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International Validation of a Novel PEACE Scale to Improve the Quality of Upper Gastrointestinal Mucosal Inspection During Endoscopy

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PEACE scale's international validation

- 16 expert endoscopists (6 North America, 6 Europe and Middle East, 4 Japan and Australia)
- Teaching with 21 photographs, 4 example videos, 4 test videos
- Assessment of 39 videos
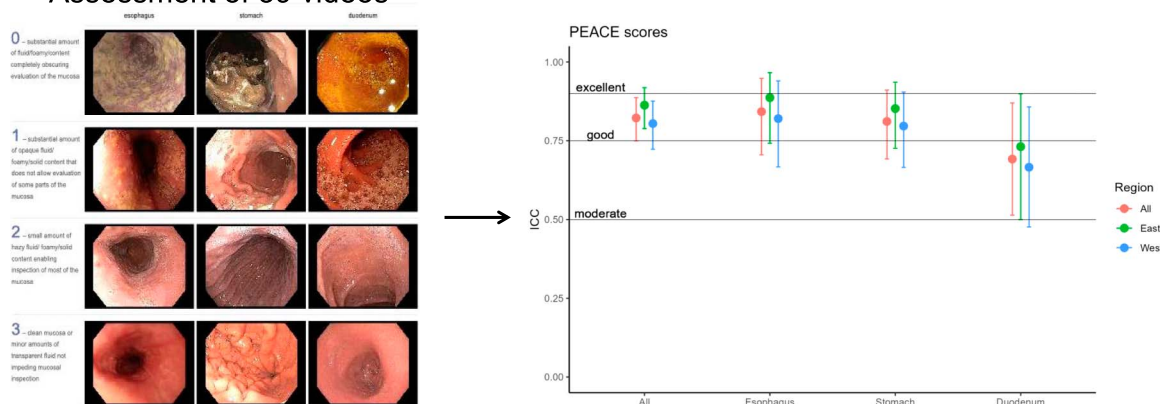
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Clinical and Translational GASTROENTEROLOGY

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INTRODUCTION: **The performance of a high quality esophagogastroduodenoscopy (EGD) is dependent on the mucosal cleanliness. Recently, the Polprep: Effective Assessment of Cleanliness in EGD (PEACE) scale was created to assess the degree of mucosal cleanliness during EGD. The aim of this study was to validate this scoring system in a cohort of international endoscopists.**

METHODS: **In total, 39 EGD videos, with different degrees of mucosal cleanliness were retrieved from a previously conducted prospective trial. All experts rated the cleanliness of the mucosa on each video using the PEACE scale. To evaluate agreement of all scores (0–3), intraclass correlation coefficient 2.1 was used. The agreement on adequate (scores 2 and 3) and inadequate (scores 0 and 1) cleanliness was assessed using kappa values.**

RESULTS: **Videos evaluating esophagus, stomach, and duodenum cleanliness were reviewed by 16 endoscopists. The PEACE scores demonstrated good agreement (intraclass correlation coefficient 0.82, 95% CI 0.75–0.89), especially for esophagus (0.84; 95% CI 0.71–0.95) and stomach (0.81; 95% CI 0.69–0.91), while agreement was moderate for the duodenum (0.69; 95% CI 0.51–0.87). The agreement was similar between Eastern (0.86; 95% CI 0.79–0.92) and Western experts (0.80; 95% CI 0.72–0.88). Similarly, agreement regarding adequate cleanliness was comparable between Eastern (0.70; 95% CI 0.55–0.85) and Western (0.74; 95% CI 0.64–0.84) endoscopists being overall 0.75 (95% CI 0.65–0.85).**

DISCUSSION: **The PEACE scoring system is a simple and reliable scale to assess the cleanliness during EGD. The score is now validated among international experts with high concordance, justifying its use in clinical practice.**

INTRODUCTION

Endoscopic procedures have become indispensable tools in the evaluation and management of gastrointestinal diseases. Technological progress has allowed for rapid improvements for both optical diagnosis and therapeutic procedures in the field of gastrointestinal endoscopy. For instance, high-definition endoscopes have replaced standard definition endoscopes in modern endoscopy (1,2). Dye-based and electronic chromoendoscopy are essential modalities for detection and evaluation of neoplastic lesions such as gastric neoplasm, gastric intestinal metaplasia, Barrett esophagus, and related neoplasia and esophageal squamous cell neoplasia (2–5). To achieve high quality diagnostic esophagogastroduodenoscopy (EGD) and to use high-definition electronic chromoendoscopy, a clean mucosa of the area of interest is required. Poor mucosal visibility during EGD could be due to various factors including the formation of bubbles, food residue, bile etc. However, this also requires efforts from the endoscopist to clear the contents and clean the mucosa to the best of their ability. To achieve mucosal cleaning, several agents have been evaluated (6–8). The preparation with simethicone/dimethicone and pronase has become the standard in EGD screening in high prevalence of gastric cancers areas (9).

In colonoscopy, where adequate preparation has been evaluated for many years, proper preparation and achieving adequate visibility is a crucial quality indicator (10). A higher clean bowel mucosal score (such as using the Boston Bowel Preparation Scale [BBPS]) has been shown to be associated with improved adenoma detection rate (11). Despite the conceived benefit of a clean mucosal inspection in the upper gastrointestinal (UGI) tract for a higher yield, there is lack of research in this area. Recently, we

proposed a novel UGI cleanliness scale—PEACE (Polprep: Effective Assessment of Cleanliness in EGD) (12,13). We showed that adequate cleanliness was associated with higher detection of pathologies in the UGI tract. In a retrospective feasibility study and subsequent prospective study, it was also shown that inadequate preparation was showed to be associated with lower detection of clinically significant UGI lesions. We also presented good interobserver and intraobserver agreement of scoring based on the still endoscopic images assessment (12). In this study we aimed to assess the interobserver agreement of the PEACE cleanliness scores among an international cohort of expert endoscopists using videos assessment.

METHODS

The study was conducted as post hoc assessment of EGD videos that were collected during the period of prospective validation study (August 2021 to October 2022) (13). The EGDs were performed using EVIS EXERA III and X1 systems (Olympus Europe, Hamburg, Germany) with GIF-EZ1500, GIF-1100, GIF-HQ190, GIF-H180J, and GIF-Q160Z endoscopes and Fujifilm EP-6000 system (Fujifilm Europe, Düsseldorf, Germany) with EG-760R endoscopes. The study was performed in accordance with the Declaration of Helsinki and conducted under Institutional Review Board agreement (No. PCN/CBN/0052/KB/15/23).

To assess the reliability of the scale, we decided to assess videos as it reflects real assessment of the cleanliness of the mucosa. We invited international endoscopy experts from different geographic regions to simulate different fashions of performing endoscopy around the world. The selected method was non-extensive training explained below followed by a single round
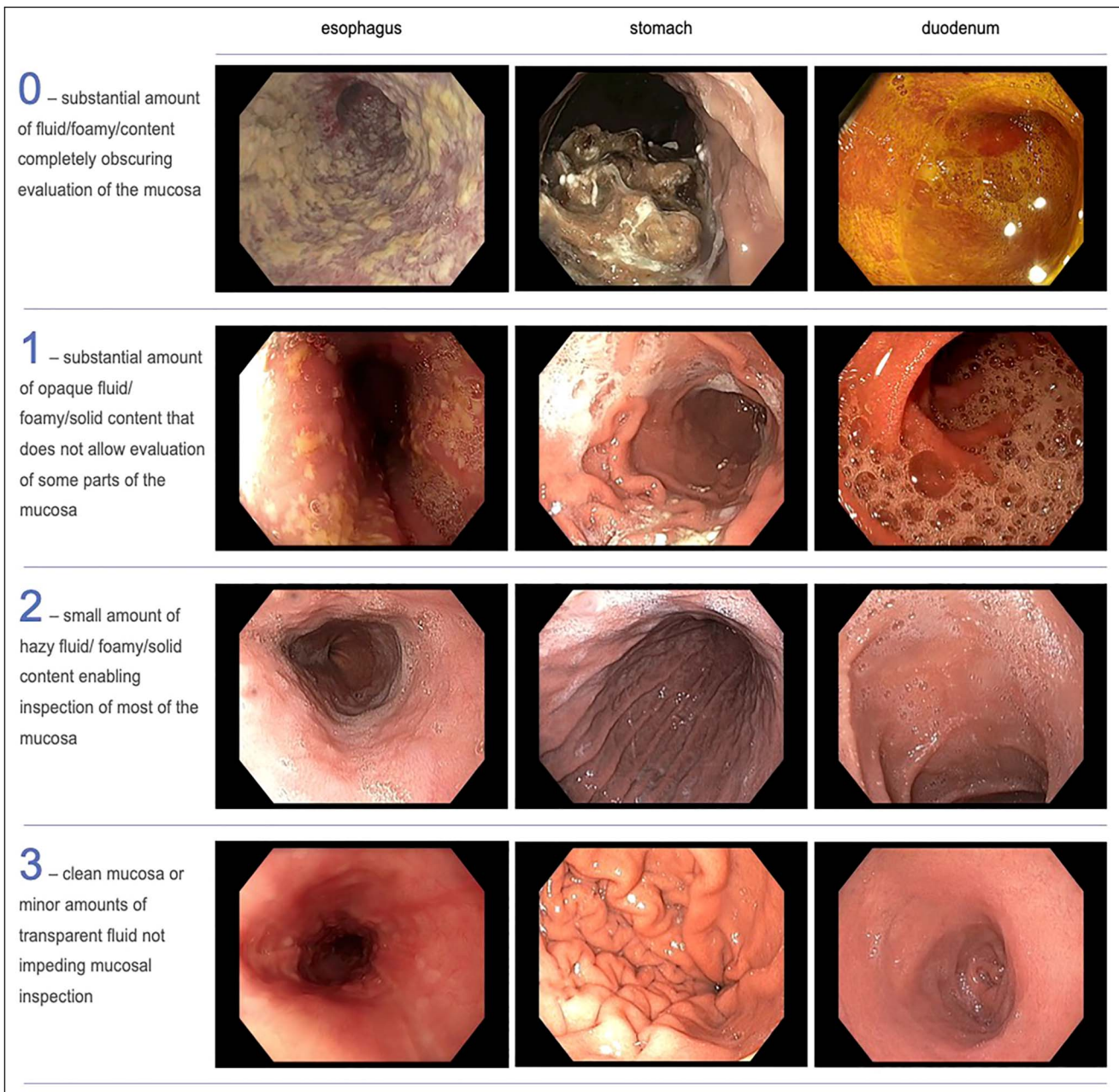
Figure 1. Example of PEACE scores.

assessment of videos to avoid very isolated study conditions that could not be transferred into real-world scenario.

Teaching materials and training phase

To familiarize the assessors with the PEACE scale, 21 representative and example endoscopic pictures were provided (12). In addition, 4 videos with different grades of the PEACE score were sent to the assessors. An overview of the PEACE scale along with clear instructions was provided to the assessors on how the rating should be performed:

The scoring for the PEACE scale—see Figure 1:

- 3—clean mucosa or minor amounts of transparent fluid not impeding mucosal inspection,
- 2—small amount of hazy fluid/foamy/solid content enabling inspection of most of the mucosa,
- 1—substantial amount of opaque fluid/foamy/solid content that does not allow evaluation of some parts of the mucosa,
- 0—substantial amount of fluid/foamy/content completely obscuring evaluation of the mucosa.

  Instructions on how to evaluate the scale:

  Authors who selected and edited the videos as well as the senior author did not participate in the assessment. To avoid significant selection bias, the author who edited the videos did not perform any EGD during the study period.
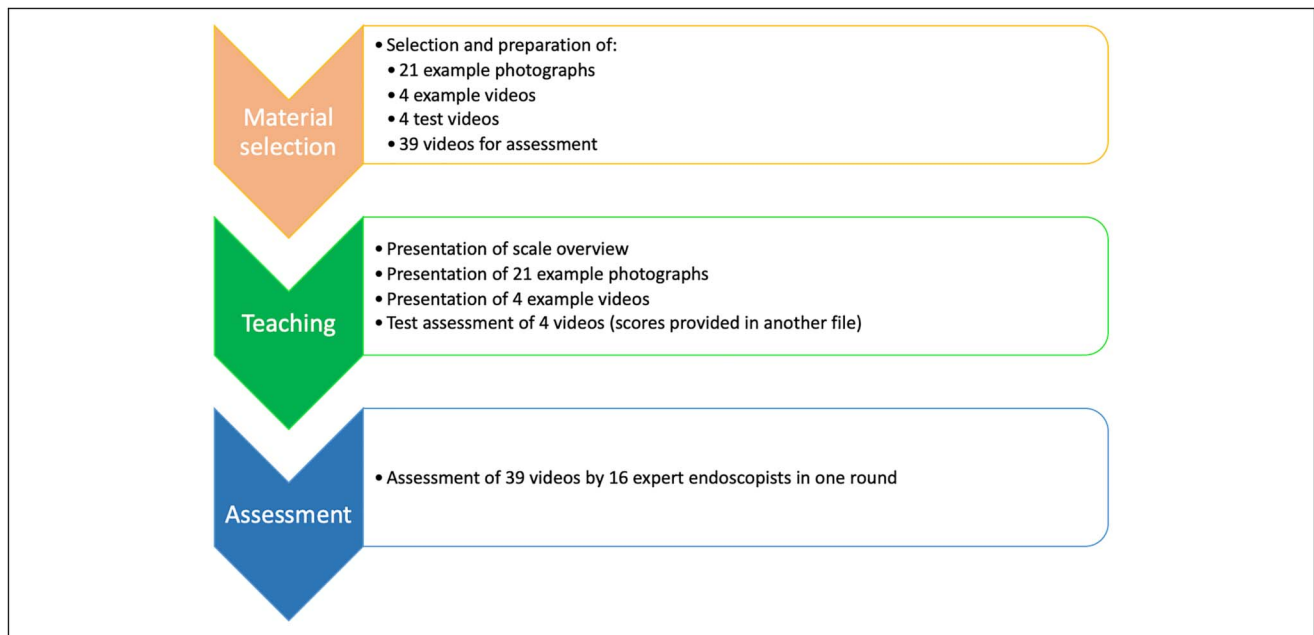
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Figure 2. Study flowchart.

The overview contained information how the rating should be performed:

- Assessment of the 3 segments: esophagus, stomach, duodenum,
- Each segment scored 0–3,
- Assessment of each segment after cleansing (irrigation, suction),
- The score for each segment was the lowest score within each component of that segment (e.g. If the proximal esophagus is scored as 2, and distal esophagus scored as 3—then the score for esophagus is 2).

Finally, all assessors were asked to grade 4 test videos and the correct results were provided to them, so they could evaluate their ability to use the PEACE scale.

Video selection
The EGD videos used for the interobserver agreement study were selected from adult symptomatic patients referred for diagnostic EGD and screened for the study (13). Videos with poor technical quality of recording (such as low resolution or disturbances of images) were excluded. The videos were selected according to scoring of specific segments during the study period to provide a representation of all scores (0–3) after cleansing. Then recordings were cropped to 20–40 seconds parts representative for each segment (esophagus, stomach, and duodenum). The whole process has been summarized at Figure 2.

Sample size and statistical analysis
To achieve intraclass correlation coefficient (ICC) of 0.7 (95% CI 0.6–0.8), the minimal number of videos and assessors was 39 and 15, respectively. To evaluate interobserver agreement of all PEACE scale scores (0–3), ICC 2.1 was used. ICC values 0.5–0.75 were considered as moderate, 0.75–0.9 as good, and >0.9 as excellent (14). For the agreement of inadequate (scores 0 and 1) and adequate cleanliness (scores 2 and 3), the Conger kappa value was

calculated. Kappa values of 0.33–0.5 were considered as fair, 0.5–0.67 as moderate, 0.67–0.9 as substantial, and over 0.9 as almost perfect (15). Statistical analysis was performed in R version 4,2,3, in the RStudio environment 2023.06.0 + 421, using packages tidyverse, irr, and irrCAC.

RESULTS

Assessors and videos
A total of 39 videos were selected for assessment by 16 international experts—6 from North America (United States and Canada), 6 from Europe and Middle East, and 4 from Japan and Australia.

Scoring and reliability of PEACE scores
Of 39 videos, 13 were scored 3, 10 were scored 2, 14 were scored 1, and 2 were scored 0. Five of 39 videos (12.8%) were scored equally by all experts, 22 (56.4%) were scored within one range, 9 (23.1%) within 2, and in 3 cases (7.7%) the range was 3. The scoring has been summarized in Figure 3.

The overall reliability, based on ICC values, exceeded the assumed threshold, and was 0.82. For specific segments, the ICC was as follows: 0.84 for esophagus, 0.81 for stomach, and 0.69 for duodenum—see Table 1. The overall mean range of scores was 1.26, being highest for duodenum (1.42), followed by stomach (1.41) and esophagus (0.8).

The accordance of identification of inadequate cleanliness
The identification of adequate cleanliness (PEACE scores 2 and 3 = adequate cleanliness) was characterized with substantial agreement—kappa value of 0.75. The agreement was substantial in stomach and esophagus and moderate in duodenum (kappa value highest in stomach [0.77], then in esophagus [0.68] and lowest in duodenum [0.55]). These data have been summarized in Table 2.
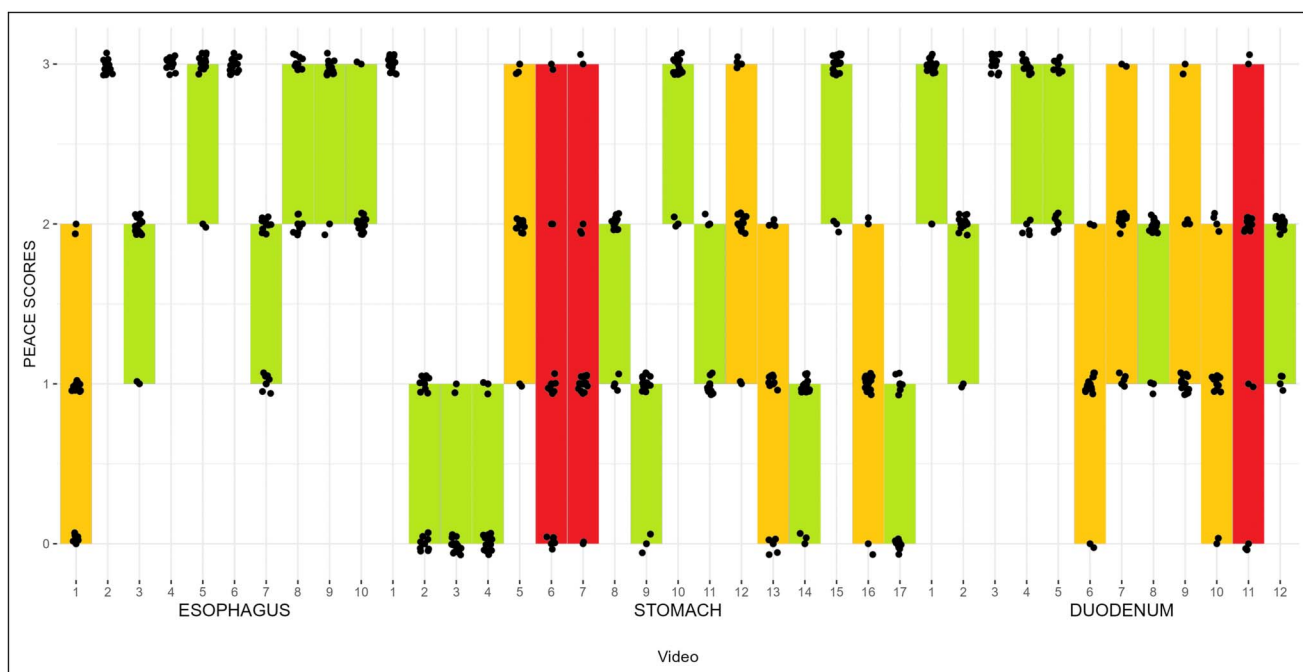
Figure 3. Scores of assessed videos. The figure presents scorings of each video. Each vertical line represents video. Each dot represents one assessment. Cases not colored represents videos where concordance was 100%, green color represents videos with scores range of 1 score, orange with range 2 scores, and red with range of 3 scores.

Accordance of scores between Eastern and Western experts

The agreement among Japanese and Australian experts in comparison with European (including Middle East), United States, and Canadian experts was not significantly different—being good in both cases (ICC 0.86; 95% CI 0.79–0.92 and ICC 0.80; 95% CI 0.72–0.88, respectively). These data have been presented in Figure 4. The mean range of scores among Western experts was higher than among Eastern experts (1.15 and 0.54, respectively).

The accordance in identification of adequate and inadequate cleanliness was also not significantly different among Western experts (kappa value of Western experts 0.74; 95% CI 0.64–0.84 and kappa value of Eastern experts 0.70; 95% CI 0.55–0.85)—see Figure 5.

DISCUSSION

In this international validation study, we presented interobserver agreement of a recently created and validated PEACE scale used

for the assessment of UGI mucosal inspection and cleanliness among international endoscopy experts. We showed that despite heterogeneity of UGI tract segments and no extensive teaching, the assessment of cleanliness during EGD with PEACE scale was reliable. We also demonstrated that agreement for the scale was overall high for subgroups of Western and Eastern Experts. The good interobserver agreement may most likely be related to the impact of the scale design, which was created based on the widely used Boston Bowel Preparation Scale (16).

Our previous retrospective feasibility study of PEACE scale performance demonstrated good interobserver and intraobserver reproducibility of photographs assessment (ICC 0.8 and the Fleiss Kappa value 0.64, respectively) [9]. In this study, the interobserver agreement of UGI cleanliness assessment based on the evaluation of videos was even slightly higher. It was higher in the stomach and esophagus than in the duodenum. In previous study, on photographs, the difference was not seen. That could be

**Table 1. Interobserver agreement analysis of PEACE scores (scores 0–3)**

Variable	Intraclass correlation coefficient	95% CI
All scores (N = 39)	0.82	0.75–0.89
Esophagus (N = 10)	0.84	0.71–0.95
Stomach (N = 17)	0.81	0.69–0.91
Duodenum (N = 12)	0.69	0.51–0.87

The table presents interobserver agreement in the assessment of all videos and particular segments (esophagus, stomach, and duodenum).
95% CI, 95% confidence interval; PEACE, Polprep: Effective Assessment of Cleanliness in Esophagogastroduodenoscopy.

Table 2. Interobserver agreement analysis of inadequate and adequate cleanliness according to PEACE scores

Variable	Conger's kappa value	95% CI
All scores (N = 39)	0.75	0.65–0.85
Esophagus (N = 10)	0.68	0.23–1
Stomach (N = 17)	0.77	0.62–0.93
Duodenum (N = 12)	0.55	0.32–0.79

The table presents interobserver agreement in the assessment of inadequate (PEACE scores 0 and 1) and adequate (PEACE scores 2 and 3) cleanliness of all videos and particular segments (esophagus, stomach, and duodenum).
95% CI, 95% confidence interval; PEACE, Polprep: Effective Assessment of Cleanliness in Esophagogastroduodenoscopy.
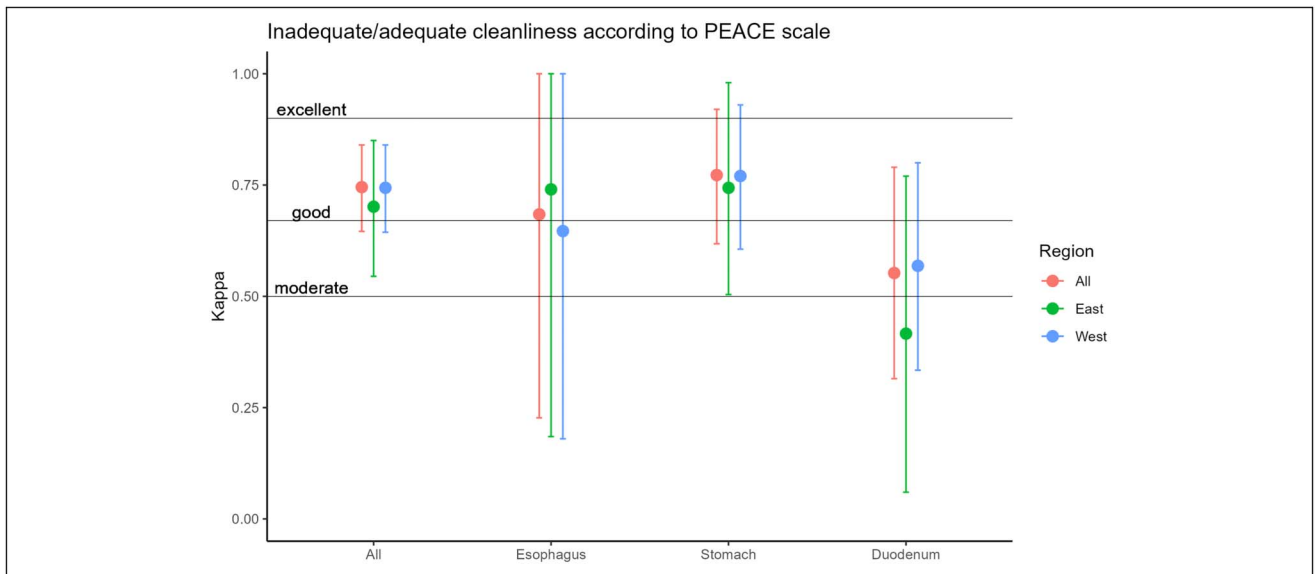
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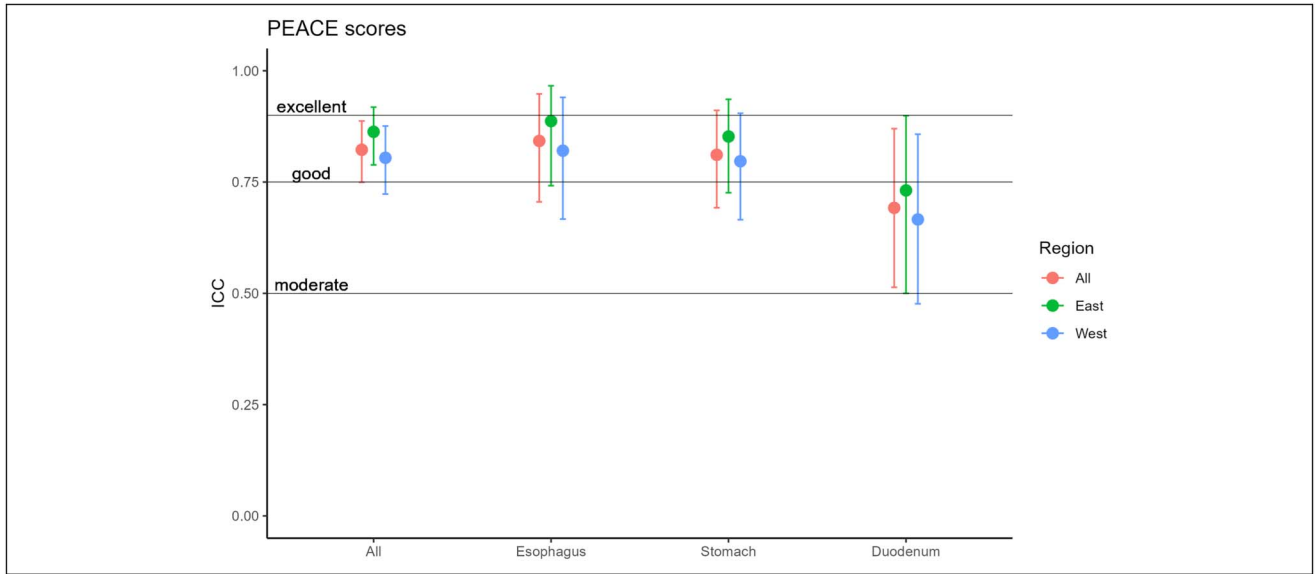
Figure 4. PEACE scores agreement. The figure represents intraclass correlation coefficient for all raters, among Western raters (United States, Canada, and Europe with Middle East) and Eastern (Japan and Australia) raters for videos of the esophagus, stomach, and duodenum and for all videos. Each vertical line on the plot represents 95% confidence interval, and dots represent intraclass correlation coefficient values. PEACE, Polprep: Effective Assessment of Cleanliness in Esophagogastroduodenoscopy.

explained by different appearance of duodenal bulb and second part of duodenum with partially blind spot between them resulting in some differences in the assessment not observed at still photographs assessment. The strength of our study is the assessment of prospectively acquired video records by world class experts. An important aspect was the participation of experts from North America, Europe, Middle East, Japan, and Australia. The results show that despite differences in the process of performing routine EGD, the agreement on cleanliness assessment by PEACE remains similar among different parts of the globe.

Although the topic of adequate mucosal cleanliness during EGD is of great clinical importance, no reliable tool allowing the identification of inadequately prepared patients for EGD is in common use. This issue is well accepted in colonoscopy where inadequate cleanliness is related not only with lower detection of

Figure 5. Adequate and inadequate cleanliness agreement based on the PEACE scores. The figure represents Conger kappa value for the agreement on adequate (2 and 3 PEACE scores) and inadequate cleanliness (0 and 1 PEACE scores) for all raters, among Western raters (United States, Canada, and Europe with Middle East) and Eastern (Japan and Australia) raters for videos of the esophagus, stomach, and duodenum and for all videos. Each vertical line on the plot represents 95% confidence interval, and dots represent Conger kappa values. PEACE, Polprep: Effective Assessment of Cleanliness in Esophagogastroduodenoscopy.

adenomas but also with lower rate of cecum intubation and higher discomfort felt by patients (17–19). The high reliability of the PEACE scale would allow to identify patients who require a repeat EGD due to inadequate cleanliness based on our previous study with any segment scored as 0 or 1 (12,13). This is important for a high quality EGD, as it has been well documented that there is a miss rate of neoplastic lesions (5–10%) in the UGI tract, and only a few risk factors of missed neoplasia have been identified so far (20–22). Identification of inadequately prepared individuals during all diagnostic EGDs could possibly result in better risk stratification by identification of precancerous conditions and lower miss rate of early neoplasia, especially in high-risk groups such as advanced atrophic gastritis or long Barrett esophagus. The degree of cleanliness should be assessed in the future on pre-neoplastic conditions (Barrett esophagus and advanced atrophic gastritis) and neoplastic lesions detection. In addition, the degree of demanded cleanliness needs to be assessed in the cohort of high-risk groups of patients with preneoplastic conditions during surveillance examinations. It should be also assessed along with other quality measures such as examination time. It should be mentioned that not only the identification of inadequately clean segments (scores 0 and 1) but also the assessment of full scale (scores 0–3) was associated with a high accordance.

The Toronto Upper Gastrointestinal Cleaning Score (TUGCS) was recently reported, supporting our work that scales for mucosal cleanliness of the foregut can be developed with strong validity evidence. However, the TUGCS has the notable limitations of having excluded the esophagus from assessment and having potentially introduced unnecessary complexity by having the stomach subgrouped into fundus, body, and antrum (23). It may be argued that assessing the entire stomach with one score maybe difficult. However, endoscopists are currently assessing the entire transverse colon or left colon with a single score as well. In addition, our study shows that the interobserver agreement of the stomach score was very good. Recently, the Barcelona scale was introduced also where 5 landmarks are scored from 0 to 2 (24). However, we find easy clinical implementation by similar scoring to colonoscopy scales and simple judgment of 3 investigated organs, as most important aspect of the UGI cleanliness scale.

Despite the ease and validity of the PEACE scale, our study has limitations. First, the videos were rated by international endoscopy experts and cannot be directly generalizable to the community endoscopists. This needs to be done in a future study along with assessment of degree of cleanliness on neoplastic lesions detection. Since the PEACE scale is simple to follow, does not require specific training or learning curve, and can be readily adopted without prolonging the procedure time, we do believe, that it could be adopted in clinical practice by the general gastroenterology community. Third, the PEACE scale was designed similar to the scoring of the BBPS and its utility might be lower in endoscopy units where BBPS is not routinely used. We have not measured the operator's performance that could affect the final result. In addition, we cannot exclude potential videos selection bias and bias caused by videos' cropping.

In conclusion, the interobserver agreement on UGI tract cleanliness assessment using the PEACE scale by a group of expert international endoscopists was good. This could be achieved with minimal training on the scoring system, allowing for a broad clinical implementation on this easy-to-use scale.

Study Highlights

WHAT IS KNOWN

✓ Detection of clinically significant lesions during upper gastrointestinal endoscopy depends on the degree of cleanliness.

✓ Until now, no scale assessing cleanliness has been properly validated.

WHAT IS NEW HERE

✓ Polprep: Effective Assessment of Cleanliness in Esophagogastroduodenoscopy scale allows for precise assessment of upper gastrointestinal cleanliness without extensive training.

✓ Its performance is unequivocal regardless the geographical distribution of endoscopists.

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