Supplemental Digital Appendix 1

ACE Tool for EGD

Confidential

ACE Tool: EGD

Record ID _____

Evaluating Physician: _____

Number of EGDs Completed Prior to 01-JUL-2016: _____

Procedure Number _____

Date: _____

Time of Intubation: _____

Time of Maximal Insertion Extent: _____

Time of Extubation: _____

1. Fellow's knowledge of the indication & pertinent medical issues (INR, Vitals, Allergies, PMH etc.):

- ◯ N/A Fellow observed
- ◯ 1. Novice (Poor knowledge of patient's issue, or started sedating without knowing the indication)
- ◯ 2. Intermediate (Missed an Important element, i.e. Allergies, GI Surgical History or INR if pt on Coumadin)
- ◯ 3. Advanced (Missed minor elements)
- ◯ 4. Superior (Appropriate knowledge and integration of patient information)

2. Management of patient discomfort during this procedure (sedation titration, insufflation management, loop reduction):

- ◯ N/A Fellow observed
- ◯ 1. Novice (Does not quickly recognize patient discomfort or requires repeated staff prompting to act)
- ◯ 2. Intermediate (Recognizes pain but does not address in a timely manner)
- ◯ 3. Advanced (Adequate recognition and correction measures)
- ◯ 4. Superior (Competent continuous assessment & management. i.e. intermittently reassess sedation level and comfort)

3. What is the farthest landmark the fellow reached without any hands-on assistance?:

- ◯ N/A Fellow observed only or Procedure terminated before completion
- ◯ 1. Hypopharynx
- ◯ 2. Distal esophagus
- ◯ 3. Stomach
- ◯ 4. Duodenal bulb
- ◯ 5. Second portion of the duodenum
- ◯ 6. Other (Post-surgical anatomy encountered, fellow reached maximal intubation)

4. Scope tip control/advancement techniques (esophageal intubation, traversing pylorus & duodenal sweep):

- ○ N/A Fellow observed
- ○ 1. Novice (Unable to intubate esophagus or traverse pylorus without significant coaching or assistance)
- ○ 2. Intermediate (Slow advancement, wide tip motions, repeated attempts needed to intubate esophagus or traverse pylorus)
- ○ 3. Advanced (Reasonable fine tip control for all intubation, traverse pylorus and inspection)
- ○ 4. Superior (Safe & effective technique, efficient independent advancement without the need for coaching)

5. Adequately visualized mucosa during withdrawal (including retroflexion):

- ○ N/A Fellow observed withdrawal
- ○ 1. Novice (difficulty with retroflexion, requires assistance to visualize significant portions of the mucosa)
- ○ 2. Intermediate (Able to visualize much of the mucosa but requires direction to re-inspect missed areas)
- ○ 3. Advanced (Able to adequately visualize most of the mucosa without coaching)
- ○ 4. Superior (Competent visualization around difficult turns and folds and good use of suction/cleaning techniques.)

6. Pathology identification/ interpretation:

- ○ N/A Study was normal (Go to Question 7)
- ○ 1. Novice (Poor recognition of abnormalities. Misses or doesn't recognize significant pathology)
- ○ 2. Intermediate (Recognize abnormal findings but cannot interpret. i.e. "Erythema")
- ○ 3. Advanced (Recognizes abnormalities and correctly interprets. i.e. "erythema suggestive of gastritis")
- ○ 4. Superior (Competent identification & assessment. e.g. "erythema with erosions in a pattern suggestive of NSAID gastropathy")

7. Interventions performed by fellow:

- ☐ N/A Fellow did not perform any interventions (go to question 8)
- ☐ Biopsy
- ☐ Submucosal injection (Saline, Epinephrine, Other)
- ☐ Band ligation
- ☐ Hemostasis (Hemoclip, electrocautery, etc)
- ☐ PEG tube placement
- ☐ Dilation (Balloon, Savary, other)
- ☐ APC vascular lesion ablation (GAVE, A VMs)
- ☐ Other

If Other, please specify:

7a. What was the fellow's participation in the therapeutic maneuver(s) (tool & setting selection and ability to apply tool effectively):

- ○ 1. Novice (Performed with significant hands-on assistance)
- ○ 2. Intermediate (Performed with minor hands-on assistance or significant coaching)
- ○ 3. Advanced (Performed independently with minor coaching)
- ○ 4. Superior (Performed independently without coaching)

Overall Assessment:

8. The fellow's overall hands-on skills:

- ◯ N/A Not Assessed (i.e. Fellow observed procedure only)
- ◯ 1. Novice (Learning basic scope advancement; requires significant hands-on assistance and coaching)
- ◯ 2. Intermediate (Acquired basic motor skills but still requires limited hands-on assistance and/or significant coaching)
- ◯ 3. Advanced (Able to perform independently with limited coaching and/or requires additional time to complete)
- ◯ 4. Superior (Competent to perform routine EGD independently)

9. The fellow's overall cognitive skills (Situational awareness (SA)/ abnormality interpretation/decision making skills):

- ◯ N/A Not Assessed (i.e. Fellow observed procedure only)
- ◯ 1. Novice (Needs significant prompting, correction or basic instruction by staff)
- ◯ 2. Intermediate (Needs intermittent coaching or correction by staff)
- ◯ 3. Advanced (Fellow has good SA, and interpretation/ decision making skills)
- ◯ 4. Superior (Competent to make interpretations and treatment decisions independently)

Would you feel comfortable having this trainee perform this procedure with remote supervision (supervising physician not in room but readily available)?

- ◯ Yes
- ◯ No

Would you feel comfortable having this trainee perform this procedure independently?

- ◯ Yes
- ◯ No

Entrustment

What TRAINEE factors contributed most to your entrustment decision? Please choose the 3 most important factors:

- ☐ Procedural competence
- ☐ Reliability (trainee is predictable, will do what they say they will do)
- ☐ Truthfulness (trainee will describe what they observed and did, including what they should have done but did not)
- ☐ Recognition of limitations (willingness to ask for help)
- ☐ Communication skills (with endoscopy team/patient/supervising physician)
- ☐ Trainee confidence (lacking overconfidence)

Try to describe why you made your entrustment decision:

_____

Supplemental Digital Appendix 2

ACE Tool for Colonoscopy

ACE Tool: Colonoscopy

Record ID _____

Evaluating Physician: _____

Number of Colonoscopies Completed Prior to 01-JUL-2016: _____

Procedure Number: _____

Date: _____

Time of Intubation: _____

Time of Maximal Insertion Extent: _____

Time of Extubation: _____

1. Fellow's knowledge of the indications & pertinent medical issues (INR, Vitals, Allergies, PMH, etc):

- ◯ N/A Not assessed (i.e. Fellow observed procedure only)
- ◯ 1. Novice (Poor knowledge of patient's issues, or started sedating without knowing the indication)
- ◯ 2. Intermediate (Missed an important element, i.e. Allergies, GI Surgical History or INR in pt on Coumadin
- ◯ 3. Advanced (Missed minor elements)
- ◯ 4. Superior (Appropriate knowledge and intergration of patient information)

2. Management of patient discomfort during this procedure (Sedation Titration, Insufflation management, Loop reduction):

- ◯ N/A Fellow observed
- ◯ 1.Novice (Does not quickly recognize patient discomfort or requires repeated staff prompting to act)
- ◯ 2.Intermediate (Recognizes pain but does not address cause [loop or sedation problems] in a timely manner)
- ◯ 3. Advanced (Adequate recognition and corrective measures)
- ◯ 4. Superior (Competent continuous assessment & management, i.e. intermittently reassess level of sedation and comfort)

3. Effective and efficient use of air, water and suction:

- ◯ N/A Not Assessed (i.e. Fellow observed procedure only)
- ◯ 1. Novice (Repeated prompting due to too much/little air, Inadequate washing or repeated suctioning of mucosa)
- ◯ 2. Intermediate (Occasional Prompting due to too much/little air, Inadequate washing or repeated suctioning of mucosa)
- ◯ 3. Advanced (Adequate use of air, water and suctioning, but room to improve on efficiency)
- ◯ 4. Superior (Efficient and effective management of washing, suctioning and air)

4. Lumen identification:	◯ N/A Not Assessed (i.e. Fellow observed procedure only) ◯ 1. Novice (Generally only able to recognize lumen if in direct view) ◯ 2. Intermediate (Can grossly interpret large folds to help locate which direction the lumen is located) ◯ 3. Advanced (Can use more subtle clues (Light/shadows, arcs of fine circular muscles in wall) but struggles at times) ◯ 4. Superior (Quickly and reliably recognizes where lumen should be based on even subtle clues)
5. Scope steering technique during advancement:	◯ N/A Not Assessed (i.e. Fellow observed procedure only) ◯ 1. Novice (Primarily "Two-hand knob steering", Unable to perform two steering maneuvers simultaneously) ◯ 2. Intermediate [(Frequent 2-hand knob steering, Limited use of simultaneous steering maneuvers (i.e. torque, knob, advance)] ◯ 3. Advanced (Primarily uses torque steering. Can perform simultaneous steering techniques) ◯ 4. Superior [Effortlessly combines simultaneous steering techniques (torque, knob, advance) to navigate even many difficult turns]
6. Fine tip control:	◯ N/A Not Assessed (i.e. Fellow observed procedure only) ◯ 1. Novice (Primarily gross tip control only, frequently in red out) ◯ 2. Intermediate (Limited fine tip control "frequently over-steers turns, struggles with biopsy forceps/ snare targeting") ◯ 3. Advanced (loses fine control when keeping lumen or targeting tools at difficult turns when torque or knobs are needed) ◯ 4. Superior (Excellent fine tip control or tool targeting even in difficult situation.)
7. Loop reduction techniques (pull-back, external pressure, patient position change):	◯ N/A Not Assessed (i.e. Fellow observed procedure only) ◯ 1. Novice (Unable to reduce/ avoid loops without hands-on assistance) ◯ 2. Intermediate (Needs considerable coaching on when or how to perform loop reduction maneuvers) ◯ 3. Advanced (Able to reduce/ avoid loops with limited coaching) ◯ 4. Superior (without coaching, uses appropriate ext. pressure/ position changes/ loop reduction techniques)

8. What is the farthest landmark the fellow reached without any hands-on assistance?:	◯ N/A Fellow observed only or Procedure terminated before completion. ◯ 1. Rectum ◯ 2. Sigmoid ◯ 3. Splenic flexure ◯ 4. Hepatic flexure ◯ 5. Cecum No TI attempt (Reached cecum with no attempt at TI intubation) ◯ 6. Cecum Failed TI attempt (Reached cecum but Failed attempt at TI intubation) ◯ 7. Terminal ileum (successful intubation of TI) ◯ 8. Other-Post surgical anatomy encountered, fellow reached maximal intubation
9. Adequately visualized mucosa during withdrawal:	◯ N/A Not Assessed (i.e. Fellow observed procedure only) ◯ 1. Novice (red out much of the time, does not visualize significant portions of the mucosa or requires assistance) ◯ 2. Intermediate (Able to Visualize much of the mucosa but requires direction to re-inspect missed areas) ◯ 3. Advanced (Able to adequately visualize most of the mucosa without coaching) ◯ 4. Superior (Good visualization around difficult corners and folds and good use of suction/ cleaning techniques.)
10. Pathology identification/ interpretation:	◯ N/A Study was normal (Go to question 11) ◯ 1. Novice (Poor recognition of abnormalities. Misses or cannot 1D significant pathology) ◯ 2. Intermediate (Recognizes abnormal findings but cannot interpret. "erythema") ◯ 3. Advanced (Recognizes abnormalities and correctly interprets. "colitis") ◯ 4. Superior (Competent Identification and assessment "Mild chronic appearing colitis in pattern suggestive of UC")
10a. Independent polyp detection by fellow:	◯ N/A No Polyps present ◯ 1. None (Staff identified all polyps) ◯ 2. Some (Fellow independently identified at least one polyp but not all polyps present) ◯ 3. All (Fellow independently ID 'ed all polyps encountered)
10b. Accurate location of lesion/pathology:	◯ 1. Novice (Unable to use landmarks to ID location in the colon, "I don't know ") ◯ 2. Intermediate (Understands landmarks but either does not recognize or incorporate into decision making process). ◯ 3. Advanced (Good understanding and recognition of landmarks but generalizes pathology location "Descending colon") ◯ 4. Superior (Very Specific about location, e.g. "Splenic Flexure region approx. 60 cm from the anal verge with a straight scope"

11. Interventions performed by fellow:

- ☐ N/A Fellow did not perform any interventions (go to question 12)
- ☐ Biopsy
- ☐ APC Vascular lesion ablation (AVMs)
- ☐ Snare polypectomy
- ☐ Hemostasis (Hemoclip, electrocautery, etc)
- ☐ Submucosal injection (Lift, Epinephrine, Tattoo)
- ☐ Other

If Other, please specify:

_____

11a. What was the fellow's participation in the therapeutic maneuver(s) (ability to apply tool effectively)?:

- ○ N/A Not assessed (i.e. Fellow observed procedure only)
- ○ 1. Novice (Performed with significant hands-on assistance or coaching)
- ○ 2. Intermediate (Performed with minor hands-on assistance or significant coaching)
- ○ 3. Advanced (Performed Independently with minor coaching)
- ○ 4. Superior (Performed independently without coaching)

11b. What was the fellow's knowledge of the therapeutic tool(s) (tool selection, knowledge of set up, cautery setting, how to employ tool)?:

- ○ N/A Not Assessed (i.e. Fellow observed procedure only)
- ○ 1. Novice (Unsure of the possible tool(s) indicated or settings for pathology encountered.)
- ○ 2. Intermediate [(Able to identify possible appropriate tool choices but not sure which would be ideal (Snare vs lift & snare)]
- ○ 3. Advanced (Independently selects the correct tool yet needs coaching on settings)
- ○ 4.Superior (Independently identifies correct tool and settings as applicable.)

Overall Assessment:

12. The fellow's overall hands-on skills:

- ○ N/A Not Assessed (i.e. Fellow observed procedure only)
- ○ 1. Novice (Learning basic scope advancement; requires significant assistance and coaching)
- ○ 2. Intermediate (Acquired basic motor skills but still requires limited hands-on assistance and/or significant coaching)
- ○ 3. Advanced (Able to perform independently with limited coaching and/or requires additional time to complete)
- ○ 4. Superior (Competent to perform routine colonoscopy independently)

13. The fellow's overall cognitive skills (Situational Awareness/abnormality interpretation/decision making skills):

- ○ N/A Not Assessed (i.e. Fellow observed procedure only)
- ○ 1. Novice (Needs significant prompting, correction or basic instruction by staff)
- ○ 2. Intermediate (Needs intermittent coaching or correction by staff)
- ○ 3. Advanced (Fellow has good SA, and interpretation/ decision making skills)
- ○ 4. Superior (Competent to make interpretations and treatment decisions independently)

Entrustment

Would you feel comfortable having this trainee perform this procedure with remote supervision (supervising physician not in room but readily available)?	◯ Yes ◯ No
Would you feel comfortable having this trainee perform this procedure independently?	◯ Yes ◯ No
What TRAINEE factors contributed most to your entrustment decision? Please choose the 3 most important factors:	☐ Procedural competence ☐ Reliability (trainee is predictable, will do what they say they will do) ☐ Truthfulness (trainee will describe what they observed and did, including what they should have done but did not) ☐ Recognition of limitations (willingness to ask for help) ☐ Communication skills (with endoscopy team/patient/supervising physician) ☐ Trainee confidence (lacking overconfidence)
Try to describe why you made your entrustment decision:	_____

Supplemental Digital Appendix 3

Statistical Analysis

Cumulative sum (CUSUM) analysis was used to create individualized learning curves. A successful procedure was designated as *s* and failure as 1- *s*. The reward for a successful procedure(s) was less than the penalty for a failed procedure (1-*s*) and >1 success was needed to compensate for a failure. Acceptable failures rates (p0, level of inherent error if procedure is carried out correctly) and unacceptable failure rates (p1, where p1- p0 represents the maximum acceptable level of human error, score <3) were set at 0.1 and 0.2, respectively. CUSUM graphs were constructed to assess overall colonoscopy and EGD performance based on these predetermined rates. The CUSUM scores were calculated from the probabilities of success, p0, and the probabilities of failure, p1, as such: $s = Q / (Q + P)$ where $P = 1n (p1/p0)$ and $Q = [(1-p1) / (1-p0)$, where n equals the number of procedures performed. As such, $s = 0.15$, and $1 – s = 0.85$ when $p0 = 0.1$ and $p1 = 0.2$.

CUSUM curves were created by plotting the cumulative sum after each case against the index number of that case. Cn was the sum of all individual outcome scores and the CUSUM graph depicts when Cn crosses a predetermined decision interval, H. H0 represents the value between each acceptable decision interval and H1 the value between each unacceptable decision level and are marked as horizontal lines on the graph. These limits are calculated based on the risk for type 1(α) and type II (β) error which was set at 0.1 for this analysis. Formulae for H0 and H1 were: $H1 = a / (P + Q)$ and $H0 = b / (P + Q)$, where $a = 1n [(1-β) / α]$ and $b = 1n[(1-α) / β]$. When the CUSUM plot crossed below the acceptable line, the performance was acceptable and when the plot was between the two boundary lines, no conclusion could be drawn and further training was recommended. Aggregate learning curves were created by year of training using generalized linear mixed effects models with a random intercept for each trainee and an auto-regressive covariance structure. This allowed for compilation of trainees' data to estimate "average" learning experiences and achievement of competency with 95% CIs by year of training.

Supplemental Digital Appendix 4

Participating Gastroenterology Fellowships

Program Name	Location
University of Colorado	Aurora, CO
University of California, Irvine	Irvine, CA
Drexel University	Philadelphia, PA
University of South Alabama	Mobile, AL
University of Texas Health, San Antonio	San Antonio, TX
Northwestern University	Chicago, IL
Washington University in St. Louis	St. Louis, MO
Providence Park Hospital	Southfield, MI
State University of New York Downstate	Brooklyn, NY
Advocate Lutheran General Hospital	Park Ridge, IL
University of Wisconsin, Madison	Madison, WI
Oschner Clinic	New Orleans, LA

Supplemental Digital Appendix 5

Breakdown of Interventions Performed in EGD and Colonoscopy

Interventions	1st Year Trainees	2nd Year Trainees	3rd Year Trainees
EGD			
Dilation	3.4%	5.6%	7.1%
Band Ligation	2.4%	4.3%	3.8%
Hemostasis	3.1%	1.9%	2.5%
Submucosal Injection	1%	1%	1.7%
APC	1%	0.9%	0.8%
PEG Tube	0.9%	0.9%	1.3%
Other	2.7%	2.8%	2.9%
Colonoscopy			
Snare Polypectomy	21.7%	32.4%	30.1%
Submucosal Injection	2.8%	4.2%	2.9%
Hemostasis	2%	3.5%	2.2%
APC	0.6%	1.2%	0.7%
Other	0.6%	0.8%	1.8%

APC: argon plasma coagulation; PEG: percutaneous endoscopic gastrostomy.

