

ORIGINAL ARTICLE

Colonoscopy training in gastroenterology fellowships: determining competence

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Background: Although 140 colonoscopies is the recommended minimal requirement for gastroenterology fellows, it is unclear whether this minimum is a surrogate for competence.

Objective: To assess whether 140 colonoscopies is an adequate threshold to determine $\geq 90\%$ colonoscopy performance independence.

Design: Retrospective analysis on a database constructed for quality control/improvement.

Setting: Gastroenterology fellowship training program at a veterans hospital.

Patients: Consecutive patients who underwent colonoscopy primarily for symptoms, previous polyps, or family history of cancer (a minority were performed for screening only) from April 2007 to September 2008. This study involved 11 gastroenterology fellows who performed 770 colonoscopies during 18 individual month-long rotations.

Intervention: Assessment of various procedure-related parameters.

Main Outcome Measurements: Determining when $\geq 90\%$ independence in colonoscopy performance was reached.

Results: Total colonoscopy time, time to cecal intubation, withdrawal time, and independent completion rates all significantly improved when first and third years of training were compared ($P < .001$ for all comparisons). The adenoma detection rate did not change between years of training. Independent completion was achieved in $\geq 90\%$ of cases for all fellows after 500 colonoscopies, whereas no fellow reached a $\geq 90\%$ independent colonoscopy completion rate after 140 colonoscopies.

Limitations: Number of participants, single center.

Conclusions: Becoming a competent colonoscopist requires repeated practice. Our study suggests that, although there is variability between a trainee's ability to become colonoscopy independent, 500 colonoscopies are likely required to ensure reliable ($\geq 90\%$) independent completion rates. Competency requires more than a single parameter. (Gastrointest Endosc 2009;■:■-■.)

Competence in endoscopic procedures is a critical component for gastroenterology fellowship training programs. Specific measures of colonoscopy competence

Abbreviations: ACGME, Accreditation Council for Graduate Medical Education; ADR, adenoma detection rate; ASGE, American Society for Gastrointestinal Endoscopy; VA, William S. Middleton Memorial Veterans Hospital, Madison, Wisconsin.

DISCLOSURE: All authors disclosed no financial relationships relevant to this publication.

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S0016-5107/\$36.00
doi:10.1016/j.gie.2009.05.012

have been ill-defined and often rest upon the judgment of the fellowship program director to credential a trainee, once a minimum threshold number of 140 colonoscopies has been attained. Over the past 10 years, the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Medical Specialties have made competence the key end-point of training of medical residents and fellows. To assist program directors in achieving and assessing this goal, these groups have produced a "tool box" of assessment methods for determining competence.¹ Although some of these tools, such as 360-degree (or multisource) evaluation and procedure logs, are useful aids for monitoring a trainee's experience,

individualized assessment standards for specific procedures have been lacking. Instead, in addition to the toolbox measures, the ACGME program requirements have stated a minimum threshold number of procedures, which each fellow should carry out in the course of the fellowship. The current ACGME guidelines state that assessment of procedural competence should not be based solely on a minimum number of procedures performed but on a formal evaluation process. These evaluations should include objective performance criteria (eg, rate of successful cecal intubation for colonoscopy).² For gastroenterology fellows, a minimal threshold of 140 colonoscopies is required before competency can be assessed. However, this is an arbitrary figure, as shown by differing minimal threshold bars for other training programs (eg, 50 colonoscopies are required as part of training in general surgery).³

Colonoscopy lends itself to objective analysis because several parameters of competence have been identified for practicing endoscopists. Indeed, concern about the competence of practitioners performing colonoscopy has reached the lay public. An observational study from a community gastroenterology practice found a wide difference in the conduct of colonoscopy, with a resultant disparity in the outcome.⁴ A corresponding editorial in the *New York Times* recommended that “smart patients should not hesitate to ask their doctors how their polyp-detection rate compares with national norms, and how much time they actually spend looking for polyps.”⁵ In response to such anxiety, an expert panel of the American Society for Gastrointestinal Endoscopy (ASGE) published a set of recommended quality parameters to define clinical competence in the conduct of colonoscopy. They suggested that effective colonoscopists should be able to intubate the cecum in more than 90% of all cases and in more than 95% of cases when the indication is screening a healthy adult.⁶ Similarly, the ASGE recommended that when healthy, asymptomatic patients undergo screening colonoscopy, the adenoma detection rate (ADR) should be >25% in men and >15% in women who are more than 50 years old.⁶

Given the concern about clinicians competently performing colonoscopy, we therefore asked the question, “At what point in their training do our fellows in gastroenterology become independent colonoscopists?” We sampled our fellows’ levels of independence, our surrogate for procedural competence, at several points in their 3-year-long fellowships.

METHODS

Fellows in the gastroenterology training program have the opportunity to learn endoscopy at 4 hospitals in Madison, Wisconsin, from several faculty endoscopists. For the purposes of this study, data were collected during fellow-

Capsule Summary

What is already known on this topic

- Gastroenterology fellows are required to perform a minimum of 140 colonoscopies before competency can be assessed, but this is an arbitrary figure that may not reflect competence.

What this study adds to our knowledge

- Of 11 gastroenterology fellows who performed a total of 770 colonoscopies in 18 individual monthly rotations, no fellow reached a $\geq 90\%$ independent colonoscopy completion rate after 140 colonoscopies; rather, all reached this goal only after 500 colonoscopies.

ship rotations at one site only, the William S. Middleton Memorial Veterans Hospital, Madison, Wisconsin (VA). As part of a quality control/improvement project, we constructed a database and collected data prospectively. After an 18-month period, we then obtained approval from the institutional review board and analyzed the data in a retrospective fashion.

The primary outcome measure was the relative frequency of the fellow performing colonoscopy independently, which was defined as having “completed” the procedure (including all aspects such as cecal intubation, polypectomy, hemostasis) without assistance from the supervising gastroenterologist. This was recorded in a yes/no fashion, and specific reason for failure was not documented. We also calculated the ADR (the total number of adenomatous lesions detected, divided by the number of patients evaluated), the percentage of cases with adenomas, and times for completion of various components of the procedure as described in the following.

Patient population

The study population consisted of consecutive patients who underwent colonoscopy primarily for symptoms, previous polyps, or family history of cancer (a minority were performed for screening only) from April 2007 to September 2008. Participants were outpatients scheduled by local providers through open access, outpatients scheduled by the gastroenterology clinic or scheduled in follow-up of previous studies, or inpatients seen in consultation.

Study procedures

Colonoscopies were performed during a standard 8 AM to 4 PM clinic day. Eleven full-time gastroenterology fellows performed the colonoscopies with 1 of 8 experienced faculty gastroenterologists who were present for the entire procedure. The majority of cases were supervised by 2 attending gastroenterologists who had primary VA appointments. There were no standardized instructions/protocols to direct assistance with the procedure. Adult

or pediatric, variable-stiffness video colonoscopes (Olympus America) were used. The standard bowel preparation was a 4-liter oral lavage of polyethylene glycol electrolyte solution. Patients were monitored in a standard fashion and received conscious sedation with intermittent aliquots of intravenous midazolam and fentanyl.

At the outset of the monitored interval, the prior experience of gastroenterology fellows under review ranged from 3 to 36 months. All fellows had completed at least 1 month dedicated to endoscopy prior to their initial monitored month.

Variables assessed

Trainees were aware that a study examining certain colonoscopy parameters, including procedure times, was being conducted for quality improvement/control. They gave oral consent for participation in the study before its onset. The endoscopy nurse recorded times for the following procedural parameters: cecal intubation time, defined as the time from insertion of the colonoscope into the rectum until identification of the base of the cecum, confirmed by both trainee and supervising attending gastroenterologist; withdrawal time, defined as the time from cecal identification to the time when the colonoscope was withdrawn across the anus; and total procedure time. Withdrawal time included time taken for maneuvers such as polypectomy or biopsy that were performed during the withdrawal phase of the examination. Times were rounded to the nearest minute. Withdrawal times were also separately determined for cases with and without polypectomy performed. The number and size of polyps were recorded, and the pathology of polyps was determined. Finally, it was noted whether the fellow completed all phases of the colonoscopy without assistance of the supervising gastroenterologist.

Determining total number of colonoscopies performed

Trainees in our program are instructed at and perform colonoscopies at 4 hospitals. A running tally of the total number of colonoscopies performed by each fellow was determined by summing the number of colonoscopies performed from these 4 sites. The majority (8-10 months) of the fellows' clinical training is undertaken at 2 hospitals that have electronic medical records, which provided an accurate number of colonoscopies performed by each fellow at these primary sites. At the 2 community hospitals that do not use electronic records, an averaged number of colonoscopies performed per month at those locations was used, based on averaged records of 3 trainees who maintained accurate individual procedure logs (15 colonoscopies average; range 9-20). Fifteen colonoscopies was the number used for the trainee colonoscopy count for each month of training at those 2 hospitals. Colonoscopy "performed" was defined as any time the trainee physically participated in a colonoscopy.

Statistical analysis

Comparisons of the colonoscopy procedure times, completion rates, and number of polyps or adenomas detected were made between the first-year and third-year fellows. A *t*-test was used to compare the samples. Statistical significance was considered if the 2-sided *P* value was less than .05. A linear regression was used to estimate the percent independence as a function of number of colonoscopies. As is typical with responses that are expressed as a percentage, the arcsine square-root transformation was taken of the percent independence before the model was fitted, to obtain a linear relationship between the predictor and response and to obtain heterogeneous variance of the residuals (both assumptions required for the validity of the regression). The fitted values were transformed back to the original percentage scale for plotting, which produces a fitted curve that is not a straight line. Also, because of the transformation, the regression coefficient cannot be interpreted directly. However, it is possible to calculate an approximate slope at any given value of the predictor variable. Another assumption required for linear regression is the independence of the data. Our data include multiple observations from some of the fellows. To test for the effect of correlation among individuals, we fitted a linear mixed effects model with a random effect for fellow. This fit was then compared to the simple linear regression, and no important differences were found in the parameter estimates. We therefore report the results of the simple linear regression.

RESULTS

During the observation period, 11 gastroenterology fellows (6 women, 5 men) performed a total of 770 colonoscopies in the course of 18 individual monthly rotations at the VA medical center, with an average of 43 colonoscopies performed per month (range 11-61). Of the colonoscopies performed, 748 (97%) were on male patients. During the month-long observational interval, the fellows were at various stages of fellowship training (month 3-36). For example, prior to their first colonoscopy, which was observed as part of this study, first-year fellows had performed, on average, 119 colonoscopies (range 31-250). In contrast, when second-year fellows began the observational interval, they had performed, on average, 318 colonoscopies (range 264-372), whereas third-year fellows beginning the observational interval had performed, on average, 566 colonoscopies (range 372-678).

Procedural data

As shown in Table 1, total colonoscopy time was 48 minutes (range 41-60 minutes) for first-year fellows compared to 33 minutes (range 31-42 minutes) for third-year fellows (*P* < .001). Time to cecal intubation for first-year fellows was 19 minutes, compared to 11.4

TABLE 1. Procedure data by year of training recorded for 11 individual fellows over an 18-month observational period

Procedure data	Year of training			P value
	First	Second	Third	
Total colonoscopies performed/no. of fellows	369/9	158/4	243/5	
Average colonoscopies performed per month	41	40	49	
Mean colonoscopy time (min)	48	31	33	<.001
Mean time to cecal intubation (min)	19	10	11	<.001
Colonoscopy completion* rate (%)	63	84	92	<.001
Polyp detection rate per patient	2.5	2.2	2.7	.94
Adenoma detection rate per patient	1.1	1.3	1.2	.64
Procedures with adenoma detected (%)	47	47	54	
Withdrawal time (min)	29	21	22	<.001
With polypectomy	33	26	25	<.001
Without polypectomy	18	14	16	.13

P values calculated (by *t*-test) comparing differences between first- and third-year fellows.

*The fellow completed all phases of the endoscopy without assistance of the supervising gastroenterologist.

minutes for third-year fellows ($P < .001$). There were modest, relevant changes in time taken to withdraw the colonoscope (with or without polyps) in the course of the fellowship. There was no difference in the detection of adenomas in colonoscopies performed by first- and third-year fellows.

Colonoscopy independence

No fellow was able to reliably perform colonoscopy independently $\geq 90\%$ of the time after having performed the threshold of 140 colonoscopies (Fig. 1). Our first fellow to perform colonoscopy independently $\geq 90\%$ of the time during a month-long observational period had performed 330 colonoscopies prior to starting the interval. It was not until 500 colonoscopies were performed that all trainees obtained $\geq 90\%$ colonoscopy independence reliably during the month-long observational interval. First-year fellows performed colonoscopy independently 63% of the time, compared to 92% in third-year fellows ($P < .001$).

The relationship between percent independence and the number of colonoscopies performed is significant ($P = .0041$). The fitted regression line is shown in Figure 1. The estimated percent independence at 140 colonoscopies is just 64%. The estimated percent independence at 300 colonoscopies is 78%, and the estimated rate of increase in percent independence is 1% per 12 additional colonoscopies. The estimated percent independence at 467 colonoscopies is 90%, whereas the estimated percent independence at 500 colonoscopies is 92%.

DISCUSSION

Although there is widespread agreement that competence is the goal of training of medical residents and subspecialty fellows, measurement of competence is more problematic. Colonoscopy provides an attractive model to use objective parameters to test for procedural competence. The primary aim of this study was to use objective, easily recorded parameters that have received favorable review by experts as a means of assessing competence of trainees to carry out colonoscopy. ACGME guidelines have encouraged the use of a panel of tools to assess competence. These include direct observation, 360-degree or multisource evaluations, and procedure logs. In addition, guidelines recommend an arbitrary minimal threshold number of procedures (140 colonoscopies) as a requirement for completion of training. An informal survey we performed canvassing gastroenterology fellowship program directors has clearly shown that there is no consensus on this estimation. Most considered 140 to be insufficient, and several considered 500 or more to be required (personal communication with 49 American Board of Internal Medicine–accredited gastroenterology fellowship program directors).

When reviewing the experience of our fellows, we found, by use of objective parameters including colonoscopy independence, total colonoscopy time, time to cecal intubation, and withdrawal times, that the ability to perform colonoscopy improves throughout training. Although the rate of acquisition of colonoscopy independence differed among fellows, all reached $\geq 90\%$

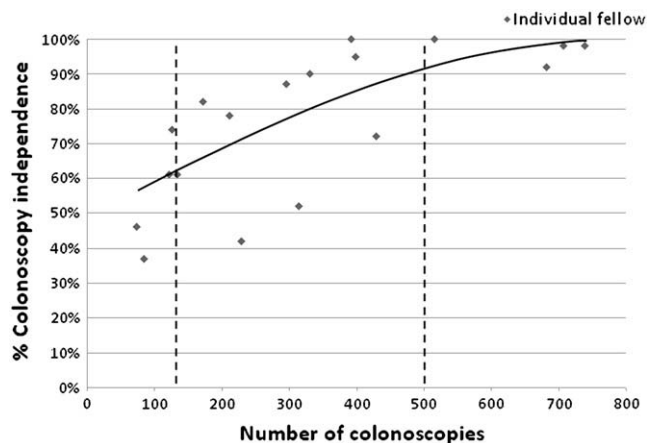


Figure 1. Colonoscopy independence based on the total number of colonoscopies performed. The first vertical dashed line represents the current threshold of 140 colonoscopies (a point by which no fellow had obtained 90% colonoscopy independence). The second vertical dashed line represents 500 colonoscopies (a point by which all fellows had reached 90% colonoscopy independence). Data were generated based on 11 individual fellows over an 18-month observation period. The fitted line is based on a linear regression in which the percent independence is transformed, and then the fitted values are transformed back. This results in a curved fit.

colonoscopy independence in the course of 3 years of training. Our data indicate and further validate the study findings of Cass et al⁷ and Chak et al⁸ that, although the stage of training at which an individual fellow achieves colonoscopy independence differs, no one achieves colonoscopy independence after only 140 colonoscopies. Therefore, if a threshold number must be used as the determination of competence in performing colonoscopies, neither 50 colonoscopies (threshold for general surgeons) nor 140 colonoscopies (threshold for gastroenterology fellows) performed would be adequate. In fact, the earliest level at which any of our trainees reached the $\geq 90\%$ colonoscopy independence rate was 330 colonoscopies, and it was not until 500 colonoscopies were performed that all trainees reliably reached the 90% colonoscopy independence rate. This suggests that 500 colonoscopies may be a more appropriate minimal threshold to ensure competence, if competence is solely defined as $\geq 90\%$ colonoscopy independence.

During our study, we did not observe a difference in the rate of polyp detection among fellows or years of training. This attests to the supervised nature of these tests, and shows that the patients' interests are protected while the fellows are learning. Thus, polyp detection rates should not be factored into the equation of determining competence. Additionally, a high total number of polyps per patient was detected, perhaps because a large percentage of patients had received colonoscopy previously and were undergoing repeat colonoscopy as follow-up for detection of a prior polyp.

Our study does not consider what frequency of procedure performance is needed to maintain competence in colonoscopy.

A recent study⁹ from Canada found that colonoscopists who performed fewer than 240 colonoscopies per year had significantly more incomplete colonoscopies than those who performed 370 colonoscopies per year. These data suggest that continued practice is required for maintenance of competence. Transferring this observation to the fellowship setting, we have the unanswered question of how many procedures are necessary to maintain competence, once a trainee achieves competence. For example, if a fellow is competent after 350 colonoscopies carried out in the first 18 months of fellowship, how many are necessary to maintain this level of competence until the fellow graduates?

There are limitations to our study. Because our observations were made during VA clinical rotations, it is not surprising that men predominated the population receiving colonoscopy. This is an important consideration, because colonoscopy is more difficult in women, and the numbers required to reach competence may be greater in a more gender-balanced population. The lack of a protocol for intervention by an attending gastroenterologist during a colonoscopy created variability in decisions regarding when to assist, but we think this variability was limited by the fact that 2 attending gastroenterologists with primary VA assignments supervised the majority of cases. Allowing extended periods of time (48 minutes for first-year trainees) to perform a colonoscopy may not be realistic for a trainee learning colonoscopy at a private hospital, and that likely reflects that the study was performed at a VA hospital. However, this setting may provide a more accurate delineation of the true learning curve in colonoscopy. Also, although time to cecal intubation was recorded, we did not record cecal intubation rates specifically, but rather "independent completion rates" as including both cecal intubation and polyp detection/removal. This point should be considered in future studies evaluating measures of competence in colonoscopy. Finally, the number of trainees included in the study is small and from a single training program but is well-matched for gender (6 women, 5 men).

What do these data mean? Based on our findings, we suggest that individualized assessment of competence and serial monitoring during the course of training are required to determine a trainee's ability to perform a colonoscopy. Although an absolute threshold number of procedures is a poor surrogate for a more nuanced assessment, if a threshold were to be used, we would suggest that it be at 500 procedures, as this reliably ensures $\geq 90\%$ colonoscopy independence rates. We find that, rather than setting a threshold number, the toolbox approach advocated by the ACGME is most attractive. In this plan, each program could use a panel of testing methods, including multisource evaluations, procedure logs, direct observation, and the achievement of specific markers, to assess the endoscopic skill of trainees. These measures could be linked to common procedures such as colonoscopy, polypectomy, upper GI endoscopy, esophageal dilatation, and simple motility studies. The use of simulators to assess competence is also worthy of

consideration.¹⁰ In addition, we should not forget that competence is more than technical ability with an endoscope, but, as embodied within the 6 core competencies, must include appropriate selection of patients, communication (explaining risks and benefits, communicating results to patients and family), professionalism, systems-based practice, and practice-based learning. Indeed, our study embodies elements of practice-based learning, systems-based practice, and professionalism.

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Received January 28, 2009. Accepted May 4, 2009.

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