

## Appropriateness, endoscopic findings and contributive yield of pediatric gastrointestinal endoscopy

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### Abstract

**AIM:** To determine the predictability of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) and American Society for Gastrointestinal Endoscopy (ASGE) guideline with regard to appropriate endoscopic practice in children, positive endoscopic findings and contributive yield in clinical practice.

**METHODS:** This was a descriptive, retrospective analysis, conducted at the Department of Paediatrics, University Malaya Medical Centre, Malaysia. All children who had esophagogastroduodenoscopy (EGD) and colonoscopy from January 2008 to June 2011 were included. An endoscopy was considered appropriate when its indication complied with the NASPGHAN and ASGE guideline. All endoscopic findings were classified as either positive (presence of any endoscopic or histo-

logic abnormality) or negative (no or minor abnormality, normal histology); effecting a positive contributive (a change in therapeutic decisions or prognostic consequences) or non-contributive yield (no therapeutic or prognostic consequences).

**RESULTS:** Overall, 76% of the 345 procedures (231 EGD alone, 26 colonoscopy alone, 44 combined EGD and colonoscopy) performed in 301 children (median age 7.0 years, range 3 months to 18 years) had a positive endoscopic finding. Based on the NASPGHAN and ASGE guideline, 99.7% of the procedures performed were considered as appropriate. The only inappropriate procedure (0.3%) was in a child who had EGD for assessment of the healing of gastric ulcer following therapy in the absence of any symptoms. The overall positive contributive yield for a change in diagnosis and/or management was 44%. The presence of a positive endoscopic finding was more likely to effect a change in the therapeutic plan than an alteration of the initial diagnosis. A total of 20 (5.8%) adverse events were noted, most were minor and none was fatal.

**CONCLUSION:** The NASPGHAN and ASGE guideline is more likely to predict a positive endoscopic finding but is less sensitive to effect a change in the initial clinical diagnosis or the subsequent therapeutic plan.

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**Key words:** Pediatric gastrointestinal endoscopy; Contributive yield; Esophagogastroduodenoscopy; North American Society for Pediatric Gastroenterology, Hepatology and Nutrition; American Society for Gastrointestinal Endoscopy

**Core tip:** Since the publication of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) and American Society for Gastrointestinal Endoscopy (ASGE) modification of the

guideline on the appropriate use of endoscopy in children, no study has been conducted to ascertain the applicability of this guideline in the pediatric population. The present study addressed the deficiency in the literature by conducting a retrospective review of the gastrointestinal endoscopies conducted in a university setting in an Asian country. The present study showed that the modified NASPGHAN and ASGE guideline is applicable universally, be it in a Western country or an Asian country.

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## INTRODUCTION

Endoscopy is a useful diagnostic tool in both adult and pediatric populations<sup>[1,2]</sup>. Endoscopy in the pediatric population is usually performed by a pediatric gastroenterologist, and occasionally by a pediatric surgeon. In settings where the expertise of a fully trained pediatric gastroenterologist is not available, an adult gastroenterologist, supported by a pediatrician, can perform simple, diagnostic endoscopy in children safely<sup>[3]</sup>.

Esophagogastroduodenoscopy (EGD) and colonoscopy in children can be either diagnostic or therapeutic<sup>[2]</sup>. Common indications for diagnostic EGD and colonoscopy in children include the presence of symptoms indicative of an underlying organic pathology of the gastrointestinal (GI) tract<sup>[1,2,4,5]</sup>.

Generally, diagnostic pediatric EGD and colonoscopy are safe<sup>[6]</sup>. The risks of therapeutic endoscopy depend on the nature of interventions, but if performed by a pediatric endoscopist with appropriate training, the complication rate is less than 1%<sup>[6,7]</sup>. Potential complications may be encountered in sedation and anesthesia provided during the procedure<sup>[8]</sup>.

In 2000, the American Society for Gastrointestinal Endoscopy (ASGE) published a guideline on the appropriate use of GI endoscopy in the adult population<sup>[9]</sup>. Since then, many studies have found the ASGE guideline to be applicable in the adult population<sup>[10-12]</sup>. ASGE and the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) published a modification of the guideline for the pediatric population, where clear indications for both EGD and colonoscopy in children were recommended<sup>[2]</sup>.

There are several studies on the appropriateness of endoscopy in the adult population<sup>[10-12]</sup>. However, similar studies in the pediatric population are limited<sup>[5,13,14]</sup>. We conducted a retrospective review to assess the appropriateness of GI endoscopy performed in children in our

unit, based on the NASPGHAN and ASGE guideline<sup>[9]</sup>. In addition, the rates of positive and negative endoscopic findings as well as contributive and non-contributive yields to the diagnosis and management of the patients were also studied.

## MATERIALS AND METHODS

This was a retrospective, descriptive study conducted at the Gastroenterology and Nutrition Unit, Department of Paediatrics, University of Malaya Medical Centre (UMMC), Malaysia; from 1<sup>st</sup> January 2008 to 30<sup>th</sup> June, 2011. The present study was approved by the institutional ethical committee of UMMC.

During the study period, all children who required GI endoscopy in the unit, including those who were referred from outside the unit, were screened initially by one of the three practicing pediatric gastroenterologists (Lee WS, Chai PF, Boey CCM). All endoscopic procedures were performed by one of these three pediatric gastroenterologists.

### Case ascertainment

All consecutive patients younger than 18 years of age who had undergone EGD and colonoscopy during the study period were included. Patients were identified from the electronic database of the unit, and were cross-checked with the patient database from the endoscopic unit of the hospital. The case notes were reviewed. Patients who had inadequate data or incomplete procedures were not included.

### Data collection

The following data were collected: basic demographic data, preliminary diagnosis, indication for endoscopy, sedation or anesthesia, endoscopic finding, adverse events encountered during and after the procedure, clinical course and final diagnosis.

### Definitions

“Appropriate” and “inappropriate” indications for EGD and colonoscopy were defined according to the “Modifications in Endoscopic Practice for Pediatric Patients” by ASGE and NASPGHAN, published in 2008<sup>[9]</sup>. The indication for endoscopic procedures performed during the study period, if found to be compliant with the indications listed under “pediatric upper endoscopy” and “pediatric colonoscopy” in the ASGE and NASPGHAN guideline, was considered as “appropriate”. An indication was classified as “inappropriate” if the indication of the procedure was not listed in the guideline.

Anesthetic techniques and drugs used: In the present study, the induction of anesthesia used in children was the inhalational technique with sevoflurane and oxygen. After endotracheal intubation, patient paralysis, if necessary, was achieved by intravenous atracurium. Maintenance anesthesia was achieved by inhalational sevoflurane. Reversal of anesthesia was achieved by neostigmine and atropine.

**Table 1 Characteristics of 310 children undergoing 345 endoscopic procedures *n* (%)**

Age	
< 6 mo	3 (1)
6 mo-2 yr	32 (11)
2-10 yr	185 (61)
> 10 yr	81 (27)
Gender	
Male	158 (53)
Female	143 (47)
Weight-for-age	
< 3 <sup>rd</sup> centile	123 (41)
3 <sup>rd</sup> -50 <sup>th</sup> centile	154 (51)
50 <sup>th</sup> -95 <sup>th</sup> centile	22 (6)
> 95 <sup>th</sup> centile	4 (1.4)
Type of procedure	
Esophagogastroduodenoscopy	231 (77)
Colonoscopy	26 (9)
Both	44 (15)

Three hundreds and forty-five endoscopic procedures took place in University Malaya Medical Center, Kuala Lumpur; January 2008 to June 2011.

### Positive and negative findings

By screening the procedures report, the endoscopic findings were divided into positive (presence of any abnormality in the endoscopic findings, or presence of relevant histologic findings), or negative (no abnormality or minor abnormality, normal histology)<sup>[10]</sup>.

### Contributive and non-contributive yields

The endoscopic procedures were divided into two categories: a positive contributive yield (the procedure had a positive effect on therapeutic decisions or prognostic consequences; this included interventional procedures) and non-contributive yield (a procedure which has no therapeutic or prognostic consequences)<sup>[10]</sup>. The patient may have a negative endoscopic finding and yet the procedure may be considered as having a positive contributive yield (example: a negative EGD finding in a child with upper GI bleeding).

### Adverse events

Adverse events which occurred during and after the procedures were noted. These were divided into sedation- or anesthesia-related, or procedure-related.

### Statistical analysis

Data were collected and managed by using statistical software programs (SPSS version 20.0, SPSS Inc., Chicago, IL, United States). Data were analyzed using a two-tailed  $\chi^2$  test; OR and related 95%CI were calculated. A *P* value < 0.05 was considered significant. Multivariate analysis was performed on selected symptoms and signs predicting a positive contributive yield (change) on the initial diagnosis or subsequent therapeutic plan.

## RESULTS

During the study period, a total of 362 procedures were

**Table 2 Indications for esophagogastroduodenoscopy and colonoscopy in 310 children *n* (%)**

Indications	Value
Esophagogastroduodenoscopy	
Diagnostic	
Variceal surveillance/eradication	137 (48.9)
Hematemesis	41 (14.9)
Significant recurrent abdominal pain	37 (13.4)
Malenic stool	20 (7.3)
Chronic diarrhea/malabsorption	16 (5.8)
Recurrent vomiting	5 (1.8)
Malignancy surveillance	5 (1.8)
Dysphagia/odynophagia	4 (1.4)
Complicated gastroesophageal reflux disease	3 (1.0)
Unexplained anemia	1 (0.3)
Failure to thrive	1 (0.3)
Therapeutic	
Gastrostomy insertion	2 (0.7)
Foreign body removal	1 (0.3)
Colonoscopy	
Rectal bleeding	19 (27.0)
Monitoring of inflammatory bowel disease	19 (27.0)
Chronic diarrhea/malabsorption	18 (25.7)
Surveillance for polyp syndrome	6 (8.5)
Recurrent abdominal pain	5 (7.1)
Malignancy surveillance	3 (4.2)

performed in 318 children. Of these, 17 procedures involving 17 patients were excluded from analysis: 8 had incomplete data (three for EGD, two each for colonoscopy and percutaneous endoscopic gastrostomy feeding tube, and one for foreign body removal), and 9 had an incomplete procedure (seven had colonoscopy abandoned because of poor bowel preparation, and two patients had EGD abandoned because of esophageal stricture). Thus, a total of 345 procedures involving 301 patients were analyzed. Of these, 231 patients had EGD alone, 26 had colonoscopy alone, while 44 had combined EGD and colonoscopy.

### Patients' characteristics

The median age of these 301 children was 7.0 years old (range 3 mo to 18 years; Table 1). There were 158 (53%) males and 143 (48%) females. Almost half of the patients had a weight-for-age below the 3<sup>rd</sup> centile (*n* = 141, 41%).

### Indications for endoscopy

The two most common indications for EGD were surveillance for esophageal varices (*n* = 137, 50%) and upper GI bleed (*n* = 73, 26%; Table 2), while the two most common indications for colonoscopy were per rectal bleeding (*n* = 19, 27%), and surveillance/diagnosis of inflammatory bowel disease (IBD; *n* = 19, 27%). Of the total 86 therapeutic procedures performed, three-quarters (74%) were rubber banding for esophageal varices (Table 3).

### Appropriateness of endoscopy

Based on the NASPGHAN and ASGE guideline, 99.7% (*n* = 344) of the 345 procedures performed during the

**Table 3** Therapeutic procedures *n* (%)

Procedures	Value
Esophageal varices eradication	
Rubber banding for esophageal varices	64 (74)
Sclerotherapy	18 (21)
Polypectomy	2 (2.3)
Foreign body removal	1 (1)
Insertion of percutaneous gastrostomy feeding tube	2 (2)
Total	86 (100)

study period were considered as appropriate. The only procedure (0.3%) which was considered as inappropriate was in a child who had an EGD for assessment of the healing of a gastric ulcer following medical therapy in the absence of any signs and symptoms.

### Positive and negative findings

Three-quarters ( $n = 261$ , 76%) of the 345 procedures performed showed a positive (abnormal) endoscopic finding [EGD: 216 (79% of all EGD performed), colonoscopy: 45 (64% of all colonoscopy performed); Table 4] while the remaining 84 (24%) had a negative endoscopic finding. A rapid urease test from a mucosal biopsy taken from the stomach and duodenum for *Helicobacter pylori* (*H. pylori*) infection was performed in 62 patients and was positive in 10 patients (16%).

### Factors predicting a positive endoscopic finding

Six clinical symptoms and four signs were analyzed to predict a positive contributive yield (effecting a change) in the initial diagnosis or subsequent therapeutic plan (Tables 5 and 6). On multivariate analysis, the presence of an enlarged liver or an enlarged spleen were least likely to effect a change in the diagnosis, while vomiting and abdominal pain were most likely to be associated with a change in the initial diagnosis. The presence of hematemesis was most likely to be associated with a change in therapeutic plan.

### Contributive and non-contributive yields

The overall contributive yield was 44.3% (Table 7). All the 79 patients who had a change in the initial diagnosis (positive contributive yield in diagnosis) also had a change in the subsequent therapeutic plan (positive contributive yield in therapeutic plan).

The presence of a positive (abnormal) endoscopic finding confirmed the clinical diagnosis in 57% ( $n = 197$ , negative contributive yield) of patients, while it altered the diagnosis in 19% ( $n = 64$ , positive contributive yield) of patients (Table 7). Conversely, a negative (normal) endoscopic finding confirmed the clinical diagnosis in 20% ( $n = 69$ ) of patients, while it altered the diagnosis in 4.3% ( $n = 15$ ) of patients (Table 7). This was not statistically significant ( $P = 0.234$ ). Of the 15 patients (4.3%) who had an alteration in the final diagnosis despite a negative endoscopic finding, most had an abnormal histology in the presence of normal endoscopic findings.

**Table 4** Probability of positive (abnormal) vs negative (normal) endoscopic findings *n* (%)

Procedures	Endoscopic findings		Total
	Positive	Negative	
Esophagogastroduodenoscopy	216 (79)	59 (21)	275 (100)
Colonoscopy	45 (64)	25 (36)	70 (100)
All	261 (76)	84 (24)	

The presence of a positive endoscopic finding was more likely to effect a change in the management plan of a patient as compared to having a negative endoscopic finding (positive finding:  $n = 145$ , 42% vs negative finding:  $n = 8$ , 2.3%,  $P < 0.001$ ; Table 7). Most of those ( $n = 8$ ) who had a negative endoscopic finding but had a change in management plan were found to have a positive urease test for *H. pylori*. All had eradication therapy initiated.

### Adverse events

A total of 20 (5.8%) adverse events were noted; most were minor (Table 8). Secondary bleeding following rubber banding or sclerotherapy for esophageal varices was noted in 12 patients, while the bleeding rate following EGD was 4.3%. All the bleeding episodes were seen in patients with ( $n = 3$ , aged 11 mo to 2 years) biliary atresia and liver cirrhosis who had rubber banding for esophageal varices. None had liver transplantation. All patients needed blood transfusion but none became hemodynamically unstable.

Two patients who had esophageal varices and large ascites complicating liver cirrhosis needed assistance in respiration for a few hours following general anesthesia. Three children developed fever after endoscopy. All recovered uneventfully following a course of oral antibiotics. Another patient developed transient bronchospasm following extubation.

Two iatrogenic perforations following colonoscopy were noted in two children who had Crohn's disease. Both had gross delay in referral, severe malnutrition and extensive colonic disease. Both had fecal diversion surgery and recovered following surgical repair. The perforation rate following colonoscopy was 2.9%. No death occurred as a result of endoscopy in the present study.

## DISCUSSION

Generally, for a procedure to be considered as appropriate, its expected benefit should be greater than its expected negative consequences by a sufficiently wide margin to make the procedure worthwhile<sup>[15]</sup>. Benefit and negative consequences of a procedure are both defined in the broadest terms<sup>[10,15]</sup>.

Guidelines on the appropriateness of endoscopic procedures have been devised to aid clinicians in selecting more appropriate patients for referral, especially to units with limited expertise and financial resources<sup>[2,9]</sup>. Recently, a guideline pertaining to the appropriate use of endoscopy in children was published by NASPGHAN and

**Table 5** Univariate analysis for clinical parameters predicting a positive (abnormal) endoscopic finding

Clinical parameters	Positive contributive yield (a change in diagnosis)			Positive contributive yield (a change in treatment)		
	P value	OR	95%CI	P value	OR	95%CI
Symptoms						
Vomiting	< 0.001	4.5	2.0-10.3	0.456	1.4	0.5-3.5
Diarrhea	0.010	2.6	1.5-4.2	0.940	0.4	0.4-1.8
Abdominal pain	0.020	2.1	1.1-4.0	0.750	0.9	0.5-1.7
Hematemesis	0.321	1.7	0.5-5.5	0.001	4.3	1.7-10.3
Melena	0.048	0.7	0.05-0.5	0.027	0.6	0.27-1.4
Hematochezia	0.065	2.0	0.9-4.3	0.040	2.8	1.3-5.7
Signs						
Pallor	0.525	1.2	0.5-2.8	0.520	1.2	0.6-2.3
Hepatomegaly	0.551	1.4	0.43-4.7	0.825	0.9	0.5-1.7
Splenomegaly	< 0.001	0.082	0.029-0.2	0.227	0.6	0.3-1.2
Abdominal tenderness	0.396	0.5	0.14-2.1	0.242	0.37	0.07-1.9

**Table 6** Multivariate analysis for clinical parameters predicting a positive (abnormal) endoscopic finding

Clinical parameters	Positive contributive yield (a change in diagnosis)			Positive contributive yield (a change in treatment)		
	P value	OR	95%CI	P value	OR	95%CI
Symptoms						
Vomiting	< 0.001	4.5	2.0-10.3	0.827	0.9	0.4-2.6
Diarrhea	0.014	2.6	1.5-4.7	0.448	0.8	0.4-1.4
Abdominal pain	< 0.001	3.7	2.1-6.4	0.664	0.6	0.4-1.6
Hematemesis	0.251	1.5	0.7-3.3	< 0.001	4.3	1.8-9.5
Melena	0.080	1.7	0.9-4.3	0.022	2.9	1.0-5.2
Hematochezia	0.010	3.1	1.6-6.3	0.020	1.9	1.1-4.5
Signs						
Pallor	0.768	1.4	0.5-2.1	0.113	2.0	0.8-3.0
Hepatomegaly	0.004	0.2	0.1-0.5	0.629	1.3	0.6-1.9
Splenomegaly	< 0.001	0.08	0.04-0.17	0.198	1.3	0.8-2.0
Abdominal tenderness	0.267	1.9	0.5-2.1	0.097	0.2	0.05-3.0

**Table 7** Endoscopic findings and a subsequent contributive yield *n* (%)

Endoscopic findings	Positive contributive yield (a change in diagnosis)		Positive contributive yield (a change in management)		Total
	Yes	No	Yes	No	
Positive	64 (18.6) <sup>1</sup>	197 (57.1)	145 (42.0) <sup>2</sup>	116 (33.6)	261 (75.7)
Negative	15 (4.3)	69 (20.0)	8 (2.3)	76 (22.0)	84 (24.3)
Total	79 (22.9)	266 (77.1)	153 (44.3)	192 (55.7)	345 (100)

<sup>1</sup>*P* = 0.234 ( $\chi^2$  test); <sup>2</sup>*P* < 0.001 ( $\chi^2$  test).

ASGE<sup>[2]</sup>. We believe that, although there are unavoidable socio-cultural and geographical differences as well as pattern of diseases, the NASPGHAN and ASGE guideline can be applied universally. Thus, for the present study the NASPGHAN and ASGE guideline was chosen.

In addition, little is known about pediatric endoscopic practice and its appropriateness in Asian countries, where human and financial resources, funding model, pattern of GI and liver diseases are different from the more advanced Western countries.

There have been several studies on the appropriateness of EGD in various clinical situations in children<sup>[13,14]</sup>. However, none are based on the NASPGHAN and ASGE guideline. For example, Jantchou *et al*<sup>[13]</sup>, based on the recommendations by the French-language Pediatric Hepatology, Gastroenterology and Nutrition Group (GF-HGNP), noted that 18% of the 251 EGD procedures

performed were considered as inappropriate, a figure which was higher among outpatient referrals. Guariso *et al*<sup>[5]</sup>, using a model of expert consensus from theoretical scenarios, noted that except in cases with a positive family history of peptic ulcer and/or *H. pylori* infection, children aged 10 years of older, or with persistent symptoms, not all EGD in children with dyspeptic symptoms could be considered as appropriate. Miele *et al*<sup>[14]</sup> found that the publication of Rome II criteria for functional GI disorders has a positive impact on the appropriateness of GI endoscopy, with inappropriate procedures reduced significantly after its publication. Nevertheless, 26% of all procedures were still considered as inappropriate<sup>[14]</sup>.

In contrast, although using different standards, the overall inappropriateness for pediatric endoscopy in the present study was 0.3%, with an overwhelming 99.7% of the cases being considered as appropriate. The only case

**Table 8 Adverse events encountered in 345 endoscopic procedures**

Complications	<i>n</i>
Procedure-related	
Secondary bleeding following rubber banding or sclerotherapy	12
Bowel perforation during colonoscopy	2
Anesthesia/sedation-related	
Delayed extubation due to ascites	2
Post-extubation bronchospasm	1
Secondary fever	3
Total	20

in the present study which was deemed to be inappropriate was an EGD reassessment of a healing gastric ulcer, in the absence of any symptoms and signs. This figure compares favorably with 18% of inappropriateness noted by Jantchou *et al.*<sup>[13]</sup> and 26% found by Miele *et al.*<sup>[14]</sup>.

There is, at present, limited availability of human resources in pediatric gastroenterology practice in Malaysia. The pediatric gastroenterology and nutrition unit of UMMC is only one of two pediatric gastroenterology units in Malaysia providing regular pediatric endoscopic services. The model of practice is not an open-access system. Thus, in the present study, all referrals for GI endoscopy from office-based pediatricians were screened initially by one of the practicing gastroenterologists before being subjected to endoscopy, hence reducing potentially inappropriate cases.

Nevertheless, some authors argued that the probability of detecting a clinically relevant lesion is considered as important as the appropriateness of the procedure<sup>[16,17]</sup>. Gonvers *et al.*<sup>[18]</sup> found that when applying the ASGE criteria to 450 outpatients who underwent EGD, there were no significant differences in clinically relevant findings in those patients who had an appropriate *vs* an inappropriate EGD.

Thus, we also studied the probability of finding a positive endoscopic finding in addition to studying the appropriateness of endoscopy. In the present study, the overall probability of detecting a positive endoscopic finding was 76%, higher in EGD (79%) than in colonoscopy (64%).

In the present study, the positive contributive yield for a change in the initial diagnosis was only 23% (Table 5). This is mainly because in over half of the cases (57%), a positive endoscopic finding confirmed the initial diagnosis, thus the contributive yield was considered as negative. However, what is equally important was a negative finding which has a positive contributive yield. Examples included the reassuring negative EGD finding in a child with upper GI bleeding. In the present study, a positive endoscopic finding was more likely to effect a change in the management plan than to effect a change in the initial diagnosis.

Although endoscopic procedures in the pediatric population are generally safe, adverse events and complications related to anesthesia and the endoscopic procedure itself are well documented<sup>[7,8,19]</sup>. Most of the adverse events encountered in the present study were minor and transient in nature. The perforation rate of colonoscopy

in the present study was 2.9%, higher than similar figures in the literature<sup>[7,19]</sup>. Both cases were children with Crohn's disease who had severe delay in referral, advanced malnutrition and total colonic involvement. Nevertheless, efforts should be initiated to reduce the complications rate further by improving the training of endoscopy in the unit<sup>[20]</sup>.

The main shortcoming in the present study was its retrospective nature. Thus, it may not be entirely accurate in ascertaining whether an endoscopic finding effected any alteration in the initial diagnosis and subsequent therapeutic plan. In addition, the age range of the patients in the present study was wide, and the indications for endoscopy in young children may not be similar to adolescents. Thirdly, the present study was conducted in a university hospital setting and the procedures were performed by experienced pediatric gastroenterologists. Thus, the findings of the present study may not be entirely applicable in other settings.

In conclusion, the present study showed that the modified NASPGHAN and ASGE guideline is applicable universally, be it in a Western country or an Asian country. Although the NASPGHAN and ASGE guideline on the appropriateness of pediatric endoscopy is useful in helping clinicians selecting the most appropriate patient for GI endoscopic procedures, nevertheless its predictability of a positive endoscopic finding is moderate, and it is not very sensitive in predicting whether a procedure has any positive contributive yield in the diagnosis and management of the patients.

## COMMENTS

### Background

Esophagogastroduodenoscopy (EGD) and colonoscopy in children can either be diagnostic or therapeutic. Generally, diagnostic pediatric EGD and colonoscopy are safe, but the risks of therapeutic endoscopy depend on the nature of interventions. If performed by an experienced pediatric endoscopist with appropriate training, the complication rate is less than 1%. Generally, for a procedure such as gastrointestinal endoscopy to be considered as appropriate, its expected benefit should be greater than its expected negative consequences by a sufficiently wide margin to make the procedure worthwhile. There have been several publications on the appropriateness of gastrointestinal endoscopy in the adult population. But studies of a similar nature in the pediatric population are limited.

### Research frontiers

The present study planned to address the deficiency in the literature on the appropriateness of pediatric gastrointestinal endoscopy by conducting a retrospective review on the gastrointestinal endoscopies conducted in a university setting in an Asian country.

### Innovations and breakthroughs

The present study was the first major study to ascertain the applicability of the Modified Guidelines on the Appropriate use of Gastrointestinal Endoscopy in children by North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) and American Society for Gastrointestinal Endoscopy (ASGE). It is also the first study from an Asian country to determine the indications of pediatric gastrointestinal endoscopy in children. There have been several publications on the indications of childhood gastrointestinal endoscopy from the Western countries, but none from an Asian country.

### Applications

The results of the present study showed that the vast majority of the pediatric gastrointestinal endoscopies performed in a university hospital setting were appropriate according to the modified guidelines. Thus, other pediatric endoscopists performing pediatric gastrointestinal endoscopy should consider referring

to the "Modified Guidelines" for the purpose of benchmarking.

### Terminology

"Appropriate" and "inappropriate" indications for pediatric gastrointestinal endoscopies were defined according to the "Modifications in Endoscopic Practice for Pediatric Patients" by the American Society for Gastrointestinal Endoscopy and North American Society for Pediatric Gastroenterology, Hepatology and Nutrition. A contributive yield was defined as a procedure that had a positive effect on therapeutic decisions or prognostic consequences in a patient. A non-contributive yield was defined as a procedure that had no therapeutic or prognostic consequences.

### Peer review

This article from an Asian country aimed to determine the predictability of the NASPGHAN and ASGE guideline in endoscopic practice for children on positive endoscopic finding and contributive yield in clinical practice in children. Although there are some unavoidable socio-cultural and geographical differences as well as pattern of diseases, the NASPGHAN and ASGE guidelines, as the present study shows, can be applied universally. The overall study is interesting, and no similar study was detected in the literature.

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