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Length of Endoscopic Workup in Gastrointestinal Bleeding

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Abstract

Background—The number of procedures utilized in the general management of gastrointestinal bleeding (GIB) has not been previously investigated. We used the National Endoscopic Database of the Clinical Outcomes Research Initiative (CORI) for an observational study to analyze the average length of workup in GIB.

Methods—The electronic database was queried for all patients aged 18 years and older who underwent endoscopic evaluation for any bleeding indication between 2000 and 2014. Data were stratified by indication, type and number of endoscopies per patient, and length of workup.

Results—A total of 603,807 endoscopic procedures among 451,470 individual patients were used in the workup of GIB, with 152,337 procedures among 113,030 patients (25%) being performed as secondary procedure. The average length was 2.4 ± 0.9 procedures per workup in procedural sequences involving multiple endoscopies. The length of workup was independent of the initial type of GIB. An EGD followed by a colonoscopy or a colonoscopy followed by an EGD were the most frequent combinations. In another substantial fraction of two consecutive procedures, the first and the second procedure were of identical type. This pattern applied not only to EGD and colonoscopy, but also to flexible sigmoidoscopy, enteroscopy, and video capsule endoscopy.

Conclusion—The majority of patients with GIB require only one type of endoscopy to manage their bleeding. However, in a quarter of patients, on average 2.4 procedures are needed. Previous trials assessing the outcomes of individual types of endoscopy may have exaggerated their overall success rates in diagnosing and treating GIB.

Keywords

colonoscopy; epidemiology; esophago-gastro-duodenoscopy; gastrointestinal bleeding; hemostasis; outcome research

Introduction

The management of gastrointestinal bleeding (GIB) is one of the most common clinical problems encountered by gastrointestinal endoscopists. The type of bleeding, such as upper vs. lower GIB, acute vs. chronic, or overt vs. covert, its accompanying symptoms and

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laboratory parameters are all used as guidance in deciding how to structure the workup and which endoscopic procedures to choose for GIB workup and its management. [1-3] In general, gastroenterologists hope to efficiently identify and treat a bleeding site by investing only one or few endoscopic procedures. Occasionally, however, a patient may undergo multiple consecutive endoscopic procedures to diagnose the cause of bleeding and achieve hemostasis. A variety of circumstances contribute to sequences involving multiple endoscopic procedures. [4-6] Lesions that bleed only intermittently are sometimes difficult to detect. Large amounts of blood inside the visceral lumen or an overlying blood clot compromise the diagnosis and treatment of a bleeding lesion. In a patient who harbors more than one potential bleeding site, the initially diagnosed lesion may not represent the true culprit for the patient's GIB. The bleeding site resides outside the reach of the initial endoscope and a different type of instrumentation is needed to diagnose or treat the GIB. Repeat endoscopy is also required if hemostasis is not achieved during the initial endoscopy or if the bleeding restarts few days later after achieving initial hemostasis. Other potential causes for lengthy sequences involving repeat endoscopy abound, but the medical literature contains little if any information about the number of endoscopies and length of workup to be expected in the average management of GIB. Accordingly, the aims of the present observational study were to examine the length of GIB workup with respect to the number of procedures and time, and to examine the consecutive utilization of different endoscopic procedures based on the initial bleeding presentation.

Methods

The Clinical Outcomes Research Initiative (CORI) Endoscopic Database was established in 1995 as a means of studying outcomes and utilization of endoscopy in a variety of practice settings. [7] Endoscopy sites include over 89 different community/private practices, academic centers, and Department of Veterans Affairs (VA) medical centers. The endoscopic reports from the participating centers are sent to the National Endoscopic Database after the patient records have been de-identified and all identifying personal information has been removed from individual patient records. Individual patients can still be traced within the database by their unique codes. Because of the use of de-identified data only, the study was granted a waiver of consent by the institutional review board at the Oregon Health & Science University.

The database from 2000 to 2014 was queried for all adult patients (18 years and older), undergoing endoscopy for any indication associated with GIB. CORI reports differentiated between the following 8 bleeding-related indications: hematemesis, hematochezia, melena, anemia, iron deficiency, positive fecal occult blood test (FOBT), suspected upper GIB, and other gastrointestinal blood loss. Endoscopies with indications other than GIB were not included in the present analysis. In instances where the indication varied among consecutive procedures, the endoscopies were grouped according to the first indication that initiated the entire workup sequence. Workup and management of known gastro-esophageal varices were not included in the present analysis. Endoscopic procedures were grouped into the following 5 categories: Esophago-gastro-duodenoscopy (EGD), colonoscopy, flexible sigmoidoscopy, enteroscopy, and video capsule endoscopy (VCE). For each indication, as well as all bleeding indications grouped together, we recorded the number of individual procedure

types, the average number (and standard deviation (SD)) of all procedures per patient, and the average length of time (and SD) of the entire endoscopic workup per individual patient, regardless of the length of time between procedures.

We also recorded the transitions between each two consecutive endoscopic procedures. A temporal sequence of N separate endoscopic procedures resulted in $N-1$ pairs of two procedures. Consider for example a sequence of procedures in a patient with hematochezia as shown below. Overall, this patient had 6 procedures and 5 transitions between each two consecutive procedures

Time (1d) Time (0d) Time (5d) Time (10d) Time (2d) with VCE terminating the sequence. Its total length with respect to procedures was 6 and with respect to time 15 days. In sequences comprising a single procedure, there are no pairs of consecutive procedures, and the initial procedure equals the terminating procedure. All transitions between various pairs of procedure types were listed in a table. This analysis was carried out separately for each indication, as well as all indications analyzed jointly.

The relationship between patient frequency and length of workup in terms of procedure count or days were assessed using bi-logarithmic regression analyses, with the independent and dependent variable both being log-transformed prior to being entered into the linear regression.

Results

The study included 451,470 patients who underwent a total of 603,807 endoscopic procedures for the workup of GIB. **Table 1** contains a stratification of all endoscopic procedures by indication and type. In declining order, hematochezia, anemia, FOBT, melena, and hematemesis were the most commonly named indications. Colonoscopy, EGD, and flexible sigmoidoscopy were by far the most commonly used procedures. As to be expected, symptoms or indications suggestive of upper GIB sites, such as hematemesis and melena were predominantly associated with EGD, whereas symptoms suggestive of lower GIB site, such as hematochezia, were predominantly associated with colonoscopy or flexible sigmoidoscopy. Workup of less specific indications, such as anemia or GI blood loss were equally associated with the usage of both, EGD and colonoscopy. Enteroscopy and VCE were most commonly used in the workup of anemia, melena, and hematochezia. In addition to such overlaying general patterns, however, it was obvious that all available procedures were utilized in the workup of all indications. For instance, an appreciable fraction of patients with hematemesis or melena also underwent EGD and, similarly, patients with hematochezia quite frequently also underwent an EGD (Table 1 and **Figure 1**).

Of all 451,470 patients with GIB, only 113,030 (25%) patients underwent more than one endoscopic procedure. Of all patients, 75.0% underwent a single procedure, 19.9% underwent two procedures, 3.3% underwent three procedures, 1.2% underwent four procedures, 0.4% underwent five procedures, etc. The patient frequencies dropped

precipitously with rising procedure counts. Using linear scales to plot patient frequency (y-axis) against procedure count (x-axis) resulted in an L-shaped hyperbola that was characterized by a steep rise along the y-axis and a long tail along the x-axis. Instead of a linear scale, the left panel of **Figure 2** uses a bi-logarithmic scale to plot patient frequency against procedure count. The alignment of the frequency distribution along a straight line is suggestive of an underlying power law. The line is approximated by logarithmic regression analysis as $y=6,020,000 \cdot x^{4.23}$ with $R^2=0.98$ and $p<0.001$. The right panel of Figure 2 shows a similar bi-logarithmic graph of patient frequency plotted against workup length measured in 30-day increments. Again, the significant ($p<0.001$) bi-logarithmic regression between patient frequency and length of workup is suggestive of an underlying power law. [8-10] As a frequent occurrence of such graphs, however, the behavior became more irregular at the far tail end (involving frequencies of less than 20 patients, which was cut-off for illustrative purposes).

The left panel of **Figure 3** contains the frequency distribution of procedure count in patients with multiple procedures only, that is, two or more endoscopies. In this graph, a logarithmic scale was used for patient frequency, but linear scales for cumulative percent of patient frequency and procedure count. Considering only the 25% fraction of procedural sequences involving multiple endoscopies, the average length was 2.4 (0.9) procedures per workup. The lengths ranged from 2 to 33 procedures, with 97% of patients undergoing 4 or fewer endoscopic procedures. Similar relationships applied to procedure counts associated with individual indications for endoscopic workup. The right panel of **Figure 3** shows the stratification of sequence lengths by the initial indication for endoscopic sequences involving multiple procedures. In terms of *procedure count*, there was little variation amongst the lengths of workup associated with different indications. The longest workups in terms of *days* were associated with hematochezia, positive FOBT, and hematemesis, the shortest ones with anemia and melena, although these differences were not significantly significant (data not shown separately).

Table 2 contains a stratification of all endoscopies of whether they were done as terminating procedure or whether they were followed by any subsequent secondary procedure. In most sequences of multiple sequential procedures, EGD was followed by a colonoscopy or, vice versa, a colonoscopy was followed by an EGD. In another substantial fraction of two consecutive procedures, the first and the second procedure were of identical type. This pattern applied not only to EGD and colonoscopy, but also flexible sigmoidoscopy, enteroscopy, and video capsule endoscopy.

In Figure 4, the data of Table 2 were additionally stratified by the 4 most common indications for the initial endoscopy. In patients with hematemesis, 71% were managed with a single initial procedure, most often EGD. In patients with hematochezia, 85% were managed with a single initial procedure, most often colonoscopy. Colonoscopy was also associated with the smallest fraction of secondary follow-up endoscopies. In patients with melena, 63% were managed with a single initial procedure, most often a colonoscopy or EGD. In 6% and 12% of patients with melena, respectively, these two procedures were performed at least twice. In patients who underwent enteroscopy and video capsule endoscopy, 12% and 3% of patients, respectively, underwent the same procedure at least

twice. Of all major indications, the workup of anemia was associated with the smallest fraction of patients who were managed with a single procedure, that is 54%. Accordingly, the fractions of secondary EGD and colonoscopy (20% and 21%, respectively), following any type of primary endoscopy, were higher than in any other indication.

Discussion

Our study utilized a large national database of endoscopic procedures to assess the length of GIB management in terms of the number of procedures, as well as the length of time from the first until the terminating endoscopy, stratified by the initial bleeding presentation. The results showed that in 3/4 of all patients only one procedure was needed to manage a GIB. EGD, colonoscopy, and flexible sigmoidoscopy were the most commonly used procedures. In patients undergoing multiple consecutive endoscopies, on average, 2.4 procedures were spent on GIB management. The average number of procedures was largely independent of the initial indication. In most endoscopic sequences involving multiple procedures, an EGD was followed by a colonoscopy or a second EGD and, vice versa, a colonoscopy was followed by an EGD or a second colonoscopy.

The database analysis of 450,000 adult patients who underwent gastrointestinal endoscopy with a bleeding indication during a 15 year period provides a bird's eye view of practice patterns in the workup of GIB. The data reported here represent the average values over many individual patients with their own distinct case histories influenced by different etiologies, medical presentations, management styles, and clinical outcomes. The data were not meant to assess appropriateness or quality of workups and whether endoscopies generally succeed or fail in managing GIB. Instead, the primary aim of the study was to paint a current picture of the clinical epidemiology and practice patterns associated with the management of GIB.

Several of the findings in our study seem to fit an expected pattern. For instance, we anticipated beforehand that EGD, colonoscopy, and flexible sigmoidoscopy would constitute the most commonly used endoscopic procedures. Similarly, it came as no surprise that in instances of multiple endoscopies, an EGD followed by a colonoscopy or a colonoscopy followed by an EGD were the most frequent combinations. Since hematemesis and melena generally suggest an upper GIB site, EGD was frequently used as the initial endoscopic procedure for both these indications. Since hematochezia generally suggests a lower GIB site, colonoscopy or flexible sigmoidoscopy were frequently used as its initial endoscopic procedures. One could also have predicted that workup of a positive FOBT would generally start with a colonoscopy. [2-3]

Although the usage of multiple consecutive endoscopic procedures in the management of GIB is not uncommon, the medical literature contains little if any information about the frequency and the characteristics of such procedural sequences. Most published studies deal with the success rates of individual procedure types in managing specific causes of GIB. [5,6,11] For instance, EGD is reported to correctly diagnose Dieulafoy's lesion in 70% of patients, or the overall diagnostic yield of video capsule endoscopy in obscure GIB is reported to be 58%. [12-13] However, because the source of bleeding is rarely known

beforehand, such information is of little help in predicting the expected length and characteristics of true GIB workups. Moreover, the existing data are biased by retrograde stratification according to the diagnostic outcome of the endoscopic workup. No publication has reported, for instance, the frequency of other procedure types following a failed EGD or colonoscopy. Moreover, the published studies have been affected by a considerable selection bias towards successful outcomes. The prior history of unsuccessful workups has remained largely unreported, and failed or aborted procedures have not been included in the final count. It is interesting to note that in a large database of endoscopic procedures, like many other natural phenomena, the true lengths of endoscopic workup for GIB follow a power law. [8-10]

A prior decision analysis tried to model the occurrence of lengthy workups caused by the limited success rates of individual endoscopic and radiographic procedures. [11] The analysis yielded an expected average length of 2.7 procedures per patient with GIB. Different from the present study, the model also considered the contributions of catheter and CT angiography, as well as nuclear scan of technetium 99m-labeled red blood cells. Because of the lack of reliable epidemiologic data, however, the decision analysis mostly relied on estimated rather than validated transition rates between two consecutive procedures. Table 2 of the present analysis provides a guide to assess the transition rates between each two procedures utilized in the management of GIB. Since this analysis was based on a large sample size from endoscopy centers distributed throughout the US, they are likely to provide a representative picture of current practice patterns.

There are several potential limitations associated with our data analysis. Since the database is restricted to endoscopic procedures, we were unable to capture any non-endoscopic procedures commonly used by nuclear medicine, interventional radiology, or surgery in the management of GIB. Because some patients may have undergone additional workup for GIB before and after being managed by a physician affiliated with CORI sites, the database may also underestimate the true number of procedures and length of time for individual workups. This is a general limitation that applies to any type of epidemiologic project utilizing electronic databases. Endoscopic procedures are generally done for diagnostic, as well as therapeutic reasons, and the distinction between the two indications and their respective outcomes are far from being clear-cut. Although it is possible to discern the indication for a procedure from the CORI database, based on the electronic record alone, it is difficult to validate the indication or assess its clinical severity. Does the hematemesis reflect on a single episode of blood tinged emesis after retching or recurrent episodes of vomiting copious amounts of bright red blood? Similarly, hematochezia could stem from hemorrhoidal bleed with minor staining of the toilet tissue or from maroon-colored stool accompanied by a marked drop in the hematocrit. Such potential imprecision in phrasing the initial indication for endoscopy, however, is inherent to all consults for endoscopy, and endoscopists struggle with such ambiguity on a daily basis. In this regard, the CORI data present a true snapshot of clinical reality, where certainty and precision regarding the indication for endoscopy are not considered absolute prerequisites for initiating a GIB workup.

These potential limitations need to be contrasted with the strengths of our study. During the past decade, the usefulness of CORI database has been proven by large number of studies

analyzing practice patterns of gastrointestinal endoscopy and the epidemiology of various gastrointestinal diseases. The CORI endoscopic database provided the unique opportunity to include a large sample of over 600,000 endoscopic procedures performed for the management of GIB during the past 15 years. The data collected from 89 individual endoscopic centers in 24 US states reflect on general practice patterns in the US and render the results applicable to most endoscopists managing patients with GIB. Using data stored in the electronic database, which utilized a standardized format to document endoscopic procedures, also eliminated various types of selection bias. All clinical records were entered into the database without prior knowledge of their future use for the present study.

In conclusion, using a large national endoscopic database to assess patterns of endoscopy in the management of gastrointestinal bleeding, our study shows that the majority of patients with GIB require only one type of endoscopy to manage their bleeding. However, in a quarter of patients, on average 2.4 procedures are needed. By ignoring unsuccessful workups and stratifying endoscopic success according to the final diagnosis, previous trials assessing the outcomes of individual types of endoscopy may have exaggerated their overall success rates in diagnosing and treating GIB.

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Figure 1.

Stratification of endoscopic procedure type by primary indication. Fe def w/o anemia, iron deficiency without anemia; FOBT, fecal occult blood test; UGIB, upper gastrointestinal bleeding; GIB loss, gastrointestinal blood loss; flex. sig., flexible sigmoidoscopy; VCE, video capsule endoscopy.

Figure 2.
Frequency distribution of procedure counts and workup lengths (in days).

Figure 3.

Left: Frequency distribution of procedure counts in patients with multiple endoscopies.

Right: Average length of endoscopic workup in terms procedure counts by primary indication among patients with multiple endoscopic procedures.

Figure 4.

Types of consecutive endoscopies performed in the workup of hematemesis, hematochezia, melena, and anemia. Fe def w/o anemia, iron deficiency without anemia; FOBT, fecal occult blood test; UGIB, upper gastrointestinal bleeding; GIB loss, gastrointestinal blood loss; termin. proc., terminal procedure; flex. sig., flexible sigmoidoscopy; VCE, video capsule endoscopy.

Table 1

Procedure counts by initial indication for workup of GIB

Indication	EGD (%)	Colonoscopy (%)	Flex. Sig. (%)	Enteroscopy (%)	VCE (%)	All procedures	All patients
Hematemesis	26,217 (89.8)	2,488 (8.5)	278 (1.0)	163 (0.6)	42 (0.1)	29,188	20,820
Hematochezia	17,371 (6.4)	226,017 (83.8)	25,251 (9.4)	588 (0.2)	468 (0.2)	269,695	230,717
Melena	31,393 (68.7)	12,078 (26.4)	513 (1.1)	1,268 (2.8)	447 (1.0)	45,699	28,957
Anemia	74,256 (47.7)	75,883 (48.7)	1,379 (0.9)	2,567 (1.6)	1,625 (1.0)	155,710	89,405
Iron deficiency	1,871 (41.3)	2,526 (55.8)	20 (0.4)	52 (1.1)	61 (1.3)	4,530	2,695
Positive FOBT	12,498 (14.8)	71,078 (84.0)	822 (1.0)	181 (0.2)	75 (0.1)	84,654	69,101
Suspected UGIB	8,858 (77.5)	2,024 (17.7)	186 (1.6)	203 (1.8)	165 (1.4)	11,436	7,417
Other GI blood loss	1,249 (43.1)	1,469 (50.7)	105 (3.6)	52 (1.8)	20 (0.7)	2,895	2,358
All indications	173,713 (28.8)	393,563 (65.2)	28,554 (4.7)	5,074 (0.8)	2,903 (0.5)	603,807	451,470

EGD, esophago-gastro-duodenoscopy; flex. Sig., flexible sigmoidoscopy; VCE, video capsule endoscopy.

Table 1

Counts and percent of endoscopic procedure pairs performed for bleeding workup

Procedure #1	Procedure #2						All
	Terminating procedure	EGD	Colonoscopy	Flexible sigmoidoscopy	Enteroscopy	Video capsule endoscopy	
EGD	103,582	16,693	49,684	1,957	924	873	173,713
Colonoscopy	319,662	47,831	20,693	2,908	1,666	803	393,563
Flexible sigmoidoscopy	23,348	919	2,824	1,406	40	17	28,554
Enteroscopy	2,759	427	1,375	55	355	103	5,074
Video capsule endoscopy	2,119	292	192	21	194	85	2,903
Procedure #1	Procedure #2						All
	Terminating procedure	EGD	Colonoscopy	Flexible sigmoidoscopy	Enteroscopy	Video capsule endoscopy	
EGD	59.6%	9.6%	28.6%	1.1%	0.5%	0.5%	100.0%
Colonoscopy	81.2%	12.2%	5.3%	0.7%	0.4%	0.2%	100.0%
Flexible sigmoidoscopy	81.8%	3.2%	9.9%	4.9%	0.1%	0.1%	100.0%
Enteroscopy	54.4%	8.4%	27.1%	1.1%	7.0%	2.0%	100.0%
Video capsule endoscopy	73.0%	10.1%	6.6%	0.7%	6.7%	2.9%	100.0%

EGD, esophago-gastro-duodenoscopy