4

Maintaining Quality in Endoscopy

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1. Introduction

If something is worth doing it is worth doing well.
A colonoscopy is only of value if the procedure accurately assesses the whole of the mucosa with minimal morbidity and distress to the patient. Colonoscopic examination properly performed is safe, sensitive and well-tolerated by the majority of patients. The benefits of colonoscopy are within acceptable cost-benefit rates; screening colonoscopies carry a cost of $20,000 per year of life saved(Pignone, Saha et al. 2002; Smith, Cokkinides et al. 2002; Winawer, Fletcher et al. 2003). However complications, such as the need for repeat procedures, and the use of surgical intervention for endoscopically-removable polyps, will reduce this cost-benefit ratio thereby reducing patient acceptance of this examination.
The inconsistency in the degree of technical expertise of colonoscopists as documented in the literature suggests the need for standardization of the quality of colonoscopy service provision nationally and internationally(Marshall and Barthel 1993; Rex, Cutler et al. 1997; Rex 2000; Postic, Lewin et al. 2002; Gatto, Frucht et al. 2003; Rabeneck, Souchek et al. 2003; Schoenfeld, Cash et al. 2005; Barclay, Vicari et al. 2006; Rex, Petrini et al. 2006; Simmons, Harewood et al. 2006; Shah, Paszat et al. 2007; Rabeneck, Paszat et al. 2008; Imperiale, Glowinski et al. 2009). These studies have contributed to the identification of a number of parameters that can be analysed to determine the quality of the colonoscopic procedures performed by an individual endoscopist or within an endoscopy unit(Rex, Petrini et al. 2006; Lieberman, Nadel et al. 2007) (Table 1). This chapter examines these factors which contribute to quality outcomes by review of the published evidence and expert opinion.

2. Patient experience

Pre-procedural checks are essential to identify risk factors that may contribute to an adverse outcome from colonoscopy. Such risk factors include the use of anti-coagulants that may predispose to bleeding following a therapeutic component of colonoscopy such as biopsy or polyp removal, or the existence of comorbidities such as heart failure, respiratory problems or renal failure(Sharma, Nguyen et al. 2007; Ko, Riffle et al. 2010). Indeed the commonest complications following colonoscopy are respiratory depression due to oversedation and renal failure induced by dehydration due to the effects of bowel preparation(Sharma, Nguyen et al. 2007; Ko, Riffle et al. 2010). The American Society of Anesthesiologists (ASA) score is a crude but effective parameter in the risk assessment for sedation and correlates

with sedation-related complications of endoscopy(Dominitz, Eisen et al. 2003; Sharma, Nguyen et al. 2007; Vargo 2007).

Appropriate indication for procedure
Informed consent obtained, including discussion of risks of and alternatives to colonoscopy
Use of recommended post-polypectomy and post-resection surveillance intervals
Documentation of the adequacy of bowel preparation
Caecal intubation rates evidenced by photodocumentation
Adenoma detection rate in asymptomatic (screening) individuals
Withdrawal time (minimum $\geq$ 6 minutes in individuals with intact anatomy)
Biopsies taken in patients with chronic diarrhoea
Sufficient biopsies obtained in patients with inflammatory bowel disease
Endoscopic resection of polyps where possible or documentation of unresectability
Incidence of perforation or bleeding documented
Post polypectomy bleeding managed endoscopically (nonoperatively)

Adapted from Rex et al, Gastrointestinal Endoscopy 2006; 63 (4):S16-S28

Table 1. Quality indicators for colonoscopy

3. Bowel preparation

Bowel preparation is another important factor in ensuring successful colonoscopic outcomes as poor bowel preparation has been shown to not only increase procedure time but also to decrease the adenoma detection rate(Harewood, Sharma et al. 2003; Froehlich, Wietlisbach et al. 2005; Chiu, Lin et al. 2006). Common bowel preparation regimens include split dose sodium picosulphate or polyethylene glycol-electrolyte solutions. Patient related factors such as prior constipation, comorbid status and mobility may affect the regime prescribed as well as compliance thereby determining the success of bowel preparation(Athreya, Owen et al. 2011). The quality of bowel preparation and mucosal views should be documented for every case and is considered adequate if it permits the detection of polyps of 5mm or greater(Rex, Bond et al. 2002). High rates of inadequate bowel preparation should highlight the need for investigation into the method of patient information and the sufficiency of the bowel preparation regimen in use.

4. Patient information

Patients are often anxious about the impending procedure and their reassurance and subsequent tolerance of the procedure is dependent on the manner and professionalism of the doctors and nurses as well as the physical environment(Ko, Zhang et al. 2009). The use of electronic media such as information videos has been found to positively supplement the written information contained in leaflets by improving patients knowledge of colonoscopy and decreasing anxiety levels compared to information leaflets alone(Luck, Pearson et al. 1999). A consultation with either a medical professional or a nurse specialist prior to the procedure is necessary to allow detailed explanation of the procedure prior to obtaining informed consent. During the consent process, specific risks of colonoscopy should be explained including bleeding, perforation, infection, sedation adverse events, missed diagnosis, missed lesions and intravenous site complications(Rex, Petrini et al. 2006).

5. Endoscopy facilities

Appropriate waiting facilities, bathrooms and endoscopy rooms are essential in ensuring a comfortable patient experience. In addition, endoscopy departments are obliged to adhere to the published guidelines for endoscope disinfection(Banerjee, Shen et al. 2008; Beilenhoff, Neumann et al. 2008) and to have full resuscitation facilities including a cardiac defibrillator and emergency drugs tray(Working Party of the Clinical Services Committee of the British Society of Gastroenterology 1991). Procedure rooms should be equipped with pulse oximetry, piped oxygen and suction, electronic blood pressure cuffs and facilities for ECG monitoring(Working Party of the Clinical Services Committee of the British Society of Gastroenterology 1991).

6. Ensuring appropriate indications and surveillance intervals

Colonoscopy should be performed in accordance with accepted guidelines (Terraz, Wietlisbach et al. 2005; Rex, Kahi et al. 2006; Winawer, Zauber et al. 2006; U.S. Preventive Services Task Force 2008; Cairns, Scholefield et al. 2010) as previous studies have shown a higher rate of detection of pathology when endoscopies are performed for appropriate indications(Vader, Pache et al. 2000; de Bosset, Froehlich et al. 2002; Balaguer, Llach et al. 2005). The indications for colonoscopy in symptomatic patients are well described, and include evaluation of gastrointestinal bleeding of unknown origin, investigation of unexplained iron deficiency anaemia, evaluation of an abnormality (such as a filling defect, stricture or wall thickening) on barium enema or CT, assessment of chronic inflammatory bowel disease of the colon and changes in bowel habit such as diarrhoea(American Society for Gastrointestinal Endoscopy 2000). In particular, endoscopists should adhere to the recommended surveillance guidelines post-resection or post-polypectomy as well as the guidelines for surveillance in patients with Crohn's or ulcerative colitis, which make the assumption of caecal intubation, adequate bowel preparation and careful examination(Rex, Petrini et al. 2006). Overuse of surveillance colonoscopy is not cost-effective and unnecessarily exposes patients to the discomfort and risks of a colonoscopy.

7. Sedation and analgesia

Ensuring an adequate yet safe degree of sedation is of paramount importance for successful colonoscopy and increases the likelihood of the patients' willingness to have a repeat procedure if necessary. Recent studies have suggested that "moderate" sedation, in which patients continue to respond purposefully to either verbal commands alone or with light tactile stimulation without requiring intervention to maintain a patent airway or spontaneous ventilation, is sufficient for colonoscopy and safer than deep sedation, in which ventilation may be inadequate and airway protection may be required(Triebwasser and Browning 2001; American Society of Anesthesiologists 2002; Faigel, Baron et al. 2002; Brisith Society of Gastroenterology 2003; Waring, Baron et al. 2003; Rex 2006). Agents used for sedation include benzodiazepines (midazolam, diazepam), narcotics (fentanyl, meperidine), propofol, neuroleptic tranquilizers (droperidol), antihistamines (diphenhydramine), and dopaminergic receptor antagonists (promethazine). A meta-analysis showed no difference in the incidence of hypoxemia, need for supplemental oxygen, physician satisfaction with the procedure, or rates of patient pain or discomfort when either midazolam or diazepam was co-administered with a narcotic for colonoscopy (McQuaid and Laine 2008).

The use of propofol as a sole sedative agent was associated with higher rates of patient satisfaction and less memory of the procedure compared to midazolam co-administered with a narcotic, however no significant difference was noted in the incidence of bradycardia, hypotension, hypoxemia, physician satisfaction, or the number of patients reporting pain or discomfort(McQuaid and Laine 2008). Rates of propofol use are increasing in the United States, with >20% of physicians using propofol routinely for endoscopy. The narrow therapeutic window of propofol and the lack of a reversal agent can contribute to rapid depression of consciousness and cardiovascular function, necessitating additional training and monitoring when using this agent(American Society of Anesthesiologists 2002; Faigel, Baron et al. 2002; Vargo, Cohen et al. 2009). Combining propofol with midazolam and narcotics is believed to allow lower doses to be used thus improving the safety profile(Cohen, Dubovsky et al. 2003; Cohen, Hightower et al. 2004). The use of patient controlled analgesia using narcotics such as alfentanyl and fentanyl has also been associated with high patient satisfaction and willingness to undergo repeat procedure(Usta, Turkay et al. 2011).

The inhalational agent nitrous oxide is also used for sedation and analgesia in colonoscopy due to its rapid onset of action and short recovery time. Randomised trials comparing nitrous oxide to intravenous opiates with or without benzodiazepines failed to show a clear difference between the two groups in terms of pain relief, reaction times or complex psychomotor co-ordination(Lindblom, Jansson et al. 1994; Saunders, Fukumoto et al. 1994; Notini-Gudmarsson, Dolk et al. 1996; Trojan, Saunders et al. 1997; Forbes and Collins 2000; Maslekar, Gardiner et al. 2009; Welchman, Cochrane et al. 2010). Patients given intravenous sedation had worse recall of the procedure and reduced manual dexterity compared to those given nitrous oxide(Lindblom, Jansson et al. 1994; Saunders, Fukumoto et al. 1994; Notini-Gudmarsson, Dolk et al. 1996; Trojan, Saunders et al. 1997; Forbes and Collins 2000; Maslekar, Gardiner et al. 2009; Welchman, Cochrane et al. 2010). All studies showed reduced post-procedural stay in patients given nitrous oxide compared to intravenous sedation(Lindblom, Jansson et al. 1994; Saunders, Fukumoto et al. 1994; Notini-Gudmarsson, Dolk et al. 1996; Trojan, Saunders et al. 1997; Forbes and Collins 2000; Maslekar, Gardiner et al. 2009; Welchman, Cochrane et al. 2010).

Carbon dioxide insufflation has been recommended during colonoscopy as carbon dioxide is highly soluble and can thus be passively absorbed by the colon and excreted by the lungs, thereby minimizing intra-procedural and post-procedural discomfort(Williams 1986). In addition the rapid absorbance of carbon dioxide allows double contrast CT or barium enema to be performed on the same day if necessary, while the minimal interference of carbon dioxide with colonic blood flow reduces the risk of ischaemia(Williams 1986). Studies comparing the use of carbon dioxide insufflation to the more routinely used air insufflation in colonoscopy have demonstrated decreased levels of pain and shorter examination times in the carbon dioxide insufflations group (Bretthauer, Thiis-Evensen et al. 2002; Sumanac, Zealley et al. 2002; Church and Delaney 2003; Uraoka, Kato et al. 2009; Yamano, Yoshikawa et al. 2010).

8. Measurements of technical expertise

8.1 Caecal intubation rates

Caecal intubation (passage of the colonoscope to a point proximal to the ileocaecal valve) is necessary to ensure adequate visualisation of the entire colon. A significant fraction of colonic neoplasms are located in the right colon(Imperiale, Wagner et al. 2000; Rabeneck, Souchek et al. 2003), hence successful caecal intubation should be specifically noted, ideally

by photo documentation(Rex 2000). Intubation of the terminal ileum or visualization of the lips of the ileocaecal valve may be further necessary if there is any doubt as to whether the caecum has been entered. Failure to intubate the caecum is associated with decreased sensitivity of the examination as well as the need for further radiographic imaging or repeat colonoscopy, thereby reducing the cost-effectiveness of the procedure. Recommended caecal intubation rates are ≥90% for all cases(Marshall and Barthel 1993) and ≥95% of screening cases in healthy adults(Rex, Petrini et al. 2006; Rabeneck, Rumble et al. 2007; Levin, Lieberman et al. 2008; National Health Service Cancer Screening Programmes 2011). Procedures which have been aborted due to poor bowel preparation, severe colitis, equipment failure and those performed solely for the treatment of strictures or polyp removal (where complete colonic imaging has been previously performed) are not included in calculation of the caecal intubation rate(Rex, Bond et al. 2002; Rex, Petrini et al. 2006).

8.2 Adenoma detection rate in screening

The adenoma detection rate (ADR) in asymptomatic patients undergoing screening colonoscopy is an important quality indicator in colonoscopy. A recent study by Kaminski *et al* demonstrated that the ADR of the endoscopist was an independent risk factor for the subsequent development of interval cancers (cancers occurring during surveillance colonoscopy after a previous screening colonoscopy). The number of interval cancers was significantly higher in patients who had undergone colonoscopy by endoscopists with an ADR of <20% compared to those who had undergone colonoscopy by endoscopist with an ADR of ≥20% (Kaminski, Regula et al. 2010). Studies of different practice groups have shown large disparities in the rates of adenoma detection between endoscopists within the same practice for both screening and symptomatic indications(Barclay, Vicari et al. 2006; Chen and Rex 2007; Imperiale, Glowinski et al. 2009) highlighting the possibility that suboptimal colonoscopy rather than technological limitations may be a significant contributing factor to the miss rate of incident cancers(Rex, Hewett et al.; Rex, Petrini et al. 2006). The decrease in sensitivity of colonoscopy associated with missed adenomas also has implications on surveillance intervals, as guidelines for surveillance interval assume thorough examination of the colon and cannot compensate for disparities in technical expertise between colonoscopists. Tandem colonoscopy studies demonstrated adenoma miss rates ranging from 0-6% for adenomas more than 1cm in size, 12-13% for those between 6-9mm, and 15-27% for those under 5mm(Hixson, Fennerty et al. 1990; Rex, Cutler et al. 1997). CT-colonography in turn demonstrated miss rates between 12 and 17% for adenomas greater than 1cm in size, indicating that tandem colonoscopies may underestimate the true prevalence of missed lesions (Pickhardt, Nugent et al. 2004; Van Gelder, Nio et al. 2004). Colonoscopy screening studies have consistently demonstrated adenoma prevalence rates of >25% in men and >15% in women over 50 years old (Johnson, Gurney et al. 1990; Lieberman and Smith 1991; Lieberman, Weiss et al. 2000; Schoenfeld, Cash et al. 2005); hence these form the basis of the current recommended ADRs in the United States. In the United Kingdom a slightly higher ADR of 35% has been set for screening colonoscopy (performed following positive faecal occult blood tests)(National Health Service Cancer Screening Programmes 2011).

While the ADR is considered a good quality indicator for colonoscopy, this parameter cannot be determined at the time of endoscopy and requires histological confirmation before

an accurate ADR can be calculated. Polypectomy rates have therefore been postulated as a suitable surrogate, as this can be calculated at the time of colonoscopy and appear to correlate with the ADR(Williams, Le et al. 2011). A disadvantage of using polypectomy rates is the potential for "gaming" –endoscopists artificially increasing their polypectomy rates by removing benign hyperplastic polyps rather than true adenomas(Rex, Hewett et al. 2010).
A recent randomized study examining the effects of the antispasmodic buscopan on polyp detection demonstrated increased polyp detection rates in only a subgroup of patients with significant colonic spasm (Lee, Cheon et al. 2010). In addition, the majority of studies to date have focused on the use of buscopan for the alleviation of colonic spasm and attendant discomfort during colonoscopy with inconsistent results (Saunders and Williams 1996; Mui, Ng et al. 2004; Yoong, Perkin et al. 2004), suggesting that further studies are necessary before buscopan can be routinely recommended for the improvement of polyp detection.

9. Withdrawal time

Measurement of colonoscope withdrawal time (the time between reaching the caecum and withdrawing the scope from the anus) has been used as a further quality indicator in units or endoscopists with low adenoma detection rates. Endoscopists who took longer than 6 minutes to withdraw the colonoscope were found to have very low miss rates and more than 2-fold higher rates of detection of both small and large adenomas(Rex 2000; Barclay, Vicari et al. 2006; Simmons, Harewood et al. 2006). It has therefore been recommended that withdrawal of the colonoscope in patients without any prior colonic surgery should last at least 6 minutes on average(Rex, Petrini et al. 2006). Mean withdrawal times are used rather than individual times as this figure is influenced by the adequacy of colon preparation as well as the length of the colon and the prominence of haustral markings. In addition a recent study has shown that the withdrawal time can be reduced safely with the use of wide angle scopes(Deenadayalu, Chadalawada et al. 2004). Despite the positive correlation between withdrawal time and ADR, Gellad *et al* showed that withdrawal times failed to correlate with 5-year interval neoplasia(Gellad, Weiss et al. 2010). In addition in their study withdrawal times beyond a threshold of 5.2 to 8.6 minutes no longer correlated with adenoma detection rates. This may be explained by the possibility that longer withdrawal times were representative of more difficult rather than more careful examinations. Additionally longer withdrawal times have been found to correlate with the detection of smaller polyps(Simmons, Harewood et al. 2006), not all of which might have been removed at colonoscopy.

10. Surrogate markers

Despite the emphasis placed on caecal intubation rates and withdrawal times as a marker of adequacy of examination, Beckly *et al* (2007) found no correlation between caecal intubation rate or withdrawal times and the detection of artificial bowel markers placed within the colon by a separate intubating colonoscopists (Beckly, Douie et al. 2007). The miss rates of these markers corroborated the findings of Postic *et al* identifying synchronous lesions in specimens of resected colon(Postic, Lewin et al. 2002) as well as the findings of tandem colonscopy studies which used a second closely sequential colonoscopy to determine the miss rate of the first colonoscopy(Hixson, Fennerty et al. 1990; Rex, Cutler et al. 1997). The

higher miss rate for markers placed at the flexures highlights the fact due to the high degree of angulation required to navigate these corners lesions may be missed at these sites even with good technique. The use of surrogate markers for assessing lesion detection may therefore represent a useful addition to endoscopy training.

10.1 Colonic biopsy

The sensitivity of colonoscopy for neoplastic and other pathological processes increases when coupled with endoscopic biopsies. This is particularly relevant in patients undergoing colonoscopic surveillance for Crohn's or ulcerative colitis. The sensitivity of the examination for detecting dysplasia in this patient group is improved by quadrantic biopsies every 10cm of colon as well as biopsy of any suspicious lesions (Rubin, Haggitt et al. 1992). Panchromoscopy (dye-spray) of the colon with targeted biopsies has also been shown to increase sensitivity for dysplasia (Kiesslich, Fritsch et al. 2003; Rutter, Saunders et al. 2004).
In addition to surveillance in inflammatory bowel disease, recent guidelines also recommend the use of biopsies in patients with chronic diarrhoea(Rex, Petrini et al. 2006). Serial biopsies of macroscopically normal colon can identify microscopic (collagenous and lymphocytic) colitis in patients with normal mucosa at colonoscopy (Zins, Tremaine et al. 1995; Yusoff, Ormonde et al. 2002). Detection of collagenous colitis in particular is improved when the proximal colon is biopsied (Zins, Tremaine et al. 1995; Yusoff, Ormonde et al. 2002).

10.2 Colonoscopic polypectomy

Routine polypectomy should be performed at diagnostic colonoscopy to minimize the reduction in cost-effectiveness and increased risk associated with an additional unnecessary colonoscopy for removal of the polyp. The UK national guidelines recommend that 90% of screen-detected polyps are removed at the time of detection (National Health Service Cancer Screening Programmes 2011). Consistent referral of sessile polyps <2cm in size for surgical resection is discouraged as these polyps are frequently amenable to endoscopic removal. In cases of technically difficult polyps, referral to an endoscopist experienced in endoscopic resection may be appropriate. The need for surgical intervention, where unavoidable, should be substantiated by photo documentation of the polyp and subsequent review of images with a second endoscopist. Furthermore, correlation of the endoscopic and pathologic measurements of the polyp should be performed following surgical resection to confirm the necessity of surgical resection(Rex, Petrini et al. 2006).

11. Post-procedure quality indicators

11.1 Complication rates

All complications such as perforation or bleeding following the procedure should be monitored and documented to allow identification and correction of any systematic errors that may be contributing to the incidence of these events.
Perforations can occur during diagnostic colonoscopies, either mechanical in nature (e.g. rupture of the rectosigmoid by the instrument or perforation through a stricture) or barotrauma-related due to an excess of pneumatic pressure causing rupture of the caecum (Woltjen 2005). Therapeutic colonoscopies often run a greater risk of perforation, which can occur following polypectomy. This is most often associated with electrocautery and most

frequently occurs following attempts at removal of large polyps from the proximal colon. Submucosal saline injection prior to polypectomy has been suggested might reduce the risk, (Norton, Wang et al. 2002; Singh, Harrison et al. 2004) however randomized controlled trial evidence on this observation is lacking. Current guidelines suggest that perforation rates of greater than the rate of 1:500 overall or 1:1000 in screening patients as documented in previous studies should highlight the need for further investigation into any inappropriate practices that may be a contributory (Silvis, Nebel et al. 1976; Nivatvongs 1986; Gatto, Frucht et al. 2003; Rabeneck, Paszat et al. 2008; National Health Service Cancer Screening Programmes 2011).

Bleeding is the most common complication following colonoscopic polypectomy, and is more frequent in large polyps with a proximal colonic location. Bleeding rates of large polyps (>2cm) in the proximal colon may exceed 10% however the recommended overall acceptable rate of bleeding is 1% (National Health Service Cancer Screening Programmes 2011). The risk of bleeding (particularly immediate bleeding) may be reduced by the use of epinephrine injections (Hsieh, Lin et al. 2001; Di Giorgio, De Luca et al. 2004) or detachable snares(Iishi, Tatsuta et al. 1996; Di Giorgio, De Luca et al. 2004). Immediate bleeding can often be managed endoscopically by pressure on the stalk for up to 10-15 minutes or injection of adrenaline followed by electrocautery (Rex, Lewis et al. 1992). Delayed bleeding is rarely significant and often stops spontaneously. Exceptions are patients who continue to pass bright red blood who may be experiencing arterial bleeding; urgent repeat colonoscopy with clipping or injection and electrocautery of the bleeding site is then necessary (Rex, Lewis et al. 1992). By these means over 90% of post-polypectomy bleeding can be managed conservatively without resorting to surgical intervention(Rex, Petrini et al. 2006). Accurate assessment of the delayed complication rates of individual colonoscopists such as perforation or bleeding may be difficult as patients may present to different centres, hence regular feedback and audit systems should be in place to ensure delayed complications are recorded.

11.2 Standardised reporting

Although standardized reporting and data collection systems are currently in use for many other large scale tests such as Papanicolaou testing and mammography, these have not currently been adopted for colonoscopy. Standardization of reporting colonoscopic procedures would allow improved communication of test results to primary care providers and patients as well as standardized terms and measurement criteria. In addition this would allow the development of national databases to be interrogated for audit and research purposes. In 1997 the Quality Assurance Task Group in the United States developed a standardized colonoscopy reporting and data system (CO-RADS) in conjunction with the major national gastroenterological societies, outlining the key components of colonoscopy that should be closely monitored in every endoscopy unit(Lieberman, Nadel et al. 2007) (Table 2). The use of and adherence to this standardized reporting has not been audited and remains to be seen. No standardized national reporting system exists for symptomatic colonoscopies in many other countries including the United Kingdom. (these are however in place in the United Kingdom for screening colonoscopies). Most endoscopic units in the United Kingdom employ commonly used endoscopic data recording software such as Endosoft® or Endoscribe® which require the documentation of the major quality indicators.

Patient demographics
History of complaint and indications for colonoscopy
Assessment of patient risk and comorbid status
Technical description of procedure
Findings on colonoscopy
Assessment
Any intervention / unplanned events
Follow-up plan
Pathology

Adapted from Lieberman et al, Gastrointestinal Endoscopy 2007; 65(6): 757-766

Table 2. Key subject areas in a standardized colonoscopy report

12. Other factors

12.1 Training and accreditation

As indicated by the studies quoted above, technical competence is of paramount importance in ensuring the delivery of a high quality endoscopy service. To achieve this particular attention must be paid to the instruction of medical and surgical trainees in the necessary skills for competent colonoscopy, and in many countries including the United Kingdom endoscopists are required to be formally certified to perform independent procedures (British Society of Gastroenterology 2004). Several studies have attempted to better define the learning curve that unquestionably accompanies colonoscopic training. Lee *et al* demonstrated achievement of the basic competencies (in terms of caecal intubation rate and polyp detection rate) after 150 colonoscopies(Lee, Chung et al. 2008), however this was disputed by Spier *et al*, who showed that over 500 colonoscopies were necessary before their gastroenterological fellows could perform $\geq$ 90% of colonoscopies independently(Spier, Benson et al. 2010; Spier, Durkin et al. 2010). Simulator training has been suggested as an alternative or adjunct to colonoscopic experience on live patients; Haycock *et al* demonstrated no significant difference between the performance novice colonoscopists trained on a simulator or live patients when assessed on live cases(Haycock, Koch et al. 2010), suggesting that use of the simulator may shorten the learning curve to competency on live patients.

Once competencies are acquired continued regular colonoscopic experience is necessary to maintain the skill levels required for this procedure. A recent study from Canada revealed that patients were more likely to have an incomplete colonoscopy if the procedure was performed by a low volume endoscopist (<240 colonoscopies per year) compared to a high volume endoscopist (370 colonoscopies per year)(Shah, Paszat et al. 2007). This was corroborated by a study from the United States showing no difference in complications but significant differences in completion rates and time to completion between endoscopists that performed 100-200 colonoscopies per year and those that only performed less than 10 per year(Harewood 2005). In keeping with these findings the National Institute for Clinical Excellence (NICE) in the United Kingdom has recommended that on average colonoscopists should perform a minimum of 100 procedures per year(National Institute for Clinical Excellence 2004). while screening colonoscopists should perform at least 150 procedures per year(National Health Service Cancer Screening Programmes 2011)

12.2 Nurse endoscopists

In countries such as the United Kingdom the demand for endoscopists is rapidly outstripping the capacity for medical endoscopists to perform the service within a reasonable time-frame. This has led to the training of nurse endoscopists to meet this need. To avoid any compromise in quality, nurse endoscopists are required to train to achieve the same competencies as medical endoscopists. Two to three sessions a week are mandated to maintain competencies achieved by a closely supervised period of apprenticeship as well as attendance of national endoscopy courses(Brisith Society of Gastroenterology 2001). A recent pilot study from the Netherlands identified no difference in the caecal intubation rate and caecal intubation time between nurse endoscopists and gastrointestinal fellows in training, with 150 examinations required before independent procedures could be performed(Koornstra, Corporaal et al. 2009).

12.3 Cost effectiveness

Provision of a quality colonoscopic service should not only encompass clinical performance but also cost-effectiveness, which relies on the efficient use of resources as well as successful team-working. Challand *et al* found that colonoscopists performing >150 cases per year were more likely to achieve the recommended workload of 4 colonoscopies per 4 hour session that would be required to meet session costs, however the volume of cases of each endoscopist per year had no effect on the caecal intubation rate. In addition, endoscopists who offered $\geq$ 15% of their sessions for training were more likely to achieve the work required to meet session costs, suggesting that the most clinically effective endoscopists also offered the greatest number of training opportunities(Challand, Bullen et al. 2010).

Cost-effectiveness has also been an important factor in the development of screening and surveillance guidelines. The majority of gastroenterological societies recommend surveillance colonoscopy following adenoma detection at ten yearly frequency in low-risk groups or five yearly in groups where the miss rate for adenomas is suspected to be high(Saini, Schoenfeld et al. 2010). Three yearly surveillance is not cost-effective and the inherent risks of colonoscopy may make such frequent surveillance incrementally harmful (Saini, Schoenfeld et al. 2010). Cost-effectiveness analyses have shown that colonoscopy is not an appropriate first line screening tool but is instead often used as a further investigation in patients with positive faecal occult blood tests(Pignone 2005).

13. Conclusion/ summary

The effectiveness and safety of colonoscopy is dependent on the quality of the procedure performed. The identification of specific quality indicators for colonoscopy as described above (outlined in Table 3) has contributed to the development of recommendations for improving the quality of colonoscopy internationally. Adherence to these recommendations will ensure a thorough examination that achieves the expected sensitivity of the procedure while avoiding complications that would offset the cost-benefit ratio of the process. Ensuring quality in colonoscopy is therefore of paramount importance in ensuring the delivery of a safe, accurate, effective and acceptable service for the diagnosis and management of colonic pathology.

Disclosures: est.

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Abbreviations:

ADR – adenoma detection rate
ASA – American Society of Anaesthesiologists

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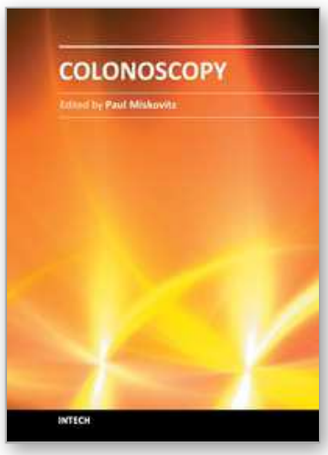

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To publish a book on colonoscopy suitable for an international medical audience, drawing upon the expertise and talents of many outstanding world-wide clinicians, is a daunting task. New developments in videocolonoscope instruments, procedural technique, 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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