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Quality of Screening Colonoscopy: Learning Technical Skills and Evaluating Competence

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1. Introduction

Colonoscopy is an essential part of colorectal cancer (CRC) screening programs since it can diagnose CRC as well as identify and excise precursor lesions before the carcinoma fully develops (Winawer et al., 1993). Although colonoscopy has shown to be effective in decreasing the incidence and mortality of CRC (Kahi et al., 2009), it does not provide total protection against cancer since, in daily practice, a clinically significant number of CRCs and adenomas still go undetected. For example, the proportion of undiagnosed CRC in patients having previously undergone colonoscopy ranges from 2.1%, when the cancer is located in the left colon and the splenic angle, to 5.9% when located in the right colon (Bressler et al., 2007). The proportion of undetected adenomas ranges from 2% for polyps ≥ 10 mm to 26% for polyps of between 1 and 5 mm (van Rijn, 2006). Consequently, an incidence of interval cancers has been described which ranges from 1.7 to 2.4/1000 person-years of follow-up in patients included in a control program following the excision of one or more adenomas (Pabby et al., 2005).

One of the factors which seem to have the most bearing on the number of lesions diagnosed by colonoscopy is the endoscopist him/herself. A difference of up to 20% has been described in the proportion of colonoscopies with at least one adenoma (Chen & Rex, 2007) and of up to 9 times in the proportion of patients with advanced adenomas (Barclay et al., 2006). Other studies confirm these results and suggest that some endoscopists could leave up to half of the adenomas undiagnosed (Rex, 2006b). A number of technical aspects could be responsible for these differences, in particular the ability to reach the cecum and the withdrawal technique (longer explorations, better examination of the proximal mucosa in folds and angles, better management of colon distension and better cleaning of the remains and fluids in the colon) (Rex, 2000).

Screening colonoscopy is a special situation which involves an invasive exploration of an asymptomatic subject with the theoretical promise of detecting CRC before it produces symptoms, or of reducing the individual risk of suffering CRC by detecting and excising colorectal adenomas. In this context, where the detection of lesions is crucial, it appears to be essential to have endoscopists with the necessary technical skills. A study carried out recently in the setting of a CRC screening program based on the detection of fecal occult blood showed that the endoscopist was an independent predictive factor in the detection of

adenomas (Bretagne et al., 2010). In fact, the rate of adenoma detection per endoscopist is the factor most associated with the risk of interval cancer (Karniski et al., 2010).

In conclusion, for a CRC screening program to be truly effective, it must be based on high-quality colonoscopies in such a way that the protective effect against CRC of this procedure approaches the theoretical maximum possible. For these programs it would therefore appear logical to have endoscopists who are experts in colonoscopy in order to reduce to a minimum the degree of variability in the detection of lesions attributable to the examiner. However, at the present time, with screening programs still in their infancy, the basic characteristics of Endoscopy Departments and of those endoscopists who will be in charge of such programs have yet to be defined. The training of endoscopists to carry out screening colonoscopies and their evaluation in terms of seeking possible accreditation have not yet been regulated either. In this review, we will go over the current situation of the training in colonoscopy for gastroenterology specialists, the possibility of evaluating their skills and we will make some recommendations for the future.

2. Quality parameters in screening colonoscopies

Over the past few years, much attention has been given to the definition of auditable parameters to measure the quality of colonoscopies. Systematic monitoring of certain variables allows for the quality of colonoscopies to be controlled and may be used as a tool for improvement (Lin et al., 2010; Barclay et al., 2008). This review does not intend to make a comprehensive review of the parameters used to measure the quality of colonoscopy, for which there are very recent guides and revisions, including the clinical practice guidelines on the quality of screening colonoscopies produced by the Spanish Association of Gastroenterology (Jover, J. ed., 2011). (Table 1).

However, it is worth commenting on the adenoma detection rate (ADR), the variable which has become the most important, since it is directly related to the preventive capacity of colonoscopies in terms of CRC. This rate is equal to the proportion of patients undergoing colonoscopy in which at least one adenoma has been detected. The ADR is associated with a better technique for carrying out the colonoscopy, for example, a thorough exploration of folds and angles, adequate management of distension-aspiration, control of the remains of filth and the time dedicated to the exploration (Rex, 2006b). Since it is necessary to wait for the pathology result in order to measure this parameter, other authors have suggested using the number of polypectomies as an auditable parameter, which is associated with the above, but which is more directly measurable (Williams et al., 2011). Other frequently used quality parameters are associated with the ADR. Several studies have shown that the time of withdrawal is associated with the frequency of polyp detection (Barclay et al., 2006; Rex 2000; Imperiale et al., 2009). A recent study found a significant association between the proportion of adenoma detection and the "cecal intubation time/withdrawal time" ratio < 1 for those endoscopists with higher detection rates (Benson et al., 2010). Almost all recommendations consider a minimum withdrawal time of 6 minutes for a normal colonoscopy as the threshold for a quality endoscopy (Rex et al., 2006b). The proportion of colonoscopies in which the cecum is reached is also associated with the ADR, and is a parameter which must be controlled, since in several studies, most interval CRCs were diagnosed in proximal parts of the colon (Pabby et al., 2005; Singh et al., 2006). For example, the American Society for Gastrointestinal endoscopy (ASGE)/American College of Gastroenterology (ACG) Task Force on quality in endoscopy recommends that effective

colonoscopists must be able to intubate the cecum in $\geq 90\%$ of cases, and in $\geq 95\%$, when the indication for the colonoscopy is screening (Rex et al., 2006b). Other parameters may be the endoscopic resection of polyps and the control in collecting complications (Rex et al., 2006b; Romagnuolo et al., 2008; Gonzalez-Huix et al., 2010).

| Indicator | Advisable level |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Adenoma detection rate | > 20% (colonoscopy as a primary screening strategy) > 40% (colonoscopy as a secondary screening strategy, following a positive FOBT) |
| Colonoscope withdrawal time | > 6 minutes |
| Number of colonoscopies without supervision | 400 before entering the screening program 200 annually |
| Cecal intubation rate | > 95% colonoscopies |
| Use of sedation | > 90% colonoscopies |
| Perforation rate | < 1/1000 colonoscopies |
| Post-polypectomy bleeding rate | < 1/200 polypectomies |
| Accurate description of polyp characteristics | 100% |
| Endoscopic excision of pedunculated and sessile/flat polyps up to 2 cm of diameter | > 95% |
| Polyp retrieval rate | > 95% for polyps > 10 mm > 80% for polyps < 10 mm |

Table 1. Screening colonoscopy quality indicators

However, the evaluation of these parameters may not be sufficient to increase the frequency of adenoma detection (Sawhney et al., 2008). For example, a recent study found an inverse relationship between the total duration of the exploration and the ADR. Furthermore, control of the ADR by feeding back the results to the endoscopists did not improve the ADR (Shaukat et al., 2009). This is probably due to the fact that there are other technical aspects relating to the withdrawal exploration which are essential in order to increase the lesion detection rate but which are more difficult to evaluate quantitatively. This happens, for example, with the thorough examination of the colon mucosa, especially the angles and the proximal parts of the folds, the aspiration of the liquid content and the exploration with different degrees of insufflation. In a center where a protocol for exploration on withdrawal was applied, which, in addition to time, included these technical aspects, a 10% increase in the total number of neoplasms detected was achieved, as well as a 15% increase in the number of lesions under 10 mm (Barclay et al., 2008).

Therefore, a quality colonoscopy is characterized by the combination of certain measurable parameters, as well as others which, even though they are not measurable, are essential in screening colonoscopies. These technical aspects may be responsible for the differences found between endoscopists in the frequency of lesion detection, in such a way that it seems to be of the utmost importance to ensure adequate teaching of these technical skills for all endoscopists, and especially for those who are going to be in charge of a CRC screening program. Collection and measurement of these parameters must also be the basis for control and evaluation of the endoscopist competence.

3. Current situation of learning in colonoscopy: acquisition and evaluation of competence

Competence in a procedure is the minimum level of skills, knowledge and/or expertise acquired through training and practice which is required to safely and effectively carry out a task or procedure without any help or supervision (Faigel et al., 2006). Applied to colonoscopy, competence entails the ability to confidently carry out the exploration, interpret the findings, apply the necessary treatments and manage the complications that may arise.

Clearly, the first step towards achieving competence is adequate training during the residency period in the specialty of Gastroenterology. However, specialty training programs are greatly undefined and variable, and they are mostly based on general recommendations by Scientific Societies and opinions from experts. For example, the training period necessary to acquire competence has not been clearly defined. In general terms, it appears that the training period should be no shorter than 6-12 months (Conjoint Committee for the recognition of training in Gastrointestinal Endoscopy, n.d.). In Spain, a minimum period of 6 months is recommended for basic endoscopy, with an additional 3 months for advanced endoscopy (Consejo Nacional de Especialidades Médicas, 2009), but training periods vary greatly from country to country. Generally speaking, there is no structured procedure for teaching during the residency program either, which would allow all areas of learning to be managed and for their results to be assessed. Furthermore, trainers in endoscopy are usually not trained in teaching techniques. In practice, training of endoscopists during the residency is done in a barely regulated manner, integrating teaching into the normal activities of attendance in Endoscopy Departments, and by trainers who are not specifically trained to that effect. All of this may influence the quality of the training and may be responsible for the poor quality perceived by residents in their learning in endoscopy (Wells et al., 2009).

Traditionally, two supplementary learning methods have been proposed to improve the results of standard teaching during the residency: short courses and simulators. Short courses, usually lasting two to three days, are not considered to be enough to acquire the technical skills or judgment necessary to carry out the colonoscopy, since their short duration does not allow for adequate training (Romagnuolo, 2008). In a short course, 10 supervised colonoscopies can be done at most, a long way from the Societies' recommendations and, of course, far short of the minimal number of colonoscopies required to achieve competence. The ASGE recommends that short courses be considered as training opportunities or tools for continued education but never as substitutes for a formal training program of adequate duration (ASGE Taskforce on ensuring competence in endoscopy, n.d.).

Simulators are computer-based devices which offer different degrees of difficulty, with a sense of touch through a simulated endoscope and the ability to administer sedation as well as incorporating systems which simulate pain and discomfort in the virtual patient. Moreover, data associated with the procedure, such as duration, the ability to visualize the mucosa and the ability to complete the procedure is collected. The aspect in which they have been evaluated the most is the resident's learning, with the aim of shortening the learning curve and reducing the patient's discomfort when examined by an inexperienced examiner. In general terms, it appears that the greatest benefit is obtained in the early stages of learning, in such a way that experienced endoscopists hardly obtain any benefit (Sedlack & Kolars, 2002). Moreover, it would appear that even for inexperienced endoscopists, the

learning curve flattens after only 7 simulated explorations (Eversbusch & Grantcharov, 2004). A randomized study compared the skills of two groups of residents, one which had received simulator training and the other which had not, before starting the traditional training program. This study showed that if the use of the simulator was extended to 10 sessions in the residents in the first group, a benefit in competence parameters was seen, which was maintained until real exploration number 80 (Cohen et al., 2006). However, this device does not seem to be of any use to endoscopists who have already completed the standard period of practical training. In fact, this type of device is able to distinguish between the user's technical capacity and differentiate expert endoscopists from novice ones (Grantcharov et al., 2005; Koch et al., 2008). In one study, for expert endoscopists, the learning curve in the device was only two simulated explorations (Eversbusch, 2004). Residents do, however, perceive this device as being effective as a supplementary learning system (Lightdale, 2010).

As regards the evaluation of competence, until now, the most usual way has been a subjective assessment whereby at the end of the residency period the trainer states that the resident can carry out colonoscopies autonomously. A more objective attempt at evaluation is the measurement of parameters which support the fact that the individual is competent to carry out the exploration. The one which has been studied the most, perhaps because it is the easiest to measure is the minimum number of colonoscopies performed, but this also involves great variability. In the United States, the ASGE recommends carrying out a minimum of 140 colonoscopies during the training period, with at least 20 polypectomies. However, the program for the specialty of surgery is different with only a minimum of 50 explorations being required (Accreditation Council for Graduate Medical Education, 2006). The Canadian and Australian Societies of Gastroenterology require 100 complete, totally unassisted explorations up to the cecum to have been carried out (Romagnuolo, 2006; Conjoint Committee for the recognition of training in Gastrointestinal Endoscopy, n.d.). In Spain, the minimum number of colonoscopies which must be carried out is 150 (Consejo Nacional de Especialidades Médicas, 2009). However, carrying out a specific number of colonoscopies does not guarantee competence in this exploration since learning varies greatly from individual to individual. In a recent study, it was determined that the number of colonoscopies necessary to reach the cecum in 90% of explorations was 150, and 200 in 95% (Lee et al., 2008). However, another study suggested a threshold of 500 colonoscopies for all residents to have autonomy of $\geq 90\%$ to carry out colonoscopies (Spier et al., 2010). The first resident to become autonomous did so after carrying out 330 colonoscopies. It would therefore appear that linking the evaluation of competence to having carried out a specific number of explorations is not an adequate system. This was demonstrated by Cass et al., who designed an evaluation system with key points which should be learned in order to carry out a colonoscopy, which included, for example correct identification of any anomalies found in the exploration (Cass et al., 1993). Adequate competence in these variables was not reached with the minimum number of colonoscopies recommended by the experts (Cass et al., 1996). Another finding of this study was that the subjective assessment overestimated the resident's competence compared to objective assessments. Moreover, nowadays competence assessment cannot focus solely on variables related to diagnostic colonoscopy, such as the number of procedures carried out or the percentage that reached the cecum. These days a student cannot be considered competent if he/she is not capable of carrying out the endoscopic treatment of the lesions found.

Finally, in addition to the basic training, continued practice is necessary to maintain competence. The secondary results of a Canadian study showed that endoscopists who carried out less than 240 colonoscopies per year had significantly more incomplete colonoscopies than those who carried out 370 per year (Shah et al., 2007). A similar study in the U.S. showed that endoscopists who carried out less than 100 colonoscopies per year had a significantly lower proportion of complete colonoscopies (Wexner et al., 2001).

In conclusion, there are still no standardized or universally accepted methods to achieve and evaluate competence when autonomously carrying out colonoscopies. Carrying out a certain number of explorations does not guarantee competence, and specific tools must be developed to assess cognitive aspects and competence skills.

4. Towards a new teaching system: structured learning and training the trainers

Colonoscopy is a complex procedure at the psychomotor level which also requires a solid knowledge base allowing for clinical and therapeutic decisions to be made. Traditionally, however, the learning of endoscopy has been based on passing from watching explorations to carrying them out outside the context of an organized teaching system which ensures that learning is carried out correctly. This procedure has several limitations which affect the quality of the learning, such as the ever greater work load of endoscopy departments which reduces the time assigned to each exploration, the reduction of the residents' overall working hours, who thus have less time to dedicate to practicing colonoscopy, and the fact that every person learns in a different way and at a different pace. An alternative teaching system which allows these difficulties to be overcome is therefore necessary. In this system, the responsibility for learning would no longer lie on the student but would focus on the trainer, who must follow a structured teaching system based on communication and feedback with the student, and who must also be responsible of evaluating the student in each of the phases.

4.1 The teaching process. The role of trainers and endoscopy departments

The trainer must have broad technical knowledge and experience in diagnostic and therapeutic colonoscopy, and must be able to finalize a procedure when the student fails. This, however, is not enough. He/she must know what the resident needs to learn, know the basic concepts of the learning process and apply teaching techniques which ensure the resident's training. The learning of colonoscopy includes three areas: i) cognitive skills which include the indications and contraindications of the test, the identification and classification of lesions and clinical decision-making based on the findings; ii) technical skills, which include methods for advancing the endoscope and handling the loops that are formed, the ability to carry out the test adequately and in a reasonable time, as well as the ability to apply endoscopic treatments, and iii) procedure-related skills, such as information to the patient, informed consent, risk assessment, the safe administration of sedation-analgesia and the drafting of an adequate report of the exploration (Raman & Donnon, 2008).

The colonoscopy teaching process should go through three phases: acquisition of theoretical knowledge, observation of the procedure with comments by the tutor and tutored practice. Each of these phases will be planned beforehand and it will be the active responsibility of the trainer to ensure that the way in which students go through each one of the phases is not left to chance (Figure 1).

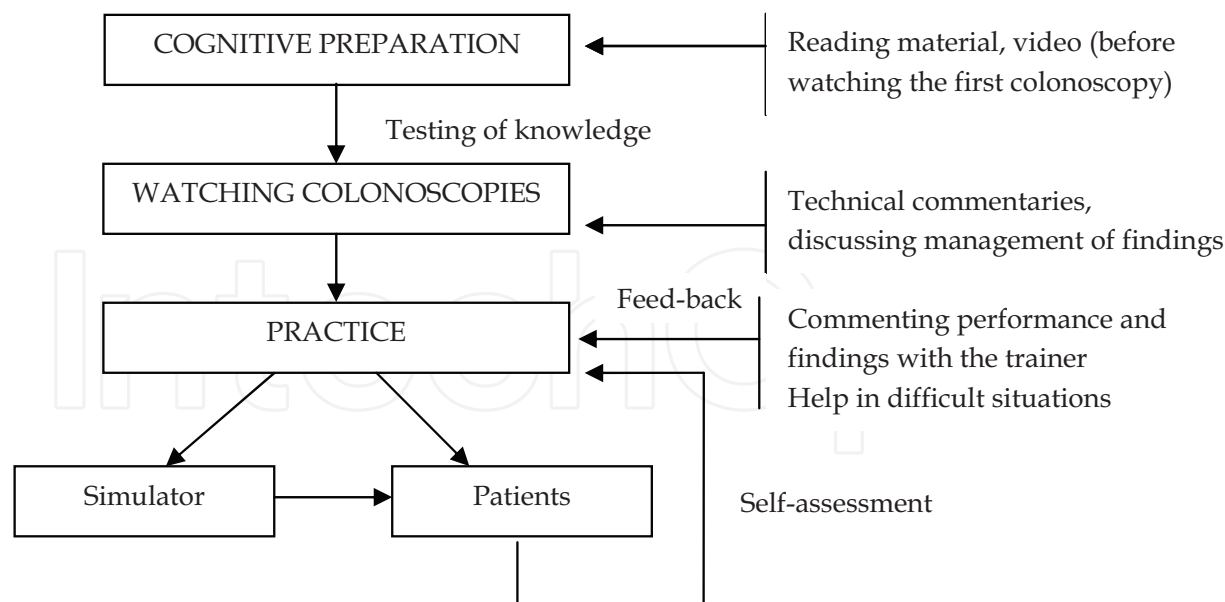


Fig. 1. Teaching phases in colonoscopy

Evaluation of the student by the trainer and the feedback between both is a fundamental part of this process and is supported by recent evidence. For example, the use of checklists which ensure the inclusion of key points in colonoscopic technique and the design of a system for evaluating trainees, with feedback to the trainers on their results, seems to improve the effectiveness of teaching certain aspects of endoscopy (Alevi, 2010).

As for the role of endoscopy departments, a working group suggested that endoscopy departments where teaching is carried out must have at least two designated trainers, each with one or two sessions dedicated to the teaching process. Furthermore, at least 300 colonoscopies should be carried out annually in the department, of which at least 100 should be carried out by the student. It would also be advisable to have audiovisual teaching material available. The department should have a record of the student's colonoscopy activity, including the parameters described above (Teague, 2002). Teaching should be student oriented (trainer-student), with dedicated time established and separated from the needs of the department.

4.2 Answer to these demands. Training the trainers and evaluation systems

The main problem behind implementing such a change in the form of teaching is the trainer's and institution's lack of knowledge of learning techniques. The solution would involve the training of trainers, which has shown to be effective in improving the results of the teaching process. For example, in the aforementioned study by Alevi et al. (Alevi, 2010), trainers attended a previous educational module on the effective practice of feedback with the student. This training is necessary because an analysis of cognitive tasks, in which 3 colonoscopists were asked to explain what they were doing and why, allowed the relevant steps and important clinical decisions that were omitted during traditional training to be identified (Sullivan, 2008).

In the United Kingdom, in 2004, a structured training program on endoscopy was put into practice. This system is based, firstly, on the training of trainers by means of a three-day course, where they learn teaching techniques. The trained trainers complete 3-day courses locally, where the technical principles of colonoscopy are taught. Finally, the students must

continue developing their technical skills in their own centers (Balfour, 2001). This centrally organized system has been shown to improve the quality of explorations, reduce complications and increase the students' satisfaction with their training (Haycock, 2010). The importance of training the trainers is included in the recent recommendations by the United European Gastroenterology Federation (UEGF), where it recommends providing trainers in gastroenterology with a standardized tool for teaching (Berberat, 2010).

As for the evaluation of the student, supervision must be done by the trainer by way of the systematic collection and evaluation of a series of technical data. In general terms, the resident should be successful in 80-90% of the technical objectives included in the training program in order to complete it successfully (ASGE standards of training committees, 1999). These parameters should coincide with the quality markers for colonoscopy and should, amongst others, include intubation in the cecum and ileum, adenoma detection rate, technical ability to carry out standard polypectomies and recover polyps for pathological analysis, an acceptable rate of complications, the number of colonoscopies carried out and a correct use of sedation (Romagnuolo, 2008; Joint Advisory Group [JAG] on Gastrointestinal Endoscopy, n.d.a; JAG, 2010). This evaluation should also include cognitive criteria and assessment of tasks related to the procedure (table 2).

| Cognitive criteria | Related tasks |
|-------------------------------------------------|--------------------------------------------------------------------------------|
| Identification of risk factors | Reviewing of patient chart and images |
| Evaluation of indications and contraindications | Obtention of informed consent |
| Recognizing and managing complications | Preparation of an accurate report |
| Planning management based on findings | Discussion of findings with the patient, family and other healthcare providers |

Table 2.

The development of several tools for objectively measuring competence is currently underway. For example, the Accreditation Council for Graduate Medical Education (ACGME) developed a structured tool for evaluating residents (ACGME, 2000) which could be effective in terms of teaching colonoscopy (Spier, 2010). More recently, authors in the Mayo Clinic have developed a tool to objectively measure the quality in conducting colonoscopies longitudinally in time, which also includes parameters of endoscopic treatment (Sedlack, 2010). Other groups have proposed similar tools (Vassilou, 2008; Tang, 2006). A structured evaluation is also to be found in the English system, in which the latest component of this system is monitoring and auditing (Balfour, 2001). Although all these instruments have to be specifically validated in the evaluation of competence, it is clear that this is the path that must be taken in order to achieve a more objective assessment of the individual ability to carry out colonoscopies.

5. Credentialing of individuals and units

The final goal of healthcare systems is to provide high quality medical services. In the case of colonoscopy, local institutions and stakeholders are responsible for designing and implementing a quality assurance program able to ensure quality and safety of all phases of the colonoscopy process including pre- and post-procedural aspects. This quality control program must apply to individuals and endoscopy units in a standardized way.

5.1 Granting privileges to individuals for colonoscopy

A privilege is the authorization by a local institution (hospital or endoscopy unit) for a physician to perform a particular procedure (Faigel, 2009). Granting privileges is the mainstay of this process as it requires reviewing in a systematic and reproducible manner the performance of endoscopists and units involved in the colonoscopy process. Privileges must be granted only to competent individuals, and healthcare providers must establish specific policies for granting, complying with local, regional and national regulations (fig. 2). The process for granting privileges includes a formal review of the applicant's credentials by a physician member of the healthcare institution, including documentation of the accomplished training. The reviewer should also have privileges to perform colonoscopy. If the applicant's credential accomplish healthcare institution criteria, a proctoring evaluation must follow. Proctoring includes direct observation of the applicant performing a pre-specified number of procedures, with evaluation of a group of criteria that should include the aforementioned technical and cognitive items (Tables 1 and 2). The proctor must be an unbiased individual, with expertise in colonoscopy to allow judgement of the applicant skills but uninvolved in teaching or active patient care (Dominitz, 2008). A written guideline of the whole competence assessment process must be included in the institution's bylaws. Competence must be reassessed periodically through a renewal of privileges process, performed in a similar way to the initial credentialing process. Again the institution must have a written guideline for the renewal process, including timing of reevaluation and recommendations for additional training.

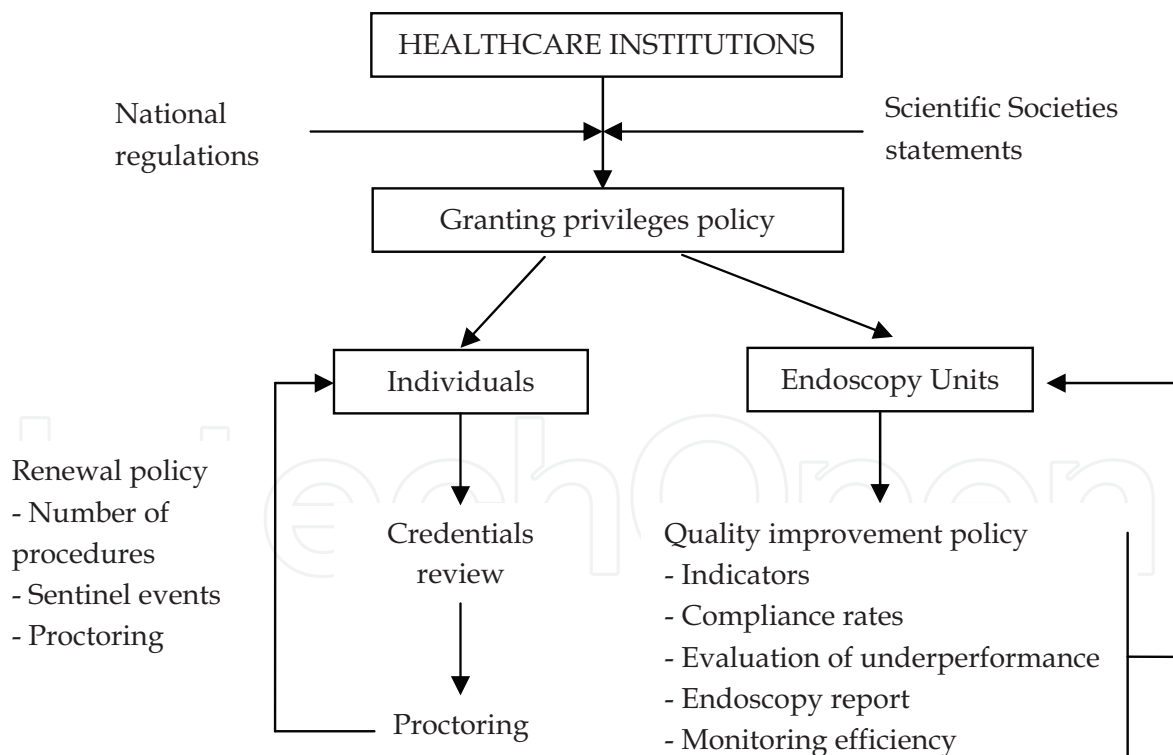


Fig. 2. Granting and renewal of privileges for individuals and endoscopy units

5.2 Credentialing for endoscopy units

Units are responsible for maintaining and enhancing the quality of endoscopic procedures, by means of an institutional policy for quality improvement (Faigel, 2009). Individual

quality indicators must be assessed periodically and improvement plans must be implemented if needed. Poor performance must be addressed offering feed-back and plans for improvement to underperformers. Each institution should have policies for reviewing and reporting sentinel events. This term is used to describe significant deviations from optimal patient care, which in the case of colonoscopy, should include adverse outcomes of sedation, bleeding, perforation and infections. Inappropriate indications, lack of informed consent and inadequate colonoscopy report should also be included and formally assessed. All the process of quality control, indicators, feed-back and consequences of repeated underperformance should be pre-specified and written-down.

Units should be evaluated and subject to a formal credentialing and re-credentialing process. The ASGE is recognizing units which adhere to ASGE guidelines on privileging and quality assurance with a Certificate of Recognition award (ASGE, n.d.a). In the UK the British Global Rating Scale is the standard of accreditation for endoscopy services (JAG, n.d.b) and in Spain the Spanish Association of Gastroenterology (AEG) has recently launched a practice guideline for quality in screening colonoscopy aimed to define auditable quality indicators for endoscopists and units (table 1) (AEG & SEED working group, 2011).

6. Conclusions and recommendations

The performance of screening colonoscopy requires high quality standards to guarantee the efficiency of the CRC screening programs. Since there is a great variability between endoscopists in the detection of colorectal lesions, only experienced examiners with adequate technical and cognitive skills should be in charge of those programs. However, there is a lack of uniformity and standardization in the evaluation of technical skills, and classical teaching programs may not be enough to meet all the quality requirements.

Recently, much attention has been given to the definition of auditable parameters to measure the quality of colonoscopies. Systematic monitoring of certain variables allows for the quality of colonoscopies to be controlled and may be used as a tool for evaluation and improvement. The identification of these variables may also point out the main issues to be taught, leading to a more structured way of teaching.

Based on the current evidence the following general recommendations may be stressed:

- The use of auditable parameters to assess quality is of paramount importance in screening colonoscopy. These parameters will be also useful to evaluate competence.
- The teaching process should be structured in different phases, and monitoring and evaluation in each phase is advisable. Teaching techniques should be learned by the trainer, preferably during training the trainers courses. Endoscopy units should be adapted to teaching activities.
- A structured and reproducible system of evaluating competence, taking into account cognitive and technical skills, should be designed and validated.
- Local institutions and stakeholders are responsible for designing and implementing a quality assurance program able to ensure quality and safety of all phases of the colonoscopy process. Granting privileges for individuals and endoscopy units is advisable.

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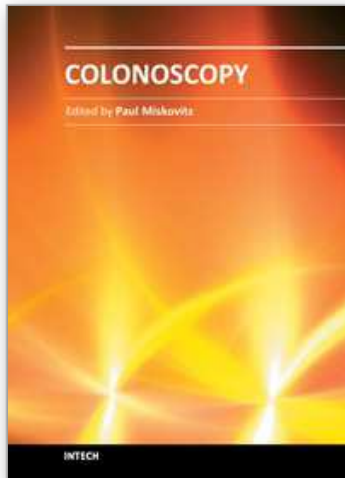
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To publish a book on colonoscopy suitable for an international medical audience, drawing upon the expertise and talents of many outstanding world-wide clinicians, is a daunting task. New developments in videocolonoscopy instruments, procedural technique,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