plesko, S., Petrovecki, M., Urek, M., Babic, Z., Kujundzic, M., Rotkvic, I. (2008) Informed consent for gastrointestinal endoscopy: a view of endoscopists in Croatia. *Dig Dis.* Vol.26, No.1, (February 2008) pp. 66-70. ISSN 0257-2753

Basseri, R.J., Basseri, B., Papadakis, K.A. (2011) Dysplasia and cancer in inflammatory bowel disease. *Expert Rev Gastroenterol Hepatol.* Vol.5, No.1, (February 2011) pp. 59-66. ISSN 1747-4124

Beck, D.E. (2010) Bowel preparation for colonoscopy. *Clin Colon Rectal Surg.* Vol.23, Vol.1, (February 2010) pp. 10-3. ISSN 1531-0043

Bell, G.D., McCloy, R.F., Charlton, J.E., Campbell, D., Dent, N.A., Gear, M.W., Logan, R.F., Swan, C.H. (1991) Recommendations for standards of sedation and patient monitoring during gastrointestinal endoscopy. *Gut.* Vol.32, No.7, (July 1991) pp. 823-7. ISSN 0017-5749

Benson, A.A., Cohen, L.B., Waye, J.D., Akhavan, A., Aisenberg, J. (2008) Endoscopic sedation in developing and developed countries. *Gut Liver.* Vol.2, No.2, (September 2008) pp. 105-12. ISSN 1976-2283

Blum, K. (2011) More data, but few answers for anesthesia safety in peds. *Anesthesiol News.* Vol.37, No.4, (April 2011) pp. 1, 26-8. ISSN 0747-4679

Bonin, E.A., Baron, T.H. (2010) Update on the indications and use of colonic stents. *Curr Gastroenterol Rep.* Vol.12, No.5, (October 2010) pp. 374-82. ISSN 1522-8037

Brown, S.R., Baraza, W. (2010) Chromoscopy versus conventional endoscopy for the detection of polyps in the colon and rectum. *Cochrane Database of Systematic Reviews.* Vol.6, No.10, (October 2010) pp. 1-30. ISSN 1469-493X

Buchner, A.M., Shahid, M.W, Heckman, M.G. Krishna, M., Ghabril, M., Hasan, M., Crook, J.E., Gomez, V., Raimondo, M., Woodward, T., Wolfsen, H.C., Wallace, M.B. (2010) Comparison of probe-based confocal laser endomicroscopy with virtual chromoendoscopy for classification of colon polyps. *Gastroenterology.* Vol.138, No.3, (March 2010) pp. 834-42. ISSN 0016-5085

Buchner, A.M., Shahid, M.W., Heckman, M.G., McNeil, R.B., Cleveland, P., Gill, K.R., Schore, A., Ghabril, M., Raimondo, M., Gross, S.A., Wallace, M.B. (2010) High-definition colonoscopy detects colorectal polyps at a higher rate than standard white-light colonoscopy. *Clin Gastroenterol Hepatol.* Vol.8, No.4, (April 2010) pp. 364-70. ISSN 1542-3565

Cacho, G., Pérez-Calle, J.L., Barbado, A., Lledó, J.L., Ojea, R. Fernández-Rodríguez, C.M. (2010) Capnography is superior to pulse oximetry for the detection of respiratory depression during colonoscopy. *Rev Esp Enferm Dig.* Vol.102, No.2, (February 2010) pp. 86-9. ISSN 1130-0108

Caruso, A., Bouillon, T.W., Schumacher, P.M., Zanderigo, E., Morari, M. (2009) Control of drug administration during monitored anesthesia care. *IEEE Tran Automation Sci Eng.* Vol.6, No.2, (April 2009) pp. 256-64. ISSN 1545-5955

Cash, B.D. (2010) Narrow-band imaging for colorectal polyps: it can be taught but will it be used? *Gastrointest Endosc.* Vol.72, No.3, (September 2010) pp. 577-9. ISSN 0016-5107

Chak, A.M., Cooper, G.S., Blades, E.W., Canto, M., Sivak, M.V. Jr. (1996) Prospective assessment of colonoscopic intubation skills in trainees. *Gastrointest Endosc.* Vol.44, No.1, (July 1996) pp. 54-7. ISSN 0016-5107

Chiu, H-M., Wang, H-P., Wu M-S., Lin, J-T. (2011) The clinical efficacy and future perspective of narrow band imaging for the diagnosis of colorectal neoplasm. *Dig Endosc.* Vol.23, Suppl.1, (May 2011) pp. 116-9. ISSN 1443-1661

Choudari, C.P., Rajgopal, C., Palmer, K.R. (1994) Acute gastrointestinal haemorrhage in anticoagulated patients: diagnoses and response to endoscopic treatment. *Gut.* Vol.35, No.4, (April 1994) pp. 464-6. ISSN 0017-5749

Chung, S.J., Kim, D., Song, J.H., Park, M.J., Kim, Y.S., Jung, H.C., Song, I.S. (2010) Efficacy of computed virtual chromoendoscopy on colorectal cancer screening: a prospective, randomized, back-to-back trial of Fuji Intelligent Color Enhancement versus conventional colonoscopy to compare adenoma miss rates. *Gastrointest Endosc.* Vol.72, No.1, (July 2010) pp. 136-42. ISSN 0016-5107

Church, J., Delaney, C. (2002) Randomized, controlled trial of carbon dioxide insufflation during colonoscopy. (2002) *Dis Colon Rectum*. Vo.46, No.3, (March 2003) pp. 322-6. ISSN 0012-3706

Clarke, R.J., Mayo, G., FitzGerald, G.A., Fitzgerald, D.J. (1991) Combined administration of aspirin and a specific thrombin inhibitor in man. *Circulation*. Vol.83, No.5. (May 1991) pp. 1510-8. ISSN 0009-7322

Cohen, J. (Editor) (2011) *Successful Training in Gastrointestinal Endoscopy.* pp. 1-416. Wiley-Blackwell, ISBN-10 978-1405196635, Hoboken, New Jersey

Cohen, L.B., Wecsler, J.S., Gaetano, J.N., Benson, A.A., Miller, K.M., Durkalski, V., Aisenberg, J. (2006) Endoscopic sedation in the United States: results from a nationwide survey. *Am J. Gastroenterol.* Vol.101, No.5, (May 2006) pp. 967-74. ISSN 0002-9270

Consolo, P., Strangio, G., Luigiano, C., Giacobbe, G., Pallio, S., Familiari, L. (2008) Optical coherence tomography in inflammatory bowel disease: prospective evaluation of 35 patients. *Dis Colon Rectum.* Vol.51, No.9, (September 2008) pp. 1374-80. ISSN 0012-3706

Coté, G.A. (2011) The debate for nonanesthesiologist-administered propofol sedation in endoscopy rages on: who will be the "King of Prop?" *Gastrointest Endosc.* Vol.73, No.4, (April 2011) pp. 773-6. ISSN 0016-5107

Danhof, M., de Boer, A., Magnani, H.N., Stiekema, J.C. (1992) Pharmacokinetic considerations on Orgaran (Org 10172) therapy. *Haemostasis* Vol.22, No.2, (February 1992) pp. 73-84. ISSN 0340-5338

Davila, R.E., Rajan, E., Adler, D.G., Egan, J., Hirota, W.K., Leighton, J.A., Qureshi, W., Zuckerman, M.J., Fanelli, R., Wheeler-Harbaugh, J., Baron, T.H., Faigel, D.O., Standards of Practice Committee. (2005) ASGE Guideline: the role of endoscopy in the patient with lower-GI bleeding. *Gastrointest Endosc.* Vol.62, No.5, (November 2005) pp. 656-60. ISSN 0016-5107

Davila, R.E., Rajan, E., Baron, T.H., Adler, D.G., Egan, J.V., Faigel, D.O., Gan, S.I., Hirota, W.K., Leighton, J.A., Lichtenstein, D., Qureshi, W.A., Shen, B., Zuckerman, M.J., VanGuilder, T., Fanelli, R.D.; Standards of Practice Committee, American Society of Gastrointestinal Endoscopy. (2006) ASGE guideline: colorectal cancer screening and surveillance. *Gastrointest Endosc.* Vol.63, No.4, (April 2006) pp. 546-57. ISSN 0016-5107

De Melo, S.W., Cleveland, P., Raimondo, M., Wallace, M.B., Woodward, T. (2011) Endoscopic mucosal resection with the grasp-and-snare technique through a double-channel endoscope in humans. *Gastrointest Endosc.* Vol.73, No.2, (February 2011) pp. 349-52. ISSN 0016-5107

Denberg, T.D., Melhado, T.V., Coombes, J.M., Beaty, B.L., Berman, K., Byers, T.E., Marcus, A.C., Steiner, J.F., Ahnen, D.J. (2005) Predictors of nonadherence to screening colonoscopy. *J Gen Intern Med.* Vol.20, No.11, (November 2005) pp. 989-95. ISSN 0884-8734

DiSario, J.A., Fennerty, M.B., Tietze, C.C., Hutson, W.R., Burt, R.W. (1994) Endoscopic balloon dilation for ulcer-induced gastric outlet obstruction. *Am J Gastroenterol.* Vol.89, No.6, (June 1994) pp. 868-71. ISSN 0002-9270

Dobie, K.A., Burke, C. (2011) *Colonoscopy for Dummies.* pp. 1-64, Wiley Publishing Inc., ISBN 978-0-47061661-1, Hoboken, New Jersey

Eickhoff, A., van Dam, J., Jakobs, R., Kudis, V., Hartmann, D., Damian, U., Weickert, U., Schilling, D., Riemann, J.F. (2007) Computer-assisted colonoscopy (the NeoGuide Endoscopy System): results of the first human clinical trial ("PACE study"). *Am J Gastroenterol.* Vol.102, No.2, (February 2007) pp. 261-6. ISSN 0002-927

Eisen, G.M., Baron, T.H., Dominitz, J.A., Faigel, D.O., Goldstein, J.L., Johanson, J.F., Mallery, J.S., Raddawi, H.M., Vargo, J.J., Waring, J.P., Fanelli, R.D., Wheeler-Harbaugh, J. (2002) Acute colonic pseudo-obstruction. *Gastrointest Endosc.* Vol.56, No.6, (December 2002) pp. 789-92. ISSN 0016-5107

Eisen, G.M., Dominitz, J.A., Faigel, D.O., Goldstein, J.L., Kalloo, A.N., Petersen, J.L., Raddawi, H.M., Ryan, M.E., Vargo, J.J. 3rd, Young, H.S., Fanelli, R.D., Hyman, N.H., Wheeler-Harbaugh, J., American Society for Gastrointestinal Endoscopy Standards of Practice Committee. (2001) Endoscopic therapy of anorectal disorders. *Gastrointest Endosc.* Vol.53, No.7, (June 2001) pp. 867-70. ISSN 0016-5107

Eisen, G.M., Dominitz, J.A., Faigel, D.O., Goldstein, J.A., Kalloo, A.N., Petersen, B.T., Raddawi, H.M., Ryan, M.E., Vargo, J.J. 3rd, Young, H.S., Fanelli, R.D., Hyman, N.H., Wheeler-Harbaugh, J.; American Society for Gastrointestinal Endoscopy. (2001) Use of endoscopy in diarrheal illnesses. *Gastrointest Endosc.* Vol.54, No.6, (December 2001) pp. 821-3. ISSN 0016-5107

Elfant, A.B., Korn, C., Mendez, L., Pello, M.J., Peikin, S.R. (1995) Recall of informed consent after endoscopic procedures. *Dis Colon Rectum.* Vol.38, No.1. (January 1995) pp. 1-3. ISSN0012-3706

Elitsur, Y., Blankenship, P., Lawrence, Z. (2000) Propofol sedation for endoscopic procedures in children. *Endoscopy.* Vol.32, No.10. (October 2000) pp. 788-91. ISSN 0013-726X

Eun, C.S., Han, D.S., Hyun, Y.S., Bae, J.H., Park, H.S., Kim, T.Y., Jeon, Y.C., Sohn, J.H. (2011) The timing of bowel preparation is more important than the timing of colonoscopy in determining the quality of bowel cleansing. *Dig Dis Sci.* Vol.56, No.2, (February 2011) pp. 539-44. ISSN 0163-2116

Faigel, D.O., Baron, T.H., Goldstein, J.L., Hirota, W.K., Jacobson, B.C., Johanson, J.F., Leighton, J.A., Mallery, J.S., Peterson, K.A., Waring, J.P., Fanelli, R.D., Wheeler-Harbaugh, J; Standards Practice Committee, American Society for Gastrointestinal Endoscopy. (2002) Guidelines for the use of deep sedation and anesthesia for GI endoscopy. *Gastrointest Endosc.* Vol.56, No.5. (November 2002) pp. 613-7. ISSN 0016-5107

Faigel, D.O., Pike, I.M., Baron, T.H., Chak, A., Coen, J. Deal, S.E., Hoffman, B., Jacobson, B.C., Mergener, K., Petersen, B.T., Petrini, J.L., Rex, D.K., Safdi, M.A; ASGE/ACG Taskforce on Quality in Endoscopy. (2006) *Am J Gastroenterol.* Vol.101, No.4, (April 2006) pp. 866-72. ISSN 0002-9270

Farrell, J.J. (2007) Preoperative colonic stenting: how, when and why? *Curr Opin Gastreoenterol.* Vol.23, No.5, (September 2007) pp. 544-9. ISSN 0267-1379

Farrell, J.J., Sack, J. (2008) Removable colonic stenting: time to expand the indications? *Gastrointest Endosc.* Vol.68, No.4, (October 2008) pp. 721-3. ISSN 0016-5107

Fedeli, P., Gasbarrini, A., Cammarota, G. (2011) Spectral endoscopic imaging: the multiband system for enhancing the endoscopic surface visualization. *J Clin Gastroenterol.* Vol.45, No.1, (January 2011) pp. 6-15. ISSN 0192-0790

Feld, A.D. (12/2010-1/2011) Open access. Risky business. *AGA Perspectives.* Vol.6, No.6, (December 2010-January 2011) pp. 5,7. ISSN 1554-3366

Filip, M., Iordache, S., Săftoiu, A., Ciurea, T. (2011) Autofluorescence imaging and magnification endoscopy. *World J Gastroenterol.* Vol.17, No.1, (January 2011) pp. 9-14. ISSN 1007-9327

Fredette, M.E., Lightdale, J.R. (2008) Endoscopic sedation in pediatric practice. *Gastrointest Endosc Clin N Am.* Vol.18, No.4, (October 2008) pp. 739-51. ISSN 1052-5157

Freedman, J.S., Harari, D.Y., Bamji, N.D., Bodian, C.A., Kornacki, S., Cohen, L.B., Miller, K.M., Aisenberg, J. (2011) The detection of premalignant colon polyps during colonoscopy is stable throughout the workday. *Gastrointest Endosc.* Vol.73, No.6, (June 2011) pp.1197-206. ISSN 0016-5107

Ganz, R.A. (2004) The development and the implementation of new endoscopic technology: what are the challenges? *Gastrointest Endosc.* Vol.60, No.4, (October 2004) pp. 592-8, ISSN 0016-5107

Gheonea, D.I., Cârţână, T., Ciurea, T., Popescu, C., Bădăräu, A., Săftoui, A. (2011) Confocal laser endomicroscopy and immunoendoscopy for real-time assessment of vascularization in gastrointestinal malignancies. *World J Gastroenterol.* Vol.17, No.1, (January 2011) pp. 21-7. ISSN1007-9327

Goddard, A.F., James, M.W., McIntyre, A.S., Scott, B.B., on behalf of the British Society of Gastroenterology. (2011) *Gut.* (May 2011) [Epub ahead of print] pp. 1-8. ISSN 1468-3288

Goh, K-L. (2011) Development of gastrointestinal endoscopy in Malaysia: A historical perspective with special reference to the experience at the University of Malaya Medical Centre. *Dig Endosc.* Vol.23, Suppl.1, (May 2011) pp. 150-3. ISSN 1443-1661

Goodwin, J.S., Singh, A., Reddy, N., Riall, T.S., Kuo, Y.F. (2011) Overuse of screening colonoscopy in the Medicare population. *Arch Intern Med.* (May 2011) [Epub ahead of print] pp. E1-9. ISSN 0003-9926

Greinacher, A., Warkentin, E. (2008) The direct thrombin inhibitor hirudin. *Thromb Haemost.* Vol.99, No.5, (May 2008) pp. 819-29. ISSN 0340-6245

Groenen, M.J., Kuipers, E.J., van Berge Henegouwen, G.P., Fockens, P., Ouwendijk, R.J. (2006) Computerisation of endoscopy reports using standard reports and text blocks. *Neth J Med.* Vol.64, No.3, (March 2006) pp. 78-83. ISSN 0300-2977

Gurudu, S.R., Ratuapli, S., Heigh, R., DiBaise, J., Leighton, J., Crowell, M. (2010) Quality of bowel cleansing for afternoon colonoscopy is influenced by time of administration. *Am J Gastroenterol.* Vol.105, No.11, (November 2010) pp. 2318-22. ISSN 0002-9270

Habbema, J., Moore, E.A., Zauber, A.G. (2011) Until what age is colonoscopy indicated in elderly people without prior screening (abstract)? *Gastroenterology.* Vol.140, No.5, Supplement 1, (May 2011) pp. S-16. ISSN 0016-5085

Han, J-H., Park, S., Youn, S. (2011) Endoscopic closure of colon perforation with band ligation; Salvage technique after endoclip failure. *Clin Gastroenterol Hepatol.* Vol.9, No.6, (June 2011) pp. e54-5. (Available online at www.cghjournal.org.) ISSN 1542-3565

Helwick, C. (2011a) "Clouds" still hover over colonoscopy. *Gastroenterol Endosc News.* Vol.62, No.3, (March 2011) pp. 6-7. ISSN 0162-6566

Helwick, C. (2011b) Colorectal cancer screening: United States vs. Europe. *Gastroenterol Endosc News.* Vol.62, No.3, (March 2011) pp. 9-10. ISSN 0162-6566

Heuss, L.T., Froehlich, F., Beglinger, C. (2005) Changing patterns of sedation and monitoring during endoscopy: results of a nationwide survey in Switzerland. *Endoscopy.* Vol.37, No.2, (February 2005) pp. 161-6. ISSN 013726X

Hickle RS. (2001) Apparatus and method for providing a conscious patient relief from pain and anxiety associated with medical or surgical procedures. US Patent Application 2001: 20020017296.

http://blogs.wsj.com/health/2009/08/06/the-other-propofol-issue-when-insurance-should-pay-for-it/ (The other propofol issue: when insurance should pay for it-Accessed 4/17/2011)

http://promotions.mardenkane.com/cbs/cbscares/rules.cfm (Accessed 1/10/2011)

http://thehappyhospitalist.blogspot.com/2009_08_01_archive.html (Propofol during colonoscopy anesthesia by gastroenterologists and general practitioners-Accessed 4/17/2011)

http://www.asge.org/PublicationsProductsIndex.aspx?id=352 (Accessed 1/11/2011

http://www.cbs.com/cbs cares/topics/?sec=colorectal cancer (Accessed 1/15/2011)

http://www.cbs.com/cbs cares/video/?cid=822059380 (Accessed 1/15/2011)

http://www.invendo-medical.com/index_eng.html (Accessed 1/17/2011)

Huffman, M., Unger, R.Z., Thatikonda, C., Amstutz, S., Rex, D.K. (2010) Split-dose bowel preparation for colonoscopy and residual gastric fluid volume: an observational study. *Gastrointest Endosc.* Vol.72, No.3, (September 2010) pp. 516-22. ISSN 0016-5107

Jaskiewicz, K., Rzepko, R., Adrych, K., Smoczynski, M. (2006) Microscopic colitis in routine colonoscopies. *Dig Dis Sci.* Vol.51, No.2, (February 2006) p. 241-4. ISSN 0163-2116

Jemal, A., Bray, F., Center, M.M., Ferlay, J., Ward, E., Forman, D. (2011) Global cancer statistics. *CA: Cancer J Clin.* Vol61, No.2, (March-April 2011) pp. 69-90. ISSN 0007-9235

Kahi, C.J., Anderson, J.C., Waxman, I., Kessler, W.R., Imperiale, T.F., Li, X., Rex, D.K. (2010) High-definition chromocolonoscopy vs. high-definition white light colonoscopy for average-risk colorectal cancer screening. *Am J Gastroenterol.* Vol.105, No.6, (June 2010) pp. 1301-7. ISSN 0002-9270

Katsanos, K., Sabharwal, T., Adam, A. (2010) Stenting of the lower gastrointestinal tract: current status. *Cardiovasc Intervent Radiol.* (December 2010) [Epub ahead of print] ISSN 0174-1551

Kavin, H., Sinicrope, F., Esker, A.H. (1992) Management of perforation of the colon at colonoscopy. *Am J Gastroenterol.* Vol.87, No.2, (February 1992) pp. 161-7. ISSN 0002-9270

Keswani, R.N. (2011) Single-balloon colonoscopy versus repeat standard colonoscopy for previous incomplete colonoscopy: a randomized, controlled trial. *Gastrointest Endosc.* Vol.73, No.3, (March 2011) pp. 507-12. ISSN 0016-5107

Khalid, A.B., Majid, S., Salih, M., Hashmat, F., Jafri, W. (2011) Is full colonoscopic examination necessary in young patients with fresh bleeding per rectum? *Endoscopy.* (March 2011) [Epub ahead of print] ISSN 0013-726X

Khalid, O., Srivastava, R., Mulhall, A., Paladugu, A., Dryden, G., Lippman, S. (2011) Conscious sedation: Is it always needed for endoscopy? *Practical Gastroenterol.* Vol.35, No.2, (February 2011) pp. 10-15. ISSN 0277-4208

Kistler, C.E., Kirby, K.A., Lee, D., Casadei, M.A., Walter, L.C. (2011) Long-term outcomes following positive fecal occult blood test results in older adults. *Arch Intern Med.* (May 2011) [Epub ahead of print] pp. E1-8. ISSN 1538-3679

Korkis, A.M., Miskovitz, P.F., Yurt, R.W., Klein, H. (1992) Rectal prolapse after oral cathartics. *J Clin Gastroenterol.* Vol.14, No.4. (June 1992) pp. 339-41. ISSN 0192-0790

Krishnan, S. Wolf, J.L. (2011) Colorectal cancer screening and prevention in women. *Women's Health.* Vol.7, No.2, (March 2011) pp. 213-26. ISSN 1541-0331

Kuramoto, T., Umegaki, E., Kinoshita, S., Kojima, Y., Shindo, Y., Nishihara, H., Murano, M., Ohtsuka, N., Higuchi, K. (2011) Retrograde colon capsule endoscopy from anus using a new self-propelling capsule; the first human trial (abstract). *Gastrointest Endosc.* Vol.73, No.4S, (April 2011) pp. AB67(Su1552). ISSN 0016-5107

Lasser, K.E., Murillo, J., Lisboa, S., Casimir, A.N., Valley-Shah, L., Emmons, K.M., Fletcher, R.H., Ayanian, J.Z. (2011) Colorectal cancer screening among ethnically diverse, low-income patients. *Arch Intern Med.* Vol.171, No.10, (May 2011) pp. 906-12. ISSN 0003-9926

Lee, A., Iskander, J.M., Gupta, N., Borg, B.B., Zuckerman, G., Banerjee, B., Gyawali, C.P. (2011) Queue position in the endoscopic schedule impacts effectiveness of colonoscopy. *Am J Gastroenterol.* (March 2011) [Epub ahead of print] pp. 1-9. EISSN 1572-0241

Leffler, D.A., Neeman, N., Rabb, J.M., Shin, J.Y., Landon, B.E., Pallav, K., Falchuk, Z.M., Aronson, M.D. (2011) An alerting system improves adherence to follow-up recommendations from colonoscopy examinations. *Gastroenterol.* Vol.140, No.4, (April 2011) pp. 1166-73. ISSN 0016-5085

Leighton J.A., Shen, B., Baron, T.H., Adler, D.G., Davila, R., Egan, J.V., Faigel, D.O., Gan, S.I., Hirota, W.K., Lichtenstein, D., Qureshi, W.A., Rajan, E., Zuckerman, M.J., VanGuilder, T., Fanelli, R.D.; Standards of Practice Committee, American Society of Gastrointestinal Endoscopy. (2006) ASGE guideline: endoscopy in the diagnosis and treatment of inflammatory bowel disease. *Gastrointest Endosc.* Vol.63, No.4, (April 2006) pp. 558-65. ISSN 0016-5107

Leufkens, A.M., Demarco, D.C., Rastogi, A., Akerman, P.A., Azzouzi, K., Rothstein, R.I., Vieggaar, F.P., Repici, A., Rando, G., Okolo, P.I., Dewit, O., Ignjatovic, A., Odstrcil, E., East, J., Deprez, P.H., Saunders, B.P., Kalloo, A.N., Creel, B., Singh, V., Lennon, A.M., Siersema, P.D; The Third Eye Retroscope Randomized Clinical Evaluation [TERRACE] Study Group. (2011) Effect of a retrograde-viewing device on adenoma detection rate during colonoscopy: the TERRACE study. *Gastrointest Endosc.* Vol.73, No.3, (March 2011) pp. 480-9. ISSN 0016-5107

Luginbühl, M., Vuilleumier, P., Schumacher, P., Stüber, F. (2009) Anesthesia or sedation or gastroenterologic endoscopies. *Curr Opin Anaesthesiol.* Vol.22, No.4, (August 2009) pp. 524-31. ISSN 0952-7907

Marshall, J.B. (1995) Technical proficiency of trainees performing colonoscopy: a learning curve. *Gastrointest Endosc* Vol.42, No.4, (October 1995) pp. 287-91. ISSN 0016-5107

Marshall, J.B. (2011) Post-colonoscopy era ahead? Not immediately. *AGA Perspectives*. Vol.6, No.2, (April-May 2011) pp. 5,7. ISSN 1554-3366

Matsukawa, H., Shiraga, N., Tsugu, T., Adachi, M., Miyazawa, M., Kashiwazaki, K., Hibi, T. (2007) The use of water-soluble contrast enema without pretreatment for the diagnosis of colon disease. *Nippon Shokakibyo Gakkai Zasshi.* Vol.104, No.9, (September 2007) pp. 1344-51. ISSN 0446-6586

McHugh, M., Osei-Anto, A., Klabunde, C.N., Galen, B.A. (2011) Adoption of CT colonography by US hospitals. *J Amer Coll Radiol.* Vol.8, No.3. (March 2011) pp. 169-74. ISSN 15461440

Miskovitz, P. Gibofsky, A. (1995) Risk management in endoscopic practice. *Gastrointest Endosc Clin North Am.* Vol.5, No.2, (April 1995) pp. 391-401. ISSN 1052-5157

Miskovitz, P., Gordon, B., Yurt, R., Herbstman, C. (1987) Gastrointestinal bleeding in the critically ill immunosuppressed patient. In: *The Critically Ill Immunosuppressed Patient: Diagnosis and Management,* Parrillo, J.D. & Mazur, H.; (Eds.). pp. 189-213, Aspen Publishers, Inc. ISBN 0-87189-636-2, Rockville, MD.

Miskovitz P., Margulis, S.J., (1990) Risikogruppen und ihre Überwachung In: *Das kolorektale Karazinom und seine Präkanzerosen. Grundlagen, Diagnostik, interdisziplinäre Therapie und Operationstechnik*, Izbicki J.R., Wilker D.K., Schweiberer L. (Eds), pp. 139-45, Walter de Gruyter, ISBN 3110115751, Berlin & New York.

Miskovitz, P.F., Rochwarger, A. (1993) *The Evaluation and Treatment of the Patient with Diarrhea.* pp. 1-179. Andover Medical Publisher, ISBN 1563720590, Boston, Massachusetts

Miskovitz, P.F., Steinberg, H. (1982) Diverticula of the gastrointestinal tract. *Dis Mon.* Vol.29, No.3, (December 1982) pp. 1-61. ISSN 1557-8194

Misra, V., Misra, S.P., Dwivedi, M., Singh, P.A., Agarwal, V. (2010) Microscopic colitis in patients presenting with chronic diarrhea. *Indian J Pathol Microbiol.* Vol.53, No.1, (January-March 2010) pp. 15-19. ISSN 0337-4929

Modlin, I.M. (2000) *A Brief History of Endoscopy*. pp. 1-144. Multimed ISBN None, Milano, Italy

Moss A., Bourke, M.J., Williams, S.J., Hourigan, L.F., Brown, G., Tam, W., Singh, R., Zanati, S., Chen, R.Y., Byth, K. (2011) Endoscopic mucosal resection outcomes and prediction of submucosal cancer from advanced colonic mucosal neoplasia. *Gastroenterology.* (March 2011) [Epub ahead of print] ISSN 0016-5085

Naravadi, V., Balasubramanian, G., Madireddy, S., Shenoy, S., Guthrie, W., Verma, A.K., Anand, K. (2011) Screening for colorectal cancer above 75 years--Is it necessary (abstract)? *Gastroenterology.* Vol.140, No.5, Supplement 1, (May 2011) pp. S-16-S-17. ISSN 0016-5085

Nurmohamed, M.T., Fareed, J., Hoppensteadt, D., Walenga, J.M., ten Cate, J.W. (1991) Pharmacological and clinical studies with Lomoparan, a low molecular weight glycosaminoglycan. *Semin Thromb Hemost.* Vol.17 Suppl.2, pp. 205-13. ISSN 0094-6176

Obstein, K.L., Patil, V.D., Jayender, J., Estépar, R.S., Spofford, I.S., Lengyel, B.I., Vosburgh, K.G., Thomson, C.C. (2011) Evaluation of colonoscopy technical skill levels by use of an objective kinematic-based system. *Gastrointest Endosc.* Vol.73, No.2, (February 2011) pp. 315-21. ISSN 0016-5107

Oka, S., Tanaka, S., Takata, S., Kanao, H., Chayama, K. (2011) Clinical usefulness of narrow band imaging magnifying classification for colorectal tumors based on both surface pattern and microvessel features. *Dig Endosc.* Vol.23, Suppl.1, May 1011) pp. 101-5. ISSN 1443-1661

Ortner, M.A., Fusco, V., Ebert, B., Sukowski, U., Weber-Eibel, J., Fleige, B., Stolte, M., Oberhuber, G., Rinneberg, H., Lochs, H. (2010) Time-gated fluorescence spectroscopy improves endoscopic detection of low-grade dysplasia in ulcerative colitis. *Gastrointest Endosc.* Vol.71, No.2, (February 2010) pp. 312-8. ISSN 0016-5107

Pambianco, D.J. (2008) Future directions in endoscopic sedation. *Gastrointest Endosc Clin N Am.* Vol.18, No.4, (October 2008) pp. 789-99. ISSN 1052-5157

Pambianco, D.J., Vargo, J.J., Pruitt, R.E., Hardi, R., Martin J.F. (2011) Computer-assisted personalized sedation for upper endoscopy and colonoscopy: a comparative multicenter randomized study. *Gastrointest Endosc.* Vol.73, No.4. (April 2011) pp. 765-72. ISSN 0016-5107

Parra-Blanco, A., Kaminaga, N., Kojima, T., Endo, Y., Uragami, N., Okawa, N., Hattori, T., Takahashi, H., Fujita, R. (2000) Hemoclipping for postpolypectomy and postbiopsy colonic bleeding. *Gastrointest Endosc.* Vol.51, No.1, (January 2000) pp. 37-41. ISSN 0016-5107

Parry, B.R., Williams, S.M. (1991) Competency and the colonoscopist: a learning curve. *Aust N Z J Surg*. Vol.61, No.6, (June 1991) pp. 419-22. ISSN 0004-8690

Petersen, B.T. (2006) Promoting efficiency in gastrointestinal endoscopy. *Gastrointest Endosc Clin N Am.* Vol.16, No.4, (October 2006) pp. 671-85. ISSN 1052-5157

Pfeffer, J., Grinshpon, R., Rex. D., Levin, B., Rösch, T., Arber, N., Halpern, Z. (2006) The Aer-O-Scope: proof of the concept of a pneumatic, skill-independent, self-

propelling, self-navigating colonoscope in a pig model. *Endoscopy.* Vol.38, No.2, (February 2006) pp. 1444-8. ISSN 0013726

Pohl, J., Schneider, A., Vogell, H., Mayer, G., Kaiser, G., Ell, C. (2011) Pancolonic chromoendoscopy with indigo carmine versus standard colonoscopy for detection of neoplastic lesions: a randomized two-centre trial. *Gut.* Vol.60, No.4, (April 2011) pp. 485-490. ISSN 0017-5749

Qureshi, W., Adler D.G., Davila, R.E., Egan, J. Hirota, W.K., Jacobson, B.C., Leighton, J.A., Rajan, E., Zuckerman, M.J., Fanelli, R., Wheeler-Harbaugh, J., Baron, T.H., Faigel, D.O. (2005) ASGE guideline: guideline on the use of endoscopy in the management of constipation. *Gastrointest Endosc.* Vol.62, No.2, (August 2005) pp. 199-201. ISSN 0016-5107

Rabeneck, L., Saskin, R., Paszat, L.F. (2011) Onset and clinical course of bleeding and perforation after outpatient colonoscopy: a population-based study. *Gastrointest Endosc.* Vol.73, No.3 (March 2011) pp. 520-523. ISSN 0016-5107

Rappaport, B., Mellon, R.D., Simone, A., Woodcock, J. (2011) Defining safe use of anesthesia in children. N Engl J Med. Vol.364, No.10, (March 2011) pp. 1-3. ISSN 0028-4793

Rex, D.K. (2009) Third eye retroscope: rationale, efficacy, challenges. *Rev Gastroenterol Disord.* Vol.9, No.1, (Winter 2009) pp. 1-6. ISSN 1533-001X

Rex, D.K. (12/2010-1/2011) Open access endoscopy is indispensable. *AGA Perspectives.* Vol.6, No.6, (December 2010-January 2011) pp. 4,6. ISSN 1554-3366

Rösch. T., Adler, A., Pohl, H., Wettschureck, E., Koch, M., Wiedermann, B., Hoepffner, N. (2008) A motor-driven single-use colonoscope controlled with a hand-held device: a feasibility study in volunteers. *Gastrointest Endosc.* Vol.67, No.7, (June 2008) pp. 1129-46. ISSN 0016-5107

Rösch, T., Eickhoff, A., Fritscher-Ravens, A., Eliakim, R., Arber, N. (2007) The new scopes—broadening the colonoscopy marketplace. *Digestion.* Vol.76, No.1, (October 2007) pp. 42-50. ISSN 0012-2823

Roy, H.K., Turzhitsky, V., Kim, Y., Goldberg, M.J., Watson, P., Rogers, J.D., Gomes, A.J., Kromine, A., Brand, R.E., Jameel, M., Bogovejic, A., Pradhan, P., Backman, V. (2009) Association between rectal optical signatures and colonic neoplasia: potential applications for screening. *Cancer Res.* Vol.69, No.10. (May 2009) pp. 4476-83. ISSN 0008-5472

Sacher-Huvelin, S., Coron, E., Gaudric, M., Planche, L., Benamouzig, R., Maunoury, V., Filoche, B., Frédéric, M., Saurin, J.C., Subtil, C., Lecleir, S., Cellier, C., Coumaros, D., Heresbach, D., Galmiche, J.P. (2010) Colon capsule endoscopy vs. colonoscopy in patients at average or increased risk of colorectal cancer. *Aliment Pharmacol Ther.* Vol.32, No.9, (November 2010) pp. 1145-53. ISSSN 0269-2813

Safioleas, M., Stamatakos, M., Safioleas, C., Chatziconstantinou, C., Papachristodoulou, A. (2009) The management of patients with retained foreign bodies in the rectum: from surgeon with respect. *Acta Chir Belg.* Vol.109, No.3, (May-June 2009) pp. 352-5. ISSN 0001-5458

Savides, T.J., Chang, K., Cotton, P. (2004) Possible features of current electronic endoscopic information systems: what to look for. *Gastrointest Endosc Clin N Am.* Vol.14, No.4, (October 2004) pp. 735-43. ISSN 1052-5157

Sawhney, M.S. (2011) The future of endoscopy, post-colonoscopy. *AGA Perspectives.* Vol.7, No.2, (April-May 2011) pp. 4,6. ISSN 1554-3366

Schloendorff v Society of New York Hospital, 105 N.E. 92, N. Y., (1914)

Schulman, S., Kearon, C., Kakkar, A.K., Mismetti, P., Schellong, S., Eriksson, H., Baanstra, D., Schnee, J., Goldhaber, S.Z.; RE-COVER Study Group. (2009) Dabigatran versus warfarin in the treatment of acute venous thromboembolism. *N Engl J Med.* Vol.361, No.24, (December 2009) pp. 2342-52. ISSN 0028-4793

Sedlack, R.E. (2010) The Mayo Colonoscopy Skills Assessment Tool: validation of a unique instrument to assess colonoscopy skills in trainees. *Gastrointest Endosc.* Vol.72, No.6. (December 2010) pp. 1125-33. ISSN 0016- 5107

Sieg, A., Hachmoeller-Eisenbach, U., Eisenbach, T. (2001) Prospective evaluation of complications in outpatient GI endoscopy: a survey among German gastroenterologists. *Gastrointest Endosc.* Vol.53, No.6, (May 2001) pp. 620-7. ISSN 0016-5107

Singh, R., Chen Yi Mei, S.L., Tam, W., Raju, D., Ruszkiewicz, A. (2010) Real-time histology with the endocytoscope. *World J Gastroenterol.* Vol.16, No.40, (October 2010) pp. 5016-9. ISSN 1007-9327

Singh, V.V., Draganov, P., Valentine, J. (2005) Efficacy and safety of endoscopic balloon dilation of symptomatic upper and lower gastrointestinal Crohn's disease strictures. *J Clin Gastroenterol.* Vol.39, No.4, (April 2005) pp. 284-90. ISSN 0192-0790

Sivak, M.V. Jr., Fleischer, D.E. (1984) Colonoscopy with a VideoEndoscope: preliminary experience. *Gastrointest Endosc.* Vol.30, No.1, (February 1984) pp. 1-3. ISSN 0016-5107

Smith, M.J. (2011a) Is colonoscopy the optimal method for colorectal cancer screening? *Gastroenterol Endosc News*. Vol.62, No.3, (March 2011) pp. 1,5,7. ISSN 0162-6566

Smith, M.J. (2011b) Withdrawal time during colonoscopy: much ado about nothing? *Gastroenterol Endosc News*. Vol.62, No.3, (March 2011) pp. 11,29. ISSN 0162-6566

Solt, J., Bajor, J., Szabó, M., Horváth, O.P. (2003) Long-term results of balloon catheter dilation for benign gastric outlet stenosis. *Endoscopy.* Vol.35, No.6, (June 2003) pp. 490-5. ISSN 0013726X

Sonoda, H, Kohnoe, S, Yamazato, T, Satoh, Y. Morizono, G., Shikata, K., Morita, M., Watanabe, A., Morita, M., Kakeji, Y., Inoue, F., Maehara, Y. Colorectal cancer screening with odour material by canine scent detection. *Gut.* (January 2011) [Epub ahead of print] ISSN 0017-5749

Stunkel, L., Benson, M., McLellan, L., Sinaii, N., Bedarida, G., Emanuel, E., Grady, C. (2010) Comprehension and informed consent: assessing the effect of a short consent form. *IRB.* Vol.32, No.4, (July-August 2010) pp. 1-9. ISSN 0193-7758

Thakkar, K., El-Serag, H.B., Mattek, N., Gilger, M.A. (2007) Complications of pediatric EGD: a 4-year experience in PEDS_CORI. *Gastrointest Endosc.* Vol.65, No. 2, (February 2007) pp. 213-21. ISSN 0016-5107

Turpie, A.G. (2008) New oral anticoagulants in atrial fibrillation. *Eur Heart J.* Vol.29, No.2. (December 2008) pp. 155-65. ISSN 0195-668X

Uraoka, T., Kato, J., Kuriyama, M., Hori, K., Ishikawa, S., Harada, K., Takemoto, K., Hiraoka, S., Fujita, H., Horii, J., Saito, Y., Yamamoto, K. (2009) CO_2 insufflation for potentially difficult colonoscopies: Efficacy when used by less experienced colonoscopists. *World J Gastroenterol.* Vol.15, No.41, (November 2009) pp. 5186-92. ISSN 1007-9327

Van den Broek, F.J., Fockens, P., van Eeden, S., Stokkers, P.C., Ponsioen, C.Y., Reitsma, J.B., Dekker, E. (2011) Narrow-band imaging versus high-definition endoscopy for the diagnosis of neoplasia in ulcerative colitis. *Endoscopy.* Vol.43, No.2, (February 2011) pp. 108-15. ISSN 0013726X

Wada, Y., Kudo, S-E., Misawa, M., Ikehara, N., Hamatani, S. (2011) Vascular pattern classification of colorectal lesions with narrow band imaging magnifying endoscopy. *Dig Endosc.* Vol.23, Suppl.1, (May 2011) pp. 106-11. ISSN 1443-1661

Ward, B., Shah, S., Kirwan, P., Mayberry, J.F. (1999) Issues of consent in colonoscopy: if a patient says 'stop' should we continue? *J R Soc Med.* Vol.92, No.3, (March 1999) pp. 132-3. ISSN 0141-0768

Warkentin T.E., Greinacher, A., Koster, A. (2008) Bivalirudin. *Thromb Haemost.* Vol.99, No.5. (May 2008) pp. 830-9. ISSN 0340-624

Waye, J.D., (2010) Improving lesion detection during colonoscopy. *Gastroenterol Hepatol.* Vol.6, No.10, (October 2010) pp. 647-52. ISSN 1554-7914

Waye, J.D., Kahn, O., Auerbach, M.E. (1996) Complications of colonoscopy and flexible sigmoidoscopy. *Gastrointest Endosc Clin North Am.* Vol.6, No.2, (April 1996) pp. 343-7. ISSN 1052-5157

Wexner, S.D., Beck, D.E., Baron, T.H., Fanelli, R.D., Hyman, N., Shen, B., Wasco, K.E.; American Society of Colon and Rectal Surgeons; American Society for Gastrointestinal Endoscopy; Society of American Gastrointestinal and Endoscopic Surgeons. (2006) A consensus document on bowel preparation before colonoscopy: prepared by a task force from the American Society of Colon and Rectal Surgeons (ASCRS), the American Society for Gastrointestinal Endoscopy (ASGE), and the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). *Gastrointest Endosc.* Vol.63, No.7. (June 2006) p. 894-909. ISSN 0016-5107

Wexner, S.D., Garbus, J.E., Singh, J.J. (2001) SAGES Colonoscopy Outcomes Study Group. A prospective analysis of 13,580 colonoscopies. Reevaluation of credentialing guidelines. *Surg Endosc.* Vol.15, No.3. (March 2001) pp. 251-61. ISSN 1432-2218

Wexner, S.D., Litwin, D., Cohen, J., Earle, D., Ferzli, G., Flaherty, J., Graham, S., Horgan, S., Katz, B.L., Kavic, M., Kilkenny, J., Meador, J., Price, R., Quebberman, B., Reed, W., Sillin, L., Vitale, G., Xenos, E.S., Eisen, G.M.,

Dominitz, J., Faigel, D., Goldstein, J., Kalloo, A., Peterson, B. Raddawi, H., Ryan, M., Vargo, J., Young, H., Simmang, C., Hyman, N., Eisenstat, T., Anthony, T., Cataldo, P., Church, J., Cohen, J., Denstman, F., Glennon, E., Kilkenny, J., McConnell, J., Nogueras, J., Orsay, C., Otchy, D., Place, R., Rakinic, J., Savoca, P., Tjandra, J.; American Society for Gastrointestinal Endoscopy, Society of American Gstrointestinal Endoscopic Surgeons, American Society of Colorectal Surgeons. (2002) Principles of privileging and credentialing for endoscopy and colonoscopy. *Gastrointest Endosc.* Vol.55, No.2, (February 2002) pp. 145-148. ISSN 0016-5107

Williams, J.E., Le, T.D., Faigel, D.O. (2011) Polypectomy rate as a quality measure for colonoscopy. *Gastrointest Endosc.* Vol.73, No.3, (March 2011) pp. 498-506. ISSN 0016-5107

Wilschut, J.A., Steyerberg, W.W., van Leerdam, M.D., Lansdorp-Vogelaar, I., Habbema, J.D., van Ballegooijen, M. (2011) How much colonoscopy screening should be recommended to individuals with various degrees of family history of colorectal cancer? *Cancer.* (March 2011) [Epub ahead of print] pp. 1-9. ISSN 1097-0142

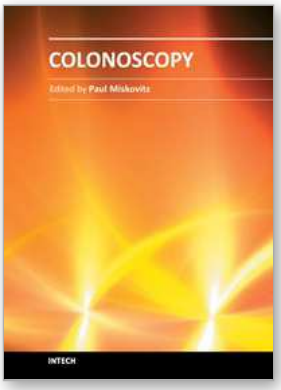
Wilson, W., Taubet, K.A., Gewitz, M., Lockhart, P.B., Baddour, L.M., Levison, M., Bolger, A., Cabell, C.H., Takahashi, M., Baltimore, R.s., Nwburger, J.W., Strom, B.L., Tani, L.Y., Gerber, M., Bonow, R.O., Pallasch, T., Shulman, S.T., Rowley, A.H., Burns, J.C., Ferrieri, P., Gardner, T., Goff, D., Durack, D.T.; American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee; American Heart Association Council on Cardiovascular Disease in the Young; American Heart Association Council on Clinical Cardiology; American Heart Association Council on Cardiovascular Surgery and Anesthesia; Quality of Care and Outcomes Research Interdisciplinary Working Group. (2007) Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. *Circulation* Vol.116, No.15, (October 2007) pp. 1736-54. ISSN 0009-7322

Winawer, S.J., Krabshuis, J., Lambert, R., O'Brien, M., Fried, M. (2011) Cascade colorectal cancer screening guidelines: A global conceptual model. *J Clin Gastroenterol*. Feb 4, 2011, [Epub ahead of print] pp. 297-300. ISSN 0192-0790

Wolff, W.I. (1989) Colonoscopy: history and development. *Am J Gastro*. Vol.84, No.9, (September 1989) pp. 1017-25. ISSN 0002-9270

Wolff, W.I., Shinya, H. (1971) Colonfiberoscopy. *JAMA.* Vol.217, No.11, (September 13, 1971) pp. 1509-12, ISSN 0098-7484

Yamano, H., Yoshikawa, K., Kimura, T., Yamamoto, E., Harada, E., Kudou, T., Katou, R., Hayashi, Y., Satour, K. (2010) Carbon dioxide insufflation for colonoscopy: evaluation of gas volume, abdominal pain, examination time and transcutaneous partial CO_2 pressure. *J Gastroenterol*. Vol.45, No.12, (December 2010) pp. 1235-40. ISSN 0944-1174



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To publish a book on colonoscopy suitable for an international medical audience, drawing upon the expertise and talents of many outstanding world-wide clinicians, is a daunting task. New developments in videocolonoscope instruments, procedural technique, patient selection and preparation, and moderate sedation and monitoring are being made and reported daily in both the medical and the lay press. Just as over the last several decades colonoscopy has largely supplanted the use of barium enema x-ray study of the colon, new developments in gastrointestinal imaging such as computerized tomographic colonography and video transmitted capsule study of the colonic lumen and new discoveries in cellular and molecular biology that may facilitate the early detection of colon cancer, colon polyps and other gastrointestinal pathology threaten to relegate the role of screening colonoscopy to the side lines of medical practice. This book draws on the talents of renowned physicians who convey a sense of the history, the present state-of-the art and ongoing confronting issues, and the predicted future of this discipline.

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