

Table 5A. Learning curves and threshold numbers as a measure for EGD, sigmoidoscopy and colonoscopy.

Study	Setting and participants	n participants	Assessment method – outcome measures	Results	LOE
Sedlack (2011)	Single center, prospective, trainees at different levels of experience	41	Learning curves through assessment (MCSAT) with scores from 1-4: competency when score >3.5. CIR & time to cecum.	4103 of 6635 colonoscopies (62%) assessed (mean n per trainee: 399; 95% CI 365-433). Competency after mean 275 procedures. CIR of 85% after 250-275 colonoscopies, time to cecum <16 min after 275.	⊕⊕⊕ ⊕
Koch et al (2012)	Single center, prospective, trainees at different levels of experience	19	Learning curves through self-assessment (Rotterdam Assessment Form for Colonoscopy). CIR and time to cecum.	2887 colonoscopies (152 per trainee, range 91-347). Baseline CIR: 65% improved to 78% after 100 and 85% after 200 colonoscopies (p<0.001). After 280 ≥90% CIR. Time to cecum decreased from baseline 13:10 min to 8:30 min after 200.	⊕⊕⊕ ⊕
Chung et al (2009)	Single center, prospective, GI fellows with no colonoscopy experience	12	Learning curves per 50 procedures for adjusted completion rate (>90%) and time to cecum (<20 min).	3243 colonoscopies (n per trainee not mentioned). First 50 completion was 37% and improved to 94% after 250. Mean time improved from 12.9 min to 8.0 min. After 200 procedures, >90% completion rate within 20 min was reached.	⊕⊕⊕○
Lee et al (2008)	Multicenter, prospective, first-year GI fellows with no colonoscopy experience	24	Outcome: adjusted CIR (>90%) and time to cecum (<20 min). Learning curves per 50 colonoscopies.	4351 colonoscopies (n per trainee not mentioned). CIR per 50 consecutive procedures: 71.5% - 82.6% - 91.3% - 94.4% - 98.4% - 98.7% (p<0.05). Time to cecum decreased from 11.2 min to 6.6 min. Competency after 150 procedures.	⊕⊕⊕○

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Tassios et al (1999)	Single center, prospective, trainees with no colonoscopy experience	8	Learning curves for completion rate. Outcome: completion of colonoscopy (CIR) per training year and per number of procedures performed.	N = 978 colonoscopies performed by trainees (median n 1 st year: 43, range 31-69 and 2 nd year 91 (79-143). Completion rates in %: first-year 33 (range 15-42); second-year 60 (range 55-79) and third-year 75 (range 58-94) (p<0.001). Per number: after 60 52.6 (95% CI 45.2-59.9); after 100 67.1 (95% CI 59.1-75.2) and after 180 76.8 (95% CI 66.1-87.6).	⊕⊕○○
Marshall et al (1995)	Multicenter, prospective, first and second-year trainees with different levels of experience.*	9	Frequency of reaching cecum <30 min in last 7 months of 1 st and 2 nd year training.	N colonoscopies: 186 (n per trainee not mentioned) by first-year and 203 by second-year fellows. CIR 1 st year: 53.7%, 2 nd year 85.8%. Time to cecum 28, 19 and 9 min, respectively. Difference in performance by groups (p<0.001).	⊕⊕○○
Selvasekar et al (2012)	Single center, prospective, fellows with different levels of experience in colonoscopy	6	Learning curves by completion and time to cecum. Cusum analysis. Competency defined as significant reduction in time and 80% CIR within 35 min.	1498 out of 2904 colonoscopies performed by fellows (mean n per fellow 249). Mean procedure time 30.2 +-15 min; decreased significantly during first 120 procs (p<0.001). 80% completion within 35 min after 114 colonoscopies.	⊕⊕○○
Parry et al (1990)	Single center, retrospective, trainee with no experience in colonoscopy	1	Learning curve by cusum analysis for completion rate.	305 of 334 consecutive colonoscopies analyzed. First 100 procedures completion rate 67%, 101-200 was 88% and 201-305 91%. After 200 procedures, steady >90% completion.	⊕○○○

Study	Setting and participants	n participants	Assessment method – outcome measures	Results	LOE
Cass et al (1993)**	Single center, prospective cross-sectional design, surgical and GI trainees with different levels of endoscopy experience. <i>EGD</i>	12	Intubation esophagus	Median 113 UGI endoscopies per trainee (range 54-162). Esophagus intubation 90% after 50 procedures, but declined and reached 80% after 100 procedures.	⊕⊕⊕○
Cass et al (1993)**	<i>Colonoscopy</i>	12	Intubation cecum	Median 49 colonoscopies per trainee (range 39-127). CIR of 80% after 50 procedures but only 85% at 100 procs.	⊕⊕⊕○
Chak et al (1996)	Single center, prospective, GI fellows at various stages of endoscopy training, attendings	12 fellows, 17 attendings	Cecal intubation rate, time to cecum per training year, assistance needed. Adequacy of threshold of 100 colonoscopies	496 colonoscopies performed (79 by 5 first-years, 102 by 7 second-years, 315 by attendings). Second-years performed mean of 123 colonoscopies prior to study. First-years required assistance in 92% of procs vs 36% for second-years. CIR second-years vs attendings: 84 vs 94%, p<0.05. Time to cecum second-years vs attendings: 14.5 vs 10.5 min (p<0.01). 90% success rate within 15 min not reached after 100.	⊕⊕⊕○
Vassiliou et al (2010)**	Multicenter, prospective design, surgical and GI trainees with different levels of endoscopy experience. Single observations. <i>UGI endoscopy</i>	86	Score on GAGES for UGI, 3 different groups: <35 cases (1), 35-130 cases (2), >130 cases (3)	86 evaluations, group (1) n=35, (2) n=22, (3) n=29. Mean +-SD score: (1) 14.4 +- 3.7; (2) 17.8 +- 1.8; (3) 19.1 +- 1.1. Difference between groups significant (p<0.05) but not for (2) and (3). Plateau score at n=50.	⊕⊕○○

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Vassiliou et al (2010)**	Colonoscopy	57	Scores on GAGES colonoscopy, 2 groups: cutoff <50 cases (1) and <140 cases (2); novices and experienced	57 evaluations, cutoff (1) 29 novices vs 28 experienced. Mean +- SD score: (1) novices 11.8 +-3.8 vs. experienced 18.8 +- 1.3 (p<0.001). Cutoff (2) 32 vs. 25. Novices 12.4 +- 4.2 vs. experienced 18.8 +- 1.3. No difference between cutoff groups. Plateau score at n=75.	⊕⊕○○
Spier et al (2010)	Single center, surgical trainees who participated in 2-month endoscopy rotation, survey	21	Numbers performed, CIR, perception of colonoscopy training	100% response rate, 15 2 nd year residents, 6 4 th year. Mean 80 +- 35 colonoscopies during rotation. Average CIR 47% (range 9-78%). Adequacy of training: 67% of 2 nd year felt it was adequate vs 100% 4 th years.	⊕⊕○○
Spier et al (2010)	Single center, retrospective, GI fellows at various stages of endoscopy training	11	Total colonoscopy time, time to cecal intubation, independent completion rates. Adequacy of threshold of 140 colonoscopies	770 colonoscopies performed (369 by 9 first-years, 158 by 4 second-years, 243 by 5 third-years). Improvements from first- to third-year: mean colonoscopy time from 48 to 33 min, time to cecal intubation 19 to 11 min, completion rate 63 to 92% (all p<0.001). No independent completion of >90% after 140 colonoscopies.	⊕⊕○○
Leyden et al (2011)	Single center, retrospective, GI and surgical trainees with >2 years endoscopic experience	13	Completion rates, polyp detection rates, withdrawal time in subset of patients, comparison of GI and surgical trainees	1998 and 1081 colonoscopies performed by GI and surgical trainees, respectively. Crude completion rate for GI vs surgical: 84 vs 78% (p<0.0001). PDR was 21 vs. 14% (p<0.001); withdrawal time 5 vs 2.5 min (p=0.003).	⊕⊕○○

Study	Setting and participants	n participants	Assessment method – outcome measures	Results	LOE
Church et al (2002)	Single center, prospective, trainees with different endoscopy experience	18	Performance during first 125 colonoscopies, completion rate defined as cecum reached by trainee as a percentage of completion by staff. Time to cecum	Completion improved from first 25 cases to fifth 25 cases: 43.1% to 75.1%. Time to cecum from 18.7 to 17.1 min.	⊕○○○
Hawes et al (1986)	Single center, prospective, residents rotating on GI ward performing <i>sigmoidoscopy</i>	25	Assessment of overall skill on 6-point competence scale (1-3 not competent, 4-6 competent), accuracy of diagnosis	495 of 662 sigmoidoscopies were graded. Initial 10 examinations largely graded 3 or less. Examinations 10 to 25: largely grade 3 or 4, and >25, 82% was graded 4 or above. With increasing competence score, more correct diagnoses.	⊕○○○

*2 testing periods. Period 1: 4 first-year fellows, 2 second-year. Period 2: 3 first-year fellows, 4 second-year.

** These studies reported on both UGI endoscopy and colonoscopy, the study population is the same.